NORTH RICHLAND HILLS

NRH

THE CITY OF CHOICE

PURCHASING DEPARTMENT

REQUEST FOR BID

21-019 DESCRIPTION

BIDS DUE WEDNESDAY, JUNE 30, 2021

BY 2:00 P.M.

CONTRACT DOCUMENTS
AND
CONSTRUCTION SPECIFICATIONS
FOR

CONN PUMP STATION REHABILITATION PROJECT

FOR THE

CITY OF NORTH RICHLAND HILLS

June 2021

City of North Richland Hills
Public Works Department

Project RFB 21-019

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SECTION IV TECHNICAL SPECIFICATIONS

For this contract, the Site Protection & Preparation (Division 200), Roadway Construction (Division 300), Roadway Maintenance & Rehabilitation (Division 400), Underground Construction & Appurtenances (Division 500), Conduit and Appurtenance Rehabilitation (Division 600), Structures (Division 700) and Miscellaneous Construction & Materials (Division 800) of the "Public Works Construction Standards – North Central Texas" adopted by the North Central Texas Council of Governments (NCTCOG), November 2017 Edition, with all amendments thereto, shall govern and shall constitute as the Technical Specifications except as herein amended, modified or supplemented. Omission of any section from the Project's Contract Documents does not mean that such section is not applicable to this Project. The NCTCOG Technical Specifications will be referred to as the Technical Specifications (TS) and will not be physically bound with the other contract documents. Copies may be obtained from the North Central Texas Council of Governments.

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SECTION I – NRH PURCHASING GUIDANCE

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INVITATION TO BID

The City of North Richland Hills is accepting sealed bids from all interested parties for:

- Bid Number: 21-019
- Bid Type: REQUEST FOR BID
- Bid Name: CONN PUMP STATION REHABILITATION
- Bid Due Date: Wednesday, June 30, 2021
- Bid Due Time: 2:00 P.M. Central Standard Time
- Pre-Bid Conference: 1:00 P.M. Central Standard Time Wednesday June 16, 2021
- Location: Community Room, 4301 City Point Dr, North Richland Hills, TX 76180
- Deadline for questions:
  Date: Friday, June 25, 2021
  Time: 12:00 P.M. Central Standard Time

DOCUMENTS MUST BE SUBMITTED ELECTRONICALLY VIA:

www.publicpurchase.com

No oral explanation in regards to the meaning of the specifications will be made, and no oral instructions will be given after the pre-bid meeting and before the award of the contract. Requests from interested vendors for additional information or interpretation of the information included in the specifications should be directed in writing as a question related to this bid on Public Purchase and the question will be answered on Public Purchase. All addendums will also be posted to Public Purchase. It will be the vendor's responsibility to check all information related to this bid on Public Purchase before submitting a response.

The City of North Richland Hills reserves the right to reject in part or in whole all bids submitted, and to waive any technicalities for the best interest of the City of North Richland Hills.

GENERAL CONDITIONS

In submitting this bid, the Bidder understands and agrees to be bound by the following terms and conditions. These terms and conditions shall become a part of the purchase order or contract and will consist of the invitation to bid, specifications, the responsive bid and the contract with attachments, together with any additional documents identified in the contract and any written change orders approved and signed by a city official with authority to do so. All shall have equal weight and be deemed a part of the entire contract. If there is a conflict between contract documents, the provision more favorable to the City shall prevail.

1. BID TIME

It shall be the responsibility of each Bidder to ensure his/her bid are submitted to the Public Purchase website on or before **2:00 P.M. Wednesday, June 30, 2021**. The official time shall be determined by the Public Purchase Website. The Public Purchase Website will NOT allow bid responses to be uploaded after the closing time.

All attached bid documents are to be returned completely filled out, totaled, and signed. The City of North Richland Hills will not accept any bid documents other than the attached.

2. WITHDRAWING BIDS/PROPOSALS/QUOTES

Bids may be withdrawn at any time prior to the official opening; request for non-consideration of bids must be made in writing to the Purchasing Manager and received prior to the time set for opening bids. The bidder warrants and guarantees that his/her bid has been carefully reviewed and checked and that it is in all things true and accurate and free of mistakes. Bidder agrees that a bid price may not be withdrawn or canceled by the bidder for a period of ninety (90) days following the date designated for the receipt of bids.

3. IRREGULAR BIDS/PROPOSALS/QUOTES

Bids will be considered irregular if they show any omissions, alterations of form, additions, or conditions not called for, unauthorized alternate bids, or irregularities of any kind. However, the City of North Richland Hills reserves the right to waive any irregularities and to make the award in the best interest of the City.

4. REJECTION/DISQUALIFICATION

Bidders will be disqualified and/or their bids rejected, among other reasons, for any of the specific reasons listed below:

a) Bid received after the time set for receiving bids as stated in the advertisement;
b) Reason for believing collusion exists among the Bidders;
c) Bid containing unbalanced value of any item; bid offering used or reconditioned equipment;
d) Where the bidder, sub-contractor or supplier is in litigation with the City of North Richland Hills or where such litigation is contemplated or imminent;
e) Uncompleted work which in the judgment of the City will prevent or hinder the prompt completion of additional work, or having defaulted on a previous contract;
f) Lack of competency as revealed by reference checks, financial statement, experience and equipment, questionnaires, or qualification statement;
g) Bid containing special conditions, clauses, alterations, items not called for or irregularities of any kind, which in the Owner's opinion may disqualify the Bidder.

However, the City of North Richland Hills reserves the right to waive any irregularities and to make the award in the best interest of the City of North Richland Hills.

5. BID EVALUATION

Award of bid, if it be awarded, will be made to the lowest responsible bidder or may be awarded to the bidder that offers the goods and/or services at the *best value* for the City (Texas Local Government Code, 252.043). In determining the best value the City will consider the following:

a) The purchase price; terms and discounts; delivery schedule;
b) The reputation of the bidder and of the bidder's goods or services;
c) The quality of the bidders' goods or services;
d) The extent to which the bidder's goods or services meet the City specifications and needs;
e) The bidder's past relationship with the City;
f) Total long term cost to the city to acquire the bidder's goods or services;
g) Any relevant criteria specifically listed in the specifications;
h) Compliance with all State and local laws, General Conditions and Specifications;
i) Results of testing, if required;
j) Warranty and/or guarantee, maintenance requirements and performance data of the product requested;
k) City's evaluation of the bidder's ability to perform to specifications.

6. AWARD OF BID

The bid award will be made within sixty (60) days after the opening of bids. No award will be made until after investigations are made as to the responsibilities of the best bidder.

The City of North Richland Hills reserves the right to award bids whole or in part when deemed to be in the best interest of the City. Bidder shall state on bid form if their bid is "all or none", otherwise it shall be considered as agreeing to this section.

Information contained in submitted bid documents shall not be available for inspection until after the award has been made by the City Council. Requests for this information must be submitted in writing.

7. ASSIGNMENT

The successful bidder may not assign his/her rights and duties under an award without the written consent of the North Richland Hills City Manager. Such consent shall not relieve the assignor of liability in the event of default by his assignee.

8. SUBSTITUTIONS/EXCEPTIONS

Exceptions/variations from the specifications may be acceptable provided such variations, in each instance, is noted and fully explained in writing and submitted with bid. NO substitutions or changes in the specifications shall be permitted after award of bid without prior written approval by the Purchasing Manager.

9. DELIVERY/ACCEPTANCE

The delivery date is an important factor of this bid and shall be considered during the evaluation process. The City considers delivery time the period elapsing from the time the

order is placed until the City receives the order at the specified delivery location. All material shall be delivered F.O.B. City of North Richland Hills to the address specified at the time of order. Acceptance by the City of North Richland Hills of any delivery shall not relieve the Contractor of any guarantee or warranty, expressed or implied, nor shall it be considered an acceptance of material not in accordance with the specifications thereby waiving the City of North Richland Hills right to request replacement of defective material or material not meeting specifications.

10. NOTICE OF DELAYS

Whenever the contractor encounters any difficulty which is delaying or threatens to delay timely performance, written notice shall immediately be given to the Purchasing Manager, stating all relevant information. Such notice shall not in any way be construed as a waiver by the City of any rights or remedies to which it is entitled by law. Delays in performance and/or completion may result in cancellation of agreement.

11. SALES TAX

The City of North Richland Hills is exempt from Federal Excise and State sales tax; therefore tax must not be added to bid.

12. TIE BIDS

In the event of a tie bid, State Law provides the bid or contract shall be awarded to the local bidder. In cases where a local bidder is not involved, tie bids shall be awarded by drawing lots at the City Council meeting, or as otherwise directed by the Mayor.

13. BRAND NAME OR EQUAL

If items are identified by a "brand name" description, such identification is intended to be descriptive, not restrictive, and is to indicate the quality and characteristics of products that will be satisfactory. As used in this clause, the term "brand name" includes identification of products by make and model.

Such products must be clearly identified in the bid as an equal product and published specifications of the equal products offered must be included with the bid reply.

Bids offering equal products will be considered for award if determined by the Purchasing Manager and the user department to be equal in all material respects to the brand name products referenced. The decision of acceptable “equal" items or variations in the specifications will solely be the City of North Richland Hills. Unless the bidder clearly indicates in his/her bid that he is offering an "equal" product, his bid shall be considered as offering the brand name product referenced in the invitation for bids.

14. REFERENCES

A minimum of three (3) references, preferably located within the Dallas/Fort Worth Metroplex, must be submitted with each bid. Company name, contact and phone number must be included with each reference.

15. PROHIBITION AGAINST PERSONAL FINANCIAL INTEREST IN CONTRACTS

No employee of the City of North Richland Hills shall have a direct or indirect financial interest in any proposed or existing contract, purchase, work, sale or service to or by the City (CMA-074, Standards of Conduct, Section IV).

16. TERMINATION/NON PERFORMANCE

Continuing non-performance of the vendor in terms of Specifications shall be a basis for the termination of the contract by the City. The City of North Richland Hills reserves the right to enforce the performance of this contract in any manner prescribed by law or deemed to be in the best interest of the City in the event of breach or default of this contract. The City reserves the right to terminate the contract immediately in the event the successful bidder fails to 1.) Meet delivery schedules or, 2.) Otherwise not perform in accordance with these specifications.

Breach of contract or default authorizes the City to award to another bidder, and/or purchase elsewhere and charge the full increase in cost and handling to the defaulting successful bidder.

The contract may be terminated by either party upon written thirty (30) days' notice prior to cancellation without cause.

17. ATTORNEYS FEES

Neither party to this contract shall be entitled to attorney fees for any matter arising under this contract, whether for additional work, breach of contract, or other claim for goods, services, or compensation. All claims for attorney's fees are hereby WAIVED.

18. INDEMNITY

City shall not be liable or responsible for, and shall be saved and held harmless by Contractor from and against any and all suits, actions, losses, damages, claims, or liability of any character, type, or description, including claims for copyright and patent infringement, and including all expenses of litigation, court costs, and attorney's fees for injury or death to any person, or injury to any property, received or sustained by any person or persons or property, arising out of, or occasioned by, directly or indirectly, the performance of Contractor under this agreement, including claims and damages arising in part from the negligence of City, without; however, waiving any governmental immunity available to the CITY under Texas law and without waiving any defenses of the parties under Texas law. The provisions of this indemnification are solely for the benefit of the parties hereto and not intended to create or grant any rights, contractual or otherwise, to any other person or entity.

It is the expressed intent of the parties to this Agreement that the indemnity provided for in this section is an indemnity extended by Contractor to indemnify and protect City from the consequences of City's own negligence, provided, however, that the indemnity provided for in this section shall apply only when the negligent act of City is a contributory cause of the resultant injury, death, or damage, and shall have no application when the negligent act of City is the sole cause of the resultant injury, death, or damage, unmixed with the legal fault of another person or entity. Contractor further agrees to defend, at its own expense, and on behalf of City and in the name of

City, any claim or litigation brought in connection with any such injury, death, or damage.

The Contractor will secure and maintain Contractual Liability insurance to cover this indemnification agreement that will be primary and noncontributory as to any insurance maintained by the City for its own benefit, including self-insurance.

19. PERFORMANCE AND PAYMENT BONDS

In the event the total contract amount exceeds $100,000, the Contractor shall be required to execute a performance bond in the amount of one hundred (100) percent of the total contract price; if the total contract amount exceeds $50,000 the contractor shall be required to execute a payment bond in the amount of one hundred (100) percent of the total contact price, each in standard forms for this purpose, guaranteeing faithful performance of work and guaranteeing payment to all persons supply labor and materials or furnishing any equipment in the execution of the contract. It is agreed that this contract shall not be in effect until such performance and payment bonds are furnished and approved by the City of North Richland Hills. No exceptions to this provision allowed.

Unless otherwise approved in writing by the City of North Richland Hills, the surety company underwriting the bonds shall be acceptable according to the latest list of companies holding certificates of authority from the Secretary of the Treasury of the United States.

Attorneys-in-fact who sign bid bonds or contract bonds must file with each bond a certified and current copy of their power of attorney.

20. INTERLOCAL AGREEMENT

Successful bidder agrees to extend prices and terms to all entities who have entered into or will enter into joint purchasing interlocal cooperation agreements with the City of North Richland Hills.

[ ] Yes, we agree [ ] No, we do not agree

21. ELECTRONIC PROCUREMENT

The City of North Richland Hills has adopted policies and procedures complying with Local Government Code Section 252.0415, Section 271.906 and Section 2155.062. The City of North Richland Hills may receive submittals in electronic form in response to procurement requests. However, a bid that is submitted non-electronically by the due date and time will be accepted and then entered electronically by Purchasing after the bid opening.

22. COMPLIANCE WITH SB 89:

Vendor agrees per HB 89 of the 85th Texas Legislative Session, and in accordance with Chapter 2270 of the Texas Government Code, vendor has not and shall not boycott Israel at any time while providing products or services to the City of North Richland Hills.

[ ] Yes, we agree [ ] No, we do not agree

23. COMPLIANCE WITH SB 252:

Vendor agrees per SB 252 of the 85th Texas Legislative Session, and in accordance with Chapter 2252 of the Texas Government Code, vendor shall not do business with Iran, Sudan or a foreign terrorist organization while providing products or services to the City of North Richland Hills.

[ ] Yes, we agree [ ] No, we do not agree *

* By selecting no, vendor certifies that it is affirmatively excluded from the federal sanctions regime by the United States government and is not subject to the contract prohibition under Section 2252.154 of the Texas Government Code. Vendor shall provide sufficient documentation to the City of such exclusion prior to award of any contract for goods or services.

