

**SPECIFICATIONS
for the
LOGAN TOWNSHIP DPW POLE BARN
EXTENSION AND SITE IMPROVEMENTS RE-BID**

**Prepared for
Township of Logan
Gloucester County, New Jersey**

July 2022



2059 Springdale Road
Cherry Hill, NJ 08003
(856) 795-9595

RVE Project No. 08-09-T-126

Jessica D. Hauber

Jessica Hauber, P.E.
License No. 51487

07/22/22

Date

Annina M. Hogan, P.E.
License No. 43808

Date

NOTICE TO BIDDERS

PUBLIC NOTICE IS HEREBY GIVEN that sealed bids will be received by the Township of Logan for the Logan Township DPW Pole Barn Extension and Site Improvements Re-bid in the Township of Logan, Gloucester County, New Jersey.

Bid forms, contracts and specifications are available by contacting Remington & Vernick Engineers. Contact shall be made by phone or by email to make bid purchase arrangements. At 856 795 9595 or by submitting RVEbidinterest@rve.com.

Said Bids will be received, opened and read aloud in public at the Municipal Building, 125 Main Street, Bridgeport, Gloucester County, New Jersey 08014 on Thursday, August 18, 2022, at 10:00AM prevailing time.

Copies of the bid forms, contracts and specifications may be obtained from said Remington and Vernick Engineers, by prospective bidders upon request, upon payment of the sum of \$50.00 for each set.

PAYMENT MUST BE RECEIVED PRIOR TO OBTAINING SAID SPECIFICATIONS, EITHER BY MAIL OR IN PERSON.

NO BIDS ARE TO BE DROPPED OFF AT THE ENGINEER'S OFFICE.

The Township of Logan reserves the right to consider the bids for sixty (60) days after the receipt thereof, and further reserves the right to reject any or all bids, either in whole or in part and also to waive any informality in any and make such awards or take action as may be in the best interest of the Township of Logan, in accordance with applicable law.

Bids must be on the bid form prepared by Remington and Vernick Engineers, in the manner designated therein and required by the specifications, must be enclosed in sealed envelopes bearing the name and address of the bidder on the outside and also bearing on the outside reference to the particular work bid upon. Said bids shall be addressed to Linda Oswald, Clerk, Township of Logan, Municipal Building, 125 Main Street, P.O. Box 314, Bridgeport, New Jersey 08014-0314.

Each bid shall be accompanied by a certified check, cashier's check or bid bond duly executed by the bidder as principal and having as surety thereon a surety company approved by the Township of Logan in an amount not less than ten percent (10%) but in no case in excess of \$20,000.00 of the amount bid. Any such bid bond shall be without endorsement or conditions. Bid shall also be accompanied by a certificate letter from a surety company stating that it will provide the bidder with the completion bond.

The award of the contract shall be made subject to the necessary moneys to do the work being provided by the Township of Logan in a lawful manner. The contract to be executed by the successful bidder will provide that it shall not become effective until the necessary moneys to do the work have been provided by the Township of Logan in a lawful manner. The award shall further be subjected to the securing of necessary State, Federal or Local permits governing the work.

Bidders are required to comply with the requirements of N.J.S.A. 10:5-31 et seq., N.J.A.C. 17:27 (Affirmative Action), N.J.S.A. 34:11-56.25 et seq. (New Jersey Prevailing Wage Act), and Americans with Disabilities Act of 1990 (42 U.S.C. S12101, et seq.).

The contractor is further notified that he must comply with N.J.S.A. 52:25-24.2, and submit a Disclosure Statement listing stockholders with his bid.

The contractor is further notified that he must comply with N.J.S.A. 34:11-56.48 et seq. Public Works Contractor Registration Act and he and any subcontractors must be registered in accordance with the act.

The contractor is also further notified that he must comply with N.J.S.A. 52:32-44 and submit proof of business registration and submit proof of business registration for any named subcontractors in accordance with the act.

By Order of the Mayor & Council
Township of Logan
Gloucester County, New Jersey

Dated: July 22, 2022

PROPOSAL SECTION

BID DOCUMENT SUBMISSION CHECKLIST

TOWNSHIP OF LOGAN

(Name of Local Contracting Unit)

Logan Township DPW Pole Barn Extension and
Site Improvements Re-bid
(Name of Project)

0809-T-126
(Project or Bid Number)

- A. Failure to submit the following documents is a mandatory cause for the bid to be rejected.
(N.J.S.A. 40A:11-23.2)

Required with Submission of Bid (Owner's checkmarks)	Initial Each Item Submitted With Bid (Bidder's Initials)
X Bidder's acknowledgement of receipt of any notice(s) or revision(s) or addenda to an advertisement, specifications or bid document(s)	
X A statement of ownership disclosure, pursuant to <u>N.J.S.A.</u> 52:25-24.2 (Stockholders Statement)	
X A listing of subcontractors as required by <u>N.J.S.A.</u> 40A:11-16 (Subcontractor's Declaration)	
X A bid guarantee as required by <u>N.J.S.A.</u> 40A:11-21 (Bid Bond, Certified Check or Cashier's Check)	
X A certificate from a surety company, pursuant to <u>N.J.S.A.</u> 40A:11-22 (Consent of Surety)	

- B. Failure to submit the following documents may be a cause for the bid to be rejected.
(N.J.S.A. 40A:11-23.1b.)

Required with Submission of Bid (Owner's checkmarks)	Initial Each Item Submitted With Bid (Bidder's Initials)
X Public Works Contractor Registration Form	
X New Jersey "Business Registration Certificate" Form	
X Background Questionnaire	
X Debarred List Affidavit	
X Submission of a Non-Collusion Affidavit (this form must be notarized)	
X Affirmative Action Requirements	

X	Bidder Certificate showing ability to perform contract, pursuant to <u>N.J.S.A. 40A:11-20</u>	
	Disclosure of Investment Activities in Iran, pursuant to P.L. 2012, c. 25.	
	Certification on Non-Debarment for Federal Government Contracts Form, pursuant to <u>N.J.S.A. 52:32-44.1</u>	
X	Bid Form	

C. Owner's Statement with respect to N.J.S.A. 40:11-23.1c: See technical specifications whether uniformed law enforcement officers will or will not be required for traffic control.

D. SIGNATURE: The undersigned hereby acknowledges and has submitted the above listed requirements.

Name of Bidder: _____

By Authorized Representative:

Signature: _____

Print Name and Title: _____

Date: _____

Company Name: _____

Mailing Address: _____

Physical Address: _____

Phone Number : _____

Fax Number: _____

E-Mail: _____

ACKNOWLEDGEMENT OF RECEIPT OF CHANGES TO BID DOCUMENTS FORM

TOWNSHIP OF LOGAN
 (Name of Local Contracting Unit)

Logan Township DPW Pole Barn Extension and
Site Improvements Re-bid
 (Name of Project)

0809-T-126
 (Project or Bid number)

Pursuant to N.J.S.A. 40A:11-23.1a., the undersigned bidder hereby acknowledges receipt of the following notices, revisions, or addenda to the bid advertisement, specifications or bid documents. By indicating date of receipt, bidder acknowledges the submitted bid takes into account the provisions of the notice, revision or addendum. Note that the local unit's record of notice to bidders shall take precedence and that failure to include provisions of changes in a bid proposal may be subject for rejection of the bid.

Local Unit Reference Number Or Title of Addendum/Revision		How Received (mail, fax, pick-up, etc.)	Date Received	Bidder's Initials
Notice, Revision or Addenda No.	Title or Description			

Acknowledged by bidder:

Name of Bidder: _____

By Authorized Representative:

Signature: _____

Printed Name and Title: _____

Date: _____

STATEMENT OF OWNERSHIP DISCLOSURE

N.J.S.A. 52:25-24.2 (P.L. 1977, c.33, as amended by P.L. 2016, c.43)

This statement shall be completed, certified to, and included with all bid and proposal submissions. Failure to submit the required information is cause for automatic rejection of the bid or proposal.

Name of Organization: _____

Organization Address: _____

Part I Check the box that represents the type of business organization:

- Sole Proprietorship (skip Parts II and III, execute certification in Part IV)
- Non-Profit Corporation (skip Parts II and III, execute certification in Part IV)
- For-Profit Corporation (any type) Limited Liability Company (LLC)
- Partnership Limited Partnership Limited Liability Partnership (LLP)
- Other (be specific): _____

Part II

- The list below contains the names and addresses of all stockholders in the corporation who own 10 percent or more of its stock, of any class, or of all individual partners in the partnership who own a 10 percent or greater interest therein, or of all members in the limited liability company who own a 10 percent or greater interest therein, as the case may be. **(COMPLETE THE LIST BELOW IN THIS SECTION)**

OR

- No one stockholder in the corporation owns 10 percent or more of its stock, of any class, or no individual partner in the partnership owns a 10 percent or greater interest therein, or no member in the limited liability company owns a 10 percent or greater interest therein, as the case may be. **(SKIP TO PART IV)**

(Please attach additional sheets if more space is needed):

Name of Individual or Business Entity	Home Address (for Individuals) or Business Address

Part III DISCLOSURE OF 10% OR GREATER OWNERSHIP IN THE STOCKHOLDERS, PARTNERS OR LLC MEMBERS LISTED IN PART II

If a bidder has a direct or indirect parent entity which is publicly traded, and any person holds a 10 percent or greater beneficial interest in the publicly traded parent entity as of the last annual federal Security and Exchange Commission (SEC) or foreign equivalent filing, ownership disclosure can be met by providing links to the website(s) containing the last annual filing(s) with the federal Securities and Exchange Commission (or foreign equivalent) that contain the name and address of each person holding a 10% or greater beneficial interest in the publicly traded parent entity, along with the relevant page numbers of the filing(s) that contain the information on each such person. Attach additional sheets if more space is needed.

Website (URL) containing the last annual SEC (or foreign equivalent) filing	Page #'s

Please list the names and addresses of each stockholder, partner or member owning a 10 percent or greater interest in any corresponding corporation, partnership and/or limited liability company (LLC) listed in Part II other than for any publicly traded parent entities referenced above. The disclosure shall be continued until names and addresses of every noncorporate stockholder, and individual partner, and member exceeding the 10 percent ownership criteria established pursuant to N.J.S.A. 52:25-24.2 has been listed. Attach additional sheets if more space is needed.

Stockholder/Partner/Member and Corresponding Entity Listed in Part II	Home Address (for Individuals) or Business Address

Part IV Certification

I, being duly sworn upon my oath, hereby represent that the foregoing information and any attachments thereto to the best of my knowledge are true and complete. I acknowledge: that I am authorized to execute this certification on behalf of the bidder/proposer; that the <name of contracting unit> is relying on the information contained herein and that I am under a continuing obligation from the date of this certification through the completion of any contracts with <type of contracting unit> to notify the <type of contracting unit> in writing of any changes to the information contained herein; that I am aware that it is a criminal offense to make a false statement or misrepresentation in this certification, and if I do so, I am subject to criminal prosecution under the law and that it will constitute a material breach of my agreement(s) with the, permitting the <type of contracting unit> to declare any contract(s) resulting from this certification void and unenforceable.

Full Name (Print):		Title:	
Signature:		Date:	

SUBCONTRACTOR DECLARATION

Each bidder shall set forth in the bid the names, addresses and license number (when required) of each subcontractor for the furnishing of plumbing, and gas fitting and all kindred work, and of the steam power plants, steam and hot water heating and ventilating and refrigeration apparatus and all kindred work, steam power plants and kindred work, and electrical work, including any electrical power plants, tele-data, fire alarm, or security system, and structural steel and ornamental iron work, if any, for the construction, alteration or repair of any public buildings.

A general contractor that intends to utilize a specific subcontractor to perform work in one or more of the specialty trade categories shall provide the required information with regard to that subcontractor in the appropriate space for each specialty trade category applicable to the contract

Whenever a bid sets forth more than one subcontractor for any of the categories listed below, the bidder shall submit to the contracting unit a certificate signed by the bidder listing each subcontractor named in the bid for that category. The certificate shall set forth the scope of work, goods and services for which the subcontractor has submitted a price quote and which the bidder has agreed to award to each subcontractor should the bidder be awarded the contract. The certificate shall be submitted to the contracting unit simultaneously with the list of the subcontractors. The certificate may take the form of a single certificate listing all subcontractors or, alternatively, a separate certificate may be submitted for each subcontractor. If a bidder does not submit a certificate or certificates to the contracting unit, the contracting unit shall award the contract to the next lowest responsible bidder.

All bidders seeking to perform plumbing work on a publicly bid contract are required to comply with N.J.S.A. 45:14C-2 and N.J.A.C. 13:32-1.3. These provisions require that plumbing work on such contract may only be performed by an entity in which a licensed master plumber owns not less than 10% of the issued and outstanding shares of stock in the corporation, or not less than 10% of the capital of the partnership, or not less than 10% of the ownership of any other firm or legal entity. Accordingly, if a bidder intends to perform plumbing work on a publicly bid contract with its own employees or by the bidder himself, a master plumber must possess an ownership interest that complies with N.J.S.A. 45:14C-2 and N.J.A.C. 13:32-1.3 in the entity submitting the bid. Alternately, if a bidder intends to perform such work through a subcontractor, a master plumber must possess an ownership interest that complies with N.J.S.A. 45:14C-2 and N.J.A.C. 13:32-1.3 in the subcontractor.

There shall be submitted proof that each subcontractor is qualified in accordance with the rules and regulations of the State of New Jersey when such rules and regulations exist.

A general contractor that intends to perform work in one or more of the specialty trade categories through the use of its own employees or the general contractor himself rather than through the utilization of a subcontractor shall write the word “**IN-HOUSE**” next to each applicable category and then insert the name, and license number where required, of each such employee of the general contractor or the general contractor himself in the appropriate spaces for each specialty trade category applicable to the contract.

If the contract does not involve the any of the specialty trade categories below, please insert the word “**NONE**” in each appropriate space provided.

Plumbing Work: _____

Name _____ Phone # _____

Address _____

License Number: _____

Gas Fitting and All Kindred Work: _____

Name _____ Phone # _____

Address _____

License Number: _____

Certification Number (for Medical Gas Piping Installation): _____

Steam Power Plants, Steam and Hot Water Heating and Ventilating and Refrigeration Apparatus and all Kindred Work:

Name _____ Phone # _____

Address _____

License Number: _____

Electrical Work, including any Electrical Power Plants _____

Name _____ Phone # _____

Address _____

License Number: _____

Tele-data Systems: _____

Name _____ Phone # _____

Address _____

License Number: _____

Telecommunications Exemption (Provide copy of letter and ID card) Number: _____

Fire Alarm Systems: _____

Name _____ Phone # _____

Address _____

License Number: _____

Fire Protection Equipment Business or Fire Protection Contractor Business Permit Number: _____

Security Systems: _____

Name _____ Phone # _____

Address _____

License Number: _____

Structural Steel and Ornamental Iron Work:

Name _____ Phone # _____

Address _____

License Number: Not Applicable

BID SECURITY

Attach bid bond, cashier's check or certified check in the amount of 10% of the bid, but not in excess of \$20,000.00.

CONSENT OF SURETY

Attach Consent of Surety from a Surety Company, meeting the requirements, described herein, stating that if the bidder is awarded the contract that the surety company will supply the bonds for the contract.

1. Must be an irrevocable, unconditional commitment by the surety to issue on behalf of the bidder the bond or bonds set forth in the contract documents upon award of the project in the full amounts specified.
2. Must include all bonds required by the contract documents i.e. performance, labor and material payment, maintenance, environmental, etc.
3. Certificate (Consent) of Surety is not waiveable and will be considered a material defect resulting in rejection of bid if omitted from bid package.
4. Must not contain any provision that would serve to limit the surety’s liability to the “spread to second” bidder in the event the bidder fails to enter into a contract upon award.

Sample wording is as shown below:

CONSENT OF SURETY

KNOW ALL MEN BY THESE PRESENTS, that for and consideration of the sum of \$_____, lawful money of the United States of America, the receipt whereof is hereby acknowledged, paid the undersigned, and for other

SAMPLE

valuable consideration, the

_____ Insurance Company,
(Name)

(Address)

existing under the laws of the State of New Jersey and licensed to do business in the State of New Jersey certifies and agrees, that if the contract for Township of Logan for: Logan Township DPW Pole Barn Extension and Site Improvements Re-bid is awarded to
(Bidder) _____

the undersigned will execute the bond or bonds as required of the contract documents and will become Surety in the full amount set forth in the contract documents for the faithful performance of all obligations of the Bidder, provided however, that this commitment shall expire sixty (60) days from the bid opening, unless agreed upon by Bidder, Owner and Surety to be extended.

Signed, sealed and dated this _____ day of _____, 20_____ .

_____ INSURANCE COMPANY
(Name)

By _____
(Name)
Attorney in Fact

(To be accompanied by the usual proof of Authority of Officers of officers of the Surety Company to execute same)

PUBLIC WORKS CONTRACTOR REGISTRATION FORM

N.J.S.A. 34:11-56.48 requires that contractors and subcontractors, be registered with the New Jersey Department of Labor, Division of Wage and Hour Compliance. The definition in the law is as follows:

“Contractor means a person, partnership, association, joint stock company, trust, corporation, or other legal business entity or successor thereof who enters into a contract which is subject to the provisions of the “New Jersey Prevailing Wage Act, N.J.S.A. 34:11-56.25 et seq. and includes any subcontractor or lower tier subcontractor of a contractor as defined herein.”

1. All named contractors in a bid proposal (including out-of-state contractors) must be registered with the Department of Labor’s Division of Wage and Hour Compliance at the time proposals are received by the public entity.
2. All named sub-contractors must be registered with the Department of Labor pursuant to the PWCRA at the time the proposal is received, or the proposal will be determined to be non-responsive.
3. Any non-listed sub-contractor must be registered with the Department of Labor prior to physically starting work.
4. The law requires contractors to submit certificates after a bid proposal is received and prior to awarding the contract. (N.J.S.A. 34:11-56.55)
5. After bid proposals are received, and prior to contract award, the contractor must submit to the public entity copies of certifications of all listed sub-contractors.
6. Prior to the work being performed by non-listed subcontractors, the contractor must submit to the public entity copies of certifications of all non-listed subcontractors.

Please indicate below, for the bidder and all subcontractors listed on the “Subcontractor Declaration” herein, as to their registration with the NJ Department of Labor, Division of Wage and Hour Compliance in accordance with N.J.S.A. 34:11-56.48.

<u>Name</u>	<u>Not Registered</u>	<u>Registration Number</u>
Bidder _____	___	_____
(Subcontractor) _____	___	_____
(Subcontractor) _____	___	_____
(Subcontractor) _____	___	_____
(Subcontractor) _____	___	_____

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

Notary Public of _____

My Commission Expires _____, 20 ____.
(Seal)

Signature

Name and Title
(Type or Print)

NEW JERSEY "BUSINESS REGISTRATION CERTIFICATE" FORM

N.J.S.A. 52:32-44 requires that Business Organization's, be registered with the New Jersey Department of Treasury, Division Revenue. The definition in the law is as follows:

"Contractor" means a business organization that seeks to enter, or has entered into, a contract with a contracting agency;

"Contract" means any agreement, including but not limited to a purchase order or a formal agreement for the provision of goods, performance of services, or construction of a construction project, which is a legally binding relationship enforceable by law, between a contractor and a contracting agency that agrees to compensate the contractor, as defined by and subject to the terms and conditions of the agreement; and where the goods that are received, services that are delivered, and construction that is constructed is within the geographic borders of the State of New Jersey; and where:

- (1) the value of a single contract with the contractor is in excess of 15 percent of the amount of the contracting agency's bid threshold; or
- (2) when the aggregate amount of contracts with the contractor, during the fiscal year of the contracting agency, exceeds 15 percent of the amount of the contracting agency's bid threshold.

Please indicate below, for the bidder and all subcontractors listed on the "Subcontractor Declaration" herein, as to their registration with the NJ Department of Treasury, Division of Revenue in accordance with N.J.S.A. 52:32-44.

The contractor shall provide the contracting agency with the business registration certificate of the contractor and that of any named subcontractor prior to the time a contract, purchase order, or other contracting document is awarded or authorized.

<u>Name</u>	<u>Not Registered</u>	<u>Registration Number</u>
Bidder _____	_____	_____
(Subcontractor) _____	_____	_____
(Subcontractor) _____	_____	_____
(Subcontractor) _____	_____	_____
(Subcontractor) _____	_____	_____

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

Notary Public of _____

My Commission Expires _____, 20____.
(Seal)

Signature

Name and Title
(Type or Print)

BACKGROUND QUESTIONNAIRE

In accordance with paragraph entitled "Qualifications of Bidders" of "Information for Bidders", provide the following information:

Date of Organization of Company _____

Name and address of officers: _____

President _____

Vice President _____

Secretary _____

Treasurer _____

EXPERIENCE

1. How many years has your organization been in business as a general contractor under your present business name? _____

2. How many years experience in this type of construction work has your organization had? _____

3. What are the latest projects (within the last five years) your organization has completed?
(Attach additional pages if necessary)

	<u>Contract Amount</u>	<u>Date Work Completed</u>	<u>For Whom</u>
A.	\$ _____	_____	_____
B.	\$ _____	_____	_____
C.	\$ _____	_____	_____
D.	\$ _____	_____	_____
E.	\$ _____	_____	_____

Names, Addresses and Telephone Numbers of Reference for items listed above:

	<u>Name and Address</u>	<u>Telephone No.</u>
A.	_____	_____
B.	_____	_____
C.	_____	_____

Background Questionnaire

Page 2

Name and Address

Telephone No.

D. _____

E. _____

4. Have you ever failed to complete any work awarded to you (within the last ten years)? _____
If so, where and why? _____

5. Have you or has any officer of your organization ever been an officer or partner of some other contracting organization that failed to complete any work (within the last ten years) ? _____
If so, state the name of individual, position and the name of the other organization

Did this other contracting organization ever fail to complete any work awarded it (within the last ten years)? _____
If so, where and why? _____

6. Give list of uncompleted contracts at present held by you:

<u>Name of Contract</u>	<u>Contracting Agency</u>	<u>Amount</u>
_____	_____	\$ _____
_____	_____	\$ _____
_____	_____	\$ _____

<u>Name of Contract</u>	<u>Contracting Agency</u>	<u>Amount</u>
_____		\$ _____
_____		\$ _____

7. State approximately the largest amount of work you have done in any one year (within the last five years) of a similar nature to the work being bid on.

8. List the equipment available for the performance of work under the proposed contract (attach additional sheets if necessary)

DEBARRED LIST AFFIDAVIT

STATE OF New Jersey

COUNTY OF _____

ss:

I, _____ of the City/Town/Township/Borough, etc. _____ in the County of _____ and the State of _____ full age, being duly sworn according to law on my oath depose and say that:

I am _____ an officer of the firm of _____ the bidder making the bid for the above named work, and that I executed said bid with full authority to do so; that said bidder at the time of making of this bid is not debarred at the federal level from contracting with a federal government agency as indicated in N.J.S.A. 52:32-44.1 or included on the State of New Jersey, State Treasurer’s List of Debarred, Suspended and Disqualified Bidders; and that all statements contained in said bid and in this affidavit are true and correct, and made with the full knowledge that the TOWNSHIP OF LOGAN ,

(name of the contracting agency)

as the Owner relies upon the truth of the statements contained in said bid and in the statements contained in this affidavit in awarding the contract for said work.

The undersigned further warrants that should the name of the firm making this bid be debarred at the federal level from contracting with a federal government agency or appear on the State Treasurer’s List of Debarred, Suspended and Disqualified Bidders at anytime prior to, and during the life of this Contract, including Guarantee Period, that the Local Unit shall be immediately so notified by the signatory of this Eligibility Affidavit.

The undersigned understands that the firm making the bid as Contractor is subject to debarment, suspension and/or disqualification in contracting with the State of New Jersey, if the Contractor, pursuant to N.J.A.C. 12:60-7.1 et seq., commits any of the acts listed therein, and as determined according to applicable law and regulation.

(Insert Name, Telephone No., Fax No. and Address of Contractor)

(Insert Name and Title of Affiant)

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

Notary Public of _____

My Commission Expires _____ , 20 ____.
(Seal)

NON-COLLUSION AFFIDAVIT

STATE OF New Jersey

COUNTY OF _____

ss:

I, _____ of the (City, Town, Township, Borough, etc.)

of _____ in the County of _____ and the

State of _____, of full age, being duly sworn

according to law on my oath depose and say that:

I am _____ of the firm of _____

the bidder making the Proposal for the above named project, and that I executed the said Proposal with full authority to do so; that said bidder had not, directly or indirectly, entered into any agreement(s), participated in any collusion, or otherwise taken any action in restraint of free, competitive bidding in connection with the above named project; and that all statements contained in said Proposal and in this affidavit are true and correct, and made with full knowledge that the TOWNSHIP OF LOGAN relies upon the truth of the statements

(name of contracting agency)

contained in said Proposal and in this affidavit in awarding the contract for the said Project.

I further warrant that no person(s) or selling agency has been employed or retained to solicit, or secure such contract upon an agreement or understanding for a commission, percentage, brokerage or contingent, fee except bona fide employees or bona fide established commercial or selling agencies maintained by

(name of bidder)

(Insert Name, Telephone No., Fax No. and Address of Contractor)

(Insert Name and Title of Affiant)

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

Notary Public of _____

My Commission Expires _____, 20 ____.
(Seal)

AFFIRMATIVE ACTION REQUIREMENTS

CONSTRUCTION CONTRACTS

“Bidder is required to comply with the requirements of N.J.S.A. 10:5-31 et seq. and N.J.A.C. 17:27.

1. All successful contractor(s) must submit, to the agencies named below, after notification of award but prior to the signing of the contract an Initial Project Workforce Report (Form AA201) for any contract award that meets or exceeds the Public Agency bidding threshold.
2. The successful contractor(s) must submit the appropriate copies of the Initial Project Workforce Report (Form AA201) to the Division of Contract Compliance and the appropriate copy to the Public Agency.
3. The successful contractor(s) must submit a copy of the Monthly Workforce Report (Form AA 202) once a month thereafter for the duration of this contract to the Division and to the public agency compliance officer.

The undersigned certifies that he/she is aware of the commitment to comply with the requirements of N.J.S.A. 10:5-31 et seq. and N.J.A.C. 17:27 and agrees to furnish the required forms of evidence.

The undersigned further understands that his/her bid may be rejected as non-responsive if the requirements of N.J.S.A. 10:5-31 et seq. and N.J.A.C. 17:27 are not complied with.

(Insert Name, Telephone No., Fax No. and Address of Contractor)

(Insert Name and Title of Affiant)

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

Notary Public of _____

My Commission Expires _____ , 20 ____.
(Seal)

CERTIFICATE OF BIDDER SHOWING ABILITY TO PERFORM CONTRACT

STATE OF New Jersey

COUNTY OF _____

ss:

I, _____ of the (City, Town, Township, Borough, etc.)
of _____ in the County of _____ and the
State of _____ of full age, being duly sworn
according to law on my oath depose and say that:

- 1. I am a(n) owner, partner, shareholder or officer of the company set forth below and am duly authorized to execute this affidavit on its behalf.

(Check appropriate Statement(s))

_____ I own, lease or control the necessary equipment required by the plans, specifications, and advertisements under which bids are asked for.

_____ I do not own, lease or control all the necessary equipment required by the plans, specifications, and advertisements under which bids are asked for.
If the bidder is not the actual owner or lessee of all the necessary equipment provide the source from which the equipment will be obtained (Attach additional sheets if necessary)

(Attach certification from the owner or person in control of the equipment definitely granting to the bidder the control of the equipment required during such time as may be necessary for the completion of that portion of the contract for which it is necessary)

(Insert Name, Telephone No., Fax No. and Address of Contractor)

(Insert Name and Title of Affiant)

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

Notary Public of _____

My Commission Expires _____, 20 ____.
(Seal)

DISCLOSURE OF INVESTMENT ACTIVITIES IN IRAN

PART 1: CERTIFICATION

BIDDERS MUST COMPLETE PART 1 BY CHECKING EITHER BOX.

In accordance with Public Law 2012, c. 25, any person or entity that submits a bid or proposal or otherwise proposes to enter into or renew a contract must complete the certification below to attest, under penalty of perjury, that neither the person or entity, nor any of its parents, subsidiaries, or affiliates, is identified on the Department of Treasury’s Chapter 25 list as a person or entity engaging in investment activities in Iran.

The Chapter 25 list is found on the Division’s website at <http://www.state.nj.us/treasury/purchase/pdf/Chapter25List.pdf>. Bidders **must** review this list prior to completing the below certification. **This certification shall be completed, certified to, and submitted to the contracting unit prior to contract award.** If the Director finds a person or entity to be in violation of law, s/he shall take action as may be appropriate and provided by law, rule or contract, including but not limited to, imposing sanctions, seeking compliance, recovering damages, declaring the party in default and seeking debarment or suspension of the party.

PLEASE CHECK EITHER BOX:

I certify, pursuant to Public Law 2012, c. 25, that neither the person/entity listed below nor any of the entity’s parents, subsidiaries, or affiliates is listed on the N.J. Department of the Treasury’s list of entities determined to be engaged in prohibited activities in Iran pursuant to P.L. 2012, c. 25 (“Chapter 25 List”). I further certify that I am the person listed below, or I am an officer or representative of the entity listed below and am authorized to make this certification on its behalf. **I will skip Part 2 and sign and complete the Certification**

OR

I am unable to certify as above because I or the bidding entity and/or one or more of its parents, subsidiaries, or affiliates is listed on the Department’s Chapter 25 list. I will provide a detailed, accurate and precise description of the activities in Part 2 below and sign and complete the Certification below. Failure to provide such will result in the proposal being rendered as non-responsive and appropriate penalties, fines and/or sanctions will be assessed as provided by law.

Part 2

PLEASE PROVIDE FURTHER INFORMATION RELATED TO INVESTMENT ACTIVITIES IN IRAN

You must provide a detailed, accurate and precise description of the activities of the bidding person/entity, or one of its parents, subsidiaries or affiliates, engaging in the investment activities in Iran outlined above by completing the boxes below.

PROVIDE INFORMATION RELATIVE TO THE ABOVE QUESTIONS. PLEASE PROVIDE THOROUGH ANSWERS TO EACH QUESTION. IF YOU NEED TO MAKE ADDITIONAL ENTRIES, USE ADDITIONAL PAGES

Name: _____

Relationship to Bidder/Vendor: _____

Description of Activities:

Duration of Engagement: _____ Anticipated Cessation Date _____

Bidder/Vendor _____

Contact Name: _____ Contact Phone Number: _____

Certification: I, being duly sworn upon my oath, hereby represent and state that the foregoing information and any attachments thereto to the best of my knowledge are true and complete. I attest that I am authorized to execute this certification on behalf of the below-referenced person or entity. I acknowledge that the TOWNSHIP OF LOGAN is relying on the information contained herein and thereby acknowledge that I am under a continuing obligation from the date of this certification through the completion of contracts with the TOWNSHIP OF LOGAN to notify the TOWNSHIP OF LOGAN in writing of any changes to the answers of information contained herein. I acknowledge that I am aware that it is a criminal offense to make a false statement or misrepresentation in this certification, and if I do so, I recognize that I am subject to criminal prosecution under the law and that it will also constitute a material breach of my agreements(s) with the TOWNSHIP OF LOGAN and that the TOWNSHIP OF LOGAN at its option may declare any contract(s) resulting from this certification void and unenforceable.

Full Name (Print): _____ Signature: _____

Title: _____ Date: _____

Bidder/Vendor: _____

**CERTIFICATION OF NON-DEBARMENT
FOR FEDERAL GOVERNMENT CONTRACTS**

N.J.S.A. 52:32-44.1 (P.L. 2019, c.406)

This certification shall be completed, certified to, and submitted to the contracting unit prior to contract award, except for emergency contracts where submission is required prior to payment.

PART I: VENDOR INFORMATION	
Individual or Organization Name	
Address of Individual or Organization	
DUNS Code (if applicable)	
CAGE Code (if applicable)	
Check the box that represents the type of business organization:	

- Sole Proprietorship (skip Parts III and IV)
 Non-Profit Corporation (skip Parts III and IV)
 For-Profit Corporation (any type)
 Limited Liability Company (LLC)
 Partnership
 Limited Partnership
 Limited Liability Partnership (LLP)
 Other (be specific): _____

PART II – CERTIFICATION OF NON-DEBARMENT: Individual or Organization			
<p>I hereby certify that the individual or organization listed above in Part I is not debarred by the federal government from contracting with a federal agency. I further acknowledge: that I am authorized to execute this certification on behalf of the above-named organization; that the <i><name of contracting unit></i> is relying on the information contained herein and that I am under a continuing obligation from the date of this certification through the date of contract award by <i><type of contracting unit></i> to notify the <i><type of contracting unit></i> in writing of any changes to the information contained herein; that I am aware that it is a criminal offense to make a false statement or misrepresentation in this certification, and if I do so, I am subject to criminal prosecution under the law and that it will constitute a material breach of my agreement(s) with the <i><type of contracting unit></i>, permitting the <i><type of contracting unit></i> to declare any contract(s) resulting from this certification void and unenforceable.</p>			
Full Name (Print):		Title:	
Signature:		Date:	

PART III – CERTIFICATION OF NON-DEBARMENT: Individual or Entity Owning Greater than 50 Percent of Organization

Section A (Check the Box that applies)

<input type="checkbox"/>	Below is the name and address of the stockholder in the corporation who owns more than 50 percent of its voting stock, or of the partner in the partnership who owns more than 50 percent interest therein, or of the member of the limited liability company owning more than 50 percent interest therein, as the case may be.
--------------------------	---

Name of Individual or Organization	
---	--

Home Address (for Individual) or Business Address	
--	--

OR

<input type="checkbox"/>	No one stockholder in the corporation owns more than 50 percent of its voting stock, or no partner in the partnership owns more than 50 percent interest therein, or no member in the limited liability company owns more than 50 percent interest therein, as the case may be.
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Section B (Skip if no Business entity is listed in Section A above)

<input type="checkbox"/>	Below is the name and address of the stockholder in the corporation who owns more than 50 percent of the voting stock of the organization’s parent entity, or of the partner in the partnership who owns more than 50 percent interest in the organization’s parent entity, or of the member of the limited liability company owning more than 50 percent interest in organization’s parent entity, as the case may be.
--------------------------	---

Stockholder/Partner/Member Owning Greater Than 50 Percent of Parent Entity	
---	--

Home Address (for Individual) or Business Address	
--	--

OR

<input type="checkbox"/>	<p>No one stockholder in the parent entity corporation owns more than 50 percent of its voting stock, no partner in the parent entity partnership owns more than 50 percent interest therein, or no member in the parent entity limited liability company owns more than 50 percent interest therein, as the case may be.</p>
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Section C – Part III Certification

I hereby certify that no individual or organization that is debarred by the federal government from contracting with a federal agency owns greater than 50 percent of the **Organization listed above in Part I** or, if applicable, owns greater than 50 percent of a parent entity of _____.
(name of organization)

I further acknowledge: that I am authorized to execute this certification on behalf of the above-named organization; that the *<name of contracting unit>* is relying on the information contained herein and that I am under a continuing obligation from the date of this certification through the date of contract award *<type of contracting unit>* to notify the *<type of contracting unit>* in writing of any changes to the information contained herein; that I am aware that it is a criminal offense to make a false statement or misrepresentation in this certification, and if I do so, I am subject to criminal prosecution under the law and that it will constitute a material breach of my agreement(s) with the *<type of contracting unit>*, permitting the *<type of contracting unit>* to declare any contract(s) resulting from this certification void and unenforceable.

Full Name (Print):		Title:	
Signature:		Date:	

Part IV – CERTIFICATION OF NON-DEBARMENT: Contractor – Controlled Entities

Section A

<input type="checkbox"/>	<p>Below is the name and address of the corporation(s) in which the Organization listed in Part I owns more than 50 percent of voting stock, or of the partnership(s) in which the Organization listed in Part I owns more than 50 percent interest therein, or of the limited liability company or companies in which the Organization listed above in Part I owns more than 50 percent interest therein, as the case may be.</p>
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Name of Business Entity	Business Address

Add additional sheets if necessary

OR	
<input type="checkbox"/>	The Organization listed above in Part I does not own greater than 50 percent of the voting stock in any corporation and does not own greater than 50 percent interest in any partnership or any limited liability company.

Section B (skip if no business entities are listed in Section A of Part IV)	
<input type="checkbox"/>	Below are the names and addresses of any entities in which an entity listed in Part III A owns greater than 50 percent of the voting stock (corporation) or owns greater than 50 percent interest (partnership or limited liability company).
Name of Business Entity Controlled by Entity Listed in Section A of Part IV	Business Address
Add additional Sheets if necessary	

OR	
<input type="checkbox"/>	No entity listed in Part III A owns greater than 50 percent of the voting stock in any corporation or owns greater than 50 percent interest in any partnership or limited liability company.

Section C – Part IV Certification			
<p>I hereby certify that the Organization listed above in Part I does not own greater than 50 percent of any entity that that is debarred by the federal government from contracting with a federal agency and, if applicable, does not own greater than 50 percent of any entity that in turns owns greater than 50 percent of any entity debarred by the federal government from contracting with a federal agency. I further acknowledge: that I am authorized to execute this certification on behalf of the above-named organization; that the <i><name of contracting unit></i> is relying on the information contained herein and that I am under a continuing obligation from the date of this certification through the date of contract award by <i><type of contracting unit></i> to notify the <i><type of contracting unit></i> in writing of any changes to the information contained herein; that I am aware that it is a criminal offense to make a false statement or misrepresentation in this certification, and if I do so, I am subject to criminal prosecution under the law and that it will constitute a material breach of my agreement(s) with the <i><type of contracting unit></i>, permitting the <i><type of contracting unit></i> to declare any contract(s) resulting from this certification void and unenforceable.</p>			
Full Name (Print):		Title:	
Signature:		Date:	

BID FORM

Pursuant to and in compliance with your Advertisement for Bids and the Information for Bidders relating thereto, the undersigned hereby offers to furnish all plant, labor, materials, supplies, equipment and other facilities and things necessary for, or proper for, or incidental to the LOGAN TOWNSHIP DPW MUNICIPAL GARAGE EXTENSION AND SITE IMPROVEMENTS - REBID, as required by, and in strict accordance with the applicable provisions of plans and specifications and all addenda issued by the Logan Township or its Engineer prior to the date of opening the bids, whether received by the undersigned or not, for the amount bid based on the following unit and/or lump-sum prices:

NOTE: Extension of Unit Prices must be exact.

BASE BID

<u>Item</u>	<u>Quantity</u>	<u>Units</u>	<u>Description</u>	<u>Unit Price</u>	<u>Amount</u>
1	935	LF	SILT FENCE	\$ _____	\$ _____
2	9	UN	INLET PROTECTION	\$ _____	\$ _____
3	7540	CY	EXCAVATION, UNCLASSIFIED	\$ _____	\$ _____
4	1	LS	CLEARING SITE		\$ _____
5	0	--	NO ITEM		
6	1	DOL	FUEL PRICE ADJUSTMENT		\$19,500.00

Item	Quantity	Units	Description	Unit Price	Amount
7	1	DOL	ASPHALT PRICE ADJUSTMENT		<u>\$9,500.00</u>
8	2016	SY	GEOTEXTILE FABRIC (STORMWATER BASIN STABILIZATION)	<u>\$</u>	<u>\$</u>
9	2305	CY	BASIN SAND, K4 SAND	<u>\$</u>	<u>\$</u>
10	650	CY	I-13 SOIL AGGREGATE, IF & WHERE DIRECTED	<u>\$</u>	<u>\$</u>
11	8742	SY	DENSE GRADED AGGREGATE, 6" THICK	<u>\$</u>	<u>\$</u>
12	70	SY	DENSE GRADED AGGREGATE, 12" THICK	<u>\$</u>	<u>\$</u>
13	790	SY	HMA MILLING, 3" OR LESS	<u>\$</u>	<u>\$</u>
14	50	SY	HOT MIX ASPHALT PAVEMENT REPAIR, IF & WHERE DIRECTED	<u>\$</u>	<u>\$</u>
15	2425	GAL	PRIME COAT	<u>\$</u>	<u>\$</u>

Item	Quantity	Units	Description	Unit Price	Amount
16	1335	GAL	TACK COAT	\$ _____	\$ _____
17	1940	TONS	HOT MIX ASPHALT 19M64 BASE COURSE, 4" THICK	\$ _____	\$ _____
18	0	--	NO ITEM		
19	1065	UN	HOT MIX ASPHALT 9.5M64 SURFACE COURSE, 2" THICK	\$ _____	\$ _____
20	0	--	NO ITEM		
21	6	UN	INLET TYPE 'E'	\$ _____	\$ _____
22	200	LF	12" REINFORCED CONCRETE PIPE, CLASS IV	\$ _____	\$ _____
23	180	LF	2" HIGH DENSITY POLYETHYLENE, SDR-9, SANITARY PIPE	\$ _____	\$ _____
24	210	LF	18" REINFORCED CONCRETE PIPE, CLASS III	\$ _____	\$ _____

Item	Quantity	Units	Description	Unit Price	Amount
25	565	LF	24" REINFORCED CONCRETE PIPE, CLASS III	\$ _____	\$ _____
26	500	LF	2" HIGH DENSITY POLYETHYLENE PIPE WATER SERVICE	\$ _____	\$ _____
27	55	SY	CONCRETE PAD, 6" THICK	\$ _____	\$ _____
28	50	SY	CONCRETE SIDEWALK, 4" THICK	\$ _____	\$ _____
29	310	LF	9"x18" STEEL FACED CONCRETE VERTICAL CURB	\$ _____	\$ _____
30	1790	UN	CHAIN-LINK FENCE, PVC-COATED STEEL, 6' HIGH	\$ _____	\$ _____
31	2	UN	CHAIN-LINK FENCE, AUTOMATIC GATE, PVC-COATED STEEL, 25' WIDE	\$ _____	\$ _____
32	20	SF	REGULATORY AND WARNING SIGNS	\$ _____	\$ _____
33	900	LF	TRAFFIC MARKINGS, LINES, 4" WIDE	\$ _____	\$ _____

<u>Item</u>	<u>Quantity</u>	<u>Units</u>	<u>Description</u>	<u>Unit Price</u>	<u>Amount</u>
34	0	LF	NO ITEM		
35	285	SF	TRAFFIC MARKING SYMBOLS	\$ _____	\$ _____
36	65	SY	RIP RAP STONE PROTECTION, 12" THICK (D50=6")	\$ _____	\$ _____
37	10	UN	CONCRETE WHEEL STOP	\$ _____	\$ _____
38	20	CY	CONCRETE HEADWALL	\$ _____	\$ _____
39	0	--	NO ITEM		
40	0	--	NO ITEM		
41	515	CY	BORROW TOPSOIL	\$ _____	\$ _____
42	3675	SY	TOPSOIL SPREADING, 5" THICK	\$ _____	\$ _____
43	3675	SY	FERTILIZING AND SEEDING, TYPE A-3	\$ _____	\$ _____

Item	Quantity	Units	Description	Unit Price	Amount
44	3675	SY	STRAW MULCHING	\$ _____	\$ _____
45	60	UN	6" DIAMETER CONCRETE BOLLARD	\$ _____	\$ _____
46	1	UN	DIESEL EXHAUST FLUID SYSTEM	\$ _____	\$ _____
47	2	UN	DOUBLE SIDED HIGH FLOW FUEL DISPENSER WITH DUAL HOSES	\$ _____	\$ _____
48	1	UN	FUEL MANAGEMENT SYSTEM POS	\$ _____	\$ _____
49	2	UN	5,000 GALLON FUEL STORAGE TANK	\$ _____	\$ _____
50	90	LF	DOUBLE CONTAINMENT FUEL PIPING	\$ _____	\$ _____
51	2	UN	TRANSITION SUMP PUMP	\$ _____	\$ _____
52	2	UN	STEEL ACCESS STAIRS WITH LANDING	\$ _____	\$ _____

Item	Quantity	Units	Description	Unit Price	Amount
53	1	UN	ELECTRICAL PANEL FOR FUELING SYSTEM	\$ _____	\$ _____
54	435	SY	CONCRETE FUELING PAD, 1'-0" THICK	\$ _____	\$ _____
55	1	UN	FUEL MONITORING PANEL	\$ _____	\$ _____
56	1	UN	3.6'x9' 350 GALLON OIL/WATER SEPARATOR, INCLUSIVE OF ALL ASSOCIATED PIPING, CLEAN OUTS AND ACCESSORIES UP TO AND EXCLUDING CONNECTION TO NEW PUMP STATION CONNECTION	\$ _____	\$ _____
57	1	UN	SANITARY SEWER PUMP STATION, 3' DIAMETER FIBERGLASS, COMPLETE	\$ _____	\$ _____
58	350	LF	4" PVC, SDR 35, SANITARY PIPE	\$ _____	\$ _____
59	2	UN	INSTALLATION OF POLE PARN, COMPLETE, EXCLUSIVE OF ITEMS WITHIN ADD ALTERNATES	\$ _____	\$ _____

Item	Quantity	Units	Description	Unit Price	Amount
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60	1	LS	INSTALLATION OF WASH BAY SYSTEM IN GARAGE #2, INCLUSIVE OF FINISH PLUMBING, 6" TRENCH DRAIN, HOSE REEL AND POWER WASHER, COMPLETE		\$
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61	1	LS	ROUGH-IN PLUMBING WORK - GARAGE #2		\$
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62	1	LS	EXTRA WORK ALLOWANCE		\$50,000.00
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63	1	LS	UTILITY ALLOWANCE		\$20,000.00
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TOTAL CONSTRUCTION COST, BASE BID Items #1
 - #63, Inclusive

\$

TOTAL AMOUNT BID WRITTEN OUT

SIGNATURE **NAME & TITLE**

BID DATE **COMPANY NAME**

Item	Quantity	Units	Description	Unit Price	Amount
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ALTERNATIVE ADD OPTIONS

Item	Quantity	Units	Description	Unit Price	Amount
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A1	1	LS	PROVIDE AND INSTALL NEW INTERIOR METAL STUD/GWB WALLS, DOORS AND FRAMES FOR GARAGE #2		\$ _____
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A2	1	LS	PROVIDE AND INSTALL PLUMBING FIXTURES, FINISHES, AND TOILET & SHOWER ROOM ACCESSORIES, COMPLETE IN GARAGE #2		\$ _____
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A3	1	LS	PROVIDE AND INSTALL FINISHES, CABINETS, AND LOCKERS, COMPLETE IN GARAGE #2		\$ _____
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A4	1	LS	PROVIDE AND INSTALL 6" THICK POURED REINFORCED CONCRETE SLAB AND SURROUNDING BUILDING SIDEWALK/DRIVEWAYS FOR NEW GARAGE BUILDINGS		\$ _____
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A5	1	LS	MECHANICAL & GAS PIPING WORK FOR NEW GARAGE, COMPLETE		\$ _____
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A6	1	LS	PROVIDE AND INSTALL ELECTRICAL SERVICE, PANEL AND POWER TO NEW GARAGE BUILDINGS		\$ _____
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Item	Quantity	Units	Description	Unit Price	Amount
A7	1	LS	PROVIDE AND INSTALL ELECTRICAL WORK INCLUSIVE BUT NOT LIMITED TO: ELECTRICAL CONVENIENCE RECEPTACLES, BUILDING LIGHTING, POWER EQUIPMENT, ETC., COMPLETE FOR NEW GARAGE BUILDINGS		\$ _____
A8	1	LS	PROVIDE AND INSTALL EMERGENCY GENERATOR AND SERVICE/COMISSION, COMPLETE		\$ _____
A9	1	LS	EXTRA WORK ALLOWANCE		\$ 20,000.00

CRITERIA FOR EVALUATION OF BIDS:

1. Base Bids shall be evaluated independently of each other.
2. Owner shall evaluate bids for the lowest responsible bidder for any base bid or any base bid plus any combination of selected alternate addition or deductions.
3. Selection of alternate bid addition or deduction options shall be evaluated on the basis of price as it fits into the project budget as well as the anticipated worth of the alternate bid addition or deduction option.
4. All bids shall be reviewed in conjunction with P.L. 2009, c.292.

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INFORMATION FOR BIDDERS

1.0 BID PREPARATION

1.01 EXAMINATION AND RESPONSIBILITY

Bidders are directed to examine for themselves the drawings, specifications, estimated quantities and the location of the proposed work. They shall exercise their own judgment as to the scope and nature of the work; the difficulties to be encountered and the quantities that may actually be encountered in the work. Each bidder is fully responsible for having reviewed and understood these specifications previous to submitting his bid, that his bid covers and complies with all requirements of the Contract Documents, and shall not at any time thereafter assert any claim related to any misunderstanding of the nature or amount of work to be done.

1.02 CONDITION OF WORK

Each bidder must inform himself fully of the conditions relative to the construction under which the work is now being or will be performed. Failure to do so will not relieve a successful bidder of his obligation to furnish all materials and labor necessary to carry out the provisions of the contract documents and to complete the contemplated work for the construction as set forth in his bid. The Contractor in the carrying out of his work must employ such methods or means that will not cause any interruptions or interference with the work of any other contractor (if applicable).

1.03 OBLIGATIONS OF BIDDERS

At the time of the opening of bids each bidder will be presumed to have inspected the site and to have read and to be thoroughly familiar with the drawings and contract documents (including all addenda). The failure or omission of any bidder to receive or examine any form, instrument or documents, shall in no way relieve any bidder from any obligations contained therein.

1.04 ADDENDA, BID SPECIFICATION CHALLENGES AND INTERPRETATIONS

The Table of Contents indicates the number of pages of each section of the document. If any bidder finds that a page was miss-copied or is missing, please contact the Engineer. The page(s) will be faxed to the bidder. Issuance of any such pages will not be considered an Addendum to the contract or specifications.

No interpretations of the meaning of the drawings, specifications or other contract documents will be made to any bidder orally. Every request for such interpretation should be made in writing, addressed to the Engineer, and to be given consideration, must be received at least ten (10) days prior to the final date fixed for receiving bids. Any and all such interpretations and/or supplemental instructions will be in the form of written addenda to the specifications, which if issued, will be issued in accordance with applicable State Laws.

Any bidder who wishes to challenge a bid specification shall file such challenges in writing with the Engineer no less than three business days prior to the opening of the bids. Challenges filed after that time shall be considered void and having no impact on the contracting unit or the award of a contract.

Failure of any bidder to receive any such addendum or interpretations shall not relieve any bidder from any such obligations therein under his bid submitted. All addenda so issued shall become part of the contract documents, and shall be attached to the bid form when submitted

1.05 QUALIFICATIONS OF BIDDERS

The owner may make such investigation as is necessary to determine the responsibility of the bidder and/or the ability of the bidder to perform the work. The bidder shall furnish to the Owner all such information and data for this purpose as the Owner may request. The Owner reserves the right to reject any bid if evidence submitted by, or investigation of, such bidder fails to satisfy the Owner that said bidder is responsible or properly qualified to carry out the obligations of the contract and to complete the work therein contemplated.

Conditional bids will not be accepted. Bids which are incomplete or obscure may be rejected at Owner's option.

1.06 DISCLOSURE STATEMENT N.J.S.A. 52:25-24.2

No corporation, partnership, or limited liability company shall be awarded any contract nor shall any agreement be entered into for the performance of any work or the furnishing of any materials or supplies, the cost of which is to be paid with or out of any public funds, by the State, or any county, municipality or school district, or any subsidiary or agency of the State, or of any county, municipality or school district, or by any authority, board, or commission which exercises governmental functions, unless prior to the receipt of the bid or accompanying the bid, of said corporation, said partnership, or said limited liability company there is submitted a statement setting forth the names and addresses of all stockholders in the corporation who own 10 percent or more of its stock, of any class, or of all individual partners in the partnership who own a 10 percent or greater interest therein, or of all members in the limited liability company who own a 10 percent or greater interest therein, as the case may be. If one or more such stock holder or partner or member is itself a corporation or partnership or limited liability company, the stockholders holding 10 percent or more of that corporation's stock, or the individual partners owning 10 percent or greater interest in that partnership, or the members owning 10 percent or greater interest in that limited liability company, as the case may be, shall also be listed. The disclosure shall be continued until names and addresses of every noncorporate stockholder, and individual partner, and member, exceeding the 10 percent ownership criteria established in this act, has been listed.

To comply with this section, a bidder with any direct or indirect parent entity which is publicly traded may submit the name and address of each publicly traded entity and the name and address of each person that holds a 10 percent or greater beneficial interest in the publicly traded entity as of the last annual filing with the federal Securities and Exchange Commission or the foreign equivalent, and, if there is any person that holds a 10 percent or greater beneficial interest, also shall submit links to the websites containing the last annual filings with the federal Securities and Exchange Commission or the foreign equivalent and the relevant page numbers of the filings that contain the information on each person that holds a 10 percent or greater beneficial interest.

1.07 MANUFACTURED ARTICLES

In the specifications and on accompanying drawings, there are specified and shown certain pieces of equipment and materials, deemed most suitable for the service anticipated. This is not done, however, to eliminate other equipment and materials equally as good and efficient. When a bidder submits an equivalent, it shall be the responsibility of the bidder to document the equivalence claim. Failure to submit such documentation shall be grounds for the rejection of the claim of equivalence. The bidder shall prepare his bid on the basis of the particular equipment and materials specified or shown, and shall be responsible for the coordination, arrangement and location of all equipment and material incorporated in the work.

1.08 BID SECURITY AND CONSENT OF SURETY

Each bid shall be accompanied by a Certified Check, Cashier's Check or Bid Bond duly executed by the bidder as principal, and having as surety thereon a Surety Company approved by the Owner, in an amount not less than ten percent (10%) of the amount bid but in no case in excess of \$20,000.00. Any such Bid Bond shall be without endorsement or conditions. Bid shall also be accompanied with a certificate letter from a surety company stating that it will provide the bidder with the requisite completion performance and payment bonds, i.e. a Consent of Surety.

Such bid guarantee will be returned to all bidders, except to the three apparent lowest responsible bidders, within ten days after the formal opening of bids, Sundays and holidays, excepted.

The bid guarantee will be returned to the remaining unsuccessful bidders within three days, Sundays and holidays excepted, after the Owner and the accepted bidder have executed the contract and the Owner has approved the Bidder's Performance Bond, or if no contract has been accepted within 60 days after the date of opening of bids, any bidder upon demand made after the expiration of said 60 day period, shall be entitled to the return of his bid guarantee, so long as he has not been notified by the Owner of the acceptance of his bid.

Any such bid guarantee shall be forfeited and become the property of the Owner if the bidder whose bid is accepted shall fail: to give a satisfactory performance bond and labor and material payment bond, or a combination performance and labor and material payment bond, and/or fails to execute a contract within ten (10) days after notice from the Owner to do so.

1.09 NEW JERSEY BUSINESS REGISTRATION REQUIREMENTS

Pursuant to N.J.S.A. 52:32-44, Contracting Agency is prohibited from entering into a contract with an entity unless the bidder/proposer/contractor, and each subcontractor that is required by law to be named in a bid/proposal/contract has a valid Business Registration Certificate on file with the Division of Revenue and Enterprise Services within the Department of the Treasury.

Prior to contract award or authorization, the contractor shall provide the Contracting Agency with its proof of business registration and that of any named subcontractor(s).

Subcontractors named in a bid or other proposal shall provide proof of business registration to the bidder, who in turn, shall provide it to the Contracting Agency prior to the time a contract, purchase order, or other contracting document is awarded or authorized.

During the course of contract performance:

- (1) the contractor shall not enter into a contract with a subcontractor unless the subcontractor first provides the contractor with a valid proof of business registration.
- (2) the contractor shall maintain and submit to the Contracting Agency a list of subcontractors and their addresses that may be updated from time to time.
- (3) the contractor and any subcontractor providing goods or performing services under the contract, and each of their affiliates, shall collect and remit to the Director of the Division of Taxation in the Department of the Treasury, the use tax due pursuant to the Sales and Use Tax Act, (N.J.S.A. 54:32B-1 et seq.) on all sales of tangible personal property delivered into the State. Any questions in this regard can be directed to the Division of Taxation at (609)292-6400. Form NJ-REG can be filed online at <http://www.state.nj.us/treasury/revenue/busregcert.shtml>.

Before final payment is made under the contract, the contractor shall submit to the Contracting Agency a complete and accurate list of all subcontractors used and their addresses.

Pursuant to N.J.S.A. 54:49-4.1, a business organization that fails to provide a copy of a business registration as required, or that provides false business registration information, shall be liable for a penalty of \$25 for each day of violation, not to exceed \$50,000, for each proof of business registration not properly provided under a contract with a contracting agency.

2.0 SUBMISSION OF BIDS

2.01 GENERAL

Bidder must submit their bid on the respective "Bid Form and Package" included hereto.

No bid will be accepted or opened if received after the designated time for receipt.

For each bid made, all blank spaces in the Bid Form must be filled in, in ink, with the unit prices of the item and its extension. All bid forms submitted will be checked for arithmetic accuracy. In the event of a discrepancy between the unit price bid for any Pay Item and the extension shown for that item under the column of the Proposal Form designated "Amount," the unit price is to govern. Where a unit price is bid for a Pay Item, but no extension is provided, the Owner will provide the extension based on the unit price bid and the estimated quantity for that Pay Item. Where an extension is provided by the Bidder in the "Amount" column, but no unit price appears in the "Unit Price" column of the Proposal Form, the Owner will provide the unit price by dividing the "Amount" figure provided by the Bidder by the estimated quantity.

Award will be made on the basis of Total Contract Price. The Total Contract Price means the correctly determined summation of lump sum bids and products of all quantities for Pay Items shown in the Proposal form multiplied by the unit prices bid.

If there are minimum unit prices included in the bid form, those prices shall be the minimum acceptable unit price for the work. If bidder fails to exceed the minimum unit price in his bid, the unit price will be set to the minimum price stated on the bid form, with the appropriate increase to the extension of the unit price and total bid price.

Where no figure is provided by the Bidder in both the "Unit Price" and "Amount" columns for one or more Pay Items, or where no figure is provided in the "Amount" column for one or more lump sum Pay Items the Owner will consider the amount bid to be zero (\$0.00) for that item.

Any bid may be submitted or withdrawn prior to the scheduled time for the opening of bids, or authorized postponement thereof. Any bid received after the time and date specified in the Notice to Bidders will not be considered. No bid may be withdrawn within 60 days after the actual date of opening thereof, unless otherwise provided for by law.

2.02 PRICE TO INCLUDE

The bid submitted must cover the entire cost of the contemplated construction and installation as illustrated on the drawings and in the manner and detail described in the specifications. The price bid for each item shall cover the entire cost of its installation, construction, and completion, including all materials, workmanship, and appurtenances necessary for its completion or as implied by illustration on the drawings, by description in the specifications, or to be reasonably inferred therefrom.

2.03 REJECTION OF BIDS

The owner reserves the right to reject all bids, to reject any bid or bids not complying with the specifications, and to waive any informality in any bid or bids if such waiver be deemed by the Owner to be in the best interests of the Owner in accordance with the requirements contained in N.J.S.A. 40A:11-1 et seq. Each bidder is instructed to be present in person or by representative at the time and place fixed for the opening of bids and at every subsequent meeting of the Owner at which the bidder is advised, or it has been publicly announced at the time of bids, that said bids shall receive further consideration or shall be acted upon, if said bidder desires an opportunity to be heard.

2.04 AWARD OF BID

The award of the contract will be made, subject to necessary monies to do the work being provided by the Owner in accordance with the requirements contained in N.J.A.C. 5:30, Local Finance Board either by Resolution, Ordinance, or in other lawful manner. The contract to be executed by the successful bidder will provide that it shall not become effective until the necessary monies to do the work have been provided by the Owner, either by Resolution, Ordinance or another lawful manner.

In accordance with NJSA 34:11-56.25 et seq., New Jersey State Prevailing Wage Act and NJSA 52:32-44.1 no contract shall be awarded to any contractor, subcontractor, or to any firm, corporation or partnership in which such contractor or subcontractor has an interest, who is debarred from public works or contracting with a federal government agency.

3.0 CONTRACTS

3.01 DRAWINGS AND SPECIFICATIONS FURNISHED

The Engineer shall furnish, at no additional cost to the successful bidder, one executed contract set of drawings and specifications, and two copies of the specifications and drawings. All additional copies of the drawing and/or specifications shall be furnished to the contractor at the cost of reproduction plus handling.

3.02 PERFORMANCE, PAYMENT AND MAINTENANCE BONDS

The bidder whose bid is accepted shall furnish to the Owner, a performance bond and labor and material payment bond, or a combination performance and labor and material payment bond, and upon final completion of the work, a two (2) year maintenance bond, each in the amount of 100% of the final contract price, with such sureties as shall be approved by the Owner and as detailed and described below.

All surety companies must be authorized to transact such business in New Jersey, pursuant to N.J.S.A. 17:17-10 or 17:32-1 et seq. The surety must designate a New Jersey agent on whom service of process can be made. The Contractor shall be responsible for updating the surety's expiration from the list or an agent change, to the Engineer or Owner. All surety companies must have the minimum capital and surplus or net cash assets required, pursuant to N.J.S.A. 17:17-6 or 17:17-7, whichever is applicable, on the date of advertisement for the project. All surety companies must complete a Surety Disclosure Statement and Certification for all payment and performance bonds, pursuant to N.J.S.A. 2A:44-143d.

In addition, for these public works project bids, including any and all alternates, that equals at least \$850,000.00 but not more than \$3.5 million, the surety company must hold a current certificate of authority issued by the U.S. Secretary of the Treasury that is valid in New Jersey as listed annually in the U. S. Treasury Circular 570. However, if the surety company has been operational for a period in excess of five years, the surety company shall also be considered to have satisfied this requirement if it is rated in one of the three highest categories by an independent nationally recognized United States rating company

that determines the financial stability of insurance companies. Such rating companies must meet standards promulgated by the N. J. Commissioner of Insurance N.J.A.C. 11:1-41.1 et seq.

In addition, for those public works project bids, including any and all alternates, is in excess of \$3.5 million, the surety company must hold a current certificate of authority issued by the United States Secretary of the Treasury that is valid in the State of New Jersey listed annually in U.S. Treasury Circular 570. And, if the surety company has been operational for a period in excess of five years, it must be rated in one of the three highest categories by an independent, nationally recognized United States rating company that determines the financial stability of insurance companies. Such ratings must meet standards promulgated in N.J.A.C. 11:1-41.1 et seq.

A surety company, which seeks to provide a payment and performance bond in excess of \$3.5 million, is exempt from the requirement of Treasury Circular 570 if it meets standards developed by the Commissioner of Insurance through regulations which, at least equal, and may exceed, the general criteria required for Treasury listing. These standards are found at N.J.A.C. 11:1-41.4.

3.03 LAWS AND REGULATIONS

The bidder's attention is directed to the fact that all applicable Federal, State, County and municipal laws ordinances, regulations, etc. and the rules and regulations of all authorities having jurisdiction over construction of the project shall apply to the contract throughout, and they will be deemed to be included in the contract the same as though therein written out in full including, but not limited to the "Occupational Safety and Health Act of 1970" P.L. 91-596, as amended.

3.04 PERMITS

The Contractor shall determine which construction permits and licenses shall be needed, and shall procure and pay for all such construction permits and licenses necessary for the execution of his work.

3.05 CONTRACT DOCUMENTS

Attached hereto is the "Form of Contract" that will be executed between the Owner and the Contractor.

The Contractor shall execute and return these documents with the required bonds, insurance certificates, affirmative action forms and any other documents required within ten (10) days after receipt of the request for execution.

3.06 NOTICE TO PROCEED

After approval and execution of the contract documents by all parties and a preconstruction meeting, the contractor shall be sent a "Notice to Proceed." This document serves as formal authorization to proceed with the project.

Any and all work performed by the contractor prior to receipt of the Notice to Proceed is at the contractor's risk with no claim against the Owner for such work.

4.0 AFFIRMATIVE ACTION AGAINST DISCRIMINATION

4.01 BIDDER REFERRED TO LAW

The bidder is specifically referred to N.J.S.A. 10:5-31 et seq., and N.J.A.C. 17:27 as amended and the Regulations adopted pursuant thereto, relating to affirmative action in relation to discrimination.

4.02 SPECIFIC LANGUAGE REQUIRED

In accordance with the Affirmative Action Regulations adopted pursuant to N.J.S.A. 10:5-31 et seq., and N.J.A.C. 17:27, the following is made a part of this Contract:

During the performance of this contract, the contractor agrees as follows:

- a. The contractor or subcontractor, where applicable, will not discriminate against any employee or applicant for employment because of age, race, creed, color, national origin, ancestry, marital status, affectional or sexual orientation, gender identity or expression, disability, nationality or sex. Except with respect to affectional or sexual orientation and gender identity or expression, the contractor will ensure that equal employment opportunity is afforded to such applicants in recruitment and employment, and that employees are treated during employment, without regard to their age, race, creed, color, national origin, ancestry, marital status, affectional or sexual orientation, gender identity or expression, disability, nationality or sex. Such equal employment opportunity shall include, but not be limited to the following: employment, up- grading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the Public Agency Compliance Officer setting forth provisions of this nondiscrimination clause.
- b. The contractor or subcontractor, where applicable will, in all solicitations or advertisements for employees placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to age, race, creed, color, national origin, ancestry, marital status, affectional or sexual orientation, gender identity or expression, disability, nationality or sex.
- c. The contractor or subcontractor will send to each labor union, with which it has a collective bargaining agreement, a notice, to be provided by the agency contracting officer, advising the labor union or workers' representative of the contractor's commitments under this act and shall post copies of the notice in conspicuous places available to employees and applicants for employment.
- d. The contractor or subcontractor, where applicable, agrees to comply with any regulations promulgated by the Treasurer, pursuant to N.J.S.A. 10:5-31 et seq., as amended and supplemented from time to time and the Americans with Disabilities Act.
- e. When hiring or scheduling workers in each construction trade, the contractor or subcontractor agrees to make good faith efforts to employ minority and women workers in each construction trade consistent with the targeted employment goal prescribed by N.J.A.C. 17:27- 7.2; provided, however, that the Dept. of LWD, Construction EEO Monitoring Program may, in its discretion, exempt a contractor or subcontractor from compliance with the good faith procedures prescribed by the following provisions, A, B and C, as long as the Dept. of LWD, Construction EEO Monitoring Program is satisfied that the contractor or subcontractor is employing workers provided by a union which provides evidence, in accordance with standards prescribed by the Dept. of LWD, Construction EEO Monitoring Program, that its percentage of active "card carrying" members who are minority and women workers is equal to or greater than the targeted employment goal established in

accordance with N.J.A.C. 17:27- 7.2. The contractor or subcontractor agrees that a good faith effort shall include compliance with the following procedures:

- (A) If the contractor or subcontractor has a referral agreement or arrangement with a union for a construction trade, the contractor or subcontractor shall, within three business days of the contract award, seek assurances from the union that it will cooperate with the contractor or subcontractor as it fulfills its affirmative action obligations under this contract and in accordance with the rules promulgated by the Treasurer pursuant to N.J.S.A. 10:5-31 et seq., as supplemented and amended from time to time and the Americans with Disabilities Act. If the contractor or subcontractor is unable to obtain said assurances from the construction trade union at least five business days prior to the commencement of construction work, the contractor or subcontractor agrees to afford equal employment opportunities minority and women workers directly, consistent with this chapter. If the contractor's or subcontractor's prior experience with a construction trade union, regardless of whether the union has provided said assurances, indicates a significant possibility that the trade union will not refer sufficient minority and women workers consistent with affording equal employment opportunities as specified in this chapter, the contractor or subcontractor agrees to be prepared to provide such opportunities to minority and women workers directly, consistent with this chapter, by complying with the hiring or scheduling procedures prescribed under (B) below; and the contractor or subcontractor further agrees to take said action immediately if it determines that the union is not referring minority and women workers consistent with the equal employment opportunity goals set forth in this chapter.
- (B) If good faith efforts to meet targeted employment goals have not or cannot be met for each construction trade by adhering to the procedures of (A) above, or if the contractor does not have a referral agreement or arrangement with a union for a construction trade, the contractor or subcontractor agrees to take the following actions:
- (1) To notify the public agency compliance officer, the Dept. of LWD, Construction EEO Monitoring Program, and minority and women referral organizations listed by the Division pursuant to N.J.A.C. 17:27-5.3, of its workforce needs, and request referral of minority and women workers;
 - (2) To notify any minority and women workers who have been listed with it as awaiting available vacancies;
 - (3) Prior to commencement of work, to request that the local construction trade union refer minority and women workers to fill job openings, provided the contractor or subcontractor has a referral agreement or arrangement with a union for the construction trade;
 - (4) To leave standing requests for additional referral to minority and women workers with the local construction trade union, provided the contractor or subcontractor has a referral agreement or arrangement with a union for the construction trade, the State Training and Employment Service and other approved referral sources in the area;
 - (5) If it is necessary to lay off some of the workers in a given trade on the construction site, layoffs shall be conducted in compliance with the equal employment opportunity and non-discrimination standards set forth in this regulation, as well as with applicable Federal and State court decisions;
 - (6) To adhere to the following procedure when minority and women workers apply or are referred to the contractor or subcontractor:

- (i) The contractor or subcontractor shall interview the referred minority or women worker.
 - (ii) If said individuals have never previously received any document or certification signifying a level of qualification lower than that required in order to perform the work of the construction trade, the contractor or subcontractor shall in good faith determine the qualifications of such individuals. The contractor or subcontractor shall hire or schedule those individuals who satisfy appropriate qualification standards in conformity with the equal employment opportunity and non-discrimination principles set forth in this chapter. However, a contractor or subcontractor shall determine that the individual at least possesses the requisite skills, and experience recognized by a union, apprentice program or a referral agency, provided the referral agency is acceptable to the Dept. of LWD, Construction EEO Monitoring Program. If necessary, the contractor or subcontractor shall hire or schedule minority and women workers who qualify as trainees pursuant to these rules. All of the requirements, however, are limited by the provisions of (C) below.
 - (iii) The name of any interested women or minority individual shall be maintained on a waiting list, and shall be considered for employment as described in (i) above, whenever vacancies occur. At the request of the Dept. of LWD, Construction EEO Monitoring Program, the contractor or subcontractor shall provide evidence of its good faith efforts to employ women and minorities from the list to fill vacancies.
 - (iv) If, for any reason, said contractor or subcontractor determines that a minority individual or a woman is not qualified or if the individual qualifies as an advanced trainee or apprentice, the contractor or subcontractor shall inform the individual in writing of the reasons for the determination, maintain a copy of the determination in its files, and send a copy to the public agency compliance officer and to the Dept. of LWD, Construction EEO Monitoring Program.
- (7) To keep a complete and accurate record of all requests made for the referral of workers in any trade covered by the contract, on forms made available by the Dept. of LWD, Construction EEO Monitoring Program and submitted promptly to the Dept. of LWD, Construction EEO Monitoring Program upon request.
- (C) The contractor or subcontractor agrees that nothing contained in (B) above shall preclude the contractor or subcontractor from complying with the union hiring hall or apprenticeship policies in any applicable collective bargaining agreement or union hiring hall arrangement, and, where required by custom or agreement, it shall send journeymen and trainees to the union for referral, or to the apprenticeship program for admission, pursuant to such agreement or arrangement. However, where the practices of a union or apprenticeship program will result in the exclusion of minorities and women or the failure to refer minorities and women consistent with the targeted county employment goal, the contractor or subcontractor shall consider for employment persons referred pursuant to (B) above without regard to such agreement or arrangement; provided further, however, that the contractor or subcontractor shall not be required to employ women and minority advanced trainees and trainees in numbers which result in the employment of advanced trainees and trainees as a percentage of the total workforce for the construction trade, which percentage significantly exceeds the apprentice to journey worker ratio specified in the applicable collective bargaining agreement, or in the absence of a collective bargaining agreement, exceeds the ratio established by practice in the area for said construction trade. Also, the contractor or subcontractor agrees that, in implementing the procedures of (B) above, it shall, where applicable, employ minority and women workers residing within the geographical jurisdiction of the union.

After notification of award, but prior to signing a construction contract, the contractor shall submit to the public agency compliance officer and the Dept. of LWD, Construction EEO Monitoring Program an initial project workforce report (Form AA 201) electronically provided to the public agency by the Dept. of LWD, Construction EEO Monitoring Program, through its website, for distribution to and completion by the contractor, in accordance with N.J.A.C. 17:27-7. The contractor also agrees to submit a copy of the Monthly Project Workforce Report once a month thereafter for the duration of this contract to the Division and to the public agency compliance officer.

The contractor agrees to cooperate with the public agency in the payment of budgeted funds, as is necessary, for on - the - job and/or off - the - job programs for outreach and training of minorities and women.

- (D) The contractor and its subcontractors shall furnish such reports or other documents to the Dept. of LWD, Construction EEO Monitoring Program as may be requested by the Dept. of LWD, Construction EEO Monitoring Program from time to time in order to carry out the purposes of these regulations, and public agencies shall furnish such information as may be requested by the Dept. of LWD, Construction EEO Monitoring Program for conducting a compliance investigation pursuant to N.J.A.C. 17:27-1.1 et seq.

4.03 CONTRACT PROCEDURES

The Contractor must sign a contract containing the mandatory language in Section 4.02 above entitled "Specific Language Required."

The construction contractors shall complete and submit an Initial Project Workforce Report Form AA-201 upon notification of award. Proper completion and submission of this Report shall constitute evidence of the contractor's compliance with the regulations. Failure to submit this form may result in the contract being terminated. The contractor also agrees to submit a copy of the Monthly Project Workforce Report, Form AA-202 once a month thereafter for the duration of the contract to the Dept. of LWD and to the Public Agency Compliance Officer.

The EEO/AA evidence must be submitted after notification of award, but prior to signing a construction contract. All Public Agencies must retain the affirmative action evidence in their files for review by the Division.

4.04 EQUAL OPPORTUNITY FOR INDIVIDUALS WITH DISABILITIES

The contractor and the Owner do hereby agree that the provisions of Title II of the Americans With Disabilities Act of 1990 (the "Act") (42 U.S.C. S12101 et seq.), which prohibits discrimination on the basis of disability by public entities, in all services, programs and activities provided or made available by public entities, and the rules and regulations promulgated pursuant thereto, are made part of this contract. In providing any aid, benefit or service on behalf of the Owner pursuant to this contract, the contractor agrees that the performance shall be in strict compliance with the Act. In the event the contractor, its agents, servants, employees, or subcontractors violate or are alleged to have violated the Act during the performance of this contract, the contractor shall defend the Owner in any action or administrative proceeding commenced pursuant to this Act. The contractor shall indemnify, protect, and save harmless the Owner, its agents, servants and employees from and against any and all suits, claims, losses, demands, or damages of whatever kind or nature arising out of or claimed to arise out of the alleged violation. The contractor shall, at its own expense, appear, defend, and pay any and all charges for legal services and any and all costs or other expenses arising from such action or administrative proceeding or incurred in connection therewith. In any and all complaints brought pursuant to the Owner's grievance procedure, the contractor agrees to abide by any decision of the Owner which is rendered pursuant to said grievance procedure. If any action or administrative proceeding results in an

award of damages against the Owner, or if the Owner incurs any expense to cure a violation of the Act which has been brought pursuant to its grievance procedure, the contractor shall satisfy and discharge the same at its own expense.

The Owner shall, as soon as practical after a claim has been made against it, give written notice thereof to the contractor along with the full particulars of the claim. If any action or administrative proceeding is brought against the Owner or any of its agents, servants and employees, the Owner shall expeditiously forward or have forwarded to the contractor every demand, complaint, notice, summons, pleading, or other process received by the Owner or its representatives.

It is expressly agreed and understood that any approval by the Owner of the services provided by the contractor pursuant to this contract will not relieve the contractor of the obligation to comply with the Act and to defend, indemnify, protect, and save harmless the Owner pursuant to this paragraph.

It is further agreed and understood that the Owner assumes no obligation to indemnify or save harmless the contractor, its agents, servants, employees and subcontractors for any claim which may arise out of their performance of this contract. Furthermore, the contractor expressly understands and agrees that the provisions of this indemnification clause shall in no way limit the contractor's obligations assumed in this contract, nor shall they be construed to relieve the contractor from any liability, nor preclude the Owner from taking any other actions available to it under any other provisions of this contract or otherwise at law.

**CONTRACT FOR LOGAN TOWNSHIP DPW POLE BARN EXTENSION AND SITE
IMPROVEMENTS RE-BID**

THIS AGREEMENT, between the, Township of Logan a municipal corporation of the State of New Jersey, having its principal offices located at 125 Main Street, Bridgeport, New Jersey 08014, hereinafter referred to as Owner and *(insert contractor name)*, having its principal place of business located at *(insert contractor address)* hereinafter referred to as "Contractor;"

WITNESSETH;

That for and in consideration of the sum of _____ and 00/100 (\$000,000.00), contractor agrees to furnish to the Owner, the labor, material, equipment and services in accordance with the contract documents hereinafter set forth.

That for and in consideration of the amount payable under this agreement by the Owner, the Contractor agrees, at its own proper cost and expense, and with due skill and diligence, that it will complete the Logan Township DPW Pole Barn Extension and Site Improvements Re-bid project in accordance with the contract documents and in compliance with this agreement.

Contractor agrees to receive as full compensation the amount stated herein, namely \$000,000.00, for said services provided to the Owner. Contractor shall be responsible for all loss or damage arising out of the furnishing of the services aforesaid.

To prevent all disputes and litigation, it is agreed by and between the parties to the Contract that the Owner shall in all cases determine the quantity of the goods delivered and paid for under this contract, and as to the interpretation of any ambiguity in or intent of the drawings and specifications.

The Contract documents shall consist of the following:

1. Notice to Bidders.
2. Specifications.
3. Contractors Proposal (as accepted).
4. Contract Agreement.
5. Contract Drawings
6. All Addenda.

The parties to this contract agree to incorporate into this contract the mandatory language of the Regulations promulgated by the Treasurer pursuant to N.J.S.A. 10:5-31 et seq. and N.J.A.C. 17:27, as amended and supplemented from time to time and the contractor or subcontractor agrees to comply fully with the terms, provisions, and obligations of said Regulations.

AND in all respects comply with all requirements of the Labor Laws of the State of New Jersey, applicable to contracts on behalf of the Municipal Government for construction, alteration, or repair of any building or public work, including particularly, be without limitation of the foregoing, the provision that not less than the prevailing rate of daily wages in the locality where the work is performed shall be paid to mechanics, workmen and laborers employed by the contractors or subcontractors or by or in behalf of the State or any county or municipality;

(The contract partner) shall maintain all documentation related to products, transactions or services under this contract for a period of five years from the date of final payment. Such records shall be made available to the New Jersey Office of the State Comptroller upon request.

Payment shall be made to said Contractor by orders upon the Treasurer of said Township, founded upon estimates of the Township Committee as to the amount of work done or articles furnished and delivered, or both, and upon presentation by said Contractor, to the Township Treasurer of said Township an appropriate voucher setting forth, in writing, the amount of work done or goods furnished, and that the work done or articles furnished are according to this Contract, and according to law;

AND it is distinctly and mutually understood and agreed by and between the parties hereto, that in case a default is made in the completion of the Contract, in accordance with the terms and conditions hereof, such money as may be due to said Contractor, or such as would have become due had the terms and conditions of this Contract and agreement been complied with, shall be and is hereby forfeited to said Township, and said Township is free to use the same in and about the completion of said contract, and in case said Township is put to any costs and expenses over and above the contract price of the Contractor, in and about the completion of the Contract, said Contractor for themselves, itself, their heirs, executors,

administrators, successors and assigns, expressly agree to hold themselves, itself, their heirs, executors, administrators, successors and assigns, liable therefore, and hereby covenant and agree to make good the same to the Township. Upon the Township's determination that services provided by the contractor are unsatisfactory, said contract may be cancelled subject to thirty (30) days written notice being provided to the contractor;

The Contractor agrees to make payments of all proper charges for labor and materials required in the aforementioned work, and defend, indemnify and save harmless the Township of Logan, its officers, agents and servants and each and every one of them against and from all suits and costs of every name and description, including attorney's fees and costs and from all damages to which said Township of Logan or any of its officers, agents or servants may be put by reason of injury to the person or property of others resulting from carelessness in the performance of said work, or through the negligence of the Contractor, or through any improper or defective machinery, implements or appliances used by said Contractor in the aforesaid work or through any act or omission on the part of said Contractor, or his agent or agents. This provision applies regardless of whether insurance coverage is provided. It is also agreed and understood that the acceptance of the final payment by the Contractor shall be considered as a release in full of all claims against the Township out of, or by reason of, the work done and materials furnished under this contract; and

AND it is expressly understood and agreed that this Contract and the referenced inclusion of the bid documents represent the full understanding between the parties and any representations, whether oral or in writing, not contained herein, will not be binding on the parties hereto.

This agreement, together with the contract documents, forms the contract and they are as fully a part of this contract as if hereto attached or herein repeated.

The Owner and the Contractor, for themselves, their heirs, executors, administrators, successors or assigns, hereby agree to the full performance of the covenants herein contained.

IN WITNESS WHEREOF, they have executed this Agreement.

CONTRACTOR:

ATTEST:

BY _____

Print Name & Title

Print Name & Title (Seal)

Dated this ____ **day of** _____, **20**__.

TOWNSHIP OF LOGAN:

ATTEST:

BY _____

(Seal)

Dated this ____ **day of** _____, **20**__.

CERTIFICATE OF INSURANCE

Name & Address of Insured

Afforded	Required <small>Enter (X)</small>	Type of Insurance	Policy Number and Insuring Company(ies)	Policy Expiration Date	Limits of Liability		
					Amounts of Less Than \$1,000,000 Will Not Be Acceptable	Amount Required Each Occurrence	Amount Provided Each Occurrence
<input type="checkbox"/>	<input checked="" type="checkbox"/>	General Liability Comprehensive Gen. Form			General Aggregate	\$2,000,000	\$
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Premises-Operations			Bodily Injury	\$1,000,000	\$
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Explosion & Collapse Hazard			Property Damage	\$1,000,000	
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Underground Hazard			Bodily Injury and Property Damage Combined	\$1,000,000	\$
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Products/Completed Operations Hazard			Personal Injury	\$	\$
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Contractual Ins. (Blanket)					
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Broad Form Prop. Damage					
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Independent Contractors					
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Personal Injury					
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Automobile Liability Comprehensive Form			Bodily Injury (Each Person)	\$	\$
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Owned			Bodily Injury (Each Accident)	\$	\$
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Non-Owned			Property Damage	\$	\$
<input type="checkbox"/>	<input type="checkbox"/>	Garagekeepers Insurance (Without regard to legal liability as direct coverage on a primary basis)			Bodily Injury and Property Damage Combined	\$1,000,000	
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Excess Liability Umbrella Form			Bodily Injury and Property Damage Combined	\$1,000,000	\$
<input type="checkbox"/>	<input type="checkbox"/>	Other Than Umbrella Form					
<input type="checkbox"/>	<input checked="" type="checkbox"/>	Worker's Compensation and Employers' Liability	*All States Endorsement		Statutory NJ Coverage \$100,000/\$500,000		
					Minimum \$100,000	\$100,000	\$

Remarks: Additional Insured: **REMINGTON & VERNICK ENGINEERS, TOWNSHIP OF LOGAN and TOWNSHIP OF LOGAN'S SOLICITOR**

It is understood and agreed that in the event of any material change in, cancellation of, or expiration of the above policy or policies the undersigned Insurance Company agrees to give a written notice to the Owner, at the above address thirty (30) days in advance of such change or cancellation.

This certificate is executed and issued to the Owner on the day and date herein below written certifying that the Insured has been issued the above policy or policies with Limits of Liability of at least the required amounts.

*** PLEASE PUT "X'S" IN AFFORDED COLUMN OR CERTIFICATE WILL BE RETURNED ***

Name of Agency

Street Address

City, State & Zip Code

Signature of Authorized Representative of Insurance Company

Address Date

Agency Telephone No.

TO: INSURANCE PRODUCER

Your client, as a supplier to the Owner is required to provide a certificate of insurance for the coverages and amounts indicated on the reverse side of this insurance certificate. It is important to your client that you respond quickly since continued business relationships depend upon valid insurance. Additionally, the minimum amount and type of coverage shown on our certificate is not negotiable and is not intended to imply that is all the insurance necessary to protect him/her from all losses or liability. It is the Owner's policy to require all suppliers who make deliveries or perform assembly, repair operations or a service in, on or upon our property/premises or property/premises under our care, custody and control to maintain the insurance coverage described below; such insurance must be obtained prior to the start of any such work the Owner.

A. Comprehensive General Liability (CGL)

This coverage must include: Premises-Operations, Products/Completed Operations Hazard, Contractual Insurance (Blanket Coverage), Broad Form Property Damage, Independent Contractors, and Personal Injury and all others shown on "X" in the required column.

Minimum Coverage

Bodily Injury and Property Damage combined - as shown in the amount required column

AMOUNTS OF LESS THAN \$1,000,000 WILL NOT BE ACCEPTABLE.

Contractual Insurance (Blanket Coverage)

Contractual Indemnification - Save Harmless Agreement which is incorporated into all Vouchers, General Purchase Agreements and Contracts.)

INDEMNIFICATION

Supplier shall defend, indemnify and save harmless, the Owner from and against all losses, costs, damages, expense claims or demands arising out of or caused or alleged to have been caused in any manner by a defect in any equipment or materials supplied hereunder or by doing the work herein provided, including all suits or actions of every kind of description brought against Owner, either individually or jointly with Supplier for or on account of any damage or injury to any person or persons or property, caused or occasioned or alleged to have been caused by or on account of the performance of any work pursuant to or in connection with this contract or through any negligence or alleged negligence in guarding the work or through any act, omission or fault or alleged act, omission or fault of the Supplier, its employees or agents, or others under Supplier's control.

B. Automobile Liability - Comprehensive Form (or as shown on reverse side)

Minimum Coverage

Bodily Injury and Property Damage combined - as shown in the amount required column.

C. Worker's Compensation - As required by New Jersey State Statute

and

Employer's Liability (minimum \$100,000)

D. Excess Liability

Commercial Umbrella Form - \$1,000,000.

E. Other Coverage(s)

As shown on reverse side.

THANK YOU

Important - Producer:

PLEASE CHECK THE AFFORDED BLOCK FOR EACH COVERAGE PROVIDED.

THE CERTIFICATE MUST BE SIGNED BY THE AGENT OF THE INSURER OR CERTIFICATE WILL BE RETURNED.

IT IS NECESSARY TO SUBMIT YOUR CLIENTS COVERAGE THIRTY (30) DAYS PRIOR TO THE EXPIRATION OF THE EXISTING COVERAGE ON OUR CERTIFICATE ONLY; ALL OTHERS WILL BE RETURNED TO THE SUPPLIER AND SERVE TO DELAY FUTURE BUSINESS DEALINGS BETWEEN THE OWNER AND YOUR CLIENT.

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GENERAL CONDITIONS

1.0 GENERAL

1.01 DEFINITIONS

The following words and expressions used in the contract documents shall be construed as follows:

Owner.....Township of Logan
125 Main Street
Bridgeport, NJ 08014

EngineerRemington & Vernick Engineers
2059 Springdale Road
Cherry Hill, New Jersey 08003

Contractor.....Party, firm, corporation with whom or which the contract is
made, or authorized agent thereof.

DayCalendar day.

Legal Holiday.....Days which the owner does not conduct regular business hours. The
Contractor is responsible to contact the Owner for a listing of these days.

Substantial Completion The work will not reach Substantial Completion until all project systems included in the work are operational as designed and scheduled, all designated or required inspections, certifications, permits, approvals, licenses and other documents from any governmental authority having jurisdiction thereof necessary for the beneficial use and occupancy of the work are received, designated instruction of Owner’s personnel has been completed, and all final finishes within the Contract are in place. Any remaining work shall be minor in nature, so that the Owner can occupy the building on that date and the completion of the remaining work by the Contractor would not materially interfere or hamper the Owner’s (or those claiming by, through or under the Owner) normal operations. Contractor recognizes that normal operations require the use and occupancy of the work area without interruption and that any punchlist or corrective work shall be done at times when the work area is not so occupied. As a further condition of reaching Substantial Completion, the Contractor shall certify that all remaining work will be completed within thirty (30) consecutive calendar days or as so agreed upon following the date of Substantial Completion. Site related projects and/or projects including facilities with site improvements shall not reach Substantial Completion until such time as all site amenities (i.e. lighting, top paving, striping, fencing, stormwater compliance, etc..) are placed into service leaving only minor improvements that will not hamper access or use to complete the project.”

Final CompletionAll warranties and guarantees required pursuant to the Contract Documents shall be assembled and delivered by the Contractor to the Owner as part of the final application for payment. The final Certificate for Payment will not be issued by the Engineer until all warranties and guarantees have been received and accepted by the Owner.

1.02 SPECIAL NOTICE

The "Information for Bidders", the "General Conditions", the "Notice to Bidders", and "Proposal Section" shall be held equally binding with and are to be considered a part of the specifications and contract and the party of the second part, the Contractor, will be held responsible for neglect in attending to any part, paragraph or item therein.

1.03 REPRESENTATION OF CONTRACTOR

The Contractor represents and warrants:

- (a) That he is financially solvent and that he is experienced in and competent to perform the type of work to furnish the labor, plant, materials and supplies or equipment to be so performed or furnished by him and
- (b) That he is familiar with all Federal, State, County, Municipal and Department Laws, Ordinances and Regulations, which may in any way affect the work or those employed therein, including, but not limited to, any special Acts relating to the work or to the project of which it is a part, and
- (c) That such temporary and permanent work required by the contract documents and is to be done by him can be satisfactorily constructed and used for the purpose for which it is intended, and that such construction will not injure any persons or damage any property, and
- (d) That he has carefully examined the drawings, specifications, and the site of the work, and that from his own investigations he has satisfied himself as to the nature and location of the work, the character, quality and quantity of surface and subsurface materials likely to be encountered, the character of equipment and other facilities needed for the performance of the work, the general and local conditions and all other items which may in any way affect the work or its performance.

1.04 SUBLETTING OR ASSIGNING OF CONTRACT

The Contractor shall not assign, sell or transfer or otherwise dispose of the contract or any portion thereof or of the work provided therein or his right, title or interest therein, to any persons, firm or corporation, without prior written consent of the Owner.

1.05 CONSTRUING THE SPECIFICATIONS

To avoid disputes and litigation, it must be distinctly understood by the Bidder/Contractor that the Engineer shall construe or interpret the specifications and explain any ambiguity therein and shall have the right to decide as to their purpose and intent and his decision upon any such ambiguity shall be final, conclusive and binding.

1.06 NECESSARY TO COMPLETE

If any work or materials are required which are obviously necessary to carry out the full intent and meaning of the said specifications although the same may not be either directly or indirectly in the specifications, the Contractor is hereby bound to furnish the same without charge or claim.

1.07 DRAWINGS AND SPECIFICATIONS

The Contractor shall keep at the site of the work one copy of the drawings and specifications signed and identified by the Engineer and shall at all times give the Engineer and other representatives of the Owner access thereto. Anything shown on the drawings and not mentioned in the specifications, or mentioned in the

specifications and not shown on the drawings, shall have the same affect as if shown or mentioned respectively in both. In case of any conflict within the construction documents, the Engineer shall determine which of the requirements shall govern based upon the most stringent of the requirements, and the Contractor shall perform the work at no additional cost or time to the owner. Any ambiguity or discrepancy between drawings and specifications shall be submitted by the Contractor to the Engineer whose decision shall be conclusive.

The general arrangement and location of equipment, the various pipe, duct, and conduit runs, etc. are shown on the drawings. All dimensions or the scales of the drawings shall be considered as approximate and shall be checked by each bidder to his own satisfaction prior to bid. The exact location of all parts of the work shall be governed by existing conditions, and the Contractor shall coordinate and locate all work at the time of installation. Any changes in location, etc. from that shown on the drawings, necessary by existing conditions, shall be made by the Contractor at no increase of the contract sum.

1.08 RIGHT-OF-WAY

All right-of-ways through private property required shall be secured by the Owner. Contractor shall not start construction in right-of-ways until directed by the Engineer. No claim shall be made by the Contractor for damage due to delay in securing right-of-ways.

1.09 TIME LIMITS

The Contractor agrees to start the work herein contracted for within ten (10) days from the date of the Engineer's Notice To Proceed to the Contractor directing him to proceed with the work. The time to complete the work contracted for, from the date of the Proceed Order, shall be limited to the following:

Three Hundred (300) Calendar Days

No extension of time will be allowed for delay from any cause whatsoever, including normal weather conditions unless the Contractor shall have notified the Engineer in writing of such delay and his intention to claim an extension of time within two (2) days after the beginning of such delay. Such notice shall give complete information concerning the nature, extent and cause of the delay. If, in the opinion of the Owner, an extension of time is warranted the Owner or Owner's representative, will issue a written extension, setting a new time limit for the completion of the work. Additionally, should the Owner grant the Contractor an extension of Contract time, the Contractor shall not be due any compensation for the extended contract time unless specifically indicated in writing at the time of the extension. Failure of Owner or Owner's Representative to expressly respond to a reservation of rights letter from Contractor reserving a right to additional compensation shall in no way be deemed an admission that Contractor is entitled to additional fees. Any costs associated with increased contract time due to approved change order work must be specifically identified included in the change order at the time of submission.

1.10 LIQUIDATED DAMAGES

In case the Contractor fails to complete the work contracted for, satisfactory to and acceptable to the Owner within the stipulated time limit, or violates any terms or conditions of said contract or the terms and conditions of N.J.S.A. 40A:11-1 et seq. (Local Public Contracts Law), then the Contractor shall and will pay to the Owner for each and every calendar day determined to be in default, the following sums, which are agreed upon, fixed and determined by the parties hereto to be liquidated damages. Liquidated damages shall not be assessed beyond substantial completion.

One (1) to Fifteen (15) Days beyond Contract Time Limits

Five Hundred (\$500.00) dollars per calendar day.

Sixteen (16) to Thirty (30) Days beyond Contract Time Limits

One Thousand (\$1,000.00) dollars per calendar day.

Greater than Thirty (30) Days beyond Contract Time Limits

Two Thousand (\$2,000.00) dollars per calendar day

The Owner shall recover said damages by deducting the amount thereof out of any money which may be due or become due the Contractor, or by an action of law against the Contractor, his surety or by either or both of these methods.

In case the Contractor shall be delayed due to the failure on the part of the Owner to furnish anything on its part to be furnished or for any other cause beyond the control of the Contractor, he shall be entitled to such an extension of time for the delivery of equipment, materials, work and supplies as in the judgement of the Owner or Owner's representative to be fair and just.

1.11 OWNER'S RIGHT TO STOP WORK OR TERMINATE CONTRACT

The Owner has the right to stop work or terminate the contract, if:

- (a) The Contractor has violated the provisions of N.J.S.A. 40A:11-1 et seq. (Local Public Contracts Law), or any other Federal, State or Local law, or
- (b) The Contractor shall be adjudged bankrupt or make an assignment for the benefit of creditors, or
- (c) A receiver or liquidator shall be appointed for the Contractor or for any of his property and shall not be dismissed within 20 days after such appointment or the proceedings in connection therewith shall not be stayed on appeal within the said 20 days, or
- (d) The Contractor shall refuse or fail, after notice or warning from the Engineer, to supply enough properly skilled workmen or proper materials, or
- (e) The Contractor shall refuse or fail to prosecute to work or any part thereof with such diligence as will ensure its completion within the period herein specified (or any duly authorized extension thereof) or shall fail to complete the work within said period, or
- (f) The Contractor shall fail to make prompt payment to persons supplying labor or materials for the work, or
- (g) The Contractor shall fail or refuse to regard laws, ordinances or regulations or otherwise to be guilty of a violation of any provisions of the contract or the Scope of Work therein, then and in such event, the Owner, without prejudice or any rights or remedy it may have, may give seven (7) days notice to the Contractor to terminate the employment of the Contractor and his right to proceed, either as to the entire work or at the option of the Owner as to any portion thereof as to which delay shall have occurred, and may take possession of the work and complete the work by the Contractor or otherwise, as the Owner may deem expedient. In such case, the Contractor shall not be entitled to receive any further payment until the work is finished. If the unpaid balance of the compensation to be paid the Contractor hereunder shall exceed the expense of so completing the work, including compensation for additional managerial, administrative and inspection services and any damages for delay, such excess shall be paid to the Contractor. If such expense shall exceed such unpaid balance, the Contractor and his sureties shall be liable to the Owner for such expenses. If the right of the Contractor to proceed with the work is terminated, the Owner may take possession of and utilize in completing the work such materials, appliances, supplies, drawings, and equipment, as may be on the site of the work and necessary therefore. If the Owner does not terminate the right of the Contractor to proceed, the Contractor shall continue the work.

If the work shall be stopped by order of the Court or any other public authority, for a period of three (3) months without act or fault of the Contractor or of any of his agents, servants, employees, or Subcontractor, the Contractor may, upon ten (10) days notice to the Owner, discontinue his performance of the work and/or terminate the contract, in which event the liability of the Owner to the Contractor shall be determined as provided in the paragraphs immediately preceding, except that the Contractor shall not be obligated to pay to the Owner any excess of the expense of completing the work over the unpaid balance of the compensation to be paid by the Contractor hereunder.

1.12 REFERENCE TO THE STANDARD SPECIFICATIONS

- (a) All applicable portions of the work performed under this contract shall comply with the requirements of the current New Jersey Department of Transportation Standard Specifications for Road and Bridge Construction, as amended or supplemented and whose specifications are made part of these specifications. The New Jersey Department of Transportation Standard Construction Details shall govern except insofar as same are expressly modified, amended or changed in detail drawings prepared specifically for this particular project.
- (b) The Standard Specifications are made part of these specifications by this reference as if were set forth in full. It is the responsibility of the prospective bidder to be familiar with these Standard Specifications. The Contractor is required to follow only the electronic version, effective September 1, 2019, as referenced in Baseline Document Change announcement BDC19S-01 of the New Jersey Department of Transportation Standard Specifications for Road and Bridge Construction, 2019, unless modified in the technical specifications of this contract. Copies may be examined in the Engineer's office or may be obtained from the New Jersey Department of Transportation.

2.0 INSURANCE

2.01 STATE LAW AND REGULATIONS AND INSURANCE

The Contractor must assume all risks connected with his work. He shall comply with all State Laws and Regulations concerning Workmen's Compensation and shall maintain such insurance as will protect him against all claims for damages for personal injury, including death which may arise during prosecution of the contract, either by himself or by any Subcontractor or anyone directly or indirectly employed by either of them.

2.02 CONTRACTOR'S INSURANCE

The Contractor shall not commence work under this contract, until he has obtained all insurance required under this paragraph and such insurance has been approved by the Owner, nor shall the Contractor allow any Subcontractor to commence work, in his subcontract until all similar insurance required of the Subcontractor has been so obtained and approved.

Insurance coverage shall remain in effect until the project is accepted by the Owner, and at all times thereafter when the Contractor may be removing or replacing defective work.

The Contractor shall furnish the Owner with proof of insurance by execution of the Certificate of Insurance, of which a copy is included herein. The Owner, Remington & Vernick Engineers and the Solicitor shall be a named additional insured.

The Certificate of Insurance shall give the Owner and Engineer 30 days written notice of any material change in, cancellation of, or expiration of the policies.

The following types of insurance are required:

- a. General Liability
- b. Automobile Liability
- c. Excess Liability
- d. Worker's Compensation and Employer's Liability

The amounts for property damage and bodily injury for each type of insurance are as shown on the Certificate of Insurance herein.

The Contractor's insurance shall apply to and provide coverage for all Subcontractors and/or suppliers unless the Contractor forwards to the Owner and Engineer the Certificate of Insurance for the Subcontractor and/or supplier.

Any insurance company providing coverage must be licensed, admitted and authorized to do business in the State of New Jersey.

2.03 SUIT OR CLAIMS

The Contractor agrees to indemnify and save harmless the Owner and the Engineer and all their agents and employees from actions and suits of every kind and description brought against them, or on account of the use of patented rights, and from any damages or injuries received or sustained by any party, or parties, arising out of any act or omission of the Contractor, his workmen or agents in performance of the work under this agreement, including the furnishing of equipment, materials and supplies at the site of the proposed work.

2.04 DAMAGES TO PERSONS AND PROPERTY

Contractor shall fully and completely indemnify and save harmless the Owner from damages or injury to persons or property resulting from the performance of the work, or through negligence to the contract, or through the use of any improper or defective machinery implements or appliances or through any act of omission of the Contractor, or his agents, or his employees.

3.0 CONDUCT OF THE WORK

3.01 ROLE OF THE ENGINEER

The Engineer may verify, by observation and/or required tests, the amount, quality, acceptability and fitness of the materials, equipment and supplies furnished; and shall interpret any ambiguities in the drawings and specifications, contract documents, and any extra work order. Upon request, the Engineer shall confirm in writing any oral direction, requirement or determination.

All work of refilling sunken ditches, repaving over trenches and keeping the streets and sidewalks in passable condition shall be satisfactorily performed by the Contractor during the construction of the work as well as during the maintenance period. If any work is not done within 48 hours after written notice given by the Engineer, the work may be done by the Owner and charged to the Contractor.

3.02 SURVEYS

Unless otherwise expressly provided for in the specifications, the Contractor will furnish all surveys necessary for the execution of the work. The Owner will furnish a base line and datum bench marks as required. The Contractor shall measure and lay out his work and be responsible for the accuracy thereof from bench marks and base lines established by the Engineer which shall constitute the surveys hereinbefore referred to. The contractor shall submit cut sheets for curb, sidewalk and roadway construction projects unless specifically waived in writing by the Engineer.

3.03 PRESERVATION OF STAKES

The Contractor shall carefully preserve bench marks, reference points and stakes, and in case of willful or careless destruction, he will be charged with the resulting expense and shall be responsible, for any mistakes that may be caused by their unnecessary loss or disturbance.

3.04 USES OF PREMISES AND REMOVAL OF DEBRIS

The Contractor expressly undertakes at his own expense:

- (a) To take every precaution against injuries to persons or damage to property.
- (b) To store his apparatus, materials, supplies and equipment in such orderly fashion at the site of the work as will not unduly interfere with the progress of his work or the administration of Owner's affairs.
- (c) To place upon the work any part thereof only such loads as are consistent with the safety of that portion of the work.
- (d) To frequently clean up all refuse, scrap material and debris caused by his operations and at all times the site of the work shall present a neat, orderly condition.
- (e) Before final payment to remove all surplus material, false work, temporary structures, including foundations thereof, plant of any description and debris of every nature resulting from his operations and to put the site in a neat orderly condition.
- (f) To affect all cutting, fitting, or patching of his work required to make the same conform to the drawings and specifications, and except with the consent of the Engineer, not to cut or otherwise alter the work.

3.05 INJURY TO EXISTING STRUCTURES

The Contractor shall be responsible for all injury to existing structures met within the prosecution of the work, including the delivery to the site of the proposed improvements of materials and supplies. In case of accident to existing structures met within the prosecution of the work, the Contractor will be required to immediately notify the proper authorities and as soon as possible thereafter also notify the Engineer.

3.06 CORRECTION OF WORK

The Contractor expressly warrants that his work shall be free from any defects in materials or workmanship and agrees to correct any such defects which may appear in such materials or workmanship within two years or the term of the maintenance bond, whichever is longer, following the final acceptance of the work by the Owner, such final acceptance to be evidenced by an appropriate resolution of the governing body in the case of municipal corporation, quasi municipal corporation, municipal board, municipal commission or other municipal authority or by the issuance of final payment in the case of any Owner other than a municipal corporation, quasi municipal corporation, municipal board, municipal commission or other municipal authority.

Neither, the acceptance of the completed work, nor payment therefore shall operate to release the Contractor or his surety or sureties from any obligation or obligations under this contract or the bonds required under these Contract Documents.

3.07 PUBLIC UTILITIES

The contract drawings indicate the approximate location of known overhead and subsurface utilities in the vicinity of the work. The bidder is advised to investigate and ascertain for himself all the facts concerning the actual location of these utilities.

The Contractor shall cooperate with the utility Owners in the adjustment of their facilities and shall notify the utility Owners not less than ten (10) days in advance of the time he proposes to perform any work that will endanger or affect their facilities.

The Contractor shall permit the Owners of utilities, or their agents, access to the site of the work at all times in order to relocate, construct or protect their lines and he shall cooperate with them in performing this work.

Separate payments will not be made for the following:

1. Coordination and cooperation of the Contractor with the utility companies, nor for the protection or replacement of utilities as specified hereinbefore.
2. Damages for delay caused by conflicts with utilities outside the jurisdiction of the Owner (ex: gas mains, telephone or electric lines, county storm sewer, water mains, etc.).

The bidder shall include all such costs in the prices bid for the various scheduled items in the Bid form.

3.08 PROTECTION OF WORK AND PROPERTY

The Contractor shall continuously maintain adequate protection of his work and shall protect Owner's property from injury or loss arising in connection with his work. He shall also protect all adjacent property as provided by law, and shall be responsible for all injury to property and existing structures sustained during the prosecution of his work, including delivery to the site of the equipment, materials and supplies. He shall repair and replace any such damage, injury or loss equal or better than the condition of the item prior to the Contractor's action.

All passageways, guard fences, light and other facilities required for protection by local authorities or local conditions must be provided and maintained.

3.09 CONTRACTOR TO ACT IN AN EMERGENCY

In case of any emergency which threatens loss or injury of property, and/or safety of life, the Contractor is required to act as he sees fit. He shall notify the Engineer thereof immediately thereafter.

3.10 EXTRA WORK

The Contractor further agrees that the Engineer may make such alterations as he may see fit in the form, dimensions, plans for materials of the work, materials and supplies bid upon or any part thereof, either before or after work. If such alterations diminish the quantity of the equipment, materials and supplies to be furnished and delivered to the site or work to be executed, they shall not constitute a claim for damages for anticipated profits on the work that may be dispensed with. If the extra work, change or alteration increases the amount of work to be performed or equipment, they shall be paid for at the price bid. If prices for such extra work are not included in the lump sum prices or unit prices bid, the Contractor hereby agrees to furnish the necessary materials and perform such labor as extra work, and agrees to accept in full payment therefore a price which shall be fixed by the Engineer previous to its commencement. The basis of such price will be the estimated actual cost of materials, labor, equipment, and a maximum 10% overhead plus a maximum 10% profit. Contractor shall furnish a detailed cost breakdown for proposed extra work for

review by the Engineer. The Owner and/or Engineer has the sole authority to unilaterally direct extra work to be performed on a force account basis. The basis of payment for force account work shall be the actual cost of the materials, labor and equipment, and a maximum 10% overhead plus a maximum 10% profit. Contractor shall furnish a detailed cost estimate of the extra work to be paid by force account previous to its commencement. Contractor shall submit daily or shift reports for actual force account costs. Payment for markup on subcontracted work shall be at a maximum rate of 5% of the total amount for all costs on the subcontracted work, for both fixed price and force account extra work. Change Orders and Open End Contracts will be in accordance with N.J.A.C. 5:30-11 et seq.

The Contractor shall not be entitled to receive payment for any extra work unless the same is certified in writing by the Engineer.

3.11 DISPUTE RESOLUTION

For construction contracts, the Owner and Contractor agree that in the event of a dispute arising under this contract, it shall be submitted to a process of resolution pursuant to alternative dispute resolution practices, such as mediation, binding arbitration or non-binding arbitration pursuant to industry standards, prior to being submitted to a Court for adjudication. Nothing in this section shall prevent the contracting unit from seeking injunctive or declaratory relief in court at any time. The alternative dispute resolution practices shall not apply to disputes concerning the bid solicitation or award process, or to the formation of contracts or subcontracts to be entered to pursuant to N.J.S.A. 40A:11-1 et seq. (Local Public Contracts Law).

Notwithstanding industry rules or any provision of law to the contrary, whenever a dispute concerns more than one contract, such as when a dispute in a contract involving design, architecture, engineering or management, upon demand of a contracting party, other interested parties to the dispute shall be joined unless the arbitrator or person appointed to resolve the dispute determines that such a joinder is inappropriate. Notwithstanding industry rules or any provision of law to the contrary, whenever more than one dispute of a similar nature arises under a construction contract, or related construction contracts, upon demand of a contracting party, the disputes shall be joined unless the arbitrator or person appointed to resolve the dispute determines that the disputes are inappropriate for joinder.

During any dispute the Contractor shall diligently proceed with completing the contract unless otherwise directed, in writing, by the Owner or Engineer.

4.0 CONTRACTOR'S PERSONNEL

4.01 PERSONAL ATTENTION

The Contractor shall give his personal supervision to the prosecution of the work, or have a competent representative on the work who shall have written authority to carry out the requirements of the Contract Documents. He shall also supply all manpower, materials and equipment as they may be required in the furnishing and delivery to the site of the proposed work, the equipment, materials and supplies bid upon.

4.02 CONTRACTOR'S SUPERINTENDENT

The Contractor shall attend to the work personally or through a competent, English-speaking superintendent, who shall be continually present on the project site whenever work is in progress. Such a superintendent shall be satisfactory to the Owner and Engineer and shall not be removed or replaced without due notice being given the Owner and Engineer. The Superintendent shall have full authority to act for the Contractor without the need to consult any higher level of authority.

4.03 LABOR LAWS

The Contractor and any Subcontractors shall comply with all the requirements of the Labor Laws of the State of New Jersey applicable to contracts on behalf of this Owner for construction, alteration or repair of any building or public work, including particularly, but without limitation of the foregoing, the provisions of N.J.S.A. 10:2-1 to 10:2-4, inclusive and N.J.S.A. 34:11-56.25 et seq., New Jersey Prevailing Wage Act.

The Contractor hereby agrees to comply in all respect with the New Jersey Prevailing Wage Act, N.J.S.A. 34:11-56.25 et seq. as amended. A copy of the prevailing wage rates pertaining to the work and issued by the New Jersey Department of Labor entitled, "Prevailing Wage Rate Determination" is on file in the Engineer's office and is included herein. Pursuant to N.J.S.A. 34:11-56.25 et seq. – New Jersey Prevailing Wage Act, no public works contract may be awarded to any contractor and subcontractor or to any firm, corporation or partnership in which they have an interest on the attached disbarred bidders list located at the end of this specification, until expiration date given. Workmen shall be paid not less than such prevailing wage rate.

Before final payment is made by or on behalf of the Owner of any sum or sums due to the work, the Contractor or Subcontractor shall file with the treasurer of the Owner, written statements in form satisfactory to the Commissioner of Labor certifying to the amounts then due and owing from such contractor or subcontractor filing such statement to any and all workmen for wages due on account of the work, setting forth therein the names of the persons whose wages are unpaid and the amount due to each respectively which statement shall be certified by the oath of the Contractor or Subcontractor as the case may be in accordance with the said New Jersey Prevailing Wage Act.

The prevailing wage rate shall be determined by the Commissioner of Labor or his duly authorized representative.

Contractors or Subcontractors performing public work of a public body subject to the provisions of this act shall post the prevailing wage rates for each craft and classification involved as determined by the Commissioners of Labor including the effective date of any changes thereof, in prominent and easily accessible places at the site of the work or at such place or places as are used by them to pay workmen their wages.

In the event it is found that any workmen, employed by the Contractor or any Subcontractor, on this project, has been paid a rate of wages less than the prevailing wage required, the Department of Labor along with the Owner may terminate the Contractor's or Subcontractor's right to proceed with the work or such part of the work as to which there has been a failure to pay required wages and to prosecute the work to completion or otherwise, the Contractor and his surety(ies) shall be liable to the Department of Labor along with the Owner for any excess costs occasioned thereby.

Prior to final payment, the Contractor shall be required to execute and deliver an Affidavit of Compliance in a form provided by the Engineer, as required by the Act.

4.04 CONTRACTOR'S EMPLOYEES

All workmen must be competent and fully qualified in the type of work to be performed. Any employee of the Contractor, who is found by the Engineer to be incompetent, or who is performing his work in an unsightly manner or contrary to the specifications or the Engineer's instructions, or who is disorderly, shall be removed from the project and shall not again be employed on the project without the Engineer's consent.

4.05 EIGHT HOUR DAY: PREVAILING WAGE RATE

All mechanics, workers, laborers, employed or engaged in the work hereunder shall work no more than eight (8) hours in any one day. In case of necessity for the protection of property or human life, mechanics, workmen and laborers may be employed for longer periods than eight hours per calendar day, if paid extra

compensation on the basis of eight hours, constituting a days work, in accordance with the Prevailing Wage Act, N.J.S.A. 34:11-56-25 et seq., and all State and Federal laws.

4.06 PAYMENT OF EMPLOYEES

The Contractor and each of his Subcontractors shall pay each of his employees engaged in work on the project under this contract in full (less deductions made mandatory by law) in legal tender and not less often than once each month.

4.07 SAFETY AND HEALTH REGULATIONS

The Contractor shall comply with the Department of Labor, Safety and Health Regulations for construction promulgated under the Occupational Safety and Health Act of 1970 (P.L.91-596) and under Section 107 of the Contract Work Hours and Safety Standards for Construction (P.L.91-54).

4.08 ACCIDENT PREVENTION

Precautions shall be exercised at all times for the protection of persons (incl. employees) and property. The safety provisions of applicable laws, buildings and construction codes shall be observed. Machinery, equipment, and all hazards shall be guarded or eliminated in accordance with the safety provisions of the Manual of Accident Prevention in Construction published by the Association General Contractors in America and Part VI "Temporary Traffic Control" of the U.S. Dept. of Transportation. Federal Highway Administration "Manual on Uniform Traffic Control Devices", latest edition, whichever is more stringent to the extent that such provisions are not in contravention of applicable law. Contractor alone shall be responsible for the safety, efficiency, and adequacy of his plant, appliances and methods and for any damage which may result from their failure for their improper construction, maintenance or operation. The cost of "Accident Prevention" shall be included in the lump sum or unit price bid whichever is applicable.

5.0 MATERIALS

5.01 CONTRACTOR'S TITLE TO MATERIALS

No materials or supplies for the work shall be purchased by the Contractor or by Subcontractor that are subject to any chattel mortgage or under a conditional sale or other agreement by which an interest is retained by the seller. The Contractor warrants that he has good title to all materials and supplies used by him in the work.

5.02 ROYALTIES AND PAYMENTS

The Contractor shall pay all royalties and license fees. He shall defend all suits or claims for infringements of any patent rights and shall save the Owner harmless from loss or account thereof.

5.03 USE OF DOMESTIC MATERIAL

In the performance of the work, the Contractor and all Subcontractors shall use only manufactured materials and farm products of the United States of America, wherever available.

All Contractors and Subcontractors shall comply with the provisions of N.J.S.A. 40A:11-18, which relate to the use of domestic materials.

5.04 ORDERING MATERIALS

Before ordering materials, the Contractor shall obtain the Engineer's approval of their conformity to the specifications. In the case of concrete aggregate, and similar materials, samples must accompany the request for approval. The Contractor must forward to the Engineer copies of all shipping lists, invoices or delivery slips accompanying such deliveries.

5.05 SAMPLES

The Contractor shall submit to the Engineer any samples of materials before or during the progress of the work that may be required by the Contract Documents and all materials and workmanship must be equal in every respect to the samples submitted and approved.

5.06 SHOP OR SETTING DRAWINGS

- (a) The Contractor shall submit promptly eight copies, of which two will be returned to the contractor, of each shop or setting drawings prepared in accordance with the schedule predetermined under the provisions of the preceding paragraph hereof with the Contractor's approval stamp and date thereon. After examination of such drawings by the Engineer, and the return thereof, the Contractor shall make such corrections to the drawings as have been indicated and shall furnish the Engineer with eight corrected copies. If requested by the Engineer, the Contractor must furnish additional copies, regardless of corrections made in or approval given to such drawings by the Engineer. The Contractor will nevertheless be responsible for the accuracy of such drawings and for their conformity to the drawings and specifications unless he notified the Engineer in writing of any deviations, at the time he furnished such drawings. Shop drawing requirements as detailed within the technical specifications and scope of work shall govern should they be in conflict with the General Conditions.
- (b) The Contractor shall likewise submit, in writing, the type, kind and name of the manufacturer of all materials to be used in the work for the written approval of the Engineer prior to the installation of same.
- (c) Any equipment or materials installed without this written approval of the Engineer will be required to be removed by the Contractor at his own expense and replaced with equipment and materials as approved.

5.07 ADDITIONAL INSTRUCTIONS AND DETAIL DRAWINGS

The Contractor will be furnished additional instructions and detail drawings to carry out the work included in the contract as required. The additional drawings and instructions thus supplied, to the Contractor, will coordinate with the contract documents and will be so prepared that they can be reasonably interpreted as a part thereof. The Contractor shall carry out the work in accordance with the additional detail drawings and instructions.

The Contractor and the Engineer will prepare, jointly (a) a schedule fixing the date at which special drawings will be required and by whom they will be made, such drawings, if any, to be furnished by the Engineer in accordance with said schedule, and (b) a schedule fixing the respective dates for the submission of shop or setting drawings; the beginning of manufacture, testing and installation of materials, supplies and equipment and the completion of the various parts of the work, each such schedule to be subject to change from time to time in accordance with the progress of the work.

5.08 OR EQUAL CLAUSES

Wherever in these contract documents a particular brand, make of materials, device or equipment is shown or specified, such brand, make of material, device or equipment should be regarded merely as a standard.

When a bidder submits an equivalent, it shall be the responsibility of the bidder to document the equivalence claim.

Failure to submit such documentation shall be grounds for rejection of the claim of equivalence.

If two or more brands, makes of material, devices or equipment are shown or specified, each should be regarded as the equal of the other. Any other brand, make of material, devices or equipment, which in the opinion of the Engineer is the recognized equal of that specified, considering quality, workmanship and economy of operation, and is suitable for the purpose intended, will be accepted. All material and workmanship shall, in every respect be in accordance with what, in the opinion of the Engineer is in conformity with approved modern practice.

Whenever the drawings, specifications or other contract documents or the direction of the Owner or its authorized agent admit of doubt as to what is permissible, and/or fail to note the quality of any work, that interpretation will be made by the Engineer which is in accordance with approved modern practice to meet the particular requirement of the contract.

In all cases, new materials shall be used unless this provision is waived by notice from the Engineer.

5.09 SUBSTITUTIONS

After the execution of the contract, substitution of equipment or materials of makes other than those named in the contract will be considered for one reason only. That the equipment proposed for substitution is superior or equal in construction and/or efficiency to that named in the contract.

Complete data, to include: shop drawings, specifications, performance curves, test results, list of similar installation with years of service, operating and maintenance instruction, a statement that the Contractor agrees to pay all costs that will result directly or indirectly from acceptance of the substitute, and all other necessary information; shall be submitted in triplicate to enable the Engineer to evaluate the proposed substitution equipment or material. The determination as to whether or not such changes will be permitted rests solely with the Engineer.

The Contractor shall take and assume full responsibility and bear any extra expense or cost incurred by changes advocated by him. Those costs include, but are not limited to, review time by the Engineer or the Engineer's Consultants, costs of redesign, and claims of other contractors affected by the resulting change. It will be assumed that the cost to the Contractor of the equipment or materials proposed to be substituted is less than the equipment or materials named in the contract, and if the substitution is approved, the contract price shall be reduced by an amount equal to the savings.

5.10 MATERIAL SAFETY DATA

In accordance with the requirements of N.J.S.A. 34:5A-1 et seq., "Workers and Community Right to Know Act", the State Department of Health has adopted a Workplace Hazardous Substance List (N.J.A.C. 8:59-9) which includes substances that pose a threat to the health and safety of employees. Therefore, under the provisions of N.J.A.C. 8:59-7, the contractor must furnish the Owner a "Material Safety Data Sheet" for each product which is supplied to the Owner which contains a substance listed on the Hazardous Substance List (N.J.A.C. 8:59-9). The Owner reserves the right to request a copy of the applicable Material Safety Data Sheet be forwarded with the delivery of each product. Furthermore, under the provisions of N.J.A.C. 8:59-5, each

product shall have a label affixed or stenciled onto any container that contains any substance listed on the Hazardous Substance List (N.J.A.C. 8:59-9).

6.0 INSPECTION AND TESTING

6.01 INSPECTION

The Contractor shall afford every facility for inspection of the equipment, materials and supplies at all times by the Engineer prior to the delivery of same to the site of the work. All equipment, supplies and materials shall be tested in the presence of the Engineer, if so desired.

Any equipment, materials, supplies or workmanship deemed of inferior quality, or not in accordance with the finally approved specifications, brought to or incorporated in the work may be rejected by the Engineer. The equipment, materials and supplies and workmanship may be re-inspected at any time, prior to delivery to the site of the proposed improvements. The Contractor shall bear all the expense of testing materials.

When construction is not continuous through the normal work week, (Monday through Friday), Contractor must notify the Engineer at least 24 hours in advance of any stopping or starting of the work. Notification may be by writing, telephone, facsimile, telegraph or personal visit to the Engineer's listed office.

Contractor shall notify Engineer at least forty-eight (48) hours in advance to any work on Saturdays. There will be no work permitted on Sundays or holidays. If the project receives inspection by the Engineer, the normal working hours for the Engineers inspector are from 7:30 a.m. to 4:00 p.m., Monday through Friday. Any overtime inspection costs for the Engineers inspector which are avoidable shall be reimbursed by the Contractor.

Should the contractor have an emergency or need to cancel scheduled work, notification of the cancelled work must be received by the Engineer's inspector no later than 6:00 am the morning of the cancellation. Failure of the contractor to provide the required notification will require the contractor to pay for eight (8) hours of inspection at the rate of the Engineer's local inspector. The costs for cancellation of inspection without the required notification will be deducted from the contractor's payment application.

As the Owner is only paying for the contract time in the Contract Documents, the Contractor shall be responsible for all costs of inspection and contract management beyond the contract time limits, unless a written extension of time has been granted by the Owner. These costs are in addition to any liquidated damages that may be charged to the Contractor.

6.02 DAILY REPORTS

On a daily basis, the Contractor shall have his Authorized Representative complete, sign and present the Engineer with a Certificate of Site Safety Conditions, attached hereto as Form GC-6.02S.

At the Engineers discretion, the Contractor may be directed to furnish a daily report, on a form, which will include the date, the weather, a general description of the work performed, line item quantities involved, number and skill type of workers, equipment utilized, location of work, and any pertinent remarks affecting the work.

6.03 INSPECTORS

The work shall be conducted under the general observation of the Engineer through such Inspectors as the Engineer employs. Inspectors are stationed on the site of the work to represent the Engineer and to report to him concerning the observation of progress of the work and the workmanship and materials being furnished. Such Inspectors shall inform the Engineer and the Contractor when they observe that work being performed and/or the materials being furnished do not conform to the requirements of the Contract Documents. Such

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observation, if and when provided, shall not relieve the Contractor of any responsibility to furnish materials and perform work in complete accordance with the requirements of the Contract Documents, nor does such observation create any duty or obligation to any employee or invitee of Contractor, any Subcontractor, or to any third party. The Contractor is prohibited from relying upon the Engineer's site inspections or raising the engineer's observations as a defense to claims of defective work.

The Inspector is not authorized to revoke, alter, enlarge, relax or release any requirements of the Contract Documents or to issue instructions contrary to the Contract Documents.

6.04 ACCESS TO THE WORK

The Contractor shall furnish the Engineer with every reasonable facility for observing the work as performed.

The Engineer shall have the right to inspect all work done and all materials furnished either in the field or at the point of manufacture. The Contractor shall furnish or cause to be furnished safe access at all times to the places where preparation, fabrication or manufacture of materials and/or construction of the work is in progress.

When the Engineer or his representative are in or about the premises mentioned above in the course of their duties, they shall be deemed conclusively to be an invitee of the Contractor. If the Contractor is not the Owner of the premises mentioned above, the Owner thereof shall be deemed an agent of the Contractor with respect to the obligation assumed hereby. The Contractor or his agent, as described above, shall be liable for the payment of claims for injuries, damages, etc, for death of the Owner or his representative due to the negligence on the part of the Contractor or his agent.

6.05 COVERING UNINSPECTED WORK

If any work be buried, covered or otherwise concealed prior to observation by Engineer or contrary to the orders and direction of the Engineer and such work is not subject to testing and approval by any acceptable alternate method it must, if required by the Engineer, be uncovered for examination. Such uncovering and all necessary restoration regardless of the final acceptability of the work, uncovered, shall be at the expense of the Contractor.

6.06 TESTING MATERIALS

Except as may be provided elsewhere, tests or analysis of materials which are usually tested after delivery to the site, such as concrete aggregate, mixed-in-place concrete, and similar materials; will be performed by the Engineer or testing laboratories which will be approved by the Engineer and selected and paid for by the Contractor. The preliminary testing of concrete mixtures and tests or analysis of other materials, samples of which are to be submitted prior to delivery, will also be performed by the laboratory and paid for by the Contractor at the Engineer's request.

If the Engineer orders sampling and analysis or tests of materials which are usually accepted on certification of the manufacturer but which appear defective or not conforming to the requirements of the Specifications, the Contractor will bear the reasonable costs of sampling, transportation, tests and analysis.

7.0 PAYMENTS

7.01 CONSTRUCTION SCHEDULE AND PERIODIC ESTIMATES

Immediately after execution and delivery of the contract, and before the first partial payment is made, the Contractor shall deliver to the Engineer an estimated construction progress schedule in form satisfactory to the Engineer, showing proposed dates of commencement and completion of each of the various subdivisions of work required under the Contract Documents and the anticipated amount of each monthly payment that will

become due to the Contractor in accordance with the progress schedule. The Contractor shall update the schedule each time a change is approved, but at a minimum every 30 days. An updated schedule shall be submitted with the Contractor's payment application. Should a payment application be submitted without an updated schedule, payment processing may be delayed. The Contractor shall also furnish the Engineer (a) a detailed estimate giving a complete breakdown of the contract price on Lump Sum Contracts and (b) periodic itemized estimates of work done for the purpose of making partial payments thereon. The costs employed in making up any of these schedules are to be used in determining the basis of partial payments.

Approval of the progress schedule by the Engineer does not modify the Contract or constitute Acceptance of the feasibility of the Contractor's logic, activity durations, or assumptions used in creating the schedule. If the schedule reflects a completion date different than that defined by the date of Notice to Proceed and Contract Time, this does not change the specified completion date. If the Engineer approves a schedule that reflects a completion date earlier than that specified as the Contract Time, the Owner will not accept claims for additional Contract Time or compensation as the result of failure to complete the Work by the earlier date shown on the progress schedule. Float is the amount of time that an activity may be delayed from its early start without delaying Completion. Float belongs to the Project and is not for the exclusive use of the Contractor or the Owner.

7.02 PAYMENTS

Unless otherwise specified, on the first day of each month or within thirty (30) days thereafter, the Engineer will estimate approximately the value of the work performed, and equipment, materials and supplies delivered on the ground inspected and accepted during the preceding month, according to these specifications, less any retainage, and shall be certified by the Engineer for payment to the Contractor. The value of the work, as estimated, will be determined by the lump sum and/or unit price bid. Requests for payment for materials on hand shall be accompanied with receipted invoice from supplier. Prior to such payment being made, the Contractor shall execute an agreement, provided by the Engineer and Solicitor on behalf of the Owner, which details the conditions of payment.

If, in the opinion of the Engineer, it is undesirable to replace any defective or damaged materials or to reconstruct or correct any portion of the work injured or not performed in accordance with the contract documents, the compensation to be paid to the Contractor hereunder shall be reduced by such amount as in the judgment of the Engineer shall be equitable.

No request for payment shall be approved until a Certification of Site Safety Conditions showing no unsafe conditions for each day worked in the payment request period has been furnished by the Contractor. When the work performed under this contract has been completed by the Contractor and accepted by the Owner, the Engineer shall make a final estimate of the work and certify the same to the Owner which shall for causes herein specified, pay to the Contractor the balance due, excepting therefrom such sum as may be lawfully retained under any provisions of this contract. All prior estimates and payments including those relating to extra work shall be subjected to corrections by this payment.

The Owner shall pay the amount due to the prime contractor for each periodic payment, final payment or retainage monies not more than 30 calendar days after the billing date, except as provided herein, which for periodic billing shall be established at the pre-construction meeting and memorialized in the minutes of the pre-construction meeting. The billing shall be deemed approved and certified 20 days after the Owner or Owner's Representative receives it, as indicated by the date stamped received on the billing by the Owner or Owner's Representative, except as provided herein, unless the Owner or Owner's Representative provides, before the end of the 20 day period, a written statement of the amount withheld and the reason for withholding payment. The Owner is a public or governmental agency that requires the governing body to vote on authorizations for each periodic payment, final payment or retainage monies, the amount due may be approved and certified at the next scheduled public meeting of the Owner's governing body, and paid during the Owner's subsequent payment cycle.

7.03 RETAINAGE

The Contractor is advised that for contracts \$100,000.00 and under for improvement to real property, the sum of 10% of the amount due shall be held on each partial payment pending completion of the project.

The Contractor is advised that the Local Public Contracts Law, N.J.S.A. 40A:11-1 et seq., are applicable if the total amount of the contract awarded for this project exceeds \$100,000.00. The provisions of N.J.S.A. 40A:11-1 et seq., provide that the Contractor may:

1. Agree to the withholding of payments in the manner prescribed in the contract, or may deposit with the contracting unit registered book bonds, entry municipal bonds, State bonds or other appropriate bonds of the State of New Jersey, or negotiable bearer bonds or notes of any political subdivision of the State, the value of which is equal to the amount necessary to satisfy the amount that otherwise would be withheld pursuant to the terms of the contract. The nature and amount of the bonds or notes to be deposited shall be subject to approval by the contracting unit. For the purposes of this section, "value" shall mean par value or current market value, whichever is lower.
2. Such agreement will be indicated by signing of estimate or payment certificates unless written communication to the contrary is made to the Owner and Engineer, or

If the Contractor agrees to the withholding of payments, the amount withheld shall be deposited, with a banking institution or savings and loan association insured by an agency of the Federal Government, in an account bearing interest at the rate currently paid by such institutions or associations on time or savings deposits. The amount withheld, or the bonds or notes deposited, and any interest accruing on such bonds or notes, shall be returned to the contractor upon fulfillment of the terms of the contract relating to such withholding. Any interest accruing on such cash withholdings shall be credited to the Owner.

Furthermore, N.J.S.A. 40A:11-1 et seq. provides that for contracts over \$100,000.00 for improvement to real property:

1. From the total amounts due as ascertained through a current Engineer's estimate will be deducted an amount equivalent to two percent (2%) of the amount due on each partial payment shall be withheld by the Owner pending completion of the contract.
2. Upon acceptance of the work performed pursuant to the contract for which the contractor has agreed to the withholding of payments pursuant to this section, all amounts being withheld by the Owner shall be released and paid in full to the contractor as required by law after final acceptance by the Owner, without further withholding of any amounts for any purpose whatsoever, provided that the contract has been completed as indicated.

7.04 ACCEPTANCE OF FINAL PAYMENT AS RELEASE

The acceptance by the Contractor of final payment shall be and shall operate as the Contractor's release of the Owner from all claims and all liability to the Contractor, other than claims in stated amounts as may be specifically excepted by the Contractor, for all things done or furnished in connection with the work and for every act and neglect of the Owner, or Owners designee and others relating to or arising out of this work. Any payment, however, final or otherwise, shall not release the Contractor or its sureties from any obligations under the contract documents, and/or arising out of performance of the work, and/or arising out of the obligations undertaken by the surety under performance, payment and/or maintenance bonds.

7.05 OWNER'S RIGHT TO WITHHOLD PAYMENTS

Owner may withhold from the Contractor as much of any approved payments due him, as may, in the judgment of the Owner, be necessary, to

- (a) Secure the payment of just claims then due and unpaid by any persons supplying labor or materials for the work.
- (b) Protect the Owner from loss due to defective work not remedied, or
- (c) Protect the Owner from loss due to injury to persons or damage to the work or property of other Contractors, Subcontractors or others caused by the act or neglect of the Contractor or any of his Subcontractors that the Owner may deem proper to satisfy such claims or to secure such protection. Such application of such money shall be deemed payment for the amount of the Contractor.
- (d) Protect the Owner from enforcement action by others or from being in non-compliance with laws or regulations due to the failure of the Contractor to supply the Engineer and or Owner with Monthly Manning Reports, Certified Payroll Reports or other submittals required by the Engineer or Owner.

7.06 COSTS OF ENGINEERING AND INSPECTION

There will be deducted from the contract and retained by the Owner an amount to defray the cost of wages and overhead paid by the Owner to the Resident Engineer, Inspector or Inspectors employed on the work for any avoidable time in excess of eight (8) hours per day or on Saturdays, Sundays or legal holidays. This amount shall be determined at the rate of the hourly rate contract with the Owner per man hour for each Inspector or Resident Engineer for, in excess of 8 hours per day and at the rate of the hourly rate contract with the Owner per man hour for Saturday, Sunday and Holidays for each Inspector or Resident Engineer.

In addition, there will be deducted from the contract and retained by the Owner an amount equal to the cost paid by the Owner to the Engineer, for all inspection and contract administration performed in excess of the completion time stipulated for the contract, or as amended by approved change orders.

7.07 LIENS

Final payment of retained percentage shall not become due until the Contractor, shall furnish the Owner a complete release of liens arising out of his contract, or receipts in full, in lieu thereof covering claims of any kind or character for work or labor done, or labor or materials furnished by the Subcontractor, materialmen, persons or corporations whatsoever. The form attached entitled "Full Release and Waiver of Liens" shall be submitted with the final voucher prior to final payment.

7.08 PREVAILING WAGE PAYMENT CERTIFICATE

The form attached hereto, entitled "Prevailing Wage Payment Certification" shall be executed by the Contractor and submitted with the final voucher prior to final payment.

7.09 CERTIFIED PAYROLL REPORTS

The Contractor shall submit original certified payroll reports within 10 days of the payment of wages to the Owner with a copy to the Owners designee, in compliance with N.J.A.C. 12:60.

8.0 VALUE ENGINEERING CONSTRUCTION CHANGE ORDERS

8.01 IMPLEMENTATION OF VALUE ENGINEERING

In accordance with N.J.S.A. 40A:11-16.6 a contractor may submit a Value Engineering Construction Proposal (VECP) after the award of a contract for a project for structures or other improvements to real property, other than work affecting a public building, that exceed \$5,000,000. This includes most public works projects, such as utility and environmental systems, road construction and repair, etc., but not building construction, improvements, or renovation. A VECP is a cost reduction proposal based on analysis by a contractor of the functions, systems, equipment, facilities, services, supplies, means and methods of construction, and any other item needed for the completion of the contract consistent with the required performance, quality, reliability, and safety.

8.02 STATUTORY PROVISIONS

- a. Value engineering construction change orders shall not be used to impair any of the essential functions, or characteristics of the project, or any portion of the work involved.
- b. The contractor shall submit a value engineering construction proposal that completely describes the changes to the original specifications or proposal, impact on other project components, advantages and disadvantages of the proposed change, cost estimates and calculations on which they are based, any impact on the contract time schedule, and any other relevant information that the contracting unit may require in order to review the value engineering construction proposal. The contractor's cost for developing the value engineering construction proposal shall not be eligible for reimbursement by the contracting unit.
- c. The contractor shall be liable for all reasonable costs incurred by the contracting unit for the technical evaluation and engineering review of a value engineering construction proposal presented by the contractor.
- d. The contracting unit's engineer shall prepare a written report for the governing body that shall evaluate the value engineering construction proposal, make a recommendation on whether or not it should be accepted, rejected, or modified, and state to the contracting unit and contractor the amount of any projected cost savings.
- e. The proposal shall not be approved unless the engineer reports to the governing body that the proposal appears consistent with the required performance, quality, reliability, and safety of the project and does not impair any of the essential functions, or characteristics of the project, or any portion of the work involved.
- f. The contracting unit shall have the sole discretion to approve or disapprove a value engineering construction proposal.
- g. The contractor and the contracting unit shall equally share in the cost savings generated on the contract as a result of an approved value engineering construction change order. Once the project is completed, the contracting unit's engineer shall verify the cost savings to reflect the actual cost of the work, and such verified cost saving shall be the basis for the savings shared equally with the contractor.
- h. The contractor shall have no claim against the contracting unit as a result of the contracting unit's disapproval of a value engineering construction proposal.

8.03 PROCEDURES

An initial submission is required to use the Value Engineering process. The initial proposal shall outline the general technical concepts associated with the proposal and the estimated savings that will result.

The initial proposal will be reviewed by the Owner and, if found to be conceptually acceptable, approval to submit a final proposal will be granted by the Owner. A finding of conceptual acceptability of the initial proposal in no way obligates the Owner to approve the final proposal. The Contractor shall have no claim against the Owner as a result of the rejection of any such final proposal.

Final proposals will be considered only after Owner approval of the initial proposal.. Final proposals will not be considered if submitted after 50 percent completion of the Work has occurred, based on monthly estimates amounting to more than 50 percent of the total Contract price (subject to any approved adjustments), unless the remaining Contract Time is one year or more.

Proposals will not be considered that change the following:

- a. The type, thickness, or joint designs of a concrete, or HMA surface, intermediate, or base course.
- b. The types and thicknesses of the unbound materials underlying a concrete, or HMA surface, intermediate, or base course.
- c. The basic design of bridges, defined as the type of superstructure and substructure, span length type and thickness of deck, type of beam and arrangement, geometrics, width, and underclearance.
- d. The basic design of retaining walls.
- e. The basic design of overhead sign supports and breakaway sign supports.
- f. The type of noise barriers.
- g. Special architectural aesthetic treatments of structures.

All proposals for changes to bridges and structures shall conform to the current AASHTO Standard Specifications for Highway Bridges as modified by the NJDOT Design Manual for Bridges and Structures.

As a minimum, the following materials and information shall be submitted with each final proposal plus any additional information requested by the Owner:

- a. A statement that the final proposal is submitted as a Value Engineering proposal.
- b. A description of the difference between the existing Contract requirements and the proposed change, and the comparative advantages and disadvantages of each, including considerations of safety, service life, economy of operations, stage construction, ease of maintenance, and desired appearance.
- c. Complete plans, specifications, and calculations showing the proposed revisions relative to the original Contract features and requirements. If the proposal is approved, the Contractor shall submit drawings, in ink, on polyester film such as Mylar or Herculene, 4 mils thick, matted on both sides except as follows:
 - (1) Structural drawings may be submitted in pencil.
 - (2) Electrical drawings may be matted on one side and may be submitted in pencil.
 - (3) Cross-section sheets may be 3 mils thick and may be matted on one side.

All plans and engineering calculations shall bear the signature of a Professional Engineer licensed to practice in the State.

- d. A complete cost analysis indicating the final estimated costs and quantities to be replaced by the proposal, the new costs and quantities generated by the final proposal, and the cost effects of the proposed changes on operational, maintenance, and other considerations.
- e. A specific date by which a Change Order adopting the final proposal must be executed so as to obtain the maximum cost reduction during the remainder of the Contract. This date must be selected to allow the Owner ample time, usually a minimum of 45 days, for review and processing a Change Order. Should the Owner find that insufficient time is available for review and processing, it may reject the final proposal solely on such basis.
- f. A statement as to the effect the final proposal has on the Contract Time.
- g. A description of any previous use or testing of the final proposal on another Owner project or elsewhere and the conditions and results therewith. If the final proposal was previously submitted on another Owner project, indicate the date, the project, and the action taken by the Owner.
- h. The proposal shall not be experimental in nature but shall have been proven to the Owner's satisfaction under similar or acceptable conditions on another Owner project or at another location acceptable to the Owner.

Proposals will be considered only after Award of Contract and only when all of the following conditions are met:

- a. The Contractor is cautioned not to base any bid prices on the anticipated approval of a proposal and to recognize that such proposal may be rejected. In the event of rejection, the Contractor is required to complete the Contract according to the original Plans and Specifications and the prices initially bid and accepted by the Governing Body.
- b. All proposals, approved or not approved by the Owner for use in the Contract, apply only to the ongoing Contract or Contracts referenced in the proposal. The proposals shall become the property of the Owner and shall contain no restrictions imposed by the Contractor on their use or disclosure. The Owner will have the right to use, duplicate, and disclose in whole or in part any data necessary for the utilization of the proposal. The Owner retains the right to use any accepted proposal or part thereof on any other or subsequent project without any obligation to the Contractor. This provision is not intended to deny rights provided by law with respect to patented materials or processes.
- c. If the Owner already has under consideration certain revisions to the Contract that are subsequently incorporated in a proposal, the Owner will reject the Contractor's proposal and may proceed with such revisions without any value engineering obligation to the Contractor.
- d. The Contractor shall make no claim against the Owner or Owner's agents for any costs or delays due to the Owner's rejection of a proposal, including but not limited to development costs, anticipated profits, or increased materials or labor costs resulting from delays in the review of such proposal.
- e. The Engineer will determine whether a proposal qualifies for consideration and evaluation. The Owner may reject any proposal which is not consistent with the basic design criteria for the Project.
- f. The Engineer may reject all or any portion of Work performed pursuant to an approved proposal if the Engineer determines that unsatisfactory results are being obtained. The Engineer may direct the removal of such rejected Work and require the Contractor to proceed according to the original Contract requirements without reimbursement for any Work performed under the proposal, or for its removal. Where modifications to the proposal are approved to adjust to field or other conditions, reimbursement is limited to the total amount payable for the Work at the Contract prices as if it were constructed according to the original Contract requirements. Such rejection or limitation of reimbursement does not constitute the basis of any claim against the Owner for delay or for any other costs.
- g. Proposals will be considered only if equivalent options are not already provided in the Contract Documents.

- h. The proposal shall be made based on items of work scheduled to be done by the Contractor. Anticipated cost savings based on revisions of utility relocations or other similar items to be done by others will not be considered. Proposals that may increase the cost of Work done by others may be considered.
- i. If additional information is needed to evaluate proposals, this information must be provided in a timely manner. Such additional information could include, where design changes are proposed, results of field investigations and surveys, design computations, and field change sheets.

The contracting unit's engineer shall prepare a written report for the governing body that shall evaluate the value engineering construction proposal, make a recommendation on whether or not it should be accepted, rejected, or modified, and state to the contracting unit and contractor the amount of any projected cost savings.

- a. The proposal shall not be approved unless the Engineer reports to the Owner's governing body that the proposal appears consistent with the required performance, quality, reliability, and safety of the project and does not impair any of the essential functions, or characteristics of the project, or any portion of the work involved.
- b. If the Owner fails to respond to the final proposal by the date specified, the Contractor shall consider the final proposal rejected and shall make no claim against the Owner as a result thereof.
- c. The Owner shall have the sole discretion to approve or disapprove a value engineering construction proposal.

If the proposal is accepted, the changes will be authorized by Change Order. Payment will be made as follows:

- a. The changes will be incorporated into the Contract by adjustments in the quantities of Pay Items, agreed upon Extra Work Items or by Force Account, as appropriate, according to the Specifications.
- b. Once the project is completed, the contracting unit's engineer shall verify the cost savings to reflect the actual cost of the work, and such verified cost saving shall be the basis for the savings shared equally with the contractor. The costs of such verification shall be borne equally by both parties.
- c. The Owner's costs for review and processing of the proposal will be deducted from the savings. The cost of the Engineer to verify the savings shall be apportioned equally between the parties.
- d. A Contractor's costs for development, design, and implementation of the proposal are not eligible for reimbursement.
- e. The Contractor may submit proposals for an approved Subcontractor, provided that reimbursement is made by the Owner to the Contractor and that the terms of the remuneration to the Subcontractor are satisfactorily negotiated and accepted before the proposal is submitted to the Owner. Subcontractors may not submit a proposal except through the Contractor.

9.0 DIFFERING SITE CONDITIONS PROVISIONS (N.J.S.A. 40A:11-16.7)

a. Differing Site Conditions Provisions:

- (1) If the contractor encounters differing site conditions during the progress of the work of the contract, the contractor shall promptly notify the contracting unit in writing of the specific differing site conditions encountered before the site is further disturbed and before any additional work is performed in the impacted area.
- (2) Upon receipt of a differing site conditions notice in accordance with Section 9.0(a)1 of this subsection, or upon the contracting unit otherwise learning of differing site conditions, the contracting unit shall promptly undertake an investigation to determine whether differing site conditions are present.
- (3) If the contracting unit determines different site conditions that may result in additional costs or delays exist, the contracting unit shall provide prompt written notice to the contractor containing directions on how to proceed.
- (4)
 - (a) The contracting unit shall make a fair and equitable adjustment to the contract price and contract completion date for increased costs and delays resulting from the agreed upon differing site conditions encountered by the contractor.
 - (b) If both parties agree that the contracting unit's investigation and directions decrease the contractor's costs or time of performance, the contracting unit shall be entitled to a fair and equitable downward adjustment of the contract price or time of performance.
 - (c) If the contracting unit determines that there are no differing site conditions present that would result in additional costs or delays, the contracting unit shall so advise the contractor, in writing, and the contractor shall resume performance of the contract, and shall be entitled to pursue a differing site conditions claim against the contracting unit for additional compensation or time attributable to the alleged differing site conditions.
- (5) Execution of the contract by the contractor shall constitute a representation that the contractor has visited the site and has become generally familiar with the local conditions under which the work is to be performed.
- (6) As used in this subsection, "differing site conditions" mean physical conditions at the contract work site that are subsurface or otherwise concealed and which differ materially from those indicated in the contract documents or are of such an unusual nature that the conditions differ materially from those ordinarily encountered and generally recognized as inherent in the work of the character provided for in the contract.

b. Suspension of Work Provisions:

- (1) The contracting unit shall provide written notice to the contractor in advance of any suspension of work lasting more than 10 calendar days of the performance of all or any portion of the work of the contract.
- (2) If the performance of all or any portion of the work of the contract is suspended by the contracting unit for more than 10 calendar days due to no fault of the contractor or as a consequence of an occurrence beyond the contracting unit's control, the contractor shall be entitled to compensation for any resultant delay to the project completion or additional contractor expenses, and to an extension of time, provided that, to the extent feasible, the contractor, within 10 calendar days following the conclusion of the suspension, notifies the contracting unit, in writing, of the nature

and extent of the suspension of work. The notice shall include available supporting information, which information may thereafter be supplemented by the contractor as needed and as may be reasonably requested by the contracting unit. Whenever a work suspension exceeds 60 days, upon seven days' written notice, either party shall have the option to terminate the contract for cause and to be fairly and equitably compensated therefore.

- (3) Upon receipt of the contractor's suspension of work notice in accordance with Section 9.0(A)2 of this subsection, the contracting unit shall promptly evaluate the contractor's notice and promptly advise the contractor of its determination on how to proceed in writing.
- (4)
 - (a) If the contracting unit determines that the contractor is entitled to additional compensation or time, the contracting unit shall make a fair and equitable upward adjustment to the contract price and contract completion date.
 - (b) If the contracting unit determines that the contractor is not entitled to additional compensation or time, the contractor shall proceed with the performance of the contract work, and shall be entitled to pursue a suspension of work claim against the contracting unit for additional compensation or time attributable to the suspension.
- (5) Failure of the contractor to provide timely notice of a suspension of work shall result in a waiver of a claim if the contracting unit can prove by clear and convincing evidence that the lack of notice or delayed notice by the contractor actually prejudiced the contracting unit's ability to adequately investigate and defend against the claim.

c. Change in Character of Work Provisions:

- (1) If the contractor believes that a change directive by the contracting unit results in a material change to the contract work, the contractor shall so notify the contracting unit in writing. The contractor shall continue to perform all work on the project that is not the subject of the notice.
- (2) Upon receipt of the contractor's change in character notice in accordance with paragraph (1) of this subsection, the contracting unit shall promptly evaluate the contractor's notice and promptly advise the contractor of its determination on how to proceed in writing.
- (3)
 - (a) If the contracting unit determines that a change to the contractor's work caused or directed by the contracting unit materially changes the character of any aspect of the contract work, the contracting unit shall make a fair and equitable upward adjustment to the contract price and contract completion date. The basis for any such price adjustment shall be the difference between the cost of performance of the work as planned at the time of contracting and the actual cost of such work as a result of its change in character, or as otherwise mutually agreed upon by the contractor and the contracting unit prior to the contractor performing the subject work.
 - (b) If the contracting unit determines that the contractor is not entitled to additional compensation or time, the contractor shall continue the performance of all contract work, and shall be entitled to pursue a claim against the contracting unit for additional compensation or time attributable to the alleged material change.
- (4) As used in this subsection, "material change" means a character change which increases or decreases the contractor's cost of performing the work, increases or decreases the amount of time by which the contractor completes the work in relation to the contractually required completion date, or both.

d. Change in Quantity Provisions:

- (1) The contracting unit may increase or decrease the quantity of work to be performed by the contractor.
- (2) (a) If the quantity of a pay item is cumulatively increased or decreased by 20 percent or less from the bid proposal quantity, the quantity change shall be considered a minor change in quantity.

(b) If the quantity of a pay item is increased or decreased by more than 20 percent from the bid proposal quantity, the quantity change shall be considered a major change in quantity.
- (3) For any minor change in quantity, the contracting unit shall make payment for the quantity of the pay item performed at the bid price for the pay item.
- (4) (a) For a major increase in quantity, the contracting unit or contractor may request to renegotiate the price for the quantity in excess of 120 percent of the bid proposal quantity. If a mutual agreement cannot be reached on a negotiated price for a major quantity increase, the contracting unit shall pay the actual costs plus an additional 10 percent for overhead and an additional 10 percent for profit, unless otherwise specified in the original bid.

(b) For a major decrease in quantity, the contracting unit or contractor may request to renegotiate the price for the quantity of work performed. If a mutual agreement cannot be reached on a negotiated price for a major quantity decrease, the contracting unit shall pay the actual costs plus an additional 10 percent for overhead and an additional 10 percent for profit, unless otherwise specified in the original bid; provided, however, that the contracting unit shall not make a payment in an amount that exceeds 80 percent of the value of the bid price multiplied by the bid proposal quantity.
- (5) As used in this subsection, the term “bid proposal quantity” means the quantity indicated in the bid proposal less the quantities designated in the project plans as “if and where directed.”

PREVAILING WAGE PAYMENT CERTIFICATION

This form must be executed by Contractor and submitted with final voucher prior to final payment.

PROJECT Logan Township DPW Pole Barn Extension and Site
Improvements Re-bid

TO Township of Logan

(NAME OF OWNER AS IT APPEARS IN CONTRACT)

RE: Contract for Certification of Contractor of Payment of Prevailing Wages to Workmen Pursuant to
New Jersey Prevailing Wage Act. Chapter 150 Laws of 1963 of New Jersey and all other claims.

The undersigned Contractor hereby certifies that any and all workmen employed by the undersigned Contractor and all Subcontractors have been paid in full and prevailing wages for their respective crafts or trades as determined and computed by the Commissioner of Labor and Industry, of the State of New Jersey, and that all suppliers and material men have been paid in full all amounts claimed by them, and there remains no outstanding claim, lien, or dispute; nor any contingent claim by any of the foregoing:

DATED: _____

CONTRACTOR

STATE OF NEW JERSEY

COUNTY OF _____

_____, being duly sworn according to law, upon his oath disposes and says that he is the _____ (Owner-pres. or authorized agent) of _____ (name of corporation) that he has read the aforesaid statement of certification and knows the content thereof, and that the same is true of his own knowledge and this affidavit is being executed by him pursuant to the New Jersey Prevailing Wage Act (Chapter 150 of Laws of 1963).

Signature

Sworn and subscribed to
before me this _____ day of _____ 20____,

Notary Public of New Jersey

CERTIFICATION OF SITE SAFETY CONDITIONS

Form GC-6.02S

TOWN: _____ PROJECT Logan Township DPW Pole Barn Extension and
NAME: Site Improvements Re-bid
COUNTY: Gloucester JOB #: 0809-T-126

I hereby certify that site safety conditions and the means and methods of construction have been and are in accord with the provisions of the Contract Documents and all requirements contained and referenced therein since the last executed Certificate of Site Safety Conditions, except as noted:

- | | |
|---|---|
| <input type="checkbox"/> Unsafe Trench Condition | <input type="checkbox"/> Unsafe Entry to Live Manhole |
| <input type="checkbox"/> Unsafe Traffic Control | <input type="checkbox"/> Unsafe Equipment |
| <input type="checkbox"/> Inadequate Fall Protection | <input type="checkbox"/> Proximity to Electric |
| <input type="checkbox"/> Other _____ | |

None _____

Comments/Resolutions _____

Contractor: _____

by: _____
Authorized Representative

I executed this form at _____ on _____.
Time Date

FULL RELEASE AND WAIVER OF LIENS

WHEREAS, the undersigned is a subcontractor, supplier or other person furnishing work, services, materials or equipment upon real estate owned by TOWNSHIP OF LOGAN in LOGAN TOWNSHIP, State of New Jersey in furtherance of that certain LOGAN TOWNSHIP DPW POLE BARN EXTENSION AND SITE IMPROVEMENTS RE-BID sponsored by the TOWNSHIP OF LOGAN (hereinafter referred to as "Owner").

Receipt is acknowledged of \$ _____, which represents full payment, for work, services, materials and/or equipment furnished and installed by us at the above referenced project, the undersigned does hereby waive, release and relinquish the Owner and the Building/Land from any and all claims and/or construction liens pursuant to N.J.S.A. 2A:44A-1 *et seq.* relating to this Project, to the extent of \$ _____.

We agree to hold the Owner and the Building/Land harmless against any claim made or lien filed by any of our material suppliers and subcontractors who performed work or supplied materials for the Project to-date.

In addition, the undersigned warrants: (a) that any claims for payment for work, services, materials and/or equipment furnished in the construction or repair of the aforesaid real estate and improvements have not been assigned; (b) that all laborers, subcontractors and suppliers of the undersigned who have furnished work, services, materials and/or equipment in the construction or repair of the aforesaid real estate and improvements have been fully paid and that none of such laborers, subcontractors or suppliers have or will have any claim, demand or lien against the aforesaid real estate and improvements; and (c) that no financing statement, chattel mortgage, security interest, conditional bill of sale or retention of title agreement has been given or executed or will be given or executed for or in connection with any materials, appliances, machinery, fixtures or furnishings placed upon or installed, or to be placed upon or installed, in the aforesaid real estate and improvements by the undersigned.

IN WITNESS WHEREOF, the undersigned has executed and sealed this Full Release and Waiver of Liens this

_____ day of _____, 20.

Paid to date: \$ _____

NAME OF SUBCONTRACTOR/SUPPLIER: _____

By: _____

Title: _____

Sworn and subscribed to

before me this _____ day of _____ 20____,

Notary Public of New Jersey

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LOGAN TOWNSHIP DPW POLE BARN EXTENSION AND SITE IMPROVEMENTS

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SCOPE OF WORK

1.01 General

The project consists of the extending the Department of Public Works garage by installing two pole barns including additional site improvements at 125 Main Street in the Township of Logan, Gloucester County, New Jersey.

1.02 Description

The work of this project consists of the following:

BASE BID:

1. Prepare sub-grade for proposed post framed structures including all required site work and stone base, as indicated in the contract documents.
2. Installation of a one (1) 6,750 square-foot and one (1) 6,600 square-foot pre-engineered post framed structure as indicated in the contract documents. The interior height from the clean stone base (or concrete slab if Alternate Bid Option A4 is awarded) to the underside of the truss of the primary portion of the proposed buildings (Garage #1 – 75'x90' and Garage #2 – 60'x110') shall be sixteen (16) feet. The portion of the proposed Garage #2 building for that connects the existing building to the 60'x110' section shall have an interior height of sixteen (16) feet measured from the top of the concrete slab to the underside of the truss. If the concrete slab alternate is not awarded, clean stone shall be placed to elevation and compacted grade for future addition of slab. The rough in plumbing work will also be included in the base bid for Garage #2. Contractor to provide construction documents signed and sealed by a Professional Engineering, licensed in the State of New Jersey.
3. Excavation, unclassified of existing soils to construct stormwater basin, and installation of geotextile fabric and basin sand, K4 Sand to meet the proposed stormwater basin grades, as indicated on the Plans.
4. Installation of 12" Reinforced Concrete Pipe, Class IV, 18" Reinforced Concrete Pipe, Class III, and 24" Reinforced Concrete Pipe, Class III, where indicated.
5. Installation of Inlet Type 'E', Rip Rap Stone Protection, 12" Thick (D50=6"), Concrete Headwall, where indicated.
6. Installation of all utility hook-ups exclusive of gas utility (see Alternate A6), as shown on the plans. All cleanouts and connections shall be included in the cost of the pipe. The Contractor shall be aware that the new water tie in will have an interior connection into the existing main building boiler room. Costs shall be included in the bid item for the pipe.
7. Any connections to the existing site water, sewer, or electrical utilities required as part of this project shall be performed in a manner such that the other buildings on the site affected by the new work shall not be without adequate utility service at any time during the duration of the contract and the Contractor shall be required to phase the installation of the new systems as needed to accommodate the Owner's schedule and any off hour work required to comply with this requirement shall be included in the Contractor's bid.

8. Furnish and install one (1) oil water separator with integral sand interceptor compartment, complete, including but not limited to, OWS, alarm panel, connections and all appurtenances as shown, specified, or required for a complete and operable system. All costs for these efforts shall be included in line "3.6'x9' 350 Gallon Oil/Water Separator, Inclusive of All Associated Piping, Clean Outs and Accessories Up to and Excluding Connection to New Pump Station Connection" in the proposal.
9. Furnish and install one (1) factory fabricated, assembled, and tested wet-well package pumping station with two (2) submersible grinder sewage pumps, complete, including but not limited to packaged pumping station, controls and annunciator panel, connections, accessories, and all appurtenances as shown, specified, or required for a complete and operable system. All costs for these efforts shall be included in line "Sanitary Sewer Pump Station, 3' Diameter Fiberglass Complete" in the proposal.
10. Furnish and install one (1) concrete fueling pad, 1'-0" thick and one (1) fueling island, 6" thick and 9"x18" Steel Faced Concrete Vertical Curb, complete including but not limited to excavation, select fill, formwork, rebar, concrete, stainless steel curbs/forms, pipe bollards, and all miscellaneous appurtenances as shown, specified or required. Include all site excavation and backfill. Contractor shall coordinate locations of electrical conduits, pipe penetrations, etc. and incorporate into the fueling pad as required. All costs of these efforts shall be included in the individual items for the fueling station in the proposal.
11. Furnish and install fuel dispensing systems capable of dispensing diesel fuel to DPW fleet vehicles, complete, including but not limited to, two (2) remote dispensers, two (2) dispenser sumps, two (2) transition sumps, two (2) 5,000 gallon aboveground fuel storage tanks, anchors, grounding, risers, access stairs, signage, vents, overfill prevention valves, drop tubes, level gauges, stick gauges, product delivery adapters, anti-siphon valves, ball valves, hoses, breakaways, nozzles, submersible pumps, valves, fuel management system, fuel monitoring system, sensors, probes, conduit, piping, accessories, spare parts, DEF dispenser, and all appurtenances as shown, specified or required for a complete and operational system. All costs for these efforts shall be included in the individual items for the fueling station in the proposal.
12. Furnish and install pressure washer system, complete, including but not limited to one (1) natural gas-heated electric pressure washer, hose reel, hose, remote control, nozzle, flue, valves, damper, flashing, connections, detergent, and all accessories and appurtenances as shown, specified or required for a complete and operable system. All costs for these efforts shall be included in the bid item for the wash bay in the proposal.
13. The excavation and re-grading of land, stone area and milled parking lot surrounding the constructed post framed structure to the necessary depths to meet the proposed asphalt grades indicated on the plans. The parking lot resurfacing shall consist of installing 6" thick DGA Base Course, 4" thick HMA 19 M 64 Base Course and 2" thick HMA 9.5M64 Surface Course to allow for positive stormwater drainage to meet proposed elevations.
14. Installation of Chain-link Fence, PVC-Coated Steel, 6' High around perimeter with two (2) Chain-link Fence, Automatic Gate, PVC-Coated Steel, 25' Wide. Automatic gate operator shall be Eagle Slide Gate Opener, 2000 series, as manufactured by Eagle Access Control System, or approved equal. Credential Reader/activator shall be coordinated with the Township and operable with Township's badge system.

15. Price for sawcutting shall be included in various bid items.
16. Borrow topsoil, fertilizer, seed and straw mulching will be placed at all disturbed areas. Areas that are affected by the proposed work will be regraded.
17. All items not otherwise specified for payment shall be included in various lump sum and unit prices in the proposal.
18. The Contractor is required to provide survey layout services by a New Jersey State Licensed Professional Land Surveyor to ensure positive drainage along all resurfaced roadways and to ensure that standard curb ramp tolerances are adhered to. Separate payment will not be made for survey layout services; the cost shall be included in the various items of the proposal.
19. The Contractor is responsible for cleaning and restoration of the site to the pre-construction conditions.

ALTERNATE BID CONSIDERATIONS:

1. Alternative Add Item A1 – Contractor shall provide and install new interior metal stud and gypsum wall board walls, doors and frames for Garage #2.
2. Alternative Add Item A2 – Contractor shall provide and install plumbing fixtures, and Toilet & Shower Room accessories, complete in Garage #2.
3. Alternative Add Item A3 – Provide and install finishes, cabinetry, and lockers, complete in Garage #2.
4. Alternative Add Item A4 – Contractor shall install a 6” thick reinforced concrete slab and surrounding building sidewalk/driveway aprons for entire proposed post framed structures, including welded wire fabric reinforcing, as indicated in the contract documents.
5. Alternative Add Item A5 – All mechanical work as detailed in the plans and specifications. The scope of work for this project consists of the installation of gas-fired unit heaters, exhaust fans, louvers and all related accessories as shown on the drawings and as required by the specifications.

A new gas service, piping and accessories shall be provided to support the new unit heaters in both buildings. The coordination of the new gas service with South Jersey gas shall be performed by the Contractor as part of this project

6. Alternative Add Item A6 – Contractor shall install electrical service to the two (2) buildings that includes all panel and powering work as indicated on the construction plans. The scope of work shall include all electrical service equipment, panel boards, wiring and related accessories shown on the drawings and as required by the specifications.
7. Alternative Add Item A7 – Contractor shall install electrical convenience services to the building that includes receptacles and building lighting as indicated on the construction plans.

8. Alternative Add Item A8 – Contractor shall provide and install emergency generator and service/commission, complete.
 9. Alternative Add Item A9 - An extra work allowance has been provided to cover other work the owner may desire to be performed on a unit rate basis.
- 1.03 The Contractor is responsible for the location of all utilities on-site and for coordination with the Logan Township MUA. Any cost related to this coordination shall be included in the various items in the proposal.
 - 1.04 All related incidental work, including earthwork, traffic control, dust control, soil erosion and sediment control, cleaning and restoration.
 - 1.05 The Contractor shall visit the site and include all the costs for a complete project. The Owner is not responsible for additional costs based on the Contractor's failure to properly inspect the existing conditions, field verify all dimensions, and include all costs in the bid.
 - 1.06 Storage of construction materials of any kind and/or equipment will not be allowed on private property.
 - 1.07 The contractor shall perform a preconstruction video of the site. The cost of the video is not paid separately but is to be included in the various items in the proposal.
 - 1.08 The Contractor shall turn in submittals for review and approval prior to the start of work.
 - 1.09 Contractor is responsible to coordinate with Logan Township in order to obtain and pay for any required Gloucester County Road Opening Permits. Separate payment will not be made; all costs shall be included in the various items in the proposal.
 - 1.10 The above Scope of Work outlines the general items and shall not be construed as being all-inclusive.
 - 1.11 **The Township reserves the right to award the Base Bid plus the Alternate Bids at their discretion, based on the available funds for this project prior to awarding the contract. Should a contractor choose not to bid an add alternate his bid will not be considered should the Township have funds to engage the addition to the base bid. Contractors are encouraged to bid all alternates.**
 - 1.12 The plans entitled "Logan Township DPW Pole Barn Extension and Site Improvements" in the Township of Logan, Gloucester County, New Jersey are appended hereto and are now made part of these specifications.
 - 1.13 The Contractor is advised that the Executive Order 107 issued by Governor Murphy on March 21, 2020 allows construction projects to continue in New Jersey.
 - a. This project is being advertised under COVID-19 Pandemic conditions with the intention of construction Summer/Fall 2022. The local construction office is operational to perform necessary inspections. Remington & Vernick Engineers is operational to provide all necessary construction management and administration.

- b. In accordance with the contract documents, the Contractor alone is responsible for safety. All guidelines issued by Federal, State, and local authorities shall be followed. Costs associated with added safety measures to comply with these guidelines under the current conditions should be included in the contractor's bid price. This includes, but is not limited to: PPE, labor scheduling and staging, added sanitizing and cleaning, and reduced productivity due to social distancing requirements.
- c. In accordance with the contract documents, the Contractor is responsible for the protection of his work, the Owner's property, and all adjacent property as provided by law. This provision applies during active construction, during downtime, and includes delivery to the site of equipment, materials and supplies.

Additionally, Governor Murphy's Executive Order No. 122, issued and effective April 10, 2020 at 8 pm, requires that essential construction projects must adopt policies meeting certain minimum guidelines targeted at safety and reducing opportunity for COVID-19 transmission.

All NJ construction projects will be required to implement the following minimum guidelines:

- a. Prohibit non-essential visitors from entering the worksite;
- b. Limit worksite meetings, inductions, and workgroups to groups of fewer than ten (10) individuals;
- c. Require individuals to maintain six (6) feet or more distance between them wherever possible;
- d. Stagger work start and stop times where practicable to limit the number of individuals entering and leaving the worksite concurrently;
- e. Stagger lunch breaks and work times where practicable to enable operations to safely continue while utilizing the least number of individuals possible at the site;
- f. Restrict the number of individuals who can access common areas, such as restrooms and breakrooms, concurrently;
- g. Require workers and visitors to wear cloth face coverings, in accordance with CDC recommendations, while on the premises, except where doing so would inhibit the individual's health or the individual is under two years of age, and require workers to wear gloves while on the premises;
- h. Require infection control practices, such as regular hand washing, coughing and sneezing etiquette, and proper tissue usage and disposal;
- i. Limit sharing of tools, equipment, and machinery;
- j. Provide sanitization materials, such as hand sanitizer and sanitizing wipes, to workers and visitors; and
- k. Require frequent sanitization of high-touch areas like restrooms, breakrooms, equipment, and machinery.

These minimum standards are required site safety measures that contractors must implement and include the prices within the bid proposal. Contractor claims for lost productivity or schedule delays related to guidelines or restrictions already in place at the time if bidding will not be considered for approval.

The Contractor is expected to provide a supplement to their safety plan to incorporate and provide details with regard to these parameters and any additional as may be implemented.

END OF SCOPE OF WORK

SECTION 01000 - GENERAL REQUIREMENTS

1.01 GENERAL

- A. Only major items of work are given in the Bid Form, but it is the intent of the specifications to secure a completely interconnected and functionable system, and if any workmanship or materials be required which are obviously necessary to carry out the full intent and meaning of the plans and specifications or to be reasonably inferred therefrom, the cost of such workmanship or materials shall be included in the unit price for the major items of work.
- B. Where construction is being performed in traveled roadways, Contractor is to provide necessary traffic control and devices in accordance with the Current Manual on Uniform Control Devices.
- C. Contractor shall notify all utility companies prior to construction of the work under this contract including the utility "Call Before You Dig" requirement at 1-800-272-1000 for any excavation or asphalt paving work under the contract.
- D. Prior to any excavation, the Contractor shall have all utilities marked, and shall excavate or otherwise determine the exact location and elevations of said utilities. The Contractor shall notify the Engineer of any conflicts. The Contractor shall arrange for any necessary utility relocations or plan changes and shall reschedule his operations appropriately.
- E. The contractor, in the construction of any project, shall not stockpile materials or his equipment on any private property; except areas designated by the plans or as directed by the Engineer. If so required, the Engineer may direct the Contractor to have his equipment removed from any project during weekend hours.
- F. All work of refilling sunken ditches, repaving over trenches and keeping streets and sidewalks in passable condition shall be done to the satisfaction of the owner during the construction of the above work as well as during the maintenance period. If any work is not done within five (5) days after written notice is given by the Engineer, the work may be done by the Owner and charged to the Contractor.
- G. Special care shall be taken to prevent contamination, siltation, or interfering in any way with the stream flows or ponds along the line of work. No waste matter of any kind will be allowed to discharge into the stream flows or impounded water or any ponds or other bodies of water.
- H. The contractor is hereby advised that Public Law 1975, Chapter 251, as amended by P.L. 1979, Chapter 459 is applicable to this project.
- I. It is the intent of the current standards for Soil Erosion and Sediment Control to ensure that proper measures for erosion control are employed and provide for the early establishment of vegetation that will help avoid erosion problems during and after construction. It is expected that the contractor will anticipate possible problems and provide timely and adequate control to prevent or minimize adverse effect.
- J. The contractor shall apply and pay for all permits that may be required for any of the work involved with this project. Municipalities or Authorities having an interest or jurisdiction on this project are: **Logan Township**

- K. Contractor is to notify residents by door-hangers at least forty-eight (48) hours in advance before starting construction work.
- L. All notes on plans shall be made a part of the specifications.
- M. Contractor shall notify Engineer at least forty-eight (48) hours in advance of any work on Saturdays. There will be no work permitted on Sundays or holidays. This project will receive inspections and the normal working hours for the Inspector are from 8:00 AM to 4:30 PM, Monday through Friday. Any overtime inspection costs which are avoidable will be reimbursed by the contractor.
- N. During the construction of the project, travel lanes shall remain open at all times.
- O. Contractor shall take extreme care in the placement of the asphaltic tack coat so as to not make it visible on the concrete curb. It shall be the contractor's responsibility to keep the concrete curb clean of this oil.

1.02 PUBLIC UTILITIES

- A. The bidder is advised to ascertain for himself all the facts concerning the location of existing utilities.
- B. The contractor shall cooperate with the utility owners in the adjustment of their facilities and shall notify the utility owners not less than ten (10) days in advance of the time he proposes to perform any work that will endanger or affect their facilities.
- C. The Contractor shall permit the owners of utilities, or their agents' access to the site of the work at all times in order to relocate, construct or protect their lines and he shall cooperate with them in performing this work.
- D. Separate payments will not be made for the coordination and cooperation of the contractor with the utility companies, nor for the protection or replacement of utilities as specified hereinbefore and the bidder shall include all such costs in the prices bid for the various scheduled items in the Bid Form.

1.03 PRE-CONSTRUCTION PHOTOGRAPHS

- A. The Contractor shall, at no extra cost, take DVD or digital photographs of the site prior to the commencement of construction. The DVD or photograph record shall accurately depict the existing preconstruction condition of all curbs, sidewalks, driveways, fences, lawns, landscaped areas, mailboxes, street furniture and all other appurtenances within, or outside a 25-foot radius of the limits of the construction of the project. One (1) copy of the CD photograph record or DVD shall be provided to the Engineer. The date of all disks, as well as identification as to the location which the records depict, must be provided.

1.04 MAINTENANCE & PROTECTION OF TRAFFIC

- A. The contractor shall erect or place and maintain in good condition, barricades, warning signs, lights, rubber traffic cones, and other warning and danger signals and devices, appropriate and adequate for the specific needs and subject to the Engineer's approval at working sites, closed roads, intersections, open excavations, locations of material storage, standing equipment and other obstructions, at points where the usable traffic width of the road is reduced, and at points where traffic is deflected from its vehicular or pedestrian traffic.
- B. The contractor shall provide sufficient watchmen and traffic directors and shall take all other precautions including any that may be ordered by the Engineer, which are necessary for the safety of the public and protection of the work.
- C. The contractor shall obtain the approval and consent of all appropriate authorities having jurisdiction, for any detours which may be required. The contractor shall make all necessary arrangements with such authorities regarding the establishment, maintenance and repair of such detours, the regulations and direction of traffic thereon, and the installation and maintenance of sign and traffic devices.
- D. Before beginning work on any phase of the project, the contractor shall furnish and install all specified warning signals, barricades, wood traffic guides, lights and other devices necessary, in the opinion of the Engineer, to protect the public during that phase of his operations.
- E. Road construction signs shall be placed at each end of the project along the road for the work along the public road.
- F. During the work on this project, the contractor shall provide and/or be prepared to provide traffic protection devices in accordance with Part VI "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES FOR STREETS AND HIGHWAYS," Current Edition. The minimum numbers set forth in the Manual shall be on hand at each separate project site prior to the commencement of any work (or phase of work) and shall be maintained available on the project site throughout the period of the project (or phase). Failure to provide and maintain the minimum number of devices specified in the Manual shall be sufficient cause for the Engineer to order cessation of the work. When lack of any required safety devices presents an immediate hazard, the engineer may order that such devices be provided by the Owner or by other contractors, deducting the cost thereof from any monies due or becoming due the contractor.
- G. Additional devices up to the maximum number set forth in the Manual shall be provided by the contractor as required or directed prior to the commencement of any operation or phase of an operation requiring such devices.
- H. Traffic directors (flagmen) shall be provided whenever alternate two-way traffic is maintained in a single lane, whenever contractor's operations require closing of a lane or portion of a lane on a multiple lane roadway, whenever the contractor's equipment or vehicles are entering or leaving active roadways at other than normal street intersections, whenever a contractor's operations will be contrary to or cause confusion regarding normal traffic control devices (traffic signals, signs, etc.) within a work area and whenever else, in the opinion of the Engineer, the contractor's operations cause such hazards as to require the use of Traffic Directors.

- I. Traffic Directors shall be responsible and thoroughly familiar with their responsibilities, and while serving as Traffic Directors, shall not be required to perform any other duties. Traffic Directors shall be provided with an orange or red flag, an orange or orange and white traffic safety vest or orange hard hat or other appropriate head gear.
- J. Traffic must be maintained throughout each separate work area during construction. At least one 12' lane must be maintained for traffic during all actual construction periods and at least two 10' lanes must be maintained for traffic at all other times.
- K. The contractor is advised that there is heavy commuter traffic during the morning from 7:30 AM to 9:00 AM and the afternoon from 4:00 PM to 5:30 PM. The contractor shall schedule his construction activity such that he does not interfere or restrict traffic during the above peak hours.
- L. Construction shall be so staged to maintain at least one lane for traffic in each direction throughout each separate work area during the morning, 7:30 AM to 9:00 AM, and the afternoon, 4:00 PM to 5:30 PM weekday periods of peak traffic.
- M. Any restriction of traffic at any time shall be subject to the review of the Engineer and the Police Department having jurisdiction in the work area. The contractor shall submit a schedule of staged construction for review prior to any restriction of traffic.
- N. If detours are proposed by the Contractor, they are to be submitted to the Engineer for review and approval by the Police Department having jurisdiction in the work area and any other agency having jurisdiction of the roadway that will be detoured or roadway that will be used as a detour.
- O. All detour signs shall conform to the requirements for Traffic Control Devices.
- P. Temporary traffic stripes will be necessary to control and guide traffic through individual work areas. The contractor shall submit a scheme for review by the Engineer of all temporary traffic stripes prior to removal of any existing traffic stripes.
- Q. Construction of proposed utilities across existing roadways shall be so staged to maintain one lane in each direction. Trenches shall not remain open overnight.
- R. The contractor shall provide adequate means of access for fire, police and emergency vehicles throughout the length of the project.

1.05 TEMPORARY PAVING FOR ALL TRENCHES

- A. Description - 2" thick temporary paving shall be in accordance with the plans and specifications and to the prescribed lines and grades. Temporary paving replacement shall include necessary excavation.
- B. Materials - Materials shall conform to the New Jersey Department of Transportation Standard Specifications for Road and Bridge Construction 2007 and/or as amended by these contract specifications.

- C. Contractor shall submit to Engineer, in triplicate, reports on materials used, attesting to the fact that said materials conform with these specifications of the State of New Jersey Department of Transportation and the Engineer.
- D. Method of Construction - Unless shown or specified otherwise, the trenches or other excavation, after backfilling, shall be covered with 2" thick temporary paving in passable condition suitable for normal use. The cost of such temporary paving and maintenance shall be included in the contract price for all items.

1.06 REFERENCE TO THE STANDARD SPECIFICATIONS

- A. Portions of the work performed under this contract shall comply with the requirements of the State of New Jersey Department of Transportation Standard Specifications for Road and Bridge Construction 2007, and all requirements modified, as amended or supplemented and whose specifications are made part of these specifications. The New Jersey Department of Transportation Standard Construction Details shall govern except insofar as same are modified, amended or changed in detail drawings prepared specifically for this particular project.
- B. The Standard Specifications are made part of these specifications by this reference as if they were set forth in full. It is the responsibility of the prospective bidder to be familiar with these Standard Specifications. Copies may be examined in the Engineer's office or may be purchased from the New Jersey Department of Transportation, 1035 Parkway Avenue, Trenton, New Jersey, 08625.

1.07 DUST CONTROL

The contractor will be required to maintain all excavations, embankments, stockpiles, haul roads, permanent access roads, plant sites, waste areas, borrow areas, and all other work areas within or outside the project boundaries free from dust which would cause a hazard or nuisance to others. Approved temporary methods of stabilization consisting of sprinkling, chemical treatment, light bituminous treatment or similar methods will be permitted to control dust. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the contractor must have sufficient competent equipment on the job to accomplish this if sprinkling is used. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs. If any dust control is not done within twenty-four (24) hours after written notice is given by the Engineer, the work may be done by the Owner and charged to the Contractor. Costs for dust control shall be included in the prices bid for the various items in the bid form.

1.08 QUANTITY AND PAYMENT

Unless otherwise provided for in these contract specifications, no separate payment will be made for work associated with this section and all costs shall be included in the various items of the bid proposal.

END OF SECTION

SECTION 01010

AS-BUILT DRAWINGS

1.01 GENERAL

The Contractor shall provide a set of reproducible as-built drawings by a licensed NJPLS prior to final payment.

2.01 MATERIALS

A. As-builts shall be a reproducible of the original contract drawings including any additional sheets required. All deviations from the original contract drawings shall be on the as-builts. The drawings shall be legible, neat, and of a quality acceptable to the Engineer.

B. The Engineer shall provide a set of reproducible drawings at the beginning of the project.

3.01 EXECUTION

A. The Contractor shall be responsible for keeping the as-built up-to-date as the project progresses.

B. This section is intended to provide a minimum level of acceptance. Any section with more stringent requirements shall have precedence over this section.

4.01 PAYMENT

No separate payment will be made for work performed under this section.

END OF SECTION

SECTION 01710 - CLEANING AND RESTORATION

1.01 DESCRIPTION

- A. Contractor shall provide all equipment, labor and materials required to clean and restore the site and building to at least the existing condition.
- B. Maintain premises and public properties free from accumulations of waste, debris and rubbish caused by work operations.
- C. At completion of work, remove waste materials, rubbish, tools, equipment, machinery and surplus materials; clean all sight exposed surfaces; leave project clean and ready for occupancy.
- D. At completion of project, restore and replace, when and as directed by the Engineer, any public or private property disturbed, damaged or exposed by Contractor's work operations to a condition at least equal to that existing prior to beginning work, or as otherwise specified. Materials, equipment and methods shall be approved by the Engineer.

1.02 MATERIALS

- A. For restorations, use the following materials. All materials shall comply with the following Articles of the New Jersey Department of Transportation Standard Specifications latest revisions and these specifications.
- B. Grass restorations: See Section 806 "Fertilizing and Seeding" and Section 808 "Sodding."
- C. Pavement restorations: See Section 401 "Hot Mix Asphalt (HMA) courses."
- D. Restoration of curbs and other concrete structures:
 - 1. Concrete:
 - a. Shall conform to Section 903.
 - b. Compressive Strength: 4,000 psi at 28 days.
 - c. Air-entrained.
 - 2. Joint Fillers: Section 914.01, preformed expansion joint filler.
 - 3. Curing Compound: Section 903.10.
 - 4. Roof Drains: Any damaged drains located within the curb shall be restored.
- E. All Other Materials: As approved by the Engineer or authorities as jurisdiction.
 - 1. Interior finishes shall match existing adjacent surfaces and/or approved by owner.

1.03 METHOD OF CONDUCTING WORK - CLEANING

A. Requirements of regulatory agencies:

All excess material shall be removed from the site and disposed of by the Contractor at his expense. Cost to be included in the unit price bid for all items. The disposal site shall be in permanently established licensed OSWA (Office of Solid Waste Administration, New Jersey Department of Environmental Protection) landfills.

B. Cleaning during construction:

Provide periodic cleaning to keep the work, the site, and adjacent properties free from accumulations of waste materials, rubbish and windblown debris resulting from construction operations.

Provide on-site containers for the collection of waste materials, debris and rubbish. Maintain containers as required.

C. The Contractor will be required to maintain all excavations, embankments, stockpiles, haul roads, permanent access roads, plant sites, waste areas, borrow areas, and all other work areas within or outside the project boundaries free from dust which would cause a hazard or nuisance to others. Approved temporary methods of stabilization consisting of sprinkling, chemical treatment, light bituminous treatment or similar methods will be permitted to control dust. Sprinkling, to be approved, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times, and the Contractor must have sufficient competent equipment on the job to accomplish this if sprinkling is used. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs. If any dust control is not done within twenty-four (24) hours after written notice is given by the Engineer, the work may be done by the Owner and charged to the Contractor.

1.04 METHODS OF CONSTRUCTION

A. General: All existing structures, unpaved areas and paved areas disturbed or damaged during the work under this contract shall be restored or replaced to a condition at least equal to that existing prior to the beginning work, or as otherwise specified. The methods of conducting this work shall, as a minimum, conform to the following Articles of the New Jersey Department of Transportation Standard Specifications, latest revision.

B. Grass Restorations:

See Section 806 "Fertilizing and Seeding" and Section 808 "Sodding."

C. Pavement Restorations:

The method of construction employed shall conform to the requirements set forth in Section 301, 304 and 401 of the Standard Specifications as applicable to the type of material being utilized.

Restoration type and thickness shall be as shown on the contract drawings.

D. Restorations of curbs and other concrete structures:

1. Curbs: Section 607
2. Other concrete structures: Restore in accordance with applicable Articles of the Standard Specifications.

E. All Other Restorations:

Restore in accordance with applicable Articles of the Standard Specifications, or as approved by the Engineer or authorities having jurisdiction.

1.05 QUANTITY AND PAYMENT

- A. All costs for Cleaning and Restorations shall be included in prices bid for various items scheduled in the Proposal.

END OF SECTION

SECTION 02 21 00
TRENCHING, SITE EXCAVATION, BACKFILLING AND COMPACTION

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

- A. Refer to Division 1 as they form a part of this Section.
- B. Furnish all tools, equipment, labor and materials, and perform operations necessary for complete all required Trenching, Site Excavation, Backfilling and Compaction Work of this Section in strict accordance with these Specifications and requirements of Drawings.

1.2 WORK INCLUDED

- A. Provide trenching, site excavation, backfilling and compaction as indicated on Drawings, as specified herein and as needed for a complete and proper installation, including but not necessarily limited to the following:
 - 1. Excavate trenches for rerouting of existing utilities.
 - 2. Excavate all equipment foundations and footings as indicated on the contract documents.
 - 2. Shore, form or brace excavations as may be required.
 - 3. Dewater all open trenches as may be required.
 - 4. Compact bed and compacted fill over utilities to subgrade elevations.
 - 5. Compaction requirements.
 - 6. Existing utility lines encountered in the Work shall be capped and removed if not used in the Project. Utility lines to remain or to be used shall be rerouted as indicated or as required for project requirements.
 - 7. Testing Laboratory Services.
- B. All material and compaction of soil shall be approved by the Soils Engineer as provided and paid for by the General Contractor.

1.3 RELATED WORK

- A. Section 02210 – Trenching, Backfilling and compaction.
- B. Section 02115 – Landscaping - Topsoil, seed, sod, and tree planting.
- C. Water Distribution: Water piping from buildings to municipal utilities.
- D. Sewerage and Drainage: Sewer piping from buildings to municipal utilities.
- E. Electric Service: Electric service from buildings to municipal utilities.

1.4 TESTS

- A. General
 - 1. The Contractor shall retain of a qualified, experienced soil testing laboratory to provide compaction data on fill and backfill material and in-place density control. The cost of this laboratory and field testing shall be borne by the Contractor. The Contractor shall submit the credentials of the testing laboratory to the Architect for approval prior to beginning any site work.
- B. Tests and analysis of fill materials will be performed in accordance with ASTM D1557.
- C. When Work of this Section or portions of Work are completed, notify the testing laboratory to perform density tests. Do not proceed with additional portions of Work until results have been verified.

- D. If, during progress of Work, tests indicate that compacted materials do not meet specified requirements, remove defective work, replace and retest at no cost to Owner, as directed by the Architect.
- E. Ensure compacted fills are tested before proceeding with placement of surface materials.

1.5 REFERENCES

- A. ASTM C136 - Sieve Analysis of Fine and Coarse Aggregates.
- B. ASTM D1556 - Density of Soil in Place.
- C. ASTM D1557 - Method C, Moisture Density Relationship

1.6 SAMPLES

- A. Submit 10 lb. sample of each type of fill to testing laboratory, in air-tight containers.

1.7 PROTECTION

- A. Protect areas to receive seeding and other features remaining as part of final landscaping.
- B. Protect bench marks and existing structures, roads, sidewalks, paving and curbs against damage. Repair damage at no costs to Owner.
- C. Protect excavations by shoring, bracing, sheet piling, underspinning, or other methods required to prevent cave-in or loose soil from falling into excavation.
- D. Notify Architect of unexpected subsurface conditions and discontinue work in affected area until notification to resume work.
- E. Protect bottom of excavations and soil adjacent to and beneath foundations from frost.
- F. Grade excavation top perimeter to prevent surface water run-off into excavation.

1.8 TEMPORARY DRAINAGE, PUMPING AND DEWATERING

- A. Keep excavations free of water. Form protective swales to drain water away from top of banks of excavated areas and to prevent erosion of banks.
- B. If pumping of water becomes necessary, include equipment, fuel, labor, maintenance and other relevant work necessary to keep pumps operating. Pump the water to natural or manmade drainage without overloading or eroding same.
- C. During filling operations, maintain water level below deposited fill material.

PART 2 - PRODUCTS

2.1 SELECT BED AND FILL MATERIALS

- A. Provide soil materials free from organic matter and deleterious substances, containing no rocks or lumps over 6" in greatest dimension.
- B. Fill under landscaped areas: Free from alkali, salt, petroleum products. Use subsoil excavated from site only if conforming to specified requirements.
- C. Pipe bedding: granular material consisting of sand, gravel, crushed gravel or crushed stone conforming to ASTM C33-78, gradation 67, (3/4 inch to No.4)
- D. Fill material is subject to the approval of the Soils Engineer.

2.2 COMMON FILL MATERIALS

- A. Subsoil: Reused; free of gravel larger than 3 inch size, and debris.
- B. Test and verify the stockpiles backfill material as still being in conformance with the quality specified. If tests show material unacceptable, modify to acceptable condition, or provide new acceptable off-site material. Remove unacceptable material from site.
- C. Fill material is subject to the approval of the Soils Engineer.

2.3 OTHER MATERIALS

- A. All other materials not specifically described but required for a complete and proper installation of the Work of this Section, shall be provided by the Contractor and shall be new, first quality of their respective kinds and subject to approval of the Architect.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Verify stockpiled fill to be reused is approved by the Soils Engineer.
- B. Verify areas to be backfilled are free of debris, snow, ice, or water, and surfaces not frozen.

3.2 PREPARATION

- A. Identify and set required lines, levels, contours, and datum.
- B. Maintain benchmarks, monuments and other reference points.
- C. When necessary, compact subgrade surfaces to density requirements for backfill material.

3.3 SURFACE CONDITIONS

- A. Examine the areas and conditions under which Work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.4 UTILITIES

- A. Before starting excavation, establish the location and extent of underground utilities occurring in the Work area.
- B. Notify utility companies to remove and relocate lines which are in the way of excavation.
- C. Maintain, reroute or extend as required, existing utility lines to remain which pass through the Work area. Pay costs for this Work, except those covered by the utility companies.
- D. Protect active utility services uncovered by excavation.
- E. Remove abandoned utility service lines from areas of excavation. cap, plug or seal such lines and identify at grade.
- F. Accurately locate and record abandoned and active utility lines rerouted or extended, on project record drawings.

3.5 EXCAVATION

- A. Excavate for all utility services from building(s) to municipal utilities. Ensure trenching does not interfere with normal 45 degree bearing splay of any foundation.
- B. Excavate in accordance with lines and grades.
- C. Remove lumped subsoil, boulders and rock.
- D. Do not disturb soil within branch spread of existing trees or shrubs that are to remain. If it is necessary to excavate through roots, perform work by hand and cut roots with a sharp ax.
- E. Hand Excavation: Do excavation within 3 feet of any existing utility line by hand and in accordance with the requirements of the utility company involved. Coordinate with the utility company and make necessary arrangements to avoid damages. Be responsible for damage during excavation to existing pipe, conduit or equipment and repair any damage. Protect trees and roots from damage.
- F. Trench Depth: Excavate to the minimum depths below the bottom of the conduit as shown.

Trench Width:

1. From the subgrade elevation to an elevation at least 12 inches above the top of the conduit, the banks of the trenches shall be excavated to vertical lines and the trenches shall not be less than 23 inches nor more than 16 inches wider than the conduit to be laid. If sheeting is required, the foregoing dimensions shall be applicable to the inside faces of the sheeting.
 2. From a point 12 inches above the top of the conduit to the surface, the banks of trenches in streets, roads or highways, paved or unpaved, shall be kept as nearly vertical as possible, and in no case shall the width of trench at the top exceed the outside diameter of the conduit plus 48 inches.
 3. As warranted by working conditions and where permitted by applicable local and state requirements, the Owner's Representative may waive the requirements that the maximum width at the top of the trench not exceed the outside diameter of the conduit plus 48 inches.
- G. Trench Length - No trench shall be opened more than 400 feet in advance of conduit installation without express permission. Where rock excavating is encountered, trenches must be fully opened at least 30 feet in advance of pipe installation.
- H. Bottoms of excavations are subject to approval. Protect bottoms of excavations from freezing.
- I. Do additional excavation only by written authorization of Architect.
- J. Correct unauthorized excavation as directed by Soils Engineer, at no cost to Owner.
- K. Fill over-excavated areas under pipe bearing surfaces in accordance with direction of the Soils Engineer.
- L. Stockpile excavated material in area designated on site and remove excess subsoil not being re-used, from site.
- M. Where it becomes necessary to excavate beyond the limits of normal excavation lines, backfill the voids remaining after removal of foreign objects as directed by the Soils Engineer.
1. When the void is below the subgrade for the utility bedding, use suitable earth materials and compact to the relative density directed by the Soils Engineer, but in no case to a relative density less than 90%.
 2. When the void is below the subgrade for the utility bedding, use suitable earth materials or sand compacted or consolidated as approved by the Soils Engineer, but in no case to a relative density less than 80%.
 3. Remove interfering objects and backfill voids left by such removals, at no additional cost to the Owner.
- N. Depressions
1. Dig bell holes and depressions for joints after the trench has been graded. Provide uniform bearing for the pipe on prepared bottom of the trench.
- O. Where utility runs traverse public property or is subject to governmental or utility company jurisdiction, provide depth, bedding, cover and other requirements as set forth by legally constituted authority having jurisdiction, but in no case less than the depth shown in the Contract Documents.

3.6 PROTECTION OF PERSONS AND PROPERTY

- A. Barricade open holes and depressions occurring as part of the Work, and post warning lights on property adjacent to or with public access.
- B. Operate warning lights during hours from dusk to dawn each day and as otherwise required.

3.7 SHORING, BRACING AND SHEET PILING

- A. Design and provide shoring and bracing necessary to retain earth banks and to prevent collapse or displacement of soil adjacent to excavations. Provide necessary timbers, cribbing, planking or sheet piling, for shoring and bracing, and other materials and work necessary.

- B. Shoring, bracing, sheet piling and other protective work provided as part of the Work of this section shall be removed from the site when no longer required, except whether local regulations do not permit complete removal; in such instance, cut off to depth permitted.
- C. Do not damage underground utilities, existing or new, in driving or removing sheet piling.

3.8 DEWATERING

- A. Keep trenches dry. Provide necessary equipment including pumps, piping and temporary drains.
- B. Do not discharge drainage water lines into municipal sewers without municipal approval. Ensure water discharge does not contain silt held in suspension.
- C. Direct surface drainage away from excavated areas.
- D. Control the grading in and adjacent to excavations to prevent water running into excavated areas or onto adjacent properties or public thoroughfares.
- E. Furnish and operate suitable pumps on a 24 hour basis to keep excavations free of water until services have been placed and backfilling is completed.

3.9 PIPE FOUNDATION

- A. Place bedding material under and around the pipe in 6 inch layers. Compact by rodding or spading.
- B. Where soil at the bottom of the trench is unsuitable because of soft, unstable or water saturated conditions, remove such unsuitable material and stabilize the trench bottom with a granular material similar to bedding material except that maximum size shall be 2 inches. Provide depth of stabilization as required to construct a firm subgrade for the bedding material. Provide concrete cradles where necessary to bridge highly unstable soils.

3.10 BACKFILLING

- A. General
 - 1. Do not completely backfill trenches until required pressure and leakage tests have been performed and until the utilities systems, as installed, conform to the requirements specified in the pertinent Sections of these Specifications.
 - 2. Except as otherwise specified or directed for special conditions, backfill trenches to the ground surface with selected material approved by the Soils Engineer.
 - 3. Reopen trenches which have been improperly backfilled to a depth as required for proper compaction. Refill and compact as specified, or otherwise correct to the approval of the Soils Engineer.
 - 4. Do not allow or cause any of the Work performed or installed to be covered up or enclosed by Work of this section prior to required inspections, tests and approvals.
 - 5. Should any of the Work be so enclosed or covered up before it has been approved, uncover all such Work, and after approvals have been made, refill and compact as specified, all at no additional cost to the Owner.
- B. Begin no backfilling until pipe systems are inspected, approved and comply with all applicable codes.
- C. Support pipe and conduit during placement and compaction of bedding fill.
- D. Backfill trenches to contours and elevations. Backfill systematically, as early as possible to allow maximum time for natural settlement. Do not backfill over porous, wet, or spongy subgrade surfaces.
- E. Leave sheeting in place by cutting off no lower than one foot above the top of the pipe.
- F. Ensure trenches are free of building debris, snow, ice, and water and that ground surfaces are not in a frozen condition.
- G. Do not damage protective coatings on piping.
- H. Bring backfill up evenly on both sides of the pipe.
- I. Maintain optimum moisture content of backfill materials to attain required compaction density.

3.11 COMPACTION

- A. Compaction testing will be performed in accordance with ASTM.
- B. Place and compact backfill materials in continuous layers not exceeding 6 inches loose depth.
- C. Employ a placement method so not to disturb or damage foundation dampproofing and waterproofing.
- D. Degree of compaction is expressed as a percentage of maximum density obtained by test procedure in ASTM C 1557.
- E. Compact each layer of earth fill, depending upon location to the respective percentage of maximum density (ASTM D 1557) as follows:
 - 1. 95% under slabs on grade within building.
 - 2. Under roads, parking areas, steps, site paving:
 - a. 90% for depths greater than 6 inches below finished subgrade.
 - b. 95% for the top 6 inches of subgrade and for 12 inches horizontally beyond edges of roads, parking areas and site paving.
 - 3. Lawn and planted areas:
 - a. 90% for depth 30 inches and greater below finished subgrade.
 - b. 85% for the top 30 inches or portion thereof where depth of fill is less than 30 inches.
- F. Backfilled areas shall be compacted to density specified for the type of areas which occur (road, parking area, steps, site paving, lawn, planted area, respectively.) These percentages apply for cohesive soil. Should the earth fill be cohesionless soil, increase these percentages 5%.
- G. Perform compaction by rolling with approved tamping rollers, pneumatic tired roller, three-wheel power roller, or other equipment well suited to the area of work. Do not use rollers or other heavy equipment closer than 4 feet over sanitary sewers and water distribution lines unless specifically approved.
- H. Do not operate heavy equipment for compacting backfilling closer than 10 feet from exterior walls, but in any case sufficiently far enough away to prevent damage to the walls. Compact backfill in areas remaining by means of power-driven hand tampers or other approved equipment.
- I. As compaction of fill in each work area has been completed, leave the area undisturbed for a reasonable period of time for testing and inspection. Do not place additional fill material on an area of compact fill until the area has been approved.

3.12 TOLERANCES

- A. Top Surface of Backfilling: Plus or minus one inch.

3.13 FOOTING PROTECTION

- A. Provide 2,000 PSI concrete fill in pipe trenches whenever trenches are running parallel to structural footings. Use the following 2:1 ratio.

<u>Distance from Trench to Edge of Footing</u>	<u>Distance from Bottom of Footing to Top of Concrete Fill</u>
2 feet	1 foot
4 feet	2 feet

3.14 REPAIR

- A. Repair all damages to other property such as sidewalks, streets, curbs and walls resulting from the Work.

3.15 SURPLUS MATERIALS

- A. Remove surplus backfill materials from site.
- B. Leave stockpile areas completely free of all excess fill materials.

3.16 FIELD QUALITY CONTROL

- A. The Soils Engineer will inspect and approve open cuts and trenches before installation of utilities and will make the following tests:
 - 1. Assure that trenches are not backfilled until all tests have been completed.
 - 2. Check backfilling for proper layer thickness and compaction.
 - 3. Verify that test results conform to the specified requirements, and that sufficient tests are performed.
 - 4. Assure that defective work is removed and properly replaced.

PART 4 - QUANTITY AND PAYMENT

4.01 METHOD OF MEASUREMENT

- A. N/A

4.02 BASIS OF PAYMENT

- A. Payment for the Specification Section shall be Lump Sum provided under Bid Sheet Line item #4 of the Bid Sheet.

END OF SECTION 022100

SECTION 024330

OIL/WATER SEPARATOR

PART 1: GENERAL

1.01 DESCRIPTION

- A. Provide an underground double wall oil/water separator with integral sand interceptor compartment, connections, and all appurtenances for a complete and operable system.

1.02 RELATED SPECIFICATIONS

- A. Section 01300 – Submittals
- B. Division 16 - Electrical

1.03 SUBMITTALS

- A. Product Data: Contractor shall provide manufacturer's information for all equipment and components to be provided. Product information shall include catalog cut sheets, manufacturer's standard drawings, anchoring information, or other literature and shall provide sufficient information to fully describe the proposed equipment and confirm conformity to the project documents. Product information shall show principal dimensions, size, type and locations of all connections and fittings and locations of all options/accessories. Provide manufacturer's written delivery, storage and handling requirements and installation procedures
- B. Shop Drawings: Contractor shall provide shop drawings showing equipment, components layout, connections & fittings, etc. Shop drawings shall be site specific and provide sufficient information to fully describe the proposed locations, elevations, and layout of the system.
- C. Submit copies of all quality control testing documentation and installation inspection documentation.
- D. Operation and Maintenance Data: Submit manufacturer's O&M information including maintenance requirements, spare parts, special tools (if any), etc. O&M submission shall include site specific drawings of entire system including all equipment, locations, elevations, electrical information, etc.
- E. Warranty: Submit manufacturer's standard warranty information for all equipment, components, and appurtenances.
 - a. The manufacturer shall warrant its products to be free from defects in material and workmanship for a period of one year from the date of shipment. The warranty shall be limited to repair or replacement of the defective part(s).
 - b. Highland Tank 10-year Limited Warranty for external corrosion and structural defects.

1.04 QUALITY ASSURANCE

- A. Fabricate, deliver, assemble, and install all equipment under this specification in full conformity with the specifications, all local, state, and federal laws/standards, as shown on the Contract Drawings and approved shop drawings.
- B. Inspections: Contractor is responsible for all inspection coordination and the associated fees.
- C. Manufacturer shall have a minimum of 5 years experience in producing similar equipment and shall show evidence of at least 10 installations in satisfactory operation.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver, handle and store equipment components in accordance with approved shop drawings, manufacturer's written instructions and as specified.
- B. Use every precaution to prevent damage to the equipment during transport and delivery to the site.
 - a. Do not allow equipment to be dropped, bumped, dragged, pushed, rolled, or moved in any way which will cause damage.
 - b. If, in the process of transportation or handling, any equipment is damaged, replace or repair such equipment or accessories. Make all required repairs. Repairs shall be subject to the approval of the Engineer.
- C. Materials may be stored outdoors on pallets, or other wooden structures providing for proper support and drainage.
- D. On-site storage location shall be coordinated with the Owner and all trades prior to delivery of materials.
- E. Damage to materials during storage shall be prevented primarily by minimizing the amount of time they are stored at the jobsite before being incorporated into the work.

1.06 COORDINATION

- A. Coordinate location and elevation of equipment to actual field conditions and final selection of equipment.
- B. Contractor shall be responsible to coordinate the work with all other trades.
- C. Work shall be scheduled to not interfere with Owner's on-site operations.

PART 2: PRODUCTS

2.01 Basis of Design

- A. Highland Tank & Mfg. Co. Model HTC-350 Series-G Underground Double-Wall Parallel-Flat/Corrugated Plate Gravity Displacement Oil/Water Separator with Integral 316-gallopng Sand Interceptor Compartment or approved equal.
- B. Equivalent equipment products of other manufacturers may be submitted for approval

2.02 Oil/Water Separator

- A. Separator shall be 3'-6" in diameter, 9' long, having a total volume of 350 gallons.
- B. The separator shall be designed for gravity separation of free oils (hydrocarbons and other petroleum products) along with some settable solids from water. The source of the influent to the separator shall be gravity flow from the vehicle wash bay.

2.03 Performance

2.1 Influent Characteristics

Provide oil water separator designed for intermittent and variable flows of water, oil, or any combination of non-emulsified oil-water mixtures ranging from zero to 35 gpm. Operating temperatures of the influent oil in water mixture shall range from 40° F. to 80° F. The specific gravities of the oils at operating temperatures shall range from 0.71 to 0.92 and the petroleum hydrocarbon concentration less than or equal to 200,000 mg/l (20%). The specific gravity of the fresh water at operating temperatures shall range from 1.00 to 1.03.

2.2 Effluent Characteristics

The oil and grease concentration in the effluent from the oil water separator shall not exceed 10 mg/l (10 ppm). To achieve this goal, it will be necessary to remove all free oil droplets equal to and greater than 20 microns.

3.0 DESIGN CRITERIA

- 3.1 The oil water separator shall be designed in accordance with Stokes Law and the American Petroleum Institute Manual on Disposal of Refinery Wastes, Volume on Liquid Wastes as stated in Chapter 5, Oil Water Separator Process Design and API Bulletin No. 1630 First Edition, Waste Water Handling and Treatment Manual for Petroleum Marketing Facilities.

The oil water separator shall comply with the following design criteria:

- 3.2 Capacities, dimensions, construction, and thickness shall be in strict accordance with Underwriters Laboratories, Subject UL-58 Standard for Safety, Steel Underground Tanks for Flammable and Combustible Liquids, Double-wall construction with 360-degree Steel Secondary Containment.
- 3.3 The oil water separator shall comply with National Fire Protection Association NFPA 30 Flammable and Combustible Liquids Code. The inner steel tank shall be completely contained within the outer steel tank, enclosing 100% of the tank volume. The tank must have a double steel shell without a defined space between the layers (UL Type 1 Double-wall). The space between the inner and outer steel walls shall be monitored with an approved electronic leak detection device through a pipe that extends vertically to the top of the tank from the bottom of the shell. Tank construction using thin-walled primary tank with external fiberglass jacket shall not be permissible.
- 3.4 Corrosion Control System shall be in strict accordance with Underwriters Laboratories Inc. Subject UL-1746 Standard for External Corrosion Protection Systems for Steel

Underground Storage Tanks and HighGuard External Corrosion Protection Specifications.

- 3.5 Separator shall be the standard product of a steel tank manufacturer regularly engaged in the production of such equipment. No subcontracting of tank fabrication shall be permitted.
- 3.6 Separator shall be fabricated, inspected, and tested for leakage before shipment from the factory by manufacturer as a completely assembled vessel ready for installation. Inspection and test reports shall be supplied to customer on Manufacturer's letterhead.
- 3.7 Separator shall be cylindrical, horizontal, atmospheric-type steel vessel intended for the separation and storage of flammable and combustible liquids. The separator shall have the structural strength to withstand static and dynamic hydraulic loading while empty and during operating conditions. The Oil Water separator's dimensions and thickness shall be in strict compliance with Roark's Formulas for Stress and Strain as presented in UL 58. Calculations, signed and stamped by a Registered Professional Engineer shall be submitted to document structural strength under specified overbearing or external pressure. A separator with a reduced shell thickness is not permissible.
- 3.8 Separator shall have the following oil storage capacities:
- High oil level (warning), equal to about 20% of the static vessel volume,
 - High-high oil (alarm), equal to about 43% of the static vessel volume,
 - Emergency oil spill capacity equal to about 80% of the static vessel volume.
- 3.9 Separator shall consist of inlet and outlet connections, integral sand interceptor compartment, non-clogging flow distributor and energy dissipater device, stationary under flow baffle, presettling chamber for solids, sludge baffle, oil coalescing chamber with removeable parallel flat/corrugated plate coalesce and/or removeable plates, and sectionalized removable polypropylene impingement coalescers to optimize the separation of free oil from water, effluent downcomer positioned to prevent discharge of free oil that has been separated from the water, access ways for coalescers and each chamber, fittings for vent, oil pump-out, sampling, gauging, leak detection, and lifting lugs.

4.0 GENERAL DESCRIPTION

The separator shall be cylindrical parallel corrugated plate gravity displacement type oil water separator with construction and thickness in strict accordance with Underwriters Laboratories Subject 58, using flat flanged heads.

The separator shall be a pre-packaged, pre-engineered, ready to install unit consisting of:

- 4.1 An influent connection four (4) inch, flanged.
- 4.2 An internal influent nozzle at the inlet end of the separator, located at the furthest diagonal point from the effluent discharge opening.
- 4.3 A 216-gallon integral sand interceptor compartment containing one (1) 18-inch diameter manhole, UL approved, complete with extension, cover, gasket, and bolts. A heavy-duty bulkhead shall retain sand, grit, settleable solids or semisolids and prevent them from

entering the separation chamber. Bulkhead shall have 4-inch transfer pipe. Contractor shall coordinate length of extension to match field conditions.

- 4.4 A velocity head diffusion baffle at the inlet to:
- Reduce horizontal velocity and flow turbulence.
 - Distribute the flow equally over the separator's cross-sectional area.
 - Direct the flow in a serpentine path in order to enhance hydraulic characteristics and fully utilize all separator volume.
 - Completely isolate all inlet turbulence from the separation chamber.
- 4.5 A sediment chamber to disperse flow and collect oily solids and sediments.
- 4.6 A sludge baffle to retain settleable solids and sediment and prevent them from entering the separation chamber.
- 4.7 An Oil Water Separation Chamber containing removable Corella® inclined parallel flat/corrugated plates, sloped downward toward the sediment chamber to:
- Shorten the vertical distance than an oil globule has to rise to effective removal. Minimum plate gap to be 1-1/4-inches.
 - Enhance coalescence by generating a slight sinusoidal (wave-like) flow pattern thereby causing smaller, slow rising, oil globules to coalesce on the undersides of the plates forming larger, rapidly rising sheets of oil.
 - Direct the paths of the separated oil to the surface of the separator.
- 4.8 An Oil Water Separation Chamber Containing a removable 'PETRO-SCREEN™' polypropylene coalescer designed to intercept oil globules of less than 20 microns in diameter. Heavy, one-piece impingement coalescers are not permissible.
- 4.9 An internal effluent downcomer at the outlet end of the separator, to allow for discharge from the bottom of the separation chamber only.
- 4.10 An effluent connection four (4) inch, flanged.
- 4.11 Fittings for vent, interface/level sensor, and waste oil pump-out, sampling, and gauge.
- 4.12 One 30-inch diameter manway, UL approved, complete with extensions, covers, gaskets, and bolts. Manway shall be positioned to facilitate access into sediment chamber for solids removal and oil removal. Contractor shall coordinate length of extension to match actual field conditions.
- 4.13 Lifting lugs at balancing points for handling and installation.
- 4.14 Identification Plates: Plates to be affixed in prominent location and be durable and legible throughout equipment life.
- 4.15 HighGuard Corrosion Protection System consisting of:
- External surfaces commercial grit blasted and coated with 75 mils DFT HighGuard self-reinforcing polyurethane.
 - 10-year limited warranty.

4.16 Internal surfaces commercially sand-blasted, coated with 15 mils DFT heavy duty polyurethane.

4.17 Separator shall be supplied with an audible and visual alarm system that indicates high oil level (visual only) and high-high oil level (audible and visible) of oil storage in the oil water separator will be provided. An audible and visual leak detection alarm system that indicates the hydrocarbon and/or water in the interstice. A silence control shall be provided for the audible alarms. Level sensor(s) to be intrinsically safe. Level sensor floats to be made of stainless steel. The control panel shall contain both level sensor and leak detection control. The control panel shall be NEMA 4. Power to the control panel is to be 120 volt, 1 phase.

Commented [CP1]: Verify w/ Electrical

4.18 Separator shall be supplied with Highland Tank Deadman Anchoring System that include polyester hold-down straps and concrete deadman anchors or approved equal.

5.0 APPROVED MANUFACTURES

The Oil Water Separator shall be manufactured by Highland Tank and Mfg. Co., One Highland Road, Stoystown, PA 15563, as distributed by TJ Equipment Co., (610) 328-3001, or approved equal.

6.0 ACCESSORIES

6.1 Steel hold-down straps with turnbuckles and liners. Two (2) required. Provide hold-down straps per manufacturer's written instructions.

7.0 QUANTITY AND PAYMENT

Payment for oil water separator and all related items listed in this specification shall be made as specified in the "Scope of Work". Price shall include the cost of the mechanisms, including but not limited to installation, freight to the site, pipe connections, testing, inspection, all materials, labor, and equipment and all else necessary therefore, and all other work in connection there with and incidental to.

SECTION 026220

GRAVITY POLYVINYL CHLORIDE PIPE

1.01 DESCRIPTION

- A. Gravity Sewer - Poly Vinyl Chloride (PVC) shall include the excavation and backfill for and the construction, furnishing and installation of gravity sewers for conveying sanitary sewage in accordance with the drawings and specifications and as directed by the Engineer.
- B. Also included shall be any by-pass piping and pumping required to construct this pipeline and keep the existing sanitary sewer main in continuous service.

1.02 SUBMITTALS

- A. Contractor shall supply copies of shop drawings for all pipe and fittings for approval prior to installation.
- B. Submit copies of manufacturer's certified letter stating that the pipe or joint materials ordered meets the requirements of this specification. Letter shall indicate compliance with appropriate reference standards listed.

2.01 MATERIALS

- A. PVC Sewer Pipe:
 - 1. Sizes 4" through 15", SDR 35 shall conform to ASTM D 3034.
 - 2. Sizes 18" through 48", SDR 35 shall conform to ASTM F 679.
 - 3. Pipe Cell Classification shall be 12454 B.
- B. PVC Fittings shall conform to ASTM D 3034 with socket dimensions per Table 2.
- C. Joint Design shall conform to ASTM D 3212.
- D. Joint material: Elastomeric ring rubber gasket, ASTM F 477.
- E. Joint material Primer/Adhesive: As provided or specified by pipe manufacturer.
- F. Special - Pipe adapters : Where necessary to join pipe of different types the Contractor shall provide necessary adapters. Ends shall conform to the specifications for the appropriate type of joint.

3.01 METHODS OF CONSTRUCTION

- A. General - All pipe shall be installed in accordance with the details shown on the drawings unless otherwise hereinafter specified and all excavation and backfill shall conform to the requirements herein specified.
- B. Handling Pipe & Accessories - All pipe and accessories shall be new material which has at no time previously been used for any purpose whatsoever. Pipe and accessories shall be handled in such a manner to insure delivery on the work in sound, undamaged condition and conforming in all respects to these specifications. No other pipe or material of any kind shall be placed inside of any pipe or fittings at any time.
- C. Placing Pipe in Trench - The interior of all pipe shall be thoroughly cleaned of all foreign matter before being lowered into the trench and shall be kept clean during laying operations by means of plugs or other approved methods. No trench water shall be allowed to enter the pipe or fittings. At all times when work is not in progress, all open ends of pipes and fittings shall be securely closed to the satisfaction of the Engineer. Prior to recommencing pipe installation, remove plug, clean and inspect pipe.
- D. Alignment and Grade - The pipe must be laid in the trench accurately to line and grade as shown on the drawings and profile subject to change in the field as directed by the Engineer. Pipe must not be backfilled until inspected and approved by the Engineer. Great care must be exercised in the protection of finished work on pipe by protection during backfilling. All pipe shall be installed with a laser.

Except where necessary in making connection with other lines and as authorized by the Engineer, pipe shall be laid with the bells facing in the direction of laying, and for lines on the appreciable slope bells shall, at the direction of the Engineer, face upgrade.

Under no circumstances will pipe be laid in water and no pipe shall be laid when trench conditions or the weather is unsuitable for such work, except by permission of the Engineer.

- E. Cutting Pipe - Cutting the pipe for closure pieces or for other reasons shall be done by a method which will not damage the pipe lining. Unless otherwise authorized by the Engineer, all cutting of pipes shall be done by means of mechanical cutters of an approved type or types. Wheel cutters shall be used wherever practicable.
- F. Pipe Supports - All exposed piping shall be provided with a minimum of two supports per full pipe length.
- G. Jointing - The jointing of pipe will receive the most strict supervision and inspection. All sewers must be as nearly watertight as possible. All visible leaks shall be repaired. Joints can only be made when free of water below the bell joint. The making of joints shall conform in all respects with pipe manufacturer's recommendations. When connections are made to structures or manholes, a joint shall be placed within 4' of structure or manhole to which connection is made. Joints that do not meet these specifications shall be remade.
- H. Repair Couplings - Fernco rubber couplings with stainless steel shear bands, or approved equal, two (2) per location.

- I. No defective pipe, fittings, or other materials shall be laid or placed in the piping. Any material discovered to be defective after having been laid shall be removed and replaced with satisfactory material by the Contractor at his expense.

- K. Test - Leakage, air testing and deflection tests will be performed on all pipes in accordance with this section.
 - 1. Leakage Test -All sewers shall be tested for leakage as the work progresses. Sewer shall be tested from manhole to manhole. Where sewer is laid in ground that is wet up to top of sewer, test may be made by measuring leakage into pipe, otherwise sewer shall be plugged and filled and leakage measured out. All material, labor and equipment shall be furnished and installed by contractor for test and test shall be performed in the presence and under the supervision of the Engineer. The leakage either in or out of sewer shall not exceed fifty (50) gallons per twenty-four (24) hours per inch of sewer internal diameter, per mile of pipe, per day.

 - 2. Air Testing - Air testing shall conform to the manufacturer's recommendations. All laterals are to be installed prior to the air test. The minimum time duration for a low pressure exfiltration pressure drop between two consecutive manholes shall not be less than shown in Table 1. The prescribed drop shall not exceed .5 psi from 4.0 to 3.5 psi in excess of the ground water pressure above the top of the sewer. The Contractor shall submit for Engineering approval the height of the groundwater above the pipe and the required pressure adjustment. The pressure adjustment shall be the height divided by 2.31 to yield the pressure in psi.

TABLE 1

MINIMUM DURATION FOR AIR TEST PRESSURE DROP

Pipe Size *		Time **
<u>Inches</u>	<u>mm.</u>	<u>(Min)</u>
4	102	2
6	152	3
8	203	5
10	254	8
12	305	11.5
15	381	18
18	457	25.5
21	533	35
24	610	45.5
27	686	57.5
30	762	71.5

* Multiple Pipe Sizes: When sewer line undergoing test is 8 inches or larger diameter pipe and includes different sized laterals, the test time shown for the sewer line shall be utilized and no time adjustments for the laterals shall be considered.

** Test Time: Minimum test time durations listed do not include minimum of two minute air stabilization period required before commencing test.

Sewers not meeting these requirements shall be repaired or rebuilt as directed by the Engineer at no cost to Owner. Before final acceptance, contractor shall provide means for final inspection by the Engineer. Sewers must be left clean and free throughout their entire length.

3. Deflection Testing -

- a. The maximum allowable pipe deflection (reduction in vertical inside diameter) shall be 7 1/2%.
- b. Deflection tests shall be successfully performed on the complete installation by the "Go/No-Go" Mandrel Method. Mandrel shall be properly sized for the tested pipe diameter.
- c. The pipe shall be installed at least 30 days prior to deflection testing.
- d. All pipes shall be deflection tested.

4. Lamping -

- a. The Engineer will lamp all installed pipe between manholes. Sewer lines shall meet the following standards to pass the lamping inspection.
 1. Barrel of pipe shall have no vertical deflection (not to be confused with the deflection test), and at least eighty percent of barrel shall be visible in the horizontal direction.

4.01 QUANTITY & PAYMENT

Payment for Poly Vinyl Chloride (PVC) Pipe of the sizes specified will be included in the various lump sum prices bid which price shall include the cost of excavation, 3/4" broken stone bedding, haunching, initial backfill, in accordance with these specifications, backfill, dewatering, furnishing pipe, couplings, and fittings, laying, assembling and jointing pipe complete, testing trench bottom materials, flushing, inspection, shoring, sheathing, timbering, bracing, by-pass pumping, all labor and materials, equipment and all necessary therefore and all other work in connection therewith and incidental thereto.

END OF SECTION

SECTION 026270

HDPE SANITARY SEWER FORCE MAIN & FITTINGS

PART 1:GENERAL

1.01 DESCRIPTION

- A. Furnish and install HDPE (High Density Polyethylene) Sewer Force Main and Fittings for proposed sanitary sewer force main complete as shown on the drawings and specified herein.