24. ETHICS AND COMPLIANCE POLICY

The City's Ethics and Compliance Policy can be found at The City of North Richland Hills Purchasing Division webpage - Or you may request a copy from the Purchasing Division. Acknowledgment - The City of North Richland Hills' Internal Ethics and Compliance Policy has been made available to me. I understand the expectations of ethical behavior and compliance with the law, and agree to adhere to the City's ethics policies.

https://www.nrhtx.com/DocumentCenter/View/389/Code-of-Ethics---PDF?bidId

[ ] I agree
[ ] I do not agree

25. DEPARTMENT OF TRANSPORTATION (TXDOT) RELATED BIDS

"The City of North Richland Hills, in accordance with the provisions of Title VI of the Civil Rights Act of 1964 (78 Stat. 252, 42 U.S.C. §§ 2000d to 2000d-4) and the Regulations, hereby notifies all bidders that it will affirmatively ensure that any contract entered into pursuant to this advertisement, disadvantaged business enterprises will be afforded full and fair opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of race, color, or national origin in consideration for an award." Due care and diligence has been used in preparation of this information, and it is believed to be substantially correct. However, the responsibility for determining the full extent of the exposure and the verification of all information presented herein shall rest solely with the bidder. The City of North Richland Hills and its representatives will not be responsible for any errors or omissions in these specifications, nor for the failure on the part of the proposer to determine the full extent of the exposures.

MINIMUM INSURANCE REQUIREMENTS

Contractors performing work on City property or public right-of-way for the City of North Richland Hills shall provide the City a certificate of insurance evidencing the coverages and coverage provisions identified herein. Contractors shall provide the City evidence that all subcontractors performing work on the project have the same types and amounts of coverages as required herein or that the subcontractors are included under the contractor's policy. The City, at its own discretion, may require a certified copy of the policy.

All insurance companies and coverages must be authorized by the Texas Department of Insurance to transact business in the State of Texas and must be acceptable to the City of North Richland Hills.

The following guidelines are designed to show the most common minimum insurance requirements for standard contracts and agreements with the City. Non-standard agreements may require additional coverage and/or higher limits. Coverage Amounts required for non-standard agreements to be determined by the department and the City Manager.

General Contracts for Services:
Service work, and general maintenance agreements, etc.

- ☐ Commercial General Liability
- ☐ Automobile Liability
- ☐ Workers' Compensation & Employer's Liability
- ☐ Payment and Maintenance Bond (if applicable)

See Exhibit A for insurance language to include in general contracts for services

Professional Services:
Consultants or other professionals including: accountants, attorneys, architects, engineers, medical professionals, medical services, etc.

- ☐ Commercial General Liability
- ☐ Automobile Liability
- ☐ Workers' Compensation & Employer's Liability
- ☐ Professional Liability or equivalent Errors & Omissions (appropriate to Contractor's profession)

See Exhibit B for insurance language to include in professional services contracts

Construction:
Building contractors for construction projects.

- ☐ Commercial General Liability
- ☐ Automobile Liability
- ☐ Workers' Compensation & Employer's Liability

- Professional Liability (if applicable for design function)
- Builder's Risk (required for new or existing property under construction)
- Payment and Maintenance Bond (if applicable)

See Exhibit C for insurance language to include in construction contracts

Information Technology/Network Access Services:
For the purchasing and installation of technology-related software and equipment or contracting services that support, maintain or interact with the CITY'S technology systems.

- Commercial General Liability
- Automobile Liability
- Workers' Compensation & Employer's Liability
- Professional Liability (if applicable)
- Cyber Liability

See Exhibit D for insurance language to include in IT/network access services agreements

Standard Minimum Required Insurance Coverage

Insurance Type	Limit	Provision
Commercial General Liability	$1,000,000 Each Occurrence $2,000,000 Aggregate	City to be listed as additional insured and provided 30-day notice of cancellation or material change in coverage
	For Construction Projects: $2,000,000 Each Occurrence $4,000,000 Aggregate	
Automobile Liability	$1,000,000 Combined Single Limit	
Workers' Compensation	Texas Statutory Requirements	Waiver of subrogation in favor of City
Employer's Liability	$500,000 injury - each accident $500,000 disease - each employee $500,000 disease - policy limit	
Professional Liability (or equivalent Errors & Omissions coverage appropriate to the Contractor's profession)	$1,000,000 Each Occurrence	
Builder's Risk (required for new or existing property under construction)	100% Value	
Cyber Liability	$1,000,000 Each Occurrence	
Payment/Maintenance Bonds	In accordance with Chapter 2253 of the Texas Government Code	

EXHIBIT A

GENERAL CONTRACTS FOR SERVICES

For the duration of this Agreement, CONTRACTOR shall maintain the following minimum insurance which shall protect CONTRACTOR, its subcontractors, its sub-consultants and CITY from claims for injuries, including accidental death, as well as from claims for property damage which may arise from the performance of work under this Agreement.

A. Workers' Compensation and Employer's Liability Insurance:

Workers' Compensation	Texas Statutory
Employer's Liability	$500,000 injury - each accident
	$500,000 disease - each employee
	$500,000 disease - policy limit

B. Commercial General Liability:

On an "occurrence" basis, including, property damage, bodily injury, products and completed operations and personal & advertising injury with limits no less than $1,000,000 per occurrence and $2,000,000 aggregate.

C. Automobile Liability:

Covering any auto, or if CONTRACTOR has no owned autos, covering hired and non-owned autos with a Combined Single Limit no less than $1,000,000 per accident for bodily injury and property damage.

Insurance limits can be met with a combination of primary and excess/umbrella coverage.

The CITY, its officers, officials and employees are to be covered as "Additional Insured" on the commercial general liability and automobile liability policies as respects liability arising out of activities performed by or on behalf of the CONTRACTOR.

A waiver of subrogation in favor of the CITY, its officers, officials and employees shall be contained in the Workers' Compensation insurance policy.

Policies of insurance shall not be cancelled non-renewed, terminated, or materially changed unless and until thirty (30) days' notice has been given to CITY.

All insurance shall be issued by responsible insurance companies eligible to do business in the State of Texas and having an A.M. Best Financial rating of A- VI or better.

CONTRACTOR shall furnish the CITY certificates of insurance affecting coverage required. The certificates for each insurance policy are to be signed by a person authorized by that insurer to bind coverage on its behalf. Certificates of Insurance must be submitted on a form approved by the Texas Department of Insurance.

Payment and Maintenance Bonds (if applicable): CONTRACTOR shall procure Payment and Maintenance Bonds as applicable and in accordance with Chapter 2253 of the Texas Government Code.

EXHIBIT B

PROFESSIONAL SERVICES

For the duration of this Agreement, CONTRACTOR shall maintain the following minimum insurance which shall protect CONTRACTOR, its subcontractors, its sub-consultants and CITY from claims for injuries, including accidental death, as well as from claims for property damage which may arise from the performance of work under this Agreement.

A. Workers' Compensation and Employer's Liability Insurance:

Workers' Compensation	Texas Statutory
Employer's Liability	$500,000 injury - each accident
	$500,000 disease - each employee
	$500,000 disease - policy limit

B. Commercial General Liability:

On an "occurrence" basis, including, property damage, bodily injury, products and completed operations and personal & advertising injury with limits no less than $1,000,000 per occurrence and $2,000,000 aggregate.

C. Automobile Liability:

Covering any auto, or if CONTRACTOR has no owned autos, covering hired and non-owned autos with a Combined Single Limit no less than $1,000,000 per accident for bodily injury and property damage.

D. Professional Liability (Errors and Omissions)

CONTRACTOR shall maintain Professional Liability (or equivalent) errors and omissions insurance appropriate to the CONTRACTOR'S profession, utility construction, pump installation, electrical, paving, with a limit no less than $1,000,000 per occurrence or claim.

Insurance limits can be met with a combination of primary and excess/umbrella coverage.

The CITY, its officers, officials and employees are to be covered as "Additional Insured" on the commercial general liability and automobile liability policies as respects liability arising out of activities performed by or on behalf of the CONTRACTOR.

A waiver of subrogation in favor of the CITY, its officers, officials and employees shall be contained in the Workers' Compensation insurance policy.

Policies of insurance shall not be cancelled non-renewed, terminated, or materially changed unless and until thirty (30) days' notice has been given to CITY.

All insurance shall be issued by responsible insurance companies eligible to do business in the State of Texas and having an A.M. Best Financial rating of A- VI or better.

CONTRACTOR shall furnish the CITY certificates of insurance affecting coverage required. The certificates for each insurance policy are to be signed by a person authorized by that insurer to bind coverage on its behalf. Certificates of Insurance must be submitted on a form approved by the Texas Department of Insurance.

EXHIBIT C

CONSTRUCTION

For the duration of this Agreement, CONTRACTOR shall maintain the following minimum insurance which shall protect CONTRACTOR, its subcontractors, its sub-consultants and CITY from claims for injuries, including accidental death, as well as from claims for property damage which may arise from the performance of work under this Agreement.

A. Workers' Compensation and Employer's Liability Insurance:

Workers' Compensation	Texas Statutory
Employer's Liability	$500,000 injury - each accident
	$500,000 disease - each employee
	$500,000 disease - policy limit

B. Commercial General Liability:

On an "occurrence" basis, including, property damage, bodily injury, products and completed operations and personal & advertising injury with limits no less than $2,000,000 per occurrence and $4,000,000 aggregate.

C. Automobile Liability:

Covering any auto, or if CONTRACTOR has no owned autos, covering hired and non-owned autos with a Combined Single Limit no less than $1,000,000 per accident for bodily injury and property damage.

D. Professional Liability (if contract involves design work)

CONTRACTOR shall maintain Professional Liability (or equivalent) errors and omissions insurance appropriate to the CONTRACTOR'S profession, with a limit no less than $1,000,000 per occurrence or claim

E. Builder's Risk

CONTRACTOR shall maintain Builder's Risk Insurance providing All-Risk (Special Perils) coverage in an amount equal to one hundred percent (100%) of the completed value of the project in question and no coinsurance penalty provisions. The policy shall list the CITY as loss payee as their interests may appear.

Insurance limits can be met with a combination of primary and excess/umbrella coverage.

The CITY, its officers, officials and employees are to be covered as "Additional Insured" on the commercial general liability and automobile liability policies as respects liability arising out of activities performed by or on behalf of the CONTRACTOR.

A waiver of subrogation in favor of the CITY, its officers, officials and employees shall be contained in the Workers' Compensation insurance policy.

Policies of insurance shall not be cancelled non-renewed, terminated, or materially changed unless and until thirty (30) days' notice has been given to CITY.

All insurance shall be issued by responsible insurance companies eligible to do business in the State of Texas and having an A.M. Best Financial rating of A- VI or better.

CONTRACTOR shall furnish the CITY certificates of insurance affecting coverage required. The certificates for each insurance policy are to be signed by a person authorized by that insurer to bind coverage on its behalf. Certificates of Insurance must be submitted on a form approved by the Texas Department of Insurance.

Payment and Maintenance Bonds (if applicable): CONTRACTOR shall procure Payment and Maintenance Bonds as applicable and in accordance with Chapter 2253 of the Texas Government Code.

EXHIBIT D

INFORMATION TECHNOLOGY/NETWORK ACCESS SERVICES

For the duration of this Agreement, CONTRACTOR shall maintain the following minimum insurance which shall protect CONTRACTOR, its subcontractors, its sub-consultants and CITY from claims for injuries, including accidental death, as well as from claims for property damage which may arise from the performance of work under this Agreement.

A. Workers' Compensation and Employer's Liability Insurance:

Workers' Compensation	Texas Statutory
Employer's Liability	$500,000 injury - each accident
	$500,000 disease - each employee
	$500,000 disease - policy limit

B. Commercial General Liability:

On an "occurrence" basis, including, property damage, bodily injury, products and completed operations and personal & advertising injury with limits no less than $1,000,000 per occurrence and $2,000,000 aggregate.

C. Automobile Liability:

Covering any auto, or if CONTRACTOR has no owned autos, covering hired and non-owned autos with a Combined Single Limit no less than $1,000,000 per accident for bodily injury and property damage.

D. Professional Liability (Errors and Omissions)

If appropriate for CONTRACTOR'S work, CONTRACTOR shall maintain Professional Liability (or equivalent) errors and omissions insurance appropriate to the CONTRACTOR'S profession, with a limit no less than $1,000,000 per occurrence or claim.

E. Cyber Liability

CONTRACTOR shall maintain cyber liability (or equivalent) insurance. Such insurance shall provide limits of no less than $1,000,000 per occurrence. Coverage shall be sufficiently broad to respond to the duties and obligations as undertaken by the CONTRACTOR.

Insurance limits can be met with a combination of primary and excess/umbrella coverage.

The CITY, its officers, officials and employees are to be covered as "Additional Insured" on the commercial general liability and automobile liability policies as respects liability arising out of activities performed by or on behalf of the CONTRACTOR.

A waiver of subrogation in favor of the CITY, its officers, officials and employees shall be contained in the Workers' Compensation insurance policy.

Policies of insurance shall not be cancelled non-renewed, terminated, or materially changed unless and until thirty (30) days' notice has been given to CITY.

All insurance shall be issued by responsible insurance companies eligible to do business in the State of Texas and having an A.M. Best Financial rating of A- VI or better.

CONTRACTOR shall furnish the CITY certificates of insurance affecting coverage required. The certificates for each insurance policy are to be signed by a person authorized by that insurer to bind coverage on its behalf. Certificates of Insurance must be submitted on a form approved by the Texas Department of Insurance.

Other Insurance Requirements - To Be Included As Applicable

CONTRACTORs who serve or distribute liquor:

Liquor Legal Liability - CONTRACTOR shall maintain Liquor Legal Liability coverage covering the selling, serving, or furnishing of any alcoholic beverage performed by CONTRACTOR, or on its behalf. Such insurance shall provide limits of no less than $1,000,000.00 per occurrence.

CONTRACTORs who hold long-term leases:

Property Insurance – LESSEE shall maintain Property Insurance against all risks of loss to any improvements or betterments, at full replacement cost with no coinsurance penalty provision. The CITY shall be added as a Loss Payee to the policy as interests may appear.

CONTRACTOR's whose work involves chemicals or otherwise has a pollution exposure:

Contractors' Pollution Liability (or equivalent) – CONTRACTOR shall maintain Contractors' Pollution Liability with limits no less than $1,000,000.00 per occurrence or claim and $2,000,000 policy aggregate.

CONTRACTORs who take possession of City or public vehicles (e.g., parking lots operators, auto repair shops):

Garage Keepers Liability (or equivalent) – CONTRACTOR shall maintain Garage Keepers Liability or equivalent coverage for applicable property while in the CONTRACTOR'S care, custody or control. Coverage must include Comprehensive and Collision coverage. Such insurance shall provide limits equal to no less than the total value of CITY or public property in the CONTRACTOR'S care, custody and control at any one time.

CONTRACTORs who own and operate unmanned aircraft (drones):

UAS Liability (or equivalent) - CONTRACTOR shall procure and maintain for the duration of the contract insurance against claims for injuries to persons or damage to property which may arise from or in connection with the ownership, maintenance or use of Unmanned Aerial Systems (Drones). Coverage must include limits no less than $1,000,000 per occurrence and $2,000,000 aggregate.