1.02 REFERENCES

- A. ASTM D 638 Standard Test Method for Tensile Properties of Plastics
- B. ASTM D 696 Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C with a Vitreous Silica Dilatometer
- C. ASTM D 746 Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
- D. ASTM D 790 Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastic and Electrical Insulating Materials
- E. ASTM D 1238 Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer
- F. ASTM D 1248 Standard Specification for Plastic Pipe
- G. ASTM D 1505 Standard Test Method for Density of Plastics by the Density-Gradient Technique
- H. ASTM D 1525 Standard Test Method for Vicat Softening Temperature of Plastics
- I. ASTM D 1603 Standard Test Method for Carbon Black Content in Olefin Plastics
- J. ASTM D 1693 Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
- K. ASTM D 2837 Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products
- L. ASTM D 3035 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
- M. ASTM D 3261 Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
- N. ASTM F 714 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
- O. AWWA C 906 Polyethylene (PE) Pressure Pipe and Fittings
- P. PPI TR-3 Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Hydrostatic Design Stresses (HDS), Pressure Design Basis (PDB), Strength Design Basis (SDB), Minimum Required Strength (MRS) Ratings, and Categorized Required Strength (CRS) for Thermoplastic Piping Materials or Pipe
- Q. PPI TR-4 HDB/HDS/SDB/PDB/MRS Listed Materials
- R. 914 NJDOT Standard Specifications

1.03 SUBMITTALS

- A. Certifications: Submit copies of manufacturer's certified letter stating that pipe or joint materials ordered meets requirements of this specification. Letter shall indicate compliance with appropriate reference standards listed.
- B. Product Data: Contractor shall provide manufacturer's information for all equipment and components to be provided. Product information shall include catalog cut sheets, manufacturer's standard drawings, anchoring information, or other literature and shall provide sufficient information to fully describe the proposed equipment and confirm conformity to the project documents. Product information shall show principal dimensions, size, type and locations of all connections and fittings and locations of all options/accessories. Provide manufacturer's written delivery, storage and handling requirements and installation procedures.
- C. Shop Drawings: Contractor shall provide shop drawings showing equipment, components layout, connections & fittings, etc. Shop drawings shall be site specific and provide sufficient information to fully describe the proposed locations, elevations, and layout of the system.
- D. Submit copies of all quality control testing documentation and installation inspection documentation.
- E. Operation and Maintenance Data: Submit manufacturer's O&M information including maintenance requirements, spare parts, special tools (if any), etc. O&M submission shall include site specific drawings of entire system including all equipment, locations, elevations, electrical information, etc.
- F. Warranty: Submit manufacturer's standard warranty information for all equipment, components, and appurtenances.

1.03 QUALITY ASSURANCE

- A. Fabricate, deliver, assemble, and install all equipment under this specification in full conformity with the specifications, all local, state, and federal laws/standards, as shown on the Contract Drawings and approved shop drawings.
- B. Inspections: Contractor is responsible for all inspection coordination and the associated fees.
- C. Manufacturer shall have a minimum of 5 years experience in producing similar equipment and shall show evidence of at least 10 installations in satisfactory operation.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Deliver, handle and store equipment components in accordance with approved shop drawings, manufacturer's written instructions and as specified.
- B. Use every precaution to prevent damage to the equipment during transport and delivery to the site.
 - 1. Do not allow equipment to be dropped, bumped, dragged, pushed, rolled, or moved in any way which will cause damage.

- 2. If, in the process of transportation or handling, any equipment is damaged, replace or repair such equipment or accessories. Make all required repairs. Repairs shall be subject to the approval of the Engineer.
- C. Materials may be stored outdoors on pallets, or other wooden structures providing for proper support and drainage.
- D. On-site storage location shall be coordinated with the Owner and all trades prior to delivery of materials.
- E. Damage to materials during storage shall be prevented primarily by minimizing the amount of time they are stored at the jobsite before being incorporated into the work.

1.05 COORDINATION

- A. Coordinate location and elevation of equipment to actual field conditions and final selection of equipment.
- B. Contractor shall be responsible to coordinate the work with all other trades.
- C. Work shall be scheduled to not interfere with Owner’s on-site operations.

PART 2:MATERIALS

2.01 Basis of Design

- A. Pipe shall be black HDPE PE 4710 pipe as manufactured by Chevron Plexco, Phillips Driscopipe or equal.

2.02 Material Properties and Requirements

- A. The pipe materials shall meet the following requirements.
 - 1. Polyethylene Compound: Class 345434C conforming to ASTM D 3350, and shall meet the following physical property requirements:

Property/ Value	Unit	Test Procedure Typical	
Material Designation		PPI/ASTM	PE 3408
PPL Material Listing		PPI TR-4	Plexco P34CH
Material Classification		ASTM D-1248	III C 5 P34
Cell Classification		ASTM D-3350	345434C
Density (3)	g/cm ³	ASTM D-1505	0.955
Melt Index (4)	g/10 minutes	ASTM D-1238	0.1
Flexural Modulus (5)	psi	ASTM D-790	133,000
Tensile Strength (4)	psi	ASTM D-638	3500
ESCR (3)	fail % hours	ASTM D-1693	f0>5000

HDB (4)	psi	ASTM D-2837	1600
UV Stabilizer (C)	% Carbon Black	ASTM D-1603	2 to 3
Elastic Modulus	psi	ASTM D-638	110,000
Brittleness Temperature	°F	ASTM D-746	<-180
Vicat Softening Temperature	°F	ASTM D-1525	255
Thermal Expansion	inches/inches/°F	ASTM D-696	8x10 ⁻⁵
Molecular Weight Category			Extra High
HDB @ 73.4°F	psi	ASTM D-2837	1600
HDB @ 140°F	psi	ASTM D-2837	800

2. Pipe: ASTM D 1248 "Standard Specification for Plastic Pipe". Pipe shall be suitable for conveying water under pressure. Pressure rating shall be 160 psi. with Standard Dimension Ratio (DR) of 9 and meet AWWA C-906 standards and manufactured per ASTM F-714 and D-3035 and tested per ASTM D2837.

Printline markings shall include a production code from which the location and date of manufacture can be identified. Upon request, the manufacturer shall provide an explanation of his production code.

The pipe shall have a metallic locating wire or tape buried with the pipe.

3. Fittings: Fittings shall be fittings compatible with the piping system and manufacturer per ASTM D-3261.

Fittings shall be produced by the same manufacturer as the pipe from identical materials meeting the requirements of this specification.

Fittings shall be pressure rated to meet the service pressure requirements specified. Whether molded or fabricated, fittings shall be fully pressure rated to at least the same service pressure rating as the pipe to which joining is intended.

Molded fittings shall meet the requirements of ASTM D-3261 and this specification. At the point of fusion, the outside diameter and minimum wall thickness of fitting butt fusion outlets shall meet the outside diameter and minimum wall thickness specifications of ASTM F-714 for the same size of pipe. Fitting markings shall include a production code from which the location and date of manufacture can be determined. Upon request, the manufacturer shall provide an explanation of his production code.

Fittings shall be manufactured in production facilities designed for that purpose. Field fabricated fittings are not allowed.

4. Joints:

Except where flange connections or other mechanical connections are specified, pipe and fittings shall be butt fusion joined in accordance with the manufacturer's recommended procedure. Upon request, the pipe and fitting manufacturer shall provide fusion training services for field construction and inspection personnel.

Training shall be conducted by the pipe and fitting manufacturer or his authorized representative.

Heat Fusion Joining Systems: Pipes shall be joined to one another and to polyethylene fittings by thermal butt fusion, saddle fusion, or socket fusion, excepting directional outlets, in accordance with procedures recommended by the pipe manufacturer.

Butt fusion joining of unlike SDR's shall not be permitted. Transition from one SDR to another may be accomplished by the use of mechanical couplings, or a transition nipple, which is a short length off the heavier SDR pipe with one end machined to the lighter SDR.

Joining, Terminating, or Adapting by Mechanical Means: Mechanical connections of polyethylene pipe to systems or fittings of other materials, or to unlike SDR's shall be by means of flanged connections (flange adapters and back-up rings rated for the same pressure service as the system piping), or mechanical compression couplings designed for joining polyethylene pipe to polyethylene pipe or to another piping material.

Flanged joints shall use bolts of compatible material (insulated from the fittings where necessary). Gaskets of reinforced black rubber, asbestos-rubber compound or other material specified by the engineer, shall be required when joining to non-polyethylene materials. Flanged polyethylene joints shall be gasketed. In all cases, the bolts shall be evenly torqued using a crossing pattern like that used to tighten lug nuts on a car wheel. Flanged joints are to be re-torqued after one hour or more has passed.

Polyethylene pipe adjacent to flanged joints and the joints themselves must be rigidly supported for a distance of one pipe diameter or 1 foot, whichever is the greater, beyond the flange assembly.

When mechanical compression couplings are used, polyethylene pipes shall be reinforced by a stiffener in the pipe bore. Stiffeners shall be properly sized for the size and SDR of polyethylene pipe being joined.

Mechanical couplings shall be installed in accordance with the manufacturer's recommended procedure.

5. Drilling Fluid - Drilling fluid shall be a mixture of water and bentonite clay. The fluid will be inert. The fluid shall remain in the tunnel to ensure the stability of the tunnel, reduce drag on pulled pipe and provide backfill within the annulus of the pipe and tunnel.

Disposal of excess drilling fluid and spoils will be the responsibility of the Contractor who must comply with all relevant regulations, right of way, work space and permit agreements. Excess drilling fluid and spoils will be disposed of at an approved location. The Contractor is responsible for transporting all excess drilling fluid and spoils to the disposal site and paying any disposal costs. Excess drilling

fluids and spoils will be transported in a manner that prevents accidental spillage onto roadways. Excess drilling fluid and spoils will not be discharged into sanitary sewer or storm drain systems, ditches or roadways.

2.03 Concrete for Thrust Blocks:

- A. Compressive Strength: Minimum of 4,000 psi at twenty-eight days.
- B. Concrete shall be Class C conforming to Section 914 of the New Jersey Department of Transportation Standard Specifications.

PART 3: EXECUTION

3.01 METHOD OF CONSTRUCTION

- A. General - All pipe shall be installed in accordance with the details shown on the drawings unless otherwise hereinafter specified and all excavation and backfill shall conform to the requirements hereinbefore specified.
- B. Handling Pipe & Accessories - All pipe and accessories shall be new material which has at no time previously been used for any purpose whatsoever. Pipe and accessories shall be handled in such a manner to insure delivery on the work in sound, undamaged condition and conforming in all respects to these specifications.

The pipe and fitting manufacturer shall package products for shipment in a manner suitable for safe transport on commercial carriers. When delivered, a receiving inspection shall be performed, and any shipping damage reported to the pipe and fitting manufacturer within 7 days. Pipe and fittings shall be handled, installed, and tested in accordance with manufacturer's recommendations, and the requirements of this specification.

- C. Placing Pipe in Trench - The interior of all pipe shall be thoroughly cleaned of all foreign matter before being lowered into the trench and shall be kept clean during laying operations by means of plugs or other approved methods. No trench water shall be allowed to enter the pipe or fittings. At all times when work is not in progress, all open ends of pipes and fittings shall be securely closed to the satisfaction of the Engineer. The method of directional moling of pipe is acceptable.
- D. Laying Pipe - Under no circumstances will pipe be laid in water and no pipe shall be laid when trench conditions or the weather is unsuitable for such work, except by permission of the Engineer.
- E. Cutting Pipe - Cutting the pipe for closure pieces or for other reasons shall be done in a neat and workmanlike manner by a method which will not damage the pipe lining. Unless otherwise authorized by the Engineer, all cutting of pipes shall be done by means of mechanical cutters of an approved type or types. Wheel cutters shall be used wherever practicable.
- F. Test - All joints in pipe lines shall remain uncovered until the pipe has been subject to pressure tests of 125 lbs. per square inch. When all joints being subjected to the test are found to be tight at this pressure, in the presence of the Engineer, the test may be stopped

and backfiring commenced, as hereinbefore specified. The cost of testing of the pipe lines shall be borne by the contractor who must furnish all necessary equipment, labor and materials for the tests. Pressure shall remain on the pipe at least 60 minutes and shall not drop more than 2 pounds in 60 minutes. Defective joints, pipe and fittings shall be removed and replaced by the contractor.

G. Bracing the Pipe at Bends - All fittings at bends in the pipe lines shall be firmly wedged between the fittings and the vertical face of the trench consisting of undisturbed earth in order to prevent the fittings from being blown off the line when under pressure by means of a 1-2-4 concrete mix except at plugs where wood block shall be used.

3.02 WARRANTY AND ACCEPTANCE: The contractor shall warrant all work to be free of defects in workmanship or materials for a period of one year from the date of completion of all construction. In the event deficiencies are discovered during the warranty period, they shall be corrected by the contractor before final acceptance.

During the warranty period, the Engineer shall determine if warranty repairs or replacement work shall be performed by the contractor. The decision of the Engineer shall be binding upon the contractor.

3.03 QUALIFICATION OF MANUFACTURERS: Manufacturer's production facilities shall be open for inspection by the owner or his designated agents. During inspection, the manufacturer shall demonstrate that he has facilities capable of manufacturing the pipe and fittings required by this specification, that a quality control program meeting the minimum requirements specified in ASTM F-714 is in place, and that facilities for performing the tests required by this specification are available.

The manufacturer shall certify that the material supplied meets the specifications and that samples of his production pipe have undergone stress regression testing, evaluation, and validation in accordance with ASTM D-2837 and PPI TR-3.

4.00 PAYMENT

A. QUANTITY AND PAYMENT

Payment for HDPE force main of the type and sizes specified will be included in the various lump sum prices bid which price shall include the cost of excavating, laying, assembling, and jointing of the pipe complete, shoring, dewatering, pumping, backfiring, cutting, testing, stone bedding, imported or on-site select fill, fittings, all labor, equipment, materials and all else necessary therefore and all other work in connection therewith and incidental thereto.

END OF SECTION

SECTION 033000

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and various Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mix design, placement procedures, and finishes.

1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume.

1.4 SUBMITTALS

- A. Product Data: For each type of manufactured material and product indicated.
- B. Design Mixes: For each concrete mix. Include alternate mix designs when characteristics of materials, project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mix water to be withheld for later addition at Project site.
- C. Steel Reinforcement Shop Drawings: Details of fabrication, bending, and placement, prepared according to ACI 315, "Details and Detailing of Concrete Reinforcement." Include material, grade, bar schedules, stirrup spacing, bent bar diagrams, arrangement, and supports of concrete reinforcement. Include special reinforcement required for openings through concrete structures.
- D. Construction, Expansion and Control Joint Shop Drawings: Indicate locations of all joints in concrete slabs.
- E. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork. Design and engineering of formwork are Contractor's responsibility.
 - 1. Shoring and Reshoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing reshoring.

- F. Welding Certificates: Copies of certificates for welding procedures and personnel.
- G. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:
- H. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
 1. Cementitious materials and aggregates.
 2. Steel reinforcement and reinforcement accessories.
 3. Admixtures.
 4. Waterstops.
 5. Curing materials.
 6. Floor and slab treatments.
 7. Bonding agents.
 8. Vapor retarders.
 9. Joint-filler strips.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed concrete Work similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for formwork and shoring and reshoring installations that are similar to those indicated for this Project in material, design, and extent.
- C. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment.
 1. Manufacturer must be certified according to the National Ready Mixed Concrete Association's Certification of Ready Mixed Concrete Production Facilities.
- D. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
- E. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.
- F. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

G. ACI Publications: Comply with the following, unless more stringent provisions are indicated:

1. ACI 301, "Specification for Structural Concrete."
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle steel reinforcement to prevent bending and damage.

PART 2 - PRODUCTS

2.1 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than .1 inch (25 mm) to the plane of the exposed concrete surface.

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

B. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated from as-drawn steel wire into flat sheets.

2.3 REINFORCEMENT ACCESSORIES

A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete.

- B. Joint Dowel Bars: Plain-steel bars, ASTM A 615/A 615M, Grade 60 (Grade 420). Cut bars true to length with ends square and free of burrs.

2.4 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II.
- B. Normal-Weight Aggregate: ASTM C 33, uniformly graded, and as follows:
 - 1. Class: Severe weathering region, but not less than 3S.
 - 2. Nominal Maximum Aggregate Size: 3/4 inch (19 mm).
- C. Water: Potable and complying with ASTM C 94.

2.5 ADMIXTURES

- A. General: Admixtures certified by manufacturer to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material and to be compatible with other admixtures and cementitious materials. Do not use admixtures containing calcium chloride.
- B. Air-Entraining Admixture: ASTM C 260.
- C. Water-Reducing Admixture: ASTM C 494, Type A.
- D. High-Range Water-Reducing Admixture: ASTM C 494, Type F.
- E. Water-Reducing and Accelerating Admixture: ASTM C 494, Type E.
- F. Water-Reducing and Retarding Admixture: ASTM C 494, Type D.

2.6 WATERSTOPS

- A. Flexible Rubber Waterstops: CE CRD-C 513, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
 - 1. Profile: Ribbed with center bulb.
- B. Manufacturers: Subject to compliance with requirements, provide the following products or equal:
 - 1. Greenstreak
 - 2. Progress Unlimited, Inc.
 - 3. Williams Products, Inc.

2.7 VAPOR RETARDERS

- A. Vapor Retarder: polyethylene sheet, not less than 6 mils (0.15 mm) thick.

2.8 FLOOR AND SLAB TREATMENTS

- A. Slip_Resistive Aggregate Finish: Factory-graded, packaged, rustproof, non-glazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 25 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
- B. Penetrating Liquid Floor Treatment: Chemically reactive, waterborne solution of inorganic silicate or silicate materials and proprietary components; odorless; colorless; that penetrates, hardens, and densifies concrete surfaces.
- C. Products: Subject to compliance with requirements, provide the following penetrating liquid floor treatment products or equal:
 - 1. Day-Chem Sure Hard; Dayton Superior Corporation
 - 2. Euco Diamond Hard; Euclid Chemical Co.
 - 3. Seal Hard; L&M Construction Chemicals, Inc.

2.9 CURING MATERIALS

- A. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
- B. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound:
 - a. Klear-Kote Cure-Sealer-Hardener, 30 percent solids; Burke Group, LLC (The).
 - b. Polyseal WB; ChemMasters.
 - c. UV Safe Seal; Lambert Corporation.
 - d. Lumiseal WB Plus; L&M Construction Chemicals, Inc.

2.10 RELATED MATERIALS

- A. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- C. Epoxy-Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements, and as follows:
 - 1. Type II, non-load bearing, for bonding freshly mixed concrete to hardened concrete.
 - 2. Type I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
 - 3. Type IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

2.11 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
 4. Compressive Strength: Not less than 4100 psi (29 MPa) at 28 days when tested according to ASTM C 109/C 109M.

2.12 CONCRETE MIXES

- A. Prepare design mixes for each type and strength of concrete determined by either laboratory trial mix or field test data bases, as follows:
1. Proportion normal-weight concrete according to ACI 211.1 and ACI 301.
- B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the laboratory trial mix basis.
- C. Footings and Foundation Walls: Proportion normal-weight concrete mix as follows:
1. Compressive Strength (28 Days): 4000 psi (27.6 MPa).
 2. Maximum Slump: 4 inches (100 mm).
- D. Slab-on-Grade: Proportion normal-weight concrete mix as follows:
1. Compressive Strength (28 Days): 4000 psi (27.6 MPa).
 2. Maximum Slump: 4 inches (100 mm).
- E. Cementitious Materials: For concrete exposed to deicers, limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements.
- F. Air Content: Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 5 percent +/- 1 percent, unless otherwise indicated.
- G. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- H. Admixtures: Use admixtures according to manufacturer's written instructions.
1. Use water-reducing admixture, as required, for placement and workability.
 2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

2.13 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

2.14 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94, and furnish batch ticket information.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until concrete structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Construct forms tight enough to prevent loss of concrete mortar.
- D. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical. Kerf wood inserts for forming keyways, reglets, recesses, and the like, for easy removal.
 - 1. Do not use rust-stained steel form-facing material.
- E. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- F. Chamfer exterior corners and edges of permanently exposed concrete.
- G. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- H. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- I. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- J. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor bolts, accurately located, to elevations required.

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork, for sides of beams, walls, columns, and similar parts of the Work, that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete provided concrete is hard enough to not be damaged by form-removal operations and provided curing and protection operations are maintained.
- B. Leave formwork, for beam soffits, joists, slabs, and other structural elements, that supports weight of concrete in place until concrete has achieved the following:
 - 1. 28-day design compressive strength.
- C. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- D. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Engineer.

3.4 SHORES AND RESHORES

- A. Comply with ACI 318 (ACI 318M), ACI 301, and recommendations in ACI 347R for design, installation, and removal of shoring and reshoring.
- B. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 VAPOR RETARDERS

- A. Vapor Retarder: Place, protect, and repair vapor-retarder sheets according to ASTM E 1643 and manufacturer's written instructions.

3.6 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire fabric in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.7 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Form from preformed galvanized steel, plastic keyway-section forms, or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
 - 3. Use a bonding agent or epoxy-bonding adhesive, as required, at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, as follows:
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groove tool marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 - 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
- E. Dowel Joints: Install dowel sleeves and dowels or dowel bar and support assemblies at joints where indicated.

1. Use dowel sleeves or lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Before placing concrete, water may be added at Project site, subject to limitations of ACI 301.
- C. Deposit concrete continuously or in layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as specified. Deposit concrete to avoid segregation.
- D. Deposit concrete in forms in horizontal layers no deeper than 24 inches (600 mm) and in a manner to avoid inclined construction joints. Place each layer while preceding layer is still plastic, to avoid cold joints.
 1. Consolidate placed concrete with mechanical vibrating equipment. Use equipment and procedures for consolidating concrete recommended by ACI 309R.
 2. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the vibrator. Place vibrators to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix constituents to segregate.
- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
 1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Scream slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, free of humps or hollows, before excess moisture or bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.

2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
- G. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R and as follows, when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F_ (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
 3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.9 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding ACI 347R limits for class of surface specified.

3.10 FINISHING FLOORS AND SLABS

- A. General: Comply with recommendations in ACI 302.1R for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes.
1. Apply scratch finish to surfaces indicated and to surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraighening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system
 2. Finish surfaces to the following tolerances, measured within 24 hours according to ASTM E 1155/E 1155M for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 35; and levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and levelness, F(L) 17; for slabs-on-grade.
- E. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thin-set method. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Engineer before application.
- G. Slip-Resistant Aggregate finish: Before final floating, apply slip-resistive aggregate finish where indicated and to concrete stair treads, platforms, and ramps. Apply according to manufacturer's written instructions and as follows:
1. Uniformly spread 25 pounds per 100 square feet of dampened slip-resistive aggregate over surface in one or two applications. Tamp aggregate flush with surface, but do not force below surface.
 2. After broadcasting and tamping, apply float finish.
 3. after curing, lightly work surface with a steel wire brush or an abrasive stone, and water to expose slip-resistive aggregate.

3.11 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete Work.
- B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates of manufacturer furnishing machines and equipment.
- D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.12 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with recommendations in ACI 305R for hot-weather protection during curing.
- B. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces, as follows:
 - 1. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.13 LIQUID FLOOR TREATMENTS

- A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions. Penetrating liquid floor treatment shall be applied to all exposed interior concrete floor slabs.
 - 1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
 - 2. Do not apply to concrete that is less than seven days old.
 - 3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

3.14 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
 - 1. Defer joint filling until concrete has aged at least six months. Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid epoxy joint filler full depth in saw-cut joints and at least .2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

3.15 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.2-mm) sieve, using only enough water for handling and placing.

- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension in solid concrete but not less than .1 inch (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 2. After concrete has cured at least 14 days, correct high areas by grinding.
 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 5. Repair defective areas, except random cracks and single holes .1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least 3/4 inch (19 mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mix as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
 6. Repair random cracks and single holes .1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.

- F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

3.16 FIELD QUALITY CONTROL (TESTING)

- A. Testing Agency: Engage a qualified testing and inspecting agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified in this Article. The scheduling and costs for all testing shall be the responsibility of the contractor.
- B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
 - 1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mix placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mix, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - 2. Slump: ASTM C 143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
 - 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
 - 4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
 - 5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of four standard cylinder specimens for each composite sample.
 - a. Cast and field cure one set of four standard cylinder specimens for each composite sample.
 - 6. Compressive-Strength Tests: ASTM C 39; test two laboratory-cured specimens at 7 days and two at 28 days.
 - a. Test two field-cured specimens at 7 days and two at 28 days.
 - b. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at age indicated.
- C. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
- D. Strength of each concrete mix will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).

- E. Test results shall be reported in writing to Engineer, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7-and 28-day tests.
- F. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.
- G. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Engineer. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42 or by other methods as directed by Engineer.

PART 4 - QUANTITY AND PAYMENT

- 4.1 Payment for Cast-in-Place Concrete shall be included in the lump sum contract cost which shall include formwork, reinforcement, concrete materials, mix design, placement procedures, finishes, treatments, testing and all else necessary therefor and all other work in connection therewith or incidental thereto.

END OF SECTION

SECTION 055000
MISCELLANEOUS METAL WORK

1.01 GENERAL

The Contractor shall furnish, erect, and set all miscellaneous steel, aluminum and iron work necessary for the completion of this contract as indicated on the drawings and as herein specified. All such work shall be fabricated as detailed or approved and installed complete with all necessary anchors, bolts and other accessories.

1.02 SUBMITTALS

- A. Samples, shop drawings and manufacturer's product literature.
- B. Samples include all factory made items.
- C. Shop drawings shall show gauges, thicknesses, sizes and construction of all members as well as the manner of assembling the various members that make up the different items. Show true profiles, connections and relationship to adjoining work, methods of anchoring, and all other pertinent information. Submit eight (8) copies of all shop drawings.

1.03 QUALITY ASSURANCE

- A. Welder Qualifications: Welds shall be made only by welders, tackers and welding operators who have been previously qualified by tests as prescribed in the Structural Welding Code, AWS D1.1 of the American Welding Society to perform the type of work required.
- B. Anchor and Fastener Design Requirements:
 - 1. Sizing: Provide anchors and fasteners for product installations of such diameters and lengths as recommended by the particular product manufacturer involved.
 - 2. Safety Factor: Determine the lengths of anchors and fasteners based on substrate materials at points of anchor installation and to provide a safety factor of four to one.
 - 3. Materials Compatibility: Where anchors and fasteners contact dissimilar metal products provide anchors and fasteners of compatible material so that neither will have a deteriorating action on the other.

1.04 WORKMANSHIP

- A. Steel shall be well formed to shape and size with sharp lines and angles. Shearing and punching shall leave clean, true lines and surfaces. Permanent connections shall be welded or riveted, unless bolting is indicated on the drawings or specified. The design details and workmanship shall conform to the current AISC Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings insofar as applicable.
- B. Castings shall be sounded and free from warp and defects that impair their strength or appearance. Exposed surfaces shall be smooth and shall have sharp, well-defined lines and arises. Joints shall be milled to a close fit.

- C. Aluminum shall be of alloy and temper suitable for each specific use.

2.01 MATERIALS

- A. Steel plates and structural shapes shall conform to the ASTM Standard Specifications for Structural Steel, Designation A36-70a.
- B. Steel pipe shall conform to ASTM Standard Specifications for Seamless and Welded Steel Pipe, Designation A53-69a, Grade B.
- C. Cast steel shall be Grade N2 conforming to the ASTM Tentative Specifications for Mild-to Medium Strength Carbon-Steel Castings for General Application, Designation A27-46T.
- D. Iron castings shall be of good quality, strong, tough, even-grained iron, free from scale, lumps, blisters, sand holes and defects of every nature which would render them unfit for the service for which they are intended. Castings shall conform at least to the ASTM Standard Specifications for Gray Iron Castings, Designation A48-48 for Class 25 castings. All castings shall be thoroughly cleaned and subjected to a careful hammer inspection.
- E. Abrasive cast iron shall be "Feralun" made by the American Abrasive Metals Company, or approved equal.
- F. Stainless steel shall be Type 316, unless otherwise specified.
- G. Welding Electrodes: Table 4.1.1 of AWS D1.1 as required for applicable base metals and welding process.
- H. Round bars used in diagonal bracing shall conform to ASTM specification A-572 GR50, 60 or 65 with the respective minimum yield strength.

2.02 FABRICATION

- A. Form metals to shape and size, with sharp lines and angles, and with smooth surfaces and faces. Shearing and punching shall leave clean true lines and surfaces, free from distortion. Weld or rivet permanent connections with all rivets in finished work countersunk. Do not use screws unless specifically shown and if used shall be countersunk stainless steel or metal compatible with the members being joined. Mill fastenings to a close fit. Provide necessary rabbets, lugs and brackets, etc., so that work can be assembled neatly. Thickness of metals and details of assembly and supports shall provide ample strength and stiffness. Form joints exposed to the weather to exclude water. Countersink and recess to receive hardware. Provide with proper bevels and clearances.
- B. Provide all anchors, sleeves, screws, bolts and connecting members necessary for securing metal work to other adjacent or adjoining work. Provide and install angles and other reinforcement. Do all cutting, drilling or modifying of adjacent or adjoining work where necessary for proper installation. Set all hardware that is shop installed. Do all fittings true to line. Bend or form all tubing, pipe and other members to continuous and true curves, with all joints flush, hairline, neatly fastened together and assembled to other materials. Furnish all necessary patterns and templates and check all measurements with the work at the site. Furnish all sockets, anchors and other portions of this work that are to be built into the structure and supervise and be responsible for their accurate spacing and setting.

- C. Furnish in ample time all anchors, bolts, inserts, clips and other items furnished under this section, but built in with the work of other trades.
- D. Use plug welds wherever practicable in work exposed to view. Use fillet welds only where plug welding is impractical. Where welds are exposed to view, bevel members prior to welding and weld full. Grind welds flush and smooth, level with the adjacent surfaces so that the resultant weld provides the appearance and strength of a continuous member of uniform thickness.

Grind welds at intersecting member of uniform thickness. Grind welds at intersecting members to sharp lines.

2.03 PRIME COAT

- A. Sandblast interior steel to remove all dust and dirt. Shop prime all ferrous metal.
- B. Use shop and field primer and touch-up that will be compatible with the finish paint coating. Where two coats of primer are required, tint the second coat a recognizably different shade. Clean and touch-up with a zinc rich paint all welds and abrasions on galvanized items before shipment.

PART 3 - EXECUTION

3.01 ERECTION

- A. Erect all metal items in proper position, securely fastened, plumb, in line, and level. The completed installation shall be free of sharp edges and rough spots. Touch up all abrasions and metal cuts, bolts and nut with the material used for shop priming so that the entire assembly, as erected, presents a complete smooth prime coat of paint.
- B. Provide and set structural shapes such as angles, channels, plates, etc., shown to be built-in or anchored into concrete for attachment of other work. Anchors, unless otherwise shown, shall be 1/4" x 1-1/4" x required lengths for secure anchorage, spaced approximately 24" o.c. Coordinate with the trades furnishing items that will attach to these built-in members for proper positioning.

3.02 SCHEDULE

- A. Loose lintels: Of sizes shown or required, minimum 6" bearing on each side of masonry opening. Lintels are furnished under this section but erected under Division 4, Masonry.
- B. Angle guards: Structural steel angles of sizes indicated. Weld a minimum of 3 strap anchors spaced to suit coursing approximately 24" o.c.
- C. Channel door guards: Structural steel channels of sizes indicated. Weld a minimum of three anchors at least 8-1/2" long after bending to each jamb, spaced to suit coursing and approximately 24" o.c.
- D. Pipe railing: 1-1/4" IPS, all welded construction and flush fittings. Where pipe rails are detailed, construct as shown. Where pipe rails are shown only in plan, construct with a top and intermediate rail with standard spaced not more than 6'-0" o.c. Mount wall rails with plain design brackets spaced not over 6'-0" o.c. with a minimum of 1 intermediate bracket per run. Return ends to wall.

Where railings are mounted in concrete, grout into galvanized steel sleeves. Where railings are mounted on steel, weld and grind smooth. Galvanize all exterior pipe railings.

4.01 QUANTITY AND PAYMENT

All costs for furnishing and installing the work of this section shall be included in with the prices bid for the various related items of work as listed in the Proposal.

END OF SECTION

SECTION 060000 - PRE-ENGINEERED POST-FRAMED BUILDING

PART 1 – GENERAL

1.1 Work Included

- A. Design, supply, and construction of a pre-engineered post-frame building by a contractor, who is regularly engaged in this type of specialty work. The supplier and installer must be certified by the manufacturer. The Post Frame building includes but is not limited to the following:
1. New Jersey sealed structural drawings: Note all structural engineering will be completed by successful bidder.
 2. Bonding
 3. Permits
 4. Footings
 5. Insulation
 6. Smart posts- support posts
 7. Girts/Purlins
 8. Skirt Boards
 9. Trusses, Truss Carriers, hurricane clips and bracing
 10. Siding and Roofing
 11. Gutters and Downspouts
 12. Doors, windows and Trim
 13. Interior/Exterior Concrete flat work
 14. Labor
 15. Clean up
 16. All other required components and accessories for a completed pre-engineered building.

1.2 Submittals

- A. Membership – Submit proof of membership in good standing for the National Frame Building Association. NFBA standards are used for quality assurance purposes.
- B. Product Data – Submit manufacturer’s product information, specifications, and installation instructions for building components and accessories. Submit a written letter of certification prepared and signed by a Professional Engineer, registered to practice in New Jersey, verifying that the building system design and roof system meet indicated loading requirements and codes of authorities having jurisdiction.
- C. Dealer Certification – Submit current certification with the bid that the building system supplier or metal roof system supplier is a manufacturer’s authorized and franchised dealer of the system to be furnished. Certification shall state date on which authorization was granted.
- D. Installer Certification – Submit certificate with the bid that the building system and roof system installer has been regularly engaged in the installation of building systems of the same or equal construction to the system specified.

- E. Shop Drawings – Submit complete detailed construction and erection drawings and product data. Indicate profiles, sizes, spacing, location of structural members, connections, attachments, openings, etc. of entire building system. Structural calculations prepared and signed by a Professional Engineer, registered to practice in New Jersey, shall be included in the shop drawing submissions.
- F. Samples – Submit samples, two (2) each of the following for Engineer's/Owner's review. Samples will be used as basis for evaluating quality of the finished roof and wall systems.
 - 1. 12-inch long by actual width of roofing panels, siding panels, soffit panels & fascia panels with required finish.
 - 2. Fasteners for application of roofing, siding, and soffit panels.

1.3 Building Description

- A. Building Sizes – Both buildings are to receive the following: Clear height from the finished slab elevation to the underside of the roof trusses will be 16 feet. The building framing system is to be custom designed and there will be no interior columns to support the roof framing. The building will have a A-framed gable roof with a 3/12 roof pitch and 12-inch eave and gable overhangs with fully vented soffit, ridge vent, and 6-inch seamless gutters.
 - 1. Garage No. 1: The building size will measure 75 feet wide by 90 feet long.
 - 2. Garage No. 2: The building size will measure 60 feet wide by 110 feet long.
- B. Footings - Footings will be sized according to local building code and soil conditions. All footings must be wet poured to meet or exceed local building code and soil conditions. Footer size and bearing capacity must be determined by contractor and approved before placement of concrete.
- C. Poles – Minimum Three-ply (2x6) glue-laminated posts on eave walls, three-ply (2x6) glue-laminated posts on gable end walls. Posts are 8 feet on center on side walls and gable ends. Post must run to top of trusses on gable walls, no splicing will be allowed. All posts shall be Smart Posts. The post adhesives shall be for wet use conforming to ASTM D2559; the laminations shall be surfaced, glued and then clamped. The clamp-up shall be maintained at room temperature, at a minimum pressure of 100 psi for at least ten hours. The columns shall be surfaced, after curing, on the narrow faces of the laminations. Nail laminated or solid posts shall not be permitted.
- D. Girts/Purlins – Girts and purlins are nailed on the outside of the posts and on the top of the truss cords. They are 2x4 Spruce/Pine/Fir #2 grade or better placed 2 feet on center. All Girts and Purlins are to be installed with the wider dimension (3.5") laying flat on the posts and trusses.
- E. Skirt Board – One row of skirting, 2x8 Southern Yellow Pine with pressure treatment. Non-adhesive polymeric isolation tape must be used at all galvanized locations where steel may come into contact with pressure treated lumber, unless new treatments are deemed noncorrosive to metal.

- F. Truss Carriers – Headers are required to be engineered MSR (Machine Stress Rated) lumber. Each MSR piece to be non-destructively evaluated and quality control tested to verify the strength and stiffness of the final product. LVL truss carriers will be permitted where spans and loads require its use.
- G. Trusses – Roof trusses are 48 inches on center with a 3/12 pitch unless otherwise noted. All trusses are pre-engineered factory-made wood trusses. All trusses will receive rafter tie connectors (Hurricane clips). Draft stop trusses per code.
- H. Siding – Siding shall be structural quality, full-hard steel 29-gauge, G-90 painted with Class 4 hail impact resistance and Class A fire resistance ratings. The enamel paint is to be baked on at the factory. Color will be determined by the Owner to match existing garage(s). The steel siding is attached to the building by screws with rubber washers. All exposed fasteners will have holes punched through steel (no drilling) to maintain a straight line.
- I. Roofing – Roofing shall be 29-gauge; G-90 painted steel and must be from the same manufacturer as the steel siding. The enamel paint is to be baked on at the factory. The steel roofing is attached to the building by screws with rubber washers. Color will be determined by the Owner to match existing garage(s).
- J. Fasteners – All lumber to be fastened with double hot dipped galvanized 3-1/2” pneumatic nails (unless specified otherwise in sealed shop drawings). All metals to be fastened with color coordinated screws with rubber washers.
- K. Gutters and Downspouts – Six-inch Type K seamless gutter and downspouts spaced at 40 feet o.c. maximum. Coordinate locations with site plans. Color will be determined by the Owner from standard color choices. See specifications section 077120 for additional information.
- L. Trims – All entry doors, OHD’s and windows are to have either integral or applied J-trim with a 1-inch exposed face. Corner, rake, ridge cap, and base angle trims are also included. All trims are to be from the same manufacturer and made from the same materials as the wall and roof panels. Colors are to be determined by the Owner.
- M. Doors – See below the breakdown of doors for each contract:
 - 1. Garage No. 1: (2) exterior grade white factory primed and painted steel 4’0” x 7’0” doors with auto-closing hardware and panic hardware. (8) 15’0” x 14’0” exterior grade overhead garage doors with electric motors and all required hardware.
 - 2. Garage No. 2: (5) exterior grade white factory primed and painted steel 4’0” x 7’0” doors with auto-closing hardware and panic hardware. (1) pair exterior grade white factory primed and painted steel (2)3’0” x 7’0” doors with storage room lock function. (Doors MUST have free egress from inside at all times). (6) 15’0” x 14’0” exterior grade overhead garage doors with electric motors and all required hardware.

- N. 6-inch thick 4000 psi concrete, reinforced with #4 reinforcing bars at 9 inches on center, each way, over 6-inches of clean, compacted, crushed stone base. 10 mil polyethylene vapor barrier under all interior concrete slabs. See plans for concrete slab dimensions
- O. Insulation: R-19 insulation for all exterior walls, R-30 insulation for the ceiling. Comply with IECC 2018. Provide vapor barrier at face of insulation as indicated in the project documents.
- P. Interior framing: 6", 16 ga. metal studs. Wood blocking as required for sink and casework installation.
- Q. Interior finishes (including but not limited as noted in contract drawings & documents):
See Add Alternates for delineation of base bids and alternate bids.
 - 1. Ceiling of main building and portico to be White liner panel by the same manufacturer as the wall and roof steel. (2) Insulated 2'x4' access panels to allow access to the attic. Exterior walls of the main building to be white liner panel, made by the same manufacturer as the wall and roof steel.
 - 2. All metal stud walls shall have 1/2" gypsum wall board on both sides, tape, spackled, primed and painted. 4" Vinyl cove base shall be installed unless otherwise noted.
 - 3. Locker Room and Break Room shall have VCT flooring as noted on the contract documents.
 - 4. Toilet Rooms and Shower Room shall have a poured epoxy flooring and 4" base.
 - 5. Ceilings within the Locker Room, Break Room, Toilet Rooms and Shower Room shall be 2'x4' acoustical ceiling tile and grid. Shower Room shall have moisture resistant ceiling tile.
 - 6. Install lockers, casework, fixtures and all accessories as stated in the contract documents.

1.4 Design Criteria

- A. Governing Design Code - Structural design for the building structural system will be provided by the building manufacturer for the following design criteria:
 - 1. Governing Building Code: International Building Code, IBC 2018 – New Jersey Edition and applicable supplements.
- B. Roof Live Load – Roof live loads are loads produced during the life of the structure by moveable objects. Wind, snow, seismic or dead loads are not live loads. Roof live loads are calculated at 20 lb per square foot.
- C. Roof Snow Load – The roof snow load used for designing the structure may not be reduced and is determined by the IBC 2018 – New Jersey Edition.
- D. Wind Load
 - 1. Wind load in miles per hour only.
 - 2. Basic wind speed is 90 miles per hour.

3. Wind exposure factor is B.
 4. Winds Pressure Coefficients and the design pressures shall be applied per governing code.
- E. Seismic Load
1. Seismic site class is D.
 2. Seismic design category is B.
 2. Seismic importance factor is 1.0.
 3. Seismic load applied per governing code.
- F. Dead Load – The weight of building system construction, such as roof, framing, and covering members.
- G. Collateral Load – Additional imposed loads required by the contract documents other than the weight of the building system. These added loads could include such items as sprinklers, mechanical, electrical, and ceiling systems.
- H. Load Combinations – Load combinations used to design primary and secondary structural members shall be according to the governing code.

1.5 Warranty

The Contractor shall guarantee to the Owner the following warranties:

- A. Fifty (50) years from the date of building completion that the pressure-treated lumber will not fail due to decay or insect damage. The Manufacturer will bear the cost of repair or replacement.
- B. Two (2) years from the date of building completion that all workmanship defects will be corrected.
- C. Two (2) years from the date of building completion to repair or replace free of charge of framing, roof metal or wall metal that is damaged by direct wind loads.
- D. Two (2) year from the date of building completion, the Contractor will repair or replace items which prove to be defective.
- E. The paint coating of the roof and side panels will be guaranteed to perform under limited warranty against cracking, check or peeling (lifetime), chalk and fading (30 years), red rust (15 years), perforation of walls (25 years), or perforation of roof (20 years).

1.6 Quality Assurance

- A. Building shall be designed to conform to the International Building Code IBC 2018 – New Jersey Edition and bid documents.

- B. Material Testing – In addition, the manufacturer shall provide, upon request, evidence of compliance with specifications through testing independent of the manufacturer’s suppliers.

PART 2 – PRODUCTS

2.1 Acceptable Manufacturers

- A. Basis of Design: CB Structures, Inc. Address: 202 Orlan Road, New Holland, PA 17557
Phone: (717) 354-2613
- B. Substitutions – Approved equal.

2.2 Quality Control

A. Performance

- 1. Panels shall withstand the following tests without change in appearance or material failure:
 - a. ASTM D-4214 (latest)
 - b. ASTM D-2244 (latest) paragraph 4.3

All testing shall have been performed by an independent testing facility.

- 2. Manufacturer shall be able to guarantee the panels for ten years from date of purchase against defective materials or workmanship in fabrication.

- B. Erection – Panels must be erected plumb and true by qualified workmen with joints as shown and anchored as detailed in shop drawings.

PART 3 – EXECUTION

Foundations shall be provided in conformance with specification section 03300 – Cast-In-Place Concrete and the concrete section of the specification.

3.1 Framing Erection

- A. Erect framing in accordance with IBC 2018 – New Jersey Edition and NFBA specifications.
- B. Provide for erection and wind loads. Provide temporary bracing to maintain structure plumb and in alignment until completion of erection and installation of permanent bracing. Locate braced bays as indicated on approved shop drawings.
- C. Do not field cut or alter structural members without approval of pre-engineered building manufacturer.

3.2 Wall and Roofing Systems

- A. Install in accordance with manufacturer's instructions.
- B. Fasten cladding system to structural supports, aligned level and plumb.
- C. Install sealant and gaskets to prevent weather penetration at eaves.

3.3 Tolerances

- A. Framing Members – 1/4-inch from level; 1/8-inch from plumb.
- B. Siding and Roofing – 1/8-inch from true position.

3.4 Installation of Accessories

- A. Install door frame, door, overhead door, window and glass, and other accessories in accordance with manufacturer's instructions.
- B. Seal wall and roof accessories watertight and weather tight with proper flashings and rubber boots. Any sealants are to be used as a precautionary measure and in accordance with pre-engineered building manufacturer recommendations.

3.5 Gutter and Downspout Erection

- A. Rigidly support and secure components. Joint lengths with formed seams sealed watertight. Flash and seal gutters to downspouts.
- B. Slope gutters to achieve positive water flow to outlets per IBC 2018 – New Jersey Edition.
- C. Downspouts to discharge onto splash blocks.

PART 4- QUANTITY AND PAYMENT

- 4.1 Payment for Pre-Engineered Post-Framed Building shall be included in the lump sum contract cost which shall include design (New Jersey sealed structural drawings), supply, construction, permitting, bonding, clean up and all else necessary therefor and all other work in connection therewith or incidental thereto.

END OF SECTION

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Framing with dimension lumber.
 - 2. Framing with timbers.
 - 3. Framing with engineered wood products.
 - 4. Wood furring, grounds, nailers, and blocking.
 - 5. Sheathing.
 - 6. Subflooring.

1.3 DEFINITIONS

- A. Rough Carpentry: Carpentry work not specified in other Sections and not exposed, unless otherwise specified.
- B. Exposed Framing: Dimension lumber not concealed by other construction and indicated to receive a stained or natural finish.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.
- B. Product Data for the following products:
 - 1. Engineered wood products.
 - 2. Underlayment.
 - 3. Insulating sheathing.
 - 4. Air-infiltration barriers.
- C. Material certificates for dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the American Lumber Standards Committee's (ALSC) Board of Review.
- D. Wood treatment data as follows, including chemical treatment manufacturer's instructions for handling, storing, installing, and finishing treated materials:

1. For each type of preservative-treated wood product, include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: To qualify for approval, an independent testing agency must demonstrate to Architect's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.
- B. Single-Source Responsibility for Engineered Wood Products: Obtain each type of engineered wood product from one source and by a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Keep materials under cover and dry. Protect from weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels. Provide for air circulation within and around stacks and under temporary coverings.
 1. For lumber and plywood pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. Wood-Preservative-Treated Materials:
 - a. Baxter: J. H. Baxter Co.
 - b. Chemical Specialties, Inc.
 - c. Continental Wood Preservers, Inc.
 - d. Osmose Wood Preserving, Inc.
 2. Laminated-Veneer Lumber:
 - a. Alpine Structures.
 - b. Georgia-Pacific Corp.
 - c. Trus Joist MacMillan.
 3. Prefabricated Wood I-Joists:
 - a. Trus Joist MacMillan.
 - b. Alpine Structures.
 - c. Georgia-Pacific Corp.
 4. Gypsum Sheathing Board:
 - a. Georgia-Pacific Corp.

- b. National Gypsum Co.; Gold Bond Building Products Division.
 - c. United States Gypsum Co.
5. Air-Infiltration Barriers:
- a. Celotex Corporation (The); Building Products Division.
 - b. DuPont Company; Fibers Department.

2.2 LUMBER, GENERAL

- A. Lumber Standards: Comply with DOC PS 20, "American Softwood Lumber Standard," and with applicable grading rules of inspection agencies certified by ALSC's Board of Review.
- B. Inspection Agencies: Inspection agencies, and the abbreviations used to reference them, include the following:
- 1. NELMA - Northeastern Lumber Manufacturers Association.
 - 2. NLGA - National Lumber Grades Authority (Canadian).
 - 3. RIS - Redwood Inspection Service.
 - 4. SPIB - Southern Pine Inspection Bureau.
 - 5. WCLIB - West Coast Lumber Inspection Bureau.
 - 6. WWPA - Western Wood Products Association.
- C. Grade Stamps: Provide lumber with each piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
- D. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
- 1. Provide dressed lumber, S4S, unless otherwise indicated.
 - 2. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch nominal (38-mm actual) thickness or less, unless otherwise indicated.

2.3 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. General: Where lumber or plywood is indicated as preservative treated or is specified to be treated, comply with applicable requirements of AWPA C2 (lumber) and AWPA C9 (plywood). Mark each treated item with the Quality Mark Requirements of an inspection agency approved by ALSC's Board of Review.
- B. Pressure treat wood members in contact with ground or freshwater with waterborne preservatives to a minimum retention of .040 lb/cu. ft.. (6.4 kg/cu. m)..

2.4 DIMENSION LUMBER

- A. General: Provide dimension lumber of grades indicated according to the ALSC National Grading Rule (NGR) provisions of the inspection agency indicated.

B. Non-Load-Bearing Interior Partitions: Provide framing of the following grade and species:

1. Grade: No. 2.
2. Species: Eastern softwoods; NELMA.
3. Species: Northern species; NLGA.
4. Species: Mixed southern pine; SPIB.
5. Species: Western woods; WCLIB or WWPA.
6. Species: Any species above.

C. Exterior and Load-Bearing Walls: Provide framing of the following grade and species:

1. Grade: No. 2.
2. Species: Hem-fir (north); NLGA..
3. Species: Southern pine; SPIB.
4. Species: Douglas fir-larch; WCLIB or WWPA.
5. Species: Mixed southern pine; SPIB.
6. Species: Spruce-pine-fir; NLGA.
7. Species: Douglas fir-south; WWPA.
8. Species: Hem-fir; WCLIB or WWPA.
9. Species: Douglas fir-larch (north); NLGA.
10. Species: Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
11. Species: Any species above.

D. Framing Other than Non-Load-Bearing Partitions: Provide framing of the following grade and species:

1. Grade: No. 2.
2. Species: Spruce-pine-fir south; NELMA.
3. Species: Hem-fir north; NLGA.
4. Species: Spruce-pine-fir north; NLGA.
5. Species: Mixed southern pine; SPIB.
6. Species: Hem-fir; WCLIB or WWPA.
7. Species: Any species above.

2.5 BOARDS

A. Exposed Boards: Where boards will be exposed in the finished work, provide the following:

1. Moisture Content: 19 percent maximum.
2. Species and Grade: Spruce-pine-fir, C & Btr per WCLIB rules or C Select per NLGA or WWPA rules.
3. As noted on plans by Architect.

B. Concealed Boards: Where boards will be concealed by other work, provide lumber with 19 percent maximum moisture content and of following species and grade:

1. Species and Grade: Eastern softwoods, No. 3 Common per NELMA rules.
2. Species and Grade: Mixed southern pine, No. 2 per SPIB rules.
3. Species and Grade: Spruce-pine-fir, Standard per WCLIB rules or No. 3 Common per WWPA rules.

4. Species and Grade: Western woods, Standard per WCLIB rules or No. 3 Common per WWPA rules.
5. Species and Grade: Any species above.

2.6 MISCELLANEOUS LUMBER

- A. General: Provide lumber for support or attachment of other construction, including rooftop equipment curbs and support bases, cant strips, bucks, nailers, blocking, furring, grounds, stripping, and similar members.
- B. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into shapes shown.
- C. Moisture Content: 19 percent maximum for lumber items not specified to receive wood preservative treatment.
- D. Grade: For dimension lumber sizes, provide No. 3 or Standard grade lumber per ALSC's NGRs of any species. For board-size lumber, provide No. 3 Common grade per NELMA, NLGA, or WWPA; No. 2 grade per SPIB; or Standard grade per NLGA, WCLIB or WWPA of any species.

2.7 ENGINEERED WOOD PRODUCTS

- A. General: Provide engineered wood products acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that evidence compliance with building code in effect for Project.
 1. Allowable Design Stresses: Provide engineered wood products with allowable design stresses, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis, and demonstrated by comprehensive testing performed by a qualified independent testing agency.
- B. Laminated-Veneer Lumber: Lumber manufactured by laminating wood veneers in a continuous press using an exterior-type adhesive complying with ASTM D 2559 to produce members with grain of veneers parallel to their lengths and complying with the following requirements:
 1. Extreme Fiber Stress in Bending: 2500 psi (17 MPa) for .12-inch nominal- (286-mm actual-) depth members.
 2. Modulus of Elasticity: 2,000,000 psi (13 800 MPa).
 3. Tension Parallel to Grain: 1850 psi (13 MPa).
 4. Compression Parallel to Grain: 2800 psi (19 MPa).
 5. Compression Perpendicular to Grain: 400 psi (3 MPa) perpendicular to and 500 psi (3.5 MPa) and parallel to glue line.
 6. Horizontal Shear: 285 psi (2 MPa) perpendicular to and 190 psi (1.3 MPa) parallel to glue line.

- C. Prefabricated Wood I-Joists: Units manufactured by bonding stress-graded lumber flanges to wood-based structural-use panel webs with exterior-type adhesives complying with ASTM D 2559, to produce I-shaped joists complying with the following requirements:
1. Flange Material: Laminated-veneer lumber.
 2. Web Material: Oriented-strand board (OSB) complying with DOC PS 2.
 3. Web Material: Plywood complying with DOC PS 2.
 4. Web Material: Either material indicated above, as standard with joist manufacturer.
 5. Structural Capacities: Establish and monitor structural capacities according to ASTM D 5055.
 6. Sizes: Depths and widths as indicated, with flanges not less than 1-1/2 inches (38 mm) in actual width.
 7. I-Joists shall be installed with all required anchors, stiffeners and bracing in accordance with manufacturer requirements.
- D. Parallel-Strand Lumber: Structural composite lumber made from wood strand elements with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Louisiana-Pacific Corporation.
 - b. Weyerhaeuser Company.
 - c. Or equal.
 2. Extreme Fiber Stress in Bending, Edgewise: 2900 psi (20 MPa) for 12-inch nominal- (286-mm actual-) depth members.
 3. Modulus of Elasticity, Edgewise: 2,200,000 psi (15 100 MPa).

2.8 CONCEALED, PERFORMANCE-RATED STRUCTURAL-USE PANELS

- A. General: Where structural-use panels are indicated for the following concealed types of applications, provide APA-performance-rated panels complying with requirements designated under each application for grade, span rating, exposure durability classification, and edge detail (where applicable).
1. Thickness: Provide panels meeting requirements specified but not less than thickness indicated.
 2. Span Ratings: Provide panels with span ratings required to meet "Code Plus" provisions of APA Form No. E30, "APA Design/Construction Guide: Residential & Commercial."
- B. Subflooring: APA-rated sheathing.
1. Exposure Durability Classification: Exposure 1.
 2. Span Rating: 48/24.
 3. Minimum thickness: 3/4 inch.
 4. Floor sheathing shall be tongue and groove and installed with both construction adhesive and required nailing.
- C. Wall Sheathing: APA-rated sheathing.
1. Exposure Durability Classification: Exposure 1.

2. Span Rating: As required to suit stud spacing indicated.
3. Minimum thickness indicated on plan.

D. Roof Sheathing: APA-rated sheathing.

1. Exposure Durability Classification: Exposure 1.
2. Minimum Span Rating: 32/16.
3. Minimum thickness: 5/8 inch.
4. Roof sheathing shall be installed with panel clips.

2.9 STRUCTURAL-USE PANELS FOR BACKING

- A. Plywood Backing Panels: For mounting electrical or telephone equipment, provide fire-retardant-treated plywood panels with grade, C-D Plugged Exposure 1, in thickness indicated or, if not otherwise indicated, not less than 15/32 inch (11.9 mm) thick.

2.10 AIR-INFILTRATION BARRIER

- A. Air retarder complying with ASTM E 1677; made from polyolefins; either cross-laminated films, woven strands, or spunbonded fibers; coated or uncoated; with or without perforations to transmit water vapor but not liquid water; and as follows:

1. Minimum Thickness: 3 mils (0.08 mm).
2. Minimum Water-Vapor Transmission: 10 perms (575 ng/Pa x s x sq. m) when tested according to ASTM E 96, Procedure A.
3. Maximum Flame Spread: 25 per ASTM E 84.
4. Minimum Allowable Exposure Time: 3 months.

2.11 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

1. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with a hot-dip zinc coating per ASTM A 153 or of Type 304 stainless steel.

- B. Nails, Wire, Brads, and Staples: FS FF-N-105.

- C. Power-Driven Fasteners: CABO NER-272.

- D. Wood Screws: ASME B18.6.1.

- E. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M)

- F. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

2.12 METAL FRAMING ANCHORS

- A. General: Provide galvanized steel framing anchors of structural capacity, type, and size indicated and as follows:
 - 1. Research or Evaluation Reports: Provide products for which model code research or evaluation reports exist that are acceptable to authorities having jurisdiction and that evidence compliance of metal framing anchors for application indicated with building code in effect for Project.
 - 2. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis, and demonstrated by comprehensive testing performed by a qualified independent testing agency.
- B. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653, G60 (ASTM A 653M, Z180) coating designation; structural, commercial, or lock-forming quality, as standard with manufacturer for type of anchor indicated.
- C. Joist Hangers: U-shaped joist hangers with 2-inch- (50-mm-) long seat and 1-1/4-inch- (32-mm-) wide nailing flanges at least 85 percent of joist depth.
 - 1. Thickness: .064 inch. (1.6 mm).
- D. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.
 - 1. Strap Width: 2 inches. (50 mm).
 - 2. Thickness: .064 inch. (1.6 mm).
- E. Bridging: Rigid, V-section, nailless type, 0.064 inch. (1.6 mm) thick, length to suit joist size and spacing.
- F. Rafter Tie-Downs (Hurricane Ties): Bent strap tie for fastening rafters or roof trusses to wall studs below, 1-5/8 inches. (41 mm) wide by 0.052 inch. (1.3 mm) thick minimum. Tie-Downs must be selected to meet uplift forces as calculated in the wood truss design.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Discard units of material with defects that impair quality of rough carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.
- B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.
- C. Fit rough carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.
- D. Apply field treatment complying with AWWA M4 to cut surfaces of preservative-treated lumber and plywood.

- E. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. CABO NER-272 for power-driven staples, P-nails, and allied fasteners.
 - 2. Published requirements of metal framing anchor manufacturer.
 - 3. "Recommended Nailing Schedule" of referenced framing standard and with AFPA's "National Design Specifications for Wood Construction."
 - 4. "Table 2305.2--Fastening Schedule" of the BOCA National Building Code.
- F. Use common wire nails, unless otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; predrill as required.
- G. Use hot-dip galvanized or stainless-steel nails where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity.
- H. Countersink nail heads on exposed carpentry work and fill holes with wood filler.

3.2 WOOD FRAMING, GENERAL

- A. Framing Standard: Comply with AFPA's "Manual for Wood Frame Construction," unless otherwise indicated.
- B. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.
- C. Install framing members of size and at spacing indicated.
- D. Do not splice structural members between supports.
- E. Firestop concealed spaces of wood-framed walls and partitions at each floor level and at ceiling line of top story. Where firestopping is not inherent in framing system used, provide closely fitted wood blocks of 2-inch nominal- (38-mm actual-) thickness lumber of same width as framing members.

3.3 AIR-INFILTRATION BARRIER

- A. Cover sheathing with air-infiltration barrier as follows:
 - 1. Apply air retarder to comply with manufacturer's written instructions.
 - 2. Apply air-infiltration barrier to cover upstanding flashing with 4-inch (100-mm) overlap.

END OF SECTION 061000

SECTION 077120 - GUTTERS AND DOWNSPOUTS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Gutters and Downspouts.
- B. Related Accessories.

1.2 REFERENCES

- A. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- B. SMACNA - Architectural Sheet Metal Manual.

1.3 DESIGN / PERFORMANCE REQUIREMENTS

- A. Conform to applicable code for size and method of rainwater discharge.
- B. American Architectural Manufacturers Association (AAMA) Specification 1405.1 "Specification for Aluminum Rain carrying Systems".

1.4 SUBMITTALS

- A. Product Data: Manufacturer's catalog data, detail sheets, and specifications.
- B. Shop Drawings: Prepared specifically for this project; showing dimensions of metal gutters and accessories, fastening details and connections and interface with other products. Contractor to provide signed and sealed drawings and calculations by a licensed professional in the state of New Jersey for new gutters and downspouts.
- C. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- D. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.
- E. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- F. Manufacturers warranties.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
- B. Installer Qualifications: Certified and approved installer of the sheet metal roofing manufacturer.
- C. Perform Work in accordance with SMACNA Manual

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.

- B. Store products to prevent twisting, bending, and abrasion, and to provide ventilation. Slope stored materials to drain.
- C. During storage prevent contact with materials capable of causing discoloration, staining, or other damage.

1.7 PROJECT CONDITIONS

- A. Coordinate installation with installation of adjacent roofing, siding and related materials.

1.8 WARRANTY

- A. Provide the Manufacturer's Limited 20-Year, pro-rated and non-transferable Warranty covering labor materials.

1.9 COORDINATION

- A. Coordinate Work with other operations and installation of floor finish materials to avoid damage to installed underlayment and membrane materials.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Basis of Design: Mazmet Metal Products, which is located at: 1050 Bristol Road; Mountainside, NJ 07092; Phone: 908.654.7686; Fax: 908.654.7898;
- B. Substitutions: Approved equal.

2.2 COMPONENTS

- A. Gutters: Aluminum sheet, ASTM B 209, Alloy 3105-H24. Minimum tensile strength 26,000 psi, minimum yield strength 25,000 psi or equivalent. Continuous and seamless sheet aluminum, roll formed.
 - 1. Thickness:
 - a. 0.063 inch
- B. Downspouts: Aluminum sheet, ASTM B 209, Alloy 3105-H24. Minimum tensile strength 26,000 psi, minimum yield strength 25,000 psi or equivalent.
 - 1. Thickness:
 - a. 0.063 inch
 - 2. Size:
 - a. Match Existing : 4 inches by 4 inches (min.).
- C. Endcaps: Aluminum sheet, ASTM B 209, Alloy 3105-H24, thickness 0.063 inch
- D. Inside and Outside Mitres: Aluminum sheet, ASTM B 209, Alloy 3105-H24, thickness 0.063inch
- E. Gutter Hangers and Anchors: Aluminum sheet, ASTM B 209, Alloy 3105-H24, thickness 0.063 inch. Provide types required to suit project requirements.
- F. Downspout Anchors: Aluminum. Provide types required to suit project requirements.
- G. Elbows: Aluminum sheet, ASTM B 209, Alloy 3105-H24. Minimum tensile strength 26,000

psi, minimum yield strength 25,000 psi or equivalent.

1. Thickness:
 - a. 0.063 inch
 2. Size: To match downspouts.
- H. Aluminum Finish: Kynar 500 system factory applied in a continuous process in a single operation.
1. Color:
 - a. Approved by Owner from Manufacturer's Standard Colors.
- I. Sealant: As recommended by manufacturer.
- J. Fasteners: Same material and finish as gutters and downspouts.

2.3 FABRICATION

- A. Continuously form seamless gutters to the profiles and sizes specified.
- B. Form downspouts of profiles and sizes specified.
- C. Hem exposed edges of metal.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared.
- B. Verify governing dimensions at building.
- C. Verify surfaces are ready to receive gutters and downspouts.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Clean and repair if necessary any adjoining work on which this work is in any way dependent for its proper installation.
- C. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install gutters using appropriate hangers to allow normal expansion and contraction.
- C. Install gutter hangers using two 1-1/4 inch (32 mm) screw shank nails and fastened into solid lumber.
- D. All gutters shall be in continuous length for each elevation (run). No end laps are allowed.
- E. Exercise care in placing aluminum in contact with other dissimilar metals or materials that are not compatible with aluminum.

- F. Providing adequate insulation/separation where ever necessary, such as by painting or otherwise protecting when they are in contact with aluminum or when drainage from them passes over aluminum surfaces.
- G. Install sealants where indicated to clean dry surfaces only without skips or voids.

3.4 PROTECTION

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

PART 4- QUANTITY AND PAYMENT

- 4.1 Payment for Gutters and Downspouts shall be included in the lump sum contract cost which shall include the delivery, preparation, installation and protection of gutters and downsouts and all else necessary therefor and all other work in connection therewith or incidental thereto.

END OF SECTION

SECTION 082110 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Solid-core doors with wood-veneer faces.
 - 2. Factory finishing flush wood doors.

1.3 SUBMITTALS

- A. Product Data: For each type of door. Include details of core and edge construction, trim for openings, and louvers.
 - 1. Include factory-finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.
 - 1. Indicate dimensions and locations of mortises and holes for hardware.
 - 2. Indicate dimensions and locations of cutouts.
 - 3. Indicate doors to be factory finished and finish requirements.
 - 4. Indicate fire ratings for fire doors.
- C. Samples for Initial Selection: Color charts consisting of actual materials in small sections for the following:
 - 1. Faces of factory-finished doors with transparent finish. Show the full range of colors available for stained finishes.
- D. Samples for Verification: As follows:
 - 1. Corner sections of doors approximately 8 by 10 inches with door faces and edgings representing the typical range of color and grain for each species of veneer and solid lumber required. Finish sample with same materials proposed for factory-finished doors.
 - 2. Corner sections of plastic-laminate-clad doors, 8 by 10 inches, for each color, texture, and pattern selected.
 - 3. Frames for light openings, 6 inches long, for each material, type, and finish required.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer.
- B. Quality Standard: Comply with the following standard:
 - 1. AWI Quality Standard: AWI's "Architectural Woodwork Quality Standards" for grade of door, core, construction, finish, and other requirements.
- C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252.
 - 1. Test Pressure: Test at atmospheric pressure.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect doors during transit, storage, and handling to prevent damage, soiling, and deterioration. Comply with requirements of referenced standard and manufacturer's written instructions.
 - 1. Individually package doors in plastic bags or cardboard cartons.
 - 2. Individually package doors in cardboard cartons and wrap bundles of doors in plastic sheeting.
 - 3. Comply with WIC's Technical Bulletin 420-R for delivery, storage, and handling of doors.
- B. Mark each door with individual opening numbers used on Shop Drawings. Use removable tags or concealed markings.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until building is enclosed, wet-work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Environmental Limitations: Do not deliver or install doors until conditions for temperature and relative humidity have been stabilized and will be maintained in storage and installation areas during the remainder of the construction period to comply with requirements of the referenced quality standard for Project's geographical location.

1.7 WARRANTY

- A. General Warranty: Door manufacturer's warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

- B. Door Manufacturer's Warranty: Submit written agreement on door manufacturer's standard form, signed by manufacturer, Installer, and Contractor, agreeing to repair or replace defective doors that have warped (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section or that show telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span, or do not comply with tolerances in referenced quality standard.
 - 1. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 - 2. Warranty shall be in effect during the following period of time after the date of Substantial Completion:
 - a. Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flush Wood Doors:
 - a. Algoma Hardwoods Inc.
 - b. Graham Manufacturing Corp.
 - c. Mohawk Flush Doors, Inc.

2.2 DOOR CONSTRUCTION, GENERAL

- A. Doors for Transparent Finish: Comply with the following requirements:
 - 1. Grade: Custom, with Grade AA faces.
 - 2. Faces: Maple, plain-sliced.
 - 3. Match between Veneer Leaves: Pleasing match.
 - 4. Match within Door Faces: Running match.
 - 5. Pair and Set Match: Provide for pairs of doors and for doors hung in adjacent sets.
 - 6. Stiles: Same species as face or a compatible species.

2.3 SOLID-CORE DOORS

- A. Particleboard Cores: Comply with the following requirements:
 - 1. Particleboard: ANSI A208.1, Grade LD-1.
 - 2. Blocking: Provide wood blocking at particleboard-core doors as follows:

- a. 5-inch top-rail blocking, at doors indicated to have closers.
- b. 5-inch bottom-rail blocking, at exterior doors and doors indicated to have kick, mop, or armor plates.
- c. 5-inch midrail blocking, at doors indicated to have exit devices.

2.4 FABRICATION

- A. Fabricate flush wood doors in sizes indicated for Project site fitting.
- B. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels, unless otherwise indicated:
 1. Comply with clearance requirements of referenced quality standard for fitting. Comply with requirements of NFPA 80 for fire-rated doors.
- C. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
 1. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
 2. Metal Astragals: Premachine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- D. Openings: Cut and trim openings through doors to comply with applicable requirements of referenced standards for kind(s) of door(s) required.
 1. Light Openings: Trim openings with moldings of material and profile indicated.
 2. Louvers: Factory install louvers in prepared openings.
- E. Exterior Doors: Factory treat exterior doors with water repellent after manufacturing has been completed.
 1. Flash top of outswinging doors (with manufacturer's standard metal flashing).

2.5 SHOP PRIMING

- A. Transparent Finish: Shop seal faces and edges of doors for transparent finish with stain, other required pretreatments, and all finish coats.

2.6 FACTORY FINISHING

- A. General: Comply with referenced quality standard's requirements for factory finishing.
- B. Finish wood doors at factory.
- C. Transparent Finish: Comply with requirements indicated for grade, finish system, staining effect, and sheen.

1. Grade: Custom.
2. Finish: Manufacturer's standard finish with performance requirements comparable to AWI System TR-6 catalyzed polyurethane.
3. Staining: As selected by Architect from manufacturer's full range of colors.
4. Effect: Semifilled finish.
5. Sheen: Satin.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine installed door frames before hanging doors.
 1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with plumb jambs and level heads.
 2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Hardware: Refer to drawings.
- B. Manufacturer's Written Instructions: Install wood doors to comply with manufacturer's written instructions, referenced quality standard, and as indicated.
 1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
- C. Job-Fit Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted with fire-rated doors. Machine doors for hardware. Seal cut surfaces after fitting and machining.
 1. Clearances: Provide 1/8 inch at heads, jambs, and between pairs of doors. Provide 1/8 inch from bottom of door to top of decorative floor finish or covering. Where threshold is shown or scheduled, provide 1/4 inch from bottom of door to top of threshold.
 - a. Comply with NFPA 80 for fire-rated doors.
 2. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
 3. Bevel fire-rated doors 1/8 inch in 2 inches on lock edge; trim stiles and rails only to extent permitted by labeling agency.
- D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
- E. Factory-Finished Doors: Restore finish before installation, if fitting or machining is required at Project site.

3.3 ADJUSTING AND PROTECTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Refinish or replace doors damaged during installation.
- C. Protect doors as recommended by door manufacturer to ensure that wood doors are without damage or deterioration at the time of Substantial Completion.

END OF SECTION 08211

SECTION 092600 - GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Gypsum board and joint treatment products.
- B. Water resistant gypsum board and joint treatment products.
- C. Mold and Mildew resistant gypsum board products.
- D. Accessories for the installation and trimming of gypsum board partitions and ceilings.

1.2 RELATED SECTIONS

- A. Section 05 41 00 - Cold-Formed Metal Framing.

1.3 REFERENCES

- A. ASTM C 36 - Standard Specification for Gypsum Wallboard.
- B. ASTM C 475 - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
- C. ASTM C 754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
- D. ASTM C 1002 - Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
- E. ASTM C 1396 - Standard Specification for Gypsum Board.

1.4 PERFORMANCE REQUIREMENTS

- A. Sound Rated Assemblies: Provide materials and construction identical to those tested in STC/IIC-rated assemblies by an independent testing agency.
 - 1. Test Method: ASTM E 90/E 492 and classified according to ASTM E 413/E 989.
 - 2. STC Ratings: As indicated on the drawings; designations listed are from Gypsum Association GA-600, Fire Resistance Design Manual.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Product Date: 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. Shop Drawings: Indicate special details associated with fireproofing, acoustic seals, or curved sheet installations.

- D. Maintenance Data: Manufacturer's recommendations for cleaning each type of product specified.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Installer: Company specializing in performing Work of this section with minimum three years.
- B. Mock-Up: Provide a mock-up of the area indicated on the Drawings for evaluation of surface preparation techniques and application workmanship.
 - 1. Locate finish areas designated by Engineer.
 - 2. Refinish mock-up area as required to produce acceptable work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store gypsum board in accordance with GA-216 and GA-238.
- B. Ship materials with a weathertight cover and in manufacturer's original packages showing manufacturer's name and product brand name.
- C. Remove plastic shipping bags upon receipt and storage. Failure to remove may increase the likelihood of mold growth.
- D. Store materials inside and protected from damage by weather and direct sunlight. Stack flat; protect ends, edges, and faces of gypsum boards from damage. Protect steel studs and metal accessories from moisture.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturers: Georgia-Pacific, National Gypsum, Lafarge North America Inc
- B. Requests for substitutions will be considered in accordance with provisions of the contract documents.

2.2 INTERIOR GYPSUM MATERIALS

- A. Regular Gypsum Board: Gypsum core panel surfaced with paper on front and back edges and complying with ASTM C 1396 and ASTM C 36.
 - 1. Thickness: 1/2 inch (12.7 mm), unless otherwise indicated.
 - 2. Width: 48 inches (1219 mm).
 - 3. Length: Use longest length available, avoiding unnecessary joints.
 - 4. Edges: Tapered.
- B. Type C: Basis-of-Design Product: G-P Gypsum; ToughRock Fireguard C Gypsum Board
 - 1. Thickness: As required by fire-resistance-rated assembly indicated on Drawings.
 - 2. Thickness: As indicated on the drawings
 - 3. Width: 48 inches (1219 mm).
 - 4. Edges: Tapered.

- C. Water-Resistant Gypsum Board: Gypsum core wall panel with additives to enhance water resistance of core; surfaced with green-colored face paper and gray backing paper; and complying with ASTM C 1396 and ASTM C 630.
 - 1. Thickness: 1/2 inch (12.7 mm).
 - 2. Width: 48 inches (1219 mm).
 - 3. Length: Use longest length available, avoiding unnecessary joints.
 - 4. Edges: Tapered.

2.3 FINISH PRODUCTS

- A. Joint Treatment Tape: Complying with ASTM C 475 and GA-216.
- B. Joint Compound: Vinyl type pre-mixed compound; complying with ASTM C 475.
- C. Joint Compound: Setting type lightweight; job mixed chemical-hardening compound; off white color; complying with ASTM C 475. acceptable product(s):
- D. Joint Compound: Level Five vinyl type pre-mixed compound; off-white color or tinted gray color; complying with ASTM C 475 and fulfilling ASTM C 840; designed for joint finishing of Level Five gypsum board.

2.4 ACCESSORY MATERIALS

- A. Corner Bead: Formed galvanized steel angle, min. base steel 0.014 in. thick, and complying with ASTM C 1047.
- B. Casing Bead: Formed galvanized steel trim, minimum base steel thickness of 0.014 inch (0.35 mm), complying with ASTM C 1047.
- C. Control Joint: Extruded vinyl formed with V-shaped slot covered with removable flexible vinyl strip; complying with ASTM C 1047.
- D. Screws: ASTM C 954 or ASTM C 1002 or both with heads, threads, points, and finish as recommended by panel manufacturer.
- E. Acoustical Sealant: Nondrying, nonhardening, nonskinning, nonstaining, nonbleeding, gunnable type as recommended by panel manufacturer.
- F. Insulation: ASTM C 665, Type I, mineral fiber (either glass, rock, or slag) insulation blankets without membrane facing.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify site conditions are ready to receive work and framing and opening dimensions are as indicated on the Drawings.
- B. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.

- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Application: Apply and maintain conditions during installation in accordance with GA-216 and GA-238 and as follows:
 - 1. Keep gypsum board dry throughout application.
 - 2. Do not use gypsum board that has visible mold growth.
 - 3. Apply gypsum board on walls with a minimum 1/4 inch (6.4 mm) gap between the gypsum board and the floor.
 - 4. Do not apply gypsum board over other building materials where conditions exist that are favorable to mold growth.
 - 5. Maintain a sound weather-tight building envelope including, such elements as the roof, sealants, windows, etc.
 - 6. Immediate and appropriate remediation measures must be taken as soon as water leaks or condensation sources are identified.
 - 7. Provide routine cleaning and maintenance operations to prevent saturation of the gypsum board.
 - 8. If gypsum board is damaged by water, assess the need for replacement in accordance with GA-231.
- B. Install accordance with GA 216 and the following:
 - 1. Metal Framing: ASTM C 754.
 - 2. Gypsum Sheathing Board: ASTM C 1280 and GA-253.
 - 3. Gypsum Board and Joint Treatment: ASTM C 840 and GA-214.
 - 4. Gypsum panel manufacturer's published recommendations.
- C. Finishing: Tape, fill, sand and finish joints in accordance with ASTM C 840 and GA-214.
 - 1. Level 1: Plenums and service corridors.
 - 2. Level 2: Water resistant gypsum backing board indicated to receive tile.
 - 3. Level 3: Gypsum board indicated to receive heavy or medium textured coatings and heavy-grade wall coverings.
 - 4. Level 4: Gypsum board indicated to receive light textured coatings and light-grade wall coverings.
 - 5. Level 5: All other gypsum board.
 - 6. Exception: Prefinished gypsum board.

3.4 PROTECTION

- A. Protect work from damage and deterioration until date of Substantial Completion.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION

SECTION 095123 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section. In the event of any conflicts between the requirements of these Sections, the more stringent requirement shall apply.

1.2 SECTION REQUIREMENTS

- A. Submittals: Product Data and material Samples.
- B. Surface-Burning Characteristics of Panels: ASTM E 1264, Class A materials, tested per ASTM E 84.
- C. Seismic Standard: Provide acoustical tile ceilings designed and installed to withstand the effects of earthquake motions according to the following:
 - 1. CISCA's Recommendations for Acoustical Ceilings: Comply with CISCA's "Recommendations for Direct-Hung Acoustical Tile and Lay-in Panel Ceilings - Seismic Zones 0-2."

1.3 ATTIC STOCK

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Acoustical Ceiling Tiles: Full-size units equal to 2 boxes of quantity installed of each tile type.

PART 2 - PRODUCTS

2.1 ACOUSTICAL TILE

- A. Products:
 - 1. Type 1:
 - a. Armstrong, Ultima, or approved equal.
 - b. Location: Refer to Drawings.
 - c. Classification: As follows, per ASTM E 1264:
 - i. Type and Form: Type IV, Form 2.
 - ii. Fire Class A
 - iii. Pattern: E.
 - iv. Color: White.
 - vi. Light Reflectance (LR) Coefficient: Not less than 0.90.
 - vii. Noise Reduction Coefficient (NRC): Not less than 0.65.
 - viii. Ceiling Attenuation Class (CAC): Not less than 35.
 - ix. **HumiGuard Plus in Locker Rooms #1 & #2.**

- d. Edge Detail: Beveled Tegular, kerfed and rabbeted.
- e. Thickness: 3/4-inch.
- f. Modular Size: 24 by 24 inches.

2.2 SUSPENSION SYSTEM

- A. Ceiling Suspension System: Direct hung; ASTM C 635, intermediate-duty structural classification.
 - 1. Products:
 - a. Armstrong. "AL Prelude Plus XL", 9/16 environmental tee grid system, or approved equal.
 - 2. Color: White for Fine Fissured.
- B. Attachment Devices: Size for 5 times the design load indicated in ASTM C 635, Table 1, Direct Hung, unless otherwise indicated. Comply with seismic design requirements.
- C. Wire Hangers, Braces, and Ties: Zinc-coated carbon-steel wire; ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 - 1. Size: Provide yield strength at least 3 times the hanger design load (ASTM C 635, Table 1, Direct Hung), but not less than 0.106-inch- diameter wire.
- D. Seismic Struts: Manufacturer's standard product designed to accommodate seismic forces.
- E. Access: Identify upward access tile with manufacturer's standard unobtrusive markers for each access unit.
- F. Provide hold-down clips throughout men's toilet room.

2.3 MOLDINGS

- A. Products:
 - 1. USG, "Shadow Wall Angle", model 7873, or approved equal.
 - a. Straight sections required for walls and soffits.
 - 2. Color: White for Fine Fissured.
- B. Material: Cold rolled hot dipped galvanized steel Zinc-coated carbon-steel wire; ASTM A 641/A 641M, Class 1 zinc coating, soft temper.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Ceiling Suspension System Installation: Comply with ASTM C 636 and CISCA's "Ceiling Systems Handbook."

- B. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.
 - 1. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate fit at borders and around penetrations through tile.
- C. Arrange directionally patterned acoustical panels in accordance with manufacturer's instructions.

END OF SECTION 095123

SECTION 096723 - RESINOUS FLOORING SYSTEM – COLOR QUARTZ

1.01 DESCRIPTION OF WORK:

- A. Furnish labor and materials to complete application of Resinous Flooring System and related work as shown and specified.
- B. Related work specified elsewhere: Concrete on grade must meet local conditions to prevent osmosis, hydrostatic, vapor pressure. Specify following in Concrete Section.
 - 1. Vapor retarder: Moistop by Fortifiber, Los Angeles, Ca. Griffolyn by Reef Industries, Houston, TX. or approved equal.
 - 2. Concrete, minimum 3,000 psi. Finish: Light broom finish or float finish with proper pitching to produce a flat granular substrate relatively laitence free.
 - 3. Water cure concrete.
 - 4. Do not apply curing compounds, sealer, hardeners, or other materials to concrete that are not compatible with epoxy.
 - 5. Set drains, cleanouts, trenches, etc. 1/16” above the substrate for 1/16” floor and 1/8” for 1/8” or 3/16” floor.
 - 6. Do not cover or fill expansion, construction, or control joints.
 - 7. Do not apply any patching materials to substrate prior to consulting Palma Inc.

1.02 QUALITY ASSURANCE:

- A. Perform work with qualified supervision by formulator of materials, or by a firm specializing in application of material specified, and acceptable to formulator and owner.
- B. Formulator: Palma Inc., Bloomfield, New Jersey, or approved equal

1.03 SUBMITTALS:

- A. Formulator’s Data: Submit formulator’s printed preparation and application instructions for each type and class of material required. Include formulator’s certification showing material compliance with specified requirements.
- B. Maintenance Instructions: Submit formulator’s printed instructions.
- C. Samples: Submit samples showing range of selected color and texture variation for approval prior to commencement of work.

- D. Guaranty: Submit written warranty, signed by formulator and applicator, agreeing to guarantee application against faulty workmanship or materials for 2 years from date of acceptance.

1.04 DELIVERY, STORAGE AND HANDLING:

- A. Deliver materials in formulator’s unopened containers, with trade name, type, grade and other data. Store materials indoors in clean and dry location with temperature between 60° and 85° Fahrenheit.
- B. Damaged containers unsuitable for use will be rejected.

1.05 JOB CONDITIONS:

- A. Substrate and air temperature must be between 60° and 85° Fahrenheit before, during and until application has cured.
- B. Proper ventilation, permanent lighting, permanent heating and air conditioning must be maintained during application and curing.
- C. Provide protective gloves, shoes, goggles, and respirator when mixing during applications.

1.06 SEQUENCING AND SCHEDULING:

- A. Coordinate work with other trades.
- B. Commence preparation and application after all other trades have completed their work.

PART 2 - PRODUCTS

2.01 MATERIALS:

- A. Basis of Design: PalmaLite PaliKrom 185 (3/16”) or approved equal.
 - 1. Epoxy: PalmaLite Bodycoat 100% solids or approved equal.
 - 2. Epoxy: PalmaLite Clear Topcoat 100% solids or approved equal.
 - 3. Ceramic Colorquartz: 3M Colorquartz for color and texture, Grade 28 or approved equal.
 - 4. Silica sands: 20/40 & 140 mesh.
- B. TECHNICAL DATA: Minimum physical requirements Committee C.03 ASTM C722 Standard Specification for Resinous Monolithic Surfacing 60 mils in thickness or greater.

<u>Test</u>	<u>Physical Requirement</u>
Compressive Strength ASTM - C-579	6,000 PSI

Tensile Strength ASTM - C-307	1,500 PSI
Flexural Strength & Rupture ASTM - C-580	3,400 PSI
Flexural Modulus of Elasticity ASTM - C-580	500,000 PSI
Water Absorption ASTM - C-413	1.0% (max)
Thermal Coefficient of Expansion ASTM - C-531	40x10 ⁻⁶ in./in. deg F

Supplemental Tests

<u>Test</u>	<u>Physical Requirements</u>
Flammability ASTM - D-635	Self extinguishing
Thermal Shock 5 cycles ASTM - C-884	No cracking, crazing, warping scaling or flaking
Co-efficient of Friction ASTM - C-1028	0.5
Shore "D" Hardness ASTM - D-2240	83-90
Taber Abrasion ASTM - D-1044	0.05 grams
Waterproof ASTM - D-4068	No evidence of moisture.
Indentation MIL - D-3134	Not more than 7%
Resistance to Impact MIL - D-3134	Not more than 1/16"
Taber Wear H-22 - Wheel	Abrasive wear index 30
Bond Strength ACI - 503	175 p.s.i. (100% concrete failure)
Heat Resistance	140°F Continuous, 200°F Non-Continuous Dielectric Properties Insulation resistance and dielectric strength tests in excess of 50,000 volts.

- E. CHEMICALS AND SOLVENTS: Insert specific reagents when chemical and solvent resistance are a requirement. Test in accordance with ASTM D-1308.

PART 3- EXECUTION

3.01 INSPECTION:

- A. Examine substrate and conditions where epoxy is to be applied. Notify contractor in writing of unsatisfactory conditions. Proceed after conditions are corrected.

3.02 SURFACE PREPARATION:

- A. GENERAL: New and Existing Surfaces:

1. Prepare substrate in compliance with Committee C.03 ASTM C-811 Standard Practice for Surface Preparation of Concrete for Application of Resin Monolithic Surfacing's and formulator's written instructions for substrate indicated.

- B. Surface must be structurally sound and free of contaminants.

- C. Clean and fill joints and cracks wider than 1/16" with Palmaflex joint filler, or approved equal, and tape over crack or joint with 4" fiberglass tape to prevent reflection.
- D. Sawcut and chisel concrete substrate at termination points, keying in to maintain minimum thickness of floor coating.
- E. Tape at termination points and adjacent surfaces not to be coated with masking tape before bodycoat(s), cove base, colorquartz coat and topcoat(s).
- F. Remove tape before all applications dry.

3.03: APPLICATION: Nominal 3/16": Mandatory over ceramic tile, quarry tile, terrazzo, plywood, spalled concrete.

- A. GENERAL: Mix and apply each component of resinous flooring system in compliance with formulator's detailed instructions to produce an uninterrupted, uniform, monolithic surface. Thickness of system to be nominal 3/16".
- B. PRIMER/ MEMBRANE BODY COAT: Trowel mixture onto surface, allow to self-level, then broadcast silica aggregate into body coat. Allow to dry. Sweep excess aggregate.
- C. BODYCOAT: Trowel mixture onto surface, allow to self-level, then broadcast silica aggregate into body coat. Allow to dry. Sweep excess aggregate.
- D. COVE BASE: When shown, apply cove base after (C) bodycoat. Apply to height of 4". Follow formulator's detailed application instructions covering taping, mixing, priming, troweling, sanding and topcoating of cove base.
- E. COLORQUARTZ COAT: Trowel mixture onto surface, allow to self-level, then broadcast selected color with 3M Colorquartz into wet mixture. Allow to dry.
- F. TOPCOAT(S): Remove excess quartz from the surface, then stone. Two clear epoxy topcoats for standard slip resistant finish. One clear epoxy topcoat for coarse slip resistant finish.

3.04 CLEANING:

- A. Following completion of application, clean all areas not specified to receive flooring.

3.05 PROTECTION: (General Conditions)

- A. Close area where application is completed to all traffic for 72 hours. After initial cure, finished floor shall be protected by others until final inspection and acceptance by owner.

END OF SECTION

SECTION 098116 - ACOUSTIC BLANKET INSULATION

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes: Provide glass fiber acoustical blanket insulation for interior partitions.
- B. Related Sections:
 - 1. Section 09 20 00, Plaster and Gypsum Board.

1.2 REFERENCES

- A. Materials shall meet the property requirements of one or more of the following specifications as applicable to the specific product or end use:
 - 1. American Society for Testing of Materials (ASTM):
 - a. ASTM C423 Test Method for Sound Absorption Coefficient by the Reverberation Room Method.
 - b. ASTM C518 Test Method for Steady State Thermal Transmission Properties by Means of the Heat Flow Meter.
 - c. ASTM C665 Specification for Mineral Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
 - d. ASTM E36 Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.
 - e. ASTM E84 Test Method for Surface Burning Characteristics of Building Materials.
 - f. ASTM E119 Test Methods for Fire Tests of Building Construction and Materials.

1.2 SUBMITTALS

- A. Product Data: Submit product characteristics, performance criteria, and limitations, including installation instructions, for each type of product indicated.
- B. Sustainable Design: Submit manufacturer's sustainable design certifications as specified.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in manufacturer's original packaging.
- B. Store and protect products in accordance with manufacturer's instructions. Store in a dry indoors location. Protect insulation materials from moisture and soiling.
- C. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.
- D. Do not install insulation that has been damaged or wet. Remove it from jobsite.

1. An exception may be allowed in cases where the contractor is able to demonstrate that wet insulation when fully dried out (either before installation or afterward following exposure to system operating temperatures) will provide installed performance that is equivalent in respects to new, completely dry insulation. In such cases, consult the insulation manufacturer for technical assistance.

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. Owens Corning Insulating Systems, LLC, Toledo, OH 43659; www.owenscorning.com.

2.2 ACOUSTIC BLANKET INSULATION (SOUND ATTENUATION BATTS), FIRE-RATED

- A. Type: Unfaced glass fiber acoustical insulation, complying with ASTM C665, Type I 3-1/2" / 5-1/2" thick, 16" wide, 96" length
- B. Surface Burning Characteristics: ASTM E84.
 1. Maximum flame spread: 10
 2. Maximum smoke developed: 10
- C. Combustion Characteristics: Passes ASTM E136.
- D. Fire Resistance Ratings: Part of ASTM E119 fire tested wall assemblies.
- E. Sound Transmission Class: ASTM C423, **STC 50**
- F. Dimensional Stability: Linear Shrinkage less than 0.1%

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions under which the work of this Section is to be performed. Notify the Architect in writing of any unsatisfactory conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.
- B. Verify mechanical and electrical services within the partition have been tested and inspected.

3.2 INSTALLATION

- A. Comply with manufacturer's installation instructions.

- B. Friction-fit blanket insulation in place, until the interior finish is applied. Install batts to fill entire stud cavity, with no gaps, voids, or areas of compression. If stud cavity is less than 8 feet in height, cut lengths to friction fit against floor and ceiling tracks. Walls with penetrations require that insulation be carefully cut to fit around outlets, junction boxes, and other irregularities.
- C. Where walls are not finished on both sides or where insulation does not fill the cavity depth, install supplementary support to hold product in place.
- D. Where insulation must extend higher than 8 feet, provide temporary support to hold product in place, until finish material is applied.

3.3 PROTECTION

- A. Protect installed insulation as recommended by manufacturer.

END OF SECTION

SECTION 099000 - PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes surface preparation and field painting of the following:
 - 1. Exposed exterior items and surfaces.
 - 2. Exposed interior items and surfaces.
 - 3. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- B. Paint exposed surfaces, except where the drawings indicate that a surface or material is not to be painted or is to remain natural. If the drawings do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the drawings do not indicate color or finish, the Architect will select from standard colors and finishes available.
 - 1. Painting includes field painting of exposed bare and covered pipes and ducts (including color coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment.
- C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
 - 1. Prefinished items include the following factory-finished components:
 - a. Architectural woodwork and casework.
 - d. Metal lockers.
 - c. Finished mechanical and electrical equipment.
 - d. Light fixtures.
 - e. Distribution cabinets.
 - 2. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
 - a. Foundation spaces.
 - b. Furred areas.
 - c. Ceiling plenums.
 - d. Utility tunnels.
 - e. Pipe spaces.

- f. Duct shafts.
 - g. Elevator shafts.
3. Finished metal surfaces include the following:
- a. Anodized aluminum.
 - b. Stainless steel.
 - c. Chromium plate.
 - d. Copper.
 - e. Bronze and brass.
4. Operating parts include moving parts of operating equipment and the following:
- a. Valve and damper operators.
 - b. Linkages.
 - c. Sensing devices.
 - d. Motor and fan shafts.
5. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

1.3 DEFINITIONS

A. General: Standard coating terms defined in ASTM D 16 apply to this Section.

- 1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
- 2. Eggshell refers to low-sheen finish with a gloss range between 5 and 20 when measured at a 60-degree meter.
- 3. Satin refers to low-sheen finish with a gloss range between 15 and 35 when measured at a 60-degree meter.
- 4. Semigloss refers to medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.
- 5. High gloss refers to high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

1.4 SUBMITTALS

A. Product Data: For each paint system specified. Include block fillers and primers.

- 1. Material List: Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
- 2. Manufacturer's Information: Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.
- 3. Certification by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

- B. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated.
 - 1. After color selection, the Architect will furnish color chips for surfaces to be coated.
- C. Samples for Verification: Of each color and material to be applied, with texture to simulate actual conditions, on representative Samples of the actual substrate.
 - 1. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing Samples for review. Resubmit until required sheen, color, and texture are achieved.
 - 2. Provide a list of materials and applications for each coat of each sample. Label each sample for location and application.
 - 3. Submit Samples on the following substrates for the Architect's review of color and texture only:
 - a. Concrete: Provide two 4-inch- square samples for each color and finish.
 - b. Concrete Masonry: Provide two 4-by-8-inch samples of masonry, with mortar joint in the center, for each finish and color.
 - d. Stained: Provide two 4-by-8-inch samples of natural- or stained-wood finish on actual wood surfaces.
 - e. Ferrous Metal: Provide two 4-inch- square samples of flat metal and two 8-inch-long samples of solid metal for each color and finish.
- D. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.5 QUALITY ASSURANCE

- A. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.
- B. Source Limitations: Obtain block fillers, primers, and undercoat materials for each coating system from the same manufacturer as the finish coats.
 - 3. Final approval of colors will be from job-applied samples.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
 - 1. Product name or title of material.
 - 2. Product description (generic classification or binder type).
 - 3. Manufacturer's stock number and date of manufacture.

4. Contents by volume, for pigment and vehicle constituents.
5. Thinning instructions.
6. Application instructions.
7. Color name and number.
8. VOC content.

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1. Protect from freezing. Keep storage area neat and orderly. Remove oily rags and waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.7 PROJECT CONDITIONS

A. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 and 90 deg F.

B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 45 and 95 deg F.

C. Do not apply paint in snow, rain, fog, or mist; or when the relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.

1.8 EXTRA MATERIALS

A. Furnish extra paint materials from the same production run as the materials applied in the quantities described below. Package paint materials in unopened, factory-sealed containers for storage and identify with labels describing contents. Deliver extra materials to the Owner.

1. Quantity: Furnish the Owner with an additional 5 percent, but not less than 1 gal. or 1 case, as appropriate, of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in the paint schedules.
- B. Products: Subject to compliance with requirements, provide one of the products in the paint schedules.
- C. Manufacturers Name:

Basis of design: Benjamin Moore & Co. (Moore), or approved equal.

2.2 PAINT MATERIALS, GENERAL

- A. Material Compatibility: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
 - 1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.
- C. Colors: Provide color selections made by the Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.
 - 1. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
 - 2. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.
- B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.

1. Notify the Architect about anticipated problems using the materials specified over substrates primed by others.

3.2 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.
 1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- B. Cleaning: Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.
 1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
 1. Provide barrier coats over incompatible primers or remove and reprime.
 2. Cementitious Materials: Prepare concrete, concrete masonry block, cement plaster, and mineral-fiber-reinforced cement panel surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
 - a. Use abrasive blast-cleaning methods if recommended by paint manufacturer.
 - b. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces where moisture content exceeds that permitted in manufacturer's written instructions.
 - c. Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, rinse, allow to dry, and vacuum before painting.
 3. Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.
 - a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
 - b. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and backsides of wood, including cabinets, counters, cases, and paneling.
 - c. When transparent finish is required, backprime with spar varnish.

- d. Backprime paneling on interior partitions where masonry, plaster, or other wet wall construction occurs on backside.
 - e. Seal tops, bottoms, and cutouts of unprimed wood doors with a heavy coat of varnish or sealer immediately on delivery.
4. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with the Steel Structures Painting Council's (SSPC) recommendations.
- a. Blast steel surfaces clean as recommended by paint system manufacturer and according to requirements of SSPC-SP 10.
 - b. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
 - c. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with the same primer as the shop coat.
5. Galvanized Surfaces: Clean galvanized surfaces with nonpetroleum-based solvents so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.
- D. Materials Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
- 1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 - 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
 - 3. Use only thinners approved by paint manufacturer and only within recommended limits.
- E. Tinting: Tint each undercoat a lighter shade to simplify identification of each coat when multiple coats of the same material are applied. Tint undercoats to match the color of the finish coat, but provide sufficient differences in shade of undercoats to distinguish each separate coat.

3.3 APPLICATION

- A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
- 1. Paint colors, surface treatments, and finishes are indicated in the schedules.
 - 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 - 3. Provide finish coats that are compatible with primers used.
 - 4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.

5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
 7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
 8. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces.
 9. Finish interior of wall and base cabinets and similar field-finished casework to match exterior.
 10. Sand lightly between each succeeding enamel or varnish coat.
- B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 2. Omit primer on metal surfaces that have been shop primed and touchup painted.
 3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.
- C. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
1. Brushes: Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.
 2. Rollers: Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by the manufacturer for the material and texture required.
 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by the manufacturer for the material and texture required.
- D. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate. Provide the total dry film thickness of the entire system as recommended by the manufacturer.
- E. Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed in equipment rooms and in occupied spaces.
- F. Mechanical items to be painted include, but are not limited to, the following:
1. Piping, pipe hangers, and supports.
 2. Heat exchangers.

3. Tanks.
4. Ductwork.
5. Insulation.
6. Motors and mechanical equipment.
7. Accessory items.

G. Electrical items to be painted include, but are not limited to, the following:

1. Conduit and fittings.
2. Switchgear.
3. Panelboards.

H. Block Fillers: Apply block fillers to concrete masonry block at a rate to ensure complete coverage with pores filled.

I. Prime Coats: Before applying finish coats, apply a prime coat of material, as recommended by the manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn through or other defects due to insufficient sealing.

J. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.

K. Transparent (Clear) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.

1. Provide satin finish for final coats.

L. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.

3.4 CLEANING

A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.5 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting, as approved by Architect.

- B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
 - 1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.6 EXTERIOR PAINT SCHEDULE

All products and finishes below is considered Basis of Design. Other manufacturers with products that meet or exceed the features of the basis of design may be considered as approved equal after satisfactory review by the Engineer.

- A. Concrete, Stucco, and Masonry (Other than Concrete Masonry Units): Provide the following finish systems over exterior concrete, stucco, and brick masonry surfaces:

- 1. Flat Acrylic Finish: 2 finish coats over a primer.
 - a. Primer: Alkali-resistant, exterior, acrylic-latex primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils.

Moore: Primer not required over this substrate.

- b. First and Second Coats: Flat, exterior, acrylic-emulsion paint applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.4 mils.

Moore: MoorLife Latex House Paint #105.

- 3. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a primer.
 - a. Primer: Alkali-resistant, exterior, acrylic-latex primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.4 mils.

Moore: Moore's Latex Exterior Primer #102.

- b. First and Second Coats: Semigloss, exterior, acrylic-latex enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.4 mils.

- c. Moore: MoorGlo Latex House & Trim Paint #096.

- J. Ferrous Metal: Provide the following finish systems over exterior ferrous metal. Primer is not required on shop-primed items.

- 1. Flat, Alkyd-Enamel Finish: 2 finish coats over a rust-inhibitive primer.

- a. Primer: Rust-inhibitive metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils.

Moore: IronClad Retardo Rust-Inhibitive Paint #163.

- b. First and Second Coats: Flat, exterior, alkyd enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 3.4 mils.

Moore: Moore's PentaFlex Flat House Paint #114.

3. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a rust-inhibitive primer.

- a. Primer: Rust-inhibitive metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.3 mils.

Moore: IronClad Retardo Rust-Inhibitive Paint #163.

- b. First and Second Coats: Semigloss, exterior, acrylic-latex enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils.

Moore: MoorGlo Latex House & Trim Paint #096.

K. Zinc-Coated Metal: Provide the following finish systems over exterior zinc-coated (galvanized) metal surfaces:

1. Low-Luster Finish: 2 finish coats over a galvanized metal primer.

- a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.

Moore: IronClad Galvanized Metal Latex Primer #155.

- b. First and Second Coat: Low-luster (eggshell or satin), exterior, acrylic-latex paint applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils.

Moore: MoorGard Latex House Paint #103.

2. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a galvanized metal primer.

- a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.

Moore: IronClad Galvanized Metal Latex Primer #155.

- b. First and Second Coats: Semigloss, exterior, acrylic-latex enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than

4) Moore: MoorGlo Latex House & Trim Paint #096.

3.8 INTERIOR PAINT SCHEDULE

D. Gypsum Board: Provide the following finish systems over interior gypsum board surfaces:

3. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a primer.

- a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.

Moore: Regal First Coat Interior Latex Primer & Underbody #216.

- b. First and Second Coats: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils.

Moore: Moore's Regal AquaGlo Vinyl-Acrylic Latex Enamel #333.

H. Painted Woodwork: Provide the following stained finishes over new, interior woodwork:

1. High-Gloss, Acrylic-Enamel Finish: Two finish coats over a primer.

- a. Filler Coat: Paste-wood filler applied at spreading rate recommended by the manufacturer.

Moore: Benwood Paste Wood Filler #238.

- b. Primer Coat:

Moore: Fresh Start Enamel Underbody Primer

- c. First and Second Finish Coats:

Moore: ADVANCE Interior/Exterior High-Gloss.

J. Ferrous Metal: Provide the following finish systems over ferrous metal:

1. Flat Acrylic Finish: 2 finish coats over a primer.
 - a. Primer: Quick-drying, rust-inhibitive, alkyd-based or epoxy-metal primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils.

Moore: IronClad Retardo Rust-Inhibitive Paint #163.

- b. First and Second Coats: Flat, acrylic-latex, interior paint applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.5 mils.

Moore: Regal Wall Satin #215.

2. Semigloss, Acrylic-Enamel Finish: One finish coat over an enamel undercoater and a primer.

- a. Primer: Quick-drying, rust-inhibitive, alkyd-based or epoxy-metal primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils.

Moore: IronClad Retardo Rust-Inhibitive Paint #163.

- b. Undercoat: Alkyd, interior enamel undercoat or semigloss, acrylic-latex, interior enamel, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.3 mils.

Moore: Moore's Alkyd Enamel Underbody #217.

- c. Finish Coat: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.3 mils.

Moore: Moore's Regal AquaGlo Vinyl-Acrylic Latex Enamel

K. Zinc-Coated Metal: Provide the following finish systems over zinc-coated metal:

1. Flat Acrylic Finish: 2 finish coats over a primer.
 - a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.

Moore: IronClad Galvanized Metal Latex Primer #155.

- b. First and Second Coats: Flat, acrylic-latex, interior paint applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.5 mils

Moore: Regal Wall Satin #215.

- 3. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a primer.

- a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils.

Moore: IronClad Galvanized Metal Latex Primer #155.

- b. First and Second Coats: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils.

Moore: Moore's Regal AquaGlo Vinyl-Acrylic Latex Enamel #333.

END OF SECTION 099000

102113 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section. In the event of any conflicts between the requirements of these Sections, the more stringent requirement shall apply.

1.2 SUBMITTALS

- A. Plastic compartment work includes the following, where indicated:
 - 1. Floor-mounted overhead braced compartments.
 - 2. Wall mounted urinal screens.
- B. Furnish all labor and materials necessary for the completion of work in this section as shown on the contract drawings and specified herein.
- C. Work in this section shall include, but is not limited to:
 - 1. Toilet compartments, compartment doors, urinal screens, and privacy screens.
 - 2. Hardware for toilet compartments and plastic partitions.
 - 3. Shop drawings and working drawings.
 - 4. Manufacturer's guarantee.
- D. Related work specified elsewhere shall include accessories and anchorage/blocking for attachment of partitions.

1.3 PRODUCT DATA

- A. Submit six (6) sets of shop drawings and details for architect's approval.
- B. Colors shall be selected from the manufacturer's full range of colors.
- C. Color samples and hardware samples shall be submitted for approval by the architect.

1.4 PERFORMANCE REQUIREMENTS

- A. Fire Resistance: Partition materials shall comply with the following requirements, when tested in accordance with the ASTM E 84: Standard Test Method for Surface Burning Characteristics of Building Materials:
 - 1. Smoke Developed Index: Not to exceed 450
 - 2. Flame Spread Index: Not to exceed 75
 - 3. Material Fire Ratings:
 - a. National Fire Protection Association (NFPA): Class B
 - b. International Code Council (ICC): Class B

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: A company regularly engaged in manufacture of products specified in this section, and whose products have been in satisfactory use under similar service conditions for not less than 5 years.
- B. Installer's Qualifications: A Company or Individual, regularly engaged in installation of products specified in this Section, with a minimum of 5 years' experience.

1.6 WARRANTY

- A. Manufacturer guarantees its plastic against breakage, corrosion, and delamination under normal conditions for 15 years from the date of receipt by the customer. If materials are found to be defective during that period for reasons listed above, the materials will be replaced free of charge. (Labor shall be included in warranty.)

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. Toilet partitions and screens to be supplied by SCRANTON PRODUCTS (Santana/ Comtec/Capitol), or approved equal.

2.2 MATERIALS

- A. Doors, panels and pilasters shall be 1" thick constructed from High Density Polyethylene (HDPE) resins. Partitions shall be fabricated from polymer resins compounded under high pressure, forming a single component which is waterproof, nonabsorbent and has a self-lubricating surface that resists marks from pens, pencils, markers and other writing instruments. All plastic components shall be covered with a protective plastic masking.
 - 1. Contractor shall assume two (2) colors for project.

2.3 CONSTRUCTION

- A. Doors, panels, and pilasters shall be 1" thick with all edges rounded to a ¼" radius.
- B. Doors and dividing panels shall be 55" high and mounted at 14" above the finished floor. An aluminum heat sink may be fastened to the bottom edges.
- C. Pilasters shall be 82" high (standard) and fastened into a 3" high pilaster shoe with a stainless steel tamper resistant torx head sex bolt.

2.4 HARDWARE

- A. Door hardware shall be as noted:
 - 1. Hinges:
 - a. Two hinges per doors shall be 8" and fabricated from heavy-duty extruded aluminum (6463-T5 alloy) with bright dip anodized finish with

wrap-around flanges, through bolted to doors and pilasters with stainless steel, torx head sex bolts. Hinges operate with field adjustable nylon cams. Cams can be field set in 30-degree increments OR, hinges shall be integral, fabricated from the door and pilaster with no exposed metal parts.

- b. One hinge per door shall be 7-1/16" and fabricated from stainless steel (304 S.S. satin finish) with adjustable closing speed spring hinge, through bolted to doors and pilasters with stainless steel, torx head sex bolts. Adjustable speed hinge shall be model JSA-58/S, as manufactured by Sugatsune America, Inc. or equal.
 2. Door strike/keeper shall be 6" long and made of heavy-duty extruded aluminum (6436-T5 alloy) with a bright dip anodized finish and secured to the pilasters with stainless steel tamper resistant torx head sex bolts. Bumper shall be made of extruded black vinyl.
 3. Latch and housing shall be made of heavy-duty extruded aluminum (6463-T5 alloy). The latch housing shall have a bright dip anodized finish, and the slide bolt and button shall have a black anodized finish.
 4. Each door shall be supplied with one coat hook/bumper and door pull made of chrome plated zamak. Handicapped doors shall be supplied with a second door pull and out swing doors with one door stop made of chrome plated zamak.
- B. Pilaster shoes shall be 3" high and made of one-piece molded HDPE plastic available in the following colors: burgundy, mocha, black, parchment, white, charcoal grey, hunter, grey, fossil, linen, beige, blueberry, azure, cappuccino, sandcastle, sandstone and glacier grey. OR, pilaster shoes shall be 3" high (type 304, 20 gauge) stainless steel. Pilaster shoes shall be secured to the pilaster with a stainless steel tamper resistant torx head sex bolt.
- C. Wall brackets shall be 54" long and made of 1/2" stirrup type made of heavy-duty aluminum (6463-T5 alloy) with a bright dip anodized finish. Stirrup brackets shall be fastened to pilasters and panels with stainless steel tamper resistant torx head sex bolts.
- D. Headrail shall be made of heavy-duty extruded aluminum (6463-T5 alloy) with anti-grip design and integrated curtain track. The headrail shall have a clear anodized finish and shall be fastened to the headrail bracket by a stainless steel tamper resistant torx head sex bolt, and fastened at the top of the pilaster with stainless steel tamper resistant torx head screws.
- E. Headrail brackets shall be 20 gauge stainless steel with a satin finish and secured to the wall with a stainless steel tamper resistant torx head screws.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine areas to receive toilet partitions, screens, and shower compartments for correct height and spacing of anchorage/blocking and plumbing fixtures that may affect installation of partitions. Report any discrepancies to the architect.
- B. Take complete and accurate measurements of complete toilet compartment locations.