A PURCHASE ORDER WILL NOT BE ISSUED WITHOUT EVIDENCE OF INSURANCE.

NON-COLLUSION AFFIDAVIT OF BIDDER

State of _____ County of _____

_____ verifies that:
(Name)

(1) He/She is owner, partner, officer, representative, or agent of

_____, has submitted the attached bid: (Company Name)

(2) He/She is fully informed in respect to the preparation, contents and circumstances in regard to attached bid;

(3) Neither said bidder nor any of its officers, partners, agents or employees has in any way colluded, conspired or agreed, directly or indirectly with any other bidder, firm or person to submit a collusive or sham bid in connection with attached bid and the price or prices quoted herein are fair and proper.

_____
SIGNATURE

_____
PRINTED NAME

Subscribed and sworn to before me this

_____ Day of _____ 2021.

_____
NOTARY PUBLIC in and for

_____ County, Texas.

My commission expires: _____

THIS FORM MUST BE COMPLETED, NOTARIZED AND SUBMITTED WITH BID

BID CERTIFICATION

The Undersigned, in submitting this bid, represents and certifies:

a. He/she is fully informed regarding the preparation, contents and circumstances of the attached bid;

b. He/she proposes to furnish all equipment/service at the prices quoted herein and bid is in strict accordance with the conditions and specifications stated herein;

c. There will be at no time a misunderstanding as to the intent of the specifications or conditions to be overcome or pleaded after the bids are opened;

d. He/she is an equal opportunity employer, and will not discriminate with regard to race, color, national origin, age or sex in the performance of this contract.

e. The undersigned hereby certifies that he/she has read, understands and agrees that acceptance by the City of North Richland Hills of the bidder's offer by issuance of a purchase order will create a binding contract. Further, he/she agrees to fully comply with documentary forms herewith made a part of this specific procurement.

COMPANY: _____

ADDRESS: _____

CITY, STATE & ZIP: _____

TELEPHONE: _____

FAX _____

EMAIL: _____

SIGNATURE: _____

PRINTED NAME: _____

DATE: _____

COMPLIANCE WITH HOUSE BILL 1295

In 2015, the Texas Legislature adopted House Bill 1295, which added section 2252.908 of the Government Code. The law states that a governmental entity may not enter into certain contracts with a business entity unless the business entity submits a disclosure of interested parties to the governmental entity at the time the business entity submits the signed contract to the governmental entity.

The law applies only to a contract of a governmental entity that either (1) requires an action or vote by the governing body of the entity or agency before the contract may be signed or (2) has a value of at least $1 million. The disclosure requirement applies to a contract entered into on or after January 1, 2016.

The Texas Ethics Commission has adopted rules necessary to implement the law, prescribed the disclosure of interested parties form, and posted a copy of the form on the commission's website.

Filing Process:
The commission has made available on its website a new filing application that must be used to file Form 1295. A business entity must:

1) Use the application to enter the required information on Form 1295,
2) Print a copy of the completed form, which will include a certification of filing that will contain a unique certification number.
3) Contract Number should be the Bid/RFP Number and Bid Title.
4) Sign the printed copy of the form (an authorized agent of the business entity must sign),
5) Either include your personal information or have the form notarized,
6) File the completed Form 1295 with the certification of filing with the governmental body with which the business entity is entering into the contract.

The governmental entity must notify the commission, using the commission's filing application, of the receipt of the filed Form 1295 with the certification of filing not later than the 30th day after the date the contract binds all parties to the contract. The commission will post the completed Form 1295 to its website within seven business days after receiving notice from the governmental entity.

Information regarding how to use the filing application may be found at https://www.ethics.state.tx.us/whatsnew/elf_info_form1295.htm.

FOR DISADVANTAGED BUSINESS ENTERPRISES ONLY

Disadvantaged Business Enterprises (DBE) are encouraged to participate in the City of North Richland Hills bid process. Representatives from DBE Companies should identify themselves as such and submit a copy of their Certification.

The City of North Richland Hills recognizes the certifications of both the State of Texas Building and Procurement Commission HUB Program and the North Central Texas Regional Certification Agency. All companies seeking information concerning DBE certification are urged to contact:

Texas Building and Procurement Commission
Statewide HUB Program
1711 San Jacinto Blvd., Austin TX 78701-1416
P O Box 13186, Austin, TX 78711-3186
(512) 463-5872
http://www.window.state.tx.us/procurement/prog/hub/hub-certification/

North Central Texas
Regional Certification Agency
624 Six Flags Drive, Suite 216
Arlington, Texas 76011
(817) 640-0606
http://www.nctrca.org/certification.html

If your company is already certified, attach a copy of your certification to this form and return as part of your packet.
Company Names: _____

Representative: _____

Address: _____

City, State, Zip: _____

Telephone No. _____ **Fax No.** _____

Email address: _____

INDICATE ALL THAT APPLY:

_____**Minority-Owned Business Enterprise**
_____**Women-Owned Business Enterprise**
_____**Disadvantaged Business Enterprise**

CONFLICT OF INTEREST QUESTIONNAIRE

Pursuant to Chapter 176 of the Texas Local Government Code, a person, or agent of a person, who contracts or seeks to contract for the sale or purchase of property, goods, or services with the City of North Richland Hills must file a completed conflict of interest questionnaire. The conflict of interest questionnaire must be filed with the City Secretary of the City of North Richland Hills no later than the seventh business day after the person or agent begins contract discussions or negotiations with the City of North Richland Hills or submits to the City of North Richland Hills an application, response to a request for proposal or bid, correspondence, or another writing related to a potential agreement with the City of North Richland Hills. An updated conflict of interest questionnaire must be filed in accordance with Chapter 176 of the Local Government Code. An offense under Chapter 176 is a Class C misdemeanor.

The Conflict of Interest Questionnaire is included as part of this document and can be found at:

https://www.ethics.state.tx.us/data/forms/conflict/CIQ.pdf

CONFLICT OF INTEREST QUESTIONNAIRE

FORM CIQ

For vendor doing business with local governmental entity

This questionnaire reflects changes made to the law by H.B. 23, 84th Leg., Regular Session.

This questionnaire is being filed in accordance with Chapter 176, Local Government Code, by a vendor who has a business relationship as defined by Section 176.001(1-a) with a local governmental entity and the vendor meets requirements under Section 176.006(a).

By law this questionnaire must be filed with the records administrator of the local governmental entity not later than the 7th business day after the date the vendor becomes aware of facts that require the statement to be filed. *See* Section 176.006(a-1), Local Government Code.

A vendor commits an offense if the vendor knowingly violates Section 176.006, Local Government Code. An offense under this section is a misdemeanor.

OFFICE USE ONLY

Date Received

1 **Name of vendor who has a business relationship with local governmental entity.**

2 ☐ **Check this box if you are filing an update to a previously filed questionnaire.** (The law requires that you file an updated completed questionnaire with the appropriate filing authority not later than the 7th business day after the date on which you became aware that the originally filed questionnaire was incomplete or inaccurate.)

3 **Name of local government officer about whom the information is being disclosed.**

_____
Name of Officer

4 **Describe each employment or other business relationship with the local government officer, or a family member of the officer, as described by Section 176.003(a)(2)(A). Also describe any family relationship with the local government officer. Complete subparts A and B for each employment or business relationship described. Attach additional pages to this Form CIQ as necessary.**

A. Is the local government officer or a family member of the officer receiving or likely to receive taxable income, other than investment income, from the vendor?

☐ Yes ☐ No

B. Is the vendor receiving or likely to receive taxable income, other than investment income, from or at the direction of the local government officer or a family member of the officer AND the taxable income is not received from the local governmental entity?

☐ Yes ☐ No

5 **Describe each employment or business relationship that the vendor named in Section 1 maintains with a corporation or other business entity with respect to which the local government officer serves as an officer or director, or holds an ownership interest of one percent or more.**

6 ☐ Check this box if the vendor has given the local government officer or a family member of the officer one or more gifts as described in Section 176.003(a)(2)(B), excluding gifts described in Section 176.003(a-1).

7

_____ _____
Signature of vendor doing business with the governmental entity Date

Form provided by Texas Ethics Commission www.ethics.state.tx.us Revised 11/30/2015

CONFLICT OF INTEREST QUESTIONNAIRE
For vendor doing business with local governmental entity

A complete copy of Chapter 176 of the Local Government Code may be found at http://www.statutes.legis.state.tx.us/Docs/LG/htm/LG.176.htm. For easy reference, below are some of the sections cited on this form.

Local Government Code § 176.001(1-a): "Business relationship" means a connection between two or more parties based on commercial activity of one of the parties. The term does not include a connection based on:

(A) a transaction that is subject to rate or fee regulation by a federal, state, or local governmental entity or an agency of a federal, state, or local governmental entity;

(B) a transaction conducted at a price and subject to terms available to the public; or

(C) a purchase or lease of goods or services from a person that is chartered by a state or federal agency and that is subject to regular examination by, and reporting to, that agency.

Local Government Code § 176.003(a)(2)(A) and (B):

(a) A local government officer shall file a conflicts disclosure statement with respect to a vendor if:

***

(2) the vendor:

(A) has an employment or other business relationship with the local government officer or a family member of the officer that results in the officer or family member receiving taxable income, other than investment income, that exceeds $2,500 during the 12-month period preceding the date that the officer becomes aware that

(i) a contract between the local governmental entity and vendor has been executed; or

(ii) the local governmental entity is considering entering into a contract with the vendor;

(B) has given to the local government officer or a family member of the officer one or more gifts that have an aggregate value of more than $100 in the 12-month period preceding the date the officer becomes aware that:

(i) a contract between the local governmental entity and vendor has been executed; or

(ii) the local governmental entity is considering entering into a contract with the vendor.

Local Government Code § 176.006(a) and (a-1)

(a) A vendor shall file a completed conflict of interest questionnaire if the vendor has a business relationship with a local governmental entity and:

(1) has an employment or other business relationship with a local government officer of that local governmental entity, or a family member of the officer, described by Section 176.003(a)(2)(A);

(2) has given a local government officer of that local governmental entity, or a family member of the officer, one or more gifts with the aggregate value specified by Section 176.003(a)(2)(B), excluding any gift described by Section 176.003(a-1); or

(3) has a family relationship with a local government officer of that local governmental entity.

(a-1) The completed conflict of interest questionnaire must be filed with the appropriate records administrator not later than the seventh business day after the later of:

(1) the date that the vendor:

(A) begins discussions or negotiations to enter into a contract with the local governmental entity; or

(B) submits to the local governmental entity an application, response to a request for proposals or bids, correspondence, or another writing related to a potential contract with the local governmental entity; or

(2) the date the vendor becomes aware:

(A) of an employment or other business relationship with a local government officer, or a family member of the officer, described by Subsection (a);

(B) that the vendor has given one or more gifts described by Subsection (a); or

(C) of a family relationship with a local government officer.

Form provided by Texas Ethics Commission www.ethics.state.tx.us Revised 11/30/2015

CONTRACT CHANGES GRID

The Contractor has the obligation to review all documents that make up the contract documents in their entirety and include any objections or requests for modifications to the Terms and Conditions, or any of the Contract Documents, in the Contract Changes Grid included with the Notice to Bidders. No changes or modifications will be made to the contract documents unless such changes are set forth in the Contract Changes Grid, submitted to the City along with the Contractor's proposal, and agreed to by the City.

CONTRACT CHANGES GRID

Proposed Contractor/Bidder _____ ("Contractor" or "Bidder"), submits the following modifications to the City's Standard _____ ("Agreement") requesting changes to such provisions be accepted by the City and incorporated into the Agreement. Contractor understands and acknowledges that the City is under no obligation to accept the modification(s) proposed by Contractor; however, the City agrees to negotiate in good faith in consideration of Contractor's request, subject to legal requirements, City policies and advice of the City Attorney.

Section / Page	**Term, Condition or Specification**	**Exception/Proposed Modification**	**Disposition (For City of NRH Use Only)**
			City Response: ____ Accepted ____ Not Accepted ____ Modified

SECTION II

BIDDING DOCUMENTS

NOTICE TO BIDDERS

UPLOADED BIDS on forms prepared by the Engineer will be received until 2:00PM on Wednesday, June 30th, 2021 for furnishing all labor, material, equipment and the performance of all work required for:

CONN PUMP STATION
REHABILITATION PROJECT

COMPLETED BID FORMS DOCUMENTS MUST BE SUBMITTED ELECTRONICALLY VIA: www.publicpurchase.com at which time and place the bids will be publicly opened, read aloud and retained by the Public Works Department for tabulation, checking and evaluation. The "as read" bid results will be posted on www.publicpurchase.com

COMPLETED BID FORMS shall be accompanied by a Bid Guaranty consisting of either a cashier's check or a Bid Bond on the form included or similar form of Surety Company (FACISIMILES WILL NOT BE CONSIDERED RESPONSIVE) made payable to The City of North Richland Hills, and in the amount of five percent (5%) of the total amount of the largest amount bid as a guarantee that if the bid is accepted, the bidder will execute the Contract and furnish the required Bonds, within the time-frame indicated in the Bid Form, to the City of North Richland Hills.

BIDDERS should carefully examine the plans, specifications and other documents; visit the site of the work; fully inform themselves as to all conditions and matters that can in any way affect the work or the costs thereof. Should a bidder find discrepancies or omissions from the plans, specifications or any other documents or should he/she be in doubt as to the meaning, he/she should at once notify the Purchasing Manager and obtain clarification prior to submitting any bid.

PLANS AND SPECIFICATIONS can be downloaded from ***Public Purchase*** (see below).

A NON-MANDATORY PRE-BID CONFERENCE will be held at **1:00 p.m. on Wednesday, June 16, 2021**, at **the existing pump station site 7800 Conn Dr. North Richland Hills, Texas** keeping in accordance with the latest CDC guidelines.

PUBLIC PURCHASE: Bidders are encouraged to register with the City of North Richland Hills Purchasing Manager, Scott Kendall, via email at purchasing@nrhtx.com. All Bidders who have registered with Public Purchase (http://www.publicpurchase.com) will receive automatic email notifications pertaining to this Bid, such as addendums and other related information released subsequent to the initial release of plans, specifications, bid forms, and contract documents. **It is the sole responsibility of the Bidder to register as a planholder with the City of North Richland Hills. Questions pertaining to this project should be submitted via Public Purchase where the bid is advertised.**

Minimum wage rates to all laborers and mechanics on the project must not be less than as provided in the Contract Documents and Wage Provisions must particularly comply with all other applicable wage laws of the State of Texas.

The right is reserved, as the interest of the City of North Richland Hills may require, to reject any and all bids, to waive any informality in the bids received, and to select a bid best suited to the City of North Richland Hills' best interest.

In case of ambiguity or lack of clearness in stating bid prices, the City of North Richland Hills reserves the right to adopt the most advantageous construction thereof, or to reject any or all bids. No bid may be withdrawn within sixty (60) days after the date on which bids are opened.

SUMMARY OF WORK includes rehabilitation to the existing Conn Pump Station including (3) new, 200 hp, 2,600 gpm horizontal split case pumps, (3) variable frequency drives, HVAC improvements, miscellaneous piping and structural demolition, mechanical piping and valve improvements, site improvements, miscellaneous structural and electrical improvements, and all other improvements detailed in the in the Drawings and Specifications.

CITY OF NORTH RICHLAND HILLS

Scott Kendall
Purchasing Manager

ADVERTISEMENT DATES:

- **JUNE 11, 2021**
- **JUNE 13, 2021**

SPECIAL INSTRUCTIONS TO BIDDERS

1. BID SECURITY:

A certified check or cashier's check or acceptable bidder's bond made payable to the City of North Richland Hills, Texas, in an amount of five percent (5%) of the bid submitted must accompany each bid as a guarantee that if awarded the contract, the bidder will promptly enter into a contract and execute such bonds as are required.

2. QUALIFICATION OF BIDDERS:

No pre-qualification of bidders is required. However, in consideration of the bids, the City of North Richland Hills may require bidders to furnish a written experience record and a financial statement or the most recent audited financial statement of the firm. The City of North Richland Hills reserves the right to use these items of data to influence a decision as to the award of the contract. Bidders need not submit a statement of financial condition unless requested to do so by the City of North Richland Hills. Contractors are required to submit the Experience and Current Workload pages shown on pages I-9, 10, and 11, showing that the following items will be met:

- At a minimum, the general contractor shall show minimum 3 projects in similar size and scope completed within the last 10 years and provide reference contact information.

- The subcontractor responsible for SCADA integration shall have worked directly with the City of North Richland Hills within the last 3 years and have direct knowledge of the current SCADA programming. The electrical subcontractor will need to be a registered contractor and pull and electrical permit for the work. The following subcontractors are pre-approved:
    - WHECO Controls of Fort Worth, Texas

3. CONFLICT OF INTEREST QUESTIONNAIRE:

Bidders are required to complete the Conflict of Interest Questionnaire and to submit this completed form along with their bid form documents.

4. WAGE RATES:

Attention is called to the fact that not less than the prevailing wage rates as hereinafter set forth in the Special Provisions of these Contract Documents, which are made a part hereof, must be paid on this project.

5. PRE-BID CONFERENCE:

A pre-bid conference will be held at 1:00 p.m. on Wednesday, June 16, 2021, at the existing pump station site located at 7800 Conn Drive.

6. BONDS:

A performance bond and a payment bond, each in the amount of not less than one hundred percent (100%) of the contract price, conditioned upon the faithful performance of the contract and upon payment of all persons supplying labor or furnishing materials, will be required on this project. Additionally, a two (2) year maintenance bond, in the amount of not less than twenty percent (20%) of the final contract price, will be required on this project.

7. POWER OF ATTORNEY:

Attorneys-in-Fact who sign bid bonds or contract bonds must file with each bond a certified and current copy of their power of attorney.

8. STANDARD SPECIFICATIONS:

All work required by this project shall be in accordance with the “Public Works Design Manual” adopted by the City of North Richland Hills and the “Public Works Construction Standards - North Central Texas” adopted by the North Central Texas Council of Governments (NCTCOG), Fifth Edition (November 2017), except as modified in the Contract Documents. Where a conflict exists between the “Public Works Design Manual” and the “Public Works Construction Standards - North Central Texas”, the “Public Works Design Manual” shall govern. Copies of both of these standards are included in the Contract Documents by reference and are made a part thereof. Omission of any section from this project's Contract Documents does not mean that such section is not applicable to this project.

9. UNIT PRICE CONTRACT:

The contract for this project is a "Unit Price" Contract. As such, the City of North Richland Hills reserves the right to add and/or delete quantities to specific pay items. The City of North Richland Hills may further delete an entire unit price pay item if the City of North Richland Hills desires. The City of North Richland Hills reserves the right to increase or decrease the amount of work to be done by any amount not to be exceeded by twenty-five percent (25%) of the original contract amount. In the event the increase pertains to items not originally bid, the Contractor shall submit a bid in writing to the City of North Richland Hills for approval.

It is further agreed that lump sum prices may be increased to cover additional work ordered by the City of North Richland Hills but not shown on the plans or required by the specifications, in accordance with the provisions of the general conditions; similarly, lump sum prices may be decreased to cover deletion of work so ordered.

The City of North Richland Hills reserves the right to reject the Contractor's bid on such extra work and secure such work to be done other than by said Contractor.

10. MEASUREMENT AND PAYMENT:

The basis of payment for the pay items noted in the proceeding pages shall be full compensation for furnishing all labor, materials, equipment and incidentals required to complete the work as specified and as shown in the project plans/drawings. Any item of work not specifically listed for payment but required by the project documents shall be considered an incidental item of the project and no specific payment will be made.

11. LIQUIDATED DAMAGES FOR FAILURE TO ENTER INTO CONTRACT:

The successful bidder, upon his/her failure or refusal to execute and deliver the contract and bonds required within ten (10) days after he/she has received notice of the acceptance of his/her bid, shall forfeit to the Owner, as liquidated damages for such failure or refusal, the security deposited with his/her bond.

12. CONDITIONS OF WORK / OBLIGATION OF BIDDER:

Each bidder must inform himself/herself fully of the conditions relating to the construction of the project and the employment of labor thereon. Failure to do so will not relieve a successful bidder of his/her obligation(s) to furnish all material, labor, equipment and incidentals necessary to carry out the provisions of this contract. Insofar as possible, the Contractor, in carrying out his/her work, must employ such methods or means as will not cause any interruption of or interference with the work of any other contractor or City of North Richland Hills public employees.

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 plans and Contract Documents (including all addenda). The failure or omission of any bidder to examine any form, instrument, or documents shall in no way relieve the bidder from any obligation in respect to his/her bid.

13. ADDENDA AND INTERPRETATIONS:

Bidders wanting further information, interpretation or clarification of the Contract

Documents must make their request in writing to Scott Kendall, Purchasing Manager by 12:00pm (noon) CST on Friday, June 25, 2021. Answers to all such requests will be made a part of the Contract Documents. No other explanation or interpretation will be considered official or binding.

Should a bidder find discrepancies in, or omission from the Contract Documents, or should he/she be in doubt as to their meaning, he/she should at once notify Scott Kendall, Purchasing Manager in order that a written addendum may be sent to all bidders. Any addenda issued will be mailed or be delivered to each prospective bidder. The bid form as submitted by the bidder must be so constructed as to include any addenda issued by the City prior to 24 hours of the opening bids, with the appropriate recognition of addenda so noted in the bid form.

No interpretation of the meaning of plans, specifications or other pre-bid documents will be made to any bidder orally. Every request for such interpretation shall be in writing, addressed to Scott Kendall, Purchasing Manager or directly through Public Purchase and to be given consideration, must be received by 12:00PM (noon) on Friday, June 25, 2021. Any and all such interpretations and any supplemental instructions will be in the form of written addenda to the specifications and plans which, if issued, will be published on Public Purchase, not later than three (3) days prior to the date fixed for opening of bids. Failure of any bidder to receive any such addendum or interpretation shall not relieve the bidder from any obligation under his/her bid submitted. All addenda shall become part of the Contract Documents.

14. LAWS AND REGULATIONS:

The bidder's attention is directed to the fact that all applicable State laws, municipal ordinances 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 herein written out in full.

15. SUBMITTALS:

Prior to any construction commencing on this project the Contractor shall submit the required submittals to the City Engineer and have his approval for all such submittals as required in the Technical Specifications.

FINANCIAL STATEMENT

Condition of Bidder at close of Business month, _____, 20___

		ASSETS	LIABILITIES
1.	Cash on Hand	$ _____	$ _____
	Cash in Bank	$ _____	$ _____
	Cash Elsewhere	$ _____	$ _____
2.	Accounts receivable from completed contracts (exclusive of claims not approved for payment)	$ _____	$ _____
3.	Accounts receivable from other sources than above	$ _____	$ _____
4.	Amounts earned on uncompleted contracts (not included in Item 3) (Contract price on completed portion of uncompleted contracts less total cost of completed portion)	$ _____	$ _____
5.	Deposits for bids on other guarantees		$ _____
6.	Notes Receivable Past Due	$ _____	
	Due 90 days	$ _____	
	Due Later	$ _____	
7.	Interest Earned	$ _____	
8.	Real Estate, Business Property, present value	$ _____	
	Other property, present value	$ _____	$ _____
9.	Stocks and Bonds, Listed on Exchange	$ _____	$ _____
	Unlisted	$ _____	$ _____
10.	Equipment, Machinery, Fixtures	$ _____	$ _____
	Less Depreciation	$ _____	$ _____
11.	Other Assets	$ _____	
	TOTAL ASSETS	$ _____	$ _____

LIABILITIES AND NET WORTH

		ASSETS	LIABILITIES
1.	Notes Payable to Banks Regular	$ _____	
	(For Certified Checks)	$ _____	
	Equipment Obligations	$ _____	
	Others	$ _____	$ _____
2.	Accounts Payable Current	$ _____	
	Past Due	$ _____	
3.	Real Estate Mortgages	$ _____	$ _____
4.	Other Liabilities		$ _____
5.	Reserves	$ _____	
6.	Capital Stock Paid Up		
	Common	$ _____	
	Preferred	$ _____	
7.	Surplus	$ _____	
	TOTAL LIABILITIES	$ _____	$ _____

EXPERIENCE RECORD

List of Projects your Organization has successfully completed:

Amount of Contract Award	Type of Work	Date Accepted	Name and Address of Owner

List of Projects your Organization is now engaged in completing:

Amount of Contract Award	Type of Work	Anticipated Date of Completion	Name and Address of Owner

List of Surety Bonds in Force on above Uncompleted Work:

Date of Contract Award	Type of Bond	Amount of Bond[1]	Name and Address of Surety

List every type of bond separately. If one project has more than one type of bond, list each and every bond for that project on a separate line.

EQUIPMENT SCHEDULE

List of Equipment owned by bidder that is in serviceable condition and available for use:

Portions of work Bidder proposes to sublet if Awarded the Contract including amount and type:

BID FORM

FOR

CONN PUMP STATION REHABILITATION
PROJECT

FOR THE

CITY OF NORTH RICHLAND HILLS, TEXAS

(THIS BID FORM MUST BE COMPLETED IN ITS ENTIRETY, SUBMITTED IN ITS ENTIRETY AND NOT REMOVED FROM THE CONTRACT DOCUMENTS)

Bid Opening Date: 2:00PM (CST), June 30th, 2021

TO: City of North Richland Hills
4301 City Point Drive
North Richland Hills, Texas 76180

FOR: CONN PUMP STATION REHABILITATION PROJECT

Pursuant to the foregoing "Notice to Bidders", the undersigned bidder, having thoroughly examined the Contract Documents, the site of the project and understanding the amount of work to be done and the prevailing conditions, hereby proposes to fully complete all of the work and requirements as provided in the plans and Contract Documents and binds himself/herself upon acceptance of this bid form to execute a contract and furnish such bonds as required and proposes to complete the work within the time stated and for the following prices:

BASE BID – CONN PUMP STATION REHABILITATION PROJECT

Project Item Information					Bidder's Proposal	
Bid list Item No.	Description	Specification Section No.	Unit of Measure	Bid Quantity	Unit Price	Bid Value
1	Mobilization, Bonding, Insurance	Special Provisions	LS	1		
2	Three (3) 2,600 GPM pumps, Ductile Iron Piping, Valves, Electrical, HVAC, Site Work, and all other appurtenances on Drawings	Multiple	LS	1		
3	SCADA and Instrumentation	Multiple	LS	1		
4	Trench Safety Plan	33 05 05	LS	1		
5	Trench Safety Implementation	33 05 05	LF	232		
6	Miscellaneous Utility Allowance	01 29 73	LS	1	$50,000	$50,000
7	Miscellaneous Paving Allowance	01 29 73	LS	1	$10,000	$10,000
8	Miscellaneous Landscape Allowance	01 29 73	LS	1	$10,000	$10,000
					TOTAL BASE BID	

BID SCHEDULE

TOTAL BASE BID – **$**_____

(Total Amount Base Bid, Numerical Value)

The undersigned bidder acknowledges receipt of the following Addenda: **(If none is received, then write NONE across the blanks.)**

Addendum No. 1 - Date Received _____

Addendum No. 2 - Date Received _____

Addendum No. 3 - Date Received _____

Addendum No. 4 - Date Received _____

The undersigned bidder agrees to execute and file with the Owner a contract and bonds on the forms provided within ten (10) days after written notification of award of the contract to him and to begin the work to be performed under the contract within ten (10) days after written authorization to begin the work (Work Order) and to complete the work in full within **365 Consecutive Calendar Days** after the date specified in the "Notice to Proceed". See contract for additional schedule / time requirements.

Enclosed with this bid form is a certified check or cashier's check or bid bond payable to the City of North Richland Hills in the amount of five percent (5%) of the total bid, which is to become the property of the City of North Richland Hills, or the attached Bidder's Bond is to be forfeited in the event the contract and bond are not executed within the time set forth, as liquidated damages for delay and additional work caused thereby.

Respectfully Submitted,

Signed: _____

Company: _____

Address: _____

_____

_____ SEAL
(If Bidder is a Corporation)

Telephone: _____

Fax: _____

Submitted by: _____ an individual
A partnership
A corporation

Doing Business As: _____

SECTION III

CONTRACTUAL DOCUMENTS

STANDARD FORM OF CONSTRUCTION AGREEMENT

THE STATE OF TEXAS §
§
COUNTY OF TARRANT §

THIS AGREEMENT is entered into this the ___ day of _____, 20___, by and between the CITY NORTH RICHLAND HILLLS, a municipal corporation, of the County of Tarrant and State of Texas, hereinafter called "OWNER" and of the City of _____, County of _____ and State of _____ hereinafter called "CONTRACTOR."

OWNER and CONTRACTOR in consideration of the mutual covenants contained in this Agreement, agree as follows:

ARTICLE 1. WORK.

CONTRACTOR covenants and agrees to perform the Work in every detail, in a good and first-class workmanlike manner as specified and indicated in the Contract Documents, of which are incorporated in this Agreement in their entirety as if they were herein set out at length written word for word. The CONTRACTOR shall furnish all labor, materials, tools and equipment required to perform and complete the Work in strict accordance with these Contract Documents. The Work is described as follows:

CONN PUMP STATION REHABILITATION PROJECT

ARTICLE 2. CONTRACT PRICE.