- C. Start of work constitutes acceptance by the Contractor of field conditions.

3.2 INSTALLATION

- A. Install partitions rigid, straight, plumb, and level manor, with plastic laid out as shown on shop drawings and manufacturer's installation instructions.
- B. All doors and panels to be mounted at 14" above finished floor.
- C. Clearance at vertical edges of doors shall be uniform top to bottom and shall not exceed 3/8".
- D. No evidence of cutting, drilling, and/or patching shall be visible on the finished work.
- E. Finished surfaces shall be cleaned after installation and be left free of all imperfections.

END OF SECTION 102113

SECTION 102800 - TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section. In the event of any conflicts between the requirements of these Sections, the more stringent requirement shall apply.

1.2 SECTION INCLUDES

- A. Toilet Accessories.

1.3 REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Fasteners: Devices of similar material as accessory items to install unit per manufacturers recommendations.

2.2 TOILET AND BATH ACCESSORIES

- A. Under lavatory/Sink Piping Insulation:
 - 1. Basis-of-Design Product: Plumberex Specialty Products, Inc., "Trap Gear", ADA Compliant, Class A Material, molded closed cell PVC, secured with tamper resistant heavy-duty interlocking snap fasteners, or approved equal.
 - 2. Description: Insulating pipe coverings for supply and drain piping assemblies, which prevent direct contact with and burns from piping, and allow service access without removing coverings.
 - 3. Material and Finish: Antimicrobial, molded plastic, white.
- B. Soap Dispenser: By Owner
- C. Grab Bar Type 1: Basis of Design Product, Bobrick No. B6806 x 18 inch or approved equal; 1-1/2-inch diameter, peened grip, concealed mounting.
- D. Grab Bar Type 2: Basis of Design Product, Bobrick No. B6806 x 36 inch or approved equal; 1-1/2-inch diameter, peened grip, concealed mounting.
- E. Grab Bar Type 3: Basis of Design Product, Bobrick No. B6806 x 42 inch or approved equal; 1-1/2-inch diameter, peened grip, concealed mounting.

- F. Mirror: Bobrick 36 x 48 x 3/8-inch or approved equal; welded stainless steel frame and tempered glass.
- G. Toilet Paper Dispenser: By owner
- H. Waste Receptacle: By Owner
- I. Electric Hand Dryer: By Owner

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories using fasteners appropriate to substrate indicated and recommended by unit manufacturer.
- B. Adjust accessories and verify that mechanisms function properly. Replace damaged or defective items. Remove temporary labels and protective coatings.
- C. Install solid wood blocking in wall framing behind toilet accessories to allow anchorage. Expansion type fasteners into wallboard will not be permitted.
- D. Mount grab bars to withstand a load of 300 pounds at any point in any direction.

END OF SECTION 102800

SECTION 105113 - METAL LOCKERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Heavy duty type lockers.
- B. Accessories including, tops, bases, vertical fillers, recess trim, benches and built-in locks.

1.02 RELATED REQUIREMENTS

- A. Section 06 1000 - Rough Carpentry: Furring, blocking, and shims.
- B. Section 10 5116 - Plastic Lockers.

1.03 REFERENCES

- A. American Society for Testing and Materials (ASTM) A1008 - Standard Specification for Steel Sheet, Carbon, Cold-Rolled, Commercial Quality.
- B. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- C. LEED Green Building Rating System
 - 1. MR 4.1 and MR 4.2: Recycled Content.
 - 2. MR 6.0: Rapidly Renewable Materials.
 - 3. MR 7.0: Certified Wood.
 - 4. EQ 4.1, EQ 4.2, EQ 4.4: Low Emitting Materials.
- D. ADAAG - American with Disabilities Act, Accessibility Guidelines.
- E. ANSI A117.1 - Accessible and Usable Buildings and Facilities

1.04 SUBMITTALS

- A. Submit under provisions of Section 01 3000.
- 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. Shop Drawings: Provide layout and elevations of lockers with overall dimensions.
- D. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms.
- E. Selection Samples: For finish product specified, two complete sets of color chips representing manufacturer's full range of available colors.
- F. Verification Samples: For finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product and color selected.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Sequence deliveries to avoid project delays but minimize on-site storage.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. ASI Storage Solutions, 2171 Liberty Hill Road, Eastanollee, GA 30538; Phone: 706.827.2720; Fax: 706.827.2710; www.asilockers.com, or approved equal.
- B. Provide metal lockers from a single manufacturer.

2.02 MATERIALS

- A. Steel: Prime grade mild cold-rolled sheet steel free from surface imperfection, capable of taking a high-grade enamel finish.
- B. Hooks: Zinc plated forged steel, ball ends.
- C. Bolts and Nuts: Zinc plated truss fin head bolts and hex nuts.
- D. Rivets:

2.03 HEAVY DUTY LOCKERS

- A. Locker Configurations:
 - 1. Double Tier: 78 inches.
- B. Material: Mild cold rolled commercial quality steel, ASTM A1008.
- C. Finish: Steel surfaces power washed, phosphate treated, and finished with an electrostatically applied 2-mil thick hybrid epoxy/polyester powder coating and baked.
- D. Construction: Unitized with common intermediate uprights separating units.
- E. Door Frames:
 - 1. 16-gage channel.
 - 2. Vertical members shall have additional flange to provide a continuous door strike.
 - 3. Cross frame members; 16-gage channel shaped
 - a. Double Tier Lockers: Include intermediate cross frames.
 - b. Triple Tier Lockers: Include intermediate cross frames.
- F. Doors:
 - 1. 14-gage channel shaped on both the lock and hinge side, with angle formations across the top and bottom.
 - 2. 16-gage full height reinforcement channel on Single, Double, and Triple Tier lockers.

G. Body:

1. Bottoms: 16-gage.
2. Tops, Sides, Backs and Shelves: 24-gage.
3. Bolt spacing shall not exceed 9 inches o.c.

H. Hinges: 16-gage continuous piano type, riveted to both door and frame.

I. Handles: One-piece 20-gage deep drawn stainless steel cup designed to accommodate locks.

J. Latching:

1. 11-gage frame hook secured to the frame.
2. Padlock hasp protruding through recessed handle.
3. Provide rubber silencer secured to frame at each latch hook.

K. Interior Equipment:

1. 3 wall hooks and one ceiling hook Double Tier lockers

L. Number Plates: Polished aluminum number plate riveted to door face with black numerals 1/2 inch high.

M. Color:

1. Doors and exposed body parts as selected from ASI's standard designer color range.
2. Non-exposed body parts finished in #03 Almond.

N. Assemble locker components with rivets.

2.04 ACCESSORIES

A. Sloped Tops:

1. Continuous slope top: 18-gage sheet steel, powder coated to match locker color.
2. Hoods: 72 inches in length by depth of locker.
3. For longer lengths, provide slip joints without visible fasteners at splice locations.
4. Individual sloped tops: 24-gage sheet steel, powder coated to match locker color.
5. Provide end closures.
6. Slope Rise: 1/3 of the locker depth.
 - a. At continuous hoods add a 1 inch vertical rise at the front.

B. Bases:

1. Zee base: 14-gage sheet steel, powder coated to match locker color.
2. Front base/closed end base: 18-gage sheet steel, powder coated to match locker color.
3. Install front bases between the front legs without overlap or exposed fasteners.
4. Install end bases between front and rear legs of lockers at end of a row.

C. Fillers-Vertical:

1. 20-gage sheet steel, powder coated to match locker color.
2. Filler width: 6 inches.
3. Filler Width: 12 inches.

D. Recess Trim:

1. 18-gage sheet steel, powder coated to match locker color.
2. Left Hand Side Trim:
 - a. 3 inches wide by 75 inches high.
3. Right Hand Side Trim:
 - a. 3 inches wide by 75 inches high.
4. Top Trim: 74 inches long by 3 inches high
5. Splice: 2 inches by 3 inches.

2 .05 BENCHES

- A. Wood Bench Tops:
 1. Fabricated of hardwood with corners sanded and rounded and finished with 2 coats of clear lacquer.
 2. Accessible benches: 20 inches deep by 1-1/4 inches thick.
 - a. Length as indicated on drawings.
 3. Minimum pedestal spacing: 4'-0" o.c.

PART 3 - EXECUTION

3 .01 EXAMINATION

- A. Do not begin installation until substrates and bases have been properly prepared.
- B. If substrate and bases are the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3 .02 INSTALLATION

- A. Install metal lockers and accessories at locations shown in accordance with manufacturer's instructions.
- B. Install lockers level and plumb with flush surfaces and rigid attachment to anchoring surfaces.
- C. Anchor lockers to floor and wall at 48 inches or less, as recommended by the manufacturer.
- D. Bolt adjoining locker units together to provide rigid installation.
- E. Install sloping tops and metal fillers using concealed fasteners. Provide flush hairline joints against adjacent surfaces.
- F. Install front bases between legs without overlap or exposed fasteners. Provide end bases on exposed ends.
- G. Install benches by fastening bench tops to pedestals and securely anchoring to the floor using appropriate anchors for the floor material.

3 .03 ADJUSTING AND CLEANING

- A. Adjust doors and latches to operate without binding. Verify that latches are operating satisfactorily.
- B. Touch-up with factory-supplied paint and repair or replace damaged products before Substantial

Completion.

3 .04 PROTECTION

- A. Protect installed products until completion of project.

END OF SECTION

SECTION 113600

ABOVEGROUND STORAGE TANKS

PART 1 – GENERAL

1.1 DESCRIPTION

1. SCOPE OF WORK:

- A. Two (2) aboveground storage tanks (ASTs) shall be provided, to store diesel fuel for the fuel dispensing system supplying fuel to the Department's trucks and other vehicles.
- B. Contractor shall furnish and install tanks, risers, and all required appurtenances for a complete and operational system.

3. RELATED SPECIFICATIONS

- A. Section 01300 – Submittals
- B. Section 11591 – Fuel Dispensing Systems
- C. Section 16050 – Common Work Results for Electrical – Materials and Methods

1.2 STANDARDS, CODES AND GUIDES

- 1. The materials, designs, fabrication, erection, and inspection of the AST shall conform to the latest edition of the following standards, codes and guides, as they apply to this work.
 - a. UL-142 Steel Aboveground Tanks for Flammable and Combustible Liquids
 - b. UL-2085 Standard for Protected Aboveground Tanks for Flammable and Combustible Liquids
 - c. CAN/ULC-S601 Standard for Shop Fabricated Steel Aboveground Horizontal Tanks for Flammable and Combustible Liquids
 - d. CAN/ULC-S655 Standard for Protected Aboveground Tank Assemblies for Flammable and Combustible Liquids
 - e. CAN/ULC - Standard for Concrete Encased Aboveground Tank Assemblies for Flammable and Combustible Liquids
 - f. UFC Uniform Fire Code
 - g. NFPA 30 Flammable and Combustible Liquids Code
 - h. NFPA 30A Code for Motor Fuel Dispensing Facilities and Repair Garages

- i. NPFA 70 National Electrical Code
- j. API American Petroleum Institute Color and Symbol Code

1.3 SUBMITTALS

- A. Product Data: Contractor shall manufacturer's provide information for all equipment and components to be provided. Product information shall include catalog cut sheets, manufacturer's standard drawings, anchoring information, or other literature and shall provide sufficient information to fully describe the proposed equipment and confirm conformity to the project documents. Product information shall show principal dimensions, size, type and locations of all connections and fittings and locations of all options/accessories. Provide manufacturer's written delivery, storage and handling requirements and installation procedures.
- B. Shop Drawings: Contractor shall provide shop drawings showing equipment, components layout, connections & fittings, etc. Shop drawings shall be site specific and provide sufficient information to fully describe the proposed locations, elevations, and layout of the system.
- C. Hazardous Location Classification Drawings: Contractor shall provide hazardous location classification drawings which clearly identify all hazardous (classified) location classifications and clearly depict the boundary of each respective classification. Hazardous location classification drawings shall show both plan and elevation views and shall be coordinated with section 11591 – Fuel Dispensing Systems. Drawings shall be stamped by a NJ Professional Engineer.
- D. Test Procedures and Schedule: Contractor shall submit test procedures describing all testing to be performed and submitted with sufficient time for review/approval prior to testing. Contractor shall provided a minimum of 48-hours notice prior to commencement of any test(s).
- E. Submit copies of all quality control testing documentation, installation inspection documentation and written warranty.
- F. Operation and Maintenance Data: Submit manufacturer's O&M information including maintenance requirements, spare parts, special tools (if any), etc. O&M submission shall include site specific drawings of entire system including all equipment, locations, elevations, electrical information, etc.
- G. Submit UL files identifying each component as being UL Listed and Approved and fuel compatibility of each. Listings and Approvals from other independent testing laboratories are acceptable if no available from UL. Any items not approved by independent testing laboratories shall be clearly identified and shall be accompanied by documentation from the manufacturer stating fuel compatibility.
- H. Warranty: Submit manufacturer's standard warranty information for all equipment, components and appurtenances.

1.4 QUALITY ASSURANCE

- A. Fabricate, deliver, assemble, and install all equipment under this specification in full conformity with the specifications, all local, state, and federal laws/standards and as shown on the Contract Drawings.
- B. Inspections: Contractor is responsible for all inspection coordination and the associated fees.
- C. Manufacturer shall have a minimum of 5 years experience in producing similar equipment and shall show evidence of at least 10 installations in satisfactory operation. No subcontracting of tank fabrication by the manufacturer shall be permitted.
- D. Installer shall be a licensed NJ tank installer having a minimum of 5 years experience in installing similar equipment and shall show evidence of at least 5 installations in satisfactory operation.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver, handle and store equipment components in accordance with approved shop drawings, manufacturer's written instructions and as specified.
- B. Use every precaution to prevent damage to the equipment during transport and delivery to the site.
 - 1. Do not allow equipment to be dropped, bumped, dragged, pushed, rolled, or moved in any way which will cause damage.
 - 2. If, in the process of transportation or handling, any equipment is damaged, replace or repair such equipment or accessories. Make all required repairs. Repairs shall be subject to the approval of the Engineer.
- C. Materials may be stored outdoors on pallets, or other wooden structures providing for proper support and drainage.
- D. On-site storage location shall be coordinated with the Owner and all trades prior to delivery of materials.
- E. Damage to materials during storage shall be prevented primarily by minimizing the amount of time they are stored at the jobsite before being incorporated into the work.

1.6 COORDINATION

- A. Coordinate location and elevation of equipment to actual field conditions and final selection of equipment.
- B. Contractor shall be responsible to coordinate the work with all other trades.
- C. Work shall be scheduled to not interfere with Owner's on-site operations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Acceptable manufacturers are listed below. Equivalent equipment produces of other manufacturers may be submitted for approval.

1.Highland Tank

2. Convault
3. Morrison Bro. Co.
4. Clay and Bailey Mfg Co.
5. OPW
6. B&K Tank Gauge Company
7. Simplex
8. Or approved equal.

2.2 ABOVEGROUND STORAGE TANKS (ASTs)

1. Contractor shall provide aboveground storage tank(s) in the number and of the size shown on the plans. ASTs shall include all accessories and/or appurtenances shown, specified, or required for a complete and operable system.
2. Tanks shall be approved for listing by Underwriters Laboratories (UL). Tanks shall comply with UFC, NFPA 30, and all local, state, and federal laws.
3. ASTs shall be double walled to provide double containment of the stored liquid. Double wall shall mean the tank includes a primary tank and integral secondary containment.
4. ASTs shall be cylindrical, horizontal, steel tanks intended for the storage of flammable and combustible liquids at atmospheric pressure. Tanks shall include integral steel secondary containment and thermal insulation that provides a minimum of two-hour fire rating. ASTs shall comply with UL 2085 "Protected" tanks standard having been tested for ballistics, impact, hose stream, pool fire performance standards.
5. Inner and outer tanks shall be manufactured with UL-142 standard for Steel Aboveground Tanks for Flammable and Combustible Liquids as referenced in UL-2085. Tank shall be fabricated of mild carbon steel with shell seams of continuous lap weld construction.
6. A minimum of 3" of porous, lightweight monolithic thermal insulation material shall be installed at the factory within the interstitial space between the inner and outer wall. Thermal insulation shall conform to the following:
 - a. Shall be in accordance with American Society of Testing Materials (ASTM) Standards C-332 and C-495.
 - b. Shall allow liquid to migrate through it to the monitoring port.
 - c. Shall not be exposed to weathering and shall be protected by the steel secondary containment outer wall.
7. ASTs shall include an emergency vent system conforming to NFPA 30 requirements.
8. ASTs shall include a leak detector tube for installation of an interstitial leak sensor.
9. ASTs shall be provided with sufficient fittings for the intended use. All tank openings/fittings shall be from the top of the tank only. Tank fittings shown on the Contract Drawings are for informational purposes only and show the minimum number and size of fittings anticipated. Tank fittings shall be provided for all piping, probes,

sensors, and all other appurtenance which are required. The Contractor shall be responsible for coordinating the exact number and size of tank fittings.

10. ASTs shall be shop fabricated.
11. Exterior surface shall be grit blasted to a surface of SSPC-SP-6 White Blast and finish with White urethane paint system 5-7 DFT on the shell and heads.
12. Latest edition of the codes used for design shall be based on local jurisdiction.
13. ASTs shall be listed and approved for gasoline including ethanol blends up to 100% (E100) and biodiesel blends up to 20% (B20).
14. ASTs shall have a nominal capacity of 5,000 gallons and shall have the following nominal dimensions:
 - a. Primary Tank:
 - i. Diameter: 8-feet, 0-inches
 - ii. Length: 13-feet, 4 inches
 - iii. Minimum Steel Thickness
 1. Head: 5/16-inch
 2. Shell: ¼-inch
 - b. Secondary Tank
 - i. Diameter: 8-feet, 6-inches
 - ii. Length: 13-feet, 11-inches
 - iii. Minimum Steel Thickness
 1. Head 5/16-inch
 2. Shell: ¼-inch
15. ASTs shall include an integral 24-inch manway and integrated 10-gallon spill/overflow bucket with hinged lid.

2.3 ACCESSORIES

1. Access stairs: Provide two (2) sets access stairs, at locations shown. Access stair shall be of sufficient size and height to provide access to the spill container for manual filling of the tank. Access stairs shall be free standing, supplied by the tank manufacturer and epoxy coated safety yellow.
2. Signage: Contractor shall provide all signage required and as recommended by the manufacturer. Signage shall include tank volume and stored liquid, and all pertinent safety information required.
3. Risers: Contractor shall provide risers as required for proper installation of all components and/or equipment installed into tank openings.
4. Vents:

- a. Atmospheric updraft Vent: Atmospheric updraft vents shall be Morrison Bro. Co. model 354-0400-AV or approved equal.
5. Overfill Prevention Valve: Provide two (2) suitable overfill prevention valves designed for pressure fill applications to provide positive shut off of fuel delivery with no line shock. Overfill prevention valve shall be UL listed and compatible with manual or remove fill applications. Provide overfill prevention valve for both manual filling at the tank's spill container or as shown on drawings. Overfill prevention valves shall be OPW model 61fSTOP-2000 or approved equal. Position valve to avoid tank walls or cross-bracing.
6. Drop Tube: Provide two (2) suitable drop tube for connection to the overfill prevention valve. Drop tube shall be of the same manufacturer as the overfill prevention valve.
7. Level Gauge: Provide two (2) clock type level gauges, one per tank. Clock level gauge shall be Morrison Bro. Co. model 818F-0400AGEVR or approved equal.
8. Stick Gauge: Provide two (2) 4-fold gauge sticks, one for each tank. Gauge sticks shall be 12-feet long and shall be B&K Tank Gauge Company Model FGS4 or approved equal.
9. Product Delivery Adapter: Provide two (2) product delivery adapters for connection of the fuel delivery truck to the tank fill pipe. Product delivery adapters shall be compatible with the and by the same manufacturer as the overfill prevention valves. Provide dust cap by same manufacturer as product delivery adapter.
10. Anti-siphon Valve: Provide two (2) suitable anti-siphon valve to prevent the accidental siphoning of product from the tanks in the event of a leak downstream below the liquid level. Install on the supply piping from the tank to the dispenser. Valve shall open upon receipt of an electronic signal from the dispenser when switched to the "on" position and be equipped with a manual override. Anti-siphon valve shall be Morrison Bros. Co. model 710MO-0200-1V or approved equal. Provide all wiring, conduit and appurtenances required for complete and operable installation.
11. Ball Valves: Ball valves shall be installed on all product piping as required by NFPA 30. Ball valves shall be sized to match piping to which they are installed and shall be Morrison Bro. Co. model 691 or approved equal.

PART 3 – EXECUTION

3.1 INSTALLATION

1. All equipment shall be installed in strict accordance with the most recent manufacturer's guidelines, NFPA, local ordinance, recognized engineering procedures, and other applicable codes.
2. Installation personnel shall be trained by manufacturer, the state or other approved agency.

3.2 MANUFACTURER'S SERVICES

1. Manufacturer's Services: The Contractor shall retain the services of the supplier to supervise and/or perform checkout and start-up of all system components. As part of

these services, the supplier shall include for those equipment items not manufacturer by him, the services of an authorized manufacturer's representative to check the equipment installation and place the equipment into operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation, and maintenance of the equipment.

2. A factory trained representative shall be present at the first tank filling.

3.3 TANK TESTING

1. Factory Testing:

- a. The AST shall be tested in accordance with the associated UL listings and as required by NFPA 30, NFPA 30A and all other governing codes and standards.
- b. AST shall be tested and certified by the California Air Resources Board (CARB) for balanced Phase I and Phase II vapor recovery including methanol and ethanol.
- c. High Explosive (HE) Blas Resistance: The tank system design shall be the subject of a Blast Effects Analysis (BEA) for resistance under the following blast load scenarios:
 - i. A 50-pound HE man-portable improvised explosive device (MPIED) at the standoff distance of 5-feet;
 - ii. A 500-pound HE vehicle-born improvised explosive device (VBIED) at the standoff distance of 20-feet;
 - iii. A vapor cloud explosion (VCE) with a load of 10 psi.

The BEA shall conclude that the tank system will resist the explosion loads and remain intake, without failure of the primary tank or expectation of leakage. Movement of the tank shall not exceed 2-inches. The Engineering consultants performing the BEA shall be a nationally recognized firm with over 10-years experience offering comprehensive services related to blast and impact effects analysis, explosive safety design, vulnerability assessments and threat mitigation.

- d. Primary steel tank shall be pressure tested at 5 psig for 24 to 48 hours.

2. Field Testing:

- a. Tanks shall be tested according to manufacturer's guidelines and as required by code at time of installation.

PART 4 – PAYMENT

4.1 QUANTITIES AND PAYMENT

1. Payment for the "Storage Tanks" and all related items listed in this specification shall be made as specified in the "Scope of Work". Price shall include the cost of the mechanisms, including but not limited to installation, freight to site, pipe connections, testing, inspecting,

all materials, labor, and equipment and all else necessary therefore, and all other work in connection there with and incidental thereto.

END OF SECTION

SECTION 115910

FUEL DISPENSING SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

1. SCOPE OF WORK:

- A. Provide a fuel dispensing system capable of supplying department vehicles with diesel fuel as needed.
- B. Contractor shall furnish and install fuel dispensers; dispenser and transition sumps; hoses, breakaways, & nozzles; pumps; emergency shear valves; emergency spill kits; signage; spare parts; hose retrievers; DEF dispenser; fuel monitoring system; fuel management system; curbs & bollards; and all appurtenances required for a complete and operable system.

3. RELATED SPECIFICATIONS

- A. Section 013000 – Submittals
- B. Section 020500 – Demolition
- C. Section 113600 – Aboveground Storage Tanks
- D. Section 151910 – Fuel Piping
- E. Division 26 - Electrical

1.2 STANDARDS, CODES AND GUIDES

- 1. The materials, designs, fabrication, erection, and inspection of the AST, shall conform to the latest edition of the following standards, codes and guides, as they apply to this work.
 - a. UFC Uniform Fire Code
 - b. NFPA 30 Flammable and Combustible Liquids Code
 - c. NFPA 30A Code for Motor Fuel Dispensing Facilities and Repair Garages
 - d. NPFA 70 National Electrical Code
 - e. API American Petroleum Institute Color and Symbol Code
 - f. CC All applicable local, state, and federal construction codes, standards, rules, ordinances, etc.

1.3 SUBMITTALS

- A. Product Data: Contractor shall provide manufacturer's information for all equipment and components to be provided. Product information shall include catalog cut sheets, manufacturer's standard drawings, anchoring information, or other literature and shall

provide sufficient information to fully describe the proposed equipment and confirm conformity to the project documents. Product information shall show principal dimensions, size, type and locations of all connections and fittings and locations of all options/accessories. Provide manufacturer's written delivery, storage and handling requirements and installation procedures.

- B. Shop Drawings: Contractor shall provide shop drawings showing equipment, components layout, connections & fittings, etc. Shop drawings shall be site specific and provide sufficient information to fully describe the proposed locations, elevations, and layout of the system.
- C. Hazardous Location Classification Drawings: Contractor shall provide hazardous location classification drawings which clearly identify all hazardous (classified) location classifications and clearly depict the boundary of each respective classification. Hazardous location classification drawings shall show both plan and elevation views and shall be coordinated with section 11591 – Fuel Dispensing Systems. Drawings shall be stamped by a NJ Professional Engineer.
- D. Test Procedures and Schedule: Contractor shall submit test procedures describing all testing to be performed and submitted with sufficient time for review/approval prior to testing. Contractor shall provided a minimum of 48-hours notice prior to commencement of any test(s).
- E. Submit copies of all quality control testing documentation, installation inspection documentation and written warranty for all system components
- F. Operation and Maintenance Data: Submit manufacturer's O&M information including maintenance requirements, spare parts, special tools (if any), etc. O&M submission shall include site specific drawings of entire system including all equipment, locations, elevations, electrical information, etc.
- G. Submit UL files identifying each component as being UL Listed and Approved and fuel compatibility of each. Listings and Approvals from other independent testing laboratories are acceptable if not available from UL. Any items not approved by independent testing laboratories shall be clearly identified and shall be accompanied by documentation from the manufacturer stating fuel compatibility.
- H. Warranty: Submit manufacturer's standard warranty information for all equipment, components, and appurtenances.

1.4 QUALITY ASSURANCE

- A. Fabricate, deliver, assemble, and install all equipment under this specification in full conformity with the specifications, all local, state, and federal laws/standards, as shown on the Contract Drawings and approved shop drawings.
- B. Inspections: Contractor is responsible for all inspection coordination and the associated fees.
- C. Manufacturer shall have a minimum of 5 years experience in producing similar equipment and shall show evidence of at least 10 installations in satisfactory operation. No subcontracting of tank fabrication by the manufacturer shall be permitted.

- D. Installer shall be a licensed NJ fuel system installer having a minimum of 5 years experience in installing similar equipment and shall show evidence of at least 5 installations in satisfactory operation.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver, handle and store equipment components in accordance with approved shop drawings, manufacturer's written instructions and as specified.
- B. Use every precaution to prevent damage to the equipment during transport and delivery to the site.
 - 1. Do not allow equipment to be dropped, bumped, dragged, pushed, rolled, or moved in any way which will cause damage.
 - 2. If, in the process of transportation or handling, any equipment is damaged, replace or repair such equipment or accessories. Make all required repairs. Repairs shall be subject to the approval of the Engineer.
- C. Materials may be stored outdoors on pallets, or other wooden structures providing for proper support and drainage.
- D. On-site storage location shall be coordinated with the Owner and all trades prior to delivery of materials.
- E. Damage to materials during storage shall be prevented primarily by minimizing the amount of time they are stored at the jobsite before being incorporated into the work.

1.6 COORDINATION

- A. Coordinate location and elevation of equipment to actual field conditions and final selection of equipment.
- B. Contractor shall be responsible to coordinate the work with all other trades.
- C. Work shall be scheduled to not interfere with Owner's on-site operations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Acceptable manufacturers are listed below. Equivalent equipment produces of other manufacturers may be submitted for approval.
 - 1. Dresser Wayne
 - 2. Gasboy
 - 3. S. Bravo Systems Inc.
 - 4. VST
 - 5. Goodyear
 - 6. OPW
 - 7. Veeder Root
 - 8. Red Jacket

- 9. Universal Valve Co.
- 10. Riverside Steel, Inc.
- 11. Or approved equal.

2.2 FUEL DISPENSERS

- A. Contractor shall provide two (2) lane-oriented, twin hose, one-product remote dispensers. Dispensers shall be Dresser Wayne model 3/G7207D/GHJRUY1/JS3 or approved equal.
- B. Dispensers shall be rated for up to 36 GPM/136 LPM at the discharge and designed for dispensing gasoline, including ethanol blends up to 25% (E25), diesel, including biodiesel blends up to 20% (B20) and kerosene.
- C. Dispensers shall include ADA compliant user controls per ANSI A117.1.
- D. Dispenser shall be C-UL-US listed and have FCC and W&M approvals.
- E. Dispensers shall each include the following features:
 - 1. Electronic display. Mechanical register is not acceptable.
 - 2. One side with nozzle boot, backlit 6-digit 1.5" liquid crystal (LCD) gallons display.
 - 3. Display backup for a minimum of 15-minutes in the event of a power loss.
 - 4. Four-character ½" LCD operator message display to denote authorization status, cut-off limit, etc.
 - 5. Separate display for error codes and indicating operating mode.
 - 6. All displays covered with tempered or double-strength glass. Plastic shall not be acceptable.
 - 7. Electronic register – 115VAC/ 240VAC 50/60 Hz.
 - 8. Electromechanical totalizer, 7-digit non-resettable, located on front of dispenser for inventory control.
 - 9. Two (2) Electronic 6-digit totalizers, one (1) non-resettable and one (1) resettable.
 - 10. Diagnostics including log of last 50-errors/events. Dispenser software configurable and downloadable from PC.
 - 11. Hand held remote control for accessing totals, diagnostics, and configuring dispensers via LCD without opening cabinet.
 - 12. Dual pulse output interface for connection to fuel control and tank monitoring systems – 120 VAC.

13. Cabinet: Lower hydraulic cabinet top, sides, and base constructed from stainless steel.
14. Top register cabinet constructed from galvanized steel with powder-coated black finish.
15. Stainless steel lower doors.
16. Hinged lower doors for easy service access without having to remove panels.
17. LED-lighted brand panel labeled "DIESEL".
18. Lane-oriented nozzle boot with lift-to-start nozzle hook to turn on/off dispenser.
19. Nozzle boot shall accommodate UL standard interchangeable nozzles and short spout vapor recovery nozzles.
20. Hose mast with heavy duty spring base and top swivel connector to ease handling of hose
21. Two (2) positive displacement, two-piston meter with integral hall effect pulser with no moving parts to wear out.
22. Electronic calibration without the need to set mechanical adjusters.
23. Proportional solenoid valve on the discharge of each meter, programmable through electronic register to set maximum flow rate.
24. Two (2) internal filter with 30-micron element to help ensure product purity.
25. Two (2) 1" discharge outlet with a 3/4" reducing bushing so that either a 3/4" or 1" hose may be used.
26. One (1) 2" NPT inlet
27. Explosion-proof junction box in hydraulic cabinet for all dispenser power and control wiring terminations
28. All necessary hanging hardware required for installation and proper operation of the dispensers.
29. Hose hanger for each hose outlet to keep hoses off the island when not in use.
30. External filter kit on each discharge with 40 GPM 30-micron filter element.

2.3 DISPENSER SUMPS

- A. Contractor shall provide two (2) dispenser sumps for mounting fuel dispensers. Dispenser sumps shall be S. Bravo model B1210-S30 or approved equal.
- B. Dispenser sumps shall be embedded in the fueling islands at locations shown on Contract Drawings.
- C. Dispenser sumps shall be UL2447 listed FRP, single wall under dispenser containment sumps (UDC).
- D. Dispenser sump shall be tested for material performance, fuel compatibility with all common motor fuels.
- E. Dispenser sumps shall include:
 - a. Tank spec Fiberglass (UL 1316) FRP containment and rain lip
 - b. Epoxy coated galvanized steel top frame with shear valve centerline identification markers
 - c. Adjustable shear valve stabilizer assembly constructed of galvanized steel with epoxy coating
 - d. 30-year corrosion warranty
 - e. Structural concrete anchoring system
 - f. Double sided electronic offset frames with conduit stabilizers and clamps to eliminate containment sump electrical penetrations
 - g. Dispenser containment sump size shall be specific to dispenser manufacturer model.
 - h. Product entry fitting shall be factory installed
 - i. Provide product fittings, entry boots, EBS electrical fittings, anchors, etc. as required.
 - j. Provide two boss-mount bracket for B1000 15" wide opening and stabilizer bar 11" assembly with hardware.

2.4 TRANSITION SUMPS

- A. Contractor shall provide two (2) transition sumps for transitioning piping from aboveground to below. Transition sumps shall be S. Bravo model B501-S-220 or approved equal.
- B. Provide two (2) pipe racks capable of supporting three (3) pipes. Include all hardware required.
- C. Transition sumps shall be embedded in the fuel tank pad at locations shown on Contract Drawings.

- D. Transition sumps shall be UL2447 listed FRP, single wall pipe/vent transition containment sumps.
- E. Transition sumps shall be tested for material performance, and fuel compatibility with all common motor fuels.
- F. Transition sumps shall include:
 - a. UL -listed 2447 using FRP construction meeting tank spec UL1316 with containment and rain lip
 - b. Epoxy coated galvanized steel top frame with compression style pipe penetration entry fitting for transition from above ground to underground sump area.
 - c. 30-year corrosion warranty
 - d. Top frame shall include integral structural steel insert adaptors for accepting pipe support rack system
 - e. Transition sump assembly shall include optional RS-series Rack System for aboveground pipe support and include pipe support clamps as required.
 - f. Structural concrete anchoring system

2.5 HOSES, BREAKAWAYS, SWIVELS AND NOZZLES

- A. Hoses:
 - a. Hoses shall be factory assembled and tested, UL330 listed, CARB certified and designed and listed for petroleum products.
 - b. Provide four (4) fuel hoses, two (2) for each dispenser. Hoses shall be 1" ID.
 - i. Hose for diesel dispenser shall be VSTaflex Green Curb Pump Hose or approved equal.
 - ii. Hoses shall be 18-feet long with swivel ends.
 - c. Provide four (4) whip hoses, two (2) for each dispenser. Whip hoses shall be 1" ID.
 - i. Whip hose for diesel dispenser shall be VSTaflex Green Curb Whip Hose or approved equal.
- B. Breakaways: Provide four (4), re-attachable safety breakaways, one for each dispenser. Breakaways shall be VST Sentry VST-DS-SBK or approved equal.
- C. Nozzles:
 - a. Provide four (4) fueling nozzles, two (2) for each dispenser.
 - b. Nozzles shall be UL 2586 listed, and CARB certified.
 - c. Nozzles shall meet or exceed CARB standards for drip, spillage and liquid retention.

- d. Nozzle shall have a 1" NPT inlet and green cover.
- e. Diesel nozzle shall be OPW 7HB-0100 or approved equal.

2.6 PUMPS

- A. Contractor shall provide two (2) remote fuel pumps, one for each AST.
 - a. Gasoline system fuel pump shall be ¾ hp Red Jacket, Red Armor model AGP75S1RA1 or approved equal.
 - b. Diesel system fuel pump shall be 1-1/2 hp Red Jacket, Red Armor model AGP150S1 or approved equal.
- B. Fuel pumps shall be compatible with 100% gasoline, 100% Diesel, 0-100% biodiesel blends, jet fuel, Avgas, Methanol concentrations up to 100%, Ethanol concentrations up to 90% and MTVE, ETBE or TAME concentrations up to 20%.
- C. Provide pumps with stainless steel trapper intake screen
- D. Pump shall include provisions for line leak detector installation. Provide mechanical line leak detector for each pump, Red Jacket model FX1DV or approved equal.
- E. Provide pump controllers as required.

2.7 EMERGENCY SHEAR VALVES

- A. Contractor shall provide two (2) emergency shear valves (ESV) with stabilizer bars, one per each dispenser. ESVs shall be OPW model 10P-0152 or approved equal.
- B. ESVs shall be installed in the dispenser sump on the product supply pipe.
- C. ESVs shall be double poppet design to shut fuel flow in the event of a collision. Valve shall stop fuel flow from supply pipe and prevent release of fuel from the dispenser's internal piping.
- D. Securely anchor the ESVs to the concrete dispenser island through a stabilizer bar system within the dispenser pedestal.
- E. ESVs shall be UL 842 listed.

2.8 ACCESSORIES

- A. Emergency Spill Kit:
 - a. Provide two (2) emergency spill response kits, Universal Valve Co. model 2005-SKA-20 or approved equal.
 - b. Emergency spill kit shall contain:

- i. One (1) water and chemical resistant polyethylene container with ring clamp top lid,
- ii. Twenty (20) 15"x19" pads,
- iii. Three (3) 3"x12" Socs,
- iv. Six (6) 18"x18" pillows,
- v. One (1) goggle,
- vi. One (1) pair nitrile gloves,
- vii. One (1) pair shoe covers,
- viii. Three (3) disposable bags,
- ix. Three (3) zip ties.

B. Signage

- a. Contractor shall provide all signs and placards as required by code. Required signs shall include but not be limited to:
 - i. Two (2) "EMERGENCY SHUT OFF SWITCH"
 - ii. Two (2) "OVERFILL ALARM ACKNOWLEDGEMENT SWITCH"

C. Spare Parts:

- a. Provide manufacturer's recommended spare parts for all equipment specified herein.
- b. Four (4) dispenser filters – 30-microns
- c. Two (2) breakaways

D. Hose Retriever

- a. Contractor shall provide four (4) hose retrievers to suspend the fueling hose above the dispenser to keep the hose out of the drive.
- b. Hose retrievers shall allow 360 degree smooth rotation of the retriever head.
- c. Hose retrievers shall have the following characteristics:
 - i. Cast iron head epoxy coated black,
 - ii. Stainless steel cable and connectors
 - iii. Aluminum pulley
 - iv. Stainless steel ball bearing swivel
- d. Hose retrievers shall be Morrison Bros Model 610 or approved equal.
- e. Provide hose retrievers each with a 6x6 square base assembly, powder coated black, Morrison Bros Model 610B—0300AB or approved equal.
- f. Provide hose retrievers each with hose hanger, Morrison Bros Model 610HGR or approved equal.
- g. Provide each hose retriever with 2" schedule 80 pipe, 10-feet long.
- h. Provide all necessary hardware and appurtenances required for a complete installation.

2.9 DEF DISPENSER

- A. Contractor shall provide one (1) DEF dispensing unit, Blue Energy Equipment, model Cube.

- B. DEF dispensing unit shall have the following characteristics:
 - a. Storage for 660 gallons of DEF
 - b. Double wall tank with outer tank holding 110% of inner tank volume
 - c. 6 GPM 120V pump
 - d. Hinged, lockable lid
 - e. Integral sump
 - f. Electronic overflow sensor
 - g. Optical bund alarm
 - h. 2" dry-break fill port
 - i. Liquid level gauge
 - j. Auto nozzle and nozzle holder
- C. DEF dispensing unit shall be factory assembled and pre-wired.
- D. Provide unit with the following options:
 - a. Pulse meter
 - b. 500 W internal probe heater to prevent DEF from freezing.

2.10 FUEL MONITORING SYSTEM

- A. Provide a fuel monitoring system capable of leak detection and inventory control, complete, including but not limited to system controller(s), probes and sensors, device modules, communications modules, wiring, conduit, and all appurtenances required for a complete and operable system. At a minimum, the fuel monitoring system shall be capable of monitoring two (2) aboveground storage tanks, two (2) transition sumps, two (2) dispenser sumps, and one (1) DEF system.
- B. System Controller shall have the following characteristics:
 - a. System controller shall be Veeder Root TLS4 or approved equal.
 - b. System controller shall be capable of performing in-tank leak detection functions and external leak detection functions and compatible with all probes and sensors.
 - c. Controller shall include an 7-inch color WVGA display,
 - d. Include bay for communications and device modules,
 - e. Enclosure: 16GA powder coated steel of approx. dimensions 12.99-inches x 7.87-inches x 3.54-inches,
 - f. Power Requirements: 100 to 249 VAC, 50/60Hz, 2A max.

- g. Connectivity Methods: Ethernet, Web Browser, Modem, Fax, Serial
 - h. UL, cUL, ATEX, IECEX, NEPSI, FCC, FMC, PESO ANZEx, ULC, INMETRO, iQC, EAC NWGLDE, and CEN approved.
 - i. Provide the following system options:
 - i. SiteFax Fax/Modem Interface Module
 - ii. AccuChart In-Tank Calibration
 - iii. Business Inventory Reconciliation (BIR)
 - iv. Hourly Reconciliation Monitoring (HRM)
 - v. Timed Sudden Loss
 - vi. Continuous Statistical Leak Detection (CSLD)
- C. Probes and Sensors: Contractor shall provide fuel monitoring system probes, sensors and accessories as required to connect the fuel dispensing system and ASTs to the system controller.
- a. Mag Probe:
 - i. Provide two (2) Mag Plus 0.2 in-tank probe, one for each tank. Mag probes shall be Veeder Root model 846397-2xx or approved equal. Provide high grade polymer (HGP) canister for alternative fuels with water detection.
 - ii. Provide two (2) Mag Plus AST installation kits, one for each probe, Veeder Root model 312020-984 or approved equal.
 - iii. Provide float kits for each of the Mag Plus probes as follows:
 - 1. Gasoline tank: Phase-two float kit with 10' cable, Veeder Root model 886100-010 or approved equal.
 - 2. Diesel tank: Diesel Install Kit with float and 10' cable, Veeder Root model 846400-011 or approved equal.
 - b. Interstitial Sensors
 - i. Provide two (2) interstitial sensors, one for each tank. Interstitial sensors shall be Veeder Root model 794390-420 or approved equal. Interstitial sensors shall be for steel tanks with 16' cable.
 - ii. Provide two (2) 2-inch interstitial sensor riser cap kits, one for each interstitial sensor, Veeder Root model 312020-928 or approved equal.
 - c. Overfill Alarms:
 - i. Provide two (2) overfill alarms, one for each tank. Overfill alarms shall be Veeder Root model 790091-001 or approved equal.
 - ii. Provide two (2) overfill alarm acknowledgement switches, one for each overfill alarm. Acknowledgement switches shall be Veeder Root model 790095-001 or approved equal.
 - d. Sump Sensors:

- i. Provide four (4) solid-state discriminating pan sensors, one for each dispenser pedestal and one for each transition sump. Pan sensors shall be Veeder Root model 794380-320 or approved equal.
 - ii. Provide four (4) universal sensor mounting kits, one per sensor, Veeder Root model 3300200-012 or approved equal.
 - e. Communications Cards:
 - i. Provide Veeder Root communications cards as required for proper sensor connection/operation.
- D. Contractor shall provide all required wiring, conduit and other appurtenances required to install sensors within tanks and sumps and to connect devices to the system controller.
- E. Contractor shall coordinate the number and type of conduits and wire required for installation.

2.11 FUEL MANAGEMENT SYSTEM

- A. Provide a fuel management system to provide 24-hour controlled access to fuel dispensing activities. Fuel management system shall be Gasboy Islander Prime or approved equal.
- B. System shall consist of a site controller, interconnections to each fuel dispenser and to the Fuel Monitoring System, communications connections and all appurtenances required for a complete and operable system.
- C. Contractor shall be responsible to coordinate interface between fuel management system and all fuel dispensing equipment. Provide all required wiring, conduit and other appurtenances.
- D. Site Controller:
 - a. The site controller shall be a stand alone unit comprising all required peripherals including the central processing unit, display panel, pump control module and communication modules. Site Controller shall be located as shown on Contract Drawings.
 - b. The site controller shall be web enabled to allow independent real-time control, monitoring and reporting via the web using user ID with password and SSL protected linkSite Controller.
 - c. The site controller shall be capable of controlling up to 32 hoses at a single site. The site controller shall store up to 25,000 transactions and 50,000 vehicles/devices with the ability to set limitations and restrictions.
 - d. Site Controller shall work in online and offline modes, in case of communication failures with FHO the system continues to work offline with limits and restrictions. When communications is established again, the system shall synchronize data

automatically. The site controller shall have a Linux based embedded hardware platform designed to survive the harsh gas station environment. The site controller shall have a high level data protection through two separate isolated TCP/IP Ethernet network ports.

- e. Site Controller shall have the following characteristics:
 - i. Secured remote capabilities for monitoring, management and maintenance activities.
 - ii. Web enabled reporting and alarms for tank level sensing systems.
 - iii. Fuel management software for reconciliation reports.
 - iv. Accessible via Internet browser to control and monitor the system.
 - v. 4.3-inch multimediu color display
 - vi. Contactless tag reader (ISO-14443)
 - vii. Full alphanumeric vandal proof 40 key keyboard
 - viii. TCP/IP communication
 - ix. Built-in web server for remote control and maintenance
 - x. Self contained with pedestal
 - xi. Controls up to sixty-four (64) electronic hoses
 - xii. Controls up to eight (8) mechanical hoses
 - xiii. Insert magnetic card reader
 - xiv. Compact printer
 - xv. HID card/tag reader
 - xvi. Built-in wireless gateway
 - xvii. Wireless: WGT IEEE802.15.4 w/ proprietary mesh network (license)
 - xviii. Interfaces: RS-485, RS232, LAN, Dispenser interfaces for all common electronic and mechanical dispensers.
 - xix. Stainless Steel Pedestal
 - xx. Dimensions: 158-inches x 30-inches x 29-inches
 - xxi. Power Requirements: 100-240 VAC 50/60Hz 2A max
- f. Provide communication fobs and fob programmers for 100 vehicles.
- g. Provide site controller with Fleet Head Office and Ekos software packages. Software shall have the following characteristics:
 - i. The software shall support multiple fuel site controllers to allow data consolidation. The software shall support multiple fleets and multiple departments.
 - ii. The software shall be used as a centralized issuing and programming facility for passive fuel rings, vehicle data modules and Mifare tags.
 - iii. The software shall be installed on the host computer running Windows operating system and SQL database that supports ODBC connectivity. The system shall be centralized web server communicating with all sites to provide centralized database and on-line network access for fleet managers, key personnel and remote maintenance entities.
 - iv. The host software web interface shall use SSL security. The software shall provide secure log-in through the Web for each fleet manager, for monitoring & control and report generation including exception reports.

- v. The software shall allow exporting data to different file formats such as CSV, TXT, and XML. The user interface for all software components shall be a web browser.
- E. Contractor shall coordinate the number and type of conduits and wire required for installation.

2.12 CURBS AND BOLLARDS

- A. Island Forms: Fuel dispenser islands shall include stainless steel curbs/forms manufactured by Riverside Steel, Inc. or approved equal. Forms shall be permanently installed, 12-gauge stainless steel and shall be continuous (one-piece) with no seams.
- B. Provide bollards with high density polyethylene (HDPE) covers. Covers shall include two (2) recessed reflective stripes. Bollard covers shall be sized to fit installed bollards. Bollard covers shall be Post Guard or approved equal.

PART 3 – EXECUTION

3.1 DEMOLITION OF EXISTING EQUIPMENT

- A. Contractor shall demolish existing equipment in conformance with related specification 02050 and as specified herein.
- B. Contractor shall sequence work so the new diesel dispensing system is operational and provided for beneficial use prior to demolishing the existing diesel dispensing system.
- C. Contractor shall take care to protect all equipment being retained by the Owner

3.2 INSTALLATION

1. All equipment shall be installed in strict accordance with the most recent manufacturer's guidelines, NFPA, local ordinance, recognized engineering procedures, and other applicable codes.
2. Installation personnel shall be trained by manufacturer, the state or other approved agency.
3. Contractor shall coordinate the installation requirements of all equipment prior to shop drawing preparation to ensure all proper options, accessories, wiring, etc. are provided.
4. Provide manufacturer's training for fuel management and fuel monitoring systems. Training shall consist of two 4-hour training sessions
5. Fuel management system programming shall be provided by the manufacturer.

3.3 MANUFACTURER'S SERVICES

1. **Manufacturer's Services:** The Contractor shall retain the services of the supplier to supervise and/or perform checkout and start-up of all system components. As part of these services, the supplier shall include for those equipment items not manufacturer by him, the services of an authorized manufacturer's representative to check the equipment installation and place the equipment into operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation, and maintenance of the equipment.
2. A factory trained representative shall be present at the first tank filling.

PART 4 – PAYMENT

4.1 QUANTITIES AND PAYMENT

1. Payment for the fuel dispensing system and all related items listed in this specification shall be made as specified in the "Scope of Work". Price shall include the cost of the mechanisms, including but not limited to installation, freight to site, pipe connections, testing, inspecting, all materials, labor, and equipment and all else necessary therefore, and all other work in connection there with and incidental thereto.

END OF SECTION

SECTION 115920

VEHICLE WASH BAY EQUIPMENT

PART 1 – GENERAL

1.1 DESCRIPTION

A. SCOPE OF WORK:

1. Provide one (1) natural gas-heated belt-drive cabinet pressure washer, hose reel, hose, nozzle, flue, valves, dampers, flashing, connections and all appurtenances for a complete and operable system.

B. RELATED SPECIFICATIONS

1. Section 01300 – Submittals
2. Division 16 - Electrical

1.3 SUBMITTALS

- A. Product Data: Contractor shall provide manufacturer's information for all equipment and components to be provided. Product information shall include catalog cut sheets, manufacturer's standard drawings, anchoring information, or other literature and shall provide sufficient information to fully describe the proposed equipment and confirm conformity to the project documents. Product information shall show principal dimensions, size, type and locations of all connections and fittings and locations of all options/accessories. Provide manufacturer's written delivery, storage and handling requirements and installation procedures.
- B. Shop Drawings: Contractor shall provide shop drawings showing equipment, components layout, connections & fittings, etc. Shop drawings shall be site specific and provide sufficient information to fully describe the proposed locations, elevations, and layout of the system.
- C. Submit copies of all quality control testing documentation and installation inspection documentation.
- D. Operation and Maintenance Data: Submit manufacturer's O&M information including maintenance requirements, spare parts, special tools (if any), etc. O&M submission shall include site specific drawings of entire system including all equipment, locations, elevations, electrical information, etc.
- E. Warranty: Submit manufacturer's standard warranty information for all equipment, components, and appurtenances.

1.4 QUALITY ASSURANCE

- A. Fabricate, deliver, assemble, and install all equipment under this specification in full conformity with the specifications, all local, state, and federal laws/standards, as shown on the Contract Drawings and approved shop drawings.
- B. Inspections: Contractor is responsible for all inspection coordination and the associated fees.
- C. Manufacturer shall have a minimum of 5 years experience in producing similar equipment and shall show evidence of at least 10 installations in satisfactory operation.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver, handle and store equipment components in accordance with approved shop drawings, manufacturer's written instructions and as specified.
- B. Use every precaution to prevent damage to the equipment during transport and delivery to the site.
 - 1. Do not allow equipment to be dropped, bumped, dragged, pushed, rolled, or moved in any way which will cause damage.
 - 2. If, in the process of transportation or handling, any equipment is damaged, replace or repair such equipment or accessories. Make all required repairs. Repairs shall be subject to the approval of the Engineer.
- C. Materials may be stored outdoors on pallets, or other wooden structures providing for proper support and drainage.
- D. On-site storage location shall be coordinated with the Owner and all trades prior to delivery of materials.
- E. Damage to materials during storage shall be prevented primarily by minimizing the amount of time they are stored at the jobsite before being incorporated into the work.

1.6 COORDINATION

- A. Coordinate location and elevation of equipment to actual field conditions and final selection of equipment.
- B. Contractor shall be responsible to coordinate the work with all other trades.
- C. Work shall be scheduled to not interfere with Owner's on-site operations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Acceptable manufacturers are listed below. Equivalent equipment products of other manufacturers may be submitted for approval.
 - 1. Karcher
 - 2. Daimler
 - 3. Or approved equal.

2.2 POWER WASHER

- A. Contractor shall provide one (1) natural gas-heated cabinet pressure washer at location shown on the drawings. Power washer shall be Karcher model Sechura HDS 4.0/22 EH ST NG (prt no. 1.109-721.0) or approved equal.
- B. Power washer shall have the following characteristics:
- a. Water Delivery @ Nozzle: 4 GPM of water at 2200 PSI,
 - b. Heater: Swing-out cast iron burner ring with separate “stay-in-place” ignition pilot light; 364000 BTU, natural gas fired,
 - c. Pump: 6.2 HP pump with torsion bar belt tensioning system,
 - d. Heating Coil: Cold rolled, schedule-80 steel pipe and wrapped with tick foil blanket insulation,
 - e. Cabinet: all-access cabinet design with six lift out panels and easy lock fasteners.
 - f. Integral detergent line,
 - g. Detergent valve to allow siphon and mix detergents,
 - h. Spray gun, wand and high pressure power nozzle,
 - i. Unloader Valve: safety device which, when the spray gun closes, prevents over pressurization,
 - j. Rupture Disk: secondary pressure release in the unlikely event the unloader valve fails,
 - k. 3/4-inch natural gas inlet connection at the rear of the unit,
 - l. Integral control panel including pump/burner switches, detergent valve and other related controls.
 - m. 10-inch exhaust outlet on the top of the unit for connection to the flue,
 - n. Electrical Power Requirements: 208VAC 3Phase
 - o. Power washer unit shall have the following approximate dimensions: 49” L x 24” W x 48.5” H.
- C. Flue: Provide flue as shown on contract drawings and as recommended by the manufacturer. Flue shall include exhaust stack, sampling port, damper, draft diverter, flashing and rain cap.
- D. Provide all appurtenances necessary and/or required for a complete installation of the pressure washer.

2.3 ACCESSORIES

- A. Hose – water connection:

- a. Provide one (1) 5/8" I.D. EPDM (ethylene propylene diene monomer) commercial grade garden hose for connection of the power washer to the hose bib. Garden hose shall have crush-proof fittings on both ends. Garden hose shall be Continental model 20742765 or approved equal.
- B. Hose Reel:
 - a. Provide one (1) high pressure hose reel, located on the wall of the wash bay as shown on contract drawings. Hose reel shall have sufficient capacity to accept a minimum of 75-feet of high pressure hose. Hose reel shall be by the same manufacturer as the pressure washer.
 - b. Provide 75-feet of high pressure hose. High pressure hose shall be by the same manufacturer as the pressure washer.
 - c. Provide all appurtenances necessary and/or required for a complete installation of the hose reel.
- C. Remote Control Box:
 - a. Provide one (1) remote control box (wired) to provide remote control of pump, burner and detergent. Remote control box shall be Karcher model 8.922-157.0 and 8.921-773.0 or approved equal.
- D. Detergent:
 - a. Provide five (5) 55-gallon containers of automotive fleet detergent, Karcher Fleet Wash (prt no. 9.803-754.0) or approved equal.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. All equipment shall be installed in strict accordance with the most recent manufacturer's guidelines, NFPA, International Building Code, National Standard Plumbing Code, National Electric Code, International Mechanical Code, Fuel Gas Subcode, local ordinance, recognized engineering procedures, and all other applicable codes.
- B. Contractor shall coordinate the installation requirements of all equipment prior to shop drawing preparation to ensure all proper options, accessories, wiring, etc. are provided.

PART 4 – PAYMENT

4.1 QUANTITIES AND PAYMENT

1. Payment for the vehicle wash bay systems and all related items listed in this specification shall be made as specified in the "Scope of Work". Price shall include the cost of the mechanisms, including but not limited to installation, freight to site, pipe connections, testing, inspecting, all materials, labor, and equipment and all else necessary therefore, and all other work in connection there with and incidental thereto.

END OF SECTION

SECTION 123530 - RESIDENTIAL CASEWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Instructions to Bidders and General Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes kitchenettes and Lab cabinetry and countertops.

1.3 DEFINITIONS

- A. MDF: Medium-density fiberboard.
- B. Exposed Surfaces of Cabinets: Surfaces visible when doors and drawers are closed, including visible surfaces in open cabinets or behind glass doors.
- C. Semi-exposed Surfaces of Cabinets: Surfaces behind opaque doors or drawer fronts, including interior faces of doors, interiors and sides of drawers, and bottoms of wall cabinets.
- D. Concealed Surfaces of Cabinets: Surfaces not usually visible after installation, including sleepers, web frames, dust panels, bottoms of drawers, ends of cabinets installed directly against and completely concealed by walls or other cabinets, and tops of wall cabinets and utility cabinets.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Cabinets.
 - 2. Cabinet hardware.
- B. Shop Drawings: Include plans, elevations, details, and attachments to other work. Show materials, finishes, filler panels, and hardware.
- C. Samples: For cabinet finishes.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer that is certified for chain of custody by an FSC-accredited certification body.
- B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install casework until building is enclosed, wet work is complete and dry, and temporary HVAC system is operating and maintaining temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Provide fillers and scribes to allow for trimming and fitting.
- C. Field Measurements: Where casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.

1.8 COORDINATION

- A. Coordinate layout and installation of blocking and reinforcement in partitions for support of casework.

PART 2 - PRODUCTS

2.1 CABINETS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work are specified below.
- B. Quality Standard: Provide cabinets that comply with KCMA A161.1.
 - 1. KCMA Certification: Provide cabinets with KCMA's "Certified Cabinet" seal affixed in a semiexposed location of each unit and showing compliance with the above standard.
- C. Regional Materials: Cabinets shall be manufactured within **.500 miles** **.(800 km)** of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within **.500 miles** **.(800 km)** of Project site.
- D. Regional Materials: Cabinets shall be manufactured within **.500 miles** **.(800 km)** of Project site.

- E. Certified Wood: Cabinets shall be certified as "FSC Pure" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and to FSC STD-40-004, "FSC Standard for Chain of Custody Certification."
- F. Face Style: Flush overlay; door and drawer faces cover cabinet fronts with only enough space between faces for operating clearance.
- G. Cabinet Style: Face frame.
- H. Door and Drawer Fronts: Solid-wood stiles and rails, **5/8 inch (16 mm)** thick, with **3/4-inch (19-mm)** thick, solid-wood center panels.
- I. Face Frames: **3/4-by-1-5/8-inch (19-by-41-mm)** solid wood with glued mortise and tenon joints.
- J. Exposed Cabinet End Finish: Wood veneer.
- K. Cabinet End Construction: **5/8-inch (16-mm)** thick plywood.
- L. Cabinet Tops and Bottoms: **5/8-inch (16-mm)** thick plywood, fully supported by and secured in rabbets in end panels, front frame, and back rail.
- M. Back, Top, and Bottom Rails: **3/4-by-2-1/2-inch (19-by-63-mm)** solid wood, interlocking with end panels and rabbeted to receive top and bottom panels. Back rails secured under pressure with glue and with mechanical fasteners.
- N. Wall-Hung-Unit Back Panels: **3/16-inch (4.8-mm)** thick plywood fastened to rear edge of end panels and to top and bottom rails.
- O. Base-Unit Back Panels: **3/16-inch (4.8-mm)** thick plywood fastened to rear edge of end panels and to top and bottom rails.
- P. Front Frame Drawer Rails: **3/4-by-1-1/4-inch (19-by-32-mm)** solid wood mortised and fastened into face frame.
- Q. Drawers: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
 - 1. Join subfronts, backs, and sides with glued dovetail joints.
 - 2. Subfronts, Backs, and Sides: **3/4-inch (19-mm)** thick solid wood.
 - 3. Bottoms: **1/4-inch (6.4-mm)** thick plywood.
- R. Shelves: **5/8-inch (16-mm)** thick plywood.
- S. Countertop:
 - 1. Kitchenette: 1/2" Solid Surface
 - 2. Lab: Factory molded of modified epoxy-resin formulation, uniform mixture throughout full thickness with smooth, non-specular finish.
 - a. Physical Properties: Comply with the following minimum requirements:

- i. Flexural strength: 15,000 psi (100 MPa).
 - ii. Compressive strength: 30,000 psi (200 MPa).
 - iii. Hardness (Rockwell M): 100.
 - iv. Water absorption (24 hours): 0.02 percent (maximum).
 - v. Heat distortion point: 350 deg F (177 deg C).
 - vi. Thermal-shock resistance: Highly resistant.
 - b. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, test procedure 3.9.5:
 - i. Acetone: Moderate effect.
 - ii. Acetic acid (98 percent): No effect.
 - iii. Hydrochloric acid (37 percent): No effect.
 - iv. Nitric acid (70 percent): No effect.
 - v. Phosphoric acid (85 percent): No effect.
 - vi. Sulfuric acid (33 percent): No effect.
 - vii. Benzene: No effect.
 - viii. Butyl alcohol: No effect.
 - ix. Carbon tetrachloride: No effect.
 - x. Ethyl acetate: No effect.
 - xi. Ethyl ether: No effect.
 - xii. Formaldehyde: No effect.
 - xiii. Phenol (85 percent): No effect.
 - xiv. Xylene: No effect.
 - xv. Ammonium hydroxide (28 percent): No effect.
 - xvi. Sodium hydroxide (50 percent): Moderate effect.
 - xvii. Zinc chloride: No effect.
 - c. Colors: Provide products that result in colors complying with the following requirements:
 - i. Color: Gray.
 - ii. Top Configuration: Square edge with drip groove and integral coved backsplash.
 - iii. Top Thickness: 3/4 inch.
 - d. Product Option: Phenolic-composite tops meeting requirements specified elsewhere in this Article may be substituted for epoxy tops at Contractor's option.
- T. Joinery: Rabbet backs flush into end panels and secure with concealed mechanical fasteners. Connect tops and bottoms of wall cabinets and bottoms and stretchers of base cabinets to ends and dividers with mechanical fasteners. Rabbet tops, bottoms, and backs into end panels.
- U. Factory Finishing: Finish cabinets at factory. Defer only final touchup until after installation.
 - 1. Lab Cabinetry: Chemical and Moisture Resistant Finish. Manufacturer's standard 2-coat, chemical-resistant, baked, clear finish consisting of a thermosetting catalyzed sealer and a thermosetting catalyzed conversion varnish. Hand sand and wipe clean between applying sealer and topcoat. Topcoat may be omitted on fully concealed surfaces.

2.2 CABINET MATERIALS

A. General:

1. Composite Wood and Agrifiber Products: Products shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
2. Hardwood Lumber: Kiln dried to 7 percent moisture content.
3. Softwood Lumber: Kiln dried to 10 percent moisture content.
4. Hardwood Plywood: HPVA HP-1.
5. Particleboard: ANSI A208.1, Grade M-2.
6. MDF: ANSI A208.2, Grade MD.
7. Hardboard: ANSI A135.4, Class 1 Tempered.

B. Exposed Materials:

Exposed Wood Species: Maple.

- a. Select materials for compatible color and grain. Do not use two adjacent exposed surfaces that are noticeably dissimilar in color, grain, figure, or natural character markings.
 - b. Staining and Finish: As selected by Architect from manufacturer's full range.
2. Solid Wood: Clear hardwood lumber of species indicated, free of defects.

C. Semi-exposed Materials: Unless otherwise indicated, provide the following:

1. Solid Wood: Sound hardwood lumber, selected to eliminate appearance defects. Same species as exposed surfaces.

D. Concealed Materials: Solid wood or plywood, of any hardwood or softwood species, with no defects affecting strength or utility; particleboard; MDF; or hardboard.

2.3 CABINET HARDWARE

A. General: Manufacturer's standard units complying with BHMA A156.9, of type, size, style, material, and finish as selected by Architect from manufacturer's full range.

B. Pulls: Wire pulls.

C. Hinges: Concealed European-style, self-closing hinges.

D. Drawer Guides: Epoxy-coated-metal, self-closing drawer guides; designed to prevent rebound when drawers are closed; with nylon-tired, ball-bearing rollers; and complying with BHMA A156.9, Type B05011 or Type B05091.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of casework.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install cabinets with no variations in flushness of adjoining surfaces; use concealed shims. Where cabinets abut other finished work, scribe and cut for accurate fit. Provide filler strips, scribe strips, and moldings in finish to match cabinet face.
- B. Install cabinets without distortion so doors and drawers fit the openings, are aligned, and are uniformly spaced. Complete installation of hardware and accessories as indicated.
- C. Install cabinets level and plumb to a tolerance of **.1/8 inch in 8 feet** **.(3 mm in 2.4 m)**.
- D. Fasten cabinets to adjacent units and to backing.
 - 1. Fasten wall cabinets through back, near top and bottom, and at ends not more than **.16 inches** **.(400 mm)** o.c. with No. 10 wafer-head sheet metal screws through metal framing behind the wall finish.

3.3 ADJUSTING AND CLEANING

- A. Adjust cabinets and hardware so doors and drawers are centered in openings and operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.
- B. Clean casework on exposed and semi-exposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

END OF SECTION 123530

SECTION 151910

FUEL PIPING

PART 1: GENERAL

1.1 DESCRIPTION

- A. The work of this Section includes providing steel pipe and cast, forged, and fabricated steel fittings, flanges, unions, couplings, and connections to new and existing piping.

1.2 REFERENCE SPECIFICATIONS AND STANDARDS

- A. ANSI B 16.5 Pipe Flanges & Flanged Fittings
- B. ANSI B 16.9 Factory Made Wrought Buttwelding Fittings
- C. ANSI B 16.11 Forged Steel Fittings, Socket-Welding and Treaded
- D. ANSI B 16.21 Nonmetallic Flat Gaskets for Pipe Flanges
- E. ANSI B 31.3 Process Piping
- F. ASTM A 36 Structural Steel
- G. ASTM A 105 Forgings, Carbon Steel, for Piping Components
- H. ASTM A 106 Seamless Carbon Steel Pipe for High-Temperature Service
- I. ASTM A 193 Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Services and Other Special Purpose Applications
- J. ASTM A 194 Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
- K. ASTM A 216 Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service
- L. ASTM A 234 Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
- M. ASTM A 240 Standard Specification for Chromium and Chromium Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
- N. ASTM A 269 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
- O. ASTM D-2992 Standard Practice for Obtaining Hydrostatic or Pressure Design Basis for Fiberglass (Glass-Fiber-Reinforced Thermosetting Resin) Pipe and Fittings
- P. ASTM D-2996 Standard specification to Filament-wound "fiberglass"(Glass-Fiber-Reinforced Thermosetting Resin) Pipe.
- Q. ASTM D-2310 Standard Classification for Machine-made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting Resin) Pipe.
- R. NFPA 30 Flammable and Combustible Liquids Code
- S. NFPA 30A Code for Motor Fuel Dispensing Facilities and Repair Garages
- T. NFPA 31 Installation of Oil-Burning Equipment
- U. UL 971 Underwriters Laboratories (UL) Nonmetallic Underground Piping for Flammable Liquids.

1.3 SUBMITTALS

- A. Product Data: Contractor shall provide manufacturer's information for all equipment and components to be provided. Product information shall include catalog cut sheets, manufacturer's standard drawings, anchoring information, or other literature and shall provide sufficient

information to fully describe the proposed equipment and confirm conformity to the project documents. Product information shall show principal dimensions, size, type and locations of all connections and fittings and locations of all options/accessories. Provide manufacturer's written delivery, storage and handling requirements and installation procedures.

- B. Layout Drawings: Detailed layout drawings including all pipe runs and fittings, spool pieces, spacers, adapters, connectors, reducers, fittings and pipe supports. Label pipe size, type, and materials on drawings and include schedule. Layout drawings shall indicate information on pipe supports, location, support type, hanger rod size, insert type, and the load in pounds.
- C. O&M: provide copies of the system installation, operation and maintenance manual prior to delivery.
- D. Submit copies of all quality control testing documentation, and written warranty to the Engineer at time of documentation completion.
- E. Warranty: Submit manufacturer's standard warranty information for all equipment, components, and appurtenances.

1.4 QUALITY ASSURANCE

- A. Manufacturer shall have a minimum of 5-years experience in producing similar equipment and shall show evidence of at least 10 installations in satisfactory operation.
- B. Installer shall be a licensed NJ installer having a minimum of 5-years experience in installing similar equipment and shall show evidence of at least 5 installations in satisfactory operation.
- C. Installer must have completed, if applicable, manufacturer's training courses on installation of piping.
- D. Pipe and fittings shall be free from defects including delamination, indentations, pinholes, foreign inclusions, bubbles, resin-starved areas which, due to their nature degree or extent, detrimentally affect the strength and serviceability of pipe or fittings. The pipe and fittings shall be as uniform as commercially practicable in color, opacity, density, and other physical properties.
- E. The manufacturer's name or trademark, the year of manufacture and the ASTM or API specification number shall be rolled or permanently inscribed on the pipe surface at the manufacturer's plant. As an alternate, the manufacturer's name or trademark, year of manufacturer and ASTM or API specification number may be stenciled on the pipe surface.
- F. Pipe and fittings manufactured outside of the continental United States shall meet all the requirements of the latest ASTM standards referred to herein fore and, unless waived in writing by the Owner, shall undergo physical tests and chemical analyses to prove compliance therewith. Such tests and analyses shall be performed by an independent testing laboratory approved by the Owner. If the testing laboratory is located outside the United States, then the Contractor shall pay all costs for two Owner personnel to witness such tests. The test samples shall be selected and tested in conformance with ASTM requirements. The Owner may at its discretion visit the testing facility and witness the tests. The cost of all physical tests and chemical analyses shall be borne by the Contractor.

- G. Fabricate, deliver assemble and install all equipment under this specification in full conformity with the specifications, all local, state, and federal laws/standards, as shown on the Contract Drawings and approved shop drawings.
- H. Inspections: Contractor is responsible for all inspection coordination and the associated fees.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver, handle and store equipment components in accordance with approved shop drawings, manufacturer's written instructions and as specified.
- B. Use every precaution to prevent damage to the equipment during transport and delivery to the site.
- C. Do not allow equipment to be dropped, bumped, dragged, pushed, rolled, or moved in any way which will cause damage.
- D. If, in the process of transportation or handling, any equipment is damaged, replace or repair such equipment or accessories. Make all required repairs. Repairs shall be subject to the approval of the Engineer.
- E. Materials may be stored outdoors on pallets, or other wooden structures providing for proper support and drainage.
- F. On-site storage location shall be coordinated with the Owner and all trades prior to delivery of materials.
- G. Damage to materials during storage shall be prevented primarily by minimizing the amount of time they are stored at the jobsite before being incorporated into the work.

1.6 COORDINATION

- A. Coordinate location and elevation of equipment to actual field conditions and final selection of equipment.
- B. Contractor shall be responsible to coordinate the work with all other trades
- C. Work shall be scheduled to no interfere with Owner's on-site operations.

PART 2: PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Acceptable manufacturers are listed below. Equivalent equipment products of other manufacturers may be submitted for approval.

- 1. Underground Piping
 - a. Ameron International

- b. Or approved equal

2.2 ABOVEGROUND PIPING

- A. All aboveground piping, unless otherwise noted, shall be black steel painted with white epoxy paint. Above ground piping shall be heat traced, insulated and jacketed where shown or specified. All piping shall be fully braced to support its own weight and the weight of equipment.

2.3 BELOWGROUND PIPING

- A. All underground piping, unless otherwise noted, shall be nonmetallic double containment pipe.

B. General Requirements:

1. Both the pipe and fittings shall be from the same manufacturer, to ensure both material and dimensional compatibility
2. Double containment piping shall be manufactured as an integral unit. The primary pipe shall be chemically inert, non-permeable, fiberglass reinforced epoxy resin which is inherently resistant to deterioration due to water and microbial attack. The primary pipe shall be covered with a porous layer to provide a small interstitial space to facilitate rapid leak detection. A secondary containment layer, comprised of the same material as the primary, shall be wound over the primary and porous layers.
3. All double containment pipe components shall be listed with Underwriters Laboratories (UL) for use as nonmetallic underground piping for petroleum products, alcohols, and alcohol-gasoline mixtures. All pipe, fittings, and adhesives must demonstrate performance which meets or surpasses testing specified in UL subject 971 for all fluids.

C. Performance Requirements

1. Pipe, fittings, adhesives shall be suitable for continuous operations at the pressures listed below at a sustained temperature of 150°F:
 - a. 2-inch nominal pipe size:
 - i. Primary piping: 250 psi
 - ii. Secondary piping: 40 psi
 - b. 4-inch nominal pipe size:
 - i. Primary piping: 125 psi
 - ii. Secondary piping: 40 psi

D. Physical and Mechanical Property Requirements

1. Primary pipe shall conform to ASTM D2310 standard classification RTRP-11CX and ASTM D2996 specification RTRP 11CF1-5430. Secondary piping shall be classified as RTRP-11AX.
2. Double containment pipe shall have the following characteristics:
 - a. Longitudinal Tensile Strength: 32,500 psi

- b. Circumferential Tensile Strength: 65,000 psi
- c. Longitudinal Tensile Modulus: 2,800,000 psi
- d. Circumferential Tensile Modulus: 4,000,000 psi
- e. Longitudinal Compressive Strength: 2,800 psi
- f. Longitudinal Compressive Modulus: 2,800,000 psi
- g. Long-Term Hydrostatic Design Basis (Static): 21,000 psi
- h. Maximum Linear Thermal Expansion: 9,000,000 in/in/°F.
- i. Stiffness Factor at 5% deflection
 - a. 2-inch nominal pipe size: 45 lb-in³/in².
 - b. 4-inch nominal pipe size: 55 lb-in³/in².

E. Materials:

1. Primary Carrier Pipe:

- a. All primary filament-wound pipe shall contain a resin-rich inner liner with a minimum thickness of 0.015 inches. The liner resin system shall be a chemically resistant epoxy resin that has been demonstrated to be satisfactory for use with diesel fuel including biodiesel blends up to 20 percent (B20) and unleaded gasoline including ethanol blends up to 85 percent (E85).
- b. The resins, reinforcements, colorants, and other materials when combined as a composite laminate structure shall meet the performance requirements of this specification. Glass fiber reinforcement shall be Type E glass with all epoxy-compatible finish. Glass fiber content shall not be less than 60 percent by weight of the reinforced structural wall.

2. Interstitial Layer: The interstitial layer between the primary and secondary containment layers shall be of uniform thickness with the ability to allow fluid flow throughout, meeting UL criteria. This layer shall also prevent relative movement of the primary and secondary pipe walls.

3. Secondary Containment Pipe: Construction of the secondary containment pipe and materials used shall be identical to the reinforced portion of the primary pipe, exhibiting similar physical properties.

F. Dimensions and Tolerances

1. Primary pipe shall be manufactured to steel pipe outside diameters. Pipe outside diameter tolerances shall not exceed ± 1 percent. Secondary piping shall fit into fittings supplied by manufacturer.
2. The total wall thickness of pipe shall not at any point be greater than 120 percent or less than 87 ½ percent of the nominal thickness.
3. All fittings shall have face-to-face dimensions and laying lengths as specified in the manufacturer's literature.

G. System Joining and Assembly

1. Primary pipe and fittings shall be joint by means of a matching taper adhesive joint. Adhesives used for joining components shall be compatible with all intended fluids. The adhesive system shall be used in accordance with the manufacturer's recommendations.
2. Secondary containment pipe joints shall be made with bolted clamshell halves bonded together with adhesive. Clamshell halves shall be fabricated from the identical material to primary fittings and shall be listed by Underwriter's Laboratories (UL).
3. The following adapters and crossovers shall be provided as required:
 - a. Bell x NPT threaded female
 - b. Bell x NPT threaded male
 - c. Spigot x NTP threaded Female
 - d. Spigot x NPT threaded male
4. Flanges shall be two-piece (van stone) type with raised grooves on the sealing face. Fiberglass-reinforced stub ends shall be adhesive bonded to the pipe or fitting.

H. Marking

1. Each component shall be marked to show the following:
 - a. Underwriter's Laboratories listed mark
 - b. Manufacturer's name
 - c. Maximum pressure rating

I. Factory Testing

1. Fittings shall be hydrostatically tested according to UL specification by the manufacturer to rated pressure prior to shipment for signs of leakage or porosity.
2. All primary and secondary piping shall be proof tested at or above field test conditions.

PART 3: EXECUTION

3.1 INSTALLATION

- A. All equipment shall be installed in strict accordance with the most recent manufacturer's guidelines, NFPA, Local ordinance, recognized engineering procedure, and other applicable codes.

- B. Installer shall be trained by manufacturer, the state, or other approved agency.
- C. Fuel piping shall be supported from hangers and supports as needed.
- D. Piping shall be installed in accordance with the manufacturer's written instructions especially regarding linear expansion due to temperature differentials, contractor shall consider the linear expansion of the pipelines when installing them and provisions shall be made to compensate for such changes in length.
- E. Piping shall slope back toward sumps. Annular space shall be allowed to drain into sumps for leak detection.
- F. Double Containment Pipe:
 - 1. Field cutting and tapering primary pipe: Pipes shall be held securely during all cutting and tapering. When using a pipe vise, wrap pipe with a protective material approved by the pipe manufacturer and take care not to damage or over-deflect pipe when tightening the vise. A fine-blade hacksaw, radial cut-off saw or circular saw with abrasive wheel shall be used to cut pipe in the field. Ends shall be cut square to within 3/16-inch. Contractor shall use a taper maker approved by the piping manufacturer to taper primary pipe.
 - 2. Joint preparation: all pipe tapers must be clean, dry and war for proper bond. Avoid contamination from fingerprints, petroleum fumes, mist, and condensation. Clean contaminated joints by sanding with emery cloth. Dry wet or moist tapers with a blow dryer or heat gun taking special care not to overheat or burn the pipe. During cold weather tapers, fittings, and adhesives shall be heated to 50 to 100 degrees Fahrenheit. Only adhesives approved by the piping manufacturer shall be used.
 - 3. Buried Pipe:
 - a. For all buried fiberglass double containment piping, provide a trench width equal to the pipe diameter plus six inches on each side and allowing for at least four inches between multiple lines. Trench bottom shall slope evenly towards sumps with a minimum pitch of 1/8 inch per foot. Trench bottom shall be free of hard or sharp objects. Pipes shall be protected from impact during backfilling and abrasion during operation by surrounding with a minimum of four inches of pea gravel.
 - b. For piping buried underneath two inches or more of asphalt pavement or concrete, a minimum of eight inches of pea gravel shall be provided between the top of the pipe and asphalt pavement or concrete.

3.2 FIELD TESTING

- A. Field testing shall be done by pneumatic means and shall be done where complete adherence to the manufacturer's installation instructions and use of manufacturer's testing equipment are observed.

- B. Plan field tests carefully and carry them out with all due precautions. Pressurizing equipment shall be suited to the size of the system and the pressure required and shall be operated by qualified and experienced personnel only. Pressure sources shall be capable of approaching test pressure gradually. Use gauges with a full-scale reading of no more than twice the test pressure. Use reliable gauges calibrated against a dead weight tester zeroed for atmospheric pressure. Should gauge reading fail to remain stable, a soap solution shall be used to locate leakage.

- C. Manufacturer's services: Contractor shall retain the services of the supplier to supervise and/or perform testing and startup of all system components. As part of these services, the supplier shall include for those equipment items not manufactured by him, the services of an authorized manufacturer's representative to check the equipment installation and place the equipment in operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation and maintenance of the equipment.

PART 4: Payment

4.1 Quantities and Payment

- A. Payment for fuel piping and all related items listed in this specification shall be made as specified in the "Scope of Work". Price shall include the costs including but not limited to installation, freight to ship, pipe connections, testing, inspection, all materials, labor, and equipment and all else necessary therefore, and all other work in connection there with and incidental thereto.

SECTION 221343

FACILITY PACKAGED DUPLEX GRINDER SEWAGE PUMPING STATION

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. This Section includes wet-well, packaged pumping stations with submersible grinder sewage pumps.
- B. The contractor shall provide labor, materials, equipment and incidentals required to provide one (1) Duplex 2HP Grinder Pump Package, consisting of two (2) centrifugal grinder pumps as specified herein. The pump models shall be LSG Series three phase grinder pump as per Omnivore D3672LSG as manufactured by Liberty Pumps or approved similar.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. References:
 - 1. UL 778 Motor-Operated Water Pumps
 - 2. UL 508A Industrial Control Panels
 - 3. ASTM C 1107 Packaged Dry, Hydraulic-Cement Grout
 - 4. HI 1.1-1.2 Rotodynamic (Centrifugal) Pumps for Nomenclature and Definitions
 - 5. HI 1.3 Centrifugal Pumps for Design and Application
 - 6. HI 1.4 Centrifugal Pumps for Installation, Operation, and Maintenance
 - 7. HI 1.6 Centrifugal Pump Tests
 - 8. 033000 Cast-in-Place Concrete
 - 9. 024330 Oil Water Separator
 - 10. 026270 HDPE Pipe and Fittings
 - 11. Division 26 Electrical

1.3 PERFORMANCE REQUIREMENTS

- A. Pressure Rating of Sewage Pumps and Discharge Piping Components: At least equal to sewage pump discharge pressure, but not less than 125 psig.
- B. Pressure Rating of Other Piping Components: At least equal to system operating pressure.

1.4 SUBMITTALS

- A. Product Data: Contractor shall provide manufacturer's information for all equipment and components to be provided. Product information shall include catalog cut sheets, manufacturer's standard drawings, anchoring information, and other literature and shall provide

sufficient information to fully describe the proposed equipment and confirm conformity to the project documents. Product information shall show principal dimensions, size, type, and locations of all connections and fittings and locations of all options/accessories. Include rated capacities, operating characteristics, furnished specialties, and accessories. Provide manufacturer's written delivery, storage and handling requirements and installation procedures.

- B. Shop Drawings: Contractor shall provide shop drawings showing equipment, components layout, connections & fittings, etc. Shop drawings shall be site specific and provide sufficient information to fully describe the proposed locations, elevations and layout of the system. Show fabrication and installation details for each packaged sewage pumping station. Detail equipment assemblies and indicate dimensions; shipping, installed, and operating weights; loads; required clearances; method of field assembly; components; electrical characteristics; and location and size of each field connection.
- C. Wiring Diagrams: Contractor shall provide wiring diagrams including but not limited to power, signal, and control wiring.
- D. Submit copies of all quality control testing documentation and installation inspection documentation including but not limited to:
 - 1. Source quality-control test reports
 - 2. Field quality-control test reports
- E. Operation and Maintenance Data: Submit manufacturer's O&M information including maintenance requirements, spare parts, specialty tools (if any), etc. O&M submission shall include site specific drawings of entire system including all equipment, locations, elevations, electrical information, etc.
- F. Warranty: Submit manufacturer's standard warranty information for all equipment, components and appurtenances.
- G. Product Certificates: For each type of sewage pump, signed by product manufacturer.
- H. Qualification Data: For Installer.

1.5 QUALITY ASSURANCE

- A. Fabricate, deliver, assemble and install all equipment under this specification in full conformity with the specifications, all local, state, and federal laws/standards, as shown on the Contract Drawings and approved shop drawings.
- B. Manufacturer shall have a minimum of 5 years experience in producing similar equipment and shall show evidence of at least 10 installations in satisfactory operation.
- C. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- D. Comply with HI 1.1-1.2, "Centrifugal Pumps for Nomenclature and Definitions"; HI 1.3, "Centrifugal Pumps for Design and Application"; and HI 1.4, "Centrifugal Pumps for Installation, Operation and Maintenance," for sewage pumps.

- E. Comply with UL 778, "Motor-Operated Water Pumps," for sewage pumps.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, handle and store equipment components in accordance with approved shop drawings, manufacturer's written instructions and as specified.
- B. Use every precaution to prevent damage to the equipment during transport and delivery to the site.
 - 1. Do not allow equipment to be dropped, bumped, dragged, pushed, rolled, or moved in any way which will cause damage.
 - 2. If, in the process of transportation or handling, any equipment is damaged, replace or repair such equipment or accessories. Make all required repairs. Repairs shall be subject to the approval of the Engineer.
- C. Materials may be stored outdoors on pallets, or other wooden structures providing for proper support and drainage.
- D. On-site storage location shall be coordinated with the Owner and all trades prior to delivery of materials.
- E. Damage to materials during storage shall be prevented primarily by minimizing the amount of time they are stored at the jobsite before being incorporated into the work.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Sewer Service: Do not interrupt sanitary sewer service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sanitary sewer service according to requirements indicated:
 - 1. Notify Engineer and Owner no fewer than two days in advance of proposed interruption of sanitary sewer service.
 - 2. Do not proceed with interruption of sanitary sewer service without Engineer or Owner's written permission.

1.8 COORDINATION

- A. Coordinate location and elevation of equipment to actual field conditions and final selection of equipment.
- B. Contractor shall be responsible to coordinate the work with all other trades.
- C. Works shall be scheduled to not interfere with Owner's on-site operations.
- D. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Concrete."

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged sewage pumping stations that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including shell.
 - b. Faulty operation of sewage pumps, controls, or accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period for Shell: 3 years from date of Substantial Completion.
 - 3. Warranty Period for Sewage Pumps and Controls: 3 years from date of Substantial Completion.
 - 4. Warranty Period for Accessories: 3 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 WET-WELL, PACKAGED SEWAGE GRINDER PUMPING STATIONS

- A. Wet-Well, Packaged Sewage Pumping Station with Submersible Grinder Sewage Pumps:
 - 1. Description: Factory fabricated, assembled, and tested with wet well for sewage pumps and collection of sanitary sewage and with dry equipment chamber for controls and accessories.
 - a. Orientation: Shell underground with dry equipment chamber underground with top flush with grade.
 - b. Shell: Factory fabricated from fiberglass.
 - c. Sewage Pumps: Duplex submersible grinder-type sewage pumps, with guide rail, quick-disconnect system, controls, and piping. Include stainless-steel grinder impeller and hermetically sealed motor with moisture-sensing probe, mechanical seals, and waterproof power cable.
 - 2. Capacities and Characteristics:
 - a. Diameter or Dimensions of Shell: 36.5 inches.
 - b. Height of Shell Base Section: 120 inches.
 - c. Pumping Station, Inlet Pipe Size: 4-inches with flange gasket and pipe seal.
 - d. Pumping Station, Discharge Pipe Size: 2" SDR-9 HDPE.
 - e. Sewage Pumps: Two required.
 - f. Each Sump Pump:
 - 1) Capacity: 50 gpm.
 - 2) Total Dynamic Head: 16.30 feet.
 - 3) Speed: 3450 rpm

- 4) Impeller: Grinder type.
- 5) Inlet Size: 4" With flange gasket and pipe seal.
- 6) Discharge Size: 2" SDR-9 HDPE.
- 7) Motor Size: 2 hp.
- 8) Electrical Characteristics:
 - a) Volts: 208 V.
 - b) Phases: Three
 - c) Hertz: 60.

g. Characteristics:

- 1) Full-Load Amperes: 10.6.
- 2) Minimum Circuit Ampacity: 30 Amp
- 3) Maximum Overcurrent Protection: 30 Amp

2.2 CONTROLS

- A. Control Sequence of Operation: Cycle each sewage pump on and off automatically to maintain wet-well sewage level. Automatic control operates both pumps in parallel if wet-well level rises above starting point of low-level pump, until shutoff level is reached. Automatic alternator, with manual disconnect switch, changes sequence of lead-lag sewage pumps at completion of each pumping cycle.
- B. Transducer System: Senses variations of sewage level in wet well. Include high and low adjustments capable of operating on 6-inch minimum differential of liquid level.
- C. Motor Controllers: Magnetic, full voltage, non-reversing. Include undervoltage release, thermal-overload heaters in each phase, manual reset buttons, and hand-automatic selector switches. Include circuit breakers to provide branch-circuit protection for each controller.
- D. 120-V accessory controls with 15-A, single-phase circuit breakers or fuses for each item.
- E. Control Panel: NEMA 4X weatherproof enclosure for indoor/outdoor mounting with audible 80 DBI and visual high-water alarm, complying with UL 508A with separate compartments and covers for controllers, circuit breakers, transformers, alternators, and single-phase controls. Include 20-A duplex receptacle in NEMA WD 1, Configuration 5-20R mounted on exterior of control panel.
 1. Mounting: At locations shown on Contract Drawings
 2. Enclosure: NEMA 4X
- F. Install labels on panel face to identify switches and controls.
- G. Connection for Portable Generator: Nonautomatic (manual) transfer switch with receptacle matching generator electrical power requirements.

2.3 ACCESSORIES

- A. Ventilation system is designed to be vented from the 2-inch diameter inlet pipe through a Garage Building Vent Stack.
- B. High-Water Audio Alarm: Horn for audio indication of station high-water level, energized by Remote Alarm Circuit: Include contacts for connection to remote alarm panel.

2.4 MOTORS

- A. Motors shall be oil filled and class B insulated NEMA B design, rated for continuous duty.

2.5 MISCELLANEOUS MATERIALS

- A. Grout: ASTM C 1107, Grade B, non-shrink cement grout.
 - 1. Design Mix: 4000-psi 28-day compressive strength.
- B. Concrete: Concrete is specified in Section 033000 "Concrete."

2.6 PACKAGED SEWAGE PUMPING STATION FABRICATION

- A. Fabricate shell from fiberglass with structural-steel reinforcement.
 - 1. Attach structural-steel reinforcement to top and bottom heads.
 - 2. Fabricate shell with continuous joints to make watertight and gastight construction.
 - 3. Attach air vent to pump chamber.
- B. Entrance tube may be furnished separately for field installation.
- C. Entrance Cover: Waterproof and corrosion resistant, with lock. Include way to open cover from inside tube if cover is locked.
- D. Air Vent: Duct fabricated from corrosion-resistant material, extended to above grade, outlet turned down, and with insect screen in outlet.
- E. Valves:
 - 1. Sewage Pump Piping: Include gate valve on each pump inlet and gate and check valves on each discharge pipe.
- F. Wiring: Tin-coated copper.

2.7 SOURCE QUALITY CONTROL

- A. Test and inspect sewage pumps according to HI 1.6, "Centrifugal Pump Tests." Include test recordings that substantiate correct performance of pumps at design head, capacity, speed, and horsepower.

- B. Test accessories and controls through complete cycle. Include test recordings that substantiate correct performance.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of sewerage piping systems to verify actual locations of piping connections before packaged sewage pumping station installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Excavation, trenching, and backfilling are as specified NJDOT standards."

3.3 INSTALLATION

- A. Install packaged sewage pumping station components where indicated, according to specific equipment and piping arrangement indicated.
- B. All equipment shall be installed in strict accordance with the most recent manufacturer's guidelines, NFPA, International Building Code, National Standard Plumbing Code, National Electrical Code, International Mechanical Code, Fuel Gas Subcode, local ordinance, recognized engineering procedures, and all other applicable codes.
- C. Contractor shall coordinate the installation requirements of all equipment prior to shop drawing preparation to ensure all proper options, accessories, wiring, etc. are provided.

3.4 CONNECTIONS

- A. Sanitary sewer piping installation requirements are specified in Section 02627 "HDPE Pipe and Fittings." Drawings indicate general arrangement of piping.
- B. Ground equipment according to Division 26 requirements.

3.5 IDENTIFICATION

- A. Install identifying labels permanently attached to equipment.
- B. Install operating instruction signs permanently attached to equipment or on pumping station wall near control equipment.

- C. Arrange for installing green warning tape over outside edges of underground packaged sewage pumping stations.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing packaged sewage pumping stations and after electrical circuitry has been energized, test for compliance with requirements. Furnish water required for pump tests.
2. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- B. Remove and replace packaged sewage pumping stations that do not pass tests and inspections and retest as specified above.

3.7 STARTUP SERVICE

1. Complete installation and startup check according to manufacturer's written instructions.
2. Adjust pump, accessory, and control settings, and safety and alarm devices.

3.8 PAYMENT

A. QUANTITIES AND PAYMENT

1. Payment for the packaged sewage pump station systems and all related items listed in this specification shall be made as specified in the "Scope of Work". Price shall include the cost of the mechanisms, including but not limited to installation, freight to the site, pipe connections, testing, inspection, all materials, labor, and equipment and all else necessary therefore, and all other work in connection there with and incidental thereto.

END OF SECTION 221343

SECTION 22 05 00

COMMON WORK REQUIREMENTS FOR PLUMBING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Sleeves.
 - 5. Escutcheons.
 - 6. Grout.
 - 7. Plumbing demolition.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Concrete bases.
 - 10. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than plumbing and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and plumbing equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, .1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is 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 or BA_g1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.
- G. Solvent Cements for Joining Plastic Piping:
 - 1. ABS Piping: ASTM D 2235.
 - 2. CPVC Piping: ASTM F 493.
 - 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 - 4. PVC to ABS Piping Transition: ASTM D 3138.

2.3 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: Factory-fabricated, union assembly, for .250-psig_ (1725-kPa) minimum working pressure at .180 deg F_ (82 deg C).
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for .150- or 300-psig_ (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and .300-psig_ (2070-kPa) minimum working pressure at .225 deg F_ (107 deg C).
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and .300-psig_ (2070-kPa) minimum working pressure at .225 deg F_ (107 deg C).

2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Stainless steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

- A. Galvanized-Steel Sheet: .0239-inch_ (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.
- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 PLUMBING DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove plumbing systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. 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.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for .1-inch_ (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than .6 inches_ (150 mm) in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves .6 inches_ (150 mm) and larger in diameter.
 - 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for .1-inch_ (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble

mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 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. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

4. PVC Pressure Piping: Join schedule number ASTM D 1785, 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.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on .18-inch (450-mm) centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi (20.7-MPa) 28-day compressive-strength concrete and reinforcement as specified in Division 03 Sections.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.9 GROUTING

- A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 220500

SECTION 22 05 16

EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Flexible-hose packless expansion joints.
 - 2. Metal-bellows packless expansion joints.
 - 3. Rubber packless expansion joints.
 - 4. Grooved-joint expansion joints.
 - 5. Pipe loops and swing connections.
 - 6. Alignment guides and anchors.

1.3 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Delegated-Design Submittal: For each anchor and alignment guide 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. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
 - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
 - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
- C. Welding certificates.
- D. Product Certificates: For each type of expansion joint, from manufacturer.

- E. Maintenance Data: For expansion joints to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 PACKLESS EXPANSION JOINTS

- A. Flexible-Hose Packless Expansion Joints:
 - 1. Manufacturers: Subject to compliance with requirements:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Flex Pression Ltd.
 - d. Metraflex, Inc.
 - e. Unisource Manufacturing, Inc.
 - 2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
 - 3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
 - 4. Expansion Joints for Copper Tubing .NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
 - a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
 - b. Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
 - 5. Expansion Joints for Copper Tubing .NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.
 - 6. Expansion Joints for Steel Piping .NPS 2 and Smaller: Stainless-steel fittings with threaded end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.
 - 7. Expansion Joints for Steel Piping .NPS 2-1/2 to NPS 6: Stainless-steel fittings with flanged end connections.

- a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F. and 145 psig at 600 deg F. ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F. and 200 psig at 600 deg F. ratings.
 - 8. Expansion Joints for Steel Piping .NPS 8 to NPS 12: Stainless-steel fittings with flanged end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F. and 90 psig at 600 deg F. ratings.
 - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F. and 120 psig at 600 deg F. ratings.
- B. Metal-Bellows Packless Expansion Joints:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adscos Manufacturing LLC.
 - b. American BOA, Inc.
 - c. Badger Industries, Inc.
 - d. Expansion Joint Systems, Inc.
 - e. Flex-Hose Co., Inc.
 - f. Flexicraft Industries.
 - g. Flex Pression Ltd.
 - h. Flex-Weld, Inc.
 - i. Flo Fab inc.
 - j. Hyspan Precision Products, Inc.
 - k. Metraflex, Inc.
 - l. Proco Products, Inc.
 - m. Senior Flexonics Pathway.
 - n. Tozen Corporation.
 - o. Unaflex.
 - p. Unisource Manufacturing, Inc.
 - q. Universal Metal Hose; a subsidiary of Hyspan Precision Products, Inc.
 - r. U.S. Bellows, Inc.
 - s. WahlcoMetroflex.
 - 2. Standards: ASTM F 1120 and EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
 - 3. Type: Circular, corrugated bellows with external tie rods.
 - 4. Minimum Pressure Rating: 150 psig unless otherwise indicated.
 - 5. Configuration: Single joint class(es) unless otherwise indicated.
 - 6. Expansion Joints for Copper Tubing: Multi-ply phosphor-bronze bellows, copper pipe ends, and brass shrouds.
 - a. End Connections for Copper Tubing .NPS 2 and Smaller: Solder joint.
 - b. End Connections for Copper Tubing .NPS 2-1/2 to NPS 4: Solder joint.
 - c. End Connections for Copper Tubing .NPS 5 and Larger: Flanged.
- C. Rubber Packless Expansion Joints:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Amber/Booth Company, Inc.; a div. of Vibration Isolation Products of Texas, Inc.
 - b. Flex-Hose Co., Inc.
 - c. Flexicraft Industries.

- d. Flex-Weld, Inc.
 - e. Garlock Sealing Technologies.
 - f. General Rubber Corporation.
 - g. Mason Industries, Inc.; Mercer Rubber Co.
 - h. Metraflex, Inc.
 - i. Proco Products, Inc.
 - j. Red Valve Company, Inc.
 - k. Tozen Corporation.
 - l. Unaflex.
 - m. Unisource Manufacturing, Inc.
2. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
 3. Material: Fabric-reinforced rubber complying with FSA-NMEJ-703.
4. Arch Type: multiple with external control rods.
 5. Spherical Type: multiple spheres with external control rods.
 6. Minimum Pressure Rating for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.
 7. Minimum Pressure Rating for NPS 5 and NPS 6: 140 psig at 200 deg F.
 8. Minimum Pressure Rating for NPS 8 to NPS 12: 140 psig at 180 deg F.
 9. Material for Fluids Containing Acids, Alkalies, or Chemicals: EPDM.
 10. Material for Fluids Containing Gas, Hydrocarbons, or Oil: Buna-N.
 11. Material for Water: EPDM.
 12. End Connections: Full-faced, integral steel flanges with steel retaining rings.

2.2 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Adscos Manufacturing LLC.
 - b. Advanced Thermal Systems, Inc.
 - c. Flex-Hose Co., Inc.
 - d. Flexicraft Industries.
 - e. Flex-Weld, Inc.
 - f. Hispan Precision Products, Inc.
 - g. Metraflex, Inc.
 - h. Senior Flexonics Pathway.
 - i. Unisource Manufacturing, Inc.
 - j. U.S. Bellows, Inc.
2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.

4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Stud: Threaded, zinc-coated carbon steel.
 - b. Expansion Plug: Zinc-coated steel.
 - c. Washer and Nut: Zinc-coated steel.
5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
 - c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- C. Install rubber packless expansion joints according to FSA-NMEJ-702.
- D. Install grooved-joint expansion joints to grooved-end steel piping

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.

- C. Attach guides to pipe and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 - 1. Anchor Attachment to Black-Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Anchor Attachment to Galvanized-Steel Pipe: Attach with pipe hangers. Use MSS SP-69, Type 42, riser clamp welded to anchor.
 - 3. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
 - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 220516

SECTION 22 05 17

SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: .0239-inch. minimum thickness; round tube closed with welded longitudinal joint.
- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Smith, Jay R. Mfg. Co.
 - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Metraflex Company (The).
 - 4. Pipeline Seal and Insulator, Inc.
 - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Stainless steel.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Presealed Systems.
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.

- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide .1-inch annular clear space between piping and concrete slabs and walls.
 - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
 - 2. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide .1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide .1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.

4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
 1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than .NPS 6. Galvanized-steel wall sleeves.
 - b. Piping .NPS 6. and Larger: Galvanized-steel wall sleeves
 2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than .NPS 6: Galvanized-steel wall sleeves with sleeve seal.
 - 1) Select sleeve size to allow for .1-inch. annular clear space between piping and sleeve for installing sleeve-seal system.
 - b. Piping .NPS 6. and Larger: Galvanized-steel wall sleeves with sleeve seal.
 - 1) Select sleeve size to allow for .1-inch. annular clear space between piping and sleeve for installing sleeve-seal system.
 3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than .NPS 6. : Galvanized-steel wall sleeves with sleeve seal.

- 1) Select sleeve size to allow for .1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- b. Piping NPS 6 and Larger.: Galvanized-steel wall sleeves with sleeve seal.
 - 1) Select sleeve size to allow for .1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6 : Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves.
5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
 - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 220517

SECTION 22 05 18

ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type.
 - j. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.
 - k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type.
 - 2. Escutcheons for Existing Piping:
 - a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
 - b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge.
 - g. Bare Piping in Unfinished Service Spaces: Split-casting brass type with polished, chrome-plated finish.
 - h. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge.
 - i. Bare Piping in Equipment Rooms: Split-casting brass type with polished, chrome-plated finish.
 - j. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with concealed hinge.
- C. Install floor plates for piping penetrations of equipment-room floors.

- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 220518

SECTION 22 05 19

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Bimetallic-actuated thermometers.
2. Filled-system thermometers.
3. Liquid-in-glass thermometers.
4. Light-activated thermometers.
5. Thermowells.
6. Dial-type pressure gages.
7. Gage attachments.
8. Test plugs.
9. Test-plug kits.
10. Sight flow indicators.

B. Related Sections:

1. Division 21 fire-suppression piping Sections for fire-protection pressure gages.
2. Division 22 Section " Domestic Water Piping" for water meters inside the building.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Certificates: For each type of meter and gage, from manufacturer.
- C. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Ashcroft Inc.
 2. Ernst Flow Industries.
 3. Marsh Bellofram.

4. Miljoco Corporation.
5. Nanmac Corporation.
6. Noshok.
7. Palmer Wahl Instrumentation Group.
8. REOTEMP Instrument Corporation.
9. Tel-Tru Manufacturing Company.
10. Terice, H. O. Co.
11. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
12. Weiss Instruments, Inc.
13. WIKA Instrument Corporation - USA.
14. Winters Instruments - U.S.

B. Standard: ASME B40.200.

C. Case: Liquid-filled and sealed type(s); stainless steel with .5-inch nominal diameter.

D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F and deg C.

E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.

F. Connector Size: .1/2 inch., with ASME B1.1 screw threads.

G. Stem: .025 or 0.375 inch. in diameter; stainless steel.

H. Window: Plain glass.

I. Ring: Stainless steel.

J. Element: Bimetal coil.

K. Pointer: Dark-colored metal.

L. Accuracy: Plus or minus 1 percent of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.
 - b. Marsh Bellofram.
 - c. Miljoco Corporation.
 - d. Palmer Wahl Instrumentation Group.
 - e. REOTEMP Instrument Corporation.
 - f. Terice, H. O. Co.
 - g. Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Sealed type, drawn steel 5-inch nominal diameter.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.

6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Stainless steel.
10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
12. Accuracy: Plus or minus 1 percent of scale range.
 - a. Ashcroft Inc.
 - b. Miljoco Corporation.
 - c. REOTEMP Instrument Corporation.

B. Remote-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMETEK, Inc.; U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Marsh Bellofram.
 - d. Miljoco Corporation.
 - e. Palmer Wahl Instrumentation Group.
 - f. REOTEMP Instrument Corporation.
 - g. Terice, H. O. Co.
 - h. Weiss Instruments, Inc.
 - i. WIKA Instrument Corporation - USA.
2. Standard: ASME B40.200.
3. Case: Sealed type, drawn steel; 4-1/2-inch nominal diameter with back flange and holes for panel mounting.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Pointer: Dark-colored metal.
8. Window: Glass.
9. Ring: Stainless steel
10. Connector Type(s): Union joint, bottom; with ASME B1.1 screw threads.
11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
12. Accuracy: Plus or minus 1 percent of scale range.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Terice, H. O. Co.
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 6-inch nominal size.
4. Case Form: Back angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Window: Glass or plastic.
8. Stem: Aluminum or brass and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
9. Connector: 3/4 inch, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

B. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flo Fab Inc.
 - b. Miljoco Corporation.
 - c. Palmer Wahl Instrumentation Group.
 - d. Tel-Tru Manufacturing Company.
 - e. Terice, H. O. Co.
 - f. Weiss Instruments, Inc.
 - g. Winters Instruments - U.S.
2. Standard: ASME B40.200.

2.4 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.5 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMETEK, Inc.; U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Ernst Flow Industries.
 - d. Flo Fab Inc.
 - e. Marsh Bellofram.
 - f. Miljoco Corporation.
 - g. Noshok.
 - h. Palmer Wahl Instrumentation Group.
 - i. REOTEMP Instrument Corporation.
 - j. Tel-Tru Manufacturing Company.
 - k. Terice, H. O. Co.
 - l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - m. Weiss Instruments, Inc.
 - n. WIKA Instrument Corporation - USA.
 - o. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: Liquid-filled type(s); drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of.

B. Remote-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMETEK, Inc.; U.S. Gauge.
 - b. Ashcroft Inc.
 - c. Ernst Flow Industries.
 - d. Flo Fab Inc.
 - e. Marsh Bellofram.
 - f. Miljoco Corporation.
 - g. Noshok.
 - h. Palmer Wahl Instrumentation Group.
 - i. REOTEMP Instrument Corporation.
 - j. Tel-Tru Manufacturing Company.
 - k. Terice, H. O. Co.
 - l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 - m. Weiss Instruments, Inc.
 - n. WIKA Instrument Corporation - USA.
 - o. Winters Instruments - U.S.
2. Standard: ASME B40.100.

3. Case: Liquid-filled type; drawn steel; 4-1/2-inch nominal diameter with back flange and holes for panel mounting.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi and kPa.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of.

2.6 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.7 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Flow Design, Inc.
 2. Miljoco Corporation.
 3. National Meter, Inc.
 4. Peterson Equipment Co., Inc.
 5. Sisco Manufacturing Company, Inc.
 6. Trevice, H. O. Co.
 7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 8. Weiss Instruments, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 or NPS 1/2 ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.8 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Flow Design, Inc.
 2. Miljoco Corporation.
 3. National Meter, Inc.

4. Peterson Equipment Co., Inc.
 5. Sisco Manufacturing Company, Inc.
 6. Trerice, H. O. Co.
 7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
 8. Weiss Instruments, Inc.
- B. Furnish two test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
 - C. Low-Range Thermometer: Small, bimetallic insertion type with .1- to 2-inch- diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
 - D. High-Range Thermometer: Small, bimetallic insertion type with .1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
 - E. Pressure Gage: Small, Bourdon-tube insertion type with .2- to 3-inch- diameter dial and probe. Dial range shall be at least 0 to 200 psig .
 - F. Carrying Case: Metal or plastic, with formed instrument padding.

2.9 SIGHT FLOW INDICATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Archon Industries, Inc.
 2. Dwyer Instruments, Inc.
 3. Emerson Process Management; Brooks Instrument.
 4. Ernst Co., John C., Inc.
 5. Ernst Flow Industries.
 6. KOBOLD Instruments, Inc. - USA; KOBOLD Messring GmbH.
 7. OPW Engineered Systems; a Dover company.
 8. Penberthy; A Brand of Tyco Valves & Controls - Prophetstown.
- B. Description: Piping inline-installation device for visual verification of flow.
- C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
- D. Minimum Pressure Rating: .125 psig.
- E. Minimum Temperature Rating: .200 deg F.
- F. End Connections for .NPS 2 and Smaller: Threaded.
- G. End Connections for .NPS 2-1/2 and Larger: Flanged.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending a minimum of .2 inches into fluid and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- H. Install remote-mounted pressure gages on panel.
- I. Install valve and snubber in piping for each pressure gage for fluids.
- J. Install test plugs in piping tees.
- K. Install thermometers in the following locations:
 - 1. Inlet and outlet of each water heater.
 - 2. Inlets and outlets of each domestic water heat exchanger.
 - 3. Inlet and outlet of each domestic hot-water storage tank.
 - 4. Inlet and outlet of each remote domestic water chiller.
- L. Install pressure gages in the following locations:
 - 1. Building water service entrance into building.
 - 2. Inlet and outlet of each pressure-reducing valve.
 - 3. Suction and discharge of each domestic water pump.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

1. Liquid-filled bimetallic-actuated type.
2. Compact Industrial-style, liquid-in-glass type.
3. Direct-mounted, light-activated type.
4. Test plug with EPDM self-sealing rubber inserts.

B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.

B. Scale Range for Domestic Cold-Water Piping: 0 to 150 deg F and minus 20 to plus 70 deg C.

C. Scale Range for Domestic Cold-Water Piping: 30 to 240 deg F and 0 to plus 115 deg C.

D. Scale Range for Domestic Hot-Water Piping: 0 to 250 deg F and 0 to 150 deg C.

E. Scale Range for Domestic Hot-Water Piping: 20 to 240 deg F and 0 to 150 deg C.

F. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F and 0 to plus 115 deg C.

G. Scale Range for Domestic Cooled-Water Piping: 0 to 100 deg F and minus 20 to plus 50 deg C.

H. Scale Range for Domestic Cooled-Water Piping: 0 to 150 deg F and minus 20 to plus 70 deg C.

3.6 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Water Service Piping: 0 to 100 psi and 0 to 600 kPa.

B. Scale Range for Water Service Piping: 0 to 160 psi and 0 to 1100 kPa.

C. Scale Range for Water Service Piping: 0 to 200 psi and 0 to 1400 kPa.

D. Scale Range for Domestic Water Piping: 0 to 100 psi and 0 to 600 kPa.

E. Scale Range for Domestic Water Piping: 0 to 160 psi and 0 to 1100 kPa.

F. Scale Range for Domestic Water Piping: 0 to 200 psi and 0 to 1400 kPa.

G. Scale Range for Domestic Water Piping: 0 to 300 psi and 0 to 2500 kPa.

END OF SECTION 220519

SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Bronze angle valves.
2. Brass ball valves.
3. Bronze ball valves.
4. Iron ball valves.
5. Iron, single-flange butterfly valves.
6. Iron, grooved-end butterfly valves.
7. Bronze lift check valves.
8. Bronze swing check valves.
9. Iron swing check valves.
10. Iron swing check valves with closure control.
11. Iron, grooved-end swing check valves.
12. Iron, center-guided check valves.
13. Iron, plate-type check valves.
14. Bronze gate valves.
15. Iron gate valves.
16. Bronze globe valves.
17. Iron globe valves.
18. Lubricated plug valves.
19. Chainwheels.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set angle, gate, and globe valves closed to prevent rattling.
 - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
 - 5. Set butterfly valves closed or slightly open.
 - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.

- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
 - 1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
 - 2. Handwheel: For valves other than quarter-turn types.
 - 3. Handlever: For quarter-turn valves NPS 6 and smaller.
 - 4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
 - 1. Gate Valves: With rising stem.
 - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
 - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
 - 2. Grooved: With grooves according to AWWA C606.
 - 3. Solder Joint: With sockets according to ASME B16.18.
 - 4. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

- A. Three-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jomar International, LTD.
 - b. Kitz Corporation.
 - c. Marwin Valve; a division of Richards Industries.
 - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - e. Conbraco Industries, Inc.; Apollo Div.
 - f. Grinnell Corporation.
 - g. Jamesbury, Inc.
 - h. NIBCO INC.
 - i. PBM, Inc.
 - 2. Controls Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Three piece.
 - e. Body Material: Forged brass.

- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Stainless steel.
- i. Ball: Stainless steel, vented.
- j. Port: Full.

2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Stainless-Steel Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers

- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- b. American Valve, Inc.
- c. Conbraco Industries, Inc.; Apollo Valves.
- d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
- e. Crane Co.; Crane Valve Group; Jenkins Valves.
- f. Crane Co.; Crane Valve Group; Stockham Division.
- g. DeZurik Water Controls.
- h. Dover Corp.; Dover Resources Company; Norriseal Div.
- i. Flo Fab Inc.
- j. Grinnell Corporation
- k. Hammond Valve.
- l. Kitz Corporation.
- m. Legend Valve.
- n. Milwaukee Valve Company.
- o. Mueller Steam Specialty; a division of SPX Corporation.
- p. NIBCO INC.
- q. Norriseal; a Dover Corporation company.
- r. Red-White Valve Corporation.
- s. Spence Strainers International; a division of CIRCOR International.
- t. Sure Flow Equipment Inc.
- u. Tyco International, Ltd.; Tyco Valves & Controls.
- v. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 200 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Stainless steel.

2.4 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Class 150, Single-Flange, High-Performance Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

- a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
- b. Bray Controls; a division of Bray International.
- c. Cooper Cameron Valves; a division of Cooper Cameron Corp.
- d. Crane Co.; Crane Valve Group; Flowseal.
- e. Crane Co.; Crane Valve Group; Stockham Division.
- f. DeZurik Water Controls.
- g. Hammond Valve.
- h. Jamesbury; a subsidiary of Metso Automation.
- i. Milwaukee Valve Company.
- j. NIBCO INC.
- k. Process Development & Control, Inc.
- l. Tyco Valves & Controls; a unit of Tyco Flow Control.
- m. Xomox Corporation.

2. Description:

- a. Standard: MSS SP-68.
- b. CWP Rating: 285 psig at 100 deg F.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
- e. Seat: Reinforced PTFE or metal.
- f. Stem: Stainless steel; offset from seat plane.
- g. Disc: Carbon steel.
- h. Service: Bidirectional.

2.5 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following] [available manufacturers:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Jenkins Valves.
 - c. Crane Co.; Crane Valve Group; Stockham Division.
- 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

2.6 BRONZE SWING CHECK VALVES

A. Class 150, Bronze Swing Check Valves with Bronze Disc:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturer:

- a. American Valve, Inc.
- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Crane Co.; Crane Valve Group; Jenkins Valves.
- d. Crane Co.; Crane Valve Group; Stockham Division.
- e. Grinnell Corporation.
- f. Kitz Corporation.
- g. Milwaukee Valve Company.
- h. NIBCO INC.
- i. Red-White Valve Corporation.
- j. Watts Industries, Inc.; Water Products Div.
- k. Zy-Tech Global Industries, Inc.

2. Description:

- a. Standard: MSS SP-80, Type 3.
- b. CWP Rating: 300 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

2.7 IRON SWING CHECK VALVES

A. Class 250, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers:

- a. Crane Co.; Crane Valve Group; Crane Valves.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Division.
- d. Cincinnati Valve Company
- e. Flomatic Valves
- f. Grinnell Corporation
- g. Hammond Valve.
- h. Milwaukee Valve Company.
- i. NIBCO INC.
- j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-71, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
- c. NPS 14 to NPS 24, CWP Rating: 300 psig.
- d. Body Design: Clear or full waterway.
- e. Body Material: ASTM A 126, gray iron with bolted bonnet.
- f. Ends: Flanged.
- g. Trim: Bronze.
- h. Gasket: Asbestos free.

2.8 BRONZE GATE VALVES

A. Class 150, NRS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - a. Hammond Valve.
 - b. Kitz Corporation.
 - c. Milwaukee Valve Company.
 - d. NIBCO INC.
 - e. Powell Valves.
 - f. Red-White Valve Corporation.
 - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - h. American Valve, Inc.
 - i. Grinnell Corporation.

2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 300 psig.
 - c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
 - d. Ends: Threaded.
 - e. Stem: Bronze.
 - f. Disc: Solid wedge; bronze.
 - g. Packing: Asbestos free.
 - h. Handwheel: Malleable iron bronze, or aluminum.

2.9 IRON GATE VALVES

A. Class 250, NRS, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - a. Crane Co.; Crane Valve Group; Crane Valves.
 - b. Crane Co.; Crane Valve Group; Stockham Division.
 - c. NIBCO INC.
 - d. Cincinnati Valve Company
 - e. Grinnell Corporation

2. Description:
 - a. Standard: MSS SP-70, Type I.
 - b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
 - c. NPS 14 to NPS 24, CWP Rating: 300 psig.
 - d. Body Material: ASTM A 126, gray iron with bolted bonnet.
 - e. Ends: Flanged.
 - f. Trim: Bronze.
 - g. Disc: Solid wedge.
 - h. Packing and Gasket: Asbestos free.

B. Class 250, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - a. Crane Co.; Crane Valve Group; Crane Valves.

- b. Crane Co.; Crane Valve Group; Stockham Division.
- c. Hammond Valve.
- d. Milwaukee Valve Company.
- e. NIBCO INC.
- f. Powell Valves.
- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
- h. Grinnell Corporation

2. Description:

- a. Standard: MSS SP-70, Type I.
- b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.
- c. NPS 14 to NPS 24, CWP Rating: 300 psig.
- d. Body Material: ASTM A 126, gray iron with bolted bonnet.
- e. Ends: Flanged.
- f. Trim: Bronze.
- g. Disc: Solid wedge.
- h. Packing and Gasket: Asbestos free.

2.10 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

- 1. Babbitt Steam Specialty Co.
- 2. Roto Hammer Industries.
- 3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

- 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
- 2. Attachment: For connection to butterfly valve stems.
- 3. Sprocket Rim with Chain Guides: Ductile or cast iron, of type and size required for valve. Include zinc coating.
- 4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chainwheels on operators for butterfly and gate valves NPS 4. and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Lift Check Valves: With stem upright and plumb.
- G. Provide an additional six (6) valves of each type and size used in the project to accommodate interferences and/or as directed by Engineer.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball, butterfly or gate valves.
 - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
 - 3. Throttling Service: ball, or butterfly valves.
 - 4. Pump-Discharge Check Valves:
 - a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
 - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, metal-seat check valves.
 - c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

2. For Copper Tubing, NPS 2-1/2 to NPS 4 : Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:

1. Bronze and Brass Valves: may be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Three piece, full port, brass with stainless-steel trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.
4. Bronze Gate Valves: Class 150, NRS.

B. Pipe NPS 2-1/2 and Larger:

1. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, stainless-steel disc.
2. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, stainless-steel disc.
3. High-Performance Butterfly Valves: Class 150, single flange.
4. Iron Swing Check Valves: Class 250, metal seats.
5. Iron Gate Valves: Class 250, NRS or OS&Y.

3.6 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Brass and Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Three piece, full port, brass with stainless-steel trim.
3. Bronze Swing Check Valves: Class 150, bronze disc.
4. Bronze Gate Valves: Class 150, [NRS, bronze.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron, Single-Flange Butterfly Valves, NPS 2-1/2 to NPS 12: 200 CWP, EPDM seat, stainless-steel disc.
3. Iron, Single-Flange Butterfly Valves, NPS 14 to NPS 24: 150 CWP, EPDM seat, stainless-steel disc.
4. High-Performance Butterfly Valves: Class 150, single flange.
5. Iron Swing Check Valves: Class 250, metal seats.
6. Iron Gate Valves: Class 250, NRS or OS&Y.

END OF SECTION 220523

SECTION 22 05 29

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Pipe positioning systems.
10. Equipment supports.

- B. Related Sections:

1. Division 21 fire-suppression piping Sections for pipe hangers for fire-suppression piping.
2. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
3. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Fiberglass strut systems.
 - 4. Pipe stands.
 - 5. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Design Calculations: Calculate requirements for designing trapeze hangers.
- D. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- B. Stainless-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel .
- C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 FIBERGLASS PIPE HANGERS

- A. Clevis-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of stainless steel

- B. Strap-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel

2.4 METAL FRAMING SYSTEMS

- A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut Corporation; Tyco International, Ltd.
 - g. Wesanco, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel
7. Metallic Coating: Electroplated zinc

2.5 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
 2. Clement Support Services.
 3. ERICO International Corporation.
 4. National Pipe Hanger Corporation.
 5. PHS Industries, Inc.
 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 7. Piping Technology & Products, Inc.
 8. Rilco Manufacturing Co., Inc.
 9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 552, Type II cellular glass with 100-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.7 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 2. Base: Stainless steel.
 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:

1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
2. Bases: One or more; plastic.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.
5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.8 PIPE POSITIONING SYSTEMS

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.9 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.10 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi , 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

- C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.

- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- H. Pipe Stand Installation:
 - 1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 - 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.
- I. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 plumbing fixture Sections for requirements for pipe positioning systems for plumbing fixtures.
- J. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- K. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- L. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- M. Install lateral bracing with pipe hangers and supports to prevent swaying.
- N. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- O. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- P. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- Q. Insulated Piping:
 - 1. Attach clamps and spacers to piping.

- a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 : 12 inches long and .048 inch thick.
 - b. NPS 4 : 12 inches long and .06 inch thick.
 - c. NPS 5 and NPS 6 : 18 inches long and .06 inch thick.
 - d. NPS 8 to NPS 14 : 24 inches long and .075 inch thick.
 - e. NPS 16 to NPS 24 : 24 inches long and .105 inch thick.
 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to .1-1/2 inches .

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide a minimum dry film thickness of .2.0 mils .
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 .
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F. pipes NPS 4 to NPS 24. requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4. to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8. .
11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3. .
12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30. from two rods if longitudinal movement caused by expansion and contraction might occur.
18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24. from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42. if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24. if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30. if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24. if longer ends are required for riser clamps.

- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed .1-1/4 inches .
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 22 05 48

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Restraining braces.

1.2 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: 2009.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: 2009.
 - a. Component Importance Factor: as required by IBC 2009.
 - b. Component Response Modification Factor: as required by IBC 2009.
 - c. Component Amplification Factor: as required by IBC 2009.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): as required by IBC 2009.
 - 4. Design Spectral Response Acceleration at 1-Second Period: as required by IBC 2009.

1.4 SUBMITTALS

- A. Product Data: For each product indicated.
- B. Delegated-Design Submittal: For vibration isolation and seismic-restraint calculations and details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation and licensed in the State of New Jersey.
- C. Welding certificates.

- D. Qualification Data: For professional engineer.

1.5 QUALITY ASSURANCE

- A. Comply with seismic-restraint requirements in the IBC and NFPA 13 unless requirements in this Section are more stringent.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ace Mountings Co., Inc.
 - 2. Amber/Booth Company, Inc.
 - 3. California Dynamics Corporation.
 - 4. Isolation Technology, Inc.
 - 5. Kinetics Noise Control.
 - 6. Mason Industries.
 - 7. Vibration Eliminator Co., Inc.
 - 8. Vibration Isolation.
 - 9. Vibration Mountings & Controls, Inc.
- B. Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
 - 1. Resilient Material: Oil- and water-resistant neoprene.
- C. Mounts: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

- D. Restrained Mounts: All-directional mountings with seismic restraint.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

2.2 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Amber/Booth Company, Inc.
 - 2. California Dynamics Corporation.
 - 3. Cooper B-Line, Inc.; a division of Cooper Industries.
 - 4. Hilti, Inc.
 - 5. Kinetics Noise Control.
 - 6. Loos & Co.; Cableware Division.
 - 7. Mason Industries.
 - 8. TOLCO Incorporated; a brand of NIBCO INC.
 - 9. Unistrut; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- D. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- E. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- G. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

PART 3 - EXECUTION

3.1 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:

1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch..
2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

B. Piping Restraints:

1. Comply with requirements in MSS SP-127 and NFPA 13.
2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
3. Brace a change of direction longer than 12 feet.

C. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.

D. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

E. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.

F. Drilled-in Anchors:

1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Set anchors to manufacturer's recommended torque, using a torque wrench.
5. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.2 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- #### A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 22 Section "Domestic Water Piping" for piping flexible connections.

END OF SECTION 220548

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Stencils.
 - 6. Valve tags.
 - 7. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Stainless steel, .0025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 3. Minimum Letter Size: .1/4 inch for name of units if viewing distance is less than .24 inches, .1/2 inch for viewing distances up to .72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 4. Fasteners: Stainless-steel self-tapping screws.
 - 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, .1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White
- C. Background Color: Red
- D. Maximum Temperature: Able to withstand temperatures up to .160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: .1/4 inch for name of units if viewing distance is less than .24 inches, .1/2 inch for viewing distances up to .72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least .1-1/2 inches high.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with .1/4-inch letters for piping system abbreviation and .1/2-inch numbers.
 - 1. Tag Material: Stainless steel, .025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Fasteners: Brass beaded chain.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 - 1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7 inches
 - 2. Fasteners: Brass grommet and wire
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting".
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Pipe Label Color Schedule:
 - 1. Domestic Water Piping(Label piping as CWS, HWS, HWR):
 - a. Background Color: White
 - b. Letter Color: Blue
 - 2. Sanitary Waste and Storm Drainage Piping:
 - a. Background Color: Black
 - b. Letter Color: White
 - 3. Compressed Air Piping:
 - a. Background Color: White
 - b. Letter Color: Green

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:
 - a. Cold Water: .2 inches , round
 - b. Hot Water: .2 inches , round

2. Valve-Tag Color:
 - a. Cold Water: Green
 - b. Hot Water: Green

3. Letter Color:
 - a. Cold Water: White
 - b. Hot Water: White

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

SECTION 22 07 00

PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

- 1. Insulation Materials:

- a. Calcium silicate.
 - b. Cellular glass.
 - c. Flexible elastomeric.
 - d. Mineral fiber.
 - e. Phenolic.
 - f. Polyisocyanurate.
 - g. Polyolefin.
 - h. Polystyrene.

- 2. Insulating cements.

- 3. Adhesives.

- 4. Mastics.

- 5. Lagging adhesives.

- 6. Sealants.

- 7. Factory-applied jackets.

- 8. Field-applied fabric-reinforcing mesh.

- 9. Field-applied cloths.

- 10. Field-applied jackets.

- 11. Tapes.

- 12. Securements.

- 13. Corner angles.

- B. Related Sections include the following:

- 1. Division 23 Section "HVAC Insulation."

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

- 1. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.

- B. Shop Drawings:
1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 2. Detail attachment and covering of heat tracing inside insulation.
 3. Detail insulation application at pipe expansion joints for each type of insulation.
 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 6. Detail application of field-applied jackets.
 7. Detail application at linkages of control devices.
 8. Detail field application for each equipment type.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
1. Sample Sizes:
 - a. Preformed Pipe Insulation Materials: 12 inches long by NPS 2 .
 - b. Sheet Form Insulation Materials: 12 inches square.
 - c. Jacket Materials for Pipe: 12 inches long by NPS 2 .
 - d. Sheet Jacket Materials: 12 inches square.
 - e. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.
- D. Qualification Data: For qualified Installer.
- E. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- F. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the

location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

1. Piping Mockups:

- a. One 10-foot section of NPS 2 straight pipe.
- b. One each of a 90-degree threaded, welded, and flanged elbow.
- c. One each of a threaded, welded, and flanged tee fitting.
- d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
- e. Four support hangers including hanger shield and insert.
- f. One threaded strainer and one flanged strainer with removable portion of insulation.
- g. One threaded reducer and one welded reducer.
- h. One pressure temperature tap.
- i. One mechanical coupling.

2. Equipment Mockups: One tank or vessel.

3. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
4. Notify Architect seven days in advance of dates and times when mockups will be constructed.
5. Obtain Architect's approval of mockups before starting insulation application.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
8. Demolish and remove mockups when directed.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following
 - a. Cell-U-Foam Corporation; Ultra-CUF.
 - b. Pittsburgh Corning Corporation; Foamglas Super K.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Board Insulation: ASTM C 552, Type IV.
 - 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:

- a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; All-Service Duct Wrap.
- I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; Commercial Board.
 - b. Fibrex Insulations Inc.; FBX.
 - c. Johns Manville; 800 Series Spin-Glas.
 - d. Knauf Insulation; Insulation Board.
 - e. Manson Insulation Inc.; AK Board.
 - f. Owens Corning; Fiberglas 700 Series.
- J. Mineral-Fiber, Preformed Pipe Insulation:
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000(Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, 850 deg F. Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- K. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is .3 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F. is .029 Btu x in./h x sq. ft. x deg F. or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Pipe and Tank Insulation.
 - d. Manson Insulation Inc.; AK Flex.
 - e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Insulco, Division of MFS, Inc.; Triple I.
- b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Insulco, Division of MFS, Inc.; SmoothKote.
- b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
- c. Rock Wool Manufacturing Company; Delta One Shot.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Products, Division of ITW; CP-96.
- b. Foster Products Corporation, H. B. Fuller Company; 81-33.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Aeroflex USA Inc.; Aeroseal.
- b. Armacell LCC; 520 Adhesive.
- c. Foster Products Corporation, H. B. Fuller Company; 85-75.
- d. RBX Corporation; Rubatex Contact Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Products, Division of ITW; CP-82.
- b. Foster Products Corporation, H. B. Fuller Company; 85-20.
- c. ITW TACC, Division of Illinois Tool Works; S-90/80.
- d. Marathon Industries, Inc.; 225.
- e. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Speedline Vinyl Adhesive.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content in compliance with 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-35.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - d. Marathon Industries, Inc.; 590.
 - e. Mon-Eco Industries, Inc.; 55-40.
 - f. Vimasco Corporation; 749.
 - 2. Water-Vapor Permeance: ASTM E 96, Procedure B, .0013 perm. at .43-mil. dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 - 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Products, Division of ITW; CP-30.
- b. Foster Products Corporation, H. B. Fuller Company; 30-35.
- c. ITW TACC, Division of Illinois Tool Works; CB-25.
- d. Marathon Industries, Inc.; 501.
- e. Mon-Eco Industries, Inc.; 55-10.

- 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm. at 35-mil. dry film thickness.
- 3. Service Temperature Range: 0 to 180 deg F.
- 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
- 5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Products, Division of ITW; Encacel.
- b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
- c. Marathon Industries, Inc.; 570.
- d. Mon-Eco Industries, Inc.; 55-70.

- 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm. at 30-mil. dry film thickness.
- 3. Service Temperature Range: Minus 50 to plus 220 deg F.
- 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
- 5. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Products, Division of ITW; CP-10.
- b. Foster Products Corporation, H. B. Fuller Company; 35-00.
- c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
- d. Marathon Industries, Inc.; 550.
- e. Mon-Eco Industries, Inc.; 55-50.
- f. Vimasco Corporation; WC-1/WC-5.

- 2. Water-Vapor Permeance: ASTM F 1249, 3 perms. at 0.0625-inch dry film thickness.
- 3. Service Temperature Range: Minus 20 to plus 200 deg F.
- 4. Solids Content: 63 percent by volume and 73 percent by weight.
- 5. Color: White.

2.5 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Products, Division of ITW; CP-76.

- b. Foster Products Corporation, H. B. Fuller Company; 30-45.
- c. Marathon Industries, Inc.; 405.
- d. Mon-Eco Industries, Inc.; 44-05.
- e. Pittsburgh Corning Corporation; Pittseal 444.
- f. Vimasco Corporation; 750.

B. FSK and Metal Jacket Flashing Sealants:

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Vimasco Corporation; 750.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.
- 4. Service Temperature Range: Minus 40 to plus 250 deg F
- 5. Color: Aluminum.
- 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.
- 4. Service Temperature Range: Minus 40 to plus 250 deg F
- 5. Color: White.
- 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

- 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
- 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
- 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
- 4. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at .02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
 - a. Products: Subject to compliance with requirements, provide one of the following:

- 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
5. PVDC Jacket for Outdoor Applications: .6-mil- thick, white PVDC biaxially oriented barrier film with a permeance at .01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
 6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 2. Adhesive: As recommended by jacket material manufacturer.
 3. Color: White Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
 4. Factory-fabricated tank heads and tank side panels.
- C. Metal Jacket:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; Metal Jacketing Systems.
 - b. PABCO Metals Corporation; Surefit.
 - c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209 Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: .3-mil- thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: .3-mil- thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

- D. Underground Direct-Buried Jacket: .125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Pittsburgh Corning Corporation; Pittwrap.
 - b. Polyguard; Insulrap No Torch 125.

2.8 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: .3 inches .
 3. Thickness: .11.5 mils.
 4. Adhesion: .90 ounces force/inch. in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: .40 lbf/inch. in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
 - b. Compac Corp.; 110 and 111.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
 - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
 2. Width: .3 inches .
 3. Thickness: .65 mils .
 4. Adhesion: .90 ounces force/inch. in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: .40 lbf/inch. in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS.
 2. Width: .2 inches .
 3. Thickness: .6 mils .
 4. Adhesion: .64 ounces force/inch. in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: .18 lbf/inch. in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - b. Compac Corp.; 120.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
 - d. Venture Tape; 3520 CW.
 2. Width: .2 inches .
 3. Thickness: .37 mils .
 4. Adhesion: .100 ounces force/inch. in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: .34 lbf/inch. in width.
- E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
 2. Width: .3 inches.
 3. Film Thickness: .6 mils
 4. Adhesive Thickness: .15 mils.
 5. Elongation at Break: 145 percent.

6. Tensile Strength: .55 lbf/inch. in width.

2.9 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 .0015 inch. thick, 3/4 inch. wide with wing or closed seal.
3. Aluminum: ASTM B 209 , Alloy 3003, 3005, 3105, or 5005; Temper H-14, .0020 inch. thick, 3/4 inch. wide with wing or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, .0135-inch- diameter shank, length to suit depth of insulation indicated.
2. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; CD.
 - 3) Midwest Fasteners, Inc.; CD.
 - 4) Nelson Stud Welding; TPA, TPC, and TPS.
3. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, .0135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch. galvanized carbon-steel washer.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; Cupped Head Weld Pin.
 - 3) Midwest Fasteners, Inc.; Cupped Head.
 - 4) Nelson Stud Welding; CHP.
4. Insulation-Retaining Washers: Self-locking washers formed from .0016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches. in diameter.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.

- b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
 - D. Wire: .080-inch nickel-copper alloy, .062-inch soft-annealed, stainless steel or .062-inch soft-annealed, galvanized steel.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & F Wire.
 - b. Childers Products.
 - c. PABCO Metals Corporation.
 - d. RPR Products, Inc.

2.10 CORNER ANGLES

- A. PVC Corner Angles: .30 mils thick, minimum .1 by 1 inch., PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: .040 inch thick, minimum .1 by 1 inch. , aluminum according to ASTM B 209 , Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: .024 inch thick, minimum .1 by 1 inch. , stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer .5 mils thick and an epoxy finish .5 mils thick if operating in a temperature range between .140 and 300 deg F.

- Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F. with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
 - D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Provide an additional twenty five feet of preformed insulation and twenty five square feet of blanket and board type insulation as well as accessories and labor for each size, thickness and type used on the project to accommodate any changes required to resolve interferences or as directed by the Engineer.
- J. Install insulation with least number of joints practical.
- K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with .3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least .1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- Q. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches .
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Division 07 Section "Penetration Firestopping"irestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 3. Protect exposed corners with secured corner angles.
 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is .3 inches from insulation end joints, and .16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.

- f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of .48 inches o.c. Use this network for securing insulation with tie wire or bands.
 7. Stagger joints between insulation layers at least 3 inches.
 8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
 9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
 10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
 2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
 2. Fabricate boxes from aluminum, at least 0.060 inch thick.
 3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular

- surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement.

applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least .1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.8 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- #### A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least .1 inch. and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.10 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two .062-inch- thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-preserved jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install preserved jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.

3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.11 FINISHES

- A. Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Inspect field-insulated equipment, randomly selected by the Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to ten location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
 2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to ten locations of straight pipe, ten locations of threaded fittings, ten locations of welded fittings, five locations of threaded strainers, five locations of welded strainers, five locations of threaded valves, and five locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.13 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. Domestic water pump insulation shall be the following:
 - 1. Mineral-Fiber Board: 2 inches thick and .3-lb/cu. ft.. nominal density.
- D. Domestic chilled-water (potable) pump insulation shall be the following:
 - 1. Mineral-Fiber Board: 2 inches thick and .3-lb/cu. ft.. nominal density.
- E. Domestic hot-water pump insulation shall be the following:
 - 1. Mineral-Fiber Board: 2 inches thick and .3-lb/cu. ft.. nominal density.
- F. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation shall be the following:
 - 1. Mineral-Fiber Pipe and Tank: 2 inches thick.
- G. Domestic hot-water storage tank insulation shall be the following, of thickness to provide an R-value of 12.5:
 - 1. Mineral-fiber pipe and tank.
- H. Domestic water storage tank insulation shall be the following:
 - 1. Mineral-Fiber Pipe and Tank: 2 inches thick.
- I. Domestic chilled-water (potable) storage tank insulation shall be the following:
 - 1. Mineral-Fiber Pipe and Tank: 2 inches thick.
- J. Piping system filter-housing insulation shall be the following:
 - 1. Mineral-Fiber Pipe and Tank: 2 inches thick.

3.14 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.15 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. NPS 1 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: .1-1/2 inches thick.
 - 2. NPS 1-1/4 and Larger: Insulation shall be the following:

- a. Mineral-Fiber, Preformed Pipe Insulation, Type I: .1-1/2 inches thick.
- B. Domestic Hot and Recirculated Hot Water:
 - 1. NPS 1-1/4 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: .1-1/2 inches thick.
 - 2. NPS 1-1/2 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: .1-1/2 inches thick.
- C. Domestic Chilled Water (Potable):
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: .1-1/2 inches thick.
- D. Stormwater and Overflow:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: .1-1/2 inches thick.
- E. Roof Drain and Overflow Drain Bodies:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: .1-1/2 inches thick.
- F. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: .1-1/2 inches thick.
- G. Sanitary Waste Piping Where Heat Tracing Is Installed:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: .1-1/2 inches thick.
- H. Condensate and Equipment Drain Water below 60 Deg F.:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: .1- inch thick.
- I. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F.:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: .1-1/2 inches thick.
- J. Hot Service Drains:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I or II: .1-1/2 inches thick.

3.16 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Domestic Water Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
- B. Domestic Hot and Recirculated Hot Water:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
- C. Sanitary Waste Piping Where Heat Tracing Is Installed:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
- D. Hot Service Drains:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.17 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

- A. Loose-fill insulation, for belowground piping, is specified in Division 33 piping distribution Sections.
- B. Sanitary Waste Piping, All Sizes, Where Heat Tracing Is Installed: Cellular glass, 2 inches thick.
- C. Chilled Domestic Water, All Sizes: Cellular glass, 2 inches thick.

3.18 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Equipment, Concealed:
 - 1. Paper & Foil with Vapor Retarder
- D. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to .72 Inches :
 - 1. PVC 30 mils thick.
- E. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than .72 Inches :
 - 1. Painted Aluminum Smooth .032 inch thick.
- F. Piping, Concealed:
 - 1. Paper & Foil with Vapor Retarder
- G. Piping, Exposed:

1. PVC 30 mils. thick

3.19 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Equipment, Concealed:
 1. Aluminum, Smooth .0.040 inch. thick.
- D. Equipment, Exposed, up to .48 Inches. in Diameter or with Flat Surfaces up to .72 Inches. :
 1. Aluminum, Smooth .0.040 inch. thick.
- E. Equipment, Exposed, Larger Than .48 Inches. in Diameter or with Flat Surfaces Larger Than .72 Inches.
 1. Aluminum, Smooth .0.040 inch. thick.
- F. Piping, Concealed:
 1. Aluminum, Smooth .0.040 inch. thick.
- G. Piping, Exposed:
 1. Aluminum, Smooth .0.040 inch. thick.

3.20 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 220700

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Encasement for piping.
3. Specialty valves.
4. Flexible connectors.
5. Water meters furnished by utility company for installation by Contractor.
6. Water meters.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to ASCE/SEI 7.
- B. Performance Requirements: Provide components and installation capable of producing domestic water piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
 1. Domestic Water Service Piping: .160 psig.
 2. Domestic Water Distribution Piping: .125 psig.

1.4 SUBMITTALS

- A. Product Data: For the following products:
 1. Specialty valves.
 2. Transition fittings.
 3. Dielectric fittings.
 4. Flexible connectors.
 5. Water meters.
 6. Backflow preventers and vacuum breakers.
 7. Water penetration systems.
- B. Water Samples: Specified in "Cleaning" Article.

- C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Fire-suppression-water piping.
 - 2. Domestic water piping.
 - 3. Compressed air piping.
 - 4. HVAC equipment.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
 - 1. Do not proceed with interruption of water service without Architect's, Construction Manager's, Engineers and Owner's written permission.

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
 - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
 - 4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- B. Soft Copper Tube: ASTM B 88, Type L water tube, annealed temper.

1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.3 PIPING JOINING MATERIALS

- A. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.4 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105.
- B. Form: Tube.
- C. Material: High-density, cross-laminated PE film of 0.004-inch minimum thickness.
- D. Color: Black.

2.5 SPECIALTY VALVES

- A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.
- B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.6 TRANSITION FITTINGS

- A. General Requirements:
 1. Same size as pipes to be joined.
 2. Pressure rating at least equal to pipes to be joined.
 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
- C. Sleeve-Type Transition Coupling: AWWA C219.
 1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following].
 - a. Cascade Waterworks Manufacturing.
 - b. Dresser, Inc.; Dresser Piping Specialties.
 - c. Ford Meter Box Company, Inc. (The).
 - d. JCM Industries.
 - e. Romac Industries, Inc.
 - f. Smith-Blair, Inc; a Sensus company.
 - g. Viking Johnson; c/o Mueller Co.
- D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Charlotte Pipe and Foundry Company.
 - b. Harvel Plastics, Inc.
 - c. Spears Manufacturing Company.

2. Description: CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket[or threaded] end.

E. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
 - a. Colonial Engineering, Inc.
 - b. NIBCO INC.
 - c. Spears Manufacturing Company.

2. Description: CPVC or PVC four-part union. Include brass[or stainless-steel] threaded end, solvent-cement-joint or threaded plastic end, rubber O-ring, and union nut.

2.7 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials or ferrous material body with separating nonconductive insulating material suitable for system fluid, pressure, and temperature.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. EPCO Sales, Inc.
 - d. Hart Industries International, Inc.
 - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
 - f. Zurn Plumbing Products Group; Wilkins Water Control Products.

2. Description:
 - a. Pressure Rating: .150 psig at .180 deg F..
 - b. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Capitol Manufacturing Company.
- b. Central Plastics Company.
- c. EPCO Sales, Inc.
- d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Factory-fabricated, bolted, companion-flange assembly.
- b. Pressure Rating: .150 psig. minimum.
- c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Advance Products & Systems, Inc.
- b. Calpico, Inc.
- c. Central Plastics Company.
- d. Pipeline Seal and Insulator, Inc.

2. Description:

- a. Nonconducting materials for field assembly of companion flanges.
- b. Pressure Rating: .150 psig..
- c. Gasket: Neoprene or phenolic.
- d. Bolt Sleeves: Phenolic or polyethylene.
- e. Washers: Phenolic with steel backing washers.

E. Dielectric Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Calpico, Inc.
- b. Lochinvar Corporation.

2. Description:

- a. Galvanized-steel coupling.
- b. Pressure Rating: .300 psig. at 225 deg F..
- c. End Connections: Female threaded.
- d. Lining: Inert and noncorrosive, thermoplastic.

F. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Perfection Corporation; a subsidiary of American Meter Company.
- b. Precision Plumbing Products, Inc.
- c. Victaulic Company.

2. Description:

- a. Electroplated steel nipple complying with ASTM F 1545.
- b. Pressure Rating: 300 psig at 225 deg F.
- c. End Connections: Male threaded or grooved.
- d. Lining: Inert and noncorrosive, propylene.

2.8 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Flex-Hose Co., Inc.
 2. Flexicraft Industries.
 3. Flex Pression, Ltd.
 4. Flex-Weld, Inc.
 5. Hyspan Precision Products, Inc.
 6. Mercer Rubber Co.
 7. Metraflex, Inc.
 8. Proco Products, Inc.
 9. Tozen Corporation.
 10. Unaflex, Inc.
 11. Universal Metal Hose; a Hyspan company
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
 1. Working-Pressure Rating: Minimum 200 psig.
 2. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
 3. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
 1. Working-Pressure Rating: Minimum 200 psig.
 2. End Connections NPS 2 and Smaller: Threaded steel-pipe nipple.
 3. End Connections NPS 2-1/2 and Larger: Flanged steel nipple.

2.9 WATER METERS

- A. Displacement-Type Water Meters:
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AALIAN; a Venture Measurement Product Line.
 - b. ABB.
 - c. Badger Meter, Inc.
 - d. Carlon Meter.
 - e. Mueller Company; Water Products Division.
 - f. Schlumberger Limited; Water Division.
 - g. Sensus Metering Systems.
 2. Description:

- a. Standard: AWWA C700.
- b. Pressure Rating: .150-psig working pressure.
- c. Body Design: Nutating disc; totalization meter.
- d. Registration: In gallons or cubic feet as required by utility.
- e. Case: Bronze.
- f. End Connections: Threaded.

B. Turbine-Type Water Meters:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AALIAN; a Venture Measurement Product Line.
 - b. ABB.
 - c. Badger Meter, Inc.
 - d. Hays Fluid Controls.
 - e. Master Meter, Inc.
 - f. McCrometer.
 - g. Mueller Company; Water Products Division.
 - h. Schlumberger Limited; Water Division.
 - i. SeaMetrics Inc.
 - j. Sensus Metering Systems.
- 2. Description:
 - a. Standard: AWWA C701.
 - b. Pressure Rating: .150-psig working pressure.
 - c. Body Design: Turbine; totalization meter.
 - d. Registration: In gallons or cubic feet as required by utility company .
 - e. Case: Bronze.
 - f. End Connections for Meters NPS 2. and Smaller: Threaded.
 - g. End Connections for Meters NPS 2-1/2. and Larger: Flanged.

C. Compound-Type Water Meters:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ABB.
 - b. Badger Meter, Inc.
 - c. Master Meter, Inc.
 - d. Mueller Company; Water Products Division.
 - e. Schlumberger Limited; Water Division.
 - f. Sensus Metering Systems.
- 2. Description:
 - a. Standard: AWWA C702.
 - b. Pressure Rating: .150-psig working pressure.
 - c. Body Design: With integral mainline and bypass meters; totalization meter.
 - d. Registration: In gallons or cubic feet as required by utility company.
 - e. Case: Bronze.
 - f. Pipe Connections: Flanged.

D. Fire-Service-Type Water Meters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Badger Meter, Inc.
 - b. Mueller Company; Water Products Division.
 - c. Schlumberger Limited; Water Division.
 - d. Sensus Metering Systems.

2. Description:
 - a. Standard: AWWA C703 and UL listing.
 - b. Pressure Rating: .175-psig working pressure.
 - c. Body Design:
 - 1) Proportional, Detector-Type Water Meters: With meter on bypass.
 - a) Bypass Meter: AWWA C701, turbine or AWWA C702, compound type with bronze case; size not less than one-half nominal size of main-line meter.
 - 2) Turbine-Type Water Meters: With strainer, and with meter on bypass.
 - a) Strainer: Full size, matching water meter.
 - b) Bypass Meter: AWWA C701, turbine type with bronze case; not less than .NPS 2.
 - d. Registration: In gallons or cubic feet as required by utility company.
 - e. Case: Bronze.
 - f. Pipe Connections for Meters NPS 2 and Smaller: Threaded.
 - g. Pipe Connections for Meters NPS 2-1/2 and Larger: Flanged.

- E. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

- F. Remote Registration System: Encoder type complying with AWWA C707; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.
- G. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Install seismic restraints on piping. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- M. Install piping adjacent to equipment and specialties to allow service and maintenance.
- N. Install piping to permit valve servicing.
- O. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- P. Install piping free of sags and bends.
- Q. Provide an additional twenty five feet of piping and accessories and labor for each size of pipe used on the project to accommodate any changes required to resolve interferences or as directed by the Engineer.
- R. Install fittings for changes in direction and branch connections.
- S. Install PEX piping with loop at each change of direction of more than 90 degrees.
- T. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

- U. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.
- V. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.
- W. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- Z. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 1. Apply appropriate tape or thread compound to external pipe threads.
 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.
- E. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

3.4 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures

that do not have supply stops. Use ball or gate valves for piping .NPS 2. and smaller. Use butterfly or gate valves for piping .NPS 2-1/2. and larger.

- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
 - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
 - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.
- D. Install balancing valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Use ball valves for piping .NPS 2. and smaller and butterfly valves for piping .NPS 2-1/2. and larger. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.
- E. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.5 TRANSITION FITTING INSTALLATION

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
 - 1. .NPS 1-1/2. and Smaller: Fitting-type coupling.
 - 2. .NPS 2. and Larger: Sleeve-type coupling.

3.6 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for .NPS 2. and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for .NPS 2-1/2. to NPS 4.: Use dielectric flanges.
- D. Dielectric Fittings for .NPS 5. and Larger: Use dielectric flange kits.

3.7 FLEXIBLE CONNECTOR INSTALLATION

- A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.
- B. Install bronze-hose flexible connectors in copper domestic water tubing.
- C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.8 WATER METER INSTALLATION

- A. Rough-in domestic water piping for water meter installation and install water meters according to utility company's requirements.
- B. Water meters will be furnished and installed by utility company.
- C. Install water meters according to AWWA M6, utility company's requirements, and the following:
- D. Install displacement-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
- E. Install turbine-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
- F. Install compound-type water meters with shutoff valves on water-meter inlet and outlet and on valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.
- G. Install fire-service water meters with shutoff valves on water-meter inlet and outlet and on full-size valved bypass around meter. Support meter, valves, and piping on brick or concrete piers.
- H. Install remote registration system according to standards of utility company and of authorities having jurisdiction.

3.9 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.
- B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
 - 1. Vertical Piping: MSS Type 8 or 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs:
 - a. .100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than .100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than .100 Feet. If Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs .100 Feet. or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 and Smaller: .60 inches with 3/8-inch rod.
 - 2. NPS 1 and NPS 1-1/4: .72 inches with 3/8-inch rod.

3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.
 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
 6. NPS 6: 10 feet with 5/8-inch rod.
 7. NPS 8: 10 feet with 3/4-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 and Smaller: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3 and NPS 3-1/2: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6: 12 feet with 3/4-inch rod.
 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- H. Install supports for vertical steel piping every 15 feet.
- I. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 and Smaller: 36 inches with 3/8-inch rod.
 2. NPS 1-1/4 to NPS 2: 48 inches with 3/8-inch rod.
 3. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
 4. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 5. NPS 6: 48 inches with 3/4-inch rod.
 6. NPS 8: 48 inches with 7/8-inch rod.
- J. Install supports for vertical CPVC piping every 60 inches for NPS 1 and smaller, and every 72 inches for NPS 1-1/4 and larger.
- K. Install vinyl-coated hangers for PEX piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 and Smaller: 32 inches with 3/8-inch rod.
- L. Install hangers for vertical PEX piping every 48 inches.
- M. Install vinyl-coated hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 2 and Smaller: 48 inches with 3/8-inch rod.
 2. NPS 2-1/2 to NPS 3-1/2: 48 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
 4. NPS 6: 48 inches with 3/4-inch rod.
 5. NPS 8: 48 inches with 7/8-inch rod.
- N. Install supports for vertical PVC piping every 48 inches.
- O. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.10 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - 1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
 - 2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - 3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
 - 4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for .NPS 2-1/2 and larger.

3.11 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.12 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 - 3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.13 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.14 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:

- 1) Fill system or part thereof with water/chlorine solution with at least .50 ppm. of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least .200 ppm. of chlorine. Isolate and allow to stand for three hours.
- c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Clean non-potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities.
- D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.15 PIPING SCHEDULE

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
 1. Underground Domestic Water piping materials shall match those used for the underground site main to the building Soft copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings and brazed joints.
- D. Aboveground domestic water piping, .NPS 2 and smaller, shall be the following:
 1. Hard copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings; and soldered joints.
- E. Aboveground domestic water piping, .NPS 2-1/2 to NPS 4., shall be the following:
 1. Hard copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings; and soldered joints.
- F. Aboveground domestic water piping, .NPS 5 to NPS 8., shall be the following:

1. Hard copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings; and soldered joints.

G. Underground Domestic Water piping materials shall match those used for the underground site main to the building:

3.16 VALVE SCHEDULE

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water Circulation Piping, Balancing Duty: [Calibrated] [Memory-stop] balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116

SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated water mixing valves.
6. Strainers.
7. Outlet boxes.
8. Hose stations.
9. Hose bibbs.
10. Wall hydrants.
11. Ground hydrants.
12. Post hydrants.
13. Drain valves.
14. Water hammer arresters.
15. Air vents.
16. Trap-seal primer valves.
17. Trap-seal primer systems.

- B. Related Sections include the following:

1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Division 22 Section "Domestic Water Piping" for water meters.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: .125 psig, unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring.

- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 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. NSF Compliance:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
 - 2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 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. Ames Co.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. FEBCO; SPX Valves & Controls.
 - e. Rain Bird Corporation.
 - f. Toro Company (The); Irrigation Div.
 - g. Watts Industries, Inc.; Water Products Div.
 - h. Zurn Plumbing Products Group; Wilkins Div.
 - 3. Standard: ASSE 1001.
 - 4. Size: NPS 1/4 to NPS 3, as required to match connected piping.
 - 5. Body: Bronze.
 - 6. Inlet and Outlet Connections: Threaded.
 - 7. Finish: Rough bronze or Chrome plated.
- B. Hose-Connection Vacuum Breakers:
 - 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. Arrowhead Brass Products, Inc.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. Legend Valve.
 - e. MIFAB, Inc.
 - f. Prier Products, Inc.
 - g. Watts Industries, Inc.; Water Products Div.
 - h. Woodford Manufacturing Company.
 - i. Zurn Plumbing Products Group; Light Commercial Operation.
 - j. Zurn Plumbing Products Group; Wilkins Div.
- 3. Standard: ASSE 1011.
 - 4. Body: Bronze, nonremovable, with manual drain.
 - 5. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
 - 6. Finish: Chrome, nickel plated or rough bronze.

C. Pressure Vacuum Breakers:

- 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 by one of the following:
 - a. Ames Co.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Flomatic Corporation.
 - e. Toro Company (The); Irrigation Div.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Plumbing Products Group; Wilkins Div.
- 4. Standard: ASSE 1020.
- 5. Operation: Continuous-pressure applications.
- 6. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
- 7. Accessories:
 - a. Valves: Ball type, on inlet and outlet.

D. Laboratory-Faucet Vacuum Breakers:

- 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. Conbraco Industries, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
 - c. Woodford Manufacturing Company.
 - d. Zurn Plumbing Products Group; Wilkins Div.
- 3. Standard: ASSE 1035.

4. Size: .NPS 1/4 or NPS 3/8. matching faucet size.
5. Body: Bronze.
6. End Connections: Threaded.
7. Finish: Chrome plated.

E. Spill-Resistant Vacuum Breakers:

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. Conbraco Industries, Inc.
 - b. Watts Industries, Inc.; Water Products Div.
3. Standard: ASSE 1056.
4. Operation: Continuous-pressure applications.
5. Accessories:
 - a. Valves: Ball type, on inlet and outlet.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Flomatic Corporation.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: .12 psig maximum, through middle 1/3 of flow range.
5. Body: Bronze for .NPS 2. and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for .NPS 2-1/2. and larger.
6. End Connections: Threaded for .NPS 2. and smaller; flanged for .NPS 2-1/2. and larger.
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of .NPS 2. and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of .NPS 2-1/2. and larger.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Double-Check Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Ames Co.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Flomatic Corporation.
 - e. Watts Industries, Inc.; Water Products Div.
 - f. Zurn Plumbing Products Group; Wilkins Div.
- 2. Standard: ASSE 1015.
 - 3. Operation: Continuous-pressure applications, unless otherwise indicated.
 - 4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
 - 5. Body: Bronze for NPS 2 and smaller; [cast iron with interior lining complying with AWWA C550 or that is FDA approved] [steel with interior lining complying with AWWA C550 or that is FDA approved] [stainless steel] for NPS 2-1/2 and larger.
 - 6. End Connections: Threaded for NPS 2 and smaller; [flanged] <Insert type> for NPS 2-1/2 and larger.
 - 7. Configuration: Designed for horizontal, straight through flow.
 - 8. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

C. Reduced-Pressure-Detector, Fire-Protection Backflow-Preventer Assemblies:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.
- 2. Standard: ASSE 1047 and FMG approved or UL listed.
- 3. Operation: Continuous-pressure applications.
- 4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
- 5. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved].
- 6. End Connections: Flanged.
- 7. Configuration: Designed for horizontal, straight through flow.
- 8. Accessories:
 - a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
 - c. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

D. Double-Check, Detector-Assembly Backflow Preventers:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Watts Industries, Inc.; Water Products Div.

- e. Zurn Plumbing Products Group; Wilkins Div.
- 2. Standard: ASSE 1048 and FMG approved or UL listed.
- 3. Operation: Continuous-pressure applications.
- 4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
- 5. Body: Cast iron with interior lining complying with AWWA C550 or that is FDA approved.
- 6. End Connections: Flanged.
- 7. Configuration: Designed for horizontal, straight through flow.
- 8. Accessories:
 - a. Valves: Outside screw and yoke gate-type with flanged ends on inlet and outlet.
 - b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.

E. Backflow-Preventer Test Kits:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. FEBCO; SPX Valves & Controls.
 - c. Flomatic Corporation.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.
- 2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Cash Acme.
 - b. Conbraco Industries, Inc.
 - c. Honeywell Water Controls.
 - d. Watts Industries, Inc.; Water Products Div.
 - e. Zurn Plumbing Products Group; Wilkins Div.
- 2. Standard: ASSE 1003.
- 3. Pressure Rating: Initial working pressure of .150 psig.
- 4. Body: Bronze with chrome-plated finish for .NPS 2. and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for .NPS 2-1/2 and NPS 3.
- 5. Valves for Booster Heater Water Supply: Include integral bypass.
- 6. End Connections: Threaded for .NPS 2. and smaller; flanged for .NPS 2-1/2 and NPS 3.

B. Water Control Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. CLA-VAL Automatic Control Valves.
 - b. Flomatic Corporation.
 - c. OCV Control Valves.
 - d. Watts Industries, Inc.; Ames Fluid Control Systems.
 - e. Watts Industries, Inc.; Watts ACV.
 - f. Zurn Plumbing Products Group; Wilkins Div.
2. Description: Pilot-operation, diaphragm-type, single-seated main water control valve.
 3. Pressure Rating: Initial working pressure of 150 psig minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
 4. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
 - a. Pattern: Angle or Globe-valve design
 - b. Trim: Stainless steel.
 5. End Connections: Threaded for .NPS 2. and smaller; flanged for .NPS 2-1/2. and larger.

2.4 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Flo Fab Inc.
 - c. ITT Industries; Bell & Gossett Div.
 - d. NIBCO INC.
 - e. TAC Americas.
 - f. Taco, Inc.
 - g. Watts Industries, Inc.; Water Products Div.
2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: Brass or bronze,
4. Size: Same as connected piping, but not larger than .NPS 2.
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Cast-Iron Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Flo Fab Inc.
 - c. ITT Industries; Bell & Gossett Div.
 - d. NIBCO INC.
 - e. TAC Americas.
 - f. Watts Industries, Inc.; Water Products Div.
2. Type: Adjustable with Y-pattern globe valve, two readout ports, and memory-setting indicator.
3. Size: Same as connected piping, but not smaller than .NPS 2-1/2.

- C. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
- D. Memory-Stop Balancing Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Conbraco Industries, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Div.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Red-White Valve Corp.
 - 2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
 - 3. Pressure Rating: 400-psig minimum CWP.
 - 4. Size: NPS 2 or smaller.
 - 5. Body: Copper alloy.
 - 6. Port: Standard or full port.
 - 7. Ball: Chrome-plated brass.
 - 8. Seats and Seals: Replaceable.
 - 9. End Connections: Solder joint or threaded.
 - 10. Handle: Vinyl-covered steel with memory-setting device.

2.5 TEMPERATURE-ACTUATED WATER MIXING VALVES

- A. Water-Temperature Limiting Devices:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong International, Inc.
 - b. Cash Acme.
 - c. Conbraco Industries, Inc.
 - d. Honeywell Water Controls.
 - e. Legend Valve.
 - f. Leonard Valve Company.
 - g. Powers; a Watts Industries Co.
 - h. Symmons Industries, Inc.
 - i. Taco, Inc.
 - j. Watts Industries, Inc.; Water Products Div.
 - k. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1017.
 - 3. Pressure Rating: 125 psig.
 - 4. Type: Thermostatically controlled water mixing valve.
 - 5. Material: Bronze body with corrosion-resistant interior components.
 - 6. Connections: Threaded inlets and outlet.
 - 7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
 - 8. Valve Finish: Chrome plated or Rough bronze.

B. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2.
 - a. Armstrong International, Inc.
 - b. Lawler Manufacturing Company, Inc.
 - c. Leonard Valve Company.
 - d. Powers; a Watts Industries Co.
 - e. Symmons Industries, Inc.
3. Standard: ASSE 1017.
4. Pressure Rating: .125 psig.
5. Type: Exposed-mounting, thermostatically controlled water mixing valve.
6. Material: Bronze body with corrosion-resistant interior components.
7. Connections: Threaded inlets and outlet.
8. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
9. Valve Pressure Rating: .125 psig minimum, unless otherwise indicated.
10. Pressure Drop at Design Flow Rate: 15 psig.
11. Valve Finish: Chrome plated or Rough bronze.
12. Piping Finish: Copper.

C. Manifold, Thermostatic, Water-Mixing-Valve Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Leonard Valve Company.
 - b. Powers; a Watts Industries Co.
 - c. Symmons Industries, Inc.
2. Description: Factory-fabricated, exposed-mounting, thermostatically controlled, water-mixing-valve assembly in three-valve parallel arrangement.
3. Large-Flow Parallel: Thermostatic water mixing valve and downstream pressure regulator with pressure gages on inlet and outlet.
4. Intermediate-Flow Parallel: Thermostatic water mixing valve and downstream pressure regulator with pressure gages on inlet and outlet.
5. Small-Flow Parallel: Thermostatic water mixing valve.
6. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
7. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
8. Component Pressure Ratings: .125 psig minimum, unless otherwise indicated.
9. Cabinet: Factory-fabricated, stainless steel, for surface mounting and with hinged, stainless-steel door.
10. Unit Pressure Drop at Design Flow Rate: 15 psig.
11. Thermostatic Mixing Valve and Water Regulator Finish: Chrome plated or rough bronze.
12. Piping Finish: Copper.

D. Individual-Fixture, Water Tempering Valve:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Cash Acme.
 - b. Conbraco Industries, Inc.
 - c. Honeywell Water Controls.
 - d. Lawler Manufacturing Company, Inc.
 - e. Leonard Valve Company.
 - f. Powers; a Watts Industries Co.
 - g. Watts Industries, Inc.; Water Products Div.
 - h. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1016, thermostatically controlled water tempering valve.
 3. Pressure Rating: .125 psig minimum, unless otherwise indicated.
 4. Body: Bronze body with corrosion-resistant interior components.
 5. Temperature Control: Adjustable.
 6. Inlets and Outlet: Threaded.
 7. Finish: Rough or chrome-plated bronze.

E. Primary Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Heat-Timer Corporation.
 - b. Holby Valve Co., Inc.
2. Standard: ASSE 1017, thermostatically controlled tempering valve, listed as tempering valve.
3. Pressure Rating: .125 psig minimum, unless otherwise indicated.
4. Body: Bronze.
5. Temperature Control: Manual.
6. Inlets and Outlet: Threaded.
7. Valve Finish: Rough bronze.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: .125 psig minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: .033 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: .045 inch.
 - c. Strainers NPS 5 and Larger: .125 inch.
6. Drain: Factory-installed, hose-end drain valve.

2.7 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. Guy Gray Manufacturing Co., Inc.
 - c. IPS Corporation.
 - d. LSP Products Group, Inc.
 - e. Oatey.
 - f. Plastic Oddities; a division of Diverse Corporate Technologies.
 - g. Symmons Industries, Inc.
 - h. Watts Industries, Inc.; Water Products Div.
 - i. Whitehall Manufacturing; a div. of Acorn Engineering Company.
 - j. Zurn Plumbing Products Group; Light Commercial Operation.
2. Mounting: Recessed.
3. Material and Finish: Stainless-steel box and faceplate.
4. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
6. Drain: NPS 2 standpipe and P-trap for direct waste connection to drainage piping.
7. Inlet Hoses: Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
8. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.

B. Icemaker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. IPS Corporation.
 - c. LSP Products Group, Inc.
 - d. Oatey.
 - e. Plastic Oddities; a division of Diverse Corporate Technologies.
2. Mounting: Recessed.
3. Material and Finish: Stainless-steel box and faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.
5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.8 HOSE STATIONS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ARCHON Industries, Inc.
 2. Armstrong International, Inc.
 3. Cooney Brothers, Inc.
 4. DynaFluid Ltd.

5. Leonard Valve Company.
6. Strahman Valves, Inc.
7. T & S Brass and Bronze Works, Inc.

B. Single-Temperature-Water Hose Stations:

1. Standard: ASME A112.18.1.
2. Cabinet: Stainless-steel enclosure with exposed valve handle, hose connection, and hose rack. Include thermometer in front.
3. Hose-Rack Material: Stainless steel.
4. Body Material: Bronze with stainless-steel wetted parts.
5. Body Finish: Rough bronze or chrome plated.
6. Mounting: Wall, with reinforcement.
7. Supply Fitting: .NPS 3/4 gate, globe, or ball valve and check valve and NPS 3/4 copper, water tubing. Omit check valve if check stop is included with fitting.
8. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 50 feet long.
9. Nozzle: With hand squeeze on-off control.
10. Vacuum Breaker: Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

C. Hot- and Cold-Water Hose Stations:

1. Standard: ASME A112.18.1.
2. Type Faucet: Blending valve.
3. Cabinet: Stainless-steel enclosure with exposed valve handles, hose connection, and hose rack. Include thermometer in front.
4. Hose-Rack Material: Stainless steel.
5. Body Material: Bronze with stainless-steel wetted parts.
6. Body Finish: Rough bronze or chrome plate.
7. Mounting: Wall, with reinforcement.
8. Supply Fittings: Two .NPS 3/4 gate, globe, or ball valves and check valves and .NPS 3/4 copper, water tubing. Omit check valves if check stops are included with fitting.
9. Hose: Manufacturer's standard, for service fluid, temperature, and pressure; 50 feet long.
10. Nozzle: With hand squeeze on-off control.
11. Vacuum Breaker: Integral or factory-installed, nonremovable, manual-drain-type, hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052; and garden-hose thread complying with ASME B1.20.7 on outlet.

2.9 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: .NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: .125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze, Chrome or nickel plated.

10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Wheel handle.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Prier Products, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Woodford Manufacturing Company.
 - h. Zurn Plumbing Products Group; Light Commercial Operation.
 - i. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: .125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: .NPS 3/4 or NPS 1..
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Polished nickel bronze.
12. Operating Keys(s): Two with each wall hydrant.

2.11 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: .400-psig minimum CWP.
3. Size: .NPS 3/4..
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.

9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

B. Gate-Valve-Type, Hose-End Drain Valve:

1. Standard: MSS SP-80 for gate valves.
2. Pressure Rating: Class 125.
3. Size: NPS 3/4.
4. Body: ASTM B 62 bronze.
5. Inlet: NPS 3/4 threaded or solder joint.
6. Outlet: Garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

C. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.12 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

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. AMTROL, Inc.
 - b. Josam Company.
 - c. MIFAB, Inc.
 - d. PPP Inc.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - g. Tyler Pipe; Wade Div.
 - h. Watts Drainage Products Inc.
 - i. Zurn Plumbing Products Group; Specification Drainage Operation.
3. Standard: ASSE 1010 or PDI-WH 201.
4. Type: Metal Bellows, see fixture schedule.
5. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.13 AIR VENTS

A. Bolted-Construction Automatic Air Vents:

1. Body: Bronze.
2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 or NPS 1/2 minimum inlet.

6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.
2. Pressure Rating: .150-psig. minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: .NPS 3/8. minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.14 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:

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. MIFAB, Inc.
 - b. PPP Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - e. Watts Industries, Inc.; Water Products Div.
3. Standard: ASSE 1018.
4. Pressure Rating: .125 psig. minimum.
5. Body: Bronze.
6. Inlet and Outlet Connections: .NPS 1/2. threaded, union, or solder joint.
7. Gravity Drain Outlet Connection: .NPS 1/2. threaded or solder joint.
8. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Valves:

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. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
3. Standard: ASSE 1044, lavatory P-trap with .NPS 3/8. minimum, trap makeup connection.
4. Size: .NPS 1-1/4. minimum.
5. Material: Chrome-plated, cast brass.

2.15 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. PPP Inc.
2. Standard: ASSE 1044,
3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
4. Cabinet: Recessed-mounting steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
6. Vacuum Breaker: ASSE 1001.
7. Number Outlets: Six.
8. Size Outlets: NPS 1/2.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- C. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.
- D. Install water control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.
- E. Install balancing valves in locations where they can easily be adjusted.
- F. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 1. Install thermometers and water regulators if specified.
 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- G. Install Y-pattern strainers for water on supply side of each control valve, water pressure-reducing valve, solenoid valve and pump].
- H. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
- I. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.

1. Install shutoff valve on outlet if specified.
 2. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
- J. Install ground hydrants with [1 cu. yd.] <Insert dimension> of crushed gravel around drain hole. Set ground hydrants with box flush with grade.
- K. Install draining-type post hydrants with [1 cu. yd.] <Insert dimension> of crushed gravel around drain hole. Set post hydrants in concrete paving or in [1 cu. ft.] <Insert dimension> of concrete block at grade.
- L. Install nonfreeze, nondraining-type post hydrants set in concrete or pavement.
- M. Install freeze-resistant yard hydrants with riser pipe set in concrete or pavement. Do not encase canister in concrete.
- N. Install water hammer arresters in water piping according to PDI-WH 201.
- O. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
- P. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- Q. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
- R. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 1. Pressure vacuum breakers.
 2. Reduced-pressure-principle backflow preventers.
 3. Double-check backflow-prevention assemblies.
 4. Dual-check-valve backflow preventers.
 5. Double-check, detector-assembly backflow preventers.
 6. Water pressure-reducing valves.

7. Calibrated balancing valves.
8. Primary, thermostatic, water mixing valves.
9. Manifold, thermostatic, water-mixing-valve assemblies.
10. Primary water tempering valves.
11. Outlet boxes.
12. Hose stations.
13. Supply-type, trap-seal primer valves.
14. Trap-seal primer systems.

- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer, double-check backflow-prevention assembly and double-check, detector-assembly backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

SECTION 22 13 16

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following for soil, waste, and vent piping inside the building:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.
 - 3. Encasement for underground metal piping.
- B. Any sanitary piping located above a drop ceiling or within a wall adjacent to an occupied space is to be insulated cast iron.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. LLDPE: Linear, low-density polyethylene plastic.
- D. NBR: Acrylonitrile-butadiene rubber.
- E. PE: Polyethylene plastic.
- F. PVC: Polyvinyl chloride plastic.
- G. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Shop Drawings:
 - 1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
- C. Coordination Drawings: Plans and details, drawn to scale, on which above and below ground sanitary and vent piping is shown and coordinated with other installations, using input from installers of the items involved. Clearly indicate all inverts and coordinate with site contractors.
- D. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service class.
- B. Gaskets: ASTM C 564, rubber.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.
- C. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
 - 1. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.
 - a. Available Manufacturers:
 - 1) ANACO.
 - 2) Clamp-All Corp.
 - 3) Ideal Div.; Stant Corp.
 - 4) Mission Rubber Co.
 - 5) Tyler Pipe; Soil Pipe Div.

2.5 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.
- B. Drainage Fittings: ASME B16.12, threaded, cast-iron drainage pattern.

2.6 STAINLESS-STEEL PIPE AND FITTINGS

- A. Pipe and Fittings: ASME A112.3.1, drainage pattern with socket and spigot ends.
- B. Gaskets: Lip seals shaped to fit socket groove, with plastic backup ring.
 - 1. Material: EPDM, unless NBR is indicated.

2.7 ENCASUREMENT FOR UNDERGROUND METAL PIPING

- A. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch minimum thickness.
- B. Form: Sheet.
- C. Color: Black.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4. and smaller shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless cast-iron soil pipe and fittings heavy-duty shielded, couplings; and hubless-coupling joints.
- C. Aboveground, soil and waste piping NPS 5. and larger shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless cast-iron soil pipe and fittings and heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
- D. Aboveground, vent piping NPS 4. and smaller shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
- E. Aboveground, vent piping NPS 5. and larger shall be the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and hubless-coupling joints.
- F. Underground, soil, waste, and vent piping NPS 4. and smaller shall be the following:
 - 1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
- G. Underground, soil and waste piping NPS 5. and larger shall be the following:
 - 1. Service class, cast-iron soil piping; gaskets; and gasketed joints.

3.3 PIPING INSTALLATION

- A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."
- B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

- D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- E. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- F. Provide an additional twenty five feet of drainage and vent piping for each size used on the project to resolve interferences or as directed by the Engineer.
- G. Install underground, steel, force-main piping. Install encasement on piping according to ASTM A 674 or AWWA C105.
- H. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside the building between wall and floor penetrations and connection to sanitary sewer piping outside the building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
 - 1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- I. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
 - 1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- J. Install underground, ductile-iron, special pipe fittings according to AWWA C600.
 - 1. Install encasement on piping according to ASTM A 674 or AWWA C105.
- K. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.
- L. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- M. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- N. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3. and smaller; 1 percent downward in direction of flow for piping NPS 4. and larger.
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- O. Install engineered soil and waste drainage and vent piping systems as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
 2. Solvent Drainage System: Comply with ASSE 1043 and solvent fitting manufacturer's written installation instructions.
 3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
- P. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- C. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

3.5 VALVE INSTALLATION

- A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- B. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.
 2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
 3. Install backwater valves in accessible locations.
 4. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

- B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 2. Install individual, straight, horizontal piping runs according to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 4. NPS 6: 60 inches with 3/4-inch rod.
 5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.
- G. Install supports for vertical cast-iron soil piping every 15 feet.
- H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4: 84 inches with 3/8-inch rod.
 2. NPS 1-1/2: 108 inches with 3/8-inch rod.
 3. NPS 2: 10 feet with 3/8-inch rod.
 4. NPS 2-1/2: 11 feet with 1/2-inch rod.
 5. NPS 3: 12 feet with 1/2-inch rod.
 6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
 7. NPS 6: 12 feet with 3/4-inch rod.
 8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.
- I. Install supports for vertical steel piping every 15 feet.
- J. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 2: 84 inches with 3/8-inch rod.
 2. NPS 3: 96 inches with 1/2-inch rod.
 3. NPS 4: 108 inches with 1/2-inch rod.
 4. NPS 6: 10 feet with 5/8-inch rod.
- K. Install supports for vertical stainless-steel piping every 10 feet.

- L. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections .NPS 2-1/2 and larger.

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than .10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack

openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of .1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221316

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Cleanouts.
 - 2. Floor drains.
 - 3. Trench drains.
 - 4. Air-admittance valves.
 - 5. Roof flashing assemblies.
 - 6. Through-penetration firestop assemblies.
 - 7. Miscellaneous sanitary drainage piping specialties.
 - 8. Flashing materials.
 - 9. Grease interceptors.
 - 10. Grease removal devices.
 - 11. Oil interceptors.
 - 12. Solids interceptors.
- B. Related Sections include the following:
 - 1. Division 22 Section "Storm Drainage Piping Specialties" for trench drains for storm water, and catch basins.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
 - 1. Grease interceptors.
 - 2. Grease removal devices.
 - 3. Oil interceptors.
- B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Manufacturer Seismic Qualification Certification: Submit certification that interceptors and accessories, and components will withstand seismic forces defined in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. 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."
 - b. 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."
 - 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. Field quality-control test reports.
- E. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. 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.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group; Specification Drainage Operation.
 - f. Josam Company; Blucher-Josam Div.
 - 2. Standard: ASME A112.36.2M for cast iron & ASME A112.3.1 for stainless steel for cleanout test tee.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch as required to match connected piping.
 - 5. Closure: Countersun brass plug.
 - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 - 7. Closure: Stainless-steel plug with seal.
 - 8. See plumbing fixture schedule for additional requirements
- B. Metal Floor Cleanouts:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group; Light Commercial Operation.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 - g. Josam Company; Josam Div.
 - 2. Standard: ASME A112.36.2M for cleanout.
 - 3. Size: Same as connected branch.
 - 4. Closure: Brass plug with straight threads and gasket
 - 5. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
 - 6. Standard: ASME A112.3.1.
 - 7. Size: Same as connected branch.
 - 8. Housing: Stainless steel.
 - 9. Closure: Stainless steel with seal.
 - 10. Riser: Stainless-steel drainage pipe fitting to cleanout.
 - 11. See plumbing fixture schedule for additional requirements

C. Cast-Iron Wall Cleanouts

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: As required to match connected piping.
5. Closure: Countersunk brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
8. Wall Access: Round stainless-steel wall-installation frame and cover.
9. See plumbing fixture schedule for additional requirements

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group; Light Commercial Operation.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3.
3. Body Material: See Fixture Schedule.
4. Seepage Flange: See Fixture Schedule
5. Anchor Flange: See Fixture Schedule.
6. Clamping Device: See Fixture Schedule.
7. Outlet: Bottom
8. Trap Pattern: Deep-seal P-trap
9. See plumbing fixture schedule for additional requirements

2.3 TRENCH DRAINS

A. Trench Drains

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Tyler Pipe; Wade Div.
 - d. Watts Drainage Products Inc.
 - e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3 for trench drains.

3. Material: Ductile or gray iron.
4. Outlet: See drawings
5. See plumbing fixture schedule for additional requirements

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.

B. Description: Lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

1. Open-Top Vent Cap: Without cap.
2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

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:
 - a. ProSet Systems Inc.
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
6. Special Coating: Corrosion resistant on interior of fittings.

2.6 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.

B. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with .NPS 1/2. side inlet.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

E. Stack Flashing Fittings

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

F. Vent Caps

1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Frost-Resistant Vent Terminals

1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide .1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

H. Expansion Joints

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.7 FLASHING MATERIALS

- A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: .4.0-lb/sq. ft., 0.0625-inch thickness.
 2. Vent Pipe Flashing: .3.0-lb/sq. ft., 0.0469-inch thickness.
 3. Burning: 6-lb/sq. ft., 0.0938-inch thickness.
- B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
1. General Applications: .12 oz./sq. ft. thickness.
 2. Vent Pipe Flashing: .8 oz./sq. ft. thickness.
- C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, .40-mil. minimum thickness.
- E. Fasteners: Metal compatible with material and substrate being fastened.
- F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- G. Solder: ASTM B 32, lead-free alloy.
- H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 CONCRETE BASES

- A. Anchor grease interceptors and solids interceptors to concrete bases.
1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on .19-inch centers around full perimeter of base.
 2. For installed equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be imbedded.
 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 5. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
 6. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.2 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backwater valves in building drain piping where noted. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

- C. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 - 1. Size same as drainage piping up to .NPS 4. Use .NPS 4. for larger drainage piping unless larger cleanout is indicated.
 - 2. Locate at each change in direction of piping greater than 45 degrees.
 - 3. Locate at minimum intervals of .50 feet for piping .NPS 4. and smaller and .100 feet for larger piping.
 - 4. Locate at base of each vertical soil and waste stack.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 - 1. Position floor drains for easy access and maintenance.
 - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than .1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than .1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- G. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.
- H. Assemble and install ASME A112.3.1, stainless-steel channel drainage systems according to ASME A112.3.1. Install on support devices so that top will be flush with surface.
- I. Assemble non-ASME A112.3.1, stainless-steel channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- J. Assemble FRP channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- K. Assemble plastic channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.
- L. Install fixture air-admittance valves on fixture drain piping.
- M. Install stack air-admittance valves at top of stack vent and vent stack piping.
- N. Install air-admittance-valve wall boxes recessed in wall.

- O. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- P. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
- Q. Install through-penetration firestop assemblies in plastic at floor penetrations.
- R. Assemble open drain fittings and install with top of hub 2 inches above floor.
- S. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- T. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
 - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
 - 2. Size: Same as floor drain inlet.
- U. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- V. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- W. Install vent caps on each vent pipe passing through roof.
- X. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain .1-inch clearance between vent pipe and roof substrate.
- Y. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- Z. Install frost-proof vent caps on each vent pipe passing through roof. Maintain .1-inch clearance between vent pipe and roof substrate.
- AA. Install cleanout immediately downstream from all interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.
- BB. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
 - 1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft., .00938-inch thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft., .00625-inch thickness or thinner.
 - 2. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of .10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."
- F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.
- G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.5 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Oil interceptors.
 - 2. Sand/Sediment interceptors.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.6 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.7 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain oil and sand interceptors.

END OF SECTION 221319

SECTION 22 34 01

FUEL-FIRED, DOMESTIC WATER HEATERS

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. The plumbing equipment schedules.

1.2 SUMMARY

- A. This Section includes the following for domestic water systems:
 - 1. Light Commercial, High Efficiency, Gas-Fired Water Heaters.
 - 2. Accessories.

1.3 SUBMITTALS

- A. Product Data: For each type and size of water heater. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
- B. Shop Drawings: Detail water heater assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power, signal, and control systems. Differentiate between manufacturer-installed and field-installed wiring.
- C. Product Certificates: Signed by manufacturers of water heaters certifying that products furnished comply with requirements.
- D. Coordination Drawings: Plans and details, drawn to scale, on which the location of the water heater, drain pan, drain piping, and intake and vent piping is shown and coordinated with other installations, using input from installers of the trades involved.
- E. Maintenance Data: For water heaters to include in maintenance manuals specified in Division 1.
- F. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on specific units indicated. Other manufacturers' products complying with requirements may be considered. Refer to Division 1 Section "Substitutions."

- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ANSI Compliance: Provide gas water heaters that comply with ANSI standards for gas water heaters and related products and that bear AGA certification label.
- E. ASME Compliance: Fabricate and label water heater, hot-water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.
- F. ASHRAE Standards: Comply with performance efficiencies prescribed for the following:
 - 1. ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," for commercial water heaters.
 - 2. ASHRAE 90.2, "Energy Efficient Design of New Low-Rise Residential Buildings," for household water heaters.

1.5 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner 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.
- B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of water heaters that fail in materials or workmanship within specified warranty period. See General Conditions specification section for requirements of special extended 1 year warranty for water heater from date of issuance of Certificate of Occupancy.
 - 1. Failures include storage tanks and burner assemblies.
 - 2. Warranty Period: From date of Substantial Completion:
 - a. Storage Tanks: 5 years (min.).
 - b. Burner Assemblies/Heat Exchangers: One year (min.)

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Light Commercial, High Efficiency, Tube Type Gas-Fired Water Heaters:
 - a. Lochinvar Corp.
 - b. Bradford White
 - c. Patterson-Kelley Co.
 - 2. Expansion Tanks:
 - a. Amtrol, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Zurn Industries, Inc.; Wilkins Div.

2.2 LIGHT COMMERCIAL, HIGH EFFICIENCY GAS WATER HEATERS

- A. Description: Comply with UL 795 and ANSI Z21.13; include storage tank, circulator, piping, and controls.
- B. Water Heater: Enclosed, insulated unit with controls.
 - 1. Construction: According to ASME Boiler and Pressure Vessel Code: Section IV with 160-psig working-pressure rating.
 - 2. Heat Exchanger: Copper, finned tube with bronze or glass-lined cast-iron headers. There shall be no bolts, gaskets, or "O" rings in the header configuration. Heat exchanger shall be hydrostatically tested to 240 psig. The heat exchanger shall be equipped with an outlet thermometer to monitor discharge water temperature.
 - 3. Burner: High-temperature stainless steel construction, for use with tube-type water heaters and natural-gas fuel capable of 100% "On/Off" operation.
 - a. Combustion Air Chamber: The combustion air chamber shall be sealed and enclosed in ceramic fiberboard insulation. A flame observation port shall be provided. A combustion air blower shall be provided to control fuel/air mixture.
 - b. Automatic Ignition: Intermittent electronic ignition complying with ANSI Z21.20.
 - c. Gas Valve: Main combination gas valve shall have redundant seats and a built-in low gas pressure regulator. The gas pressure regulator shall be referenced to the combustion air fan.
 - d. Safety Controls: Automatic, high-temperature-limit cutoff device or system, a combination low air and blocked flue pressure switch to monitor fan operation, and an ASME temperature/pressure relief valve.
 - 4. Control Panel: Provide with master power switch, (4) four ignition control LED lights to indicate sequential operation and diagnostics on control sensed malfunctions, low voltage transformer, and terminal strip for field connection of remote devices/controls. All components shall be easily accessed and serviceable from the front of the jacket through the control panel cover.
 - 5. Temperature Controls: Standard immersion type operating aquastat with high limit control.
 - 6. Draft Hood: Heater jacket design shall allow single unit venting connection without the use of external draft hood devices.
- C. Hot-Water Storage Tank: Connected with piping to circulator and water heater.
 - 1. Construction: According to ASME Boiler and Pressure Vessel Code: Section VIII, steel with 150-psig working-pressure rating.
 - a. Tappings: Factory fabricated of materials compatible with tank for piping connections, relief valve, pressure gage, thermometer, drain, anode rods, and controls as required. Attach tappings to tank shell before testing and labeling.
 - 1) NPS 2 and Smaller: Threaded ends according to ASME B1.20.1, pipe threads.
 - 2) NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

- b. Interior Finish: Materials and thicknesses complying with NSF 61, barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.
 - c. Insulation: Comply with ASHRAE 90.1. Surround entire storage tank except connections and controls.
 - d. Jacket: Steel, with enameled finish.
 - e. ASME temperature/pressure relief valve.
- 2. Anode Rods: Factory installed, magnesium.
 - 3. Drain Valve: ASSE 1005, corrosion-resistant metal, factory installed.
- D. Mounting: Water heater, tank, and accessories factory mounted and provided as a single unit.
 - E. Circulator: UL 778, all bronze, in-line, centrifugal, single-stage, radially split case design, with mechanical seals; with 125-psig-minimum working-pressure rating and 225 deg F. continuous water temperature. See equipment schedule for additional requirements.
 - F. Piping: Manufacturer's standard copper tubing.

2.3 EXPANSION TANKS

- A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
- B. Construction: Working-pressure rating.
- C. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
- D. Tank Interior Finish: Materials and thicknesses complying with NSF 61, barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.
- E. Tank Exterior Finish: Manufacturer's standard, unless finish is indicated.
- F. Air-Charging Valve: Factory installed.

2.4 WATER HEATER ACCESSORIES

- A. Combination Temperature and Pressure Relief Valves: According to the following:
 - 1. Gas Water Heaters: ANSI Z21.22, combination temperature and pressure relief valve.
- B. Vacuum Relief Valves: According to the following:
 - 1. Gas Water Heaters: ANSI Z21.22.
 - 2. Exception: Omit if water heater has integral vacuum-relieving device.
- C. Gas Shutoff Valves: ANSI Z21.15, manually operated. Furnish for installation in piping.
- D. Gas Pressure Regulators: ANSI Z21.18, appliance type, factory or field installed. Include pressure rating, capacity, and pressure differential required for water heater and gas supply.
- E. Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.

- F. Water Heater Stand and Drain Pan Units: High-density-polyethylene-plastic, 18-inch- high, enclosed-base stand complying with IAPMO PS 103 and IAS No. 2. Include integral or separate drain pan with raised edge and NPS 1/2 drain outlet with ASME B1.20.1, pipe thread.
- G. Water Heater Stands: Water heater manufacturer's factory-fabricated, steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches above the floor.
- H. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Install commercial water heaters on stand, bracket, suspended platform, or directly to the floor.
- B. Install water heaters, level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- C. Install and connect gas water heaters according to NFPA 54.
 - 1. Install appliance, gas pressure regulators on gas-burner inlets of water heaters without pressure regulators.
 - 2. Install vent piping from gas-train pressure regulators and valves to outside of building where required. Terminate vent piping with brass-screened vent cap fitting. Do not combine vents except with approval of authorities having jurisdiction.
- D. Install temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend relief valve outlet with water piping in continuous downward pitch and discharge onto closest floor drain.
- E. Install vacuum relief valves in cold-water-inlet piping.
- F. Install water heater drain piping as indirect waste to spill into open drains or over floor drains.
- G. Install thermometers on water heater inlet and outlet piping. Refer to Division 15 Section "Meters and Gages" for thermometers.
- H. Install pressure gages on water heater piping. Refer to Division 15 Section "Meters and Gages" for pressure gages.
- I. Arrange for insulation on equipment and piping not furnished with factory-applied insulation.
- J. Fill water heaters with water.
- K. Charge compression tanks with air.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect hot- and cold-water piping with shutoff valves and unions. Connect hot-water-circulating piping with shutoff valve, check valve, and union.
- D. Connect gas piping to gas burner with drip leg, tee, shutoff valve, and union; minimum size same as inlet connection.
- E. Make connections with dielectric fittings where piping is made of dissimilar metal.
- F. Gas, Water Heater Vent Connections: Connect to vent system. Include draft hoods and diverters where required. Use vents same size as or larger than water heater outlets, but not smaller than indicated unless smaller vent size has been calculated according to NFPA 54. Comply with gas utility requirements for sizing. Gas vents are specified in Division 15 Section "Breechings, Chimneys, and Stacks."
- G. Electrical Connections: Power wiring and disconnect switches are specified in Division 16 Sections. Arrange wiring to allow unit service.
- H. Ground equipment.
 - 1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FIELD QUALITY CONTROL

- A. Engage a factory-authorized service representative to perform startup service.
- B. In addition to manufacturer's written installation and startup checks, perform the following:
 - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment and retest until satisfactory results are achieved.
 - 2. Verify that piping system tests are complete.
 - 3. Check for piping connection leaks.
 - 4. Check for clear relief valve inlets, outlets, and drain piping.
 - 5. Check operation of circulators.
 - 6. Test operation of safety controls, relief valves, and devices.
 - 7. Energize electric circuits.
 - 8. Adjust operating controls.
 - 9. Adjust hot-water-outlet temperature settings. Do not set above 140 deg F unless piping system application requires higher temperature.
 - 10. Balance water flow through manifolds of multiple-unit installations.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water heaters.

1. Train Owner's maintenance personnel on procedures for starting and stopping troubleshooting, servicing, and maintaining equipment.
2. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
3. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 223401

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes plumbing fixtures and related components.
- B. Related Sections include the following:
 - 1. Provide plumbing fixtures in accordance with the fixtures schedules provided on the drawings.

1.3 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.4 SUBMITTALS

- A. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture scheduled.
- B. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components in the same category through one source from a single manufacturer.
- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act";] about plumbing fixtures for people with disabilities.

- C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- F. Comply with the following applicable standards and other requirements specified for faucets:
 - 1. Faucets: ASME A112.18.1M.
 - 2. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - 3. Supply and Drain Fittings: ASME A112.18.1M.
 - 4. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
 - 5. Faucets: ASME A112.18.1M.
 - 6. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
 - 7. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
- G. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Floor Drains: ASME A112.21.1M.
 - 2. Grab Bars: ASTM F 446.
 - 3. Hose-Coupling Threads: ASME B1.20.7.
 - 4. Hot-Water Dispensers: ASSE 1023 and UL 499.
 - 5. Off-Floor Fixture Supports: ASME A112.6.1M.
 - 6. Pipe Threads: ASME B1.20.1.
 - 7. Plastic Toilet Seats: ANSI Z124.5.
 - 8. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 COORDINATION

- A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Supply, Flow-Control Fittings: Equal to 5 percent of amount of each type and size installed.
 - 2. Flushometer Valve, Repair Kits: Equal to 5 percent of amount of each type installed, but not less than 10 of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified in other Part 2 articles.
- B. Provide plumbing fixtures in accordance with the plumbing fixture schedule included with the contract drawings. Provide all accessories (carriers, mounting hardware, seats, etc) as required to install and operate plumbing fixtures even if not specifically shown on the drawings or required by the specifications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data if roughing-in data are not indicated.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIXTURE INSTALLATION

- A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install counter-mounting fixtures in and attached to casework.
- C. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.
- D. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture.
- E. Install trap and tubular waste piping on drain outlet of each fixture and connect to drainage system.
- F. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.
- G. Install toilet seats on water closets.
- H. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.

2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

- I. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings.
- J. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Plumbing Specification Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect water supplies from water distribution piping to fixtures.
- C. Connect drain piping from fixtures to drainage piping.
- D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.
- E. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.

3.4 FIELD QUALITY CONTROL

- A. Verify that installed fixtures are categories and types specified for locations where installed.
- B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.

2. Remove sediment and debris from drains.
3. Clean fixtures to a reasonable degree of shine. No visible grease or other marks from construction should be apparent.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 224000

SECTION 23 05 00

COMMON WORK REQUIREMENTS FOR HVAC

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Dielectric fittings.
 - 3. Mechanical sleeve seals.
 - 4. Sleeves.
 - 5. Escutcheons.
 - 6. Grout.
 - 7. HVAC demolition.
 - 8. Equipment installation requirements common to equipment sections.
 - 9. Concrete bases.
 - 10. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
 - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- D. Sheet metal construction documents are diagrammatic. Equivalent sizes can be substituted when construction begins as long as aspect ratios are no greater than 3:1 for rectangular, or round instead of square substitutions provide the same static pressure per 100ft. Duct runs are to be coordinated in the field with the other trades. Duct materials can not be changed without the permission of the engineer. Flex ducts are to be no longer than eight feet and must be supported from overhead.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, .1/8-inch_ (3.2-mm) maximum thickness unless thickness or specific material is 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 or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.
- G. Solvent Cements for Joining Plastic Piping:
 - 1. CPVC Piping: ASTM F 493.
 - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.3 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: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.4 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
- B. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
- C. Pressure Plates: Stainless steel. Include two for each sealing element.
- D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

- A. Galvanized-Steel Sheet: .0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.
- E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.
- F. PVC Pipe: ASTM D 1785, Schedule 40.

- G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
 - 1. Finish: Polished chrome-plated.

2.7 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 HVAC DEMOLITION

- A. Refer to Division 01 Section "Cutting and Patching" and Division 02 Section "Selective Structure Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. 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.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for .1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
 3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten

bolts against pressure plates that cause sealing elements to expand and make watertight seal.

- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for .1-inch_ (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING 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. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

- I. Plastic Piping Solvent-Cement Joints: 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 schedule number ASTM D 1785, 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.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than .4 inches (100 mm) larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on .18-inch (450-mm) centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03 Sections.

3.7 PAINTING AND FINISHING

- A. Apply semi-gloss, acrylic-enamel finish to exposed piping according to the following:
 - 1. Interior, Ferrous Piping and Ferrous Supports: Finish coat over enamel undercoat and primer.
 - 2. Interior and Exterior, Galvanized-Steel Piping: Two finish coats over galvanized metal primer.
 - 3. Exterior, Ferrous Piping and Ferrous Supports: Two finish coats over rust-inhibitive metal primer.
 - 4. Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved. Repair cut surfaces to match adjacent surfaces.

3.9 CONTROLS COORDINATION

- A. For electrical interface of controls the following is the method to be coordinated with division 23. Division 23 is to provide junction box with cover, conduit, and power to JB. The cover is to be labeled with its respective panel number and breaker number. Control contractor will provide the control transformers and all wiring there after to devices and is to coordinate with Division 16 in the field.

3.10 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.12 GROUTING

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

END OF SECTION 230500

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
 - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
 - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Trapeze pipe hangers.
3. Fiberglass pipe hangers.
4. Metal framing systems.
5. Fiberglass strut systems.
6. Thermal-hanger shield inserts.
7. Fastener systems.
8. Pipe stands.
9. Equipment supports.

B. Related Sections:

1. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
2. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 1. Trapeze pipe hangers.
 2. Metal framing systems.
 3. Fiberglass strut systems.
 4. Pipe stands.
 5. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 1. Detail fabrication and assembly of trapeze hangers.
 2. Design Calculations: Calculate requirements for designing trapeze hangers.
- D. Welding certificates.

1.6 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- B. Stainless-Steel Pipe Hangers and Supports:
 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 FIBERGLASS PIPE HANGERS

A. Clevis-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 1, steel pipe hanger except hanger is made of fiberglass or fiberglass-reinforced resin.
2. Hanger Rods: Continuous-thread rod, washer, and nuts made of stainless steel.

B. Strap-Type, Fiberglass Pipe Hangers:

1. Description: Similar to MSS SP-58, Type 9 or Type 10, steel pipe hanger except hanger is made of fiberglass-reinforced resin.
2. Hanger Rod and Fittings: Continuous-thread rod, washer, and nuts made of stainless steel.

2.4 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.
 - c. Flex-Strut Inc.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut Corporation; Tyco International, Ltd.
 - g. Wesanco, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturred lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

6. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
7. Metallic Coating: Electroplated zinc.
8. Paint Coating: Epoxy.
9. Plastic Coating: Epoxy.

2.5 FIBERGLASS STRUT SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Allied Tube & Conduit.
 2. Champion Fiberglass, Inc.
 3. Cooper B-Line, Inc.
 4. SEASAFE, INC.; a Gibraltar Industries Company.
- B. Description: Shop- or field-fabricated pipe-support assembly similar to MFMA-4 for supporting multiple parallel pipes.
 1. Channels: Continuous slotted fiberglass channel with intumed lips.
 2. Channel Nuts: Fiberglass nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.6 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Carpenter & Paterson, Inc.
 2. Clement Support Services.
 3. ERICO International Corporation.
 4. National Pipe Hanger Corporation.
 5. PHS Industries, Inc.
 6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
 7. Piping Technology & Products, Inc.
 8. Rilco Manufacturing Co., Inc.
 9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with .100-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with .100-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.7 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.8 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand:
 - 1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
 - 2. Base: Stainless steel.
 - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
 - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand:
 - 1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 2. Bases: One or more; plastic.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.9 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.10 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Fiberglass Pipe-Hanger Installation: Comply with applicable portions of MSS SP-69 and MSS SP-89. Install hangers and attachments as required to properly support piping from building structure.
- D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- E. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.
- F. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- G. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- H. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
 2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.
- I. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
 - J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
 - K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
 - L. Install lateral bracing with pipe hangers and supports to prevent swaying.
 - M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
 - N. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
 - O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
 - P. Insulated Piping:
 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.

- c. NPS 5 and NPS 6: .18 inches long and .006 inch thick.
 - d. NPS 8 to NPS 14: .24 inches long and .0075 inch thick.
 - e. NPS 16 to NPS 24: .24 inches long and .0105 inch thick.
- 5. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
 - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of .2.0 mils.

- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
 19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
 20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
 21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.

3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): .750 lb.
 - b. Medium (MSS Type 32): .1500 lb.
 - c. Heavy (MSS Type 33): .3000 lb.
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed .1-1/4 inches.
3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include

auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

- a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplementary conditions and Division 1 specification sections, apply to this section.

1.2 SUMMARY

- A. Provide seismic restraints and supports for all mechanical equipment, piping, plumbing, and fire protection in accordance with the International Building Code, NFPA-13, SMACNA and standard practice.
- B. Provide vibration isolators on all piping, ductwork, and equipment.

1.3 SUBMITTALS:

- A. Product Data: Include load deflection curves for each vibration isolation device.
- B. Shop Drawings: Include the following:
 - 1. Design Calculations: Calculate requirements for selecting vibration isolators and for vibration isolation bases. All calculations shall be signed and sealed by a professional Engineer licensed in the state of New Jersey.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 VIBRATION ISOLATORS

- A. Manufacturers:
 - 1. Mason Industries, Inc.
 - 2. Amber/Booth Company, Inc.
 - 3. Kinetics Noise Control, Inc.
- B. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
 - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 3. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 5. Baseplates: Factory drilled for bolting to structure and bonded to .1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to .100 psig.
 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- C. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.
1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
 2. Base: Factory drilled for bolting to structure.
 3. Snubbers: Vertically adjustable to allow a maximum of .1/4-inch. travel before contacting a resilient collar.
- D. Spring Hangers: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of the rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
- E. Resilient Isolation Washers and Bushings: 1-piece, molded, bridge-bearing neoprene complying with AASHTO M 251 and having a durometer of 50, plus or minus 5, with a flat washer face.

2.3 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers:
1. Amber/Booth Company, Inc.
 2. California Dynamics Corp.
 3. Isolation Technology, Inc.
 4. Kinetics Noise Control, Inc.
 5. Mason Industries, Inc.
 6. Vibration Eliminator Co., Inc.
 7. Vibration Isolation Co., Inc.
 8. Vibration Mountings & Controls/Korfund.
- B. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for field-applied, cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than .1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel angles on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.4 FACTORY FINISHES

- A. Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 1. Powder coating on springs and housings.
 2. All hardware shall be electrogalvanized. Hot-dip galvanize metal components for exterior use.
 3. Baked enamel for metal components on isolators for interior use.
 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements, installation tolerances, and other conditions affecting performance
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install thrust limits at centerline of thrust, symmetrical on either side of equipment.
- B. Install resilient bolt isolation washers on equipment anchor bolts.

3.3 EQUIPMENT BASES

- A. Fill concrete inertia bases, after installing base frame, with 3000-psi concrete; trowel to a smooth finish.

- B. Concrete Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions for seismic codes at Project site.
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on .18-inch centers around the full perimeter of the base.
 - 2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 - 1. Isolator deflection.

3.5 ADJUSTING

- A. Adjust isolators after piping systems have been filled and equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Attach thrust limits at centerline of thrust and adjust to a maximum of .1/4-inch movement during start and stop.
- D. Adjust active height of spring isolators.

3.6 CLEANING

- A. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

END OF SECTION 230548

SECTION 23 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Stencils.
 - 6. Valve tags.
 - 7. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Stainless steel, .0025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 - 3. Minimum Letter Size: .1/4 inch for name of units if viewing distance is less than .24 inches, .1/2 inch for viewing distances up to .72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 4. Fasteners: Stainless-steel self-tapping screws.
 - 5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, .1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White
- C. Background Color: Red
- D. Maximum Temperature: Able to withstand temperatures up to .160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: .1/4 inch for name of units if viewing distance is less than .24 inches, .1/2 inch for viewing distances up to .72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: At least .1-1/2 inches high.

2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, .1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: White .
- C. Background Color: Black
- D. Maximum Temperature: Able to withstand temperatures up to .160 deg F..
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch..
- F. Minimum Letter Size: .1/4 inch for name of units if viewing distance is less than .24 inches, .1/2 inch for viewing distances up to .72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
 - 2. Lettering Size: At least .1-1/2 inches high.

2.5 VALVE TAGS

- A. Valve Tags: Stamped or engraved with .1/4-inch letters for piping system abbreviation and .1/2-inch numbers.

1. Tag Material: Stainless steel, .0025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass beaded chain.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4 by 7 inches
 2. Fasteners: Brass grommet and wire
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting".
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

C. Pipe Label Color Schedule:

1. Refrigerant Piping:
 - a. Background Color: Black.
 - b. Letter Color: Yellow.

3.4 DUCT LABEL INSTALLATION

- A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
 1. Blue For cold-air supply ducts.
 2. Yellow For hot-air supply ducts.
 3. Green For exhaust-, outside-, relief-, return-, and mixed-air ducts.
 4. ASME A13.1 Colors and Designs: For hazardous material exhaust.
- B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 1. Valve-Tag Size and Shape:
 - a. Chilled Water: 2 inches, round.
 - b. Condenser Water: 2 inches, round.
 - c. Refrigerant: 2 inches, round.
 - d. Hot Water: 2 inches, round.
 - e. Gas: 2 inches, round.
 2. Valve-Tag Color:
 - a. Chilled Water: Blue.
 - b. Condenser Water: Yellow.
 - c. Refrigerant: Black.
 - d. Hot Water: Red.
 - e. Gas: Yellow.
 3. Letter Color:

- a. Chilled Water: White.
- b. Condenser Water: Black.
- c. Refrigerant: White.
- d. Hot Water: White.
- e. Gas: Black.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

- A. Qualification Data: Submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Certified TAB reports.
- C. Sample report forms.
- D. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.5 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
- B. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer
- C. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6 PROJECT CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23 Section "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
1. Permanent electrical-power wiring is complete.
 2. Hydronic systems are filled, clean, and free of air.
 3. Automatic temperature-control systems are operational.
 4. Equipment and duct access doors are securely closed.
 5. Balance, smoke, and fire dampers are open.
 6. Isolating and balancing valves are open and control valves are operational.
 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system in accordance with the following:
 - 1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure airflow of submain and branch ducts.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 - 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

- C. Measure air outlets and inlets without making adjustments.
 - 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
 - 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
 - 1. Manufacturer's name, model number, and serial number.
 - 2. Motor horsepower rating.
 - 3. Motor rpm.
 - 4. Efficiency rating.
 - 5. Nameplate and measured voltage, each phase.
 - 6. Nameplate and measured amperage, each phase.
 - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.7 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

3.8 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
 - 2. Air Outlets and Inlets: Plus or minus 10 percent.
 - 3. Heating-Water Flow Rate: Plus or minus 10 percent.
 - 4. Cooling-Water Flow Rate: Plus or minus 10 percent.

3.9 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.10 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.
 - 8. Report date.
 - 9. Signature of TAB supervisor who certifies the report.
 - 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 - 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 - 12. Nomenclature sheets for each item of equipment.
 - 13. Data for terminal units, including manufacturer's name, type, size, and fittings.

14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.
 2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.

- f. Preheat-coil static-pressure differential in inches wg.
- g. Cooling-coil static-pressure differential in inches wg.
- h. Heating-coil static-pressure differential in inches wg.
- i. Outdoor airflow in cfm.
- j. Return airflow in cfm.
- k. Outdoor-air damper position.
- l. Return-air damper position.
- m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch. o.c.
- f. Make and model number.
- g. Face area in sq. ft.
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Water flow rate in gpm.
- i. Water pressure differential in feet of head or psig.
- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig.
- n. Refrigerant suction temperature in deg F.
- o. Inlet steam pressure in psig.

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and unit size.
- e. Manufacturer's serial number.
- f. Fuel type in input data.
- g. Output capacity in Btu/h.
- h. Ignition type.
- i. Burner-control types.

- j. Motor horsepower and rpm.
- k. Motor volts, phase, and hertz.
- l. Motor full-load amperage and service factor.
- m. Sheave make, size in inches, and bore.
- n. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

- a. Total air flow rate in cfm.
- b. Entering-air temperature in deg F.
- c. Leaving-air temperature in deg F.
- d. Air temperature differential in deg F.
- e. Entering-air static pressure in inches wg.
- f. Leaving-air static pressure in inches wg.
- g. Air static-pressure differential in inches wg.
- h. Low-fire fuel input in Btu/h.
- i. High-fire fuel input in Btu/h.
- j. Manifold pressure in psig.
- k. High-temperature-limit setting in deg F.
- l. Operating set point in Btu/h.
- m. Motor voltage at each connection.
- n. Motor amperage for each phase.
- o. Heating value of fuel in Btu/h.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and size.
- e. Manufacturer's serial number.
- f. Arrangement and class.
- g. Sheave make, size in inches, and bore.
- h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and rpm.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches, and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
- g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Total system static pressure in inches wg.
- c. Fan rpm.
- d. Discharge static pressure in inches wg.
- e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
 - a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft.
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.

J. Air-Terminal-Device Reports:

1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.
 - g. Type and model number.
 - h. Size.
 - i. Effective area in sq. ft.
2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary air flow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final air flow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:
 - a. System and air-handling-unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Entering-water temperature in deg F.

- c. Leaving-water temperature in deg F.
- d. Water pressure drop in feet of head or psig.
- e. Entering-air temperature in deg F.
- f. Leaving-air temperature in deg F.

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Service.
- d. Make and size.
- e. Model number and serial number.
- f. Water flow rate in gpm.
- g. Water pressure differential in feet of head or psig.
- h. Required net positive suction head in feet of head or psig.
- i. Pump rpm.
- j. Impeller diameter in inches.
- k. Motor make and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig.
- b. Pump shutoff pressure in feet of head or psig.
- c. Actual impeller size in inches.
- d. Full-open flow rate in gpm.
- e. Full-open pressure in feet of head or psig.
- f. Final discharge pressure in feet of head or psig.
- g. Final suction pressure in feet of head or psig.
- h. Final total pressure in feet of head or psig.
- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.

M. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

3.11 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
 - a. Measure airflow of at least 10 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Engineer
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Engineer
3. Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.12 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 23 07 00

H_VAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:
 - a. Calcium silicate.
 - b. Cellular glass.
 - c. Flexible elastomeric.
 - d. Mineral fiber.
 - e. Phenolic.
 - f. Polyisocyanurate.
 - g. Polyolefin.
 - h. Polystyrene.
2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Mastics.
6. Lagging adhesives.
7. Sealants.
8. Factory-applied jackets.
9. Field-applied fabric-reinforcing mesh.
10. Field-applied cloths.
11. Field-applied jackets.
12. Tapes.
13. Securements.
14. Corner angles.

B. Related Sections:

1. Division 21 Section "Fire-Suppression Systems Insulation."
2. Division 22 Section "Plumbing Insulation."
3. Division 23 Section "Metal Ducts" for duct liners.
4. Division 33 Section "Underground Hydronic Energy Distribution" for loose-fill pipe insulation in underground piping outside the building.
5. Division 33 Section "Underground Steam and Condensate Distribution Piping" for loose-fill pipe insulation in underground piping outside the building.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail attachment and covering of heat tracing inside insulation.
 - 3. Detail insulation application at pipe expansion joints for each type of insulation.
 - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Detail application of field-applied jackets.
 - 7. Detail application at linkages of control devices.
 - 8. Detail field application for each equipment type.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.
 - 1. Sample Sizes:
 - a. Preformed Pipe Insulation Materials: .12 inches long by .NPS 2.
 - b. Sheet Form Insulation Materials: .12 inches square.
 - c. Jacket Materials for Pipe: .12 inches long by .NPS 2.
 - d. Sheet Jacket Materials: .12 inches square.
 - e. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.
- D. Qualification Data: For qualified Installer.
- E. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- F. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
1. Piping Mockups:
 - a. One .10-foot section of NPS 2. straight pipe.
 - b. One each of a 90-degree threaded, welded, and flanged elbow.
 - c. One each of a threaded, welded, and flanged tee fitting.
 - d. One NPS 2. or smaller valve, and one NPS 2-1/2. or larger valve.
 - e. Four support hangers including hanger shield and insert.
 - f. One threaded strainer and one flanged strainer with removable portion of insulation.
 - g. One threaded reducer and one welded reducer.
 - h. One pressure temperature tap.
 - i. One mechanical coupling.
 2. Ductwork Mockups:
 - a. One .10-foot section each of rectangular and round straight duct.
 - b. One each of a 90-degree mitered round and rectangular elbow, and one each of a 90-degree radius round and rectangular elbow.
 - c. One rectangular branch takeoff and one round branch takeoff from a rectangular duct. One round tee fitting.
 - d. One rectangular and round transition fitting.
 - e. Four support hangers for round and rectangular ductwork.
 3. Equipment Mockups:
 - a. One chilled-water pump and one heating-hot-water pump.
 - b. One tank or vessel.
 4. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
 5. Notify Engineer seven days in advance of dates and times when mockups will be constructed.
 6. Obtain Engineer's approval of mockups before starting insulation application.
 7. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
 8. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 9. Demolish and remove mockups when directed.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Cell-U-Foam Corporation; Ultra-CUF.
 - b. Pittsburgh Corning Corporation; Foamglas Super K.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.

4. Board Insulation: ASTM C 552, Type IV.
 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 6. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. Rubatex Corp.
 - d. Armstrong World Industries, Inc.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II without facing and with all service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil and vinyl film
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; All-Service Duct Wrap.
- I. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB. without facing and with all service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil and vinyl film
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; Commercial Board.
 - b. Fibrex Insulations Inc.; FBX.
 - c. Johns Manville; 800 Series Spin-Glas.
 - d. Knauf Insulation; Insulation Board.
 - e. Manson Insulation Inc.; AK Board.
 - f. Owens Corning; Fiberglas 700 Series.
- J. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000 Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.
 - e. Owens Corning; Fiberglas Pipe Insulation.
 2. Type I, 850 deg F. Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with all purpose factory applied vapor-retarder jacket.

3. Type II, 1200 deg F. Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with all purpose factory applied vapor-retarder jacket.
- K. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F. is 0.29 Btu x in./h x sq. ft. x deg F. or less.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. CertainTeed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Pipe and Tank Insulation.
 - d. Manson Insulation Inc.; AK Flex.
 - e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Insulco, Division of MFS, Inc.; Triple I.
 - b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.
- C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Insulco, Division of MFS, Inc.; SmoothKote.
 - b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
 - c. Rock Wool Manufacturing Company; Delta One Shot.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA Inc.; Aero seal.

- b. Armacell LCC; 520 Adhesive.
 - c. Foster Products Corporation, H. B. Fuller Company; 85-75.
 - d. RBX Corporation; Rubatex Contact Adhesive.
- 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-96.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-33.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Speedline Vinyl Adhesive.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-35.

- b. Foster Products Corporation, H. B. Fuller Company; 30-90.
 - c. ITW TACC, Division of Illinois Tool Works; CB-50.
 - d. Marathon Industries, Inc.; 590.
 - e. Mon-Eco Industries, Inc.; 55-40.
 - f. Vimasco Corporation; 749.
- 2. Water-Vapor Permeance: ASTM E 96, Procedure B, .0013 perm. at .43-mil. dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F. .
 - 4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
 - 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-30.
 - b. Foster Products Corporation, H. B. Fuller Company; 30-35.
 - c. ITW TACC, Division of Illinois Tool Works; CB-25.
 - d. Marathon Industries, Inc.; 501.
 - e. Mon-Eco Industries, Inc.; 55-10.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm. at .35-mil. dry film thickness.
 - 3. Service Temperature Range: 0 to 180 deg F. .
 - 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 - 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; Encacel.
 - b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
 - c. Marathon Industries, Inc.; 570.
 - d. Mon-Eco Industries, Inc.; 55-70.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm. at .30-mil. dry film thickness.
 - 3. Service Temperature Range: Minus 50 to plus 220 deg F. .
 - 4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 - 5. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-52.
 - b. Foster Products Corporation, H. B. Fuller Company; 81-42.
 - c. Marathon Industries, Inc.; 130.
 - d. Mon-Eco Industries, Inc.; 11-30.

- e. Vimasco Corporation; 136.
- 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
- 3. Service Temperature Range: Minus 50 to plus 180 deg F.
- 4. Color: White.

2.6 SEALANTS

A. Metal Jacket Flashing Sealants:

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76-8.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Vimasco Corporation; 750.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.
- 4. Service Temperature Range: Minus 40 to plus 250 deg F.
- 5. Color: Aluminum.
- 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. PVC Jacket Flashing Sealants:

- 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76.
 - b. Foster Products Corporation, H. B. Fuller Company; 95-44.
 - c. Marathon Industries, Inc.; 405.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Vimasco Corporation; 750.
- 2. Materials shall be compatible with insulation materials, jackets, and substrates.
- 3. Fire- and water-resistant, flexible, elastomeric sealant.
- 4. Service Temperature Range: Minus 40 to plus 250 deg F.
- 5. Color: White.
- 6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of .10 strands by 10 strands/sq. inch. for covering pipe and pipe fittings.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; Chil-Glas No. 5.
 - b. Vimasco Corporation; Elastafab 894.

B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch. for covering equipment.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Products, Division of ITW; Chil-Glas No. 5.
- b. Vimasco Corporation; Elastafab 894.

2.8 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Johns Manville; Zeston.
- b. P.I.C. Plastics, Inc.; FG Series.
- c. Proto PVC Corporation; LoSmoke.
- d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.

3. Color: White

4. Factory-fabricated fitting covers to match jacket.

- a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Childers Products, Division of ITW; Metal Jacketing Systems.
- b. PABCO Metals Corporation; Surefit.
- c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.

- a. Factory cut and rolled to size.
- b. Finish and thickness are indicated in field-applied jacket schedules.
- c. Moisture Barrier for Indoor Applications: .1-mil- thick, heat-bonded polyethylene and kraft paper .
- d. Moisture Barrier for Outdoor Applications: .3-mil- thick, heat-bonded polyethylene and kraft paper.
- e. Factory-Fabricated Fitting Covers:

- 1) Same material, finish, and thickness as jacket.
- 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
- 3) Tee covers.
- 4) Flange and union covers.
- 5) End caps.
- 6) Beveled collars.
- 7) Valve covers.
- 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Underground Direct-Buried Jacket: .125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Pittsburgh Corning Corporation; Pittwrap.
- b. Polyguard; Insulrap No Torch 125.

2.9 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
- b. Compac Corp.; 104 and 105.
- c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
- d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: .3 inches.

3. Thickness: .11.5 mils .

4. Adhesion: .90 ounces force/inch. in width.

5. Elongation: 2 percent.

6. Tensile Strength: .40 lbf/inch. in width.

7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

- a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
- b. Compac Corp.; 110 and 111.
- c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
- d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: .3 inches .

3. Thickness: .6.5 mils .

4. Adhesion: .90 ounces force/inch. in width.

5. Elongation: 2 percent.

6. Tensile Strength: .40 lbf/inch. in width.

7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS.
 2. Width: .2 inches .
 3. Thickness: .6 mils .
 4. Adhesion: .64 ounces force/inch. in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: .18 lbf/inch. in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
 - b. Compac Corp.; 120.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
 - d. Venture Tape; 3520 CW.
 2. Width: .2 inches.
 3. Thickness: .37 mils.
 4. Adhesion: .100 ounces force/inch. in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: .34 lbf/inch. in width.

2.10 SECUREMENTS

- A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products; Bands.
 - b. PABCO Metals Corporation; Bands.
 - c. RPR Products, Inc.; Bands.
 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 .0015 inch. thick, 3/4 inch. wide with wing or closed seal.
 3. Aluminum: ASTM B 209 , Alloy 3003, 3005, 3105, or 5005; Temper H-14, .0020 inch. thick, 3/4 inch. wide with wing or closed seal.
 4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, .0135-inch- diameter shank, length to suit depth of insulation indicated.
 2. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; CD.
 - 3) Midwest Fasteners, Inc.; CD.
 - 4) Nelson Stud Welding; TPA, TPC, and TPS.
 3. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, .0135-inch- diameter shank, length to suit depth of insulation indicated with integral .1-1/2-inch galvanized carbon-steel washer.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; CWP-1.
 - 2) GEMCO; Cupped Head Weld Pin.
 - 3) Midwest Fasteners, Inc.; Cupped Head.
 - 4) Nelson Stud Welding; CHP.
 4. Insulation-Retaining Washers: Self-locking washers formed from .0016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than .1-1/2 inches in diameter.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) AGM Industries, Inc.; RC-150.
 - 2) GEMCO; R-150.
 - 3) Midwest Fasteners, Inc.; WA-150.
 - 4) Nelson Stud Welding; Speed Clips.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.
- D. Wire: .0080-inch nickel-copper alloy, .0062-inch soft-annealed, stainless steel or .0062-inch soft-annealed, galvanized steel.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. C & F Wire.
 - b. Childers Products.
 - c. PABCO Metals Corporation.
 - d. RPR Products, Inc.