OWNER agrees to pay CONTRACTOR for completion of the Work in accordance with the Contract Documents, the price or prices shown in the bidder's proposal, which total the following amount:

_____ DOLLARS AND _____ CENTS ($ _____) (“Contract Price”).

ARTICLE 3. CONTRACT TIME / TERMINATION / LIQUIDATED DAMAGES.

Unless otherwise stated in this agreement, **time shall be considered of the essence.**

a. When **time is of** the essence, the CONTRACTOR shall be liable for failure to deliver or delay in delivery occasioned by and including without limitation strikes, lock-outs, inability of obtaining material or shopping space, breakdowns, delays of carriers or suppliers, and preexisting governmental acts and regulations of the Federal and State governments or any subdivision thereof, unless such governmental acts and regulations affecting delivery could not be found, recognized, or discovered by due diligence on the part of the CONTRACTOR prior to submission of his/her bid and City Council's acceptance thereof.

b. When **time is not of** the essence, this agreement shall be inoperative during such period of time that aforesaid delivery or acceptance may be rendered impossible by reason of fire, strike, Acts of God, or government regulation. Provided, however, to the extent that the CONTRACTOR has any commercially reasonable alternative method of performing this contract by purchase on the market or otherwise, he/she shall not be freed of his/her obligation hereunder by this clause, even though the goods intended for this contract were destroyed or their delivery delayed because of any event described above.

c. **As time is of the essence on this contract**, CONTRACTOR agrees to commence work under this contract within ten (10) days from the date specified in the "Notice to Proceed" and to totally complete work within **365** consecutive calendar days after the date specified in the "Notice to Proceed," subject to such extensions of time as are indicated in the Special Provisions.

d. Milestones included in this contract are as follows:
   1) When 30% of the contract time has elapsed, Contractor shall have confirmed the electrical service requirements and location with Oncor.
   2) When 50% of the contract time has elapsed, all yard piping installation shall be complete up to the points of connections.
   3) When 60% of the contract time has elapsed, all pumps shall have been delivered to the site.
   4) When 70% of the contract time has elapsed, the new electrical room and panels (including new service) shall be near completion.

   Calendar Days is defined as any day of the week or month; no days being excepted, such as, Saturdays, Sundays, holidays and inclement weather days. Counting of contract time will only be stopped when the Owner issues a written notice stating this fact, or when the project is noted as substantially complete by written notice from the Owner. OWNER shall determine when such action is necessary.

   Extensions of time due to weather delays shall be determined in accordance with the following formula:

   $E = R - P$ where R is greater than or equal to P, and

E = Extra Precipitation Days
P = Average Precipitation Days
R = Total Precipitation Days

Average Precipitation Days (P) is defined as a day of rain, sleet, hail, snow or any combination thereof, and shall be based upon the average precipitation for each month of the year as defined in the Local Climatological Data summaries issued by the National Climatic Data Center in Asheville, North Carolina, and for this contract shall be as follows:

Average Precipitation

Month	Jan	Feb	Mar	Apr	May	June
Number of Days	6	6	7	7	8	6
Month	July	Aug	Sept	Oct	Nov	Dec
Number of Days	4	4	6	6	6	6

Partial months shall be prorated uniformly for the entire month and the sum of all the months used will be rounded to the nearest whole number. This number shall be P.

Total Precipitation Days (R) is defined as a day of rain, sleet, hail, snow or any combination thereof, if determined by the Owner's Project Representative that the Contractor's construction cannot progress substantially due to precipitation and thus be put in the Daily Inspection Logs as a precipitation day. The sum of all precipitation says shall be R.

The total number of Extra Precipitation Days (E) shall be granted to the Contractor as extension of time due to weather delays, and no additional time due to drying time for saturated soil will be allowed. This contract time is both multi-tiered and cumulative.

e. **Liquidated Damages.** The CONTRACTOR further agrees to pay the following as liquidated damages:

(1) $2,160 per Calendar Day for any unfinished work beyond 365 consecutive calendar days after the “Notice to Proceed” issuance date. This rate shall continue until such time that the Project is complete and accepted by the OWNER

(2) It is understood between the parties hereto that these sums shall be treated

as liquidated damages and not as a penalty, and the OWNER may withhold from the CONTRACTOR's compensation such sums as liquidated damages.

The parties consider the CONTRACTOR's failure to complete performance of the entire contract within the 365th calendar day after the "Notice to Proceed" date a substantial breach of this agreement, and the amount of liquidated damages set forth herein is a reasonable and fair estimate of just compensation for CONTRACTOR's failure to timely perform the contract.

If there is any conflict between any provision of this Article 3, and any other Provision in this agreement, or in any attachment hereto or any other Contract Document, this Article 3 shall control.

ARTICLE 4. PARTIAL PAYMENT.

OWNER shall make payments to the CONTRACTOR in the following manner. On or about the first of each month, the OWNER, or the OWNER's Authorized Representative, will make accurate estimates of the value, based on contract prices, of the work done and materials incorporated in the work and of materials suitably stored at the site during the preceding calendar month. The CONTRACTOR shall furnish to the OWNER, or the OWNER's Representative, such detailed information as the OWNER may request to aid OWNER as a guide in the preparation of the monthly estimate.

Within the following thirty (30) days, OWNER shall make partial payments to the CONTRACTOR for work performed during the preceding calendar month as estimated by the OWNER or OWNER's Representative. Ten percent (10%) of each estimate shall be retained by the OWNER until final completion and acceptance of all work covered by the Contract for contracts less than four hundred thousand dollars ($ 400,000). Five percent (5%) of each estimate shall be retained by the OWNER until final completion and acceptance of all work covered by the Contract for contracts greater than four hundred thousand dollars ($ 400,000). Upon completion and acceptance of all work in compliance with the Contract, the OWNER shall, within thirty (30) days, pay the CONTRACTOR the balance due under the terms and conditions of the Contract.

It is understood that the monthly estimates shall be approximate only, and all monthly estimates and partial payments shall be subject to correction in the estimate rendered following the discovery of an error in any previous estimate, and such estimate shall not in any respect be taken as an admission of the OWNER of the amount of work done or of its quality or sufficiency nor as an acceptance of the work or the release of the CONTRACTOR of any of its responsibility under the Contract.

ARTICLE 5. DISCRIMINATION.

The CONTRACTOR agrees, in connection with the performance of work under this contract as follows:

a. The CONTRACTOR will not discriminate against any employee or applicant for employment because of race, creed, color, sex, religion, national origin or ancestry. Such actions shall include, but not be limited to, the following: employment, upgrading, demotion or transfer, recruiting or recruitment, advertising, layoff, termination, rates of pay or other forms of compensation and selection for training, including apprenticeship.

b. The CONTRACTOR agrees to include this non-discrimination clause in any subcontracts connected with the performance of this agreement.

c. In the event of the CONTRACTOR's non-compliance with the above non-discrimination clause, the contract may be canceled or terminated by the OWNER. The CONTRACTOR may be declared by the OWNER to be ineligible for future contracts with the OWNER, until satisfactory proof of intent to comply shall be made by the CONTRACTOR.

d. The OWNER shall be provided a list of subcontractors who are to be paid $10,000 or more. The CONTRACTOR must ensure that such subcontractors meet the requirements as outlined in Title VI of the Civil Rights Act of 1964 (42 USC 2000d et seq), execute required assurances and provide the OWNER a copy of the signed assurance of all such subcontractors prior to final payment. In the event of a claim of $10,000 or more against the CONTRACTOR by a subcontractor under this section, no further payment shall be processed unless and until each required subcontractor assurance is provided the OWNER.

ARTICLE 6. ENTIRE CONTRACT.

This Contract and Agreement contains the entire understanding and agreement of the parties upon the subject matter hereof. There is no agreement, oral or otherwise, which is not set forth in writing as part of this Agreement or the Contract Documents.

ARTICLE 7. MODIFICATION.

This contract cannot be modified except by a writing signed by both parties.

ARTICLE 8. VARIABLES IN COST.

The parties hereto assume and understand that the variables in the CONTRACTOR's cost of performance may fluctuate; consequently, the parties

hereto agree that any fluctuations in the CONTRACTOR's costs will in no way alter the CONTRACTOR's obligations under this contract nor excuse nonperformance or delay on his/her part.

ARTICLE 10. VENUE.

This contract shall be governed by the laws of the State of Texas. Venue for any court proceedings shall be in Tarrant County, Texas.

ARTICLE 11. CONTRACT DOCUMENTS.

Documents Listed. The Contract Documents which comprise the entire agreement between OWNER and CONTRACTOR for the performance of and payment for the Work, consist of the following:

(1) This Agreement
(2) Addendum(s)
(3) "Notice to Bidders" advertisement
(4) Bidder's Proposal
(5) Special Instruction to Bidders
(6) Performance, Payment and Maintenance Bonds
(7) Certification of Insurance
(8) Notice to Proceed
(9) Technical Specifications
(10) City of North Richland Hills' Public Works Design Manual
(11) Special Provisions
(12) Project Construction Plans/Drawings
(13) Special Material and/or Equipment Specifications
(14) Special Material and/or Equipment Drawings
(15) "Public Works Construction Standards - North Central Texas" adopted by the North Central Texas Council of Governments (NCTCOG), October 2017 Edition
(16) North Central Texas Council of Government references

ARTICLE 11. DEFAULT

OWNER may declare CONTRACTOR in default of this Contract in the event Contractor fails to comply with the terms and conditions set forth in this Contract or any of the Contract Documents.

ARTICLE 12. SUBCONTRACTORS

Any subcontractor who furnishes labor or materials to fulfill an obligation to CONTRACTOR under this Contract or who performs all or part of the work required by this Contract, must comply with all notice and filing requirements of Texas Property Code, Chapter 53 in order to perfect a mechanic's, contractor's or materialman's lien. If a subcontractor complies with Chapter 53 of the Texas Property Code, Owner shall be authorized to withhold payment from the CONTRACTOR for payment of the claim. Owner shall release any such payment to the CONTRACTOR upon written notice and sufficient documentation to Owner from subcontractor that the claim has been paid or otherwise settled.

IN TESTIMONY WHEREOF, the CITY OF NORTH RICHLAND HILLS has caused this instrument to be signed in its corporate name, and on its behalf by the Mayor or City Manager, duly authorized to execute this instrument by action of the City Council and_____ a corporation, partnership, individual
(Name of Contractor) ***("X" out the inappropriate wording)***
acting by and through its duly authorized officials, thereby binding themselves for the faithful and full performance of the terms and provisions of this Agreement.

CITY OF NORTH RICHLAND HILLS:

By: _____

Mark Hindman

City Manager

Date: _____

CONTRACTOR:

By: _____

Name: _____

Title: _____

Date: _____

ATTEST:

By: _____

Alicia Richardson

City Secretary

ATTEST:

By: _____

Name: _____

Title: _____

APPROVED TO FORM AND LEGALITY:

By: _____

Maleshia B. McGinnis, City Attorney

Bond No. _____

PERFORMANCE BOND

STATE OF TEXAS §

KNOW ALL MEN BY THESE PRESENTS:

COUNTY OF TARRANT §

THAT _____, a corporation organized and existing under the laws of the State of _____, and fully authorized to transact business in the State of Texas, whose address is _____of the City of _____, County of _____, and State of _____, (hereinafter referred to as "Principal"), and_____ (hereinafter referred to as "Surety"), a corporation organized under the laws of the State of_____ and authorized under the laws of the State of Texas to act as surety on bonds for principals, are held and firmly bound unto THE CITY OF NORTH RICHLAND HILLS (hereinafter referred to as "Owner") in the penal sum _____ DOLLARS AND CENTS ($XXX,XXX.00) [not less than 100% of the approximate total amount of the contract as evidenced in the bid proposal] in lawful money of the United States, for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors, and assigns, jointly and severally, firmly by these presents:

WHEREAS, the Principal has entered into a certain written Contract with the Owner, dated the _____ day of _____, 20___, to which said Contract is hereby referred to and made a part hereof and as fully and to the same extent as if copied at length herein for the construction of:

CONN PUMP STATION REHABILITATION PROJECT
Dated as of _____, 2021

NOW, THEREFORE, the condition of this obligation is such, that if the said Principal fully and faithfully executes the work and performance of the Contract in accordance with the plans, specifications and Contract Documents, including any extensions thereof which may be granted with our without notice to Surety, during the original term thereof, and during the life of any guaranty required under the Contract, and according to the true intent and meaning of said Contract and the plans and specifications hereto annexed, if the Principal shall repair and/or replace all defects due to faulty materials or workmanship that appear within a period of two years from the date of final completion and final acceptance of the work by owner; and if the Principal shall fully indemnify and save harmless the Owner from all costs and damages which Owner may suffer by reason of failure to so perform herein and shall fully reimburse and repay Owner all outlay and expense which the Owner may incur in making good any default or deficiency, then this obligation shall be void; otherwise, to remain in full force and effect; and in case said contractor shall fail to do so, it is agreed that the Owner may do said work and supply such materials and charge the same against said contractor and Surety on this obligation.

In the event that the Principal is declared in default under the said Contract by Owner, the Surety will within fifteen (15) days of Owner’s declaration of such default take all action necessary to take over the project from Contractor and assume completion of said Contract. The Surety shall become entitled to the payment of the balance of the Contract Price upon the Surety's faithful performance of its obligations under this bond.

The Surety agrees to pay to Owner, upon demand, all loss and expense, including reasonable attorney's fees, incurred by Owner by reason of or on account of any breach of this obligation by the Surety.

Provided further, that if any legal action be filed on this Bond, venue shall lie in Tarrant County, Texas.

PROVIDED, HOWEVER, that this Bond is executed pursuant to the provisions of Texas Government Code, Chapter 2253, as amended, and Article 7.19-1 of the Insurance Code, as amended, and all liabilities on this Bond shall be determined in accordance with the provisions of said articles to the same extent as if they were fully copied at length herein.

Surety, for value received, stipulates and agrees that the Bond shall automatically be increased by the amount of any Change Order or supplemental agreement with increases the Contract price with or without notice to the Surety, but in no event shall a Change Order or supplemental agreement which reduces the Contract price decrease the penal sum of this Bond. And further that no change, extension of time, alteration, or addition to the terms of the Contract, or to the work performed thereunder, or the plans, specifications, or drawings accompanying the same shall in any way affect its obligation on this Bond, and it does hereby waive notice of any such change, extension of time alteration, or addition to the terms of the Contract or to the work to be performed thereunder.

Surety agrees that this Bond provides for the repairs and/or replacement of all defects due to faulty materials and workmanship that appear within a period of two (2) years from the date of completion and acceptance of the improvement by the Owner.

The undersigned and designated agent is hereby designated by Surety herein as the agent resident to whom any requisite notice may be delivered and on whom service of process may be had in matters arising out of such suretyship.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument on this the ___ day of _____, 20___.