2.11 CORNER ANGLES

- A. PVC Corner Angles: .30 mils. thick, minimum .1 by 1 inch., PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: .0040 inch. thick, minimum .1 by 1 inch. , aluminum according to ASTM B 209 , Alloy 3003, 3005, 3105 or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: .0024 inch. thick, minimum .1 by 1 inch. , stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer .5 mils. thick and an epoxy finish .5 mils. thick if operating in a temperature range between 140 and 300 deg F.. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F. with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Provide an additional twenty five hundred feet of preformed insulation and twenty five square feet of blanket and board type insulation as well as accessories and labor for each size, thickness and type used on the project to accommodate any changes required to resolve interferences or as directed by the Engineer.
- I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Install insulation with least number of joints practical.
- K. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- Q. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.

- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
 - 1. Comply with requirements in Division 07 Section "Penetration Firestopping" and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Duct: Install insulation continuously through floor penetrations that are not fire rated. For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches .
 - 2. Pipe: Install insulation continuously through floor penetrations.
 - 3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
 - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
 - 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
 - 3. Protect exposed corners with secured corner angles.
 - 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
 - a. Do not weld anchor pins to ASME-labeled pressure vessels.
 - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
 - c. On tanks and vessels, maximum anchor-pin spacing is .3 inches from insulation end joints, and .16 inches o.c. in both directions.
 - d. Do not overcompress insulation during installation.
 - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
 - f. Impale insulation over anchor pins and attach speed washers.
 - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - 5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
 - 6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle

around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches .
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch- diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from aluminum, at least 0.060 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets,

- valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.7 CELLULAR-GLASS INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least .1 inch , and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.8 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least .1 inch , and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions .18 inches and smaller, place pins along longitudinal centerline of duct. Space .3 inches maximum from insulation end joints, and .16 inches o.c.
 - b. On duct sides with dimensions larger than .18 inches, place pins .16 inches o.c. each way, and .3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing .2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with .1/2-inch outward-clinching staples, .1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below .50 deg F. at .18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than .3 inches.
5. Overlap unfaced blankets a minimum of .2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of .18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with .6-inch- wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced .6 inches o.c.

F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions .18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and .16 inches o.c.
 - b. On duct sides with dimensions larger than .18 inches, space pins .16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with .1/2-inch outward-clinching staples, .1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at .18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.10 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two .0062-inch-thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.11 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.12 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.13 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect ductwork, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to ten location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
2. Inspect field-insulated equipment, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to ten location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
3. Inspect pipe, fittings, strainers, and valves, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to ten locations of straight pipe, ten locations of threaded fittings, ten locations of welded fittings, five locations of threaded strainers, five locations of welded strainers, ten locations of threaded valves, and ten locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.14 DUCT INSULATION SCHEDULE, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor, concealed supply and outdoor air.
2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in nonconditioned space.
4. Indoor, exposed return located in nonconditioned space.
5. Indoor, concealed, Type I, commercial, kitchen hood exhaust.
6. Indoor, exposed, Type I, commercial, kitchen hood exhaust.
7. Indoor, concealed oven and warewash exhaust.
8. Indoor, exposed oven and warewash exhaust.
9. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
10. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
11. Outdoor, concealed supply and return.
12. Outdoor, exposed supply and return.

B. Items Not Insulated:

1. Factory-insulated plenums and casings.
2. Flexible connectors.
3. Vibration-control devices.
4. Factory-insulated access panels and doors.

3.15 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and .15-lb/cu. ft. nominal density.

B. Concealed, round and flat-oval, return-air duct insulation shall be the following:

1. Mineral-Fiber Blanket: 2 inches thick and .15-lb/cu. ft. nominal density.
- C. Concealed, round and flat-oval, outdoor-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and .15-lb/cu. ft. nominal density.
- D. Concealed, round and flat-oval, exhaust-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and .15-lb/cu. ft. nominal density.
- E. Concealed, rectangular, supply-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and .15-lb/cu. ft. nominal density.
- F. Concealed, rectangular, return-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and .15-lb/cu. ft. nominal density.
- G. Concealed, rectangular, outdoor-air duct insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and .15-lb/cu. ft. nominal density.
- H. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and .15-lb/cu. ft. nominal density.
- I. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated blanket; thickness as required to achieve 2-hour fire rating.
- J. Concealed, supply-air plenum insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and .15-lb/cu. ft. nominal density.
- K. Concealed, return-air plenum insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and .15-lb/cu. ft. nominal density.
- L. Concealed, outdoor-air plenum insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and .15-lb/cu. ft. nominal density.
- M. Concealed, exhaust-air plenum insulation shall be the following:
1. Mineral-Fiber Blanket: 2 inches thick and .15-lb/cu. ft. nominal density.

- N. Exposed, round and flat-oval, supply-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- O. Exposed, round and flat-oval, return-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- P. Exposed, round and flat-oval, outdoor-air duct insulation shall be the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- Q. Exposed, round and flat-oval, exhaust-air duct insulation shall be the following:
- R.
 - 1. Mineral-Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
- S. Exposed, rectangular, supply-air duct insulation shall be the following:
 - 1. Mineral-Fiber Board: 2 inches thick 3-lb/cu. ft. nominal density.
- T. Exposed, rectangular, return-air duct insulation shall be the following:
 - 1. Mineral-Fiber Board: 2 inches thick 3-lb/cu. ft. nominal density.
- U. Exposed, rectangular, outdoor-air duct insulation shall be the following:
 - 1. Mineral-Fiber Board: 2 inches thick 3-lb/cu. ft. nominal density.
- V. Exposed, rectangular, exhaust-air duct insulation shall be the following:
 - 1. Mineral-Fiber Board: 2 inches thick 3-lb/cu. ft. nominal density.
- W. Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire-rated board, thickness as required to achieve 2-hour fire rating.
- X. Exposed, supply-air plenum insulation shall be the following:
 - 1. Mineral-Fiber Board: 2 inches thick 3-lb/cu. ft. nominal density.
- Y. Exposed, return-air plenum insulation shall be the following:
 - 1. Mineral-Fiber Board: 2 inches thick 3-lb/cu. ft. nominal density.
- Z. Exposed, outdoor-air plenum insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick 3-lb/cu. ft. nominal density.

AA. Exposed, exhaust-air plenum insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick 3-lb/cu. ft. nominal density.

3.16 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Exposed, round and flat-oval, supply-air duct insulation shall be the following:

1. **Extruded Close Cell Polystyrene Foam Board (Foamular 150): 2 inches thick.**

B. Exposed, round and flat-oval, return-air duct insulation shall be the following:

1. **Extruded Close Cell Polystyrene Foam Board (Foamular 150): 2 inches thick.**

C. Exposed, rectangular, supply-air duct insulation shall be the following:

1. **Extruded Close Cell Polystyrene Foam Board (Foamular 150): 2 inches thick.**

D. Exposed, rectangular, return-air duct insulation shall be the following:

1. **Extruded Close Cell Polystyrene Foam Board (Foamular 150): 2 inches thick.**

E. Exposed, supply-air plenum insulation shall be the following:

1. **Extruded Close Cell Polystyrene Foam Board (Foamular 150): 2 inches thick.**

F. Exposed, return-air plenum insulation shall be the following:

1. **Extruded Close Cell Polystyrene Foam Board (Foamular 150): 2 inches thick.**

3.17 EQUIPMENT INSULATION SCHEDULE

A. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

B. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, condenser bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles with the following:

1. Flexible Elastomeric: .1 inch thick.

C. Chilled-water pump insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick 3-lb/cu. ft. nominal density.

D. Condenser-water pump insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick 3-lb/cu. ft. nominal density.

E. Dual-service heating and cooling pump insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick 3-lb/cu. ft. nominal density.

F. Heating-hot-water pump insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick 3-lb/cu. ft. nominal density.

G. Heat-recovery pump insulation shall be the following:

1. Mineral-Fiber Board: 2 inches thick 3-lb/cu. ft. nominal density.

H. Chilled-water expansion/compression tank insulation shall be the following:

1. Mineral-Fiber Pipe and Tank: 2 inches thick.

I. Condenser-water expansion/compression tank insulation shall be the following:

1. Mineral-Fiber Pipe and Tank: 2 inches thick.

J. Dual-service heating and cooling expansion/compression tank insulation shall be the following:

1. Mineral-Fiber Pipe and Tank: 2 inches thick.

K. Heating-hot-water expansion/compression tank insulation shall be the following:

1. Mineral-Fiber Pipe and Tank: 2 inches thick.

L. Heat-recovery expansion/compression tank insulation shall be the following:

1. Mineral-Fiber Pipe and Tank: 2 inches thick.

M. Chilled-water air-separator insulation shall be the following:

1. Mineral-Fiber Pipe and Tank: 2 inches thick.

N. Condenser-water air-separator insulation shall be the following:

1. Mineral-Fiber Pipe and Tank: 2 inches thick.

O. Dual-service heating and cooling air-separator insulation shall be the following:

1. Mineral-Fiber Pipe and Tank: .2 inches thick.

P. Heating-hot-water air-separator insulation shall be the following:

1. Mineral-Fiber Pipe and Tank: .2 inches thick.

Q. Heat-recovery air-separator insulation shall be the following:

1. Mineral-Fiber Pipe and Tank: .2 inches thick.

R. Piping system filter-housing insulation shall be the following:

1. Mineral-Fiber Pipe and Tank: .2 inches thick.

S. Outdoor, aboveground, heated, fuel-oil storage tank insulation shall be the following:

1. Mineral-Fiber Pipe and Tank: .2 inches thick.

3.18 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.19 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F. :

1. All Pipe Sizes: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: .1 inch. thick.

B. Chilled Water and Brine:

1. NPS 3. and Smaller: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

2. NPS 4. to NPS 12. : Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I: 2-1/2 inches.

3. NPS 14. and Larger: Insulation shall be the following:

- a. Mineral-Fiber, Preformed Pipe, Type I: 3 inches.
- C. Condenser-Water Supply and Return:
 - 1. NPS 3 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.
 - 2. NPS 4 to NPS 12 : Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 2-1/2 inches
 - 3. NPS 14 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 3 inches
- D. Heating-Hot-Water Supply and Return:
 - 1. NPS 3 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.
 - 2. NPS 4 to NPS 12 : Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 2-1/2 inches
 - 3. NPS 14 and Larger: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 3 inches
- E. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1-1/2 inches thick.
- F. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 1-1/2 inches thick.

3.20 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Chilled Water and Brine:
 - 1. NPS 3 and Smaller: Insulation shall be the following:

- a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.
 - 2. NPS 4 to NPS 12 : Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 2-1/2 inches
 - 3. NPS 14 and Larger: Insulation shall be the following:
- B. Condenser-Water Supply and Return:
 - 1. NPS 3 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.
 - 2. NPS 4 to NPS 12 : Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 2-1/2 inches
 - 3. NPS 14 and Larger: Insulation shall be the following:
- C. Heating-Hot-Water Supply and Return:
 - 1. NPS 3 and Smaller: Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.
 - 2. NPS 4 to NPS 12 : Insulation shall be the following:
 - a. Mineral-Fiber, Preformed Pipe, Type I: 2-1/2 inches
 - 3. NPS 14 and Larger: Insulation shall be the following:
- D. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches thick.
- E. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: 2 inches thick.
- F. Fuel Oil Piping, Heated:
 - 1. All Pipe Sizes: Insulation shall be the following:

- a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

3.21 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

- A. Chilled Water, All Sizes: Cellular glass, 3 inches thick.
- B. Condenser-Water Supply and Return, All Sizes: Cellular glass, 3 inches thick.
- C. Heating-Hot-Water Supply and Return, All Sizes,: Cellular glass, 3 inches thick.
- D. Fuel Oil Piping, All Sizes, Heated: Cellular glass, 3 inches thick.

3.22 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
 - 1. Paper and Foil with Vapor Retarder
- D. Ducts and Plenums, Exposed:
 - 1. Painted Aluminum, Smooth: .032 inches thick.
- E. Equipment, Concealed:
 - 1. Paper and Foil with Vapor Retarder
- F. Equipment, Exposed, up to .48 Inches in Diameter or with Flat Surfaces up to .72 Inches :
 - 1. PVC .30 mils thick.
- G. Equipment, Exposed, Larger Than .48 Inches in Diameter or with Flat Surfaces Larger Than .72 Inches :
 - 1. Painted Aluminum, Smooth .032 inch thick.
- H. Piping, Concealed:
 - 1. Paper and Foil with Vapor Retarder

I. Piping, Exposed:

1. PVC .30 mils. thick.

3.23 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1. Aluminum, Smooth .0.040 inch. thick.

D. Ducts and Plenums, Exposed, up to .48 Inches. in Diameter or with Flat Surfaces up to .72 Inches.:

1. **Five (5) Ply Aluminum Self Adhesive Vapor Barrier (VentureClad 1577CW), Vapor Retarder, Aluminum finish with Stucco Embossed Texture. Provide Foil Insulation Tape (VentureTape 1520CW), Heavy Duty FSK Facing Tape (VentureTape 1549CW), and foil vapor seal tape (VentureTape 1540CW).**

E. Ducts and Plenums, Exposed, Larger Than .48 Inches. in Diameter or with Flat Surfaces Larger Than .72 Inches. :

1. **Five (5) Ply Aluminum Self Adhesive Vapor Barrier (VentureClad 1577CW), Vapor Retarder, Aluminum finish with Stucco Embossed Texture. Provide Foil Insulation Tape (VentureTape 1520CW), Heavy Duty FSK Facing Tape (VentureTape 1549CW), and foil vapor seal tape (VentureTape 1540CW).**

F. Equipment, Concealed:

1. Aluminum, Smooth .0.040 inch. thick.

G. Equipment, Exposed, up to .48 Inches. in Diameter or with Flat Surfaces up to .72 Inches. :

1. Aluminum, Smooth .0.040 inch. thick.

H. Equipment, Exposed, Larger Than .48 Inches. in Diameter or with Flat Surfaces Larger Than .72 Inches. :

1. Aluminum, Smooth .0.040 inch. thick.

I. Piping, Concealed:

1. Aluminum, Smooth .040 inch thick.

J. Piping, Exposed:

1. Aluminum, Smooth .040 inch thick.

3.24 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

- A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material. .125-mil- thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

END OF SECTION 230700

SECTION 23 09 93

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.1 DEDICATED OUTSIDE AIR SYSTEM (AHU-1)

- A. Unit consists of standalone controls via touchscreen control panel with the ability to connect to a future BAS. In the absence of a BAS system, all control inputs shall be via touchscreen control panel.
- B. Text shown in *italics* are point names in the programming. Typically, points ending with "Local" are hardwired inputs, points ending with "Active" are determined by the program and can't be adjusted by the operator or BAS.
- C. Discharge Air Temperature Setpoint Maximum is adjustable but cannot exceed 120°F for gas, heat pump, or hot water heating, and 90°F for electric heating.
- D. Program Control Type can be determined using Multi-State Value 13.
 - 1. Note that there is a 3-minute delay during compressor or gas heater staging to allow the system to stabilize before adjusting the cooling or heating capacity.

1.2 PROGRAM-CONTROLLED SETPOINTS

- A. Space Control
 - 1. *Discharge Air Temperature Setpoint Active* is reset by comparing the *Space Temperature Active* to *Occupied Cooling Setpoint* during cooling and *Occupied Heating Setpoint* during heating. If a single setpoint is preferred, use *Space Temperature Setpoint BAS* by putting it In Service using Tracer TU or BAS.
 - 2. *Dehumidification Temperature Setpoint Active* is reset by comparing the *Space Dewpoint* to the *Space Dewpoint Calculated Enable Setpoint* minus 2°F.
 - 3. If *Space Temperature Setpoint BAS* or *Space Temperature Setpoint Local* (Thumbwheel) is In Service, *Occupied Offset* is adjustable (2°F default). Otherwise, is determined using *Occupied Cooling Setpoint* and *Occupied Heating Setpoint*.
 - 4. If *Occupied Cooling Setpoint* is below *Occupied Heating Setpoint*, *Occupied Offset* is 1°F. If *Occupied Cooling Setpoint* is above *Occupied Heating Setpoint*, *Occupied Offset* is the difference between the two setpoints.
 - 5. *Space Dewpoint Calculated Enable Setpoint* is calculated using *Space Humidity Setpoint* and *Space Temperature Setpoint Active*.

1.3 OCCUPIED CONTROL

- A. Starting Sequence
 - 1. Occupied operation begins when the unit is placed in Occupied via BAS or when OAUTS-7 & 8 is closed on the field wiring terminal strip. The unit must not be in *Emergency Stop* to begin starting sequence. OAUTS-9 & 10 on the field wiring terminal strip are used as an external *Emergency Stop* for the unit. Cycling power to unit to may not resolve alarm condition.

2. Refer to Multi-State Value *Occupancy Status* to determine the active status of the unit.
- B. Two-Position Outdoor & Return Air Dampers will begin by energizing relay OADR, opening the outdoor air damper and closing the return air damper. The supply fan sequence starts immediately after the unit becomes occupied.

1.4 SUPPLY FAN SEQUENCE

- A. Supply Fan Starting Sequence begins by energizing relay G and setting the *Supply Fan Speed Command* to 50%. The supply fan status switch (IFFS) closes, energizing relay IFFR. If after two minutes there is no proven signal, *Diagnostic: Supply Fan Failure* will be displayed, and the unit will shut down requiring a manual reset.
- B. Constant Volume with ECM
1. After completing the starting sequence, the unit calculates the *Supply Fan Air Flow Active* and adjusts *Supply Fan Speed Command* to maintain the *Supply Fan Air Flow Setpoint* (adjustable, factory set according to submittal).

1.5 VENTILATION MODE

- A. Space Control
1. *Ventilation Mode* is enabled when the *Outdoor Air Temperature Active* and the *Space Temperature Active* is within two degrees of the *Space Temperature Setpoint Active*. During *Ventilation Mode*, heating and cooling is locked out and the unit supplies unconditioned air. *Ventilation Mode* is locked out whenever the unit is in *Dehumidification Mode*.

1.6 PRIMARY HEATING MODE

- A. Space Control with No Energy Recovery Wheel and 100% Outdoor Air
1. Heating Mode is enabled whenever the *Outdoor Air Temperature Active* falls below the *Outdoor Air Heating Enable Setpoint*. When this occurs, cooling and dehumidification is not allowed, regardless of space conditions.
 2. When the *Outdoor Air Temperature Active* is above the *Outdoor Air Heating Enable*, but below the *Outdoor Air Cooling Enable Setpoint*, Heating Mode is enabled according to the graph shown in Figure 1. Using the graph, setpoint is *Space Temperature Setpoint Active*, offset is *Occupied Offset*, and temperature is *Space Temperature Active*.
 3. During Heating Mode, *Heat Capacity* is adjusted to maintain the *Discharge Air Temperature Local* to *Discharge Air Temperature Setpoint Active*.

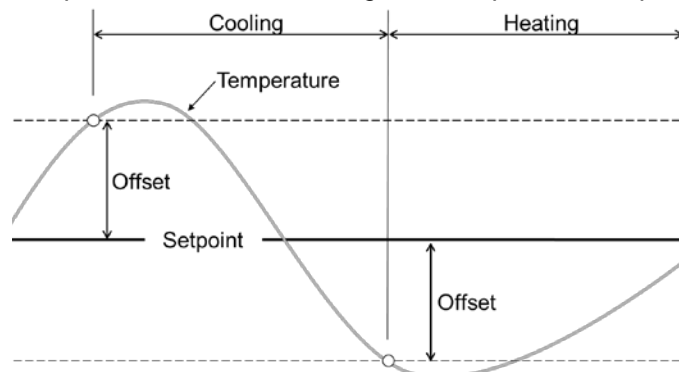


Figure 1. Heat Cool Mode Arbitration Graph.

1.7 GAS HEAT IGNITION FAILURE

- A. The unit monitors the status of the heater using *Heat On Off Status Local*. In the event of ignition failure, the unit will make three ignition attempts before displaying *Diagnostic: Heat Failure*. The unit is shut down when a heat failure occurs and resets four hours later to re-attempt ignition.

1.8 COOLING MODE

- A. Space Control with No Energy Recovery Wheel and 100% Outdoor Air
 - 1. Cooling Mode is enabled whenever the *Outdoor Air Temperature Active* rises above the *Outdoor Air Cooling Enable Setpoint*. When this occurs, heating is not allowed, regardless of space conditions.
 - 2. When the *Outdoor Air Temperature Active* is above the *Outdoor Air Heating Enable*, but below the *Outdoor Air Cooling Enable Setpoint*, Cooling Mode is enabled according to the graph shown in Figure 1. Using the graph, setpoint is *Space Temperature Setpoint Active*, offset is *Occupied Offset*, and temperature is *Space Temperature Active*.
- B. Compressor Low Ambient Lockout
 - 1. On units without head pressure control, the compressors will be locked out if the *Outdoor Air Temperature Active* falls below the *Compressor Low Ambient Lockout Setpoint* and there is a demand for cooling. When this occurs, the unit will display *Compressor Low Ambient Lockout Active* as an informational diagnostic.
- C. Evaporator Frost Protection
 - 1. Circuit 1 refrigeration pressure is monitored, and *Cooling Capacity* will be limited to prevent the indoor coil from freezing. If the unit has digital scroll on the second circuit, then both circuits will be monitored.

1.9 DEHUMIDIFICATION MODE

- A. *Outdoor Air Dewpoint* is calculated using *Outdoor Air Temperature Active* and *Outdoor Air Humidity Active*.
- B. For *Dehumidification Temperature Active*, OAN Rev. 6 (OANG) cabinet uses *Discharge Air Dewpoint* (calculated using *Discharge Air Temperature Local* and *Discharge Air Humidity Local*), all other cabinets use *Indoor Coil Leaving Air Temperature Local*.
- C. Space Control with No Energy Recovery Wheel and 100% Outdoor Air
 - 1. *Dehumidification Mode* is enabled whenever the *Space Dewpoint* rises above the *Space Dewpoint Calculated Enable Setpoint*, or when the *Outdoor Air Dewpoint* rises above the *Outdoor Air Dewpoint Enable Setpoint*.
 - 2. During *Dehumidification Mode*, the *Dehumidification Temperature Setpoint Active* is reset by comparing *Space Dewpoint* to *Space Dewpoint Calculated Enable Setpoint* minus 2°F. *Hot Gas Reheat Valve Command* (if installed) is adjusted to maintain *Discharge Air Temperature Setpoint Active*.

- D. Hot Gas Reheat Purge
 - 1. *Hot Gas Reheat Purge Mode* is initiated if the *Hot Gas Reheat Valve Command* is between 10% and 50% for thirty continuous minutes. During *Hot Gas Reheat Purge Mode* the signal first goes to 80% for one minute, then to 10% for one minute. The *Hot Gas Reheat Valve Command* returns to its previous position and will begin to modulate after a 30-second delay.

1.10 EXHAUST FAN OPERATION

- A. With Isolation Exhaust Fan Damper(s)
 - 1. After completing the Supply Fan Starting Sequence, *Exhaust Damper Open Close Command* is enabled. Once the *Exhaust Damper End Switch* has proven, *Exhaust Fan Start Stop Command* is enabled.
- B. ECM Exhaust with 2-Position OA Damper
 - 1. Using the Exhaust Air Flow Active from the exhaust fan piezo reading, the unit controls exhaust fan speed to a constant volume of according to the *Exhaust Air Flow Setpoint*.

1.11 ADDITIONAL FEATURES

- A. Space Thumbwheel Input
- B. Space Control
 - 1. With a space thumbwheel installed, the *Occupied Heating Setpoint* and *Occupied Cooling Setpoint* is replaced with a single setpoint from the input *Space Temperature Setpoint Local*. The occupancy override button will override *Occupancy Request* to Occupied for two hours from the time it was pressed.
- C. Outdoor Airflow Monitoring
 - 1. Units with *Outdoor Air Flow Local In Service* and Modulating Dampers installed will modulate the *Outdoor Air Damper Position Command* the *Outdoor Air Minimum Flow Setpoint*. Damper position is restricted between the *Outdoor Air Damper Minimum Position Setpoint* and *Outdoor Air Damper Maximum Position Setpoint*.

1.12 OPTIONAL FIELD ENABLED FEATURES

- A. Static Pressure Control for Exhaust Fan
 - 1. To enable exhaust fan control for a static pressure setpoint, set *Return Duct/Space Pressure Local* to In Service. The default input for this reading is XM70.2.UI12, but the point can be configured to any open input on the controller. The unit will modulate the *Exhaust Fan Speed Output Command* to the *Return Duct/Space Pressure Local*.
 - 2. If a setpoint less than 0.25" WC is desired. It's recommended to use a transducer that has a range of -0.5" WC to 0.5" WC.

1.13 UNOCCUPIED OPERATION

- A. To enable heating, cooling, and dehumidification during unoccupied operation, the BV *Allow Unoccupied Operation* must be set as Allowed. Space conditions must be communicated via BAS or a hardwire space/temperature humidity sensor.
- B. Starting Sequence
 - 1. Unoccupied starting sequence begins when the Unoccupied Heating, Cooling, or Dehumidification Mode is enabled. Otherwise, the unit shall remain dormant with the supply fan disabled. Supply Fan Startup sequence is identical to occupied operation.

- C. With Return Air Damper Installed
 - 1. The outdoor air damper will be commanded to close, and the return air damper will open. If the unit is under Economizer conditions as described under the occupied section the *Outdoor Air Damper Position Command* will open to the *Outdoor Air Damper Maximum Position Setpoint*.
- D. Unoccupied Heating Mode
 - 1. *Unoccupied Heating Mode* is enabled when the *Space Temperature Active* falls below the *Unoccupied Heating Enable Setpoint*. During *Unoccupied Heating Mode* the unit will run the heat to maintain 90°F for the discharge air temperature. *Unoccupied Heating Mode* is disabled when the *Space Temperature Active* rises 2°F above the *Unoccupied Heating Setpoint*.
- E. Unoccupied Dehumid Mode
 - 1. When there is no call for *Unoccupied Heating Mode*, *Unoccupied Dehumid Mode* is enabled when the *Space Dewpoint* rises above the *Unoccupied Dewpoint Enable Setpoint*. During *Unoccupied Dehumid Mode* the unit will run the cooling to maintain 45°F for the evaporator leaving temperature and reheat to 50°F for the discharge air temperature. *Unoccupied Dehumid Mode* is disabled when the *Space Dewpoint* rises 2°F above the *Unoccupied Dewpoint Enable Setpoint*.
- F. Unoccupied Cooling Mode
 - 1. When there is no call for *Unoccupied Heating Mode* or *Unoccupied Dehumid Mode*, *Unoccupied Cooling Mode* is enabled when the *Space Temperature Active* rises above the *Unoccupied Cooling Enable Setpoint*. During *Unoccupied Cooling Mode* the unit will run the cooling to maintain 50°F for the discharge air temperature. *Unoccupied Cooling Mode* is disabled when the *Space Temperature Active* rises 2°F above the *Unoccupied Cooling Enable Setpoint*.

1.14 DIAGNOSTICS

- A. The following list contains the diagnostics indicated by Binary Values or Binary Inputs. These are typically determined in the background of the program, and the status is written to these points.
- B. Analog Inputs, Analog Values, or other points may also show alarms, which typically indicates that they are outside of the normal range or that communication to the device has been lost.
- C. Emergency Stop will display a fault if the Emergency Stop circuit is opened. Line 76 on the wiring diagram shows the circuit to energize the Emergency Stop Relays.
- D. The unit is shut down when this diagnostic occurs, including the supply fan.
- E. Compressor Low Ambient Lockout Active will display a fault if there is a demand for cooling according to the setpoints, but the *Outdoor Air Temperature Active* is below the *Compressor Low Ambient Lockout Setpoint* and the unit does not have active head pressure control.
 - 1. This diagnostic locks out compressor operation.
- F. Diagnostic: Compressor Fail Unit Lockout is displayed when there is a run failure diagnostic for one of the compressors and the unit is supplying unsatisfactory conditions for ten minutes. Unsatisfactory conditions are identified by the *Discharge Air Temperature Local* is 2°F above or below the *Discharge Air Temperature Setpoint Active* during Heat Pump Heating or Cooling Mode, or when the *Dehumidification Temperature Active* is 2°F below the *Dehumidification Temperature Setpoint Active* during Dehumidification Mode.
 - 1. The unit is shut down when this diagnostic occurs, including the supply fan. The diagnostic can be cleared with an alarm reset and will auto-reset once the compressor run failure diagnostic is cleared.

- G. Diagnostic: Heat Failure is displayed after three failed attempts to ignite the primary indirect fired gas heater within a four-hour period. The unit is shut down when this diagnostic occurs, including the supply fan
- H. Diagnostic: [High, Low] Discharge Air Temp Lockout is displayed when the *Discharge Air Temperature Local* is [above 128°F, below 35°F] for a duration of 10 minutes. The diagnostic is manual reset using *Alarm Reset*.
- I. Diagnostic: Liquid Line Refrigerant Pressure Circuit [1,2] Source Failure is displayed when the respective circuit is on (indicated by the compressor run status) and the *Liquid Line Refrigerant Pressure Circuit [1,2]* falls outside of the range of 150-650 PSI for a duration of two minutes. When this occurs, the condenser fans will run at 100%
- J. Diagnostic: Low Refrigerant Suction Pressure Circuit [1,2] is displayed when the respective circuit is on (indicated by the compressor run status) and the *Suction Line Refrigerant Pressure Circuit [1,2] Local* falls below 85 PSI (55 PSI for heat pump heating) for two continuous minutes. The diagnostic auto clears when the pressure returns to normal.
- K. Diagnostic: Outdoor Air Damper End Switch is displayed when *Outdoor Air Damper Open Close Command* is On, but the *Outdoor Air Damper End Switch* does not prove for 3-minutes. The diagnostic is reset using *Alarm Reset* or when the end switch is proven.
- L. Diagnostic: Return Duct/Space Pressure Setpoint Range is displayed when the *Return Duct/Space Pressure Setpoint* is set within 20% of the maximum limit of the *Return Duct/Space Pressure Local*. If the setpoint is set too close to the maximum range of the sensor, it will not be able to recognize when it's outside of the operating range.
- M. Sensor Source Failures
 - 1. The following diagnostics are displayed when the respective sensor reading is outside of the expected range, indicating that the sensor may be faulty. Refer to the points list for expected ranges of each input.
 - 2. In some cases, a BAS point is In Service, and will take priority over a hardwired input. If the point was inadvertently put In Service, and the BAS is either not writing a value or the value is outside of the expected range, then the program will first attempt to fall back to a hardwired input before displaying a source failure diagnostic.
 - a. Diagnostic: Dehumidification Temperature Sensor Source Failure*
 - b. Diagnostic: Discharge Air Humidity Source Failure
 - c. Diagnostic: Discharge Air Temperature Source Failure
 - d. Diagnostic: Duct Static Pressure Source Failure
 - e. Diagnostic: Outdoor Air Flow Sensor Source Failure
 - f. Diagnostic: Outdoor Air Humidity Source Failure
 - g. Diagnostic: Outdoor Air Temperature Source Failure
 - h. Diagnostic: Return Duct/Space Pressure Source Failure
 - i. Diagnostic: Space CO2 Source Failure
 - j. Diagnostic: Space Humidity Source Failure
 - k. Diagnostic: Space Temperature Source Failure
 - (i) *The Dehumidification Temperature Sensor is the *Indoor Coil Leaving Air Temperature Local* on all cabinets except for the OANG (OAN Rev. 6). For the OANG cabinet, the sensor is the *Discharge Air Humidity Local*.

END OF SECTION

SECTION 23 11 23

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.
 - 5. Pressure regulators.
 - 6. Service meters.
 - 7. Concrete bases.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: .100 psig minimum unless otherwise indicated.
 - 2. Service Regulators: .100 psig minimum unless otherwise indicated.
 - 3. Minimum Operating Pressure of Service Meter: .65 psig .
- B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than .0.5 psig but not more than .2 psig, and is reduced to secondary pressure of .0.5 psig or less.

- C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.5 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Corrugated, stainless-steel tubing with associated components.
 - 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 4. Pressure regulators. Indicate pressure ratings and capacities.
 - 5. Service meters. Indicate pressure ratings and capacities. Include bypass fittings and meter bars
 - 6. Dielectric fittings.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
 - 1. Shop Drawing Scale: 1/4 inch per foot .
 - 2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.
- C. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of seismic restraints.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.
- D. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.
- E. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- F. Qualification Data: For qualified professional engineer.
- G. Welding certificates.
- H. Field quality-control reports.
- I. Operation and Maintenance Data: For motorized gas valves, pressure regulators and service meters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.8 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
 - 1. Notify Architect, Construction Manager, Owner and Engineer no fewer than ten days in advance of proposed interruption of natural-gas service.
 - 2. Do not proceed with interruption of natural-gas service without Construction Manager's and Owner's written permission.

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.

2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 4. 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:
 - a. Material Group: 1.1.
 - b. End Connections: Threaded or butt welding to match pipe.
 - c. Lapped Face: Not permitted underground.
 - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
 - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
 5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
 6. Mechanical Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dresser Piping Specialties; Division of Dresser, Inc.
 - 2) Smith-Blair, Inc.
 - b. Stainless-steel flanges and tube with epoxy finish.
 - c. Buna-nitrile seals.
 - d. Stainless-steel bolts, washers, and nuts.
 - e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.
 - f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. OmegaFlex, Inc.
 - b. Parker Hannifin Corporation; Parflex Division.
 - c. Titeflex.
 - d. Tru-Flex Metal Hose Corp.
 2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
 3. Coating: PE with flame retardant.
 - a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1) Flame-Spread Index: 25 or less.
 - 2) Smoke-Developed Index: 50 or less.

4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
5. Striker Plates: Steel, designed to protect tubing from penetrations.
6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
7. Operating-Pressure Rating: .5 psig.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: .05 psig .
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: .72 inches .

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for .NPS 2. and smaller; 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 .

D. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile 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 .

E. T-Pattern Strainers:

1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
2. End Connections: Grooved ends.

3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
 4. CWP Rating: 750 psig .
- F. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F, complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
 1. CWP Rating: 125 psig .
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
 1. CWP Rating: 125 psig.
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.

- d. McDonald, A. Y. Mfg. Co.
- e. Perfection Corporation; a subsidiary of American Meter Company.
- f. .

- 2. Body: Bronze, complying with ASTM B 584.
- 3. Ball: Chrome-plated bronze.
- 4. Stem: Bronze; blowout proof.
- 5. Seats: Reinforced TFE; blowout proof.
- 6. Packing: Threaded-body packnut design with adjustable-stem packing.
- 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
- 8. CWP Rating: 600 psig (4140 kPa).
- 9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
- 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. BrassCraft Manufacturing Company; a Masco company.
 - b. Conbraco Industries, Inc.; Apollo Div.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Perfection Corporation; a subsidiary of American Meter Company.
- 2. Body: Bronze, complying with ASTM B 584.
- 3. Ball: Chrome-plated bronze.
- 4. Stem: Bronze; blowout proof.
- 5. Seats: Reinforced TFE.
- 6. Packing: Threaded-body packnut design with adjustable-stem packing.
- 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
- 8. CWP Rating: 600 psig .
- 9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
- 10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

F. Bronze Plug Valves: MSS SP-78.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lee Brass Company.
 - b. McDonald, A. Y. Mfg. Co.
- 2. Body: Bronze, complying with ASTM B 584.
- 3. Plug: Bronze.
- 4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
- 5. Operator: Square head or lug type with tamperproof feature where indicated.
- 6. Pressure Class: 125 psig.
- 7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.

8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

G. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McDonald, A. Y. Mfg. Co.
 - b. Mueller Co.; Gas Products Div.
 - c. Xomox Corporation; a Crane company.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig .
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

H. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flowserve.
 - b. Homestead Valve; a division of Olson Technologies, Inc.
 - c. McDonald, A. Y. Mfg. Co.
 - d. Milliken Valve Company.
 - e. Mueller Co.; Gas Products Div.
 - f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig .
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

I. PE Ball Valves: Comply with ASME B16.40.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Kerotest Manufacturing Corp.
 - b. Lyall, R. W. & Company, Inc.
 - c. Perfection Corporation; a subsidiary of American Meter Company.

2. Body: PE.
3. Ball: PE.
4. Stem: Acetal.
5. Seats and Seals: Nitrile.
6. Ends: Plain or fusible to match piping.
7. CWP Rating: .80 psig.
8. Operating Temperature: Minus 20 to plus 140 deg F.
9. Operator: Nut or flat head for key operation.
10. Include plastic valve extension.
11. Include tamperproof locking feature for valves where indicated on Drawings.

J. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of .5 inches (125 mm) in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

2.5 MOTORIZED GAS VALVES

A. Automatic Gas Valves: Comply with ANSI Z21.21.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ASCO Power Technologies, LP; Division of Emerson.
 - b. Dungs, Karl, Inc.
 - c. Eaton Corporation; Controls Div.
 - d. Eclipse Combustion, Inc.
 - e. Honeywell International Inc.
 - f. Johnson Controls.
2. Body: Brass or aluminum.
3. Seats and Disc: Nitrile rubber.
4. Springs and Valve Trim: Stainless steel.
5. Normally closed.
6. Visual position indicator.
7. Electrical operator for actuation by appliance automatic shutoff device.

B. Electrically Operated Valves: Comply with UL 429.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ASCO Power Technologies, LP; Division of Emerson.
 - b. Dungs, Karl, Inc.
 - c. Eclipse Combustion, Inc.
 - d. Goyen Valve Corp.; Tyco Environmental Systems.
 - e. Magnatrol Valve Corporation.

- f. Parker Hannifin Corporation; Climate & Industrial Controls Group; Skinner Valve Div.
- g. Watts Regulator Co.; Division of Watts Water Technologies, Inc.

- 2. Pilot operated.
- 3. Body: Brass or aluminum.
- 4. Seats and Disc: Nitrile rubber.
- 5. Springs and Valve Trim: Stainless steel.
- 6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
- 7. NEMA ICS 6, Type 4, coil enclosure.
- 8. Normally closed.
- 9. Visual position indicator.

2.6 EARTHQUAKE VALVES

A. Earthquake Valves: Comply with ASCE 25.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Vanguard Valves, Inc.
- 2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
- 3. Maximum Operating Pressure: .5 psig .
- 4. Cast-aluminum body with nickel-plated chrome steel internal parts.
- 5. Nitrile-rubber valve washer.
- 6. Sight windows for visual indication of valve position.
- 7. Threaded end connections complying with ASME B1.20.1.
- 8. Wall mounting bracket with bubble level indicator.

B. Earthquake Valves: Comply with ASCE 25.

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Pacific Seismic Products, Inc.
- 2. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction.
- 3. Maximum Operating Pressure: .7 psig
- 4. Cast-aluminum body with stainless-steel internal parts.
- 5. Nitrile-rubber, reset-stem o-ring seal.
- 6. Valve position, open or closed, indicator.
- 7. Composition valve seat with clapper held by spring or magnet locking mechanism.
- 8. Level indicator.
- 9. End Connections: Threaded for valves .NPS 2. and smaller; flanged for valves .NPS 2-1/2. and larger.

2.7 PRESSURE REGULATORS

A. General Requirements:

- 1. Single stage and suitable for natural gas.

2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.

B. Service Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Actaris.
 - b. American Meter Company.
 - c. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - d. Invensys.
 - e. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 100 psig (690 kPa).

C. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Actaris.
 - b. American Meter Company.
 - c. Eclipse Combustion, Inc.
 - d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - e. Invensys.
 - f. Maxitrol Company.
 - g. Richards Industries; Jordan Valve Div.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.

10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: .5 psig (34.5 kPa).

D. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Canadian Meter Company Inc.
 - b. Eaton Corporation; Controls Div.
 - c. Harper Wyman Co.
 - d. Maxitrol Company.
 - e. SCP, Inc.
2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: .2 psig.

2.8 SERVICE METERS

A. Diaphragm-Type Service Meters: Comply with ANSI B109.1 and ANSI B109.2.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Actaris.
 - b. American Meter Company.
 - c. Invensys.
2. Case: Die-cast aluminum.
3. Connections: Steel threads.
4. Diaphragm: Synthetic fabric.
5. Diaphragm Support Bearings: Self-lubricating.
6. Compensation: Continuous temperature and pressure.
7. Meter Index: Cubic feet and liters.
8. Meter Case and Index: Tamper resistant.
9. Remote meter reader compatible.
10. Maximum Inlet Pressure: .100 psig.
11. Pressure Loss: Maximum .05-inch wg.
12. Accuracy: Maximum plus or minus 1.0 percent.

B. Rotary-Type Service Meters: Comply with ANSI B109.3.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Meter Company.
 - b. Invensys.
2. Case: Extruded aluminum.
3. Connection: Flange.
4. Impellers: Polished aluminum.
5. Rotor Bearings: Self-lubricating.
6. Compensation: Continuous temperature and pressure.
7. Meter Index: Cubic feet and liters.
8. Tamper resistant.
9. Remote meter reader compatible.
10. Maximum Inlet Pressure: 100 psig .
11. Accuracy: Maximum plus or minus 2.0 percent.

C. Turbine Meters: Comply with ASME MFC-4M.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Meter Company.
 - b. Invensys.
2. Housing: Cast iron or welded steel.
3. Connection Threads or Flanges: Steel.
4. Turbine: Aluminum or plastic.
5. Turbine Bearings: Self-lubricating.
6. Compensation: Continuous temperature and pressure.
7. Meter Index: Cubic feet and liters.
8. Tamper resistant.
9. Remote meter reader compatible.
10. Maximum Inlet Pressure: 100 psig .
11. Accuracy: Maximum plus or minus 2.0 percent.

D. Service-Meter Bars:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Actaris.
 - b. American Meter Company.
 - c. Lyall, R. W. & Company, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Mueller Co.; Gas Products Div.
 - f. Perfection Corporation; a subsidiary of American Meter Company.
2. Malleable- or cast-iron frame for supporting service meter.
3. Include offset swivel pipes, meter nuts with o-ring seal, and factory- or field-installed dielectric unions.
4. Omit meter offset swivel pipes if service-meter bar dimensions match service-meter connections.

E. Service-Meter Bypass Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Lyall, R. W. & Company, Inc.
 - b. Williamson, T. D., Inc.
2. Ferrous, tee, pipe fitting with capped side inlet for temporary natural-gas supply.
3. Integral ball-check bypass valve.

2.9 DIELECTRIC FITTINGS

A. 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. McDonald, A. Y. Mfg. Co.
 - e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - f. Wilkins; Zurn Plumbing Products Group.
2. Minimum Operating-Pressure Rating: .150 psig .
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for natural gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

B. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - d. Wilkins; Zurn Plumbing Products Group.
2. Minimum Operating-Pressure Rating: .150 psig .
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for natural gas.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

C. Dielectric-Flange Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico Inc.

- c. Central Plastics Company.
- d. Pipeline Seal and Insulator, Inc.

- 2. Minimum Operating-Pressure Rating: 150 psig.
- 3. Companion-flange assembly for field assembly.
- 4. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or PE bolt sleeves, phenolic washers, and steel backing washers.
- 5. Insulating materials suitable for natural gas.
- 6. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.10 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to .30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.

- D. Steel Piping with Protective Coating:
 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 3. Replace pipe having damaged PE coating with new pipe.
- E. Copper Tubing with Protective Coating:
 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
- F. Install fittings for changes in direction and branch connections.
- G. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."

3.4 INDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

- M. Provide an additional twenty five feet of gas piping and accessories and installation labor for each size of pipe used on the project to accommodate any changes required to resolve interferences or as directed by the engineer.
- N. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than .3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- O. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- P. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- Q. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of .1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
 - 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
 - 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 - 5. Prohibited Locations:
 - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install natural-gas piping in solid walls or partitions.
- R. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- S. Connect branch piping from top or side of horizontal piping.
- T. Install unions in pipes .NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- U. Do not use natural-gas piping as grounding electrode.

- V. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- W. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 23 Section "Meters and Gages for HVAC Piping."
- X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- Z. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.5 SERVICE-METER ASSEMBLY INSTALLATION

- A. Install service-meter assemblies aboveground, on concrete bases.
- B. Install metal shutoff valves upstream from service regulators. Shutoff valves are not required at second regulators if two regulators are installed in series.
- C. Install strainer on inlet of service-pressure regulator and meter set.
- D. Install service regulators mounted outside with vent outlet horizontal or facing down. Install screen in vent outlet if not integral with service regulator.
- E. Install metal shutoff valves upstream from service meters. Install dielectric fittings downstream from service meters.
- F. Install service meters downstream from pressure regulators.
- G. Install metal bollards to protect meter assemblies. Comply with requirements in Division 05 Section "Metal Fabrications" for pipe bollards.

3.6 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install earthquake valves aboveground outside buildings according to listing.
- E. Install anode for metallic valves in underground PE piping.

3.7 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
 - 1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
 - 2. Cut threads full and clean using sharp dies.
 - 3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
 - 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Welded Joints:
 - 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
 - 2. Bevel plain ends of steel pipe.
 - 3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.
- F. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.8 HANGER AND SUPPORT INSTALLATION

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- B. Comply with requirements for pipe hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1. and Smaller: Maximum span, .96 inches ; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, .108 inches ; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, .108 inches ; minimum rod size, 3/8 inch.
 - 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, .10 feet ; minimum rod size, 1/2 inch.
 - 5. NPS 4. and Larger: Maximum span, .10 feet ; minimum rod size, 5/8 inch.

CONNECTIONS

- D. Connect to utility's gas main according to utility's procedures and requirements.

- E. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- F. Install piping adjacent to appliances to allow service and maintenance of appliances.
- G. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within .72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- H. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.9 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 23 Section "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, .12 inches below finished grade, except .6 inches below subgrade under pavements and slabs.

3.10 PAINTING

- A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel gloss.
 - d. Color: Yellow.
- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Interior latex matching topcoat.
 - c. Topcoat: Interior latex gloss.
 - d. Color: Yellow.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

3.13 OUTDOOR PIPING SCHEDULE

- A. Underground natural-gas piping shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
- B. Aboveground natural-gas piping shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints.
- C. Branch Piping in Cast-in-Place Concrete to Single Appliance: Annealed-temper copper tube with wrought-copper fittings and brazed joints. Install piping embedded in concrete with no joints in concrete.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

3.14 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN .05 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints.

- C. Underground, below building, piping shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG

- A. Aboveground, branch piping NPS 1 and smaller shall be the following:
 - 1. Steel pipe with malleable-iron fittings and threaded joints.
- B. Aboveground, distribution piping shall be the following:
 - 1. Steel pipe with steel welding fittings and welded joints.
- C. Underground, below building, piping shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints.
- D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.
- E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.16 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 5 PSIG

- A. Aboveground Piping: Maximum operating pressure more than 5 psig.
- B. Aboveground, Branch Piping: Steel pipe with steel welding fittings and welded joints.
- C. Aboveground, distribution piping shall be the following:
 - 1. Steel pipe with steel welding fittings and welded joints.
- D. Underground, below building, piping shall be the following:
 - 1. Steel pipe with wrought-steel fittings and welded joints.

- E. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- F. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

3.17 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.
- B. Underground:
 - 1. NPS 2-1/2 and Larger: Cast-iron, lubricated plug valves.

3.18 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- E. Valves in branch piping for single appliance shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 231123

SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

- 1. This Section includes rectangular, round, and flat-oval metal ducts and plenums for heating, ventilating, and air-conditioning systems in pressure classes from minus 2- plus 10-inch wg.

B. Related Sections:

- 1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
- 2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
- 3. Division 23 Section "Duct Insulation" for insulation for metal ducts.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7, SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems.

- 1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
- 2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
- 3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.

- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

1.4 SUBMITTALS

- A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.

E. Welding certificates.

F. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."
- D. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," unless otherwise indicated.
- E. Comply with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems," unless otherwise indicated.
- F. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Chapter 3, "Duct System," for range hood ducts, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. McGill AirFlow LLC.
 2. Sheet Metal Connectors, Inc.
- B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.
- C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- D. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- E. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- F. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity: $.027 \text{ Btu} \times \text{in./h} \times \text{sq. ft.} \times \text{deg F}$ at 75 deg F mean temperature.
 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 3. Coat insulation with antimicrobial coating.
 4. Cover insulation with polyester film complying with UL 181, Class 1.
- G. Inner Duct: Minimum $.0028\text{-inch}$ solid steel galvanized sheet steel.
- H. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Traverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- I. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
 - a. Lindab Inc.
 - b. McGill AirFlow LLC.

- c. SEMCO Incorporated.
 - d. Sheet Metal Connectors, Inc.
 - e. Spiral Manufacturing Co., Inc.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- 1. Transverse Joints in Ducts Larger Than .60 Inches in Diameter: Flanged.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- 1. Fabricate round ducts larger than .90 inches in diameter with butt-welded longitudinal seams.
 - 2. Fabricate flat-oval ducts larger than .72 inches in width (major dimension) with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.4 DOUBLE-WALL ROUND DUCTS AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- 1. Lindab Inc.
 - 2. McGill AirFlow LLC.
 - 3. SEMCO Incorporated.
 - 4. Sheet Metal Connectors, Inc.
- B. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.
- 1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - a. Transverse Joints in Ducts Larger Than .60 Inches in Diameter: Flanged.
 - 2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and

Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- a. Fabricate round ducts larger than .90 inch in diameter with butt-welded longitudinal seams.
 - b. Fabricate flat-oval ducts larger than .72 inches in width (major dimension) with butt-welded longitudinal seams.
3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Inner Duct: Minimum .028-inch solid galvanized sheet steel.
- D. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity: .027 Btu x in./h x sq. ft. x deg F. at 75 deg F. mean temperature.
 2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
 3. Coat insulation with antimicrobial coating.
 4. Cover insulation with polyester film complying with UL 181, Class 1.

2.5 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G90.
 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. PVC-Coated, Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G90.
 2. Minimum Thickness for Factory-Applied PVC Coating: 4 mils. thick on sheet metal surface of ducts and fittings exposed to corrosive conditions, and minimum .1 mil. thick on opposite surface.
 3. Coating Materials: Acceptable to authorities having jurisdiction for use on ducts listed and labeled by an NRTL for compliance with UL 181, Class 1.
- D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- E. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

- F. Aluminum Sheets: Comply with ASTM B 209. Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- G. Factory- or Shop-Applied Antimicrobial Coating:
 - 1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
 - 2. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
 - 3. Coating containing the antimicrobial compound shall have a hardness of 2H, minimum, when tested according to ASTM D 3363.
 - 4. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
 - 5. Shop-Applied Coating Color: Black.
 - 6. Antimicrobial coating on sheet metal is not required for duct containing liner treated with antimicrobial coating.
- H. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- I. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.6 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 - 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 - 2. Tape Width: 4 inches.
 - 3. Sealant: Modified styrene acrylic.
 - 4. Water resistant.
 - 5. Mold and mildew resistant.
 - 6. Maximum Static-Pressure Class: 10-inch wg., positive and negative.
 - 7. Service: Indoor and outdoor.
 - 8. Service Temperature: Minus 40 to plus 200 deg F.
 - 9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
 - 10. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Water-Based Joint and Seam Sealant:
 - 1. Application Method: Brush on.
 - 2. Solids Content: Minimum 65 percent.
 - 3. Shore A Hardness: Minimum 20.
 - 4. Water resistant.

5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: .10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of .3 cfm/100 sq. ft. at 1-inch wg and shall be rated for .10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.8 SEISMIC-RESTRAINT DEVICES

- A. Manufacturers: Subject to compliance with requirements provide products by one of the following:
 - 1. Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2. Ductmate Industries, Inc.
 - 3. Hilti Corp.
 - 4. Kinetics Noise Control.
 - 5. Loos & Co.; Cableware Division.
 - 6. Mason Industries.
 - 7. TOLCO; a brand of NIBCO INC.
 - 8. Unistrut Corporation; Tyco International, Ltd.
- B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- C. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- D. Restraint Cables: ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- F. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.

- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Provide an extra 350 lbs of ductwork to accommodate ductwork revisions required to resolve interferences or as directed by the Engineer.
- H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Install ducts with a clearance of .1 inch., plus allowance for insulation thickness.
- J. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- K. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least .1-1/2 inches.
- L. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- M. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 2. Outdoor, Supply-Air Ducts: Seal Class A.
 3. Outdoor, Exhaust Ducts: Seal Class C.
 4. Outdoor, Return-Air Ducts: Seal Class C.
 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg. and Lower: Seal Class B.
 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg.: Seal Class A.
 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg. and Lower: Seal Class C.
 10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg.: Seal Class B.
 11. Conditioned Space, Exhaust Ducts: Seal Class B.
 12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
1. Where practical, install concrete inserts before placing concrete.
 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than .4 inches thick.
 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than .4 inches thick.
 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of .16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." ASCE/SEI 7.
 - 1. Space lateral supports a maximum of .40 feet o.c., and longitudinal supports a maximum of .80 feet o.c.
 - 2. Brace a change of direction longer than .12 feet.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

- A. Paint exterior of exposed ductwork with color as selected by the architect. Paint interior of metal ducts that are visible through registers and grilles. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
2. Test the following systems:
 - a. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
 - b. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
 - c. Exhaust Ducts with a Pressure Class of 2-Inch wg or Higher: Test duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
 - d. Outdoor Air Ducts with a Pressure Class of 2-Inch wg or Higher: Test duct sections totaling no less than 100 percent of total installed duct area for each designated pressure class.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
4. Test for leaks before applying external insulation.
5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.
2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 DUCT CLEANING

A. Clean new and existing duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated.
- B. All exposed round ductwork as shown on the contract drawings shall be double wall insulated spiral type. Coordinate finish color with Architect.
- C. Supply Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
 - 2. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Positive 3-inch wg.
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
- D. Return Ducts:
 - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative 2-inch wg..
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
 - 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg. .
 - b. Minimum SMACNA Seal Class: C.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
- E. Exhaust Ducts:
 - 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: C if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.
 - 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative 2-inch wg..
 - b. Minimum SMACNA Seal Class: C if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 6.
 - d. SMACNA Leakage Class for Round and Flat Oval: 3.

- F. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
 - a. Pressure Class: Positive or negative .2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 2. Ducts Connected to Air-Handling Units:
 - a. Pressure Class: Positive or negative .2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
 3. Ducts Connected to Equipment Not Listed Above:
 - a. Pressure Class: Positive or negative .2-inch wg.
 - b. Minimum SMACNA Seal Class: A.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round and Flat Oval: 12.
- G. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel.
 2. PVC-Coated Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Galvanized.
 3. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.
 4. Aluminum Ducts: Aluminum.
- H. Double-Wall Duct Interstitial Insulation:
1. Supply Air Ducts: .1 inch thick.
 2. Return Air Ducts: .1 inch thick.
 3. Exhaust Air Ducts: .1 inch thick.
- I. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm. or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity .1000 to 1500 fpm.:

- 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
- c. Velocity .1500 fpm. or Higher:
- 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
- a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
- a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity .1000 fpm. or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity .1000 to 1500 fpm.: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity .1500 fpm. or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - 4) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, .12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, .14 Inches and Larger in Diameter: Welded.
- J. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity .1000 fpm. or Lower: 90-degree tap.

- b. Velocity .1000 to 1500 fpm.: Conical tap.
- c. Velocity .1500 fpm. or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Ceiling dampers.
7. Smoke dampers.
8. Combination fire and smoke dampers.
9. Corridor dampers.
10. Flange connectors.
11. Duct silencers.
12. Turning vanes.
13. Remote damper operators.
14. Duct-mounted access doors.
15. Flexible connectors.
16. Flexible ducts.
17. Duct security bars.
18. Duct accessory hardware.

B. Related Sections:

1. Division 23 Section "HVAC Power Ventilators" for roof-mounted ventilator caps.
2. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
 - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
 - e. Duct security bars.
 - f. Wiring Diagrams: For power, signal, and control wiring.
- C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- D. Source quality-control reports.
- E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

1.5 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 1. Galvanized Coating Designation: G90.
 2. Exposed-Surface Finish: Mill phosphatized.

- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and a polished finish for exposed ducts.
- D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. American Warming and Ventilating; a division of Mestek, Inc.
 - 3. Cesco Products; a division of Mestek, Inc.
 - 4. Duro Dyne Inc.
 - 5. Greenheck Fan Corporation.
 - 6. Lloyd Industries, Inc.
 - 7. Nailor Industries Inc.
 - 8. NCA Manufacturing, Inc.
 - 9. Pottorff; a division of PCI Industries, Inc.
 - 10. Ruskin Company.
 - 11. SEMCO Incorporated.
 - 12. Vent Products Company, Inc.
- B. Description: Gravity balanced.
- C. Maximum Air Velocity: 2200 fpm.
- D. Maximum System Pressure: 2-inch wg.
- E. Frame: 0.052-inch- thick, galvanized sheet steel with welded corners and mounting flange.
- F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch width, 0.025-inch- thick, roll-formed aluminum with sealed edges.
- G. Blade Action: Parallel.
- H. Blade Seals: Neoprene, mechanically locked.
- I. Blade Axles:
 - 1. Material: Plated steel.
 - 2. Diameter: 0.20 inch.
- J. Tie Bars and Brackets: Galvanized steel.

- K. Return Spring: Adjustable tension.
- L. Bearings: Steel ball or synthetic pivot bushings.
- M. Accessories:
 - 1. Adjustment device to permit setting for varying differential static pressure.
 - 2. Counterweights and spring-assist kits for vertical airflow installations.
 - 3. Electric actuators.
 - 4. Chain pulls.
 - 5. Screen Mounting: Front mounted in sleeve.
 - a. Sleeve Thickness: .20-gage minimum.
 - b. Sleeve Length: .6 inches minimum.
 - 6. Screen Material: Galvanized steel or Aluminum.
 - 7. Screen Type: Insect.
 - 8. 90-degree stops.

2.3 BAROMETRIC RELIEF DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. American Warming and Ventilating; a division of Mestek, Inc.
 - 3. Cesco Products; a division of Mestek, Inc.
 - 4. Duro Dyne Inc.
 - 5. Greenheck Fan Corporation.
 - 6. Lloyd Industries, Inc.
 - 7. Nailor Industries Inc.
 - 8. NCA Manufacturing, Inc.
 - 9. Pottorff; a division of PCI Industries, Inc.
 - 10. Ruskin Company.
 - 11. SEMCO Incorporated.
 - 12. Vent Products Company, Inc.
- B. Suitable for horizontal or vertical mounting.
- C. Maximum Air Velocity: .2200 fpm..
- D. Maximum System Pressure: .2-inch wg..
- E. Frame: .0064-inch- thick, galvanized sheet steel, with welded corners and mounting flange.
- F. Blades:
 - 1. Multiple, .0025-inch- thick, roll-formed aluminum.
 - 2. Maximum Width: .6 inches..
 - 3. Action: Parallel.
 - 4. Balance: Gravity.
 - 5. Eccentrically pivoted.

- G. Blade Seals: Neoprene.
- H. Blade Axles: Galvanized steel.
- I. Tie Bars and Brackets:
 - 1. Material: Galvanized steel.
 - 2. Rattle free with 90-degree stop.
- J. Return Spring: Adjustable tension.
- K. Bearings: Synthetic or Stainless steel.
- L. Accessories:
 - 1. Flange on intake.
 - 2. Adjustment device to permit setting for varying differential static pressures.

2.4 MANUAL VOLUME DAMPERS

- A. Low-Leakage, Steel, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. Flexmaster U.S.A., Inc.
 - d. McGill AirFlow LLC.
 - e. METALAIR, Inc.
 - f. Nailor Industries Inc.
 - g. Pottorff; a division of PCI Industries, Inc.
 - h. Ruskin Company.
 - i. Trox USA Inc.
 - j. Vent Products Company, Inc.
 - 2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames:
 - a. Hat, U, Angle shaped.
 - b. Galvanized-steel channels, 0.064 inch. thick.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized, roll-formed steel, 0.064 inch. thick.
 - 6. Blade Axles: Galvanized steel.

7. Bearings:
 - a. Oil-impregnated bronze, Molded synthetic, Stainless-steel sleeve.
 - b. Dampers in ducts with pressure classes of .3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Blade Seals: Vinyl or Neoprene.
9. Jamb Seals: Cambered aluminum.
10. Tie Bars and Brackets: Galvanized steel.
11. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.

B. Low-Leakage, Aluminum, Manual Volume Dampers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - a. Air Balance Inc.; a division of Mestek, Inc.
 - b. American Warming and Ventilating; a division of Mestek, Inc.
 - c. Flexmaster U.S.A., Inc.
 - d. McGill AirFlow LLC.
 - e. METALAIRE, Inc.
 - f. Nailor Industries Inc.
 - g. Pottorff; a division of PCI Industries, Inc.
 - h. Ruskin Company.
 - i. Trox USA Inc.
 - j. Vent Products Company, Inc.
2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat, U, Angle-shaped, .010-inch- thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Roll-Formed Aluminum Blades: .010-inch- thick aluminum sheet.
 - d. Extruded-Aluminum Blades: .0050-inch- thick extruded aluminum.
6. Blade Axles: Stainless steel.
7. Bearings:
 - a. Oil-impregnated bronze, Molded synthetic, Stainless-steel sleeve.
 - b. Dampers in ducts with pressure classes of .3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Blade Seals: Vinyl or Neoprene.
9. Jamb Seals: Cambered aluminum.
10. Tie Bars and Brackets: Aluminum.
11. Accessories:

- a. Include locking device to hold single-blade dampers in a fixed position without vibration.

C. Jackshaft:

1. Size: .1-inch diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:

1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.5 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. American Warming and Ventilating; a division of Mestek, Inc.
2. Arrow United Industries; a division of Mestek, Inc.
3. Cesco Products; a division of Mestek, Inc.
4. Duro Dyne Inc.
5. Flexmaster U.S.A., Inc.
6. Greenheck Fan Corporation.
7. Lloyd Industries, Inc.
8. M&I Air Systems Engineering; Division of M&I Heat Transfer Products Ltd.
9. McGill AirFlow LLC.
10. METALAIRE, Inc.
11. Metal Form Manufacturing, Inc.
12. Nailor Industries Inc.
13. NCA Manufacturing, Inc.
14. Ruskin Company.
15. Vent Products Company, Inc.
16. Young Regulator Company.

B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.

C. Frames:

1. Hat, U, Angle] shaped.
2. Galvanized-steel channels, .064 inch thick.
3. Mitered and welded corners.

D. Blades:

1. Multiple blade with maximum blade width of .8 inches.
2. Parallel- and opposed-blade design.
3. Galvanized steel.

4. .064 inch. thick.
 5. Blade Edging: Closed-cell neoprene edging.
- E. Blade Axles: 1/2-inch- diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
1. Operating Temperature Range: From minus 40 to plus 200 deg F.
- F. Bearings:
1. Oil-impregnated bronze, Molded synthetic or Stainless-steel sleeve.
 2. Dampers in ducts with pressure classes of 3-inch wg. or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 3. Thrust bearings at each end of every blade.

2.6 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
1. Air Balance Inc.; a division of Mestek, Inc.
 2. Arrow United Industries; a division of Mestek, Inc.
 3. Cesco Products; a division of Mestek, Inc.
 4. Greenheck Fan Corporation.
 5. McGill AirFlow LLC.
 6. METALAIRE, Inc.
 7. Nailor Industries Inc.
 8. NCA Manufacturing, Inc.
 9. PHL, Inc.
 10. Pottorff; a division of PCI Industries, Inc.
 11. Prefco; Perfect Air Control, Inc.
 12. Ruskin Company.
 13. Vent Products Company, Inc.
 14. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Type: Static; rated and labeled according to UL 555 by an NRTL.
- C. Fire Rating: 1-1/2 and 3 hours.
- D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, .034-inch-thick galvanized steel; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
1. Minimum Thickness: .052 or 0.138 inch. thick, as indicated, and of length to suit application.
 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, .034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, .034-inch- thick, galvanized-steel blade connectors.

- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, .165 deg F. rated, fusible links.

2.7 SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Air Balance Inc.; a division of Mestek, Inc.
 - 2. Cesco Products; a division of Mestek, Inc.
 - 3. Greenheck Fan Corporation.
 - 4. Nailor Industries Inc.
 - 5. PHL, Inc.
 - 6. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Smoke Detector: Integral, factory wired for single-point connection.
- D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, .034-inch-thick galvanized steel; with mitered and interlocking corners.
- E. Blades: Roll-formed, horizontal, interlocking, .034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, .034-inch- thick, galvanized-steel blade connectors.
- F. Leakage: Class I .
- G. Rated pressure and velocity to exceed design airflow conditions.
- H. Mounting Sleeve: Factory-installed, .052-inch- thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone caulking.
- I. Damper Motors: Modulating or two-position action.
- J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC." Division 26 Sections.
 - 3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
 - 4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of .150 in. x lbf. and breakaway torque rating of .150 in. x lbf..
 - 5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F..

6. Nonspring-Return Motors: For dampers larger than .25 sq. ft., size motor for running torque rating of .150 in. x lbf. and breakaway torque rating of .300 in. x lbf.
7. Electrical Connection: 115 V, single phase, 60 Hz.

K. Accessories:

1. Auxiliary switches for signaling fan control or position indication.
2. Momentary test switch, remote mounted.

2.8 FLANGE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Ductmate Industries, Inc.
2. Nexus PDQ; Division of Shilco Holdings Inc.
3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gage and Shape: Match connecting ductwork.

2.9 DUCT SILENCERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Industrial Noise Control, Inc.
2. McGill AirFlow LLC.
3. Ruskin Company.
4. Vibro-Acoustics.

B. General Requirements:

1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

C. Shape:

1. Rectangular straight with splitters or baffles.
2. Round straight with center bodies or pods.
3. Rectangular elbow with splitters or baffles.
4. Round elbow with center bodies or pods.
5. Rectangular transitional with splitters or baffles.

- D. Rectangular Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel, .040 inch thick.
- E. Round Silencer Outer Casing: ASTM A 653/A 653M, G90, galvanized sheet steel.
 - 1. Sheet Metal Thickness for Units up to 24 Inches in Diameter: .034 inch thick.
 - 2. Sheet Metal Thickness for Units 26 through 40 Inches in Diameter: .040 inch thick.
 - 3. Sheet Metal Thickness for Units 42 through 52 Inches in Diameter: .052 inch thick.
 - 4. Sheet Metal Thickness for Units 54 through 60 Inches in Diameter: .064 inch thick.
- F. Inner Casing and Baffles: ASTM A 653/A 653M, G90 galvanized sheet metal, 0.034 inch thick, and with .1/8-inch- diameter perforations.
- G. Special Construction:
 - 1. Suitable for outdoor use.
 - 2. High transmission loss to achieve STC 45.
- H. Connection Sizes: Match connecting ductwork unless otherwise indicated.
- I. Principal Sound-Absorbing Mechanism:
 - 1. Controlled impedance membranes and broadly tuned resonators without absorptive media.
 - 2. Dissipative type with fill material.
 - a. Fill Material: Moisture-proof nonfibrous material.
 - b. Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.
 - 3. Lining: Mylar.
- J. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
 - 1. Flange connections.
 - 2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
 - 3. Reinforcement: Cross or trapeze angles for rigid suspension.
- K. Accessories:
 - 1. Factory-installed end caps to prevent contamination during shipping.
 - 2. Removable splitters.
 - 3. Airflow measuring devices.
- L. Source Quality Control: Test according to ASTM E 477.
 - 1. Record acoustic ratings, including dynamic insertion loss and generated-noise power levels with an airflow of at least 2000-fpm face velocity.
 - 2. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

2.10 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. METALAIRE, Inc.
 - 4. SEMCO Incorporated.
 - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vaness and Vane Runners," and 2-4, "Vane Support in Elbows."
- E.
- F. Vane Construction: Single wall for ducts up to 8 inches wide and double wall for larger dimensions.

2.11 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. American Warming and Ventilating; a division of Mestek, Inc.
 - 2. Cesco Products; a division of Mestek, Inc.
 - 3. Ductmate Industries, Inc.
 - 4. Flexmaster U.S.A., Inc.
 - 5. Greenheck Fan Corporation.
 - 6. McGill AirFlow LLC.
 - 7. Nailor Industries Inc.
 - 8. Pottorff; a division of PCI Industries, Inc.
 - 9. Ventfabrics, Inc.
 - 10. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.
 - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.

- c. Vision panel.
 - d. Hinges and Latches: .1-by-1-inch butt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
- 2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
 - 3. Number of Hinges and Locks:
 - a. Access Doors Less Than .12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to .18 Inches Square: Two hinges and two sash locks.
 - c. Access Doors up to .24 by 48 Inches: Three hinges and two compression latches[with outside and inside handles.
 - d. Access Doors Larger Than .24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.
- C. Pressure Relief Access Door:
- 1. Door and Frame Material: Galvanized sheet steel.
 - 2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
 - 3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
 - 4. Factory set at .10-inch wg.
 - 5. Doors close when pressures are within set-point range.
 - 6. Hinge: Continuous piano.
 - 7. Latches: Cam.
 - 8. Seal: Neoprene or foam rubber.
 - 9. Insulation Fill: .1-inch- thick, fibrous-glass or polystyrene-foam board.

2.12 DUCT ACCESS PANEL ASSEMBLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Ductmate Industries, Inc.
 - 2. Flame Gard, Inc.
 - 3. 3M.
- B. Labeled according to UL 1978 by an NRTL.
- C. Panel and Frame: Minimum thickness .0528-inch carbon steel.
- D. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.
- E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.
- F. Minimum Pressure Rating: .10-inch wg., positive or negative.

2.13 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:

1. Ductmate Industries, Inc.
 2. Duro Dyne Inc.
 3. Ventfabrics, Inc.
 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or .0032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: .26 oz./sq. yd..
 2. Tensile Strength: .480 lbf/inch. in the warp and .360 lbf/inch. in the filling.
 3. Service Temperature: .Minus 40 to plus 200 deg F..
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
1. Minimum Weight: .24 oz./sq. yd..
 2. Minimum Tensile Strength: .500 lbf/inch. in the warp and .440 lbf/inch. in the filling.
 3. Service Temperature: .Minus 50 to plus 250 deg F..
- G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
1. Minimum Weight: .16 oz./sq. yd..
 2. Tensile Strength: .285 lbf/inch. in the warp and .185 lbf/inch. in the filling.
 3. Service Temperature: .Minus 67 to plus 500 deg F..
- H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
1. Minimum Weight: .14 oz./sq. yd..
 2. Tensile Strength: .450 lbf/inch. in the warp and .340 lbf/inch. in the filling.
 3. Service Temperature: .Minus 67 to plus 500 deg F..
- I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
 7. Coil Spring: Factory set and field adjustable for a maximum of .1/4-inch. movement at start and stop.

2.14 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Flexmaster U.S.A., Inc.
 - 2. McGill AirFlow LLC.
 - 3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
 - 1. Pressure Rating: .10-inch wg. positive and .10-inch wg. negative.
 - 2. Maximum Air Velocity: 4000 fpm.
 - 3. Temperature Range: Minus 10 to plus 160 deg F.
 - 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1-2004.
- C. Flexible Duct Connectors:
 - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes .3 through 18 inches, to suit duct size.

2.15 DUCT SECURITY BARS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Carnes.
 - 2. KEES, Inc.
 - 3. Lloyd Industries, Inc.
 - 4. Metal Form Manufacturing, Inc.
 - 5. Price Industries.
- B. Description: Field- or factory-fabricated and field-installed duct security bars.
- C. Configuration:
 - 1. Frame: .10 gage by 2 inches.
 - 2. Sleeve: 3/16-inch, continuously welded steel frames with .1-by-1-by-3/16-inch. angle frame factory welded to 1 end and furnished loose for field welding on other end. To be poured in place or set with concrete block or welded or bolted to wall, one side only. Duct connections on both sides.
 - 3. Horizontal Bars: .1/2 inch.
 - 4. Vertical Bars: 3/4 inch.
 - 5. Bar Spacing: .6 inches.
 - 6. Mounting: Ductwork or other framing.

2.16 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire dampers according to UL listing.
- H. Install duct security bars. Construct duct security bars from .0164-inch steel sleeve, continuously welded at all joints and .1/2-inch diameter steel bars, .6 inches o.c. in each direction in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2-1/2-by-2-1/2-by-1/4-inch steel angle to 4 sides and both ends of sleeve. Connect duct security bars to ducts with flexible connections. Provide .12-by-12-inch hinged access panel with cam lock in duct in each side of sleeve.
- I. Connect ducts to duct silencers rigidly.
- J. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream and downstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 7. At each change in direction and at maximum .50-foot spacing.
 - 8. Upstream from turning vanes.
 - 9. Upstream or downstream from duct silencers.

- 10. Control devices requiring inspection.
 - 11. Elsewhere as indicated.
- K. Install access doors with swing against duct static pressure.
 - L. Access Door Sizes:
 - 1. One-Hand or Inspection Access: .8 by 5 inches.
 - 2. Two-Hand Access: .12 by 6 inches.
 - 3. Head and Hand Access: .18 by 10 inches.
 - 4. Head and Shoulders Access: .21 by 14 inches.
 - 5. Body Access: .25 by 14 inches.
 - 6. Body plus Ladder Access: .25 by 17 inches.
 - M. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
 - N. Install flexible connectors to connect ducts to equipment.
 - O. For fans developing static pressures of 5-inch wg. and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
 - P. Connect terminal units to supply ducts directly.
 - Q. Connect diffusers or light troffer boots to ducts directly or with maximum .10'-0" lengths of flexible duct clamped or strapped in place.
 - R. Connect flexible ducts to metal ducts with stainless steel clamps.
 - S. Install duct test holes where required for testing and balancing purposes.
 - T. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of .1/4-inch movement during start and stop of fans.
- 3.2 FIELD QUALITY CONTROL
- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
 - 4. Inspect turning vanes for proper and secure installation.
 - 5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 23 34 16

CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Backward-inclined centrifugal fans.
 - 2. Forward-curved centrifugal fans.

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.3 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. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA 1.

PART 2 - PRODUCTS

2.1 BACKWARD-INCLINED CENTRIFUGAL FANS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- C. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 1. Loren Cook Company.
 2. Trane.
 3. Greenheck

- D. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.

- E. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
 1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 2. Spun inlet cone with flange.
 3. Outlet flange.

- F. Backward-Inclined Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades and fastened to shaft with set screws.

- G. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.
 1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
 2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

- H. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
 1. Ball-Bearing Rating Life: ABMA 9, L50 at 200,000 hours.

- I. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
 1. Service Factor Based on Fan Motor Size: **[1.5]**.
 2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 6. Motor Mount: Adjustable for belt tensioning.

- J. Accessories:
 1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.

2. Scroll Drain Connection: **NPS 1_ (DN 25)** steel pipe coupling welded to low point of fan scroll.
 3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
 4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
 5. Discharge Dampers: Assembly with **opposed** blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
 6. Inlet Screens: Grid screen of same material as housing.
 7. Spark-Resistant Construction: AMCA 99.
 8. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 9. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
- K. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Enclosure Type: Totally enclosed, fan cooled.

2.2 FORWARD-CURVED CENTRIFUGAL FANS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
 1. Loren Cook Company.
 2. Trane.
 3. Greenheck
- D. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.
- E. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
 1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 2. Spun inlet cone with flange.
 3. Outlet flange.
- F. Forward-Curved Wheels: Black-enameled or galvanized steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow, mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.
- G. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment and belt adjustment made after installation.

1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
 2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- H. Prelubricated and Sealed Shaft Bearings: Self-aligning, pillow-block-type ball bearings.
- I. Belt Drives: Factory mounted, with final alignment and belt adjustment made after installation.
1. Service Factor Based on Fan Motor Size: 1.5.
 2. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 3. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
 4. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
 5. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
 6. Motor Mount: Adjustable for belt tensioning.
- J. Accessories:
1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
 2. Scroll Drain Connection: NPS 1_ (DN 25) steel pipe coupling welded to low point of fan scroll.
 3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
 4. Variable Inlet Vanes: With blades supported at both ends with two permanently lubricated bearings of same material as housing. Variable mechanism terminating in single control lever with control shaft for double-width fans.
 5. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
 6. Inlet Screens: Grid screen of same material as housing.
 7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
 8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.
- K. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Enclosure Type: Totally enclosed, fan cooled.

2.3 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install centrifugal fans level and plumb.
- B. Support floor-mounting units using **restrained spring isolators**. Vibration- and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
 - 1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.
- C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Install floor-mounting units on concrete bases designed to withstand, without damage to equipment, the seismic force required by authorities having jurisdiction. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- E. Support suspended units from structure using threaded steel rods and **spring hangers**. Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- F. Install units with clearances for service and maintenance.
- G. Label fans according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Install ducts adjacent to fans to allow service and maintenance.
- C. Install line-sized piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 3. Verify that cleaning and adjusting are complete.
 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
 5. Adjust belt tension.
 6. Adjust damper linkages for proper damper operation.
 7. Verify lubrication for bearings and other moving parts.
 8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
 9. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
 10. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 233416

SECTION 23 37 13

DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.
- B. Related Sections:
 - 1. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.
 - 2. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for balancing diffusers, registers and grilles.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.
- C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.
- D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.
- E. Source quality-control reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.
- B. Manufacturers:
 - 1. Titus
 - 2. Tuttle & Bailey
 - 3. Price (Basis of Design)
 - 4. Krueger

2.2 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Provide an additional five diffusers/registers of each type and size used on the project to accommodate ductwork revisions required to resolve interferences or as directed by the Engineer.
- D. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.4 CLEANING

- A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

END OF SECTION 233713

SECTION 23 55 33

FUEL-FIRED UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes gas -fired unit heaters.

1.2 SUBMITTALS

- A. Product Data: For each type of fuel-fired unit heater indicated. Include rated capacities, operating characteristics, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Power and control wiring.
- C. Field quality-control test reports.
- D. Operation and maintenance data.

1.3 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.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace heat exchanger of fuel-fired unit heater that fails in materials or workmanship within specified warranty period.
 - 1. Warranty Period: four (4) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GAS-FIRED UNIT HEATERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements a comparable product by one of the following:
 - 1. Lennox Industries, Inc.
 - 2. Modine Manufacturing Company.
 - 3. Reznor/Thomas & Betts Corporation. (Basis of Design)
 - 4. Sterling HVAC Products; Div. of Mestek Technology Inc.
- D. Description: Factory assembled, piped, and wired, and complying with ANSI Z83.8/CSA 2.6.
- E. Fuel Type: Design burner for natural gas having characteristics same as those of gas available at Project site.
- F. Type of Venting: separated combustion, power vented.
- G. Housing: Steel, with integral draft hood and inserts for suspension mounting rods.
- H. Heat Exchanger: Stainless steel.
- I. Unit Fan: Propeller blades riveted to heavy-gage steel spider bolted to cast-iron hub, dynamically balanced, and resiliently mounted.
- J. Controls: Regulated redundant gas valve containing pilot solenoid valve, electric gas valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.
 - 1. Gas Control Valve: Two stage.
 - 2. Ignition: Electronically controlled electric spark with flame sensor.
 - 3. Fan Thermal Switch: Operates fan on heat-exchanger temperature.
 - 4. Vent Flow Verification: Flame rollout switch.
 - 5. Control transformer.
 - 6. High Limit: Thermal switch or fuse to stop burner.
 - 7. Thermostats: Devices and wiring are specified in Division 23 Section "Instrumentation and Control for HVAC."
 - 8. Thermostat: Single-stage, wall-mounting type with .50 to 90 deg F_ (10 to 32 deg C) operating range and fan on switch.
 - 9. Thermostat: 2-stage, wall-mounting type with .50 to 90 deg F_ (10 to 32 deg C) operating range and fan on switch.
 - 10. Thermostat: Single-stage type with duct-mounting sensor and .50 to 90 deg F_ (10 to 32 deg C) operating range.
 - 11. Thermostat: 2-stage type with duct-mounting sensor and 50 to 90 deg F_ (10 to 32 deg C) operating range.
- K. Discharge Louvers: Independently adjustable horizontal blades.
- L. Accessories:
 - 1. Vertical discharge louvers.
 - 2. Discharge Nozzle: Discharge at 25 to 65 degrees from horizontal.
 - 3. Four-point suspension kit.
 - 4. Summer fan switch.
 - 5. Unit-mounted thermostat bracket.

6. Power Venter: Centrifugal aluminized-steel fan, with stainless-steel shaft; 120-V ac motor.
7. Concentric, Terminal Vent Assembly: Combined combustion-air inlet and power-vent outlet with wall or roof caps. Include adapter assembly for connection to inlet and outlet pipes, and flashing for wall or roof penetration.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install and connect gas-fired unit heaters and associated fuel and vent features and systems according to [NFPA 54], applicable local codes and regulations, and manufacturer's written installation instructions.
- B. Install and connect oil-fired unit heaters and associated fuel and vent piping according to [NFPA 31], applicable local codes and regulations, and manufacturer's written installation instructions.
- C. Suspended Units: Suspend from substrate using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.
- D. Install piping adjacent to fuel-fired unit heater to allow service and maintenance.
- E. Gas Piping: Comply with Division 23 Section "Facility Natural-Gas Piping." Connect gas piping to gas train inlet; provide union with enough clearance for burner removal and service.
- F. Fuel Oil Piping: Comply Division 23 Section "Facility Fuel-Oil Piping." Connect to fuel oil supply and return piping with shutoff valve and union at each connection.
- G. Vent Connections: Comply with Division 23 Section "Breechings, Chimneys, and Stacks."
- H. Electrical Connections: Comply with applicable requirements in Division 26 Sections.
 1. Install electrical devices furnished with heaters but not specified to be factory mounted.
- I. Adjust initial temperature set points.
- J. Adjust burner and other unit components for optimum heating performance and efficiency.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 235533

SECTION 23 74 13

DEDICATED OUTDOOR AIR UNITS (PACKAGED)

1. GENERAL

A. SECTION INCLUDES

1. Packaged outdoor air unit.
2. Dehumidification/Cooling.
3. Heating.
4. Electrical Ratings and Connections
5. Unit Controls
6. Powered Exhaust
7. Energy Recovery
8. Roof curb
9. Execution

B. RELATED SECTIONS

1. Section 230513 - Motors.
2. Section 230548 - Vibration Isolation.
3. Section 230700 - Ductwork Insulation

C. REFERENCES

1. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration. (all)
2. ANSI/ASHRAE/IESNA 90.1-2013 - Energy Standard for New Buildings Except Low-Rise Residential Buildings.
3. ANSI Z21.47/UL1995 - Unitary Air Conditioning Standard for safety requirements.
4. ANSI/NFPA 70-1995 - National Electric Code. (all)
5. International Fuel Gas Code (g/e)
6. NFPA 90 A & B - Installation of Air Conditioning and Ventilation Systems and Installation

of Warm Air Heating and Air Conditioning Systems. (all)

D. SUBMITTALS

1. Submit unit performance data including: capacity, nominal and operating performance.
2. Submit Mechanical Specifications for unit and accessories describing construction, components and options.
3. Submit drawings indicating overall dimensions as well as installation, operation and services clearances. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.
4. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or MCA, sequence of operation, safety and start-up instructions.
5. Drawings submitted for approval shall be accompanied by a copy of the purchase agreement between the Contractor and an authorized service representative of the manufacturer for check, test and start up and first year service.
6. Submit ISMRE value as per AHRI 920.
7. Submit sequence of operation.
 1. Submit BACnet integration guide detailing all the data points available for integration. At a minimum, the BACnet guide shall include:
 - A. BACnet Protocol Implementation Conformance Statement (PICS)
 - B. Object types: descriptions and configuration
 - C. BACnet protocol: data link layers, device address binding, networking options, and character sets
 - D. Object data points and configurations. Object Types with descriptions and configurations for each point (Required Properties Read, Properties Written, Optional Properties Read, Ability to Create, Ability to Delete)
 - E. Interoperability Building Blocks
 - F. Object Data Points and Diagnostic Data Points (for each data point)
 - G. BACnet Type (AI, AV, BV, MI, MV, etc) (for each data point)
 - H. BACnet Property Values (for each data point)
 - I. Baud Rate and Supported Character Sets
 - J. Inputs With Alarming Capabilities

8. Failure to submit any of these items or an impartial submittal will result in submittal rejection. Piece meal submittals are not acceptable

E. DELIVERY, STORAGE and HANDLING

1. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
2. Protect units from physical damage. Leave factory shipping covers in place until installation.
3. Units to be secured via base rail tie-down locations.

F. WARRANTY

1. Provide parts warranty extending either 12-months from date of unit start-up or a maximum of 18-months from unit ship date.
2. Provide twenty-five year heat exchanger limited warranty from unit ship date.
3. 5 year compressor warranty for units 25 tons and below.

G. REGULATORY REQUIREMENTS

1. Unit shall conform to the appropriate standards listed in Section 103 as well as be listed and labeled by a Nationally Recognized Testing Laboratory (NRTL) for compliance with the following applicable standards.
 1. Standard for Safety Heating and Cooling Equipment-Fourth Edition, UL 1995/CSA C22.2#236 Issue: 2011/10/14
 2. Standard for Gas Unit Heaters And Gas-Fired Duct Furnaces ANSI Z83.8-2013, CSA 2.6-2013, Third Edition – 2006 (indirect gas-fired/e)
 3. Standard for Non-Recirculating Direct Gas-Fired Industrial Air Heaters, ANSI Z83.4 / CSA 3.7 - Issued: 2013/03/01 Ed: 3
 4. In the event the unit is not approved by an NRTL for compliance with the appropriate standards, the manufacturer shall, at manufacturer's expense, provide for a field certification and labeling of unit by an NRTL to the appropriate standards. Manufacturer shall, at manufacturer's cost, complete any and all modifications required by NRTL prior to certification and field labeling. Manufacturer shall include coverage of all modifications in unit warranty.

H. EXTRA MATERIALS

1. Provide one set of filters.

2. PRODUCTS

A. SUMMARY

1. The contractor shall furnish and install packaged outdoor air unit(s) as shown and scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.
2. APPROVED MANUFACTURERS
 1. Trane: Horizon™ Model OAU (Packaged Outdoor Air Unit)
 2. Addison: TRS-Series
 3. LC-Systems: Commander
 4. Substitutions: Approved Equal.

B. GENERAL UNIT DESCRIPTION

1. Unit(s) furnished and installed shall be packaged outdoor air unit(s) as scheduled on contract documents and described in these specifications. Unit(s) shall be designed for dehumidification, cooling and/or heating of 100% Outdoor Air. For dehumidification and cooling modes the evaporator temperature shall be monitored, reported at unit controller. Compressor controls shall modulate capacity to maintain evaporator leaving set point. Hot Gas Bypass shall not be used to control compressor capacity. Compressor Hot Gas Reheat (HGRH) shall be factory installed. To prevent rehydration of evaporator condensate the reheat coil face shall be located a minimum of 6" downstream from the leaving face of the evaporator coil. Heating system shall include modulating controls. Compressor on-off only or primary heating on-off only controls shall not be acceptable control strategies.
2. Unit(s) shall have labels, decals, and/or tags to aid in the service of the unit and indicate caution areas.
3. Unit discharge airflow configuration shall be:
 1. Horizontal discharge through side of unit.
4. Units shall be dedicated horizontal airflow as manufactured. Unit is to be supplied in horizontal configuration with factory supplied duct flanges.
 1. As a substitute, contractor may use a downflow unit with an elevated curb that has horizontal duct transitions. The curb shall be at least 42" tall to allow for proper duct sizing and snow loading. The contractor must provide the curb with:
 - A. Elevated service platform, 4 feet in depth around entire perimeter.
 - B. Guard rail around entire perimeter of service platform of at least 45 inches or complying with OSHA regulations
 - C. Steps allowing for unencumbered access to platform. Ladders are NOT allowed.
 - D. Service disconnect located at step entrance at code compliant height.
 - E. All impacts from using an elevated curb with platform (structural, concrete, electrical, mechanical, architectural, engineering) shall be borne solely by the

installing contractor with no cost to the owner. Any structural impact must be evaluated by a New Jersey licensed structural engineer. Engineer shall provide signed and sealed drawings show that the impact has been addressed. Engineer's fees shall be borne solely by the installing contractor with no cost to the owner.

C. CABINET

1. Cabinet panels: 2" double-wall foamed panel construction throughout the indoor section of unit to provide nonporous, cleanable interior surfaces. All interior seams exposed to airflow shall be sealed.
2. Insulation: 2" polyisocyanurate foam metal encapsulated with no exposed edges. Initial R value of 6.6 per inch of thickness.
3. Cabinet base shall be double wall construction designed to prevent trapping or ponding of water within the unit base. Cabinet base pan shall be insulated with 2" thick polyisocyanurate foam. Foam insulation shall be fully enclosed with galvanized steel insulation cover. Insulation shall not be applied to underside of unit base.
4. Cabinet Base Rails: Side and end base rails shall include openings for forklift and tie-down access. To protect unit base from fork damage side rails shall include removable heavy gauge fork pockets.
5. Shipping anchors attach to and/or through unit base rails. Straps over unit shall not be used to secure unit for shipping.
6. Cabinet material interior and base rails: shall be G-90 zinc-coated galvanized steel. Material gauge shall be a minimum of 14-gauge for base rails, 16-gauge for structural members and 20-gauge for access doors and cabinet panels.
7. Exterior Corrosion Protection: Exterior cabinet panels shall be a base coat of G-90 galvanized steel with both exterior and interior surfaces cleaned, phosphatized and finished with a weather-resistant baked enamel finish. Unit's surface shall be in compliance with ASTM B45 salt spray testing at a minimum of 672 hour duration.
8. Cabinet construction shall provide hinged panels providing easy access for all parts requiring routine service.
9. Cabinet top cover shall be one piece construction or where seams exist, it shall be double-hemmed and gasket-sealed.
10. Hinged Access Panels: Water- and air-tight hinged access panels shall provide access to all areas requiring routine service including air filters, heating section, electrical and control cabinet sections, optional ERV and power exhaust fan section, supply air fan section, evaporator and reheat coil sections. Insulated doors shall be constructed to allow the hinges to be reversed in the field.
 1. Hold-open devices shall be factory installed on all hinged access doors. Chains shall not be used as hold-open devices.

2. Latches with locking hasp or tool operated closure devices shall be factory installed on all hinged access panels.
11. Drain Pan material shall be Type 430 Stainless steel drain and constructed to sloped in two directions to ensure positive drainage with corners exposed to standing water and drain fittings welded liquid tight to prevent leaks. Pan shall have a minimum depth of 2". Base of drain pan shall be insulated with 1" thick foam insulation.
12. Provide openings either on side of unit or thru the base for power, control and gas connections.
13. Cabinet shall include optional interior liner constructed of Type 304 stainless steel with sealed seams.
14. Unit shall be equipped with a 6" filter rack upstream of the evaporator. Frame shall be field-adjustable to match any filter combination specified in the following section.

D. FANS AND MOTORS

1. Indoor fans shall be high efficiency backward curved impeller.
2. The indoor fan motor shall be an electronic commutated motor with integrated power electronics for variable motor speed.
3. Outdoor fans shall be direct drive with premium efficiency motors, statically and dynamically balanced, draw through in the vertical discharge position.
4. Provide shafts constructed of solid hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.

E. AIR FILTERS

1. Evaporator Inlet shall include a full compliment of pleated media air filters. Filters shall be:
 - a. 2" deep MERV 8
 - b. 2" deep MERV 13

F. DAMPERS

1. Unit shall include a motor operated outdoor air damper constructed of galvanized steel.
2. Damper blades shall be air foil design with rubber edge seals designed not to exceed a 4 CFM/SQ FT leakage rate exceeding ASHRAE 90.1 damper leakage requirements.
3. Damper actuator shall be factory mounted and wired sealed spring return and either two-position or fully modulating.
4. Dampers air velocity shall not exceed 2000 fpm.
5. Return Air damper shall be of same material, construction and leakage rate as outdoor air damper. Return air damper actuator shall be factory mounted and wired sealed spring fully modulating and operate based on outdoor air damper feedback signal to properly regulate RA airflow.

G. DEHUMIDIFICATION/COOLING

1. Compressors

1. All units shall have direct-drive, scroll type compressors.
2. Digital Scroll Compressor shall be supplied.
 - a. Standard compressors with hot gas bypass (Emerson, Rawal, etc) are NOT acceptable.
3. Motor shall be suction gas-cooled and shall have a voltage utilization range of plus or minus 10 percent of unit nameplate voltage.
4. Internal overloads shall be provided with the scroll compressors.
5. Each compressor shall have a crankcase heater to minimize the amount of liquid refrigerant present in the oil sump during off cycles.
6. Each compressor shall be mounted on rubber vibration isolators, to reduce the transmission of noise.
7. Provide each unit with <<CIRCUIT_AMOUNT>> hermetically sealed refrigerant circuit(s) factory-supplied completely piped with liquid line filter-drier, liquid line charging port, suction and liquid line pressure ports, sight glass, and thermal expansion valve.
8. Provide each circuit with automatic reset high and low pressure and high temperature switches for safety control.

B. Coils

1. Evaporator, Condenser and Hot Gas Reheat coils shall be constructed with copper tubes mechanically bonded to configured aluminum plate fins.
2. Coils shall be factory leak tested in accordance ANSI/ASHRAE 15-1992 at a minimum pressure of 500 PSIG.
3. The condenser coil shall have a fin designed for ease of cleaning.
4. Evaporator coil shall include (six / four) rows of cooling interlaced for superior sensible and latent cooling with a maximum of 12 FPI for ease of cleaning.
5. Reheat coil shall be fully integrated into the supply airstream and be capable of delivering design supply air temperature.
6. To prevent re-hydration of condensate from evaporator coil, the evaporator coil face and the hot gas reheat coil face shall be separated by a minimum of six inches.
7. Condenser coil hail guards shall be factory installed.

C. Condenser Section

1. Outdoor Fans: Shall be direct drive vertical discharge design with low-noise corrosion resistant glass reinforced polypropylene props, powder coated wire discharge guards and electro-plated motor mounting brackets.
2. Fans shall be statically and dynamically balanced.

D. Compressor Capacity Control

1. Electronic Control: (Requires Digital Scroll Compressor be selected in compressor section of this specification.) Compressor output capacity shall be controlled by the Main Control Module. (refer to unit control and sequence sections of this specification)

H. HEATING

1. Modulating Indirect Gas Fired Heating System

1. Completely assembled and factory installed heating system shall be located in the primary heating position located downstream of the indoor fan assembly and be integral to unit and approved for use downstream from refrigerant cooling coils in units mounted outdoors. Threaded gas connection shall terminate at manual shut-off valve. Provide capability for sidewall or thru-base gas piping.
2. Heaters shall include high turn-down burners firing into individual stainless steel tubular heat exchangers. Heat exchangers shall be constructed of type 439 stainless steel and be a high efficiency dimpled tubular design capable of draining internal condensate. Units with multiple heaters shall include one fully modulating high turndown heater with additional on-off heater sections. Total heater turndown shall be based on heater gas input capacity 5:1 when ≤ 150 MBH or a minimum of 10:1 when > 150 MBH.
3. Heater outdoor air inlet shall be hooded and include internal baffle system to prevent rain blow thru. To prevent recirculation of flue gas and to prevent flue gas condensate from draining onto and obstructing the heater air inlet the inlet shall be hooded and shall be located a minimum of 11" beneath the flue outlet. Inlet hood shall include bird screen.
4. Heater flue outlet(s) shall include hooded outlet with wire cloth all constructed of Type 430 stainless steel. Hooded outlet shall be sealed to prevent flue gas recirculation.
5. Gas Burner Safety Controls: Provide safety controls for the proving of combustion air prior to ignition, continuous air proving monitoring following ignition and continuous electronic flame supervision.
6. Unit controls shall monitor heat output and shall discontinue all heating attempts and or unit operation in the event the heating section fails to ignite or fails to maintain programmed supply air temperature/time.
7. Inducer fan shall be direct drive high pressure centrifugal type with two speeds and shall include built- in thermal overload protection.

8. Limit controls: High temperature automatic reset limits shall be located on blower wall and in indoor fan chamber to shut off gas flow in the event of excessive temperatures resulting from restricted indoor airflow, or loss of indoor airflow.
9. Flame roll-out safeties shall provide continuous monitoring of proper burner operation.

I. ELECTRICAL RATINGS AND CONNECTIONS

1. All high voltage power components such as fuses, switches and contactors shall include a service personnel protection barrier or shall be a listed as touch-safe design.
2. Field wiring access to be provided thru unit base into isolated enclosure with removable cover.
3. Power wiring to be single point connection.
4. Wiring internal to the unit shall be colored and numbered for identification.
5. Unit shall be factory wired to field wiring terminal block mounted in isolated enclosure.
6. Factory wired main power disconnect and overcurrent device shall be rated for total unit connected power
7. Unit SCCR rating shall be a minimum of 5kA
8. Factory wired Voltage/Phase monitor shall be included as standard. In the event of any of the following, the units will be shut down and a fault code will be stored in the monitor for the most recent 25 faults. Upon correction of the fault condition the unit will reset and restart automatically.
 1. Phase Unbalance Protection: Factory set 2%
 2. Over/Under/Brown Out Voltage Protection: +/-10% of nameplate voltage
 3. Phase Loss/Reversal
9. Factory to mount and wire optional 120 volt convenience outlet. Field wiring of convenience outlet not acceptable.
10. All low voltage field wiring connections shall be made at factory installed low voltage terminal strip.

J. UNIT CONTROLS

1. Main Unit Controller (MCM) shall be a microprocessor based controller with resident control logic. Controller program logic shall include
 1. Include single program with field selectable
 - A. Discharge Air control with unit conditioning modes enabled based on outdoor air conditions and controlled to maintain discharge air setpoints.
 - B. Space control with unit conditioning modes enabled and controlled to maintain space setpoints.
2. MCM shall:
 1. Prevent simultaneous operation of any conditioning modes.

2. Accept separate setpoints for Occupied and Unoccupied states.
 3. Call for Dehumidification based on dew point setpoints. When no call for Dehumidification is present MCM shall control calls for Cooling, Heating and Economizer modes based on sensible or enthalpy temperature setpoints. MCM shall have onboard clock and scheduling function for occupancy.
 4. Include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.
 5. Enable HGRH dehumidification and cooling modes and control modulation to maintain (discharge air temperature / space temperature).
 6. Unit shall include minimum discharge air control.
3. MCM Touch Screen shall include full color display and shall be (factory installed in unit control compartment / field mounted remote from unit and field wired up to a maximum of 300 ft.) and provide a full list of points included in the MCM. The display shall provide a list and history of all unit alarms.
 4. System Sensors shall include: Factory installed and wired Outdoor Air Temperature, Outdoor Air Humidity and Evaporator Leaving Air Temperature and factory furnished, field installed Discharge Air Temperature.
 1. Space Control or Single Zone VAV: Factory shall furnish Space Temperature and Space Humidity sensor for field installation and connection to the unit
 2. Powered Exhaust with Economizer includes duct pressure sensor to be field installed.
 5. System controls shall include:
 1. Anti-cycle timing.
 2. Minimum compressor run/off-times.
 6. Smoke Detectors to sense (Return Air / Discharge Air / Return and Discharge Air) stream(s) shall be factory installed and wired.
11. POWER EXHAUST
- A. Provide a factory installed power exhaust assembly that shall be designed to ventilate return air to atmosphere.
 - B. Plenum mounted direct drive airfoil design exhaust wheel material shall be heavy gauge aluminum, welded construction and rated for up to Class III speed/pressure performance. Belt-drive and/or forward curve plenums fans shall not be used.
 - C. Exhaust to discharge through powered isolation dampers located on each side of unit cabinet.
13. ROOF CURB
1. Contractor shall provide factory supplied 14" tall roof curb, 18 gauge perimeter made of zinc coated steel with supply and return air gasketing and wood nailer strips. Ship

knocked down and provided with instructions for easy assembly.

2. Curb shall be manufactured in accordance with the National Roofing Contractors Association guidelines.

14. EXECUTION

A. EXAMINATION

1. Contractor shall verify that roof is ready to receive work.
2. Contractor shall verify that proper power supply adequate to supply the unit.

B. INSTALLATION

1. Contractor shall install in accordance with manufacturer's instructions.
2. Mount units on factory built roof mounting frame providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.

15. MANUFACTURER'S FIELD SERVICES

- A. Unit start-up and commissioning shall be completed by a Factory-trained and factory-certified technician.

1. Manufacturer must have twenty factory-authorized and factory-trained technicians within a 50 mile radius of job site.

- B. The contractor shall furnish manufacturer complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

- C. Provide a minimum of eight hours owner training. Training shall be provided by factory trained and certified technicians.

END OF SECTION 237414

SECTION 23 82 39

UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cabinet unit heaters with centrifugal fans and hot-water heating coils.
 - 2. Propeller unit heaters with hot-water and electric-resistance heating coils.

1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. CWP: Cold working pressure.
- C. PTFE: Polytetrafluoroethylene plastic.
- D. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Plans, elevations, sections, and details.
 - 2. Location and size of each field connection.
 - 3. Details of anchorages and attachments to structure and to supported equipment.
 - 4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
 - 5. Location and arrangement of piping valves and specialties.
 - 6. Location and arrangement of integral controls.
 - 7. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Suspended ceiling components.
 2. Structural members to which unit heaters will be attached.
 3. Method of attaching hangers to building structure.
 4. Size and location of initial access modules for acoustical tile.
 5. Items penetrating finished ceiling, including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 6. Perimeter moldings for exposed or partially exposed cabinets.
- D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.
- E. Samples for Verification: Finish colors for each type of cabinet unit heater and wall and ceiling heaters indicated with factory-applied color finishes.
- F. Manufacturer Seismic Qualification Certification: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. 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."
 - b. 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."
 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.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.
- 1.5 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
 - C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Cabinet Unit Heater Filters: Furnish one spare filter for each filter installed.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Airtherm; a Mestek Company.
 - 2. Sterling
 - 3. Berko Electric Heating; a division of Marley Engineered Products.
 - 4. Carrier Corporation.
 - 5. Chromalox, Inc.; a division of Emerson Electric Company.
 - 6. Indeeco.
 - 7. International Environmental Corporation.
 - 8. Markel Products; a division of TPI Corporation.
 - 9. Marley Electric Heating; a division of Marley Engineered Products.
 - 10. QMark Electric Heating; a division of Marley Engineered Products.
 - 11. Trane.
- C. Description: A factory-assembled and -tested unit complying with ARI 440.
 - 1. Comply with UL 2021.
- D. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
 - 1. Vertical Unit, Exposed Front Panels: Minimum .0528-inch thick, galvanized, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
 - 2. Horizontal Unit, Exposed Bottom Panels: Minimum .0528-inch thick, galvanized, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
 - 3. Recessing Flanges: Steel, finished to match cabinet.
 - 4. Control Access Door: Key operated.
 - 5. Base: Minimum .0528-inch- thick steel, finished to match cabinet, 4 inches high with leveling bolts.
 - 6. Extended Piping Compartment: 8-inch wide piping end pocket.
 - 7. False Back: Minimum .0428-inch- thick steel, finished to match cabinet.
- E. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 - 1. Pleated: 90 percent arrestance and 7 MERV.

- F. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than .01 inch. and rated for a minimum working pressure of .200 psig. and a maximum entering-water temperature of .220 deg F.. Include manual air vent and drain.
- G. Fan and Motor Board: Removable.
 - 1. Fan: Forward curved, high static, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
 - 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- H. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."
- I. Electrical Connection: Factory wire motors and controls for a single field connection.

2.2 PROPELLER UNIT HEATERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Airtherm; a Mestek Company.
 - 2. Engineered Air Ltd.
 - 3. Modine.
 - 4. Rosemex Products.
 - 5. Ruffneck Heaters; a division of Lexa Corporation.
 - 6. Trane.
- C. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.
- D. Comply with UL 2021.
- E. Comply with UL 823.
- F. Cabinet: Removable panels for maintenance access to controls.
- G. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.
- H. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.
- I. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.
- J. General Coil Requirements: Test and rate hot-water propeller unit heater coils according to ASHRAE 33.

- K. Hot-Water Coil: Copper tube, minimum .025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than .1 inch. and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of .325 deg F., with manual air vent. Test for leaks to 350 psig underwater.
- L. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than .16 inch.. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed .550 deg F. at any point during normal operation.
 - 1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
 - 2. Wiring Terminations: Stainless-steel or corrosion-resistant material.
- M. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- N. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 1. Motor Type: Permanently lubricated, multispeed variable speed.
- O. Control Devices:
 - 1. Unit-mounted or Wall-mounted thermostat.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 07 Section "Joint Sealants."
- B. Install cabinet unit heaters to comply with NFPA 90A.
- C. Install propeller unit heaters level and plumb.
- D. Suspend cabinet unit heaters from structure with elastomeric hangers and seismic restraints. Vibration isolators and seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

- E. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers with vertical-limit stop. Hanger rods and attachments to structure are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- F. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- G. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 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 cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
- D. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."
- E. Comply with safety requirements in UL 1995.
- F. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."
- G. Unless otherwise indicated, install union and gate or ball valve on steam-supply connection and union, strainer, steam trap, and gate or ball valve on condensate-return connection of unit heater. Steam specialties are specified in Division 23 Section "Steam and Condensate Heating Piping."
- H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 238239

SECTION 26 04 50
ELECTRICAL DEMOLITION & RENOVATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 REFERENCE CODES AND STANDARDS

- A. The work shall conform to:
 - 1. National Electrical Code
 - 2. State and Local Codes

PART 2 - PRODUCTS

- 2.1 Materials used for this work shall be in accordance with the applicable specification sections in Division 16.

PART 3 - EXECUTION

- 3.1 Provide demolition, relocation, and alteration of electrical construction as required.
 - A. The contractor shall notify the owner 48 hours in advance of any interruptions of electric service to any area of the building.
 - B. All interruptions of electric service shall be kept to a minimum. Where power is to be interrupted longer than twenty (20) minutes, the work shall be done after normal business hours, and where necessary, temporary power shall be provided by means of additional temporary feeds or by means of a generator.
 - C. Should the electrical service be disrupted do to construction while the building is occupied the contractor shall provide temporary electrical power at no additional cost to the contract.
- 3.2 Check the locations of all existing electrical work, such as lighting fixtures, electrical conduit, wiring, fittings, controls, starters and other electrical construction and provide the removing, relocating, rerouting, and reconnecting of this work due to demolition and new construction. Any existing apparatus or wiring device to be retained shall be disconnected, relocated and reinstalled as required, to allow for new wall, floor or ceiling finishes.
- 3.3 Methods of installation and standards of workmanship shall be in accordance with the applicable specification sections under Division 16.

- 3.4 Where existing equipment will remain in service during construction, provide rerouting and reconnection of electrical service as required.
- 3.5 Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- 3.6 Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety.
- 3.7 Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm), below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- 3.8 Remove demolished material from project site. Any particular equipment that the owner wants saved shall be stored as directed.
- 3.9 Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- 3.10 Feeders or circuits, whether spliced, extended, relocated or new, shall maintain amperage and continuity of that respective feeder or circuit.
- 3.11 Where new work interferes with existing work or other trades, relocate such existing work without additional cost. Approval by the Owner's Representative must be given before any relocation work can begin. The relocation work shall be done in a manner acceptable to the Owner. Engage Contractor of the appropriate trade to do the work.

END OF SECTION 260450

SECTION 26 05 00

COMMON WORK REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Raceways.
 - 2. Building wire and connectors.
 - 3. Supporting devices for electrical components.
 - 4. Electrical identification.
 - 5. Utility company electricity-metering components.
 - 6. Concrete equipment bases.
 - 7. Electrical demolition.
 - 8. Cutting and patching for electrical construction.

1.2 SUBMITTALS

- A. Product Data: For utility company electricity-metering components.
- B. Shop Drawings: Dimensioned plans and sections or elevation layouts and single-line diagram of electricity-metering component assemblies specific to this Project.

1.3 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. The contractor shall be fully responsible in the coordination and installation of all electrical products as per the manufacturer's recommendations. Should the contractor alter or change the manufacturer's installation recommendations, the contractor shall submit a certified installation report from the manufacturer's representative stating the installed is acceptable. Any discrepancies in the installation shall be corrected per the manufacturer's requirements at no additional cost to the owner and before final closeout of the project.
- C. Devices for Utility Company Electricity Metering: Comply and coordinate with local utility company requirements and Specification Section 262713 – Electricity Metering.
- D. Comply with NFPA 70.