(Company Name of Principal)	*(Company Name of Surety)*
(Signature)	*(Signature)*
(Printed Name)	*(Printed Name)*
(Title)	*(Title)*
(Address Line 1)	*(Address Line 1)*
(Address Line 2)	*(Address Line 2)*
(City, State and Zip Code)	*(City, State and Zip Code)*
(Witness)	*(Witness)*

The name and address of the Resident Agent of Surety is:

(Name)

(Address Line 1)

(Address Line 2)

(City, State and Zip Code)

(Telephone Number)	*(Fax Number)*

Bond No. _____

PAYMENT BOND

STATE OF TEXAS §
§ KNOW ALL MEN BY THESE PRESENTS:
COUNTY OF TARRANT §

THAT _____, a corporation organized and existing under the laws of the State of _____, and fully authorized to transact business in the State of Texas, whose address is _____of the City of _____, County of _____, and State of _____, (hereinafter referred to as "Principal"), and _____(hereinafter referred to as "Surety"), a corporation organized under the laws of the State of_____ and authorized under the laws of the State of Texas to act as surety on bonds for principals, are held and firmly bound unto THE CITY OF NORTH RICHLAND HILLS (hereinafter referred to as "Owner") and unto all persons, firms and corporations who may furnish materials for or perform labor upon the buildings, structures or improvements referred to in the attached Contract, in the penal sum DOLLARS AND CENTS ($XXX,XXX.00) [not less than 100% of the approximate total amount of the Contract as evidenced in the bid proposal] in lawful money of the United States, for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors, and assigns, jointly and severally, firmly by these presents:

WHEREAS, the Principal has entered into a certain written Contract with the Owner, dated the _____ day of _____, 20__, to which said Contract is hereby referred to and made a part hereof and as fully and to the same extent as if copied at length herein for the construction of:

CONN PUMP STATION REHABILITATION PROJECT

Dated as of _____, 2021

NOW, THEREFORE, the condition of this obligation is such, that the Bond guarantees the full and proper protection of all claimants supplying labor and material in the prosecution of the work provided for in said Contract and for the use of each claimant, and that conversely should the Principal faithfully perform said Contract and in all respects duly and faithfully observe and perform all and singular the covenants, conditions, and agreements in and by said Contract, agreed to by the Principal, and according to the true intent and meaning of said Contract and the claims and specifications hereto annexed, and any and all duly authorized modifications of said Contract that may hereafter be made, notice of which modification to Surety being hereby waived, then this obligation shall be void; otherwise, to remain in full force and effect. Provided further, that if any legal action be filed on this Bond, venue shall lie in Tarrant County, Texas.

PROVIDED, HOWEVER, that this Bond is executed pursuant to the provisions of Texas Government Code, Chapter 2253, as amended, and Article 7.19-1 of the Insurance Code, as amended, and all liabilities on this Bond shall be determined in accordance with the provisions of said articles to the same extent as if they were fully copied at length herein.

Surety, for value received, stipulates and agrees that the Bond shall automatically be increased by the amount of any Change Order or supplemental agreement with increases to the Contract price with or without notice to the Surety and that no change, extension of time, alteration, or addition to the terms of the Contract, or to the work performed thereunder, or the plans, specifications, or drawings accompanying the same shall in any way affect its obligation on this Bond, and it does hereby waive notice of any such change, extension of time, alteration, or addition to the terms of the Contract or to the work to be performed thereunder.

The undersigned and designated agent is hereby designated by Surety herein as the agent resident to whom any requisite notice may be delivered and on whom service of process may be had in matters arising out of such suretyship.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument on this the ___ day of _____, 20___.

(Company Name of Principal)	*(Company Name of Surety)*
(Signature)	*(Signature)*
(Printed Name)	*(Printed Name)*
(Title)	*(Title)*
(Address Line 1)	*(Address Line 1)*
(Address Line 2)	*(Address Line 2)*
(City, State and Zip Code)	*(City, State and Zip Code)*
(Witness)	*(Witness)*

The name and address of the Resident Agent of Surety is:

(Name)

(Address Line 1)

(Address Line 2)

(City, State and Zip Code)

(Telephone Number)	*(Fax Number)*

Bond No. _____

MAINTENANCE BOND

STATE OF TEXAS **§**
§ KNOW ALL MEN BY THESE PRESENTS:
COUNTY OF TARRANT **§**

THAT _____, a corporation organized and existing under the laws of the State of _____, and fully authorized to transact business in the State of Texas, whose address is _____of the City of _____, County of _____, and State of _____, (hereinafter referred to as "Principal"), and_____ (hereinafter referred to as "Surety"), a corporation organized under the laws of the State of _____ and authorized under the laws of the State of Texas to act as surety on bonds for principals, are held and firmly bound unto THE CITY OF NORTH RICHLAND HILLS (hereinafter referred to as "Owner") in the penal sum of DOLLARS AND /100 CENTS ($) in lawful money of the United States, for the payment whereof, the said Principal and Surety bind themselves, and their heirs, administrators, executors, successors, and assigns, jointly and severally, firmly by these presents:

WHEREAS, the Principal has entered into a certain written Contract with the Owner, dated the _____ day of _____, 20___, to which said Contract is hereby referred to and made a part hereof and as fully and to the same extent as if copied at length herein for the construction of:

CONN PUMP STATION REHABILITATION PROJECT

Dated as of _____, 2021

The maintenance under this Bond contemplates the complete restoration of the work to a functional use if that should be necessary. It is the intended purpose of this bond to require the correction of all defective conditions resulting from materials furnished or work and labor performed by the Contractor under the Contract; and in case the Contractor or Surety shall fail or refuse to commence and actively pursue such corrections within ten (10) days after written notification has been furnished to them by the Owner, it is agreed that the Owner may do the work and supply such materials and the Contractor and Surety shall be liable for the payment of all costs thereby incurred, jointly and severally.

It is further understood and agreed that the obligation under this bond shall be a continuing one against the Contractor and Surety, and that successive recoveries may be had hereon for successive breaches until the full amount shall have been exhausted. It is further understood that the obligation to maintain the work shall continue throughout the maintenance period, and the same shall not be changed, diminished, or in any manner affected from any cause during that time.

NOW, THEREFORE, the condition of this obligation is such, that the Bond guarantees the full and proper maintenance and repair of the work herein contracted to be done and performed for a period of two (2) years from the date of acceptance and Principal will do all necessary backfilling that may arise on account of sunken conditions in ditches, or otherwise, and do and perform all necessary work and repair any defective condition growing out of or arising from the improper laying or construction of same, or on account of any breaking of same caused by said Contractor in construction of same, or account of any defect arising in any of said work laid or constructed by said Contractor or on account of improper excavation or backfilling, it being understood that the purpose of this section is to cover all defective conditions arising by reason of defective materials, work or labor performed by said Contractor, then this obligation shall be void; otherwise, to remain in full force and effect; and in case said Contractor shall fail to do so, it is agreed that the Owner may do said work and supply such materials and charge the same against said Contractor and Surety on this obligation. Provided further, that if any legal action be filed on this Bond, venue shall lie in Tarrant County, Texas.

The Owner shall be entitled to its reasonable attorneys' fees and costs in any legal proceeding to enforce the Owner's rights under this bond.

PROVIDED, HOWEVER, that said Surety, for value received, stipulates and agrees that the Bond shall automatically be increased by the amount of any Change Order or supplemental agreement with increases the Contract price with or without notice to the Surety and that no change, extension of time, alteration, or addition to the terms of the Contract, or to the work performed thereunder, or the plans, specifications, or drawings accompanying the same shall in any way affect its obligation on this Bond, and it does hereby waive notice of any such change, extension of time, alteration, or addition to the terms of the Contract or to the work to be performed thereunder.

The undersigned and designated agent is hereby designated by Surety herein as the agent resident to whom any requisite notice may be delivered and on whom service of process may be had in matters arising out of such suretyship.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument on this the ___ day of _____, 20___.

(Company Name of Principal)	*(Company Name of Surety)*
(Signature)	*(Signature)*
(Printed Name)	*(Printed Name)*
(Title)	*(Title)*
(Address Line 1)	*(Address Line 1)*
(Address Line 2)	*(Address Line 2)*
(City, State and Zip Code)	*(City, State and Zip Code)*
(Witness)	*(Witness)*

The name and address of the Resident Agent of Surety is:

_____
(Name)

_____
(Address Line 1)

_____
(Address Line 2)

_____
(City, State and Zip Code)

_____ _____
(Telephone Number) *(Fax Number)*

NOTE: Date of Maintenance Bond must not be prior to date of Contract.
Power of Attorney must be attached.
Amount and Term of Maintenance Bond shall be as stated in the "Special Conditions".

CONTRACTOR'S RELEASE TO CITY

TO: CITY OF NORTH RICHLAND HILLS

RE: **CONN PUMP STATION REHABILITATION PROJECT**

This is to certify that _____, by acceptance
(NAME OF CONTRACTOR)
of this final payment, hereby releases the OWNER, the City of North Richland Hills, from all claims and all liabilities of the City of North Richland Hills for all things done or furnished in connection with work on this project and further releases the City of North Richland Hills from any and all liabilities arising from any act of the OWNER or his/her agent arising in connection with this project. This release in no way operates to release the CONTRACTOR or his/her Surety from any obligations under this contract or the bond tendered pursuant thereto.

_____
(NAME OF CORPORATION)

_____
(AUTHORIZED AGENT)

CORPORATION ACKNOWLEDGMENT

STATE OF TEXAS §
§
COUNTY OF _____ §

BEFORE ME, the undersigned authority in and for Tarrant County, Texas, on this day personally appeared _____ known to me to be the person and officer whose name is subscribed to the foregoing instrument and acknowledged to me that he/she is the _____ of the said _____, a corporation, and that he/she is authorized by said corporation to execute the foregoing instrument as the act of such corporation for the purposes and consideration therein expressed, and in the capacity therein stated.

CONTRACTOR'S RELEASE TO CITY *(Continued)*

GIVEN UNDER MY HAND AND SEAL OF OFFICE, this the _ day of _____, 20 ____.

_____ _____

(Notary Public in and for the State of Texas) *(Type or Print Notary's Name)*

My Commission Expires: _____

CONTRACTOR'S AFFIDAVIT OF FINAL PAYMENT

STATE OF TEXAS §
§
COUNTY OF TARRANT §

BEFORE ME, the undersigned authority, on this day personally appeared _____, (hereinafter referred to as "Affiant"), who,
(NAME)

after being by me duly sworn, deposes and says that he/she is the _____
(TITLE)
_____ of _____ (a
(NAME OF COMPANY)

corporation, partnership, trade name) of _____ County, State of
("X" OUT THE INCORRECT)

Texas (hereinafter referred to as "Contractor"), which said Contractor was awarded the contract dated the _____ day of _____, 2020, for the construction of the **CONN PUMP STATION REHABILITATION PROJECT** (hereinafter referred to as the "Work"), for a total consideration of and XX/100 Dollars ($ XXX,XXX.00) to be paid to the said Contractor (the "Contract"), and that Affiant has full power of authority to make this affidavit.

That THE CITY OF NORTH RICHLAND HILLS, (hereinafter referred to as "Owner"), has approved the final estimate on said Work, and that the said Contractor has fully satisfied and paid any and all claims that may be covered by Texas Government Code, Chapter 2253, as amended, or any other applicable statutes or charter provisions, and that all just bills for labor and materials have been paid and discharged by said Contractor insofar as they pertain to the Work in question.

That in addition to any funds which may have been previously paid by the Owner, the Contractor hereby accepts the amount of and ___/100 Dollars ($_____) as **FULL AND FINAL PAYMENT** under the aforementioned Contract resulting in a total revised contract amount Of and __/100 Dollars ($ _____), and hereby waives and releases any right Affiant and/or the Contractor may have to pursue claims of any nature against the Owner arising out of or in any manner connected with the performance of the Work and/or the Contract, including but not limited to claims of third parties that supplied material and/or labor for the Work for or through the Contractor (hereinafter referred to as "Subcontractors"), as well as claims for delay, additional compensation or for recovery of liquidated damages which may have been withheld by the Owner. The Contractor shall defend, hold harmless and indemnify the Owner from any such claims of such Subcontractors. The Contractor further releases the Owner from any claim or liability arising from any act of negligence of the Owner related to or connected with the Contract. This affidavit is given pursuant to the final payment provisions of the Contract, and shall not be deemed to alter or modify the terms and provisions of said Contract.

This affidavit is made in compliance with the law and in compliance especially with Chapter 2253 of the Texas Government Code, as amended, and that the undersigned, upon his/her oath, states that the facts indicated in the above instrument of writing are true and correct and that he/she is not incapacitated an any way from making this affidavit.

WITNESS my hand this the _____ day of _____, 20___.

_____
(Affiant)

_____
(Printed Name)

SUBSCRIBED AND SWORN TO BEFORE ME, this the ____ day of _____, 20 _____.

_____ _____
(Notary Public in and for the State of Texas) *(Type or Print Notary's Name)*

My Commission Expires: _____

SECTION IV

TECHNICAL SPECIFICATIONS

SECTION 01 11 00
SUMMARY OF WORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. Summary of Work to be performed in accordance with the Contract Documents the project.
   (a) The Work includes rehabilitation to the existing Conn Pump Station including (3) 200 hp, 2,600 gpm horizontal split case pumps, (3) variable frequency drives, HVAC improvements, miscellaneous piping and structural demolition, mechanical piping and valve improvements, site improvements, miscellaneous structural and electrical improvements, and all other improvements detailed in the in the Drawings and Specifications.

B. Related Specification Sections include but are not necessarily limited to

1. Bidding Requirements, Contract Forms, and Conditions/Provisions of the Contract.
2. Division 1 - General Requirements.

1.2 REFERENCES [NOT USED]

1.3 ADMINISTRATIVE REQUIREMENTS

A. Work Covered by Contract Documents

1. Work is to include furnishing all labor, materials, and equipment, and performing all Work necessary for this construction project as detailed in the Drawings and Specifications.

B. Subsidiary Work

1. Any and all Work specifically governed by documentary requirements for the project, such as conditions imposed by the Drawings or Contract Documents in which no specific item for bid has been provided for in the Proposal and the item is not a typical unit bid item included on the standard bid item list, then the item shall be considered as a subsidiary item of Work, the cost of which shall be included in the price bid in the Proposal for various bid items.

C. Examination of the Site

1. Visit the site, to compare drawings and specifications with any work in place, and observe all site conditions, including other work, if any, is being performed. Failure to visit the site shall not relieve the Contractor from the necessity of furnishing materials or performing work required to complete work in accordance with the Contract Documents.

D. Use of Premises

1. Coordinate uses of premises under direction of the City.
2. Assume full responsibility for protection and safekeeping of materials and equipment stored on the Site.

E. Partial Owner Occupancy

1. The City reserves the right to take possession and use any completed or partially completed portion of the Work regardless of the time of completion of the Work, providing it does not interfere with the Contractor's work. Such possession or use of the Work shall not be construed as final acceptance of the project or any portion thereof.