1.4 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings for electrical supports, raceways, and cable with general construction work and all trades.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment that requires positioning before closing in the building or space.
- C. Coordinate all electrical service connections to components furnished by utility companies.
 - 1. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for service entrances and electricity-metering components.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."
- E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

1.5 ITEMS NOT SHOWN OR SPECIFIED

- A. Any item of material not indicated on the drawings and/or not specified, but which is required for the complete and proper installation and/or operation of any part of the work, shall be provided as if indicated and specified, at no additional cost to the Owner.
- B. Any work not indicated on the drawings and/or not specified, but which is required for compliance with applicable codes and regulations, shall be provided as if indicated and specified, at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 RACEWAYS

- A. EMT: Electrical metallic tubing; ANSI C80.3, zinc-coated steel, with compression fittings.
- B. FMC: Flexible metal conduit; zinc-coated steel.
- C. IMC: Intermediate metal conduit; ANSI C80.6, zinc-coated steel, with threaded fittings.
- D. LFMC: Liquidtight flexible metal conduit; zinc-coated steel with sunlight-resistant and mineral-oil-resistant plastic jacket.
- E. RMC: Rigid metal conduit; galvanized rigid steel; ANSI C80.1.
- F. RNC: Rigid nonmetallic conduit; NEMA TC 2, Schedule 40 PVC, with NEMA TC3 fittings.
- G. Raceway Fittings: Specifically designed for raceway type with which used.

2.2 WIRES, CABLES, AND CONNECTIONS

- A. Conductors, No. 10 AWG and Smaller: Solid or stranded copper.
- B. Conductors, Larger Than No. 10 AWG: Stranded copper.
- C. Insulation: Thermoplastic, rated 600 V, 75 deg C minimum, Type THW, THHN-THWN, or USE depending on application..
- D. Wire Connectors and Splices: Units of size, ampacity rating, material, type, and class suitable for service indicated.

2.3 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel: Flange edges turned toward web, and .9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs. Strength rating to suit structural loading.
- D. Nonmetallic Slotted Channel and Angle: Structural-grade, factory-formed, glass-fiber-resin channels and angles with .9/16-inch- (14-mm-) diameter holes at a maximum of .8 inches (203 mm) o.c., in at least one surface. Strength rating to suit structural loading.
- E. Slotted Channel Fittings and Accessories: Recommended by the manufacturer for use with the type and size of channel with which used.
 - 1. Materials: Same as channels and angles, except metal items may be stainless steel.
- F. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
- G. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- H. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for nonarmored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- I. Expansion Anchors: Carbon-steel wedge or sleeve type.
- J. Toggle Bolts: All-steel springhead type.
- K. Powder-Driven Threaded Studs: Heat-treated steel.

2.4 ELECTRICAL IDENTIFICATION

- A. Identification Device Colors: Use those prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than .1 inch wide by 3 mils thick (25 mm wide by 0.08 mm thick).
- C. Tape Markers for Conductors: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- D. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
- E. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape compounded for permanent direct-burial service, and with the following features:
 - 1. Not less than 6 inches wide by 4 mils thick (150 mm wide by 0.102 mm thick).
 - 2. Embedded continuous metallic strip or core.
 - 3. Printed legend that indicates type of underground line.
- F. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners .1/16-inch (1.6-mm) minimum thickness for signs up to 20 sq. in. (129 sq. cm) and .1/8-inch (3.2-mm) minimum thickness for larger sizes. Engraved legend in black letters on white background.
- G. Warning and Caution Signs: Preprinted; comply with 29 CFR 1910.145, Chapter XVII. Colors, legend, and size appropriate to each application.
 - 1. Interior Units: Aluminum, baked-enamel-finish, punched or drilled for mechanical fasteners.
 - 2. Exterior Units: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate with .0396-inch (1-mm), galvanized-steel backing. .1/4-inch (6-mm) grommets in corners for mounting.
- H. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.5 EQUIPMENT FOR UTILITY COMPANY'S ELECTRICITY METERING

- A. Comply with requirements of the local electrical power utility company for meter sockets and current transformer cabinet and as per Specification Section 262713 – Electricity Metering.
- B. Provide Cold Sequence Meter Protection Switch as required by the Local Utility Company.

2.6 CONCRETE BASES

- A. Not applicable

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

- A. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom.
- B. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- C. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- D. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 RACEWAY APPLICATION

- A. Outdoor Installations:
 - 1. Exposed: RGS.
 - 2. Concealed: RGS.
 - 3. Underground, Single Run: RNC.

4. Underground, Grouped: RNC.
 5. Connection to Vibrating Equipment: LFMC.
 6. Boxes and Enclosures: NEMA 250, Type 3R or Type 4, unless otherwise indicated.
- B. Indoor Installations:
1. Exposed: EMT except in wet or damp locations, use IMC.
 2. Concealed in Walls or Ceilings: FMC.
 3. In Concrete Slab: RNC.
 4. Below Slab on Grade or in Crawlspace: RNC
 5. Connection to Vibrating Equipment: FMC; except in wet or damp locations: LFMC.
 6. Boxes and Enclosures: NEMA 250, Type 1, unless otherwise indicated.

3.3 RACEWAY AND CABLE INSTALLATION

- A. Conceal raceways and cables, unless otherwise indicated, within finished walls, ceilings, and floors.
- B. Keep legs of raceway bends in the same plane and keep straight legs of offsets parallel.
- C. Use RMC elbows where RNC turns out of slab.
- D. Where required to provide a Rough-in Only device application concealed within the vertical walls the contractor shall provide the device work box and ¾" EMT raceway to above the ceiling with a 90 degree bend turned into the ceiling space and apply an open end plastic bushing or cap for future wiring application.
- E. Install pull wires in empty raceways. Use No.14 AWG zinc-coated steel or woven polypropylene or monofilament plastic line with not less than 200-lb. (90-kg) tensile strength. Leave at least 12 inches. (300 mm) of slack at each end of pull wires.
- F. Connect motors and equipment subject to vibration, noise transmission, or movement with a maximum of 72-inches. (1830-mm) flexible conduit. Install LFMC in wet or damp locations. Install separate ground conductor across flexible connections.

3.4 WIRING METHODS FOR POWER, LIGHTING, AND CONTROL CIRCUITS

- A. Application: Use wiring methods specified below to the extent permitted by applicable codes as interpreted by authorities having jurisdiction.
- B. Exposed Feeders: Insulated single conductors in raceway.
- C. Concealed Feeders in Concrete: Insulated single conductors in PVC raceway.
- D. Exposed Branch Circuits Insulated single conductors in raceway.
- E. Concealed Branch Circuits: Insulated single conductors in FMC raceway.
- F. Underground Feeders and Branch Circuits: Insulated single conductors in raceway.
- G. Remote-Control Signaling and Power-Limited Circuits, Classes 1, 2, and 3: Insulated conductors in FMC raceway unless otherwise indicated.

3.5 WIRING INSTALLATION

- A. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

3.6 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, slotted channel system components.
- B. Dry Locations: Steel materials.
- C. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four with, 200-lb. (90-kg) minimum design load for each support element.

3.7 SUPPORT INSTALLATION

- A. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

- B. Size supports for multiple raceway or cable runs so capacity can be increased by a 25 percent minimum in the future.
- C. Support individual horizontal single raceways with separate, malleable-iron pipe hangers or clamps.
- D. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- E. Secure electrical items and their supports to building structure, using the following methods unless other fastening methods are indicated:
 - 1. Wood: Wood screws or screw-type nails.
 - 2. Gypsum Board: Toggle bolts. Seal around sleeves with joint compound, both sides of wall.
 - 3. Masonry: Toggle bolts on hollow block and expansion bolts on solid block. Seal around sleeves with mortar, both sides of wall.
 - 4. New Concrete: Concrete inserts with machine screws and bolts.
 - 5. Existing Concrete: Expansion bolts or threaded studs driven by powder charge and provided with lock washers.
 - 6. Structural Steel: Welded threaded studs.
 - a. Comply with AWS D1.1 for field welding.
 - 7. Light Steel Framing: Sheet metal screws.
 - 8. Fasteners for Damp, Wet, or Weather-Exposed Locations: Stainless steel.
 - 9. Light Steel: Sheet-metal screws.
 - 10. Fasteners: Select so load applied to each fastener does not exceed 25 percent of its proof-test load.

3.8 FIRESTOPPING

- A. Apply firestopping to cable and raceway sleeves and other penetrations of fire-rated floor and wall assemblies to restore original undisturbed fire-resistance ratings of assemblies.

3.9 DEMOLITION

- A. Protect existing electrical equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- B. Accessible Work: Remove exposed electrical equipment and installations, indicated to be demolished, in their entirety and back to electrical panel source..
- C. Abandoned Work: Cut and remove buried raceway and wiring, indicated to be abandoned in place, 2 inches (50 mm) below the surface of adjacent construction. Cap raceways and patch surface to match existing finish.
- D. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.

3.10 TEMPORARY ELECTRICAL POWER / SERVICES

- A. Provide all necessary temporary electrical construction power by either a temporary service power pole or by portable generator to maintain adequate electrical power requirements for the duration of construction.
- B. Should the project include demolition or disruption of an existing electrical service the contractor shall provide temporary back-up power source and connection that meets the demand requirements of the disturbed service at no additional cost to the project or owner.

3.11 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair, refinish and touch up disturbed finish materials and other surfaces to match adjacent undisturbed surfaces.

END OF SECTION 26 05 00

SECTION 26 05 19

CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

- A. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.4 QUALITY ASSURANCE

- A. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled" as defined in NFPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. Comply with NFPA 70.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver wires and cables according to NEMA WC 26.

1.6 COORDINATION

- A. Coordinate layout and installation of cables with other installations.
- B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Engineer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 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 manufacturers specified.

2.2 CONDUCTORS AND CABLES

- A. Manufacturers:
 - 1. American Insulated Wire Corp.; a Leviton Company.
 - 2. General Cable Corporation.
 - 3. Rome Cable Company.
 - 4. Southwire Corporation.
 - 5. Thermon
 - 6. Raychem; a Tyco Company

- 7. Or Approved Equal
- B. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.
- C. Conductor Material: Copper complying with NEMA WC 5 or 7; solid conductor for No. 10 AWG and smaller, stranded for No. 8 AWG and larger.
- D. Conductor Insulation Types: Type THW, THHN-THWN, XHHW and SO complying with NEMA WC 5 or 7.
- E. Multiconductor Cable: Armored cable Type AC, Metal-clad cable Type MC, and Type SO with ground wire. Armor shall be steel interlocked covering.
- F. Self-Regulating Heating Cable
 - A. Low Temperature - Self-Regulating Heating Cable
 - 1. Heating cables shall be self-regulating, capable of maintaining process temperatures up to 150°F and a continuous exposure to pipeline temperature of 185°F while de-energized.
 - 2. Cable must be of parallel construction so that it can be cut to length without changing its power output per unit length.
 - 3. The heater cable assembly shall have a monolithic heating core construction consisting of two parallel 16 AWG nickelplated copper bus conductors with a semiconductive PTC polymer extruded over and between these parallel conductors. A polyethylene dielectric insulating jacket is extruded over the heating element core.
 - 4. The semiconductive heating matrix and primary insulating jacket shall be cross-linked by irradiation.
 - 5. The basic cable will be covered by means of a metallic braid of tinned copper. The braid will provide a nominal coverage of eighty percent (80%) and will exhibit a resistance not exceeding 0.00045 ohm/ft.
 - 6. The cable shall be covered with a corrosion resistant overjacket of thermoplastic elastomer (for possible exposure to aqueous solutions, mild acids or bases) or fluoropolymer (for possible exposure to organic chemicals or corrosives).
 - 7. For longer circuit lengths and higher heat loss requirements greater than 10 W/ft @ 50°F, the heating cable shall have 14 AWG nickel-plated copper bus conductors.
 - 8. Long term stability shall be established by the service life
 - a. performance test per IEEE 515 Std-2004.
 - 9. Where self regulating cable is required the contractor shall also include all required control, thermostatic equipment and overcurrent protection to achieve the safe operating requirements recommended by the manufacturer.

2.3 CONNECTORS AND SPLICES

- A. Manufacturers:
 - 1. AFC Cable Systems, Inc.
 - 2. AMP Incorporated/Tyco International.
 - 3. Hubbell/Anderson.
 - 4. O-Z/Gedney; EGS Electrical Group LLC.
 - 5. 3M Company; Electrical Products Division.
 - 6. Or Approved Equal
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR AND INSULATION APPLICATIONS

- A. Service Entrance: Type THHN-THWN, single conductors in raceway, XHHW, single conductors in raceway.
- B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.
- E. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway, Armored cable Type AC, Metal-clad cable Type MC.
- G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.
- H. Branch circuit homeruns exposed: Type THHN-THWN, single conductors in EMT or RMC.
- I. Cord Drops and Portable Appliance Connections: Type SO, hard service cord.
- J. Fire Alarm Circuits: Type THHN-THWN, in raceway or Power-limited, fire-protective, signaling circuit cable in steel armor spiral cover, colored red.
- K. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- L. Class 2 Control Circuits: Power-limited cable, concealed in building finishes.

3.2 INSTALLATION

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- C. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips, which will not damage cables or raceway.
- D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- E. Support cables according to Division 26 Section "Basic Electrical Materials and Methods."
- F. Provide an additional two thousand linear feet of cable/conductor and accessories of each type and size used on the project to accommodate any changes required to resolve interferences or as directed by the Engineer.
- G. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."
- H. Identify and color-code conductors and cables according to Division 26 Section "Electrical Identification."

3.3 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least .12 inches (300 mm) of slack.

3.4 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.
- B. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

SECTION 26 05 26

GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section Includes Grounding Of Electrical Systems And Equipment. Requirements Specified In This Section May Be Supplemented By Requirements Of Other Sections.

1.2 SUBMITTALS

- A. Product Data: For Ground Rods And Chemical Rods.
- B. Field Quality-Control Test Reports.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, And Accessories: Listed And Labeled Under UI 467 As Defined In NFPA 70, Article 100, By A Testing Agency Acceptable To Authorities Having Jurisdiction, And Marked For Intended Use.
- B. Comply With NFPA 70; For Overhead-Line Construction And Medium-Voltage Underground Construction, Comply With IEEE C2.
- C. Comply With NFPA 780 And UI 96 When Interconnecting With Lightning Protection System.

1.4 EXTRA MATERIALS

- A. Furnish Extra Materials Described Below That Match Products Installed And That Are Packaged With Protective Covering For Storage And Identified With Labels Describing Contents.
 - 1. Ground Rods-Provide An Additional 4 Ground Rods Of Each Type And Size Utilized On This Project.
 - 2. Ground Conductors-Provide An Additional 150 Feet Of Each Ground Conductor Type And Size Utilized On This Project.
 - 3. Ground Connections-Provide An Additional 4 Connections Of Each Type And Size Utilized On This Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject To Compliance With Requirements, Provide Products By One Of The Following:
 - 1. Apache Grounding/Erico Inc.
 - 2. Boggs, Inc.
 - 3. Chance/Hubbell.
 - 4. Copperweld Corp.
 - 5. Dossert Corp.
 - 6. Erico Inc.; Electrical Products Group.
 - 7. Framatome Connectors/Burndy Electrical.
 - 8. Ideal Industries, Inc.
 - 9. IlSCO.
 - 10. Kearney/Cooper Power Systems.

11. Korns, C. C. Co.; Division Of Robroy Industries.
12. Lightning Master Corp.
13. Lyncole Xit Grounding.
14. O-Z/Gedney Co.; A Business Of The Egs Electrical Group.
15. Raco, Inc.; Division Of Hubbell.
16. Robbins Lightning, Inc.
17. Salisbury, W. H. & Co.
18. Superior Grounding Systems, Inc.
19. Thomas & Betts, Electrical.
20. Or Approved Equal

2.2 GROUNDING CONDUCTORS

- A. For Insulated Conductors, Comply With Division 16 Section "Conductors And Cables."
- B. Equipment Grounding Conductors: Insulated With Green-Colored Insulation.
- C. Isolated Ground Conductors: Insulated With Green-Colored Insulation With Yellow Stripe. On Feeders With Isolated Ground, Use Colored Tape, Alternating Bands Of Green And Yellow Tape To Provide A Minimum Of Three Bands Of Green And Two Bands Of Yellow.
- D. Grounding Electrode Conductors: Stranded Cable.
- E. Underground Conductors: Bare, Tinned, Stranded, Unless Otherwise Indicated.
- F. Bare, Solid-Copper Conductors: Astm B 3.
- G. Assembly Of Bare, Stranded-Copper Conductors: Astm B 8.
- H. Bare, Tinned-Copper Conductors: Astm B 33.
- I. Copper Bonding Conductor: No. 4 Or No. 6 Awg, Stranded Copper Conductor.
- J. Copper Bonding Jumper: Bare Copper Tape, Braided Bare Copper Conductors, Terminated With Copper Ferrules; 1-5/8 Inches (42 Mm) Wide And 1/16 Inch (1.5 Mm) Thick.
- K. Tinned-Copper Bonding Jumper: Tinned-Copper Tape, Braided Copper Conductors, Terminated With Copper Ferrules; 1-5/8 Inches (42 Mm) Wide And 1/16 Inch (1.5 Mm) Thick.
- L. Ground Conductor For Overhead Distribution: No. 4 Awg Minimum, Soft-Drawn Copper.
- M. Grounding Bus: Bare, Annealed Copper Bars Of Rectangular Cross Section, With Insulated Spacer.
- N. Connectors: Comply With IEEE 837 And UL 467; Listed For Use For Specific Types, Sizes, And Combinations Of Conductors And Connected Items. Compression Type Or Exothermic-Welded Type, In Kit Form, Selected Per Manufacturer's Written Instructions.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: Copper-Clad Steel.
- B. Ground Rods: Sectional Type; Copper-Clad Steel.
 1. Size: 3/4 By 120 Inches (19 By 3000 Mm) In Diameter.
- C. Chemical Electrodes: Copper Tube, Straight Or L-Shaped, Filled With Nonhazardous Chemical Salts, Terminated With A 4/0 Bare Conductor. Provide Backfill Material Recommended By Manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Use Only Copper Conductors For Both Insulated And Bare Grounding Conductors In Direct Contact With Earth, Concrete, Masonry, Crushed Stone, And Similar Materials.
- B. In Raceways, Use Insulated Equipment Grounding Conductors.

- C. Exothermic-Welded Connections: Use For Connections To Structural Steel And For Underground Connections.
- D. Grounding Bus: Install In Electrical And Telephone Equipment Rooms, In Rooms Housing Service Equipment, And Elsewhere As Indicated.
 - 1. Use Insulated Spacer; Space .1 Inch_ (25.4 Mm) From Wall And Support From Wall .6 Inches_ (150 Mm) Above Finished Floor, Unless Otherwise Indicated.
 - 2. At Doors, Route The Bus Up To The Top Of The Door Frame, Across The Top Of The Doorway, And Down To The Indicated Height Above The Floor.
- E. Underground Grounding Conductors: Use Tinned-Copper Conductor, No. 2/0 Awg Minimum. Bury At Least 24 Inches_ (600 Mm) Below Grade Or Bury .12 Inches_ (300 Mm) Above Duct Bank When Installed As Part Of The Duct Bank.
- F. Equipment Grounding Conductors: Comply With NFPA 70, Article 250, For Types, Sizes, And Quantities Of Equipment Grounding Conductors, Unless Specific Types, Larger Sizes, Or More Conductors Than Required By NFPA 70 Are Indicated.
 - 1. Install Insulated Equipment Grounding Conductors In Feeders And Branch Circuits.
 - 2. Busway Supply Circuits: Install Insulated Equipment Grounding Conductor From The Grounding Bus In The Switchgear, Switchboard, Or Distribution Panel To Equipment Grounding Bar Terminal On Busway.
 - 3. Computer Outlet Circuits: Install Insulated Equipment Grounding Conductor In Branch-Circuit Runs From Computer-Area Power Panels Or Power-Distribution Units.
 - 4. Isolated Grounding Receptacle Circuits: Install An Insulated Equipment Grounding Conductor Connected To The Receptacle Grounding Terminal. Isolate Grounding Conductor From Raceway And From Panelboard Grounding Terminals. Terminate At Equipment Grounding Conductor Terminal Of The Applicable Derived System Or Service, Unless Otherwise Indicated.
 - 5. Isolated Equipment Enclosure Circuits: For Designated Equipment Supplied By A Branch Circuit Or Feeder, Isolate Equipment Enclosure From Supply Raceway With A Nonmetallic Raceway Fitting Listed For The Purpose. Install Fitting Where Raceway Enters Enclosure, And Install An Insulated Equipment Grounding Conductor. Isolate Equipment Grounding Conductor From Raceway And From Panelboard Grounding Terminals. Terminate At Equipment Grounding Conductor Terminal Of The Applicable Derived System Or Service, Unless Otherwise Indicated.
 - 6. Nonmetallic Raceways: Install An Equipment Grounding Conductor In Nonmetallic Raceways Unless They Are Designated For Telephone Or Data Cables.
 - 7. Air-Duct Equipment Circuits: Install An Insulated Equipment Grounding Conductor To Duct-Mounted Electrical Devices Operating At 120 V And More, Including Air Cleaners And Heaters. Bond Conductor To Each Unit And To Air Duct.
 - 8. Water Heater, Heat-Tracing, And Antifrost Heating Cables: Install An Insulated Equipment Grounding Conductor To Each Electric Water Heater, Heat-Tracing, And Antifrost Heating Cable. Bond Conductor To Heater Units, Piping, Connected Equipment, And Components.
 - 9. Signal And Communication Systems: For Telephone, Alarm, Voice And Data, And Other Communication Systems, Provide No. 4 Awg Minimum Insulated Grounding Conductor In Raceway From Grounding Electrode System To Each Service Location, Terminal Cabinet, Wiring Closet, And Central Equipment Location.
 - a. Service And Central Equipment Locations And Wiring Closets: Terminate Grounding Conductor On A .1/4-By-2-By-12-Inch_ (6.4-By-50-By-300-Mm) Grounding Bus.
 - b. Terminal Cabinets: Terminate Grounding Conductor On Cabinet Grounding Terminal.
 - 10. Metal Poles Supporting Outdoor Lighting Fixtures: Provide A Grounding Electrode In Addition To Installing An Insulated Equipment Grounding Conductor With Supply Branch-Circuit Conductors.

11. Common Ground Bonding With Lightning Protection System: Bond Electrical Power System Ground Directly To Lightning Protection System Grounding Conductor At Closest Point To Electrical Service Grounding Electrode. Use Bonding Conductor Sized Same As System Grounding Electrode Conductor, And Install In Conduit.
- G. Metal Frame Grounding For Buildings: Drive A Ground Rod At The Base Of Every Corner Column And At Intermediate Exterior Columns At Distances Not More Than 60 Feet (18 M) Apart. Connect Rod To Column With An Underground Grounding Conductor. Interconnect Ground Rods With A Continuous Underground Conductor, Extending Around The Perimeter Of The Building, 24 Inches (600 Mm) Minimum From Building Foundation. Use Tinned-Copper Conductor Not Less Than No. 2/0 Awg For Underground Conductor, And Bury 18 Inches (450 Mm) Below Grade, Minimum.
- H. Building Ground Rings: Provide A Perimeter Ground Ring For The Entire Building As Required Per The National Electrical Code Article 250.66c.
- I. Bond All Concrete Encased Electrode (Foundation/Footing Reinforcing) Provide As Required Per National Electrical Code Article 250.66b.
- J. Ground Rods: Install At Least Three Rods Spaced At Least One-Rod Length From Each Other And Located At Least The Same Distance From Other Grounding Electrodes.
 1. Drive Ground Rods Until Tops Are 2 Inches (50 Mm) Below Finished Floor Or Final Grade, Unless Otherwise Indicated.
 2. Interconnect Ground Rods With Grounding Electrode Conductors. Use Exothermic Welds, Except As Otherwise Indicated. Make Connections Without Exposing Steel Or Damaging Copper Coating.
- K. Grounding Conductors: Route Along Shortest And Straightest Paths Possible, Unless Otherwise Indicated. Avoid Obstructing Access Or Placing Conductors Where They May Be Subjected To Strain, Impact, Or Damage.
- L. Bonding Straps And Jumpers: Install So Vibration By Equipment Mounted On Vibration Isolation Hangers Or Supports Is Not Transmitted To Rigidly Mounted Equipment. Use Exothermic-Welded Connectors For Outdoor Locations, Unless A Disconnect-Type Connection Is Required; Then, Use A Bolted Clamp. Bond Straps Directly To The Basic Structure Taking Care Not To Penetrate Any Adjacent Parts. Install Straps Only In Locations Accessible For Maintenance.
- M. Metal Water Service Pipe: Provide Insulated Copper Grounding Conductors, In Conduit, From Building's Main Service Equipment, Or Grounding Bus, To Main Metal Water Service Entrances To Building. Connect Grounding Conductors To Main Metal Water Service Pipes By Grounding Clamp Connectors. Where A Dielectric Main Water Fitting Is Installed, Connect Grounding Conductor To Street Side Of Fitting. Bond Metal Grounding Conductor Conduit Or Sleeve To Conductor At Each End.
- N. Water Meter Piping: Use Braided-Type Bonding Jumpers To Electrically Bypass Water Meters. Connect To Pipe With Grounding Clamp Connectors.
- O. Comply With NFPA 780 And UI 96 When Interconnecting With Lightning Protection System.
- P. Bond Interior Metal Piping Systems And Metal Air Ducts To Equipment Grounding Conductors Of Associated Pumps, Fans, Blowers, Electric Heaters, And Air Cleaners. Use Braided-Type Bonding Straps.
- Q. Bond Each Aboveground Portion Of Gas Piping System Upstream From Equipment Shutoff Valve.
- R. Connections: Make Connections So Galvanic Action Or Electrolysis Possibility Is Minimized. Select Connectors, Connection Hardware, Conductors, And Connection Methods So Metals In Direct Contact Will Be Galvanically Compatible.
 1. Use Electroplated Or Hot-Tin-Coated Materials To Ensure High Conductivity And To Make Contact Points Closer To Order Of Galvanic Series.
 2. Make Connections With Clean, Bare Metal At Points Of Contact.
 3. Make Aluminum-To-Steel Connections With Stainless-Steel Separators And Mechanical Clamps.

4. Make Aluminum-To-Galvanized Steel Connections With Tin-Plated Copper Jumpers And Mechanical Clamps.
 5. Coat And Seal Connections Having Dissimilar Metals With Inert Material To Prevent Future Penetration Of Moisture To Contact Surfaces.
 6. Exothermic-Welded Connections: Comply With Manufacturer's Written Instructions. Welds That Are Puffed Up Or That Show Convex Surfaces Indicating Improper Cleaning Are Not Acceptable.
 7. Equipment Grounding Conductor Terminations: For No. 8 Awg And Larger, Use Pressure-Type Grounding Lugs. No. 10 Awg And Smaller Grounding Conductors May Be Terminated With Winged Pressure-Type Connectors.
 8. Noncontact Metal Raceway Terminations: If Metallic Raceways Terminate At Metal Housings Without Mechanical And Electrical Connection To Housing, Terminate Each Conduit With A Grounding Bushing. Connect Grounding Bushings With A Bare Grounding Conductor To Grounding Bus Or Terminal In Housing. Bond Electrically Noncontinuous Conduits At Entrances And Exits With Grounding Bushings And Bare Grounding Conductors, Unless Otherwise Indicated.
 9. Tighten Screws And Bolts For Grounding And Bonding Connectors And Terminals According To Manufacturer's Published Torque-Tightening Values. If Manufacturer's Torque Values Are Not Indicated, Use Those Specified In UI 486a And UI 486b.
 10. Compression-Type Connections: Use Hydraulic Compression Tools To Provide Correct Circumferential Pressure For Compression Connectors. Use Tools And Dies Recommended By Connector Manufacturer. Provide Embossing Die Code Or Other Standard Method To Make A Visible Indication That A Connector Has Been Adequately Compressed On Grounding Conductor.
 11. Moisture Protection: If Insulated Grounding Conductors Are Connected To Ground Rods Or Grounding Buses, Insulate Entire Area Of Connection And Seal Against Moisture Penetration Of Insulation And Cable.
- S. Overhead Line Grounding: Comply With IEEE C2 Except Where Stricter Requirements Are Indicated. Use 2 Or More Parallel Ground Rods If A Single Ground Rod Electrode Resistance To Ground Exceeds 25 Ohms.
1. Drive Ground Rods To A Depth Of 12 Inches (300 Mm) Below Finished Grade In Undisturbed Earth.
 2. Ground Rod Connections: Use Clamp-Type Connectors Listed For The Purpose For Underground Connections And Connections To Rods.
 3. Lightning Arresters: Separate Arrester Grounds From Other Grounding Conductors.
 4. Secondary Neutral And Tank Of Transformer: Interconnect And Connect To Grounding Conductor.
 5. Protect Grounding Conductors On Surface Of Wood Poles With Molding Extended From Grade Level Up To And Through Communication Service And Transformer Spaces.
- T. Duct Banks: Install A Grounding Conductor With At Least 50 Percent Ampacity Of The Largest Phase Conductor In The Duct Bank.
- U. Manholes And Handholes: Install A Driven Ground Rod Close To Wall And Set Rod Depth So 4 Inches (100 Mm) Will Extend Above Finished Floor. If Necessary, Install Ground Rod Before Manhole Is Placed And Provide A No. 1/0 Awg Bare, Tinned-Copper Conductor From Ground Rod Into Manhole Through A Waterproof Sleeve In Manhole Wall. Protect Ground Rods Passing Through Concrete Floor With A Double Wrapping Of Pressure-Sensitive Tape Or Heat-Shrunk Insulating Sleeve From 2 Inches (50 Mm) Above To 6 Inches (150 Mm) Below Concrete. Seal Floor Opening With Waterproof, Nonshrink Grout.
- V. Connections To Manhole Components: Connect Exposed-Metal Parts, Such As Inserts, Cable Racks, Pulling Irons, Ladders, And Cable Shields Within Each Manhole Or Handhole, To Ground Rod Or Grounding Conductor. Make Connections With No. 4 Awg Minimum, Stranded, Hard-Drawn Copper Conductor. Train Conductors Level Or Plumb Around Corners And Fasten To Manhole Walls. Connect To Cable Armor And Cable Shields As Recommended By Manufacturer Of Splicing And Termination Kits.

- W. Pad-Mounted Transformers And Switches: Install Two Ground Rods And Counterpoise Circling Pad. Ground Pad-Mounted Equipment And Noncurrent-Carrying Metal Items Associated With Substations By Connecting Them To Underground Cable And Grounding Electrodes. Use Tinned-Copper Conductor Not Less Than No. 2 Awg For Counterpoise And For Taps To Equipment Ground Pad. Bury Counterpoise Not Less Than .18 Inches (450 Mm) Below Grade And .6 Inches (150 Mm) From The Foundation.

3.2 FIELD QUALITY CONTROL

- A. Testing: Perform The Following Field Quality-Control Testing:
1. After Installing Grounding System But Before Permanent Electrical Circuitry Has Been Energized, Test For Compliance With Requirements.
 2. Test Completed Grounding System At Each Location Where A Maximum Ground-Resistance Level Is Indicated And At Service Disconnect Enclosure Grounding Terminal. Measure Ground Resistance Not Less Than Two Full Days After The Last Trace Of Precipitation, And Without The Soil Being Moistened By Any Means Other Than Natural Drainage Or Seepage And Without Chemical Treatment Or Other Artificial Means Of Reducing Natural Ground Resistance. Perform Tests, By The Fall-Of-Potential Method According To Ieee 81.
 3. Provide Drawings Locating Each Ground Rod, Ground Rod Assembly, And Other Grounding Electrodes. Identify Each By Letter In Alphabetical Order, And Key To The Record Of Tests And Observations. Include The Number Of Rods Driven And Their Depth At Each Location And Include Observations Of Weather And Other Phenomena That May Affect Test Results. Describe Measures Taken To Improve Test Results. Nominal Maximum Values Are As Follows:
 - a. Equipment Rated 500 Kva And Less: 10 Ohms.
 - b. Equipment Rated 500 To 1000 Kva: 5 Ohms.
 - c. Equipment Rated More Than 1000 Kva: 3 Ohms.
 - d. Overhead Distribution Line Equipment: 25 Ohms.
 - e. Substations And Pad-Mounted Switching Equipment: 5 Ohms.
 - f. Manhole Grounds: 10 Ohms.

END OF SECTION 26 05 26

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 SUBMITTALS

- A. Product Data: For steel slotted support systems.
- B. Shop Drawings Show fabrication and installation details and include calculations for the following:
 - 1. Trapeze hangers. Include Product Data for components.
 - 2. Steel slotted channel systems. Include Product Data for components.
 - 3. Equipment supports.
- C. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Or Approved Equal
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
4. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - 4) Or Approved Equal
 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.
 8. Or Approved Equal

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 3/8 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 50 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps and/or single-bolt conduit clamps using spring friction action for retention in support channel.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb_ (90 kg).
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 6. To Light Steel: Sheet metal screws.
 - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Provide an additional 20 metal supports with required fasteners of each size and type used on the project to accommodate any changes required to resolve interferences or directed by the Engineer.
- D. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than .4 inches_ (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 4,000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete"
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29

SECTION 26 05 33

RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
 - 1. Division 26 Section "Underground Ducts" for exterior ductbanks, manholes, and underground utility construction.
 - 2. Division 26 Section "Fire Rated Penetration Systems" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
 - 3. Division 26 Section "Basic Electrical Materials and Methods" for supports, anchors, and identification products.
 - 4. Division 26 Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. ENT: Electrical nonmetallic tubing.
- C. FMC: Flexible metal conduit.
- D. IMC: Intermediate metal conduit.
- E. LFMC: Liquidtight flexible metal conduit.
- F. LFNC: Liquidtight flexible metal conduit.
- G. RMC: Rigid Metal Conduit.
- H. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings.

1.5 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. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 METAL CONDUIT AND TUBING

- A. Manufacturer:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflec Inc.
 - 3. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - 4. Electri-Flex Co.
 - 5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
 - 6. LTV Steel Tubular Products Company.
 - 7. Manhattan/CDT/Cole-Flex.
 - 8. O-Z Gedney; Unit of General Signal.
 - 9. Wheatland Tube Co.
 - 10. Or Approved Equal
- B. Rigid Steel Conduit: ANSI C80.1.
- C. IMC: ANSI C80.6.
- D. EMT and Fittings: ANSI C80.3.
 - 1. Fittings: Compression type up to 1-1/2 in. conduit, 2 in. and larger use set screw type.
- E. FMC: Zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket.
- G. Fittings: NEMA FB 1; compatible with conduit and tubing materials.

2.3 METAL WIREWAYS

- A. Manufacturer:
 - 1. Hoffman.
 - 2. Square D.
- B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1 or 3R.
- C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, plastic edge covers, and other fittings to match and mate with wireways as required for complete system.
- D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- E. Wireway Covers: Screw cover type, Flanged and gasketed type at exterior.
- F. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hoffman.
 - 2. Lamson & Sessions; Carlon Electrical Products.
 - 3. J-M Manufacturing Company, Inc.

4. Or Approved Equal

- C. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.
- D. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.
- E. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.5 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard grey finish coat.
 - 1. Manufacturer:
 - a. Walker Systems, Inc.; Wiremold Company (The).
 - b. Wiremold Company (The); Electrical Sales Division.
 - c. Or Approved Equal.
- B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.
- C. Surface Non-Metallic Raceways: Polyvinyl with snap-on covers. Finish with manufacturer's light ivory color.
 - 1. Manufacturer:
 - a. Hubbell Inc.
 - b. Or Approved Equal
- D. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.
 - 1. Single channel polyvinyl (raceway for branch circuit power and/or low potential services shall be Premise Trak (Latching) as manufactured by Hubbell.
 - 2. The two-piece single channel shall consist of a base section, 5 feet length, latching snap on cover, 0.38 in 2 channel base. Provide 1-gang or 2-gang boxes as required. Apply channel with adhesive.
 - 3. Two channel polyvinyl raceway for branch circuit power and low potential services shall be Wall Trak as manufactured by Hubbell.
 - 4. The two-piece, two channel raceway shall consist of a base section, 5 feet length, latching snap on cover, 0.81 in 2 and 0.79 in2 channel bases. Provide 1-gang or 2-gang boxes as required. Apply base with adhesive.

2.6 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturer:
 - 1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
 - 2. Emerson/General Signal; Appleton Electric Company.
 - 3. Erickson Electrical Equipment Co.
 - 4. Hoffman.
 - 5. Hubbell, Inc.; Killark Electric Manufacturing Co.
 - 6. Legrand, Inc.; Wiremold Company
 - 7. O-Z/Gedney; Unit of General Signal.
 - 8. RACO; Division of Hubbell, Inc.
 - 9. Robroy Industries, Inc.; Enclosure Division.
 - 10. Scott Fetzer Com.; Adalet-PLM Division.
 - 11. Spring City Electrical Manufacturing Co.

12. Thomas & Betts Corporation.
 13. Walker Systems, Inc.; Wiremold Company (The).
 14. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
 15. Or Approved Equal.
- B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
 - C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
 - D. Floor Boxes: Cast metal, fully adjustable, rectangular.
 - E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
 - F. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
 - G. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.
 - H. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.
 - I. Poke-Through junction boxes: 6 inch diameter junction box that complies with UL514A and/or UL514C and bear the U.S. UL Listing Mark, NEC Section 300-21, and 2-hour fire rated. Basis of design - Legrand evolution 6AT
 1. Below conference room tables: Model # 6ATP__
 2. Furniture feed assembly: Model # 6ATCFF__ with 152CHA bottom feed device plate

2.7 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer's standard gray paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors:
 1. Exposed: Rigid steel or IMC.
 2. Concealed: Rigid steel or IMC.
 3. Underground, Single Run: RMC or RNC.
 4. Underground, Grouped: RMC or RNC.
 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 6. Boxes and Enclosures: NEMA 250, Type 3R or 4.
- B. Indoors:
 1. Exposed: EMT, surface metal raceway.
 2. Concealed: EMT.
 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC; except use LFMC in damp or wet locations.
 4. Damp or Wet Locations: Rigid steel conduit.
 5. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - a. Damp or Wet Locations: NEMA 250, Type 4..
- C. Minimum Raceway Size: 3/4-inch trade size (DN 21)
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

3.2 INSTALLATION

- A. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- B. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Division 26 Section "Basic Electrical Materials and Methods."
- D. Install temporary closures to prevent foreign matter from entering raceways.
- E. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- F. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
 - 1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- H. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover.
 - 1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 2. Space raceways laterally to prevent voids in concrete.
 - 3. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 4. Change from nonmetallic tubing to Schedule 40 nonmetallic conduit, rigid steel conduit, or IMC before rising above the floor.
- I. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
 - 1. Run parallel or banked raceways together on common supports.
 - 2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- J. Join raceways with fittings designed and approved for that purpose and make joints tight.
 - 1. Use insulating bushings to protect conductors.
- K. Terminations:
 - 1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 - 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- L. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
- M. Telephone and Signal System Raceways, 2-Inch Trade Size (DN 53) and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet (45 m) and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements
- N. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where otherwise required by NFPA 70.
- O. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
- P. Flexible Connections: Use maximum of .72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
- Q. Provide an additional one thousand feet of raceway and accessories of each type and size used on the project to accommodate any changes required to resolve interferences or as directed by the Engineer.
- R. Provide an additional twenty boxes (floor, junction, etc.) and accessories of each size and type used on the project to accommodate any changes required to resolve interferences.
- S. Provide an additional three hundred feet of surface raceway and accessories of each size and type used on the project to accommodate any changes required to resolve interferences.
- T. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
- U. Set floor boxes level and flush with finished floor surface.
- V. Set floor boxes level. Trim after installation to fit flush with finished floor surface.
- W. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
- X. Poke-through junction boxes shall mount in a 6" cored hole, actual 6 1/16" core hole.

3.3 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.4 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 26 05 33

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
 - 2. Rigid nonmetallic duct.
 - 3. Flexible nonmetallic duct.
 - 4. Duct accessories.
 - 5. Polymer concrete handholes and boxes with polymer concrete cover.

1.2 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank:
 - 1. Two or more ducts installed in parallel, with or without additional casing materials.
 - 2. Multiple duct banks.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
 - a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.
 - b. Include duct entry provisions, including locations and duct sizes.
 - c. Include cover design.
 - d. Include grounding details.
 - e. Include dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

1.4 INFORMATIONAL SUBMITTALS

- A. Duct and Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures. Drawings shall be signed and sealed by a qualified professional engineer.
- B. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.
- C. Source quality-control reports.
- D. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND FITTINGS

- A. GRC: Comply with ANSI C80.1 and UL 6.
- B. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.2 RIGID NONMETALLIC DUCT

- A. Underground Plastic Utilities Duct: Type EPC-40-PVC RNC, complying with NEMA TC 2 and UL 651, with matching fittings complying with NEMA TC 3 by same manufacturer as duct.
- B. Acceptable Manufacturer:
 - 1. ARNCO Corp
 - 2. Cantex Inc.
 - 3. Certain Teed Corp.
 - 4. Condux Internations, Inc.
 - 5. Crown Line Plastics
 - 6. ElecSys, Inc.
 - 7. Electri-Flex Co.
 - 8. Lamson & Sesions
 - 9. National Pipe & Plastics
 - 10. Or Approved Equal
- C. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.
- D. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 FLEXIBLE NONMETALLIC DUCTS

- A. HDPE Duct: Type EPEC-40 HDPE, complying with NEMA TC 7 and UL 651A.
 - 1. ABB, Electrification Products
 - 2. ARNCO Corp.
 - 3. National Pipe & Plastics
 - 4. Premier Conduit
 - 5. Or Approved Equal
- B. Listed and labeled as defined in NFPA 70, by a nationally recognized testing laboratory, and marked for intended location and application.

2.4 DUCT ACCESSORIES

- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
 - 1. ABB, Electrification Products
 - 2. Allied Tube & Conduit
 - 3. Cantex Inc.
 - 4. IPEX USA LLC
 - 5. PenCell Plastics
 - 6. Underground Devices, Inc.
 - 7. Or Approved equal
- B. Underground-Line Warning Tape: Comply with requirements for underground-line warning tape specified in Section 260553 "Identification for Electrical Systems."

2.5 POLYMER CONCRETE HANDHOLES AND BOXES WITH POLYMER CONCRETE COVER

- A. Description: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two.
- B. Acceptable Manufacturers:
 - 1. Armorcast Products Co.
 - 2. MacLean Highline
 - 3. Oldcastle Infrastructure
 - 4. Quazite, Hubbell Inc. (Basis of Design)
 - 5. Or Approved Equal
- C. Standard: Comply with SCTE 77. Comply with tier requirements in "Underground Enclosure Application" Article.
- D. Color: Gray.
- E. Configuration: Units shall be designed for flush burial and have open bottom unless otherwise indicated.
- F. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
- G. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
- H. Cover Legend: Molded lettering, "ELECTRIC."
- I. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
- J. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering duct for secure, fixed installation in enclosure wall.
- K. Handholes shall have factory-installed inserts for cable racks and pulling-in irons.

2.6 SOURCE QUALITY CONTROL

- A. Nonconcrete Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 - 1. Strength tests of complete boxes and covers shall be by an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 - 2. Testing machine pressure gages shall have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.

3.2 UNDERGROUND DUCT APPLICATION

- A. Duct for Electrical Feeders 600 V and Less: RNC Type EPC-40-PVC, concrete-encased unless otherwise indicated.
- B. Duct for Electrical Feeders 600 V and Less: RNC Type EPC-40-PVC, direct-buried unless otherwise indicated.

- C. Duct for Electrical Branch Circuits: RNC Type EPC-40-PVC, direct-buried unless otherwise indicated.
- D. Bored Underground Duct: Type EPEC-40 HDPE unless otherwise indicated.
- E. Underground Ducts Crossing Paved Paths and Walks direct-buried unless otherwise indicated.
- F. Underground Ducts Crossing: Driveways, Roadways and Railroads: RNC Type EPC-40 PVC, encased in reinforced concrete.
- G. Stub-ups: Concrete-encased RNC and GRC.

3.3 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area immediately after backfilling is completed.
- C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Section 017300 "Execution."

3.4 DUCT AND DUCT-BANK INSTALLATION

- A. Where indicated on Drawings, install duct, spacers, and accessories into the duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.
- B. Install duct according to NEMA TCB 2.
- C. Slope: Pitch duct a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from a high point between two manholes, to drain in both directions.
- D. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 36" when used for Fiber Optic Cable, both horizontally and vertically, at other locations unless otherwise indicated.
- E. Joints: Use solvent-cemented joints in duct and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent duct do not lie in same plane.
- F. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.
- G. End Bell Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately .10 inches (250 mm) o.c. for .5-inch (125-mm) duct, and vary proportionately for other duct sizes.
- H. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches (150 mm) o.c. for .4-inch (100-mm) duct, and vary proportionately for other duct sizes.
- I. Building Wall Penetrations: Make a transition from underground duct to GRC at least 10 feet (3 m) outside the building wall, without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for RNC-to-GRC transition. Install GRC penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
- J. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least .15-psig (1.03-MPa) hydrostatic pressure.

- K. Pulling Cord: Install 200-lbf- (1000-N-) test nylon cord in empty ducts.
- L. Concrete-Encased Ducts and Duct Bank:
1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
 2. Width: Excavate trench 12 inches (300 mm) wider than duct on each side.
 3. Width: Excavate trench 3 inches (75 mm) wider than duct on each side.
 4. Depth: Install so top of duct envelope is at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
 5. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 6. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet (6 m) of duct. Place spacers within 24 inches (600 mm) of duct ends. Stagger spacers approximately 6 inches (150 mm) between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 7. Elbows: Use manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
 8. Elbows: Use manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct run.
 9. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
 10. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
 11. Concrete Cover: Install a minimum of 3 inches (75 mm) of concrete cover between edge of duct to exterior envelope wall, 2 inches (50 mm) between duct of like services, and 4 inches (100 mm) between power and communications ducts.
 12. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 13. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.
- M. Direct-Buried Duct and Duct Bank:
1. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inches (150 mm) in nominal diameter.
 2. Width: Excavate trench 12 inches (300 mm) wider than duct on each side.
 3. Width: Excavate trench 3 inches (75 mm) wider than duct on each side.
 4. Depth: Install top of duct at least 18 inches (900 mm) below finished grade unless otherwise indicated.
 5. Set elevation of bottom of duct bank below frost line.
 6. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 7. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than five spacers per 20 feet (6 m) of duct. Place spacers within 24 inches (600 mm) of duct ends. Stagger spacers approximately 6 inches (150 mm) between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

8. Elbows: Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 9. Install manufactured GRC elbows for stub-ups, at building entrances, and at changes of direction in duct.
 10. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inches (100 mm) over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
 - a. Place minimum 3 inches (75 mm) of sand as a bed for duct. Place sand to a minimum of 6 inches (150 mm) above top level of duct.
 - b. Place minimum 6 inches (150 mm) of engineered fill above concrete encasement of duct.
- N. Underground-Line Warning Tape: Bury conducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inches (300 mm) above all concrete-encased duct and duct banks and approximately 6" below grade. Align tape parallel to and within 3 inches (75 mm) of centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

3.5 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
- D. Install handholes and boxes with bottom below frost line, <Insert depth of frost line below grade at Project site> below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- F. Field cut openings for duct according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- G. For enclosures installed in asphalt paving and brick masonry pavers and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
 1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with a troweled finish.
 2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.6 GROUNDING

- A. Ground underground ducts and utility structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide a minimum .12-inch- (300-mm-) long mandrel equal to duct size minus .1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.
 3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.
- C. Prepare test and inspection reports.

3.8 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump.
 1. Sweep floor, removing dirt and debris.
 2. Remove foreign material.

END OF SECTION 26 05 43

SECTION 26 05 53

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

1.3 SUBMITTALS

- A. No submittals.

1.4 QUALITY ASSURANCE

- A. Comply with ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

- A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
 - 1. Color: Black letters on orange field.
 - 2. Legend: Indicates voltage and service.
- B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend overlaminated with a clear, weather- and chemical-resistant coating.
- C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.
- D. Consider alternatives before specifying self-adhesive product in paragraph below. See Editing Instruction No. 1 in the Evaluations.
- E. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide (0.08 mm thick by 25 to 51 mm wide).
- F. Underground-Line Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape.
 - 1. Not less than 6 inches wide by 4 mils thick (152 mm wide by 0.102 mm thick).
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend indicating type of underground line.
- G. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- H. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch- (0.4-mm-) thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

2.2 NAMEPLATES AND SIGNS

- A. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine plastic laminate, minimum .1/16 inch_ (1.6 mm) thick for signs up to 20 sq. in._ (129 sq. cm) and .1/8 inch_ (3.2 mm) thick for larger sizes.
 - 1. Engraved legend with black letters on white face.
 - 2. Punched or drilled for mechanical fasteners.
- C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. .1/4-inch_ (6.4-mm) grommets in corners for mounting.
- D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with .0.0396-inch_ (1-mm) galvanized-steel backing; and with colors, legend, and size required for the application. .1/4-inch_ (6.4-mm) grommets in corners for mounting.
- E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
 - 1. Minimum Width: .3/16 inch_ (5 mm).
 - 2. Tensile Strength: .50 lb_ (22.3 kg) minimum.
 - 3. Temperature Range: Minus 40 to plus 185 deg F_ (Minus 40 to plus 85 deg C).
 - 4. Color: According to color-coding.
- B. Paint: Formulated for the type of surface and intended use.
 - 1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
 - 2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
 - 3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
 - 4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.
- C. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before applying.
- E. Circuits with More Than 600 V: Identify raceway and cable with "DANGER--HIGH VOLTAGE" in black letters .2 inches_ (51 mm) high, stenciled with paint at .10-foot_ (3-m) intervals over a continuous, painted orange background. Identify the following:
 - 1. Entire floor area directly above conduits running beneath and within .12 inches_ (305 mm) of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
 - 2. Wall surfaces directly external to conduits concealed within wall.
 - 3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in the building, or concealed above suspended ceilings.
 - 4. Entire surface of exposed conduits.

- F. Install painted identification according to manufacturer's written instructions and as follows:
 - 1. Clean surfaces of dust, loose material, and oily films before painting.
 - 2. Prime surfaces using type of primer specified for surface.
 - 3. Apply one intermediate and one finish coat of enamel.
- G. Color Banding Raceways and Exposed Cables: Band exposed and accessible raceways of the systems listed below:
 - 1. Bands: Pretensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches (51 mm) wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
 - 2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
 - 3. Apply the following colors to the systems listed below:
 - a. Fire Alarm System: Red.
 - b. Fire-Suppression Supervisory and Control System: Red and yellow.
 - c. Combined Fire Alarm and Security System: Red and blue.
 - d. Security System: Blue and yellow.
 - e. Mechanical and Electrical Supervisory System: Green and blue.
 - f. Telecommunication System: Green and yellow.
- H. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange background. Install on exterior of door or cover.
- I. Circuit Identification Labels on Boxes: Install labels externally.
 - 1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
 - 2. Concealed Boxes: Plasticized card-stock tags.
 - 3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.
- J. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm) overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.
- K. Color-Coding of Secondary Phase Conductors: Use the following colors for service feeder, and branch-circuit phase conductors:
 - 1. 208/120-V Conductors:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - 2. 480/277-V Conductors:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow
 - 3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-coded wire for sizes larger than No. 10 AWG:
 - a. Colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Use 1-inch (25-mm-) wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
 - b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches (76 mm) from the terminal and spaced 3 inches (76 mm) apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

- L. Power-Circuit Identification: Metal tags or aluminum, wraparound marker bands for cables, feeders, and power circuits in vaults, pull and junction boxes, manholes, and switchboard rooms.
 - 1. Legend: .1/4-inch- (6.4-mm-) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
 - 2. Tag Fasteners: Nylon cable ties.
 - 3. Band Fasteners: Integral ears.
- M. Apply identification to conductors as follows:
 - 1. Conductors to Be Extended in the Future: Indicate source and circuit numbers.
 - 2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
 - 3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.
- N. Apply warning, caution, and instruction signs as follows:
 - 1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
 - 2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum .3/8-inch- (9-mm-) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.
- O. Equipment Identification Labels: Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise indicated, provide a single line of text with .1/2-inch- (13-mm-) high lettering on .1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high. Use white lettering on black field. Apply labels for each unit of the following categories of equipment using mechanical fasteners:
 - 1. Panelboards, electrical cabinets, and enclosures.
 - 2. Access doors and panels for concealed electrical items.
 - 3. Electrical switchgear and switchboards.
 - 4. Emergency system boxes and enclosures.
 - 5. Disconnect switches.
 - 6. Enclosed circuit breakers.
 - 7. Motor starters.
 - 8. Push-button stations.
 - 9. Power transfer equipment.
 - 10. Contactors.
 - 11. Remote-controlled switches.
 - 12. Control devices.
 - 13. Transformers.
 - 14. Power-generating units.
 - 15. Telephone switching equipment.
 - 16. Clock/program master equipment.
 - 17. Fire alarm master station or control panel.

END OF SECTION 26 05 53

SECTION 26 24 16

PANELBOARDS & SWITCHBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:
 - 1. Lighting and appliance branch-circuit panelboards.
 - 2. Distribution switchboards.
 - 3. Transient voltage surge suppressor panelboards.
- B. Related Sections include the following:
 - 1. Division 26 Section "Fuses."

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. RFI: Radio-frequency interference.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.
- F. TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

- A. Product Data: For each type of panelboard, switchboard, overcurrent protective device, TVSS device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard, switchboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Bus configuration, current, and voltage ratings.
 - c. Short-circuit current rating of panelboards and overcurrent protective devices.
 - d. UL listing for series rating of installed devices.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Field Test Reports: Submit written test reports and include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- D. Panelboard and Switchboard Schedules: For installation in panelboards. Submit final versions after load balancing.

- E. Maintenance Data: For panelboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Contract Closeout," include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device.
- F. Should the contractor submit any substitution (including other approved manufacturers) other than the specified product the contractor shall be responsible for all electrical, mechanical, structural, and architectural revisions as required to accommodate the installation of the substituted equipment at no additional cost to the owner.

1.5 QUALITY ASSURANCE

- A. Comply with NEMA PB 1.
- B. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate layout and installation of switchboards, panelboards and associated components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

1.7 EXTRA MATERIALS

- A. Keys: Four spares of each type of panelboard cabinet lock. Key all cabinets alike.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. Schneider Electric - Square D Co. (Basis of Design)
 - c. General Electric
 - d. Or Approved Equal

2.2 FABRICATION AND FEATURES

- A. Enclosures: Flush- and surface-mounted cabinets as noted on the drawings. NEMA PB 1, Type 1, to meet environmental conditions at installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
- B. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
- C. Hinged Front Cover: For boxes more than 28 inches high, entire front trim hinged to box and with standard door within hinged trim cover.
- D. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
- E. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.
- F. Bus: Hard-drawn copper, 98 percent conductivity.
- G. Main and Neutral Lugs: Mechanical type suitable for use with conductor material.

- H. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
- I. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.
- J. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- K. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
- L. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads as noted on the drawings.
- M. Split Bus: Vertical buses divided into individual vertical sections.
- N. Gutter Barrier: Arrange to isolate individual panel sections.
- O. Feed-through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device. Provide wire feed same size as feeder.
- P. Provide ARC Flash labeling as required by the National Electrical Code.

2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. UL label indicating series-connected rating with integral or remote upstream devices. Include size and type of upstream device allowable, branch devices allowable, and UL series-connected short-circuit rating.
- B. Fully rated to interrupt symmetrical short-circuit current available at terminals.
- C. Contractor shall confirm from local utility company prior to submittal review of minimum symmetrical short circuit rating requirements within project site, should the contract documents differ the contractor shall submit and provide the greater rated value.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- B. Doors: Front mounted with concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- C. All panelboards shall be fully equipped with all branch breaker mounting assemblies.
- D. All panelboards shall be fully equipped with a grounding bus bar assembly which must be large enough to meet a minimum of 100% of the branch circuit quantities plus 10%.
- E. All panelboards shall be fully equipped with a neutral bus bar assembly which must be large enough to meet a minimum of 100% of the branch breaker quantities plus 10%.

2.5 CLASS 2 LIGHTING PANELS – WITH CONTROL SYSTEM

Lighting Control System

- A. The lighting control system shall consist of microprocessor-based control electronics with remotely operated circuit breakers mounted to a UL67 listed lighting panelboard interior and enclosed in a UL50 listed panelboard enclosure. The circuit breakers shall provide overcurrent protection, and have an AIR rating or series connected rating that meets or exceeds the fault current of the system to which the panelboard is being applied.
- B. Each master control panel shall meet or exceed the following capabilities:
 1. Sixteen (16) 2-wire input terminals for connection to external low voltage switch contacts.
 2. Time of day scheduling to automatically shut off lighting at specific programmed times
 3. Direct control of branch circuits in a master/slave sub-net configuration.
 4. Provide true status feedback by monitoring branch circuit breaker status based on actual system voltage at load side terminal.
 5. Accept remote commands through the facilities Ethernet infrastructure.
- C. All lighting control components shall be installed in a conventional panelboard 20 inches wide or column-width enclosures (as noted on drawings). Suitable barriers shall be installed to separate Class 2 wiring from power conductors.

2.6 DISTRIBUTION SWITCHBOARDS

- A. Doors: Front mounted, except omit in fused-switch panelboards; secured with vault-type latch with tumbler lock; keyed alike. Door-in-door construction.
- B. Main Overcurrent Protective Devices: Circuit breaker as noted. Main lugs only unless otherwise noted.
- C. Branch overcurrent protective devices shall be one of the following:
 - 1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
 - 2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.7 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
- B. Molded-Case Circuit-Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for ALL heating, air-conditioning, and refrigerating equipment.
 - 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 4. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
 - 5. Auxiliary Switch: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 6. Lock-on clips: Install on circuit breakers for alarm, telecommunications, control systems, and refrigeration equipment.
 - 7. Shunt Trip Device: Integrally mounted relay and trip unit with manual reset ONLY. In addition to the designated locations indicated on the contract documents it shall be required to provide a shunt trip device for any/all elevator and escalator equipment and systems. All elevator and escalator shunt trip devices shall be installed per the ASME A17.1 Safety Code for Elevators and Escalators.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mounting Heights: Top of trim .74 inches (1880 mm) above finished floor, unless otherwise indicated.
- C. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- D. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- E. Install filler plates in unused spaces.

- F. Provide ONE additional panelboard and accessories of each size and type used on the project to accommodate changes required to resolve interferences or as directed by the Engineer.
- G. Provision for Future Circuits at Flush Panelboards: Stub four .1-inch_ (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four .1-inch_ (27-GRC) empty conduits into raised floor space or below slab not on grade.
- H. Wiring in Panelboard Gutters: Arrange conductors into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 16 Section "Electrical Identification."
- B. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

- A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.
- B. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each circuit.
- B. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Balancing Loads: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes as follows:
 1. Measure as directed during period of normal system loading.
 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data-processing, computing, transmitting, and receiving equipment.
 3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
 4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.6 CLEANING

- A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 24 16

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes receptacles, connectors, switches, and finish plates.

1.3 DEFINITIONS

- A. GFCI or GFI: Ground-fault circuit interrupter.
- B. SPD or TVSS: Transient voltage surge suppressor.

1.4 SUBMITTALS

- A. Product Data: For each product specified.
- B. Shop Drawings: Legends for receptacles and switch plates.
- C. Samples: For devices and device plates for color selection and evaluation of technical features.
- D. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 1.

1.5 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.
- B. Comply with NEMA WD 1.
- C. Comply with NFPA 70.

1.6 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
 - 1. Floor Service-Outlet Assemblies: One for each 10, but not less than one.
 - 2. GFCI Receptacles: One for each forty installed.
 - 3. TVSS Receptacles: One for each forty installed.
 - 4. T/R Receptacles: One for each forty installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Wiring Devices:
 - a. Hubbell, Inc.; Wiring Devices Div.
 - b. Killark Electric Manufacturing Co.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand; Wiring Devices Div.
 - f. Or Approved Equal
 2. Wiring Devices for Hazardous (Classified) Locations:
 - a. Crouse-Hinds Electrical Co.; Distribution Equipment Div.
 - b. Killark Electric Manufacturing Co.
 - c. Pyle-National, Inc.; an Amphenol Co.
 - d. Or Approved Equal
 3. Multioutlet Assemblies:
 - a. Airey-Thompson Co.
 - b. Wiremold.
 - c. Or Approved Equal

2.2 RECEPTACLES

- A. Straight-Blade and Locking Receptacles: Heavy-Duty grade.
- B. GFCI Receptacles: Feed-through type, with integral NEMA WD 6, Configuration 5-20R duplex receptacle arranged to protect connected downstream receptacles on same circuit. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter.
- C. Isolated-Ground Receptacles: Equipment grounding contacts connected only to the green grounding screw terminal of the device with inherent electrical isolation from mounting strap.
1. Devices: Listed and labeled as isolated-ground receptacles.
 2. Isolation Method: Integral to receptacle construction and not dependent on removable parts.
- D. TVSS Receptacles: Duplex type, NEMA WD 6, Configuration 5-20R, with integral/interchangeable TVSS in line to ground, line to neutral, and neutral to ground.
1. TVSS Components: Multiple metal-oxide varistors; rated a nominal clamp level of 500 transient-suppression voltage and minimum single transient pulse energy dissipation of 140 J line to neutral, and 70 J line to ground and neutral to ground.
 2. Active TVSS Indication: Light visible in face of device to indicate device as "active" or "no longer active."
 3. Identification: Distinctive marking on face of device denotes TVSS-type unit.
- E. Tamper Resistant (T/R) Receptacles: Integral NEMA WD 6, Configuration 5-20R duplex receptacle. Design units for installation in a 2-3/4-inch-deep outlet box without an adapter.
1. Devices: Listed and labeled as tamper resistant receptacles.
 2. Protection Method: Contains a sturdy mechanical shutter system to prevent objects from being inserted into the receptacle
 3. Identification: Distinctive marking on face of device denotes T/R-type unit.
- F. Industrial Heavy-Duty Receptacle: Comply with IEC 309-1.
- G. Hazardous (Classified) Location Receptacles: Comply with NEMA FB 11.

2.3 PENDANT CORD/CONNECTOR DEVICES

- A. Description: Matching, locking type, plug and receptacle body connector, NEMA WD 6, Configurations L5-20P and L5-20R, Heavy-Duty grade.
1. Body: Nylon with screw-open cable-gripping jaws and provision for attaching external cable grip.
 2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.4 CORD AND PLUG SETS

- A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
1. Cord: Rubber-insulated, stranded-copper conductors, with type SOW-A jacket. Green-insulated grounding conductor, and equipment-rating ampacity plus a minimum of 30 percent.
 2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.5 FLOOR BOX ASSEMBLIES

- A. Box size - 8" x 6" x 5" [203mm x 152mm x 127mm] (Wiremold AF1 & AF2 Series)
The panel opening shall be 8" x 6" [203mm x 152mm] and have an overall module depth of 5" [127mm]. The box must provide a total activation chamber volume of at least 130 cubic inches [2130 ml]. The total Box Volume capacity shall have a minimum of 208 cubic inches [3418 ml].

The box lid shall be constructed of polycarbonate material, available in standard colors of black, brown and gray. The lid shall provide a removable cable guard for egress of power and communication workstation cables. The cable guards shall hold workstation cables in place with the lid either in the open or closed position.

The trim flange shall be constructed of polycarbonate material and have a minimum overall dimension of 8 3/4" x 6 3/4" [222mm x 171mm]. The hinged lid and trim flange shall be available for either carpet or tile floor applications.

The wiring chamber shall provide a minimum of three separate compartments to accommodate a combination of both power and communication wiring. The compartments shall be separated by use of die cast aluminum built in dividers.

If a prewired flexible wiring system is specified, the same manufacturer shall supply the box, and the flexible wiring system. The box shall contain integral connectors to mate with the flexible wiring system. The box shall be capable of disconnecting from the flexible wiring system directly at the box. The prewired box shall be able to contain up to three separate circuits, utilizing up to an 8-conductor MC cable assembly.

The box shall be secured to the raised floor by the use of two locking tabs. The locking tabs shall be integral to the box and adjusted by use of their locking screws.

- B. Box size - 8" x 10" x 5" [203mm x 254mm x 127mm] (Wiremold AF3 & AF4 Series)
The panel opening shall be 8" x 10" [203mm x 254mm] and have an overall module depth of 5" [127mm]. The box must provide a total Device Wiring Chamber volume of at least 220 cubic inches [3604 ml]. The total Box Volume capacity shall have a minimum of 300 cubic inches [4915 ml].

The box lid shall be a hinged style and constructed of polycarbonate material, available in standard colors of black, brown and gray. The lid shall provide a minimum of three removable cable guards for egress of power and communication workstation cables. The cable guards shall hold workstation cables in place with the lid either in the open or closed position.

The trim flange shall be constructed of polycarbonate material and have a minimum overall dimension of 9 1/8" x 11" (232mm x 279mm). The hinged lid and trim flange shall be available for either carpet or tile floor applications.

The wiring chamber shall provide an upper and a lower compartment. The top compartment shall be divided into three separate compartments to accommodate a combination of both power and communication wiring. These compartments shall be separated by use of integral; die cast aluminum built in dividers. The bottom compartment shall be available for either all power or all communication wiring.

If a prewired flexible wiring system is specified, the same manufacturer shall supply the box, and the flexible wiring system. The box shall contain integral connectors to mate with the flexible wiring system. The box shall be capable of disconnecting from the flexible wiring system directly at the box. The prewired box shall be able to contain up to three separate circuits, utilizing up to an 8-conductor MC cable assembly.

The box shall be secured to the raised floor by the use of two locking tabs. The locking tabs shall be integral to the box and adjusted by use of their locking screws.

C. Communication Devices and Accessories

2.2.3 Box size - 8" x 10" x 2 1/2" [203mm x 254mm x 64mm] (SAF21/2 Series) The panel opening shall be 8" x 10" [203mm x 254mm] and have overall depth of 2 1/2" [64mm]. The box must provide a total Device Wiring Chamber volume of at least 18.5 cubic inches [303ml]. The total Box Volume capacity shall have a minimum of 29 cubic inches [475ml].

The box lid shall be a hinged style and constructed of polycarbonate material, available in standard colors of black, brown and gray. The lid shall provide a minimum of three (3) removable cable guards for egress of power and communication workstations cables. The cable guards shall hold workstation cables in place with the lid either in the open or closed position.

The trim flange shall be constructed of polycarbonate material and have a minimum overall dimension of 9 1/8" x 11" [232mm x 279mm]. The hinged lid and trim flange shall be available for either carpet or tile floor applications.

2.6 CORD REELS

- A. A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
1. Cord: Rubber-insulated, stranded-copper conductors, with type SOW-A jacket. Green-insulated grounding conductor, and equipment-rating ampacity plus a minimum of 30 percent.
 2. Plug: GFCI type device, Nylon body. Match cord and receptacle type for connection
 3. Reel: 15 Amp rated, 125V, with 45 linear feet of retractable cable (Hubbell model #HBL45123C). Provide mounting assembly as required for complete installation.

2.7 SWITCHES

- A. Snap Switches: Heavy-duty, quiet type.
 - 1. Switch: 20 A, 120/277-V ac.
 - 2. Or Approved Equal

2.8 WALL PLATES

- A. Single and combination types match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: .004-inch- (1-mm-) thick, Type 302, satin-finished stainless steel.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Or Approved Equal

2.9 MULTIOUTLET ASSEMBLIES

- A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- B. Raceway Material: Metal, with manufacturer's standard finish.
- C. Raceway Material: Nonmetal.(accepted in office areas only)
- D. Wire: No. 12 AWG minimum.

2.10 MISCELLANEOUS WIRING CONNECTIONS AND COMPONENTS

- A. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- B. Raceway Material: Metal, with manufacturer's standard finish.
- C. Raceway Material: Nonmetal.(accepted in office areas only)
- D. Wire: not less than the manufacturers recommendation unless noted otherwise.
- E. Security Devices: Provide all wiring devices and connections as specified by the manufacturer and the contract documents. Unless otherwise noted.
- F. IT Devices: Provide all wiring devices and connections as specified by the manufacturer and the contract documents. Unless otherwise noted.
- G. Audio Visual Devices: Provide all wiring devices and connections as specified by the manufacturer and the contract documents Unless otherwise noted.

2.11 FINISHES

- A. Color: Manufacturers standard, as selected by Architect.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install devices and assemblies plumb and secure.
- B. Install wall plates when painting is complete.
- C. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.
- D. All receptacles used for garage installations shall be GFCI type wiring devices.
- E. Do not share neutral conductor on load side of dimmers.
 - 1. Provide installation and materials for an additional thirty wiring devices with cover plates of each type used with 100 feet of circuit wiring to accommodate changes as directed by the Engineer.

- F. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- G. Protect devices and assemblies during painting.
- H. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Electrical Identification."
- B. Comply with Division 26 Section "Basic Electrical Materials and Methods."
 - 1. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.
 - 2. Receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate and durable wire markers or tags within outlet boxes.

3.3 CONNECTIONS

- A. Connect wiring device grounding terminal to outlet box with bonding jumper.
- B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.
- C. Isolated-Ground Receptacles: Connect to isolated-ground conductor routed to designated isolated equipment ground terminal of electrical system.
- D. Tighten electrical connectors and terminals according to manufacturers published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Test wiring devices for proper polarity and ground continuity. Operate each device at least six times.
- B. Check TVSS receptacle indicating lights for normal indication.
- C. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- D. Replace damaged or defective components.

3.5 CLEANING

- A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 26 27 26

SECTION 26 28 13

FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes cartridge fuses, rated 600 V and less, for use in switches, panelboards, switchboards, controllers, and motor-control centers; and spare fuse cabinets.

1.3 SUBMITTALS

- A. Product Data: Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings for each fuse type indicated.
- B. Product Data: Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
 - 2. Let-through current curves for fuses with current-limiting characteristics.
 - 3. Time-current curves, coordination charts and tables, and related data.
 - 4. Fuse size for elevator feeders and elevator disconnect switches.
- C. Ambient Temperature Adjustment Information. If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses adjusted.
 - 1. For each adjusted fuse, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
 - 2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
- D. Maintenance Data: For tripping devices to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Provide fuses from a single manufacturer.
- B. 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.
- C. The contractor shall coordinate with all trades and equipment suppliers and provide the required fused protection for the equipment being installed.
- D. All equipment requiring fused switches shall be provided with the properly size and type fuses and enclosures per the manufacturer's recommendation and the environment of the equipment to be protected.
- E. Comply with NEMA FU 1.
- F. Comply with NFPA 70.

1.5 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (4.4 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

- A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged in original cartons or containers and identified with labels describing contents.
 - 1. Fuses: Quantity equal to 10 percent of each fuse type and size, but not fewer than 6 of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cooper Industries, Inc.; Bussmann Div.
 - 2. Eagle Electric Mfg. Co., Inc.
 - 3. Ferraz Corp.
 - 4. General Electric Co.; Wiring Devices Div.
 - 5. Gould Shawmut.
 - 6. Tracor, Inc.; Littelfuse, Inc. Subsidiary.
 - 7. Or Approved Equal

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

2.3 SPARE FUSE CABINET

- A. Cabinet: Wall-mounted, 0.05-inch thick steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
 - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
 - 2. Finish: Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch high letters on exterior of door.
 - 4. Fuse Pullers: For each size fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

- A. Main Service: Class L, time delay.
- B. Main Feeders: Class L, time delay.
- C. Motor Branch Circuits: Class RK1, time delay.
- D. Other Branch Circuits: Class RK1, time delay.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare fuse cabinet[s].

3.4 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 26 28 13

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SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes individually mounted enclosed switches and circuit breakers used for the following:
 - 1. Service disconnecting means.
 - 2. Feeder and branch-circuit protection.
 - 3. Motor and equipment disconnecting means.
- B. Related Sections include the following:
 - 1. Division 26 Section "Wiring Devices" for attachment plugs, receptacles, and toggle switches used for disconnecting means.
 - 2. Division 26 Section "Switchboards" for individually enclosed, fusible switches used as feeder protection.
 - 3. Division 26 Section "Fuses" for fusible devices.

1.3 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
- B. RMS: Root mean square.
- C. SPDT: Single pole, double throw.

1.4 SUBMITTALS

- A. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each switch and circuit breaker.
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Enclosure types and details for types other than NEMA 250, Type 1.
 - b. Current and voltage ratings.
 - c. Short-circuit current rating.
 - d. UL listing for series rating of installed devices.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

- C. Qualification Data: Submit data for testing agencies indicating that they comply with qualifications specified in "Quality Assurance" Article.
- D. Field Test Reports: Submit written test reports and include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Manufacturer's field service report.
- F. Maintenance Data: For enclosed switches and circuit breakers and for components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Closeout Procedures," include the following:
 - 1. Routine maintenance requirements for components.
 - 2. Manufacturer's written instructions for testing and adjusting switches and circuit breakers.
 - 3. Time-current curves, including selectable ranges for each type of circuit breaker.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency that is a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. 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.
- C. Comply with NEMA AB 1 and NEMA KS 1.
- D. Comply with NFPA 70.
- E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F (40 deg C).
 - 2. Altitude: Not exceeding 6600 feet (2000 m).

1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spares: For the following:
 - a. Potential Transformer Fuses-Provide an additional 6 fuses of each type utilized on this project.

- b. Control-Power Fuses-Provide an additional 6 fuses of each type utilized on this project.
 - c. Fuses and Fusible Devices for Fused Circuit Breakers-Provide an additional 6 fuses of each type utilized on this project.
 - d. Fuses for Fused Switches-Provide an additional 10 fuses of each type utilized on this project.
 - e. Fuses for Fused Power-Circuit Devices-Provide an additional 10 fuses of each type utilized on this project.
2. Spare Indicating Lights-Provide an additional 6 lights of each type utilized on this project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Fusible Switches:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Division.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.
 - e. Or Approved Equal
 - 2. Molded-Case Circuit Breakers:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Division.
 - c. Klockner-Moeller.
 - d. Siemens Energy & Automation, Inc.
 - e. Square D Co.
 - f. Or Approved Equal
 - 3. Combination Circuit Breaker and Ground-Fault Trip:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Division.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.
 - e. Or Approved Equal
 - 4. Molded-Case, Current-Limiting Circuit Breakers:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Division.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.
 - e. Or Approved Equal
 - 5. Integrally Fused, Molded-Case Circuit Breakers:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Division.
 - c. Siemens Energy & Automation, Inc.
 - d. Square D Co.
 - e. Or Approved Equal

2.2 ENCLOSED SWITCHES

- A. Enclosed, Nonfusible Switch: NEMA KS 1, Type HD, with lockable handle.
- B. Enclosed, Fusible Switch, 800 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handle with two padlocks, and interlocked with cover in closed position.

2.3 ENCLOSED CIRCUIT BREAKERS

- A. Molded-Case Circuit Breaker: NEMA AB 1, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic Trip Unit Circuit Breakers: RMS sensing; field-replaceable rating plug; with the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and I^2t response.
 - 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 - 5. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker; trip activation on fuse opening or on opening of fuse compartment door.
 - 6. GFCI Circuit Breakers: Single- and two-pole configurations with 5-mA trip sensitivity.
 - 7. Molded-Case Switch: Molded-case circuit breaker without trip units.
- B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Mechanical style suitable for number, size, trip ratings, and material of conductors.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 4. Communication Capability: Circuit-breaker-mounted communication module with functions and features compatible with power monitoring and control system.
 - 5. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
 - 6. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - 7. Auxiliary Switch: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 8. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
 - 9. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.

2.4 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
 - 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - 4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.5 FACTORY FINISHES

- A. Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosures before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with mounting and anchoring requirements specified in Division 26 Section "Seismic Controls for Electrical Work."
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Provide an additional ten branch breakers with enclosures and accessories of each size, phase and voltage as required to accommodate changes to resolve interferences or as directed by the Engineer.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods"
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.4 CONNECTIONS

- A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.
- B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed switch, circuit breaker, component, and control circuit.
 - 2. Test continuity of each line- and load-side circuit.
- B. Testing: After installing enclosed switches and circuit breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection and electrical test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- C. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.
 - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Substantial Completion.
 - 2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies switches and circuit breakers checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.7 CLEANING

- A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 26 28 16

SECTION 26 32 13

ENGINE GENERATORS (DIESEL)

PART 1 - GENERAL

1.1 SCOPE

- A. Provide complete factory assembled generator set equipment with digital (microprocessor-based) electronic generator set controls, digital governor, and digital voltage regulator.
- B. Rebranding and OEM (original equipment manufacturer) agreements: Only equipment manufactured by the listed OEM manufacturers will be acceptable. Units that are manufactured by others and rebranded will NOT be acceptable for this contract and will be rejected. Letters from OEM stating that re-branded units are "equal" shall be rejected.
- C. Provide factory test, startup by a supplier authorized by the equipment manufacturer(s), and on-site testing of the system.
- D. The generator set manufacturer shall warrant all equipment provided under this section, whether or not it is manufactured by the generator set manufacturer, so that there is one source for warranty and product service.
- E. This specification is not a performance specification. Any/all suggested manufacturer substitutions the contractor elects to submit to the engineer MUST be fully 100% equal to or better than that specified or the product will be rejected. This includes all equipment components such as but not limited to: dip ratios, horsepower, torque, capacity, cubic inch engine size, alternator, charger, coolant system, etc.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

1.3 SUMMARY

- A. This Section includes packaged engine-generator sets suitable for use in mission critical applications with the features as specified and indicated. Engine generators will be used as the Standby power source for the system, but shall be capable of providing reliable power with no run-time limitations while the primary source of power is unavailable.
- B. The generator will replace an existing generator in the same physical location. The contractor shall be responsible of providing temporary stand-by power during the entire time the existing generator is out of commission and the new generator is in full operating and commissioned (tested & inspected) mode. The standby power shall be equal to that currently being provided.

1.4 DEFINITIONS

- A. Emergency Standby Power (ESP): Per ISO 8528: The maximum power available during a variable electrical power sequence, under the stated operating conditions, for which a generating set is capable of delivering in the event of a utility power outage or under test conditions

for up to 200 hours of operation per year with the maintenance intervals and procedures being carried out as prescribed by the manufacturers. The permissible average power output (Ppp) over 24 hours of operation shall not exceed 70 percent of the ESP unless otherwise agreed by the RIC engine manufacturer.

- B. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:
 - 1. Thermal damage curve for generator.
 - 2. Time-current characteristic curves for generator protective device.
 - 3. Sound test data, based on a free field requirement.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, and location and size of each field connection.
 - 1. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
 - 2. Wiring Diagrams: Control interconnection, Customer connections.
- C. Certifications:
 - 1. Submit statement of compliance which states the proposed product(s) is certified to the emissions standards required by the location for EPA, stationary emergency application.

1.6 INFORMATIONAL SUBMITTALS

- A. Source quality-control test reports.
 - 1. Certified summary of prototype-unit test report. See requirements in Part 2 "Source Quality Control" Article Part A. Include statement indicating torsional compatibility of components.
 - 2. Certified Test Report: Provide certified test report documenting factory test per the requirements of this specification, as well as certified factory test of generator set sensors per NFPA110 level 1.
 - 3. List of factory tests to be performed on units to be shipped for this Project.
 - 4. Report of exhaust emissions and compliance statement certifying compliance with applicable regulations.
- B. Warranty:

1. Submit manufacturer's warranty statement to be provided for this Project.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 2 hours of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.
- C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.
- D. Comply with NFPA 37 (Standard For the Installation and Use of Stationary Combustion Engines and Gas Turbines).
- E. Comply with NFPA 70 (National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702).
- F. Comply with NFPA 110 (Emergency and Standby Power Systems) requirements for Level 1 emergency power supply system.

1.8 PROJECT CONDITIONS

- A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 1. Ambient Temperature: 0.0 deg C (32.0 deg F) to 40.0 deg C (104.0 deg F).
 2. Relative Humidity: 0 to 95 percent.
 3. Altitude: Sea level to 200.0 feet (60.96 m).

1.9 WARRANTY

- A. Extended Warranty: Manufacturer shall offer extend coverage of 5 years from date of registered commissioning and start-up.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Only approved manufacturers shall supply equipment provided under this contract. Equipment specifications for this project are based on generator sets manufactured by Cummins Power Generation with microprocessor-based controls.
- B. Proposals for substitutions must include a line by line compliance statement based on this specification in a hard copy formal written submission provided only by the 'bidding contractor' (those that have purchased the contract documents). Note: This does not ensure the approval of the product. No manufacturer sales representatives requesting approval will be reviewed.

Other acceptable manufacturers listed below will be considered however must comply with the specification in its entirety (no exception).

- a. Cummins Power (Onan) Basis of Design
- b. Kohler Power Systems
- c. Caterpillar

2.2 ENGINE-GENERATOR SET

- A. Factory-assembled and -tested, engine-generator set.
- B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.
 1. Rigging Information: Indicate location of each lifting attachment, generator-set center of gravity, and total package weight in submittal drawings.
- C. Capacities and Characteristics:
 1. Power Output Ratings: Electrical output power rating for Standby operation of not less than 50.0kW, at 80 percent lagging power factor, 120/208, single phase, 3 -wire, 60 hertz
 2. Alternator shall be 6 lead reconnectable PMG with max 120C rise in 40C ambient and minimum 119MSKVA .
 3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component. The engine-generator nameplate shall include information of the power output rating of the equipment.
- D. Generator-Set Performance:
 1. Steady-State Voltage Operational Bandwidth: 0.5 percent of rated output voltage from no load to full load.
 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within 2 seconds. On application of a 100% load step the generator set shall recover to stable voltage within 10 seconds.
 3. Steady-State Frequency Operational Bandwidth: 0.25 percent of rated frequency from no load to full load.
 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 5. Transient Frequency Performance: Not more than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within 2 seconds. On application of a 100% load step the generator set shall recover to stable frequency within 10 seconds.

6. Output Waveform: At full load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for any single harmonic. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
7. Sustained Short-Circuit Current: For a 1-phase, bolted short circuit at system output terminals, system shall regulate both voltage and current to prevent over-voltage conditions on the non-faulted phases.
8. Start Time: Comply with NFPA 110, Level 1, Type 10, system requirements.
9. Ambient Condition Performance: Engine generator shall be designed to allow operation at full rated load in an ambient temperature under site conditions, based on highest ambient condition. Ambient temperature shall be as measured at the air inlet to the engine generator for enclosed units, and at the control of the engine generator for machines installed in equipment rooms.

2.3 ENGINE

- A. Fuel: ASTM D975 #2 Diesel Fuel
- B. Rated Engine Speed: 1800RPM.
- C. Lubrication System: The following items are mounted on engine or skid:
 1. Lube oil pump: shall be positive displacement, mechanical, full pressure pump.
 2. Filter and Strainer: Provided by the engine manufacturer of record to provide adequate filtration for the prime mover to be used.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Engine Fuel System: The engine fuel system shall be installed in strict compliance to the engine manufacturer's instructions
- E. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
- F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity and performance.
 1. Designed for operation on a single 120 VAC, Single phase, 60Hz power connection. Heater voltage shall be shown on the project drawings.
 2. Installed with isolation valves to isolate the heater for replacement of the element without draining the engine cooling system or significant coolant loss.
 3. Provided with a 12VDC thermostat, installed at the engine thermostat housing
- G. Governor: Adjustable isochronous, with speed sensing. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, sta-

ble operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate as appropriate to the state of the engine generator. Fuel rate shall be regulated as a function of starting, accelerating to start disconnect speed, accelerating to rated speed, and operating in various isochronous states.

H. Cooling System: Closed loop, liquid cooled

1. The generator set manufacturer shall provide prototype test data for the specific hardware proposed demonstrating that the machine will operate at rated standby load in an outdoor ambient condition of 40 deg C.
2. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
3. Size of Radiator overflow tank: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and pet-cock.
5. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
6. Duct Flange: Generator sets installed indoors shall be provided with a flexible radiator duct adapter flange.

I. Muffler/Silencer: Selected with performance as required to meet sound requirements of the application, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. For generator sets with outdoor enclosures the silencer shall be inside the enclosure.

J. Air-Intake Filter: Engine-mounted air cleaner with replaceable dry-filter element and restriction indicator.

K. Starting System: 12 or 24V, as recommended by the engine manufacturer; electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Cycle: As required by NFPA 110 for level 1 systems.
3. Battery Cable: Size as recommended by engine manufacturer for cable length as required. Include required interconnecting conductors and connection accessories.
4. Battery Compartment: Factory fabricated of metal with acid-resistant finish.
5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation. The battery charging alternator shall have sufficient capacity to recharge the batter-

ies with all parasitic loads connected within 4 hours after a normal engine starting sequence.

6. Battery Chargers: Unit shall comply with UL 1236, provide fully regulated, constant voltage, current limited, battery charger for each battery bank. It will include the following features:
 - a. Operation: Equalizing-charging rate based on generator set manufacturer's recommendations shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 20 deg C to plus 40 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - e. Provide LED indication of general charger condition, including charging, faults, and modes. Provide a LCD display to indicate charge rate and battery voltage. Charger shall provide relay contacts for fault conditions as required by NFPA110.
 - f. Enclosure and Mounting: NEMA, Type 1, wall-mounted cabinet.

2.4 FUEL OIL STORAGE

- A. Comply with NFPA 30.
- B. Sub Base-Mounted Fuel Oil Tank: Provide a double wall secondary containment type sub base fuel storage tank. The tank shall be constructed of corrosion resistant steel and shall be UL 142 listed and labeled. The fuel tank shall include the following features:
 1. Capacity: Fuel for 48 Hour(s) continuous operation at 100 percent rated power output.
 2. Tank rails and lifting eyes shall be rated for the full dry weight of the tank, genset, and enclosure.
 3. Electrical stub up(s)
 4. Normal & emergency vents
 5. Lockable fuel fill
 6. Mechanical fuel level gauge

7. Low level switch to indicate fuel level
8. Leak detector switch
9. Sub base tank shall include a welded steel containment basin, sized at a minimum of 110% of the tank capacity to prevent escape of fuel into the environment in the event of a tank rupture.
10. Tank design shall meet the regional requirements for the Project location

2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Overcurrent Protection: The generator set shall be provided with a UL Listed/CSA Certified protective device that is coordinated with the alternator provided to prevent damage to the generator set on any possible overload or overcurrent condition external to the machine. The protective device shall be listed as a utility grade protective device under UL category NRGU. The control system shall be subject to UL follow-up service at the manufacturing location to verify that the protective system is fully operational as manufactured. Protector shall perform the following functions:
 1. Initiates a generator kW overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
 2. Under single phase or multiple phase fault conditions, or on overload conditions, indicates an alarm conditions when the current flow is in excess of 110% of rated current for more than 10 seconds.
 3. Under single phase or multiple phase fault conditions, operates to switch off alternator excitation at the appropriate time to prevent damage to the alternator.
 4. The operator panel shall indicate the nature of the fault condition as either a short circuit or an overload.
 5. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot greater than 120% of nominal voltage.
 6. The protective system provided shall not include an instantaneous trip function.

2.6 CONTROL AND MONITORING

- A. Engine generator control shall be microprocessor based and provide automatic starting, monitoring, protection and control functions for the unit.
- B. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. (Switches with different configurations but equal functions are acceptable.) When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.

- C. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms. Operation of the local (generator set-mounted) and/or remote emergency-stop switch also shuts down generator set.
- D. Configuration: Operating and safety indications, protective devices, system controls, engine gages and associated equipment shall be grouped in a common control and monitoring panel. Mounting method shall isolate the control panel from generator-set vibration. AC output power circuit breakers and other output power equipment shall not be mounted in the control enclosure.
- E. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:
 - 1. AC voltmeter (3-phase, line to line and line to neutral values).
 - 2. AC ammeter (3-phases).
 - 3. AC frequency meter.
 - 4. Ammeter-voltmeter displays shall simultaneously display conditions for all three phases.
 - 5. Emergency Stop Switch: Switch shall be a red "mushroom head" pushbutton device complete with lock-out/tag-out provisions. Depressing switch shall cause the generator set to immediately stop the generator set and prevent it from operating.
 - 6. Fault Reset Switch: Supply a dedicated control switch to reset/clear fault conditions.
 - 7. DC voltmeter (alternator battery charging).
 - 8. Engine-coolant temperature gauge.
 - 9. Engine lubricating-oil pressure gauge.
 - 10. Running-time meter.
 - 11. Generator-voltage and frequency digital raise/lower switches. Rheostats for these functions are not acceptable. The control shall adjustment of these parameters in a range of plus or minus 5% of the voltage and frequency operating set point (not nominal voltage and frequency values.) The voltage and frequency adjustment functions shall be disabled when the paralleling breaker is closed.
 - 12. Fuel tank derangement alarm.
 - 13. Fuel tank high-level shutdown of fuel supply alarm.

14. AC Protective Equipment: The control system shall include over/under voltage, reverse kVAR over current, loss of voltage reference, and over excitation shut down protection. There shall be a overload warning, and overcurrent warning alarm.
15. Status LED indicating lamps to indicate remote start signal present at the control, existing shutdown condition, existing alarm condition, not in auto, and generator set running.
16. A graphical display panel with appropriate navigation devices shall be provided to view all information noted above, as well as all engine status and alarm/shutdown conditions (including those from an integrated engine emission control system). The display shall also include integrated provisions for adjustment of the gain and stability settings for the governing and voltage regulation systems.
17. Panel lighting system to allow viewing and operation of the control when the generator room or enclosure is not lighted.
18. Data Logging: The control system shall log the latest 20 different alarm and shut down conditions, the total number of times each alarm or shutdown has occurred, and the date and time the latest of these shutdown and fault conditions occurred.
19. DC control Power Monitoring: The control system shall continuously monitor DC power supply to the control, and annunciate low or high voltage conditions. It shall also provide an alarm indicating imminent failure of the battery bank based on degraded voltage recover on loading (engine cranking).

2.7 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H
- D. Temperature Rise: 120 / Class H environment.
- E. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, over speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Drip-proof.
- G. Voltage Regulator: SCR type, Separate from exciter, providing performance as specified. The voltage regulation system shall be microprocessor-controlled, full wave rectified, and provide a pulse-width modulated signal to the exciter. No exceptions or deviations to these requirements will be permitted.
- H. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- I. Subtransient Reactance: 11 percent maximum, based on the rating of the engine generator set.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Sound Attenuated Aluminum housing. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Instruments, control, and battery system shall be mounted within enclosure.
- B. Construction:
 - 1. Hinged Doors: With padlocking provisions. Restraint/Hold back hardware to prevent door to keep door open at 180 degrees during maintenance. Rain lips over all doors.
 - 2. Exhaust System:
 - a. Muffler Location: Within enclosure.
 - 3. Hardware: All hardware and hinges shall be stainless steel.
 - 4. Mounting Base: Suitable for mounting on sub-base fuel tank or housekeeping pad.
 - 5. A weather protective enclosure shall be provided which allows the generator set to operate at full rated load with a static pressure drop equal to or less than 0.5 inches of water.
- C. Engine Cooling Airflow through Enclosure: Housing shall provide ample airflow for engine generator operation at rated load in an ambient temperature of 40 deg C.
 - 1. Louvers: Fixed-engine, cooling-air inlet and discharge.
- D. Sound Performance: Reduce the sound level of the engine generator while operating at full rated load to a maximum of 75 dBA measured at any location 7 m from the engine generator in a free field environment.
- E. Site Provisions:
 - 1. Lifting: Complete assembly of engine generator, enclosure, and sub base fuel tank (when used) shall be designed to be lifted into place as a single unit, using spreader bars.

2.9 VIBRATION ISOLATION DEVICES

- A. Vibration Isolation: Generators installed on grade shall be provided with elastomeric isolator pads integral to the generator, unless the engine manufacturer requires use of spring isolation.

2.10 FINISHES

- A. Components: Powder-coated and baked over corrosion-resistant pretreatment and compatible primer. Manufacturer's standard color or as directed on the drawings.

2.11 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with NFPA 110, Level 1 Energy Converters. In addition, the equipment engine, skid, cooling system, and alternator shall have been subjected to actual prototype

tests to validate the capability of the design under the abnormal conditions noted in NFPA110. Calculations and testing on similar equipment which are allowed under NFPA110 are not sufficient to meet this requirement.

- B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
1. Test engine generator set manufactured for this Project to demonstrate compatibility and functionality.
 2. Full load run.
 3. Maximum power.
 4. Voltage regulation.
 5. Steady-state governing.
 6. Single-step load pickup.
 7. Simulated safety shutdowns.
 8. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
 9. Provide fuel transfer testing for operations with use of the existing remote fuel tank.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with packaged engine-generator manufacturers' written installation, application, and alignment instructions and with NFPA 110.
- B. Equipment shall be installed by the contractor in accordance with final submittals and contract documents. Installation shall comply with applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with manufacturer's instructions and instructions included in the listing or labeling of UL listed products.
- C. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The contractor shall also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.
- D. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with manufacturer's instructions and seismic requirements of the site.
- E. Equipment shall be initially started and operated by representatives of the manufacturer. All protective settings shall be adjusted as instructed by the consulting engineer.

- F. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to initial operation and final testing of the system.
- G. On completion of the installation by the electrical contractor, the generator set supplier shall conduct a site evaluation to verify that the equipment is installed per manufacturer's recommended practice.

3.2 ON-SITE ACCEPTANCE TEST

- A. The complete installation shall be tested to verify compliance with the performance requirements of this specification following completion of all site work. Testing shall be conducted by representatives of the manufacturer, with required fuel supplied by Contractor. The Engineer shall be notified in advance and shall have the option to witness the tests. The generator set manufacturer shall provide a site test specification covering the entire system. Tests shall include:
 - B. Prior to start of active testing, all field connections for wiring, power conductors, and bus bar connections shall be checked for proper tightening torque.
 - C. Installation acceptance tests to be conducted on site shall include a "cold start" test, a two hour full load (resistive) test, and a one-step rated load pickup test in accordance with NFPA 110. Provide a resistive load bank and make temporary connections for full load test, if necessary.
 - D. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the utility service, and observing proper operation of the system for at least 2 hours. Coordinate timing and obtain approval for start of test with site personnel.

3.3 FIELD QUALITY CONTROL

- A. **Manufacturer's Field Service:** Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

3.4 SERVICE AND SUPPORT

- A. The generator set supplier shall maintain service parts inventory for the entire power system at a central location which is accessible to the service location 24 hours per day, 365 days per year. The inventory shall have a commercial value of \$3 million or more. The manufacturer of the generator set shall maintain a central parts inventory to support the supplier, covering all the major components of the power system, including engines, alternators, control systems, paralleling electronics, and power transfer equipment.
- B. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical power system replacement parts in the local service location. Service vehicles shall be stocked with

critical replacement parts. The service organization shall be on call 24 hours per day, 365 days per year. The service organization shall be physically located within 2 hours of the site.

- C. The manufacturer shall maintain model and serial number records of each generator set provided for at least 20 years.

END OF SECTION

SECTION 26 36 00

AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switches
- B. Related Sections include the following:

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
 - 1. Technical data on all major components of all transfer switches and other products described in this section. Data is required for the transfer switch mechanism, control system, cabinet, and protective devices specifically listed for use with each transfer switch. Include steady state and fault current ratings, weights, operating characteristics, and furnished specialties and accessories.
 - 2. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
- B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
 - 1. Dimensioned outline drawings of assembly, including elevations, sections, and details including minimal clearances, conductor entry provisions, gutter space, installed features and devices and material lists for each switch specified.
 - 2. Internal electrical wiring and control drawings.
 - 3. Interconnection wiring diagrams, showing recommended conduit runs and point-to-point terminal connections to generator set.
 - 4. Installation and mounting instructions, including information for proper installation of equipment to meet seismic requirements.
- C. Manufacturer Seismic Qualification Certification: Submit certification that transfer switches accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Seismic certification, as required for site conditions. Seismic certifications shall be third-party certified, and based on testing. Certification based on calculations does not meet this requirement.
 - a. 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 *both during and after* the seismic event."
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. Manufacturer and Supplier Qualification Data

1. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.
2. The manufacturer of this equipment shall have produced similar equipment for a minimum period of 10 years. When requested, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Features and operating sequences, both automatic and manual.
2. List of all factory settings of relays, timers and protective devices; provide setting and calibration instructions where applicable.

F. Warranty documents demonstrating compliance with the project's contract requirements.

1.4 QUALITY ASSURANCE

A. Only approved bidders shall supply equipment provided under this contract.

B. Manufacturer Qualifications: The equipment supplier shall maintain a service center capable of providing training, parts, maintenance and emergency repairs to equipment, including transfer switch and generator sets.

1. The transfer switch shall be serviced by technicians employed by, specially trained and certified by, the generator set supplier and the supplier shall have a service organization that is factory-certified in both generator set and transfer switch service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles. The service organization shall be on call 24 hours per day, 365 days per year.
2. Submit names, experience level, training certifications, and locations for technicians that will be responsible for servicing equipment at this site.
3. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.

C. Source Limitations: All transfer switches are to be obtained through one source from a single manufacturer. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for products provided.

- D. 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 as suitable for use in emergency, legally required or optional standby use as appropriate for the connected load.
- E. The automatic transfer switch installation and application shall conform to the requirements of the following codes and standards:
 - 1. Transfer switches and enclosures shall be UL 1008 listed and labeled as suitable for use in emergency, legally required, and optional standby applications.
 - 2. CSA 282, Emergency Electrical Power Supply for Buildings, and CSA C22.2, No. 14-M91 Industrial Control Equipment
 - 3. NFPA 70, National Electrical Code. Equipment shall be suitable for use in systems in compliance with Articles 700, 701 and 702.
 - 4. Comply with NEMA ICS 10-1993 AC Automatic Transfer Switches
 - 5. IBC 2006 – The transfer switch(es) shall be prototype-tested and third-party certified to comply with the requirements of IBC group III or IV, Category D/F. The equipment shall be shipped with the installation instructions necessary to attain installation compliance
 - 6. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
 - 7. EN55011, Class B Radiated Emissions and Class B Conducted Emissions
 - 8. IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity
 - 9. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity
 - 10. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity
 - 11. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity
 - 12. IEC 1000-4-6 Conducted Field Immunity
 - 13. IEC 1000-4-11 Voltage Dip Immunity
 - 14. IEEE 62.41, AC Voltage Surge Immunity
 - 15. IEEE 62.45, AC Voltage Surge Testing
- F. Comply with NFPA 99 – Essential Electrical Systems for Healthcare Facilities
- G. Comply with NFPA 110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems, regardless of the actual circuit level.
- H. The manufacturer shall warrant the material and workmanship of the transfer switch equipment for a minimum of two years from registered commissioning and start-up, or eighteen (18) months from date of shipment.
- I. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, and etc. during the minimum noted warranty period described above.

1.5 PROJECT CONDITIONS

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:
 - 1. Notify (Architect/Construction Manager/Owner) no fewer than (insert appropriate number) days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without (Architect/Construction Manager/Owner's) written permission.
 - 3. Do not energize any new service or distribution equipment without notification and permission of the (Architect/Construction Manager/Owner).

1.6 COORDINATION

- A. Size and location of concrete bases and anchor bolt inserts shall be coordinated if floor mounted. Concrete, reinforcement and formwork must meet the requirements specified in Division 03. See section 3.1 for additional information on installation

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cummins Power Generation
 - 2. ASCO 4000 Series
- B. Equipment specifications for this Project are based on automatic transfer switches manufactured by Cummins Power Generation.
- C. Proposals must include a line-by-line compliance statement based on this specification.
- D. Transfer switches utilizing molded case circuit breakers do not meet the requirements of this specification and will not be accepted.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Provide Cummins model OTEC 225A 120/208 3P NEMA 1
- B. Provide transfer switches in the number and ratings that are shown on the drawings. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.
- C. Fault-Current Closing and Withstand Ratings: UL 1008 WCR ratings must be specifically listed as meeting the requirements for use with protective devices at installation locations, under specified fault conditions. Withstand and closing ratings shall be based on use of the same set of contacts for the withstand test and the closing test.
- D. Solid-State Controls: All settings should be accurate to +/- 2% or better over an operating temperature range of - 40 to + 60 degrees C (- 40 to + 140 degrees F).
- E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- F. Electrical Operation: Accomplished by a non-fused, momentarily energized solenoid or electric motor operator mechanism, mechanically and electrically interlocked in both directions (except that mechanical interlock is not required for closed transition switches).
- G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switches using molded-case switches or circuit breakers, or insulated case circuit breaker components are not acceptable.
 2. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the Source 1 and Source 2 positions.
 3. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
 4. Contacts shall be operated by a high-speed electrical mechanism that causes contacts to open or close within three electrical cycles from signal.
 5. The transfer switch operation shall include the ability to switch to an open position (both sources disconnected) for the purpose of load shedding from the generator set.
 6. The power transfer mechanism shall include provisions for manual operation under load with the enclosure door closed. Manual operation may be electromechanical or mechanical, but must be coordinated with control function.
 7. Transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with components that could be operating at line voltage levels.
 8. The transfer switch shall include the mechanical and control provisions necessary to allow the device to be field-configured for operating speed. Transfer switch operation with motor loads shall be as is recommended in NEMA MG1.
 - a. [Phase angle monitoring/timing equipment is not an acceptable substitute for this functionality](#)
 9. Transfer switches designated on the drawings as “4-pole” shall be provided with a switched neutral pole which is switched simultaneously with phase poles..
 10. Transfer switches designated on the drawings as “3-pole” shall have a full current-rated neutral bar with lugs.
 11. Transfer switches designated on the drawings as “isolation-bypass” switches shall meet the requirements of section 2.4 of this specification.
 12. Transfer switches designated on the drawings as “non-automatic” switches shall meet the requirements of section 2.5 of this specification.
 13. Transfer switches designated on the drawings as “closed transition” switches shall meet the requirements of section 2.6 of this specification.
 14. Transfer switches designated on the drawings as “service entrance” switches shall meet the requirements of section 2.7 of this specification.
- H. Control: Transfer switch control shall be capable of communicating with the genset control, other switches and remote programming devices over a high-speed network interface.
- I. Factory wiring: Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism
- J. Terminals: Terminals shall be pressure type and appropriate for all field wiring. Terminal arrangement and cabinet space must be such that feeder conductors can enter from the top, side or bottom of the switch, at the installer’s discretion. Control wiring shall be equipped with suitable lugs, for connection to terminal strips.
- K. Enclosures: All enclosures shall be third-party certified for compliance to NEMA ICS 6 and UL 508, unless otherwise indicated:
1. The enclosure shall provide wire bend space in compliance to the latest version of NFPA70, regardless of the direction from which the conduit enters the enclosure.

2. Exterior cabinet doors shall provide complete protection for the system's internal components. Doors must have permanently mounted key-type latches. Bolted covers or doors are not acceptable.
3. Transfer switches shall be provided in enclosures that are third party certified for their intended environment per NEMA requirements.
 - a. Transfer switches mounted in a controlled indoor environment shall be provided in NEMA Type 1 enclosures (IEC type IP30).
 - b. Transfer switches installed indoors shall be NEMA Type 12 (IEC type IP61) if the Project environment requires dust-proof and/or drip-proof equipment.
 - c. Transfer switches located outdoors shall be supplied in NEMA Type 3R (IEC IP34) when dust-proof and/or rain-proof enclosures are required.
 - d. Transfer switches that are installed outdoors or in any other uncontrolled environment shall be supplied with NEMA Type 4 or 4X (stainless steel) enclosures (IEC IP65).

2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with requirements for Level 1 equipment according to NFPA 110.
- B. Indicated current ratings:
 1. Refer to the Project drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosure type, and accessories.
 2. Main contacts shall be rated for 600 VAC minimum.
 3. Transfer switches shall be rated to carry 100% of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C (-40 to +140 degrees F), relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000 meters).
- C. Manual Switch Operation: The power transfer mechanism shall include provisions for manual operation under load with the enclosure door closed. Manual operation may be electromechanical or mechanical, but must be coordinated with control function
- D. Relay Signal: Control shall include provisions for addition of a pre-transfer relay signal, adjustable from 0 to 60 seconds, to be provided if necessary for elevator operation, based on equipment provided for the project..
- E. Control: Transfer switch control shall be provided with necessary equipment and software to communicate with the genset control, other transfer switches, remote annunciation equipment, and other devices over a high speed control network.
- F. Neutral Switching: Transfer switches designated on the drawings as 4-pole shall be provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Substitute equipment using overlapping neutral contacts is not acceptable.
- G. Transfer switches that are designated on the drawings as 3-pole shall be provided with a neutral bus and lugs. The neutral bus shall be sized to carry 100% of the current designated on the switch rating.
- H. The transfer switch physically located closest to the generator and not more than 50 ft (15 meters) away, except those served by generator paralleling equipment, shall be provided with a battery charger suitable for the requirements of the application and in compliance with NFPA

110 requirements for Level 1 systems. If no transfer switch is located within this distance, a battery charger shall be installed on the generator set.

I. Automatic Transfer Switch Control Features

1. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600 VAC. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.
2. All transfer switch sensing shall be configurable from an operator panel or from a Windows XP or later PC-based service tool. Designs utilizing DIP switches or other electromechanical devices are not acceptable.
3. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device for load shedding purposes. On receipt of this signal, the transfer switch shall switch to a neutral position when connected to Source 2. If Source 1 is available when the load-shed signal is received, the transfer switch shall connect to Source 1.
4. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator service.
5. The transfer switch shall provide a relay contact signal prior to transfer or re-transfer. The time period before and after transfer shall be adjustable in a range of 0 to 50 seconds.
6. The control system shall be designed and prototype tested for operation in ambient temperatures from - 40 degrees C to + 60 degrees C (- 40 to +140 degrees F). It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards.
7. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.
8. The transfer switch network monitoring equipment, when supplied, shall be provided with a battery-based auxiliary power supply to allow monitoring of the transfer switch when both AC power sources are non-operational. The battery power supply shall be monitored for proper condition, and the transfer switch shall include an alarm condition to indicate low battery condition.

J. Transfer Switch Control Panel: The transfer switch shall have a microprocessor-based control with a sealed membrane panel incorporating pushbuttons for operator-controlled functions, and LED lamps for system status indicators. The panel shall also include an alphanumeric display for detailed system information. Panel display and indicating lamps shall include permanent labels.

1. The indicator panel LEDs shall display:
 - a. Which source the load is connected to (Source 1 or Source 2)
 - b. Which source or sources are available
 - c. When switch is not set for automatic operation, because the control is disabled or the bypass switch is in use
 - d. When the switch is in test/exercise mode
2. The indicator shall have pushbuttons that allow the operator to activate the following functions:
 - a. Activate pre-programmed test sequence
 - b. Override programmed delays, and immediately go to the next operation
 - c. Reset the control by clearing any faults
 - d. Test all of the LEDs by lighting them simultaneously

3. The alphanumeric digital display shall be vacuum fluorescent-type, clearly visible in both bright sunlight and no-light conditions over an angle of 120 degrees, and shall display the following:
 - a. AC voltage for all phases, normal and emergency
 - b. Source status: connected or not connected.
 - c. Load data, including voltage, AC current, frequency, KW, KVA, and power factor.
4. The display panel shall be password-protected, and allow the operator to view and make adjustments:
 - a. Set nominal voltage and frequency for the transfer switch
 - b. Adjust voltage and frequency sensor operation set points
 - c. Set up time clock functions
 - d. Set up load sequence functions
 - e. Enable or disable control functions including program transition
 - f. View real-time clock data, operation log (hours connected, times transferred, failures) and service history

K. Control Functions: Functions managed by the control shall include:

1. Undervoltage sensing: three-phase normal, three-phase emergency source.
2. Over-voltage sensing: three-phase normal, three-phase emergency source.
3. Over/under frequency sensing:
4. Phase rotation sensing:

L. Control features shall include:

1. Programmable genset exerciser: A field-programmable control shall periodically start the generator, transfer the load to generator for a preset time, then re-transfer and shut down the generator after a preset cool-down period.
 - a. Push-button programming control shall have a selection of eight different schedules for exercising generator, with or without load.
2. In event of a loss of power to the control, all control settings, real-time clock setting and the engine start-time delay setting will be retained.
3. The system continuously logs information including the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. An event recorder stores information, including time and date-stamp, for up to 50 events.
4. Transfer Override Switch: Overrides automatic re-transfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light to indicate override status.

M. Control Interface

1. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.

2. The transfer switch shall be provided with a network communication card, and configured to allow network-based communication with the transfer switch and other network system components, including the generator set(s) provided for the Project.
3. Unassigned Auxiliary Contacts: Two normally open, 1-pole, double-throw contacts for each switch position, rated 10A at 240 VAC.

N. Engine Starting Contacts

1. One isolated and normally closed, and one isolated and normally open; rated 10A at 32 VDC minimum.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Floor-Mounting Switch: Anchor to floor by bolting.
 1. Floor-mounted transfer switches (except drawout switches supported by wheeled carriages, which must be rolled out at floor level) shall be mounted on concrete bases complying with the following requirements:
 - a. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
- D. Identify components according to Division 26 Section "Identification for Electrical Systems."
- E. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

- A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
- C. Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings.

- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 SOURCE QUALITY CONTROL

- A. Prior to shipping, factory shall test and inspect components, assembled switches, and associated equipment to ensure proper operation.
- B. Factory shall check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements.
- C. Factory shall perform dielectric strength test complying with NEMA ICS 1.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: The supplier of the transfer switch(es) and associated equipment shall inspect, test, and adjust components, assemblies, and equipment installations, including connections, and report results in writing.
- B. Manufacturer's representative shall perform tests and inspections and prepare test reports.
- C. After installing equipment and after electrical circuitry has been energized, installer shall test for compliance with requirements.
 - 1. Perform recommended installation tests as recommended in manufacturer's installation and service manuals.
 - 2. After energizing circuits, demonstrate interlocking sequence and operational function for each switch.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Verify time-delay settings.
 - c. Verify that the transfer switch is accurately metering AC voltage and current (when provided).
 - d. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
 - e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
 - 3. Ground-Fault Tests (if integral to transfer switch): Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - a. Verify grounding connections and locations and ratings of sensors.
- D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 DEMONSTRATION

- A. After generator set installation, the generator and transfer switch supplier shall conduct a complete operation, basic maintenance, and emergency service seminar covering generator set and transfer switch equipment, for up to 10 people employed by the Owner.
 1. The seminar shall include instruction on operation of the transfer equipment, normal testing and exercise, adjustments to the control system, use of the PC based service and maintenance tools provided under this contract, and emergency operation procedures.
 2. The class duration shall be at least 8 hours in length, and include practical operation with the installed equipment.

3.6 SERVICE AND SUPPORT

- A. The manufacturer shall supply the Owner with a complete set of the service and maintenance software required to support the product. The software shall be provided at a training class attended by the user, to qualify the user in proper use of the software. The software shall have the following features and capabilities:
 1. The software shall be 32 bit and shall be XP and Vista compatible.
 2. The software shall use the Windows Explorer format, for ease of use and commonality with other software in use at the facility.
 3. The software shall allow adjustment of all functions described herein, adjustment of operating levels of all protective functions, and programming of all optional functions in the controller. Adjustments shall be possible over modem from a facility that is remote from the generator set.
 4. The software shall be capable of storing and displaying data for any function monitored by the generator set control. This data shall be available in common file formats, and on graphical "strip chart" displays.
 5. The software shall automatically record all control operations and adjustments performed by any operator or software user, for tracking of changes to the control.
 6. The software shall display all warning, shutdown, and status changes programmed into transfer switch controller. For each event, the control shall provide information on the nature of the event, when it last occurred, and how many times it has occurred.

SECTION 26 43 13

SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Sample Warranty: For manufacturer's special warranty.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

- A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Comply with UL 1449.
- D. MCOV of the SPD shall be the nominal system voltage.

2.2 SERVICE ENTRANCE AND TRANSFER SWITCH SUPPRESSOR

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ABB Electrification Products.
 - 2. Eaton.
 - 3. Leviton Manufacturing Co., Inc.
 - 4. Liebert; a brand of Vertiv.

5. Schneider Electric USA, Inc.
 6. Siemens Industry, Inc., Energy Management Division.
 7. Or Approved Equal
- B. SPDs: Comply with UL 1449, Type 2.
1. SPDs with the following features and accessories:
 - a. Integral disconnect switch.
 - b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
 - c. Indicator light display for protection status.
- C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 480 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V.
 2. Line to Ground: 1200 V for 480Y/277 V.
 3. Line to Line: 2000 V for 480Y/277 V.
- E. SCCR: Equal or exceed 200 kA.
- F. Inominal Rating: 20 kA.

2.3 PANEL SUPPRESSORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ABB Electrification Products.
 2. Eaton.
 3. Leviton Manufacturing Co., Inc.
 4. Schneider Electric USA, Inc.
 5. Siemens Industry, Inc., Energy Management Division.
 6. Or Approved Equal
- B. SPDs: Comply with UL 1449, Type 2.
1. Include LED indicator lights for power and protection status.
 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
- C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- D. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V.
 2. Line to Ground: 1200 V for 480Y/277 V.
 3. Neutral to Ground: 1200 V for 480Y/277 V.
 4. Line to Line: 2000 V for 480Y/277 V
- E. SCCR: Equal or exceed 100 kA.
- F. Inominal Rating: 20 kA.

2.4 ENCLOSURES

- A. Outdoor Enclosures: NEMA 250, Type 3R.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.
- C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.
- D. Use crimped connectors and splices only. Wire nuts are unacceptable.
- E. Complete startup checks according to manufacturer's written instructions. Energize SPDs after power system has been energized, stabilized, and tested.

3.2 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
 - 1. Compare equipment nameplate data for compliance with Drawings and Specifications.
 - 2. Inspect anchorage, alignment, grounding, and clearances.
 - 3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.
- B. An SPD will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.3 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION 26 43 13

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SECTION 27 15 00

C. COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Pathways.
 - 2. UTP cabling.
 - 3. 50/125-micrometer, optical fiber cabling.
 - 4. Coaxial cable.
 - 5. Multiuser telecommunications outlet assemblies.
 - 6. Cable connecting hardware, patch panels, and cross-connects.
 - 7. Telecommunications outlet/connectors.
 - 8. Cabling system identification products.
 - 9. Cable management system.
- B. Related Sections:
 - 1. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
 - 2. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

- A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
- B. BICSI: Building Industry Consulting Service International.
- C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel.
- D. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
- E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- F. EMI: Electromagnetic interference.
- G. IDC: Insulation displacement connector.
- H. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).
- I. LAN: Local area network.
- J. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.
- K. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
- L. RCDD: Registered Communications Distribution Designer.
- M. Solid-Bottom or Nonventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom without ventilation openings.
- N. Trough or Ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom having openings for the passage of air.
- O. UTP: Unshielded twisted pair.

1.4 HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
 - 1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
 - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
 - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
 - 4. Splitters shall not be installed as part of the optical fiber cabling.
- B. A work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) in the horizontal cross-connect.

1.5 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. For coaxial cable, include the following installation data for each type used:
 - a. Nominal OD.
 - b. Minimum bending radius.
 - c. Maximum pulling tension.
- B. Shop Drawings:
 - 1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
 - 2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 3. Cabling administration drawings and printouts.
 - 4. Wiring diagrams to show typical wiring schematics, including the following:
 - a. Cross-connects.
 - b. Patch panels.
 - c. Patch cords.
 - 5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
 - 6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
 - a. Vertical and horizontal offsets and transitions.
 - b. Clearances for access above and to side of cable trays.
 - c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
 - d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
- C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Maintenance Data: For splices and connectors to include in maintenance manuals.
- G. Software and Firmware Operational Documentation:
 - 1. Software operating and upgrade manuals.

2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings by an RCDD.
 2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician who shall be present at all times when Work of this Section is performed at Project site.
 3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- B. Testing Agency Qualifications: An NRTL.
 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.
- C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 50 or less.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.
- F. Grounding: Comply with ANSI-J-STD-607-A.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
 2. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.
 3. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.
- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.11 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.
- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion.

Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.12 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Patch-Panel Units: Two of each type.
 2. Connecting Blocks: Two of each type.
 3. Device Plates: Ten of each type.
 4. Multiuser Telecommunications Outlet Assemblies: Five of each type.

PART 2 - PRODUCTS

2.1 PATHWAYS

- A. General Requirements: Comply with TIA/EIA-569-A.
- B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
 1. Support brackets with cable tie slots for fastening cable ties to brackets.
 2. Lacing bars, spools, J-hooks, and D-rings.
 3. Straps and other devices.
- C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.
 1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2.2 BACKBOARDS

- A. Backboards: Plywood, [fire-retardant treated,] 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements in Division 06 Section "Rough Carpentry" for plywood backing panels.

2.3 UTP CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Belden CDT Inc.; Electronics Division.
 2. Berk-Tek; a Nexans company.
 3. CommScope, Inc.
 4. Draka USA.
 5. Genesis Cable Products; Honeywell International, Inc.
 6. KRONE Incorporated.
 7. Mohawk; a division of Belden CDT.
 8. Nordex/CDT; a subsidiary of Cable Design Technologies.
 9. Superior Essex Inc.
 10. SYSTIMAX Solutions; a CommScope, Inc. brand.
 11. 3M.
 12. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
 13. Or Approved Equal
- B. Description: 100-ohm, 4-pair UTP, formed into 25-pair, binder groups covered with a thermoplastic jacket.
 1. Comply with ICEA S-90-661 for mechanical properties.
 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 3. Comply with TIA/EIA-568-B.2, Category 5e.

4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
 - b. Communications, Riser Rated: Type CMR; complying with UL 1666.
 - c. Communications, Limited Purpose: Type CMX.
 - d. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
 - e. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.
5. Jacket color code:
 - a. Camera cabling – White
 - b. Data & Voice – Blue

2.4 UTP CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. American Technology Systems Industries, Inc.
 2. Dynacom Corporation.
 3. Hubbell Premise Wiring.
 4. KRONE Incorporated.
 5. Leviton Voice & Data Division.
 6. Molex Premise Networks; a division of Molex, Inc.
 7. Nordex/CDT; a subsidiary of Cable Design Technologies.
 8. Panduit Corp.
 9. Siemon Co. (The).
 10. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
 11. Or Approved Equal
- B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- C. Connecting Blocks: 110-style IDC for Category 5e. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
- D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 1. Number of Terminals per Field: One for each conductor in assigned cables.
- E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
 1. Number of Jacks per Field: One for each four-pair UTP cable indicated.
- F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- G. Patch Cords: Factory-made, four-pair cables; terminated with eight-position modular plug at each end.
 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
 2. Patch cords shall have color-coded boots for circuit identification.
 3. Jacket color code:
 - a. Camera cabling – White
 - b. Data & Voice – Blue
 4. Patch Cord lengths:
 - a. Data & voice drops – 10'
 - b. Camera drops – 10'
 - c. I.T. rack patch cords - 5' (half the total number of required cords)
- 7' (half the total number of required cords)

2.5 OPTICAL FIBER CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Berk-Tek; a Nexans company.
 2. CommScope, Inc.
 3. Corning Cable Systems.
 4. General Cable Technologies Corporation.
 5. Mohawk; a division of Belden CDT.
 6. Nordex/CDT; a subsidiary of Cable Design Technologies.
 7. Optical Connectivity Solutions Division; Emerson Network Power.
 8. Superior Essex Inc.
 9. SYSTIMAX Solutions; a CommScope, Inc. brand.
 10. 3M.
 11. Tyco Electronics/AMP Netconnect; Tyco International Ltd.
 12. Or Approved Equal
- B. Description: Multimode, 50/125-micrometer, 24 fiber, tight buffer, optical fiber cable.
1. Comply with ICEA S-83-596 for mechanical properties.
 2. Comply with TIA/EIA-568-B.3 for performance specifications.
 3. Comply with TIA/EIA-492AAAA-B for detailed specifications.
 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - a. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
 - b. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
 - c. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
 - d. Riser Rated, Conductive: Type OFCR, complying with UL 1666.
 5. Conductive cable shall be steel armored type.
 6. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
 7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
- C. Jacket:
1. Jacket Color: Aqua for 50/125-micrometer cable.
 2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
 3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

2.6 OPTICAL FIBER CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ADC.
 2. American Technology Systems Industries, Inc.
 3. Berk-Tek; a Nexans company.
 4. Corning Cable Systems.
 5. Dynacom Corporation.
 6. Hubbell Premise Wiring.
 7. Molex Premise Networks; a division of Molex, Inc.
 8. Nordex/CDT; a subsidiary of Cable Design Technologies.
 9. Optical Connectivity Solutions Division; Emerson Network Power.
 10. Siemon Co. (The).
 11. Or Approved Equal
- B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.
- C. Patch Cords: Factory-made, dual-fiber cables in .36-inch (900-mm) lengths.
- D. Cable Connecting Hardware:
1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.

2. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.75 dB.
3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.7 COAXIAL CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Alpha Wire Company.
 2. Belden CDT Inc.; Electronics Division.
 3. Coleman Cable, Inc.
 4. CommScope, Inc.
 5. Draka USA.
 6. Or Approved Equal
- B. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
- C. RG-11/U: NFPA 70, Type CATV.
 1. No. 14 AWG, solid, copper-covered steel conductor.
 2. Gas-injected, foam-PE insulation.
 3. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
 4. Jacketed with sunlight-resistant, black PVC or PE.
 5. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.
- D. RG59/U: NFPA 70, Type CATVR.
 1. No. 20 AWG, solid, silver-plated, copper-covered steel conductor.
 2. Gas-injected, foam-PE insulation.
 3. Triple shielded with 100 percent aluminum polyester tape and 95 percent aluminum braid; covered by aluminum foil with grounding strip.
 4. Color-coded PVC jacket.
- E. RG-6/U: NFPA 70, Type CATV or CM.
 1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
 2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
 3. Jacketed with black PVC or PE.
 4. Suitable for indoor installations.
- F. RG59/U: NFPA 70, Type CATV.
 1. No. 20 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
 2. Double shielded with 100 percent aluminum polyester tape and 40 percent aluminum braid.
 3. PVC jacket.
- G. RG59/U (Plenum Rated): NFPA 70, Type CMP.
 1. No. 20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
 2. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
 3. Copolymer jacket.
- H. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:
 1. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
 2. CATV Riser Rated: Type CATVR, complying with UL 1666.
 3. CATV Limited Rating: Type CATVX.

2.8 COAXIAL CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Aim Electronics; a brand of Emerson Electric Co.
 - 2. Leviton Voice & Data Division.
 - 3. Siemon Co. (The).
- B. Coaxial-Cable Connectors: Type F, 75 ohms.

2.9 CONSOLIDATION POINTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. American Technology Systems Industries, Inc.
 - 2. Chatsworth Products, Inc.
 - 3. Dynacom Corporation.
 - 4. Hubbell Premise Wiring.
 - 5. Molex Premise Networks; a division of Molex, Inc.
 - 6. Nordex/CDT; a subsidiary of Cable Design Technologies.
 - 7. Ortronics, Inc.
 - 8. Panduit Corp.
 - 9. Siemon Co. (The).
 - 10. Or Approved Equal
- B. Description: Consolidation points shall comply with requirements for cable connecting hardware.
 - 1. Number of Terminals per Field: One for each conductor in assigned cables.
 - 2. Number of Connectors per Field:
 - a. One for each four-pair UTP cable indicated.
 - b. One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.
 - 3. Mounting: Recessed in ceiling.
 - 4. NRTL listed as complying with UL 50 and UL 1863.
 - 5. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.10 MULTIUSER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Chatsworth Products, Inc.
 - 2. Hubbell Premise Wiring.
 - 3. Molex Premise Networks; a division of Molex, Inc.
 - 4. Nordex/CDT; a subsidiary of Cable Design Technologies.
 - 5. Ortronics, Inc.
 - 6. Panduit Corp.
 - 7. Siemon Co. (The).
 - 8. Or Approved Equal
- B. Description: MUTOAs shall meet the requirements for cable connecting hardware.
 - 1. Number of Terminals per Field: One for each conductor in assigned cables.
 - 2. Number of Connectors per Field:
 - a. One for each four-pair UTP cable indicated.
 - b. One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.
 - 3. Mounting: Recessed in ceiling.
 - 4. NRTL listed as complying with UL 50 and UL 1863.
 - 5. Label shall include maximum length of work area cords, based on TIA/EIA-568-B.1.
 - 6. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.11 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
- B. Workstation Outlets: Six-port-connector assemblies mounted in single or multigang faceplate.
 - 1. Plastic Faceplate: High-impact plastic. Coordinate color with Division 26 Section "Wiring Devices."
 - 2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
 - 3. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.12 GROUNDING

- A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with ANSI-J-STD-607-A.

2.13 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.14 CABLE MANAGEMENT SYSTEM

- A. **Manufacturers: Subject to compliance with requirements, provide products by one of the following:**
- B. Description: Computer-based cable management system, with integrated database and graphic capabilities.
- C. Document physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.
- D. Information shall be presented in database view, schematic plans, or technical drawings.
 - 1. Microsoft Visio Professional or AutoCAD drawing software shall be used as drawing and schematic plans software.
- E. System shall interface with the following testing and recording devices:
 - 1. Direct upload tests from circuit testing instrument into the personal computer.
 - 2. Direct download circuit labeling into labeling printer.

2.15 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
- C. Factory test UTP cables according to TIA/EIA-568-B.2. All testing reports shall be turned over to the owner.
- D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3. All testing reports shall be turned over to the owner.
- E. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
- F. Cable will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

- A. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."
- B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

- A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.
- B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.
- C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.
- D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.
- E. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- F. Pathway Installation in Communications Equipment Rooms:
 - 1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
 - 2. Install cable trays to route cables if conduits cannot be located in these positions.
 - 3. Secure conduits to backboard when entering room from overhead.
 - 4. Extend conduits 3 inches (76 mm) above finished floor.
 - 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- G. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 - 1. Comply with TIA/EIA-568-B.1.
 - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. MUTOA shall not be used as a cross-connect point.
 - 5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.

- b. Locate consolidation points for UTP at least 49 feet (15 m) from communications equipment room.
 6. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
 10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 12. In the communications equipment room, install a 10-foot (3-m) long service loop on each end of cable.
 13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- C. UTP Cable Installation:
 1. Comply with TIA/EIA-568-B.2.
 2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.
- D. Optical Fiber Cable Installation:
 1. Comply with TIA/EIA-568-B.3.
 2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.
- E. Open-Cable Installation:
 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- F. Installation of Cable Routed Exposed under Raised Floors:
 1. Install plenum-rated cable only.
 2. Install cabling after the flooring system has been installed in raised floor areas.
 3. Coil cable 6 feet (1800 mm) long not less than 12 inches (300 mm) in diameter below each feed point.
- G. Outdoor Coaxial Cable Installation:
 1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
 2. Attach antenna lead-in cable to support structure at intervals not exceeding 36 inches (915 mm).
- H. Group connecting hardware for cables into separate logical fields.
- I. Provide installation and materials for an additional two thousand feet of communications horizontal cabling of each size and type used on the project along with associated accessories to accommodate changes required to resolve interferences or as directed by the Engineer.
- J. Provide installation and materials for an additional fifteen communication drops with 100 feet of horizontal cabling to accommodate changes as directed by the Engineer or Owner.
- K. Separation from EMI Sources:
 1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).

- b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of .12 inches (300 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of .24 inches (610 mm).
- 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of .6 inches (150 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of .12 inches (300 mm).
- 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of .3 inches (76 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of .6 inches (150 mm).
- 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
- 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.5 FIRESTOPPING

- A. Comply with requirements in Division 07 Section "Penetration Firestopping."
- B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with ANSI-J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.7 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
 - 1. Administration Class: 1.
 - 2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
- B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.
- C. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

- D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration, including optional identification requirements of this standard.
- E. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.
- G. Cable and Wire Identification:
 - 1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).
 - 4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
 - 6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.
- H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
 - 1. Cables use flexible vinyl or polyester that flex as cables are bent.
- I. Cable and connector color guidelines are as follows:
 - 1. Data Drop: Blue
 - 2. VOIP Drop: Red
 - 3. Security Camera Drop: Green
 - 4. Wireless Drop: Orange
- J. Cables shall be identified at each end with labels that meet the requirements of TIA/EIA-606-A. All cables must have indelible identifying labels that are printed or generated by a mechanical device:
 - 1. Backbone Cables (Fiber Optic and MATV): Each cable must carry labels indicating the closet from which the cable runs, the cable type, and identifying number. The identifying number will indicate the closet numbers of each end, type of cable (i.e. FOC=Fiber optic cable), and the fiber or conductor number (01,02,03,...)
 - 2. Horizontal Cables: Each cable must carry labels indicating the closet from which the cable runs, the room number the cable is terminating, type of cable (i.e. QTP=quad twisted pair), type of drop. The type of drop will be identified by TE for teacher desk; S1, S2, S3, ... for student drop (each drop in a room will be sequentially numbered); SC for security camera; VOIP1, VOIP2, ... for VOIP drops (each drop in a room will be sequentially numbered); P for printer drops.
- K. Contractor shall provide the owner with a complete set of laminated full size "as-built" plans showing the location of all drops.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
 - 2. Visually confirm Category 5e, marking of outlets, cover plates, outlet/connectors, and patch panels.
 - 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 - 4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - 5. Optical Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - 1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
 - 2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
 - 6. UTP Performance Tests:
 - a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
 - 1) Wire map.
 - 2) Length (physical vs. electrical, and length requirements).
 - 3) Insertion loss.
 - 4) Near-end crosstalk (NEXT) loss.
 - 5) Power sum near-end crosstalk (PSNEXT) loss.
 - 6) Equal-level far-end crosstalk (ELFEXT).
 - 7) Power sum equal-level far-end crosstalk (PSELFEXT).
 - 8) Return loss.
 - 9) Propagation delay.
 - 10) Delay skew.
 - 7. Optical Fiber Cable Performance Tests: Perform optical fiber end-to-end link tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.3.
 - 8. Coaxial Cable Tests: Conduct tests according to Division 27 Section "Master Antenna Television System."
 - 9. Final Verification Tests: Perform verification tests for UTP and optical fiber systems after the complete communications cabling and workstation outlet/connectors are installed.
 - a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
 - b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface

device at the demarcation point. Log onto the network to ensure proper connection to the network.

10. All testing reports shall be turned over to the owner upon completion.

- D. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

3.9 DEMONSTRATION

- A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets. Include training in cabling administration software.

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SECTION 28 05 13

CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. UTP cabling.
 - 2. 62.5/125-micrometer, multimode optical fiber cabling.
 - 3. Coaxial cabling.
 - 4. RS-232 cabling.
 - 5. RS-485 cabling.
 - 6. Low-voltage control cabling.
 - 7. Control-circuit conductors.
 - 8. Fire alarm wire and cable.
 - 9. Identification products.

1.2 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. EMI: Electromagnetic interference.
- C. IDC: Insulation displacement connector.
- D. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).
- E. RCDD: Registered Communications Distribution Designer.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Pathways 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."

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements.
- C. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- D. Seismic Qualification Certificates: For pathways, accessories, and components, from manufacturer.
- E. Source quality-control reports.
- F. Field quality-control reports.
- G. Operation and maintenance data.

1.5 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An NRTL.
 - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical loss test set.
 - 2. Test optical fiber cable on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; include the loss value of each. Retain test data and include the record in maintenance data.
 - 3. Test each pair of UTP cable for open and short circuits.

1.7 PROJECT CONDITIONS

- A. Do not install conductors and cables that are wet, moisture damaged, or mold damaged.
 - 1. Indications that wire and cables are wet or moisture damaged include, but are not limited to, discoloration and sagging of factory packing materials.
- B. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PATHWAYS

- A. Support of Open Cabling: NRTL labeled for support of Category 5e cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
- B. Cable Trays:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit; a business unit of Tyco Electrical & Metal Products.
 - b. Cablofil.
 - c. Cooper B-Line, Inc.
 - d. GS Metals Corp.
 - e. Snaketray; Cable Management Solutions, Inc.
 - 2. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than (0.012 mm) thick.
- C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
 - 1. Outlet boxes shall be no smaller than .2 inches wide, .3 inches high, and 2-1/2 inches deep.

2.2 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. . Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry".

2.3 UTP CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ADC.
 2. AMP Netconnect; a brand of Tyco Electronics Corporation.
 3. Belden CDT Networking Division/NORDX.
 4. Belden Inc.
 5. Berk-Tek; a Nexans company.
 6. CommScope, Inc.
 7. Draka Cableteq USA.
 8. Genesis Cable Products; Honeywell International, Inc.
 9. Mohawk; a division of Belden.
 10. Superior Essex Inc.
 11. SYSTIMAX Solutions; a CommScope, Inc. brand.
 12. 3M; Communication Markets Division.
 13. Or Approved Equal
- B. Description: 100-ohm, 4-pair UTP, covered with a blue thermoplastic jacket.
1. Comply with ICEA S-90-661 for mechanical properties.
 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 3. Comply with TIA/EIA-568-B.2, Category 5e.
 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, General Purpose: Type CM or CMG or CMP.
 - b. Communications, Plenum Rated: Type CMP or MPP, complying with NFPA 262.
 - c. Communications, Riser Rated: Type CMR; or CMP, complying with UL 1666.
 - d. Communications, Limited Purpose: Type CMX; or CMP,.
 - e. Multipurpose: Type MP or MPG; or MPP or MPR.
 - f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
 - g. Multipurpose, Riser Rated: Type MPR or MPP, complying with UL 1666.

2.4 UTP CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, all hardware must be 100% compatible with cable type and transmission equipment:
1. ADC.
 2. American Technology Systems Industries, Inc.
 3. AMP Netconnect; a brand of Tyco Electronics Corporation.
 4. Belden CDT Networking Division/NORDX.
 5. Dynacom Corporation.
 6. Hubbell Incorporated; Hubbell Premise Wiring.
 7. Leviton Voice & Data Division.
 8. Molex Premise Networks; a division of Molex, Inc.
 9. PANDUIT CORP.
 10. Siemon.
 11. Or Approved Equal
- B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.
- C. Connecting Blocks: 110-style for Category 5e or 66-style for Category 5e. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

2.5 OPTICAL FIBER CABLE

- A. Manufacturers: Subject to compliance with requirements:
1. AMP Netconnect; a brand of Tyco Electronics Corporation.
 2. Belden CDT Networking Division/NORDX.

3. Berk-Tek; a Nexans company.
 4. CommScope, Inc.
 5. Corning Incorporated; Corning Cable Systems.
 6. CSI Technologies Inc.
 7. General Cable Technologies Corporation.
 8. Mohawk; a division of Belden.
 9. Superior Essex Inc.
 10. SYSTIMAX Solutions; a CommScope, Inc. brand.
 11. 3M; Communication Markets Division.
 12. Or Approved Equal
- B. Description: Multimode, 50/125 or 62.5/125-micrometer, 24-fiber, nonconductive, tight buffer, optical fiber cable.
1. Comply with ICEA S-83-596 for mechanical properties.
 2. Comply with TIA/EIA-568-B.3 for performance specifications.
 3. Comply with TIA-492AAAB or TIA-492AAAA-A for detailed specifications.
 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:
 - a. General Purpose, Nonconductive: Type OFN or OFNG, or OFNR, OFNP.
 - b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
 - c. Riser Rated, Nonconductive: Type OFNR or OFNP, complying with UL 1666.
 5. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
 6. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.
- C. Jacket:
1. Jacket Color: Aqua for 50/125-micrometer cable, Orange for 62.5/125-micrometer cable.
 2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-C.
 3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.6 OPTICAL FIBER CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. ADC.
 2. American Technology Systems Industries, Inc.
 3. Belden CDT Networking Division/NORDX.
 4. Berk-Tek; a Nexans company.
 5. Corning Incorporated; Corning Cable Systems.
 6. CSI Technologies Inc.
 7. Dynacom Corporation.
 8. Hubbell Incorporated; Hubbell Premise Wiring.
 9. Molex Premise Networks; a division of Molex, Inc.
 10. Siemon.
 11. Or Approved Equal
- B. Cable Connecting Hardware: Meet the Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2-B, TIA-604-3-B, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
1. Quick-connect, simplex and duplex, Type SC, Type ST, Type LC, Type MT-RJ connectors. Insertion loss not more than 0.75 dB.
 2. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.7 COAXIAL CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Alpha Wire Company.
 2. Belden CDT Networking Division/NORDX.

3. Coleman Cable, Inc.
 4. CommScope, Inc.
 5. Draka Cableteq USA.
 6. Or Approved Equal
- B. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
- C. RG-11/U: NFPA 70, Type CATV.
1. No. 14 AWG, solid, copper-covered steel conductor.
 2. Gas-injected, foam-PE insulation.
 3. Double shielded with 100 percent aluminum polyester tape and 60 percent aluminum braid.
 4. Jacketed with sunlight-resistant, black PVC or PE.
 5. Suitable for outdoor installations in ambient temperatures ranging from minus 40 to plus 85 deg C.
- D. RG-6/U: NFPA 70, Type CATV or CM.
1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
 2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
 3. Jacketed with black PVC or PE.
 4. Suitable for indoor installations.
- E. NFPA and UL Compliance: CATV Cable, Type CATV, or CATVP or CATVR shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655, and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles.

2.8 COAXIAL CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Emerson Network Power Connectivity Solutions; AIM Electronics brand.
 2. Leviton Voice & Data Division.
 3. Siemon.
 4. Or Approved Equal
- B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.9 RS-232 CABLE

- A. Standard Cable: NFPA 70, Type CM.
1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 2. Polypropylene insulation.
 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 4. PVC jacket.
 5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 6. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 2. Plastic insulation.
 3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
 4. Plastic jacket.
 5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
 6. Flame Resistance: Comply with NFPA 262.

2.10 RS-485 CABLE

- A. Standard Cable: NFPA 70, Type CM or CMG.

1. Paired, 2 pairs, twisted, No. 22 AWG, stranded (7x30) tinned copper conductors.
 2. PVC insulation.
 3. Unshielded.
 4. PVC jacket.
 5. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated Cable: NFPA 70, Type CMP.
1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
 2. Fluorinated ethylene propylene insulation.
 3. Unshielded.
 4. Fluorinated ethylene propylene jacket.
 5. Flame Resistance: NFPA 262, Flame Test.

2.11 LOW-VOLTAGE CONTROL CABLE

- A. Paired Cable: NFPA 70, Type CMG.
1. 1 pair, twisted, No. 16 AWG, stranded (19x29) and No. 18 AWG, stranded (19x30) tinned copper conductors.
 2. PVC insulation.
 3. Unshielded.
 4. PVC jacket.
 5. Flame Resistance: Comply with UL 1581.
- B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
1. 1 pair, twisted, No. 16 AWG, stranded (19x29) No. 18 AWG, stranded (19x30) tinned copper conductors.
 2. PVC insulation.
 3. Unshielded.
 4. PVC jacket.
 5. Flame Resistance: Comply with NFPA 262.

2.12 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway.
- B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, complying with UL 83, in raceway
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

2.13 FIRE ALARM WIRE AND CABLE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following (IMPORTANT: ALL FIRE ALARM CABLE SHALL BE PLENUM RATED CABLE: - NO EXCEPTION)
1. Comtran Corporation.
 2. Draka Cableteq USA.
 3. Genesis Cable Products; Honeywell International, Inc.
 4. Rockbestos-Suprenant Cable Corp.
 5. West Penn Wire; a brand of Belden Inc.
 6. Or Approved Equal
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, not less than No. 16 AWG size as recommended by system manufacturer.
1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.

- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum.
 - 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

2.14 IDENTIFICATION PRODUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Brady Corporation.
 - 2. HellermannTyton.
 - 3. Kroy LLC.
 - 4. PANDUIT CORP.
 - 5. Or Approved Equal
- B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.15 SOURCE QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
- C. Factory test UTP cables according to TIA/EIA-568-B.2.
- D. Factory test multimode optical fiber cables according to TIA-526-14-A and TIA/EIA-568-B.3.
- E. Factory sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
- F. Cable will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF PATHWAYS

- A. Cable Trays: Comply with NEMA VE 2 and TIA-569-B.
- B. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.
- C. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." for installation of conduits and wireways.
- D. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- E. Pathway Installation in Equipment Rooms:
 - 1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
 - 2. Install cable trays to route cables if conduits cannot be located in these positions.
 - 3. Secure conduits to backboard when entering room from overhead.
 - 4. Extend conduits .3 inches above finished floor.
 - 5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
- F. Backboards: Install backboards with .96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

- G. Provide an additional fifty feet of pathway and accessories of each type and size used on the project to accommodate any changes required to resolve interferences or as directed by the Engineer.

3.2 INSTALLATION OF HANGERS AND SUPPORTS

- A. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems." for installation of supports for pathways, conductors and cables.

3.3 WIRING METHOD

- A. Install wiring in raceways except in accessible indoor ceiling spaces and in interior hollow gypsum board partitions where cable may be used. Conceal raceways and wiring except in unfinished spaces and as indicated. Minimum conduit size shall be $\frac{3}{4}$ inch. Control and data transmission wiring shall not share conduit with other building wiring systems.
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Use lacing bars and distribution spools. Separate power-limited and non-power-limited conductors as recommended in writing by manufacturer. Install conductors parallel with or at right angles to sides and back of enclosure. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with intrusion system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

3.4 INSTALLATION OF CONDUCTORS AND CABLES

- A. Comply with NECA 1.
- B. Conductors: Size according to system manufacturer's written instructions unless otherwise indicated.
- C. General Requirements for Cabling:
 - 1. Comply with TIA/EIA-568-B.1.
 - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 - 3. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
 - 4. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 5. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
 - 6. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 7. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 8. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- D. UTP Cable Installation: Install using techniques, practices, and methods that are consistent with Category 5e rating of components and that ensure Category 5e performance of completed and linked signal paths, end to end.
 - 1. Comply with TIA/EIA-568-B.2.
 - 2. Install 110-style IDC termination hardware unless otherwise indicated.
 - 3. Do not untwist UTP cables more than $\frac{1}{2}$ inch from the point of termination to maintain cable geometry.
- E. Optical Fiber Cable Installation:
 - 1. Comply with TIA/EIA-568-B.3.
 - 2. Cable shall be terminated on connecting hardware that is rack or cabinet mounted.
- F. Outdoor Coaxial Cable Installation:

1. Install outdoor connections in enclosures complying with NEMA 250, Type 4X. Install corrosion-resistant connectors with properly designed O-rings to keep out moisture.
 2. Attach antenna lead-in cable to support structure at intervals not exceeding .36 inches (.915 mm).
- G. Open-Cable Installation:
1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 2. Suspend copper cable not in a wireway or pathway a minimum of .8 inches above ceilings by cable supports not more than 6.0 inches apart.
 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
- H. Separation from EMI Sources:
1. Comply with BICSI TDMM and TIA-569-B recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of .5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of .12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of .24 inches.
 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of .2-1/2 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of .6 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of .12 inches.
 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of .3 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of .6 inches.
 5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of .48 inches.
 6. Separation between Cables and Fluorescent Fixtures: A minimum of .5 inches.
- I. Provide an additional one thousand linear feet of cable/conductor and accessories of each type and size used on the project to accommodate any changes required to resolve interferences or as directed by the Engineer.

3.5 FIRE ALARM WIRING INSTALLATION

- A. Comply with NECA 1 and NFPA 72.
- B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceway and Boxes for Electrical Systems."
 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
- C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

- E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- F. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.
- G. Wiring to Remote Alarm Transmitting Device: .1-inch conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.
- H. Provide an additional five hundred linear feet of fire alarm cable and accessories of each type and size used on the project to accommodate any changes required to resolve interferences or as directed by the Engineer.

3.6 POWER AND CONTROL-CIRCUIT CONDUCTORS

- A. 120-V Power Wiring: Install according to Division 26 Section "Conductors and Cables" unless otherwise indicated.
- B. Minimum Conductor Sizes:
 1. Class 1 remote-control and signal circuits, No. 14 AWG.
 2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
 3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.7 CONNECTIONS

- A. Comply with requirements in Division 28 Section "Digital Addressable Fire-Alarm System" for connecting, terminating, and identifying wires and cables.

3.8 FIRESTOPPING

- A. Comply with requirements in Division 07 Section "Penetration Firestopping."
- B. Comply with TIA-569-B, "Firestopping" Annex A.
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.9 GROUNDING

- A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.10 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.11 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 3. Test UTP cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 4. Optical Fiber Cable Tests:
 - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 - b. Link End-to-End Attenuation Tests:
 - 1) Multimode Link Measurements: Test at 850 or 1300 nm in 1 direction according to TIA-526-14-A, Method B, One Reference Jumper.
 - 2) Attenuation test results for links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.
 5. Coaxial Cable Tests: Comply with requirements in Division 27 Section "Master Antenna Television System."
- D. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
- E. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

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SECTION 283111

ADDRESSABLE FIRE ALARM SYSTEM (NON VOICE)

PART 1 - GENERAL

1.1 Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the schematic design drawings and related construction documents including General and Supplementary Conditions and Division 01 General Requirements, shall be included in and made part of this Section.

1.2 DESCRIPTION OF WORK

A. This section of the specifications includes the furnishing, installation, and connection of the fire alarm equipment to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Control Panel (FACP), auxiliary control devices, annunciators, and wiring as shown on the drawings and specified herein.

1. The system shall be a new addressable fire detection and non-voice signaling system in accordance with the schematic design drawings. It shall utilize control panels with digital communications to provide optimal fault-tolerance and support future modification and expansion with a minimum of future wiring and hardware additions, in full compliance with all applicable codes and standards. The features and capacities described in this specification are required as a minimum for this project and shall be furnished by the successful contractor.
 - a. The garage #1 & #2 share a single FACP and off-site dialer. Each building share operate independently. An alarm condition in one building shall only activate the horn/strobes in that respective building. A manual pull or detector activation shall only activate the notification appliances in the building associated with the device. the off-site shall provide four general status conditions to the monitoring company: alarm garage #1, alarm garage #2, trouble & supervisory.
2. The system shall include all necessary hardware, software and peripheral devices to perform the following functions, but not limited to:
 - a. Fire and smoke detection
 - b. Manual alarm activation
 - c. Occupant audible, visual and auxiliary notification
 - d. Report system events to the Listed Supervising Station via the approved means.
 - e. System programming and re-programming of all changes as necessary to accommodate the phased construction, alteration and demolition activities.
3. The system shall be installed per the Engineer of Record's schematic design drawings, project specifications and installed in full compliance with National, State and local Codes. These published editions of following reference standards shall be used in system design, installation, operation and maintenance unless the applicable legally referenced standard provides more stringent requirements:
 - a. New Jersey Uniform Construction Code - International Building Code 2018 Edition
 - b. New Jersey Electrical Code – National Electric Code 2018 edition.
 - c. Underwriters Laboratories (UL) Listings.
 - d. Local Fire Department Regulations
 - e. Americans with Disabilities Act (ADA), the Architectural Barriers Act (ABA), and Accessibility Regulations of the local jurisdiction.
 - f. Applicable FM Global (Factory Mutual) Property Loss Data sheets.

4. The system shall include all required hardware, raceways, interconnecting wiring and software to accomplish the requirements of this specification and the schematic design drawings, whether or not specifically itemized herein. All devices installed outdoors or within areas exposed to unconditioned spaces or wet locations shall be listed for "outdoor use". Electrical raceway, fittings and enclosures shall be NEMA Type 4.
5. All equipment furnished shall be new and the latest state-of-the-art products of a single manufacturer, engaged in the manufacturing and sale of analog fire detection devices for over 20 years.
6. Provide the services of qualified system designers to generate shop drawings, and field technicians to provide installation oversight during construction and system startup. Technicians shall inspect, program, test and make any necessary adjustments to the completed system, to ensure compliance with the manufacturer's recommended practices and the approved shop drawings.
7. The system as specified shall be supplied, installed, tested and approved by the local Authority Having Jurisdiction, and turned over to the owner in an operational condition.
8. In the interest of job coordination and responsibilities the installing contractor shall contract with a single supplier for fire alarm equipment, engineering, programming, inspection and tests. All control panel assemblies and connected field appliances shall be provided by the same system supplier, and shall be designed and tested to ensure that the system operates as specified.
9. The system specified shall be that of Siemens Industry, model Desigo Compact which meets the project requirements. Being listed as an acceptable Manufacturer in no way relieves obligation to provide all equipment and features in accordance with these specifications. All references to manufacturers model numbers and other pertinent information herein is intended to establish minimum standards of performance, function, and quality. Alternate products must be submitted to the Engineer two weeks prior to bid for approval. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification. All system approved shall meet all the requirements spelled out in this specification. System approval shall be in writing by the Engineer and a copy shall be submitted with the system submittals.
 - a. For equipment support, contact Stephen Friel Cell: 609-548-8169.
10. Strict conformance to this specification is required to ensure that the installed and programmed system will function as design, and will accommodate the future requirements and operations of the building owner. All specified operational features must be met without exception.

1.3 DEFINITIONS AND ACRONYMS

- A. AHJ: Authority Having Jurisdiction, the individual or agency that has legal responsibility for reviewing the design for conformance with local codes and regulations.
- B. ASME: American Society of Mechanical Engineers.
- C. EoR: The Engineer of Record responsible for the Schematic Design drawings and project specifications
- D. ERRCS: Emergency Responder Radio Communications System also known as a Public Safety or First Responder DAS (Distributed Antenna System).

- E. FACP: Fire alarm control panel.
- F. FM: FM Global (Factory Mutual).
- G. Furnish: To supply the stated equipment or materials.
- H. Install: To set in position and connect or adjust for use.
- I. LED: Light-emitting diode.
- J. NAC Booster: Notification Appliance Circuit audio and/or visual auxiliary power supply controlled and supervised by the FACP
- K. NFPA: National Fire Protection Association. Definitions in NFPA 72 apply to fire alarm terms used in this Section.
- L. NICET: National Institute for Certification in Engineering Technologies.
- M. Schematic design drawings: drawings which establish the objectives and design criteria of the system along with locations of fire alarm equipment, a system concept riser diagram, identification of interface(s) required with fire safety functions, and identification of all initiating device and notification appliance locations.
- N. Provide: To furnish and install the stated equipment or materials.
- O. UL: Underwriters Laboratories.

1.4 PERFORMANCE-BASED DESIGN REQUIREMENTS

- A. Fire alarm technicians must be able to perform comprehensive tests on the system with minimum disruption to occupants. Fire alarm system control must originate from the control panel and/or programmable field devices. Individual bypass switches located at the main control panel must provide system wide bypass for each type of output to accommodate testing with minimal disruption.
- B. Field located transponders, NAC power booster panels, and terminal cabinets as required to support the project, if locations not specifically provided on the design drawings. Good access must be provided for testing and maintenance requirements.
- C. NFPA 72 10.4.4 require smoke detection coverage above critical fire alarm components. The quantity of required NAC booster panels vary between manufactures and their installation location(s) are determined by the Installation Contractor. If area smoke detection is not provided in the vendor-selected NAC booster panel location, then a dedicated smoke detector shall be provided above the panel. These locations shall be shown on the installation shop drawings and approved by the EoR and AHJ prior to installation.
- D. SLC Circuit Design: Ground Fault Detection
 - 1. For addressable loops, ground fault detection shall be employed which can detect a ground fault on both the positive and negative side of each circuit. The ground fault detector shall operate the general trouble devices as specified but shall not cause an alarm to be sounded. Ground faults shall not interfere with normal operation, such as alarm, or other trouble conditions.

2. In compliance with NFPA 72, section 23.6.1, provide fault isolation for every 50 devices on any SLC, limited to a maximum area of a floor or fire/smoke barrier compartment boundaries. Provide separate ground fault detection for each floor/ level.
3. A single fault on a pathway connected to the addressable devices shall not cause the loss of the devices in more than one zone or area. If a floor of the building is subdivided into multiple zones by fire or smoke barriers and the fire plan for the protected premises allows relocation of occupants from the zone of origin to another zone on the same floor, each zone on the floor shall be considered a separate zone.
4. Dedicated isolator modules or ground fault detection integrated into an addressable device may be used to ensure
5. Acceptable wiring designs
 - a. Install SLC loops with no more than 50 addressable devices circuit, homeran back to the panel. Each SLC must be internally isolated from shorts.
 - b. Provide field circuit isolation with loop isolator devices installed as the first device and keeping the isolated legs of the circuit to fewer than 50 devices.

E. Initiating Device Installation

1. Coordinate smoke detector locations with ceiling diffusers; none maybe closer than 3 feet.
2. For ceiling tile applications, center detectors in the tile, inline with other ceiling fixtures.

1.5 SEQUENCE OF OPERATIONS

A. Alarm Sequence of Operation:

1. Activation of a manual fire alarm box, automatic detector, or fire suppression system shall initiate the system to enter "alarm" mode including the following operations:
 - a. Flash local LED red on the associated addressable device.
 - b. Provide local English language annunciation of device location, address and condition, and audible and visual alarm signal at control panel and remote annunciators.
 - c. Provide manual "acknowledge" function at control panel to silence audible alarm signal, visual signal remains displayed until initiating alarm is cleared.
 - d. Transmit "alarm" signal to off-premises equipment to notify monitoring company.
 - e. Activate fire alarm notification appliances.
 - f. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.

B. Supervisory Sequence of Operation:

1. Flash local LED red on the associated addressable device.
2. Activation of gas detection, fire sprinkler tamper, pressure switch, duct mounted smoke detector or residential smoke detector with local audible base causes system shall initiate the system to enter "supervisory" mode including the following operations:
 - a. Provide local English language annunciation of device location, address and condition, and audible and visual supervisory signal at control panel and remote annunciators.
 - b. Provide manual "acknowledge" function at control panel and remote annunciators to silence audible supervisory signal, visual signal remains displayed until initiating supervisory is cleared. If AHJ approved, a supervisory condition may be programmed as self-restoring.
 - c. Transmit "supervisory" signal to off-premises equipment to notify monitoring company.
 - d. For HVAC applications: transmit signal to shut down air associated air handling unit and close associated fire/smoke dampers.
 - e. For CO area detection applications: activate local NFPA 72 temporal-4 notification tone.

- C. Trouble Sequence of Operation:
 - 1. System trouble, including single ground or open of supervised circuit, or power or system failure, initiate the system to enter "trouble" mode including the following operations:
 - a. Flash local LED amber on the associated addressable device.
 - b. Provide local English language annunciation of device location, address and condition, and audible and visual trouble signal at control panel and remote annunciators.
 - c. Provide manual "acknowledge" function at control panel and remote annunciators to silence audible trouble signal, visual signal remains displayed until initiating trouble is cleared.
 - d. Transmit "trouble" signal to off-premises equipment to notify monitoring company.

1.6 SEQUENCE OF INSTALLATION

- A. This new system is being installed as part of a complete building construction project and shall be coordinated with the other trades and any construction phasing schedules. No existing fire alarm components shall be reused.

1.7 FIRE CONTROL PANEL – The system shall be a complete, electrically supervised fire detection and notification system, with a microprocessor based operating system having the following capabilities, features, and capacities:

- A. All control equipment shall be listed to the latest edition of UL Standard 864 (9th Edition)
- B. The FACP and auxiliary power panels shall provide power, annunciation, supervision and control for the system.
- C. Audibles and visual notification signals shall be synchronized throughout the entire building.
- D. Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.
- E. The system shall provide a peer-to-peer dedicated network between the main Administrative Building and the Maintenance Building. Each panel shall have the ability to display either local panel activity or global network activity. A master off-site cellular dialer shall be located in the main building and support both panels.
- F. The system shall be capable of the following configurations. Both configurations are permitted on the same network.
 - a. The system shall support up to 252 addressable devices, which may be divided in any ratio on one, two, three, or four separate, isolated Class B circuits.
 - b. The system shall support two loops of 252 addressable devices, each of which may be divided in any ratio on one, or two, isolated Class A circuits.
- G. The system shall be capable of remote monitoring via Windows Explorer, which provides a graphical representation of the fire alarm control panel at a remote PC when connected via Ethernet to the system. The display will show the exact state of the panel, including blinking LEDs, and with menu buttons for control.
- H. Support of single-person test system and capable of providing point test reports in NFPA standard format without manual report entries.
 - 1. The system shall provide a field test function where one person can test the complete system or a specific area while maintaining full operational function of other areas not

- being tested. Alarms, supervisory signals, trouble signals shall be logged in system history during the walk-test.
 - 2. The control panel shall allow control and monitoring from a wireless handheld display device during maintenance, inspection and troubleshooting tasks
 - 3. The control panel shall allow complete control and monitoring from a wireless handheld display device during one-man testing of the system
 - 4. Testing supported should be real smoke testing of devices, automatically logged and made available in NFPA format reports. Manual test entries will not be accepted.
- I. System shall provide an output port for monitoring purposes by external systems. Communications to an external system shall be RS-232 or RS-485 communications.
 - J. The local system shall provide status indicators and control switches for all of the following functions:
 - 1. Remote Alarm Transmission By-pass Switch: Shall prevent transmission of all signals to the main fire alarm control unit when in the "off" position. A system trouble signal shall be energized when switch is in the off position.
 - 2. HVAC/Smoke Damper By-Pass: Provide a means to disable HVAC fans from shutting down and/or smoke dampers from closing upon operation of an initiating device designed to interconnect with these devices.
 - K. The system shall be UL 1076 listed for monitoring and reporting security System Zoning.
 - L. The system shall be compliant with the requirements of NFPA 720 as a Carbon Monoxide Detection Control Unit and shall meet the UL 2075 listing requirements. All inputs from CO sensors shall be indicated visually and audibly at the control panel. CO sensor inputs shall be distinct and descriptively annunciated from other signals.
 - M. Each intelligent addressable device or conventional zone on the system shall be displayed at the main fire alarm panel and each local fire alarm remote annunciator by a unique alphanumeric label identifying its location.

1.8 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 72 installation methods, all contract documents and specification requirements.
 - 1. The FACP and auxiliary power panels shall provide power, annunciation, supervision and control for the system.
 - 2. Strobes shall be synchronized throughout the entire building.
 - 3. Provide electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, and placement of system modules within the control panel.
 - 4. Incorporate firefighter emergency communication systems, as specified.
- B. Circuits and Pathways
 - 1. Addressable Signaling Line Circuit (SLC) wiring shall be configured as Class B circuits, with a minimum Level 1.
 - a. SLC wiring shall utilize fault isolation modules so that a single wiring fault on the conductors serving one floor or evacuation signaling zone will not affect the operation of devices serving any other zone.
 - b. SLCs shall not exceed 75% of the number of each type of device the circuit is capable of supporting.
 - 2. Notification Appliance Circuit (NAC) wiring shall be configured as Class B circuits.
 - a. The system shall be provided with a minimum of two (2) NACs for each floor, evacuation zone or smoke compartment; whichever is greater. Arrange circuits to allow individual, selective, and visual notification by zone. The actual number of circuits to be installed shall be coordinated with the supplier's shop drawings.

Appliance circuits shall be zoned to correspond with the building fire barriers and other building features.

- C. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.
- D. The system shall provide a field test function where one person can test the complete system or a specific area while maintaining full operational function of other areas not being tested. Alarms, supervisory signals and trouble signals shall be logged on the system printer and in system history during the walktest.
- E. Alarm functions shall override trouble or supervisory functions. Supervisory functions shall override trouble functions.
- F. An Emergency Responder Radio Communications System (ERRCS), also known as a Public Safety or First Responder DAS (Distributed Antenna System), has become a mandated in-building requirement for many municipalities around the country and may be required per site conditions to boost weak emergency responder radio signal strength signals, as specified in Section 275319. It shall be a separate communication system from the FACP, but shall provide the ability to add the required monitoring points for general status conditions per NFPA 72 requirements.

1.9 SUBMITTALS

- A. The equipment supplier responsibilities will include the selection of equipment, devices and materials based on the schematic design drawings and project requirements, and their proper application based on the manufacturer's limitations, operating characteristics and recommended practices.
 - 1. Equipment quantities and locations shown on the schematic design drawing floorplans shall not be altered or modified without written approval of the Engineer of Record. Any deviation from the Engineer's coordinated layout or design intent will constitute the submission as incomplete and shop drawings will not be approved.
 - 2. Minor deviations, variations, changes, and corrections from layouts shown on the drawings (based on coordination, conditions, manufacturer's instructions, codes and standards, shop drawings, and verification of measurements and conditions) are permitted to facilitate construction provided the changes do not represent potential changes in scope of work and provided the changes are acceptable to the owner, architect, and engineer.
 - 3. The equipment supplier shall coordinate the installation and system operation with the work of related trades.
- B. Catalog manufacturer's product data sheets for all equipment, accessories and wiring with all applicable components being submitted for this project clearly noted. All equipment shall be subject to approval and no equipment shall be ordered without prior approval.
 - 1. Data Sheets with multiple product shall highlight or identify the specific products utilized for this project.
- C. System Calculations - Circuit calculations shall use the end-loading or point-to-point method described in NFPA recommended practices including both standby and active conditions. Complete calculations shall be provided which show the electrical load for all equipment and field circuits. (identify all mathematical formulas, variables, and constants used in all calculations) on the following system components:
 - 1. Horn/ strobe 24VDC loads and spare capacity.
 - a. NAC circuit (audible and visual) design shall incorporate a 20% spare capacity for future expansion.

2. Show wire size, estimated circuit length, and maximum allowable wiring distance as designed. Voltage drop calculations for wiring runs demonstrating worst-case condition.
 3. Power supply rating justification showing power requirements for each of the system power supplies. Power supplies shall be sized to furnish the total connected load in a worst-case condition plus 25% spare capacity.
- D. The shop drawing submittal shall clearly indicate all proposed equipment and devices (type and quantity), with wiring diagrams, detailed operational sequences, and interfaces to related systems. They shall be prepared in accordance with NFPA 72 recommended practices and include the following:
1. Floor plans showing all devices and equipment to be installed with corresponding field settings, circuit, and device designations noted. Settings shall include the device address and candela rating as applicable. Circuit identifiers, device numbers and symbols used shall be clearly defined and consistent between all related documents. Whenever possible, the drawings shall reflect other components of the building such as air diffusers, HVAC returns, etc. to determine compliance or reference the associated mechanical design drawings.
 - a. Floor plans at a scale of 1/8"=1'-0"
 - b. When candela ratings are not shown on the schematic design drawings, utilize NFPA 72 visual coverage area tables to select coverage.
 2. Complete point-to-point riser diagrams showing all equipment including size, type, number and reference designations for all circuits and devices. Each device shall be shown with address numbers or any other required field device settings including candela rating of notification appliances.
 - a. For multiple panel configurations, provide a separate block diagram to show the overall network system architecture with interconnection network circuits.
 3. System panel drawings showing cabinet dimensions, internal module placement, field wiring terminations with spare capacity allowances, and any applicable operator's display and panel switch label assignments. Where multiple equipment cabinets are used in a single location these shall be shown together in elevation for coordination of equipment installation and wireways, and to ensure proper space allocation.
 4. Provide a complete sequence of operation in the form of an NFPA Input/Output programming matrix for the entire system as shown in NFPA 72. The matrix shall reflect each unique programmed sequence, whether the sequence is initiated by an individual or common group of similar devices. Matrix shall illustrate alarm input/out events in association with initiation devices. Matrix summary shall include system supervisory and trouble output functions.
 5. Installation drawings shop drawings, and as-built drawings shall be prepared by a NICET II or higher individual experienced with the work specified herein.
 6. Incomplete submittals shall be returned without review, unless with prior approval of the Engineer.
 - a. Disposition of shop drawings shall not relieve the Contractor from responsibility for deviations from drawings and specifications, unless the deviations are specifically noted in writing at the time of submission, and written acknowledgement has been received from the Engineer or Record. The disposition of shop drawings shall not relieve the Contractor from responsibility for errors in shop drawings or schedules.
 - b. Copies of the approved shop drawings shall be maintained on-site to serve as working documents during installation for preparing as-builts.

- E. Delegated Design Review of Shop Drawings: As required per the AHJ, in addition to items listed above, provide a compliance and code review by an individual with the required credentials and submit documentation, including any evaluation analysis of the shop drawing submittal. Provide the required review's credentials and seal/ signature by the qualified professional engineer responsible for the preparation, as required. The equipment supplier's shop drawings shall not be stamped or sealed by an Engineer unless the work is performed under their direct supervision and control.

1.10 QUALITY ASSURANCE

- A. The following shall be adhered to:

- 1. State and Local Building Codes as adopted and/or amended by The Authority Having Jurisdiction, ADA, and/or State and local equivalency standards as adopted by The Authority Having Jurisdiction.
- 2. Owner's best practices for fire alarm installations/ operations including compliance with site standard operating procedures (SOP's).

- B. Equipment Supplier Qualifications

- 1. The supplied products must utilize multi-channel product distribution on a national basis to be considered for this bid. The distribution shall be from factory branches as well as independent distributors to allow the end user with the ability to utilize factory trained and authorized competitive service providers after system installation and commissioning. Single source system suppliers are not acceptable. The initial installation and commissioning shall be provided by a factory direct branch to ensure a high level of quality for the customer. For equipment support, contact Stephen Friel Cell: 609-548-8169.
- 2. A service office must be within 50 miles of the project site.
- 3. The manufacturer shall provide evidence of successfully installed similar fire detection and notification systems on comparable size and scope. The owner reserves the right to reject any installer's bid for which evidence of a successful prior installation by the contractor cannot be provided.
 - a. The equipment and service provider shall have a minimum of 10 years experience in the fire protective signaling systems industry.
- 4. Shall be licensed in the jurisdiction, if required.
- 5. The equipment supplier shall have a licensed fire protection engineer on staff to assist with all aspects of the installation including interfacing with the local AHJ and code consulting.
- 6. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system. The technician shall provide the required instruction to the owner's personnel in the system operation and maintenance.
- 7. The Equipment Supplier shall have in-house engineering and project management capability consistent with the requirements of this project. Factory trained representatives of the system manufacturer shall perform the detailed engineering of the system.

- C. Installer Qualifications:

1. Before commencing work, submit data showing that the manufacturer has successfully installed fire alarm systems of the same scope, type and design as specified.
2. The contractor shall submit copies of all required licenses and bonds as required in the State having jurisdiction.
3. The system installer shall work with the system supplier/designers to ensure all equipment is installed as shown in the Shop Drawings and manufacturer's requirements, and programmed to comply with the project requirements.
4. The installing contractor is responsible for coordination with related trades, and complete (1st party) testing of the system as installed, to include verification that the system performs as intended, and all devices and fault conditions are properly supervised and reported as specified herein.

D. Testing Agency Qualifications: Qualified for testing indicated.

E. Source Limitations for fire alarm equipment: Obtain fire alarm equipment from single source.

1.11 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to project site in original, unopened packages with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, and shelf life if applicable.
- B. Store materials inside, under cover, above ground, and kept dry and protected from physical damage until ready for use. Remove from site and discard wet or damaged materials.

1.12 PROJECT CONDITIONS

- A. Installed products or materials shall be free from any damage including, but not limited to, physical insult, dirt and debris, moisture, and mold damage.
- B. Environmental Limitations: Do not deliver or install products or materials until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.13 WARRANTY

- A. The equipment and wiring shall be warranted to be free from electrical, mechanical and performance defects, within the specified warranty period. Equipment and components that fail in materials or workmanship must be repaired or replaced. It shall include all labor/travel time, parts and programming. The warranty also provides for the adjustment of smoke detector sensitivities due to unwarranted or nuisance detector activations.
 1. Warranty Period: One year.
 2. Warranty Initiation: Commencing with start-up and owners beneficial use of any portion of the system.
 3. The warranty does not cover cases involving component failure due to abuse, misuse, and/or "Acts of God" including but not limited to lightning strikes, flooding, power surges, and fire.
 4. This warranty is void if the product is altered, repaired, or serviced by anyone other than original equipment installer.
 5. A copy of the manufacturer's warranty shall be provided with closeout documentation and included with the operation and installation manuals.

- B. All labor for administering and servicing the warranty, including actual replacement of parts, will be the responsibility of the Installer for the warranty period.
- C. This Warranty does not apply to the replacement of consumable parts such as internal standby batteries. These components are designed to diminish over time unless failure has occurred due to a defect in materials, equipment malfunction, or exposure to ambient conditions beyond their UL listing. As with all batteries, the maximum capacity and performance of the battery will decrease with time and use; this is not a defect. The expected lifespan of a fire alarm battery under normal conditions is 3 years. Only defective batteries and batteries that leak are covered by this warranty.
- D. The Owner reserves the right to make changes to the fire alarm system during the Warranty Period. Such changes do not constitute a waiver of warranty. Contractor shall warrant parts and installation work regardless of any such changes made by Owner, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the fire alarm system.

1.14 SERVICE AGREEMENT

- A. Technical Support: Beginning with Substantial Completion, provide software support for 1 year.
- B. Upgrade Service: Update software, firmware, to latest version at project completion. Install and program software upgrades that become available within one year from date of substantial completion. Upgrading software, firmware shall include operating system. Upgrade shall include new or revised licenses for use of software.
 - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.15 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. The following spare devices shall be supplied as applicable to this project:
 - 1. Two (2) keys for each locked or tamper proofed cabinet.
 - 2. Two (2) percent smoke detectors device(s).
 - 3. Two (2) of each type of smoke detector installed.
 - 4. Two (2) of each type of heat detectors installed.
 - 5. Two (2) of each type of pull stations installed.
 - 6. Two (2) of each type of standard notification appliance(s) (horn, strobe & combination) installed.
 - 7. Two (2) of each type of replaceable surge suppression modules installed.
 - 8. Two (2) of each type of replaceable fuses installed in the system. Provide in a box or cabinet with compartments marked with fuse types, sizes and equipment locations.
 - 9. One year of filters for Air-Sampling Detectors, per the manufacture's recommended service schedule.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The equipment and service described in this specification are those supplied and supported by Siemens Industry.

1. Being listed as an acceptable Manufacturer in no way relieves obligation to provide all equipment and features in accordance with these specifications.
- B. Must have multi-channel distribution for both products and equipment service. The owner shall have the ability change service provider or sales outlets. Proprietary manufactures such as single-channel suppliers are not acceptable.
 1. The initial installation shall be completed by a factory direct office.

2.2 CONTROL PANEL

- A. The fire alarm control panel shall be microprocessor-based using multiple microprocessors throughout the system, providing rapid processing of smoke detector and other initiation device information to control system output functions. The System Periphery board shall be capable of a minimum of 252 intelligent devices distributed between one, two, three, or four Class B SLC circuits. Any trouble on one circuit shall not affect the other circuit. The on board microprocessor provides the periphery board with the ability to function even if the main microprocessor fails. LED's on the board shall provide annunciation for the following; Power, Gnd. Fault, Alarm, Trouble.
- B. There shall be a watchdog circuit, which shall verify the system processors and the software program. Problems with either the processors or the system program the panel shall activate a trouble signal and reset the panel.
- C. The Signal Line Circuits (SLC) shall be tested for opens, shorts and communications with all addressable devices installed before connection to the control panel. Systems without this capability shall have a test panel installed for initial testing to eliminate any possible damage short term or long term to the control panel. After initial testing replace the test panel and proceed with complete testing.
 1. The signal line circuits (SLC) shall be polarity insensitive for all addressable devices. This permits the fire detection devices to operate even when detector and module wiring polarity are inverted on the wrong screw terminals.
- D. The primary control panel interface shall have the ability to view events, acknowledge, silence, and reset the system and any networked Fire control panels, when configured as a global PMI. The standard operator interface can acknowledge, silence, and reset panels via Global PMI.
- E. System response time from alarm to output shall be an average of three (3) seconds.
- F. To expedite system troubleshooting, the system cards shall have ground fault detection and diagnostic LEDs by card.
- G. All system cards and modules shall have Flash memory for downloading the latest module firmware.
- H. Passwords:
 1. Maintenance/Control Password - There shall be a 5 character password that a user must enter into the control panel in order to perform such maintenance- and control-related functions.
- I. Software Modifications: The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made. Systems that require the use of external programmers or change of EPROMs are not acceptable.

- J. Logic: The fire alarm system shall support generic functions that deal with binary states (True/False, high/low), and produce desired outputs from one or more binary inputs (for example, alarm outputs from spot detectors, VESDA detectors, monitor modules or manual station inputs). [AND](#), [OR](#), [NOT](#), [Any N](#), [D Latch](#), [RS Latch](#), [Time](#) Base Control, [Start Timer](#), [Restart Timer](#) are generic functions. Generic functions can be used as inputs to other function. The system shall support 2500 logic functions.
- K. History: The system shall store 5000 events in history while in straight mode and 4500 in circular mode. In straight mode, trouble warnings will occur at 4000 and 4500 events. In circular mode, the control panels shall maintain a 2000 event Alarm History buffer, which consists of the 2000 most recent alarm events from the 4500 event history file.

2.3 PRIMARY POWER SUPPLY

- A. The control panels, NAC power booster panels, system workstation, and any other fire alarm equipment shall receive their primary power from a dedicated 120VAC disconnect circuit.
 - 1. The circuit must be properly sized and protected in accordance with NEC requirements.
 - 2. This requirement does not limit that one dedicated branch circuit to serving only one power supply within a system. The dedicated branch circuit could supply several fire alarm power supplies within a control unit or within multiple interconnected control units that serve the signaling system.
 - a. The dedicated circuit can be supplied from any properly installed electrical panel board or sub-panel.
 - b. Minimum capacity of 6-amp that provides 24VDC power for system operation.
 - c. Ability to expand the power supply without adding additional cabinets.
 - 3. The circuit disconnecting means shall be labeled 'FIRE ALARM' and any other local identification requirements. Its location must be listed at the point of connection to the fire alarm control equipment. Provide a dedicated breaker lock unless the breaker is located in locked panel board or if it is in a locked electrical room.
 - 4. Transfer from AC to battery power shall be instantaneous when AC voltage drops less than 90% or brown out conditions it is not sufficient for normal operation.
- B. Loss of primary AC power shall sound a trouble signal at the FACP. The FACP shall indicate when the system is operating on an alternate power supply.

2.4 SECONDARY POWER SUPPLY

- A. When the primary AC power is lost, the system shall automatically switch to the secondary power supply.
- B. The control panels, transponders, and NAC power booster panels shall receive their secondary power from batteries.
 - 1. Battery shall be of the sealed lead-acid, maintenance free type, 24-volt nominal, suitable for life safety application.
 - 2. Provide sufficient capacity to operate the complete alarm system in quiescent standby load (system operating in a non alarm condition) for a period of 24 hours and shall have sufficient capacity to operate all alarm notification appliances and all other connected loads for a period of 5 minutes.
 - 3. The battery charger shall be able to charge the system batteries up to 100 AH batteries. Battery charging shall be microprocessor controlled and programmed to select battery sizes.
 - 4. Transfer from AC to battery power shall be instantaneous when AC voltage drops to a point where it is not sufficient for normal operation.
 - 5. Batteries shall be secured in seismic areas 2B, 3, or 4 as defined by the Building Code.

2.5 SYSTEM ENCLOSURE

- A. The control unit shall be housed in a cabinet suitable for both recessed and surface mounting. Cabinet and front shall be corrosion protected, given a rust resistant prime coat, and manufacturer's standard finish. The outer doors shall be capable of being a left hand open or a right hand open. The inner door shall have a left hand opening. System enclosure doors shall provide where required ventilation for the modules or cards in the enclosure.
- B. Enclosure needed to hold all the cards and modules as specified with at least 25% spare capacity for extra cards.
- C. Provide system enclosure for all amplifiers. Where required by the manufacturer, provide means for venting heat from the enclosure either by having enclosure sides and top vented or the doors vented.

2.6 DOCUMENT STORAGE BOX

- 1. With every new system, a documentation cabinet shall be installed at the system control unit or at another approved location at the protected premises. Where the documentation cabinet is not in the same location as the system control unit, its location shall be identified at the system control unit. It shall meet NFPA 72's record maintenance requirements and the following criteria:
 - a. Enclosure to accommodate standard 8-1/2-by-11 inch and loose document records. Legend sheet will be permanently attached to door for system required documentation, key contacts, and system information.
 - b. Provide two key ring holders with location to mount standard business cards for key contact personnel.
 - c. Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
 - d. Color: Red powder-coat epoxy finish.
 - e. Labeling: Permanently screened with 1 inch high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
 - f. Security: Locked with 3/4 inch barrel lock. Provide solid 12 inch stainless steel piano hinge.
- B. Carbon monoxide (CO) detection shall be provided in dwelling units that contain a fuel-burning appliance or a fuel-burning fireplace. Combination smoke and CO smoke alarms are acceptable. In addition to the above requirements, a CO event shall produce an audible NFPA 72 Temporal-4 pattern, rated at 85dB at 10 ft.
- C. Visible Notification
 - 1. For standard Group R-2 residential units, smoke alarms must have the must have future capability to support visual appliances utilizing one of the following methods in IBC 907.5.2.3.4.
 - 2. Where indicated on the contract drawings as a hearing impaired or accessibility residential unit, provide a 177-cd strobe in habitable spaces, typically each bedroom and common living area. Bathrooms, laundries, pantries, foyers, communicating corridors, closets, and storage do not require visual coverage to meet IBC's residential definition of residential habitable spaces.
 - 3. For
- D. Separate building fire alarm notifications appliances will be required in addition to the above requirements and as shown on the contract drawings.

2.7 INITIATING DEVICES

- A. General

1. The initiating device shall provide an alarm indication within less than four (4) seconds.
2. All initiation devices shall be insensitive to initiating loop polarity. Specifically, the devices shall be insensitive to plus/minus voltage connections.
3. Operating Voltage: 24 VDC, nominal.

B. Multi-criteria Smoke Detectors – Addressable

1. The multi-criteria fire detectors shall be an intelligent digital photoelectric detector with a programmable heat detector. Detectors shall be listed for use as open area protective coverage, in-duct installation and sampling assembly installation and shall be insensitive to air velocity changes. The detectors' communications shall allow the detectors to provide alarm input to the system and alarm output from the system within four (4) seconds. So as to minimize the effort required by the installing and maintenance technician to appropriately configure the detector to ensure optimal system design, the detectors shall be programmable as application specific. Application settings shall be selected in software for a minimum of 19 environmental fire profiles unique to the devices installed location.
 - a. UL Listed as "direct in-duct" mounting.
2. The detector shall be guaranteed in writing not to false alarm when configured by the factory trained certified technician. The detector must provide different environmental algorithms that allow the detector to provide superior false alarm immunity without the need for additional alarm verification delays.
3. Smoke detectors shall be analog sensors that utilize photoelectric-type sensing principles mounted within a smoke chamber to detect particles of combustion.
4. The control panel shall continually analyze the analog signal from each sensor to determine calibration, sensitivity and environmental changes that may affect sensor operation. The analog values from each device shall be displayed (in terms of percent of obscuration) at the control panel upon command.
5. The detectors shall have a tri-color LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm. Each detector shall include an LED that will flash periodically to indicate an active polling cycle. When the sensor reaches a predetermine alarm threshold (2% obscuration unless otherwise directed), the detector shall latch in LED shall flash continuously until reset at the control panel.
 - a. The system shall have the ability to disable the detector's LED.
6. The detectors shall be UL listed for operation in a 95% relative humidity (RH) environment.
7. The detector shall be designed to eliminate the possibility of false indications caused by dust, moisture, RFI/EMI, chemical fumes, and air movement while factoring in conditions of ambient temperature rise, obscuration rate changes and hot/cold smoke phenomenon into the alarm decision to give the earliest possible real alarm condition report.
8. The detectors shall support the use of a relay, or LED remote indicator without requiring an additional software address.
9. The intelligent smoke detector shall be capable of providing three distinct outputs from the control panel. The outputs shall be from an input of smoke obscuration, a thermal condition or a combination of obscuration and thermal conditions. The detector shall be designed to eliminate calibration errors associated with field cleaning of the chamber.
10. Where indicated on the schematic design drawings, provide remote indicator lamps and identification plates for detectors concealed from view. Each indicator will illuminate when the detector is in alarm. Locate the remote indicator lamps and identification plates flush mounted on walls so they can be observed from a normal standing position in the nearest common corridor or otherwise designated on the floorplans.
11. When required, the detectors shall incorporate an addressable Carbon Monoxide (CO) sensor. The CO sensor shall be selectable as an input to the multi-criteria fire detector

algorithm and as an independent life-safety CO gas detector (in compliance with NFPA 720).

- a. The multi-criteria detector with CO input shall be UL 2075 compliant as a gas and vapor detector.
12. The detectors shall be RoHS-compliant: it shall meet standards for Reduction of Hazardous Substances (RoHS) by reduction in lead content and other restricted substances.

C. Heat Detectors – Addressable

1. Thermal Detectors shall be analog/addressable sensors individually programmable for either fixed temperature, rate-of-rise or combined operation, except where otherwise dictated. The thermal detector shall be Model FDT421 and have the following temperature settings:
 - a. Fixed temperature at 135°F, 145°F, 155°F, 165°F, 174°F
 - b. Rate of Rise at 15°F/ min at 135°F
 - c. Rate of Rise at 15°F/ min at 174°F
2. The detectors shall have a tri-color LED to streamline system maintenance/inspection by plainly indicating detector status as follows: green for normal operation, amber for maintenance required, red for alarm. Each detector shall include an LED that will flash periodically to indicate an active polling cycle.
3. Analog sensors will also provide a low temperature warning (Supervisory condition) when the ambient temperature in a protected area reaches 40 degrees F.
4. Where ambient conditions dictate, provide conventional fixed temperature, weatherproof or explosion-proof heat detectors in lieu of analog detectors. Conventional devices shall be individually addressable via a dedicated addressable monitor module which shall be installed in an appropriately heated, ventilated location.
5. The detectors furnished shall have a listed spacing for coverage on smooth ceiling rating of up to 2,500 square feet and shall be installed according to the requirements of NFPA 72 for open area coverage.

D. Detector Bases – Addressable

1. The plug-in detector bases shall be UL compatible with the selected detector head. They shall utilize screw clamp terminals and field circuits shall terminate directly to the base. Bases shall be installed directly on an industry standard 3 1/2-inch, 4-inch octagon boxes, and 4-inch square boxes (with or without plaster). Position decorative ring around the base as required per the manufacture. Provide the ability to make the detector base tamperproof to prevent the removal of the detector head without the use of a tool.
 - a. The standard DB-11 base shall be - 6" version.

E. Carbon Monoxide Detectors

1. Carbon Monoxide Detectors: Provide Analog/Addressable sensors that include a CO sensing element where shown and required. Detectors may be either standalone sensors, or employ multi-sensing technology integrated with smoke sensors, and shall be Listed to the appropriate ANSI/UL standards, including UL 2075 (carbon monoxide), UL 268 (smoke) and UL 521 (thermal) as applicable.
2. The CO element shall operate between 30-560 parts per million (ppm), with a standard set point of 70ppm for exposure of 60 minutes accordance with NFPA 720. CO Sensors shall operate on non-resettable 24vdc power provided by the FACP, and provide full analog values directly to the FACP. The detector shall have associated programmable control module outputs, and an integral piezo horn that produces 85dbA at 10ft.

Activation of a CO Detector shall initiate a Priority 2 Supervisory CO Alarm event at the local Control Unit and Fire Response Center, and remote system Annunciators as described herein.

3. Multi-Criteria Fire Detector Model FDOOTC441 shall be listed as providing CO detection in duct application.
4. CO Sensors that are integrated into Mechanical Systems shall be designed for duct mounting or area detection, with a CO Alarm set point of not less than 50ppm, and be appropriately Listed by a Nationally-Recognized Testing Laboratory.
5. Sensors shall be provided and installed in accordance with the manufacturer's instructions. Sensors shall be monitored by the local Fire Alarm System for multiple alarm thresholds with corresponding addressable outputs to initiate equipment shutdown procedures and related life safety functions. Sensors will support periodic functional testing.
6. CO Sensors shall be monitored and programmed for Supervisory CO Alarm reporting in accordance with NFPA 720 and applicable code.

F. Manual Pull Stations – Addressable

1. Provide single-action addressable manual stations where shown on the schematic design drawings, to be flush or surface mounted as required. Manual stations shall contain the intelligence for reporting unique numeric address, identity, alarm and trouble to the fire alarm control panel.
 - a. Station will mechanically latch upon operation and remain so until manually reset by opening with a supplied alien wrench.
 - b. Stations shall be of single action pull down type with suitable operating instructions provided on front in raised or depressed letters, and clearly labeled "FIRE".
 - c. The manual station shall be equipped with terminal strip and pressure style screw terminals for the connection of field wiring. Flying lead terminals are not permitted.
 - d. Surface mounted stations where indicated on the drawings shall be mounted using a manufacturer's prescribed matching red enamel outlet box.
2. Where shown on the schematic design drawings, provide a protective shield.
 - a. Shall be constructed of a clear LEXAN shield and red frame that easily fits over manual pull stations. UL listed for damp locations.

G. Addressable Monitoring and Control Modules

1. Addressable Interface Devices shall be provided to monitor contacts for such items as water-flow, tamper, and PIV switches connected to the fire alarm system. These interface devices shall be able to monitor a single or dual contacts. An address will be provided for each contact. Where remote supervised relay is required the interface shall be equipped with a SPDT relay rated for 4 amps resistive and 3.5 amps inductive. The addressable interface modules shall be model number HTRI or FDCIO Series.
 - a. The modules shall support two operation modes: an isolator (polarity sensitive) or non-isolator (polarity insensitive) mode. The module shall be capable of being wired for either mode. During the isolator mode, the built-in dual isolators will work at both sides of the module to isolate the line short in front or behind the module.
 - 1) Supports up to 252 addressable points per SLC devices loop, and in mixed mode up to 30 devices between isolated devices
 - 2)
 - b. Modules shall support NFPA 72 survivability requirements for shorts and provide information as to the location of the fault.

- c. Each Model XTRI-series device has a multi-color LED that flashes when GREEN operating in Normal mode; AMBER if the unit is in a 'Trouble' condition, and RED to indicate a change of status.
 - d. Provide non-obstructive front-end access to programming port and wiring terminals.
2. Isolator Module: Isolator module provides short circuit isolation for addressable notification appliance SLC wiring. Isolator shall be listed to UL 864. The Isolator shall mount directly to a minimum 2 1/8" deep, standard 4" square electrical box, without the use of special adapter or trim rings. Power and communications shall be supplied by the Addressable Controller channel SLC; dual port design shall accept communications and power from either port and shall automatically isolate one port from the other when a short circuit occurs. The following functionality shall be included in the Isolator module:
- a. Report faults to the host FACP.
 - b. On-board Yellow LED provides module status.
 - c. After the wiring fault is repaired, the Isolator modules shall test the lines and automatically restore the connection.

2.8 DEVICE PROGRAMMING / TEST UNIT

- A. The device programming unit is a tool used for installation, commissioning, maintenance and servicing of addressable devices. It shall program the intelligent devices with the assigned addresses and provide an electronic test to ensure proper operation. Programming dipswitches and/or rotary switches shall not be acceptable. The portable unit shall provide the following features:
- 1. Liquid-crystal display (LCD) screen with keypad
 - 2. Built in addressable base as well as two external terminals for use with all other addressable ancillary devices.
 - 3. Powered from on-board standard NiMH' rechargeable batteries or standard 'AA' Alkaline battery or an external AC adaptor.
 - 4. Reads analogue values of addressable loops and perform maintenance features such as ground fault detection.
 - 5. nonvolatile Flash memory with ability to download software upgrades.
- B. The equipment supplier shall furnish a device programming unit to the installer for the duration of the project.

2.9 NOTIFICATION APPLIANCES

- A. General requirements: Provide combination or individual audible and visual notification appliances as shown and permitted. All appliances shall be direct-wired; devices that utilize a multi-part assembly with swipe or non-mechanical pressure-type contact connections will not be considered acceptable.
- 1. Appliance housing available in red or white.
 - 2. All field adjustments shall not require special tools or programming software for setting changes.
 - a. The selector switch for selecting the candela shall be tamper resistant.
 - 3. All inputs shall employ terminals that accept #12 to #18 AWG wire sizes
 - 4. The contractor shall provide fitted surface mount backboxes supplied by the appliance manufacturer and outdoor-rated appliances where site conditions dictate.
 - 5. wall or ceiling-mount applications.
 - 6. 24VDC operation, operating by reverse-polarity.
 - 7. The appliance shall also be designed so that the audible signal may be silenced while maintaining strobe activation.
 - 8. Provide surface or semi-flush installations
 - 9. Provide weather-proof appliances as shown on the drawings
 - a. Extended temperature range of -40°F to 150°F (-40°C to 66°C).

- b. Listed for outdoor applications under UL 1638 as well as under UL 1971
- B. Audible Horn Appliances:
- a. Evacuation signal shall be the ANSI 53.41 three-pulse temporal pattern. Sleeping areas shall have low-frequency 520 Hz audible signals.
 - 1) Horns shall be UL Listed (for indoor use under Standard 1971 and 464).
 - 2) High and Low audible outputs (90 & 95 dB)
 - 3) Selectable temporal or steady horn output.
 - b. Provide high output re-entrant-type speakers with the appropriate weatherproof listings in outdoor or other high ambient noise areas, as shown on the schematic design drawings.
- C. Visual Strobe Appliances:
- a. Visual-notification appliances shall meet and be listed for UL Standard 1971 (Emergency Devices for the Hearing-Impaired) for Indoor Fire Protection Service.
 - b. Strobe shall be listed for indoor use, and shall meet the requirements of FCC Part 15 Class B.
 - c. Ability to mix LED and xenon strobes in the same field of view
 - d. LED multi-candela strobe shall have field-selectable settings, and be rated per UL Standard 1971 for:
 - 1) Wall-mount: 15/30/75/110cd
 - 2) Ceiling mount: 15/30/75/95cd or 115/177cd ()
 - 2. The LED portions of the strobes shall meet the 20 millisecond light-pulse duration requirements of the 2016 edition of NFPA 72.
 - 3. All inputs shall be compatible with standard, reverse polarity supervision of circuit wiring by a Fire Alarm Control Panel (FACP)
 - 4. The selector switch for selecting the candela shall be tamper resistant
 - 5. The strobes shall not drift out of synchronization at any time during operation
 - a. If the sync module or Power Supply fails to operate, (i.e. - contacts remain closed), the strobe shall revert to a non-synchronized flash rate

2.10 DIGITAL COMMUNICATOR – CELLULAR TECHNOLOGY

- A. The commercial fire alarm off-site communicator shall provide general (alarm/ trouble/ supervisory) and ability for contact/ grouped event ID reporting from the fire alarm control panel (FACP). It shall be UL864 listed to provide point identification of alarm, supervisory, security and trouble events to a Central or Remote Receiving Station. It shall offer three selectable reporting paths which include: Cellular only, IP only, or IP primary/cellular backup. The Communicator shall receive its power and supervision from the FACP.
- 1. For this project, utilize cellular communications with IP communications as the primary means of communication to the off-site monitoring station, per NFPA 72 requirements. IP communications for owner selected/provided future option.
 - 2. The dual path communicator shall be provided with local cellular antenna. When the minimum cellular signal strength required by the manufacture's installation instructions cannot be met, provide an external antenna located and installed per field conditions, with the owners approval.
 - 3. Cellular operates over the following communication protocols:
 - a. HSPA+ (4G)
 - b. HSPA (HSDPA & HSUPA) + (3G)
 - c. EDGE (2G GPRS) (2G).
 - 4. Selectable reporting paths and supervision intervals to meet NFPA 72, chapter 26 requirements.

5. Cellular provide capability: With broadest coverage footprint available in Verizon Network Certified™ or AT&T networks.
6. Future IP communication works over any type of customer provided Ethernet 10/100 based network connection (LAN or WAN), DSL modem or cable modem.
7. Shall supports both dynamic (DHCP) or Public and Private Static IP addressing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Perform work in accordance with the requirements of NFPA 70, NFPA 72, NFPA 13, NFPA 2001, and NECA , Standard of Good Workmanship in Electrical Contracting.
- B. Fasten equipment to structural members of building or metal supports attached to structure, or to concrete surfaces.
- C. In the event that limited energy cable installation is allowed, all cable runs shall be run at right angles to building walls, supported from structure at intervals not exceeding 3 feet and where installed in environmental air plenums, be rated for such use and tied/supported by components listed for environmental air plenums installation.
- D. Backing Boards: Provide 3/4-inch marine plywood backing boards for support of all fire alarm equipment panels surface mounted on masonry walls.
 1. Paint both sides of boards with two (2) coats of Gray enamel, including all edges.
- E. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
- F. Wiring Integrity and survivability requirements – Specified on shop drawings per NFPA72, Chapter 12
- G. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- H. Provide Surge Protection Devices (SPD) on all fire alarm wiring, which extends beyond the main building. Locate the SPD as close as practicable to the point at which the circuit leave or enter the building where the Fire Alarm Control Panel is located. Protection devices shall be shown on the schematic design drawings and shall be UL listed or in accordance with written manufacturer's requirements.
 1. Provide equipment ground and connected to the building grounding electrode system per NEC.
 2. Provide a dedicated enclosure to house the SPD and label it.
- I. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

- J. Provide primary power for each panel from normal/ emergency panels as indicated on the Electrical Power Plans. Power shall be 120V AC service, transformed through a two-winding, isolation type transformer and rectified to low voltage DC for operation of all circuits and devices.

3.3 BOXES, ENCLOSURES AND WIRING DEVICES

- A. All fire detection and alarm system devices, control units and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.
- B. Fire Alarm: Terminal cabinets shall be provided in locations shown and as otherwise required to support wiring terminations, troubleshooting and future tenant fit-up. Cabinets shall be painted red and contain terminal blocks to support the system wiring where the Control Panels are remote from the devices served. Cabinets shall include accommodation for all wiring including SLCs, notification circuits, and related addressable and fault isolation modules for future expansion and modification.
 - 1. Terminal boxes and cabinets shall have a volume 50 percent greater than required by the NFPA 70. Minimum sized wire shall be considered as 14 AWG for calculation purposes.
- C. Boxes shall be installed plumb and firmly in position.
- D. Extension rings with blank covers shall be installed on junction boxes where required.
- E. Junction boxes served by concealed conduit shall be flush mounted.
- F. Upon initial installation, all wiring outlets, junction, pull and outlet boxes shall have dust covers installed. Dust covers shall not be removed until wiring installation when permanent dust covers or devices are installed.
- G. "Fire alarm system" decal or silk-screened label shall be applied to all junction box covers.
- H. Panel enclosures shall be installed to meet clearance requirements per NFPA 70 and local codes. Minimum requirements shall be 3 foot clearance in front of the enclosure

3.4 CONDUCTORS

- A. Each conductor shall be identified as shown on the shop drawings at each with wire markers at terminal points. Attach permanent wire markers within 2 inches of the wire termination. Marker legends shall be visible.
- B. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer.
- C. All splices shall be made using solder-less connectors. All connectors shall be installed in conformance with the manufacturer recommendations.
- D. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.
- E. The installation contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.

- F. Wiring within sub panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.

3.5 DEVICES

- A. Relays and other devices to be mounted in auxiliary panels are to be securely fastened to avoid false indications and failures due to shock or vibration.
- B. Wiring within panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance.
- C. All devices and appliances shall be mounted to or in an approved electrical box.

3.6 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- B. Permanently label or mark each conductor with alphanumeric wire markers at the main control panel, transponders, terminal cabinet and NAC booster panels.
- C. A consistent color code for fire alarm system conductors throughout the installation.

3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Testing General:
 - 1. All Alarm Initiating Devices shall be observed and logged for correct zone and sensitivity. These devices and their bases shall be tagged with adhesive tags located in an area not visible when installed, showing the initials of the installing technician and date.
 - 2. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.
 - 3. The acceptance inspector shall be notified before the start of the required tests. All items found at variance with the schematic design drawings or this specification during testing or inspection by the acceptance inspector shall be corrected.
 - 4. Test reports shall be delivered to the acceptance inspector as completed.
 - 5. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing contractor. The following equipment shall be a minimum for conducting the tests:
 - a. Ladders and scaffolds as required to access all installed equipment.
 - b. Multi-meter for reading voltage, current and resistance.
 - c. Two-way radios and flashlights.

- d. A manufacturer recommended device for measuring air flow through air duct smoke detector sampling assemblies.
- e. Decibel meter
- f. In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to test by the authority having jurisdiction.

3.8 ACCEPTANCE TESTING

- A. A written acceptance test procedure (ATP) for testing the fire alarm system components and installation will be prepared by the engineer in accordance with NFPA 72 and this specification. The contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of all system components, circuits, and programming.
 - 1. A program matrix shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm condition on that input.
 - 2. The installing contractor prior to the ATP shall prepare a complete listing of all device labels for alphanumeric annunciator displays.
- B. Preliminary Testing: Conduct preliminary tests to ensure that all devices and circuits are functioning properly. After preliminary testing is complete, provide a letter certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly. The letter shall also state that all panel functions were tested and operated properly. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.
 - 1. Verify that the control unit is in the normal condition as detailed in the manufacturer's O&M manual.
 - 2. Visually inspect wiring.
 - 3. Test the battery charger and batteries.
 - 4. Verify that software control and data files have been entered or programmed into the FACP.
 - 5. Measure the current in circuits to ensure there is the calculated spare capacity for the circuits.
 - 6. Measure voltage readings for circuits to ensure that voltage drop is not excessive.
 - 7. Measure the voltage drop at the most remote appliance (based on wire length) on each notification appliance circuit.
 - 8. Megger Tests: After wiring has been installed, and prior to making any connections to panels or devices, wiring shall be megger tested for insulation resistance, grounds, and/or shorts. Conductors with 300 volt rated insulation shall be tested at a minimum of 250 VDC. Conductors with 600 volt rated insulation shall be tested at a minimum of 500 VDC. Test results recorded for use at the final acceptance test.
 - 9. Loop Resistance Tests: Measure and record the resistance of each circuit with each pair of conductors in the circuit short-circuited at the farthest point from the circuit origin. The tests shall be witnessed by the owner and test results recorded for use at the final acceptance test.
 - 10. Verify the absence of unwanted voltages between circuit conductors and ground. The tests shall be accomplished at the preliminary test with results available at the final system test.
 - 11. Test each initiating device and notification appliance and circuit for proper operation and response at the control unit. Smoke sensors shall be tested in accordance with manufacturer's recommended calibrated test method. Use of magnets is prohibited. Testing of duct smoke detectors shall comply with the requirements of NFPA 72 except that, for item 12(e) (Supervision) in Table 14.4.2.2, disconnect at least 20 percent of

- devices. If there is a failure at these devices, then supervision shall be tested at each device.
12. All readings for Sound Pressure Level (SPL) shall be recorded on the installation drawings next to the speaker symbol. The readings shall then be added on the "as-Built" drawings to be submitted at the conclusion of the Final Acceptance test.
 13. Verify with all parties the required survivability of wiring, raceways, and junction boxes
 14. Determine that the system is operable under trouble conditions as specified.
- C. Final Acceptance Test: Notify the owner in writing when the system is ready for final acceptance testing. Submit request for test at least 30 calendar days prior to the test date. A final acceptance test will not be scheduled until the Preliminary Testing has been completed.
1. Provide documentation of Preliminary Testing results.
 2. Test the system in accordance with the procedures outlined in NFPA 72 acceptance testing.
 3. Demonstrate the performance of the required number and type of initiating devices and notification appliances per the AHJ's requirements.
 4. Verify that Shop Drawings reflecting as-built conditions are accurate. Upon final approval by all parties, provide two sets of AS-built documents in a cabinet adjacent to the main FACP or designated area within the building. Per NFPA 72 7.7.2 Measure the current in Notification appliance circuits under full load to assure that there is the calculated spare capacity for every circuit.
- D. The acceptance inspector shall use the system record drawings in combination with the documents specified in this specification during the testing procedure to verify operation as programmed. In conducting the ATP, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:
1. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
 - a. Open, shorted and grounded signal line circuits.
 - b. Open, shorted and grounded notification, releasing circuits.
 - c. Primary power or battery disconnected.
 2. System notification appliances shall be demonstrated as follows:
 - a. All alarm notification appliances actuate as programmed
 - b. Audibility and visibility at required levels.
 3. System indications shall be demonstrated as follows:
 - a. Correct message display for each alarm input at the control display.
 - b. Correct annunciator light for each alarm input at each annunciator and graphic display as shown on the drawings.

- c. Correct history logging for all system activity.
- 4. System off-site reporting functions shall be demonstrated as follows:
 - a. Correct zone transmitted for each alarm input
 - b. Trouble signals received for disconnect
- 5. Secondary power capabilities shall be demonstrated as follows:
 - a. System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
 - b. System primary power shall be restored for forty-eight hours and system-charging current shall be normal trickle charge for a fully charged battery bank.
 - c. System battery voltages and charging currents shall be checked at the fire alarm control panel.

3.9 DOCUMENTATION

- A. System documentation shall be furnished to the owner and shall include but not be limited to the following:
 - 1. System record drawings and wiring details including one set of reproducible drawings, and a CD ROM or memory stick (thumb drive) with digital copies of the record drawings in PDF format.
 - 2. System operation, installation and maintenance manuals.
 - 3. System matrix showing interaction of all input signals with output commands.
 - 4. Documentation of system voltage, current and resistance readings taken during the installation, testing and ATP phases of the system installation.
 - 5. System program showing system functions, controls and labeling of equipment and devices.

3.10 PROTECTION

- A. Remove and replace devices and panel components that are wet, moisture damaged, or mold damaged.

3.11 DEMONSTRATION

- A. Include in the project the services of a factory-trained instructor, regarding the system operations, inspection requirements, and maintenance of the system provided. The instructor shall train the employees designated by the owner, in the care, adjustment, and operation of the fire alarm system.
 - 1. Required Instruction Time: Provide 2 hours of instruction after final acceptance of the system. The instruction shall be given during working hours on such dates and times as are selected by the owner. The instruction may be divided into two periods and videotaped at the discretion of the owner.

- B. Provide a printed instruction card in a conspicuous location observable from the FACP. The card shall show those steps to be taken by an operator when a signal is received as well as the functional operation of the system under all conditions, normal, alarm, supervisory and trouble.

END OF SECTION

SUPPLEMENTARY SPECIFICATIONS

LOGAN TOWNSHIP DPW POLE BARN EXTENSION AND SITE IMPROVEMENTS

IN THE TOWNSHIP OF LOGAN

COUNTY OF GLOUCESTER

AUTHORIZATION OF CONTRACT

The contract for this project is authorized by the provisions of local public contracts law, NJSA 40A: 11-1 et seq.

SPECIFICATIONS TO BE USED

The electronic version of the 2019 Standard Specifications for Road and Bridge Construction, effective September 1, 2019 as referenced in Baseline Document Change announcement BDC19S-01 of the New Jersey Department of Transportation and as amended herein, shall govern the construction of this project.

WAGE RATES

The contractor shall pay the minimum wage rates determined by the New Jersey Department of Labor.

State wage rates may be obtained from the New Jersey Department of Labor (Telephone: 609-292-2259) or by accessing the Department of Labor's web site at:

http://lwd.dol.state.nj.us/labor/wagehour/wagehour_index.html. The State wage rates in effect at the time of award will be made a part of this Contract, pursuant to Chapter 150, Laws of 1963 (NJSA 34:11-56.25, *et seq.*).

In the event it is found that any employee of the contractor or any subcontractor covered by the contract, has been paid a rate of wages less than the minimum wage required to be paid by the contract, the contracting agency may terminate the contractor's or subcontractor's right to proceed with the work, or such part of the work, as to which there has been a failure to pay required wages and to prosecute the work to completion or otherwise. The contractor and his sureties shall be liable to the contracting agency for any excess costs occasioned thereby.

GENERAL

Award of contract and subletting will not be permitted to, materials will not be permitted from, and use of equipment will not be permitted that is owned and/or operated by, firms and individuals included in the report of suspensions, debarments and disqualifications of firms and individuals as maintained by the Department of the Treasury, General Services Administration, CN-039, Trenton NJ 08625 (609-292-5400).

Payment for a pay item in the proposal includes all the compensation that will be made for the work of that item as described in the contract documents unless the "basis of payment" clause provides that certain work essential to that item will be paid for under another pay item.

Whenever any section, subsection, subpart or subheading is amended by such terms as changed to, deleted or added it is construed to mean that it amends that section, subsection, subpart or subheading of the 2019 Standard Specifications unless otherwise noted.

Whenever reference to page number is made, it is construed to refer to the 2019 Standard Specifications unless otherwise noted.

Henceforth in this supplementary specification whenever reference to the State, Department, ME, RE or Inspector is made, it is construed to mean the particular municipality or county executing this contract.

Whenever reference to Title 27 is made, it is construed to mean Title 40.

SECTION 100 - GENERAL PROVISIONS

The following sections of the standard specifications are deleted:

SECTION 101 - GENERAL INFORMATION

SECTION 102 - BIDDING REQUIREMENTS AND CONDITIONS

SECTION 103 - AWARD AND EXECUTION OF CONTRACT

SECTION 104 - SCOPE OF WORK

SECTION 105 - CONTROL OF WORK

SECTION 106 - CONTROL OF MATERIAL

SECTION 107 - LEGAL RELATIONS AND RESPONSIBILITY TO PUBLIC

SECTION 108 - PROSECUTION AND PROGRESS

SECTION 109 - MEASUREMENT AND PAYMENT

These sections of the standard specifications are changed to the requirements of the contracting agency contained here in these contract construction specifications document.

DIVISION 150 - CONTRACT REQUIREMENTS

The following sections of the standard specifications are deleted:

SECTION 151 - PERFORMANCE BOND AND PAYMENT BOND

SECTION 152 - INSURANCE

SECTION 153 - PROGRESS SCHEDULE

SECTION 154 - MOBILIZATION

SECTION 155 - CONSTRUCTION FIELD OFFICE

SECTION 156 - MATERIALS FIELD LABORATORY

SECTION 157 - CONSTRUCTION LAYOUT AND MONUMENTS

SECTION 161 - FINAL CLEANUP

These sections of the standard specifications are changed to the requirements of the contracting agency contained here in these contract construction specifications.

**SECTION 158 - SOIL EROSION AND SEDIMENT CONTROL
AND WATER QUALITY CONTROL**

158.04 MEASUREMENT AND PAYMENT

The list of pay items besides the line items for SILT FENCE and INLET PROTECTION is deleted and the following is added:

Various temporary soil erosion and sediment control and water quality control devices will not be measured for payment besides silt fence and inlet protection.

Separate payment will not be made for temporary soil erosion and sediment control and water quality control and dust control but the cost will be included in the various items in the proposal.

SECTION 159 - TRAFFIC CONTROL

159.04 MEASUREMENT AND PAYMENT

The list of pay items is deleted and the following is added:

Separate payment will not be made for Maintenance and Protection of Traffic. All costs thereof shall be included in the various items in the proposal.

No Police Traffic Control is required.

DIVISION 200 - EARTHWORK
SECTION 201 - CLEARING SITE

201.04 MEASUREMENT AND PAYMENT

The following is added:

Payment for the item “clearing site” in excess of \$5,000.00 will not be made until completion of the project.

SECTION 202 – EXCAVATION

202.02 MATERIALS

202.03.03 Excavating Unclassified Material

A. Excavating.

THE FIRST PARAGRAPH IS CHANGED TO:

The Department, as the generator, is solely responsible for the designation of excavated material. Unclassified excavation consists of excavation and management of material of whatever nature encountered, except for regulated material and acid producing soil.

202.04 MEASUREMENT AND PAYMENT

The following is deleted:

<i>Item</i>	<i>Pay Unit</i>
STRIPPING	ACRE
REMOVAL OF PAVEMENT YARD	SQUARE

Separate payment will not be made for the stripping of topsoil. All costs shall be included in the price bid for TOPSOIL SPREADING, 5" THICK.

Separate payment will not be made for the removal of pavement. All costs shall be included in the price bid for EXCAVATION UNCLASSIFIED.

DIVISION 400 - SURFACE COURSES

SECTION 401 - HOT MIX ASPHALT (HMA) COURSES

401.03.07 HMA Courses

THIS SUBSECTION IS REPLACED BY THE FOLLOWING:

H. Air Void Requirements.

Pavement lots are defined as approximately 15,000 square yards of pavement in Surface area. If pavement lot area is less than 5000 square yards, the Regional District Local Aid Office may waive the air voids requirements.

The RE will designate an independent testing agency (Laboratory) to perform the quality assurance sampling, testing and analysis. The Laboratory is required to be accredited by the AASHTO Accreditation Program (www.amrl.net). The Laboratory's accreditation must include AASHTO T 166 and AASHTO T 209.

The Laboratory Technician who performs the quality assurance sampling shall be certified by the Society of Asphalt Technologists of New Jersey as an Asphalt Plant Technologist, Level 1.

The Laboratory will determine air voids from 5 (Five) 6 inch diameter cores taken from each lot in random locations within the traveled way and at least one core in each travel lane. The Laboratory will determine air voids of cores from the values for the maximum specific gravity of the mix and the bulk specific gravity of the core. The Laboratory will determine the maximum specific gravity of the mix according to NJDOT B-3 and AASHTO T 209, except that minimum sample size may be waived in order to use a 6-inch diameter core sample. The Laboratory will determine the bulk specific gravity of the compacted mixture by testing each core according to AASHTO T 166.

The Laboratory will calculate the in-place air voids of each completed lot outside the acceptable range of 2 percent air voids to 8 percent air voids.

The RE will assess a reduction in lot due to nonconformance to air voids according to the following Table.

Reduction for Nonconformance to Air Voids Requirements	
Lot Average Air Void Value	Reduction Per Lot
0.0 to 1.9	10
2.0 to 8.0	0
8.1 to 9.0	5
9.1 to 10.0	15
10.1 to 12.0	30
Over 12.0	Remove & Replace

If the average air voids for the lot is greater than 12.0 percent, remove and replace the lot. The replacement work is subject to the same requirements as the initial work.

407.03.07 I THICKNESS REQUIREMENTS

THIS SUBSECTION IS DELETED. IN NO INSTANCE WILL A COMPACTED AVERAGE THICKNESS OF LESS THAN 1.25 INCHES BE ACCEPTABLE.

DIVISION 600 - MISCELLANEOUS CONSTRUCTION

SECTION 601 PIPE

601.03 CONSTRUCTION

The following is added:

601.03.01 Pipe

The following is added:

All reinforced concrete pipe sections shall have full thickness bell and spicket connections.

601.04 MEASUREMENT AND PAYMENT

The following is added:

<i>Item</i>	<i>Pay Unit</i>
2" HIGH DENSITY POLYETHYLENE, SDR-9, SANITARY PIPE	LINEAR FEET
2" HIGH DENSITY POLYETHYLENE PIPE WATER SERVICE	LINEAR FEET
2" PVC, SDR 35, SANITARY PIPE	LINEAR FEET

SECTION 602 DRAINAGE STRUCTURES

602.03.03 Set Castings, Reset Casting, and Reconstructed Inlets and Manholes

The following is added:

Existing inlet and manhole castings which are no longer required shall become the property of the Woodbury Heights Elementary School.

THE FOLLOWING IS ADDED:

Separate payment will not be made for trench stabilization, fittings, pipe bedding, dewatering, shoring, sheeting, bracing, and structure connections involved in all drainage structure removal and installation, but the cost shall be included in the various items of the proposal.

Separate payment will not be made for removal of existing structures, but the cost shall be included in the various items of the proposal.

SECTION 605 - FENCE

605.02 MATERIALS

THE FOLLOWING IS ADDED:

The fence fabric core wire shall be 9-gauge galvanized with a diameter of 0.148" and a break load of 1,290 pounds woven into a two (2) inch mesh.

All pipe associated with the framework shall be Schedule 40.

Posts for swing gates shall be as follows:

<u>Single Width</u>	<u>Gate Leaf</u>	<u>Post Sizes</u>
6' & less		3" OD Sch. 40
6' – 12'		4" OD Sch. 40

605.04 MEASUREMENT AND PAYMENT

The following items are added:

<i>Item</i>	<i>Pay Unit</i>
CHAIN-LINK FENCE, PVC-COATED STEEL, ___' HIGH	LF
CHAIN-LINK FENCE, AUTOMATIC GATE, PVC-COATED STEEL, ___' WIDE	UN

SECTION 606 - SIDEWALKS, DRIVEWAYS AND ISLANDS

606.04 MEASUREMENT AND PAYMENT

The following is added:

Payment for the removal and disposal of any existing sidewalks and/or driveways and all adjacent site restoration, unless payment is otherwise provided for under other pay items, will be included in the unit price bid for Concrete Sidewalk, 4" Thick.

DIVISION 650 - UTILITIES

The following sections of the standard specifications are deleted:

SECTION 651 - WATER

SECTION 652 - SANITARY SEWER

SECTION 653 - GAS

These sections of the standard specifications are changed to the requirements of the contracting agency contained here in these contract construction specifications.

The following section is added:

SECTION 654 - WATER, GAS, AND SANITARY SEWER LINES

654.01 DESCRIPTION

This section describes the work for resetting of sewer vents and sanitary sewer cleanouts; water valve boxes, storm sewer cleanouts; and underdrain cleanouts.

654.02 MATERIALS

Coarse Aggregate (No. 57).....	901.03
Concrete.....	903.03
Castings.....	909.03

654.03 CONSTRUCTION

1. Methods of construction shall be such that, when reset, the vent/valve/cleanout boxes shall conform to the grade of the resurfaced or regraded area.
2. Care shall be exercised in resetting the vent/valve/cleanout boxes. After resetting, the vent/valve/cleanout boxes shall be protected until the final resurfacing course has been laid. Castings which are damaged because of construction operations or vehicular traffic shall be replaced in kind and in a manner satisfactory to the utility company concerned without additional compensation.

SECTION 607 - CURBS

607.04 MEASUREMENT AND PAYMENT

The following is added:

Payment for the removal and disposal of any existing curb and all adjacent site restoration will be included in the unit price bid for all curb types.

There shall be no separate payment for dense-graded aggregate required for curb installation. All costs shall be included in the unit price bid for the various curb items.

Payment will not be made to remove the existing 9"x18" Steel Faced Concrete Vertical Curb. All costs associated with this work shall be include in the unit price bid for "9"X18" STEEL FACED CONCRETE VERTICAL CURB

THE FOLLOWING PAY ITEM IS ADDED:

<i>Item</i>	<i>Pay Unit</i>
9"X18" STEEL FACED CONCRETE VERTICAL CURB	LINEAR FEET

Payment will not be made to remove the existing monolithic concrete vertical curb and gutter. All costs associated with this work shall be include in the unit price bid for "9"X18" STEEL FACED CONCRETE VERTICAL CURB"

DIVISION 800 – LANDSCAPING

SECTION 804 – TOPSOIL SPREADING

804.04 MEASUREMENT AND PAYMENT

The following is added:

Separate payment will not be made for the stripping of topsoil. All costs shall be included in the price bid for TOPSOIL SPREADING, 5” THICK.

SECTION 902 - ASPHALT

902.02.03 Mix Design

THE FOLLOWING IS ADDED TO THE FIRST PARAGRAPH:

Unless otherwise approved by the Engineer, only one source of supply for hot mix asphalt surface course may be used on the project.

902.02.04 SAMPLING AND TESTING

ADD THE FOLLOWING TO 902.02.04:

- E. Acceptance of HMA.** The Department may accept the HMA as specified in 902.02.04.A through 902-02.04, E by employing staff or an independent testing agency at the HMA plant during production. The inspector who performs the quality assurance sampling shall be certified by the Society of Asphalt Technologists of New Jersey as an Asphalt Plant Technologist, Level 2.

Alternatively, the Department may accept the HMA by Certification of Compliance according to 106.07.

902.02.03 Mix Design

The following is added to the first paragraph:

Unless otherwise approved by the engineer, only one source of supply for hot mix asphalt surface course may be used on the project.

902.02.04 Sampling and Testing

(B) Sampling

The following is added to the first paragraph:

When a lot is necessarily less than 350 tons no samples shall be taken. When a lot is greater than 350 tons a minimum of two (2) samples shall be taken.

SECTION 917 – LANDSCAPING MATERIALS

917.01 Topsoil.

The entire section is deleted and the following is added:

Topsoil shall be loamy sand, sandy loam, clay-loam, loam, silt loam, or other soil approved by the Engineer. It shall be natural, fertile soil capable of sustaining vigorous plant growth and shall be of a uniform quality, free from subsoil, slag, cinders, stones 1 inch or larger in any dimension, lumps of soil, sticks, roots, trash, or other extraneous, undesirable materials. Topsoil shall also be free of viable plants or plant parts of Bermuda grass, quackgrass, Johnson grass, nut sedge, poison ivy, Canada thistle, or similar material. The contractor shall have all topsoil tested by a reputable laboratory with resulting documentation submitted to the Engineer.

- A. If testing reveals that the topsoil does not conform to the requirements of this section, the contractor shall be responsible for adjusting the ph range and/or percent of organic matter by means of approved additives.
- B. Topsoil shall meet the following requirements:
1. ph range - 5.0 to 7.0.
 2. Organic matter - four (4) percent (loss on ignition).
 3. Soluble salts no higher than 500 parts per million.
 4. Sieve Analysis:

Sieve Size	Percent Passing
1"	100%
½"	97%
#10	60-80%
#40	40-60%
#60	40-60%
#100	10-30%
#200	10-20%

- C. When topsoil, stockpiled on site, is to be reused, soil debris to include roots, sods, stones, clay lumps, and other extraneous materials harmful to plant growth shall be removed prior to reuse.
- D. Materials stripped from the following sources shall not be considered suitable for use as topsoil:
1. Soils having less than 4.1 ph value.
 2. Chemically contaminated soils.
 3. Areas from which the original surface has been stripped and/or covered over such as borrow pits, open mines, demolition sites, dumps, and sanitary landfills.
 4. Wet excavation.

END OF SUPPLEMENTARY SPECIFICATIONS