1.4 SUBMITTALS [NOT USED]

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE [NOT USED]

1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10 FIELD CONDITIONS [NOT USED]

1.11 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION [NOT USED]

END OF SECTION

SECTION 01 22 00
MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 SUMMARY

A. This Section stipulates the method of measurement and payment for items of Work for which Unit Prices and Lump Sum Prices are stated in the Bid Form.

1.2 REFERENCES

A. Reference Section 01 29 73.

1.3 SCOPE OF PAYMENT

A. Units of measurement of items of Work for which Unit and/or Lump Sum Prices are stated will be as herein subsequently defined.

B. The estimated quantities for items of Work for which Unit Prices are given in the Bid Form are subject to variation, and payment shall be based upon the final measurement of the items of work actually installed and approved by the Owner for payment.

C. Prices bid shall include the work not specifically set forth as an individual payment item. These items are considered to be a subsidiary obligation of the Contractor and the costs for these items shall be included in the bid prices.

1.4 MEASUREMENT AND PAYMENT PROCEDURES

A. Measurement and Payment

1. Contractor will be paid according to the approved schedule of values per section 01 29 73.

B. Base Bid:

1. Item No. 1 – Mobilization, Bonding, Insurance

   Payment will be made at the Lump Sum price or as each as the work progresses. Mobilization is calculated on the base bid only and will not be paid for separately on any additive alternate items added to the contract.

2. Item No. 2 – Pump Station

   Payment will be made at the Lump Sum price for the complete construction of the Conn Pump Station Rehabilitation, to include three (3) 2,600 GPM pumps, 3 VFDs, Ductile Iron Piping (interior and yard piping), Valves, Electrical, HVAC, Ventilation, Site Work, and all other appurtenances and services required in accordance with the Contract Documents, plans and specifications for the Project.

3. Item No. 3 – SCADA and Instrumentation

   Payment will be at the Lump Sum price for the complete construction of the instrumentation and SCADA system in accordance with the Contract Documents, plans and specifications for the Project.

4. Item No. 4 – Trench Safety Plan

Payment will be made at the Lump Sum price to complete all trench safety related with the construction of the Conn Pump Station Rehabilitation and all appurtenances in accordance with plans and specifications for the Project.

5. Item No. 5 – Trench Safety Implementation

   Payment will be made at the price per Linear Feet to complete all trench safety implementation as pertains to the Trench Safety Plan and in accordance with plans and specifications for the Project.

6. Item No. 6 – Miscellaneous Utility Allowance

   Payment will be made on a case-by-case as needed basis for any Utility work (including but not limited to mobile pumping due to loss of water service/pumping capabilities) not covered by the previously listed items after discussion with and approval from Owner or Owner's Representative.

7. Item No. 7 – Miscellaneous Paving Allowance

   Payment will be made on a case-by-case as needed basis for any Paving work not covered by the previously listed items after discussion with and approval from Owner or Owner's Representative.

8. Item No. 8 – Miscellaneous Landscape Allowance

   Payment will be made on a case-by-case as needed basis for any Landscape work not covered by the previously listed items after discussion with and approval from Owner or Owner's Representative.

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION [NOT USED]

END OF SECTION

SECTION 01 25 00
SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. The procedure for requesting the approval of substitution of a product that is not equivalent to a product which is specified by descriptive or performance criteria or defined by reference to 1 or more of the following:
      a. Name of manufacturer
      b. Name of vendor
      c. Trade name
      d. Catalog number
   2. Substitutions are not "or-equals".

B. Related Specification Sections include but are not limited to:
   1. Bidding Requirements, Contract Forms, and Conditions/Provisions of the Contract.
   2. Division 1 - General Requirements.

1.2 REFERENCES [NOT USED]

1.3 ADMINISTRATIVE REQUIREMENTS

A. Request for Substitution - General
   1. Within 30 days after award of Contract (unless noted otherwise), the Engineer will consider formal requests from Contractor for substitution of products in place of those specified.
   2. Certain types of equipment and kinds of material are described in Specifications by means of references to names of manufacturers and vendors, trade names, or catalog numbers.
      a. When this method of specifying is used, it is not intended to exclude from consideration other products bearing other manufacturer's or vendor's names, trade names, or catalog numbers, provided said products are "or-equals," as determined by City.
   3. Other types of equipment and kinds of material may be acceptable substitutions under the following conditions:
      a. Or-equals are unavailable due to strike, discontinued production of products meeting specified requirements, or other factors beyond control of Contractor; or,
      b. Contractor proposes a cost and/or time reduction incentive to the City.

1.4 SUBMITTALS

A. See Request for Substitution Form (attached)

B. Procedure for Requesting Substitution
   1. Substitution shall be considered only:
      a. After award of Contract

b. Under the conditions stated herein

2. Submit electronic copy of each request for substitution, including:
   a. Documentation
      1) Complete data substantiating compliance of proposed substitution with Contract Documents.
      2) Data relating to changes in construction schedule, when a reduction is proposed
      3) Data relating to changes in cost
   b. For products:
      1) Product identification
         a) Manufacturer's name
         b) Telephone number and representative contact name
         c) Specification Section or Drawing reference of originally specified product, including discrete name or tag number assigned to original product in the Contract Documents
      2) Manufacturer's literature clearly marked to show compliance of proposed product with Contract Documents
      3) Itemized comparison of original and proposed product addressing product characteristics including, but not necessarily limited to:
         a) Size
         b) Composition or materials of construction
         c) Weight
         d) Electrical or mechanical requirements
      4) Product experience
         a) Location of past projects utilizing product
         b) Name and telephone number of persons associated with referenced projects knowledgeable concerning proposed product
         c) Available field data and reports associated with proposed product
      5) Samples
         a) Provide at request of City.
         b) Samples become the property of the City.
3. For construction methods:
   a. Detailed description of proposed method.
   b. Illustration drawings.

C. Approval or Rejection
1. Written approval or rejection of substitution given by the City
2. City reserves the right to require proposed product to comply with color and pattern of specified product if necessary to secure design intent.
3. In the event the substitution is approved, the resulting cost and/or time reduction will be documented by Change Order in accordance with the General Conditions/Provisions.
4. No additional contract time will be given for substitution.
5. Substitution will be rejected if:
   a. Submittal is not through the Contractor with his stamp of approval
   b. Request is not made in accordance with this Specification Section
   c. In the City's opinion, acceptance will require substantial revision of the original design
   d. In the City's opinion, substitution will not perform adequately the function consistent with the design intent

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE

A. In making request for substitution, Contractor represents that the Contractor:
   1. Has investigated proposed product, and has determined that it is adequate or superior in all respects to that specified, and that it will perform function for which it is intended
   2. Will provide same guarantee for substitute item as for product specified
   3. Will coordinate installation of accepted substitution into Work, to include building modifications if necessary, making such changes as may be required for Work to be complete in all respects
   4. Waives all claims for additional costs related to substitution which subsequently arise
   5. Cost data is complete and includes all related costs under Contract, excluding Engineer's redesign.

1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10 FIELD [SITE] CONDITIONS [NOT USED]

1.11 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION [NOT USED]

END OF SECTION

EXHIBIT A
REQUEST FOR SUBSTITUTION FORM:

TO:_____

PROJECT:_____ DATE:_____

We hereby submit for your consideration the following product instead of the specified item for the above project:

SECTION PARAGRAPH SPECIFIED ITEM

_____

Proposed Substitution: _____

Reason for Substitution: _____

Include complete information on changes to Drawings and/or Specifications which proposed substitution will require for its proper installation.

Fill in Blanks Below:

A. Will the undersigned contractor pay for changes to the building design, including engineering and detailing costs caused by the requested substitution?

_____

B. What effect does substitution have on other trades?

_____

C. Differences between proposed substitution and specified item?

_____

D. Differences in product cost or product delivery time?

_____

E. Manufacturer's guarantees of the proposed and specified items are:

_____ Equal _____ Better (explain on attachment)

The undersigned states that the function, appearance and quality are equivalent or superior to the specified item.

Submitted By:

Signature _____

Firm _____

Address _____

Date _____

Telephone _____

For Use by Engineer

___ Recommended
___ Recommended as noted

___ Not recommended ___Received late

By _____

Date _____

Remarks _____

For Use by Engineer:

_____Approved _____ Rejected

Project Engineer _____ Date_____

SECTION 01 29 73
SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. General requirements for the preparation, submittal, updating, status reporting and management of the Schedule of Values

B. Related Specification Sections include, but are not necessarily limited to:
   1. Bidding Requirements, Contract Forms and Conditions/Provisions of the Contract
   2. Division 1 – General Requirements

1.2 REFERENCES

A. Reference Section 01 22 00.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Measurement and Payment
   1. Unless noted otherwise in the Bid Form, measurement and payment for all items is by Lump Sum and shall be considered subsidiary to the structure or items being placed and include full compensation for the associated work. No other compensation will be allowed.

B. Schedule of Values
   1. General
      a. The Schedule of Values shall incorporate all work performed and the materials furnished in accordance with these Specifications.
      b. Prepare a schedule of values in conjunction with the preparation of the progress schedule.
         1) Coordinate preparation of schedule of values and progress schedule.
      c. Correlate line items with other administrative schedules and the forms required for the work, including the progress schedule, payment request form, listing of subcontractors, schedule of allowances, schedule of alternatives, listing of products and principal suppliers and fabricators, and the schedule of submittals.
      d. Provide breakdown of the Contract Sum with sufficient detail to facilitate continued evaluation of payment requests and progress reports.
         1) Break down principal subcontract amounts into several line items in accordance with section measurement and payment.
      e. Round off to the nearest whole dollar, but with the total equal the Contract Sum.

1.4 SUBMITTALS

A. Schedule of Values
   1. Submit Schedule of Values in native file format and pdf format.

2. Submit Schedule of Values monthly in accordance with the required progress payment schedule.

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE

A. The person preparing and revising the schedule of values shall be experienced in the preparation of schedules of similar complexity.

B. Schedule and supporting documents addressed in this Specification shall be prepared, updated and revised to accurately reflect the performance of the construction.

C. Contractor is responsible for the quality of all submittals in this section meeting the standard of care for the construction industry for similar projects.

1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10 FIELD CONDITIONS [NOT USED]

1.11 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION [NOT USED]

END OF SECTION

SECTION 01 31 20
PROJECT MEETINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Provisions for project meetings throughout the construction period to enable orderly review of the progress of the Work and to provide for systematic discussion of potential problems

B. Related Specification Sections include but are not limited to:
   1. Bidding Requirements, Contract Forms, and Conditions/Provisions of the Contract.
   2. Division 1 - General Requirements.

1.2 REFERENCES [NOT USED]

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination
   1. Schedule, attend and administer as specified, periodic progress meetings, and specially called meetings throughout progress of the Work.
   2. Representatives of Contractor, subcontractors and suppliers attending meetings shall be qualified and authorized to act on behalf of the entity each represents.
   3. Meetings administered by City may be tape recorded.
      a. If recorded, tapes will be used to prepare minutes and retained by City for future reference.
   4. Meetings, in addition to those specified in this Section, may be held when requested by the City, Engineer or Contractor.

B. Preinstallation Meetings
   1. Where required in individual specification section, convene a pre-installation conference at project site or other designed location.
   2. Require attendance of parties directly affecting or affected by work of the specific Section.
   3. Notify all parties to attend at least four (4) days in advance of meeting.
   4. Review conditions of installation, preparation and installation procedures, and coordination with related work.

C. Project Meetings
   1. Formal project coordination meetings will be held periodically. Meetings will be scheduled and administered by the City or Engineer.
   2. Additional progress meetings to discuss specific topics will be conducted on an as-needed basis. Such additional meetings shall include, but not be limited to:
      a. Coordinating shutdowns
      b. Installation of piping and equipment
      c. Coordination between other construction projects

d. Resolution of construction issues
e. Equipment approval

3. The Project Representative will preside at progress meetings, prepare the notes of the meeting and distribute copies of the same to all participants who so request by fully completing the attendance form to be circulated at the beginning of each meeting.

4. Attendance shall include:
   a. Contractor's project manager
   b. Contractor's superintendent
   c. Any subcontractor or supplier representatives whom the Contractor may desire to invite or the City may request
   d. Engineer's representatives
   e. City’s representatives
   f. Others, as requested by the City.

5. Preliminary Agenda may include:
   a. Review of Work progress since previous meeting
   b. Field observations, problems, conflicts
   c. Items which impede construction schedule
   d. Review of off-site fabrication, delivery schedules
   e. Review of construction interfacing and sequencing requirements with other construction contracts
   f. Corrective measures and procedures to regain projected schedule
   g. Revisions to construction schedule
   h. Progress, schedule, during succeeding Work period
   i. Coordination of schedules
   j. Review submittal schedules
   k. Maintenance of quality standards
   l. Pending changes and substitutions
   m. Review proposed changes for:
      1) Effect on construction schedule and on completion date
      2) Effect on other contracts of the Project
   n. Review Record Documents
   o. Review monthly pay request
   p. Review status of Requests for Information

6. Meeting Schedule
   a. Project meetings will be held monthly, or as needed based on the work being performed at the time.
      1) Additional meetings may be held at the request of the:
         a) City
         b) Engineer
         c) Contractor

7. Meeting Location
   a. The City will establish a meeting location.
      1) To the extent practicable, meetings will be held at the Site.

1.4 SUBMITTALS [NOT USED]

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE [NOT USED]

1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10 FIELD CONDITIONS [NOT USED]

1.11 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION [NOT USED]

END OF SECTION

SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. General requirements for the preparation, submittal, updating, status reporting and management of the Construction Progress Schedule

B. Related Specification Sections include, but are not necessarily limited to:
   1. Bidding Requirements, Contract Forms and Conditions/Provisions of the Contract
   2. Division 1 – General Requirements

1.2 REFERENCES

A. Definitions
   1. **Baseline Schedule** - Initial schedule submitted before work begins that will serve as the baseline for measuring progress and departures from the schedule.
   2. **Progress Schedule** - Monthly submittal of a progress schedule documenting progress on the project and any changes anticipated.
   3. **Schedule Narrative** - Concise narrative of the schedule including schedule changes, expected delays, key schedule issues, critical path items, etc

1.3 ADMINISTRATIVE REQUIREMENTS

A. Baseline Schedule
   1. General
      a. Review the draft cost-loaded baseline Schedule with the City to demonstrate understanding of the work to be performed and known issues and constraints related to the schedule.
      b. Designate an authorized representative (Project Scheduler) responsible for developing and updating the schedule and preparing reports.

B. Progress Schedule
   1. Update the progress Schedule monthly
   2. Prepare the Schedule Narrative to accompany the monthly progress Schedule.
   3. Change Orders
      a. Incorporate approved change orders, resulting in a change of contract time, in the baseline Schedule.

C. Responsibility for Schedule Compliance
   1. Whenever it becomes apparent from the current progress Schedule and CPM Status Report that delays to the critical path have resulted and the Contract completion date will not be met, or when so directed by the City, make some or all of the following actions at no additional cost to the City
      a. Submit a Recovery Plan to the City for approval revised baseline Schedule outlining:

1) A written statement of the steps intended to take to remove or arrest the delay to the critical path in the approved schedule
2) Increase construction manpower in such quantities and crafts as will substantially eliminate the backlog of work and return current Schedule to meet projected baseline completion dates
3) Increase the number of working hours per shift, shifts per day, working days per week, the amount of construction equipment, or any combination of the foregoing, sufficiently to substantially eliminate the backlog of work
4) Reschedule activities to achieve maximum practical concurrency of accomplishment of activities, and comply with the revised schedule

2. If no written statement of the steps intended to take is submitted when so requested by the City, the City may direct the Contractor to increase the level of effort in manpower (trades), equipment and work schedule (overtime, weekend and holiday work, etc.) to be employed by the Contractor in order to remove or arrest the delay to the critical path in the approved schedule.
   a. No additional cost for such work will be considered.

D. Coordinating Schedule with Other Contract Schedules

1. Where work is to be performed under this Contract concurrently with or contingent upon work performed on the same facilities or area under other contracts, the Baseline Schedule shall be coordinated with the schedules of the other contracts.
   a. Obtain the schedules of the other appropriate contracts from the City for the preparation and updating of Baseline schedule and make the required changes in his schedule when indicated by changes in corresponding schedules.
2. In case of interference between the operations of different contractors, the City will determine the work priority of each contractor and the sequence of work necessary to expedite the completion of the entire Project.
   a. In such cases, the decision of the City shall be accepted as final.
   b. The temporary delay of any work due to such circumstances shall not be considered as justification for claims for additional compensation.

1.4 SUBMITTALS

A. Baseline Schedule

1. Submit Schedule in native file format and pdf format.
   a. Native file format includes:
      1) Primavera (P6 or Primavera Contractor)
      2) Microsoft Project
2. Submit draft baseline Schedule to City prior to the pre-construction meeting and bring in hard copy to the meeting for review and discussion.

B. Progress Schedule

1. Submit progress Schedule in native file format and pdf format.
2. Submit progress Schedule monthly no later than the last day of the month.

C. Schedule Narrative

1. Submit the schedule narrative in pdf format.
2. Submit schedule narrative as requested by the City.

D. Submittal Process

1. Contractor shall submit documents as required.
2. Once the project has been completed and Final Acceptance has been issued by the City, no further progress schedules are required.

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE

A. The person preparing and revising the construction Progress Schedule shall be experienced in the preparation of schedules of similar complexity.

B. Schedule and supporting documents addressed in this Specification shall be prepared, updated and revised to accurately reflect the performance of the construction.

C. Contractor is responsible for the quality of all submittals in this section meeting the standard of care for the construction industry for similar projects.

1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10 FIELD CONDITIONS [NOT USED]

1.11 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION [NOT USED]

END OF SECTION

SECTION 01 32 30
PRECONSTRUCTION VIDEO

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for:
      a. Preconstruction Videos

B. Related Specification Sections include, but are not necessarily limited to:
   1. Bidding Requirements, Contract Forms and Conditions/Provisions of the Contract
   2. Division 1 – General Requirements

1.2 REFERENCES [NOT USED]

1.3 ADMINISTRATIVE REQUIREMENTS

A. Preconstruction Video
   1. Produce a preconstruction video of the site/alignment, including all areas in the vicinity of and to be affected by construction.
      a. Provide digital copy of video upon request by the City.
   2. Retain a copy of the preconstruction video until the end of the maintenance surety period.

1.4 SUBMITTALS [NOT USED]

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE [NOT USED]

1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10 FIELD [SITE] CONDITIONS [NOT USED]

1.11 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION [NOT USED]

END OF SECTION

SECTION 01 45 29
TESTING AND LABORATORY SERVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
   1. Provide testing and inspecting, complete, as described in this Section and elsewhere in the Contract Documents.

B. Related Specification Sections include but are not necessarily limited to
   1. Bidding Requirements, Contract Forms, and Conditions/Provisions of the Contract.
   2. Division 1 - General Requirements.

1.2 REFERENCES [NOT USED]

1.3 ADMINISTRATIVE REQUIREMENTS

A. Complete testing in accordance with the Contract Documents.

B. The Contractor shall employ and pay for an independent testing laboratory, APPROVED BY THE CITY, to perform testing of construction materials. Contractor shall submit the name of the testing laboratory prior to beginning of Work.

C. Contractor Shall coordinate all testing activities and shall assist in whatever manner necessary so that the testing laboratory may provide all testing services.

D. All re-testing costs for failed testing shall be at the expense of the Contractor.

E. The City's Representative may initiate any test.

F. The Contractor shall notify the assigned City Public Works Construction Inspector of all density testing 24 hours prior to the scheduled test. Copies of all test reports shall be sent to the Public Works Inspector for review and acceptance and inclusion in the City project file. Projects will not receive City acceptance until all test results are complete and satisfactory.

G. Materials and products incorporated in the Work, shall be inspected, tested and approved by the Contractor. Tests by the Contractor, Subcontractors or by Suppliers shall be performed by certified technicians using certified laboratories. Laboratory technicians shall hold current certification in accordance with ASTM E 329, Standard Practice for Use in Evaluation of Testing and Inspection Agencies as Used in Construction or have a nationally recognized certification acceptable to the Engineer. Work in which materials are used without prior test and approval may be ordered removed and replaced at the Contractor’s expense. The Contractor will be required to furnish such facilities and equipment as may be necessary to perform the tests and inspection and shall be responsible for calibration of all test equipment required. When requested, the Contractor shall furnish a complete written statement of the origin, composition, and/or manufacture of any or all materials that are to be used in the Work.

H. Contractor shall have testing laboratory include requested City personnel on email distribution list for all test reports. Testing reports must be submitted within five days after the test has been made. Construction shall not proceed where materials are to be placed upon materials previously placed and these previously placed materials have not been tested or the test results have not been made available to the Engineer.

I. The most current specifications for all specifications listed herein shall govern testing methods.

1.4 SUBMITTALS [NOT USED]

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE

A. Qualifications of Laboratory
   1. Meet ACIL requirements referenced.
   2. Meet basic requirements of ASTM E 329.
   3. Authorized to operate in State in which project is located.
   4. Meet minimum requirements specified in other sections of the Contract Documents.

B. Provide the services of a soils Engineer and a testing laboratory pre-approved by the Engineer and City.

C. Provide all tests and inspections required by governmental agencies having jurisdiction, required by provisions of the Contract Documents, and such other tests and inspections as are directed by the Engineer.

1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10 FIELD CONDITIONS [NOT USED]

1.11 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED OR OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 PRODUCT TYPES [NOT USED]

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL

A. City Testing and Inspection
   1. The City reserves the option to have an independent testing laboratory to perform weld tests as well as coating tests associated with the ground storage tank, at the City's expense.
      a. This does not alleviate the Contractor of his responsibility to test these items.

b. In the event of any conflicting testing data between City's laboratory and the Contractor's laboratory, the City shall have the sole authority to determine which results will be utilized. Any additional testing associated with conflicting data between testing laboratories shall be at the Contractor's expense; no additional payment will be made.

B. Notify Laboratory sufficiently in advance of operations to allow for Laboratory assignment of personnel and scheduling of tests.

C. Make arrangements with Laboratory and pay for additional samples and tests required for Contractor's convenience.

D. Standard Test Methods for Compaction and Moisture Content of Soil

1. Moisture and Compaction Testing Standards: Testing laboratory shall sample, test in laboratory, and test in field moisture content and compaction per the following ASTM designations:
   a. D-698 - Moisture Density Relations of Soil and Soil Aggregate Mixtures.
   b. D-6938 - Density, in Place, by Nuclear Methods Shallow Depth Test.
   c. D-4318 - Liquid Limit Plastic Limit and Plasticity Index of Soils Test.
   d. D-1140 - Material Greater than #200 Sieve.
   e. D-2487 - Unified Soil Classification System
2. Test Report: Laboratory shall provide both field and final copies of test results to the Engineer, Owner and other parties as directed by the Contractor.

E. Standard Test Methods for Concrete and Coring

1. Concrete
   a. Samples shall be drawn from mid-load or from point of discharge if concrete is pumped. Sampling and making of cylinders shall conform to ASTM C-172 and ASTM C-31, respectively.
   b. Field Test Methods: For concrete, laboratory shall perform field test(s) and provide the following information for each set of cylinders or beam:
      1) Contractor's name.
      2) Name of project.
      3) Exact location and description of area where concrete was placed.
      4) Date of sampling.
      5) Concrete supplier.
      6) Concrete batch design number.
      7) Minimum required strength.
      8) Ambient temperatures.
      9) Concrete temperature.
      10) Weather condition; e.g., raining, windy, cloudy, sunny, etc.
      11) Truck number.
      12) Ticket number.
      13) Any admixtures.
      14) Slump per ASTM C-143; visual inspection will not be accepted.
      15) Air content in percent per ASTM C-231.
   c. Tests and Standards for Concrete:
      1) ASTM C-172 - Sampling of Freshly Mixed Concrete.
      2) ASTM C-31 - Making and Curing of Concrete Test Specimens in the Field.
      3) ASTM C-143 - Slump of Portland Cement Concrete.
      4) ASTM C-231 - Concrete Air Content by Pressure Method (for Fresh Concrete) Test.

5) ASTM C-39 - Concrete, Cylindrical, Compressive Strength Test.
6) ASTM C-793 - Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center Point Loading.)
7) ASTM A-1064 Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete

2. Aggregate
   a. Provide one test unless character of material changes, material is substituted, or additional test is requested by the Engineer.
   b. Sample from conveyor belts or batching gates at the ready-mix plant:
      1) Sieve analysis to determine compliance with specified standards and grading;
      2) Specific gravity test for compliance with specified standards.
3. Laboratory Design Mix
   a. After approval of aggregate, and whenever character or source of materials is changed, provide mix design in accordance with ACI 613.
   b. Provide designs for all mixes prepared by a licensed civil Engineer.
4. Coring
   a. Tests and Standards for Concrete Coring:
      1) Samplings and tests of concrete cores shall conform to ASTM C-42 - Obtaining and Testing Drilled Cores Sawed Beams of Concrete.
      2) Should coring be required to demonstrate acceptable thickness, measuring of concrete cores shall conform to ASTM C-174 - Measuring Length of Drilled Concrete Cores.
      3) Testing for Comprehensive Strength shall be in accordance with ASTM C-39 Concrete Cylindrical Strength Test.
5. Molded Concrete Cylinders
   a. Provide four test cylinders for each 50 cu.yds. or fraction thereof, of each class of concrete of each day's placement.
   b. Test one cylinder at (7) seven days, two at (28) twenty-eight days, and one when so directed.
   c. Report the mix, slump, location of concrete in the structure, and test results prior to the addition of any plasticizers.
   d. Take specimens and make tests in accordance with the applicable ASTM standard specifications.
6. Placement Inspections:
   a. On concrete over 2,000 psi, provide continuous or other inspection as required by governmental agencies having jurisdiction.
   b. Throughout progress of concrete placement, make slump tests to verify conformance with specified slump.
   c. Using all required personnel and equipment, throughout progress of concrete placement verify that finished concrete surfaces will have the level or slope that is required by the Contract Documents.

F. Masonry
   1. Provide mortar testing per ASTM C-270.

G. Steel
   1. Inspection of Structural Steel:
      a. Inspect structural steel during fabrication and during and after erection for conformance with Contract Documents and Shop Drawings.

b. Inspect shop and field welds including certification of welders.
c. Visually inspect check welds for size and appearance.
d. No burning or other field corrections of steel members are permitted without express permission of the ENGINEER. Immediately report violations.

H. Inspecting Bolting
1. Visually examine joints to determine that bolts and washers are properly installed and have been tensioned.
2. Check tightness of bolts by using a calibrated torque wrench.
3. Torque wrench test two bolts in each connection, but not less than 10% of bolts.

I. Inspection of Open Web Steel Joists
1. Inspect erection of open web steel joists for conformance with Contract Documents.

J. Inspection of Metal Deck
1. Inspect all metal deck for proper installation. Include correct welds and lapping of deck.

K. Standard Test Methods for Water Systems
1. Bacterial Sampling
a. The City Public Works Construction Inspector shall supervise the taking of water samples from a suitable tap (not through a fire hydrant) for analysis by the North Texas Municipal Water District laboratory. The sample(s) shall be transported by City staff to the laboratory at 9:00 AM on Tuesdays and Thursdays. Samples may not be taken earlier than 3:00 PM on the day prior to delivery. The City Public Works Construction Inspector shall notify the Contractor of the results.
b. Microbiological sampling shall be done prior to connecting the new conduit into the existing distribution system in accordance with AWWA C651 Disinfecting Water Mains. Samples shall be tested in accordance with ***Standard Methods for the Examination of Water and Wastewater***. Samples for bacteriological analysis shall be collected in sterile bottles treated with sodium thiosulfate. At least one sample shall be collected from every 1,000-linear-feet of new water conduit, plus one set from the end of the line and at least one set from each branch. If trench water has entered the new conduit during construction or, if in the opinion of the City inspector, excessive quantities of dirt or debris have entered the new conduit, samples shall be taken at intervals of approximately 200-linear-feet. Samples shall be taken of water that has been in the new conduit for at least 16-hours.
c. Unsatisfactory test results shall require a repeat of the disinfection process and resampling as required above until a satisfactory sample is obtained.
d. In the event there are two unsatisfactory test results from the same sampling point, the Contractor must “poly-pig” the new water main and samples taken again until a satisfactory sample is obtained.
2. Hydrostatic (Pressure) Test
a. Hydrostatic testing shall be performed in accordance with Section 33 01 10.

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION [NOT USED]

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

A. Field Tests and Inspections

1. Contractor shall be responsible for all testing associated with the project. Cost associated with testing shall be included in the Contractor's bid and shall be considered subsidiary to the various pay items shown in the Bid Proposal.

B. Non-Conforming Work

1. When initial tests indicate non-compliance with the Contract Documents, the Contractor will be required to perform additional tests until the test indicate the work is in compliance with the Contract Documents. All additional tests associated with failing tests shall be at the expense of the Contractor, no additional payment will be made.

C. Manufacturer Services

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Provide temporary facilities and controls needed for the Work including, but not necessarily limited to:
   a. Temporary utilities such as water, electricity, and telephone
   b. Sanitary Facilities
   c. Field office and sheds
   d. Enclosures such as tarpaulins, barricades, and canopies
   e. Temporary fencing of the construction site
   f. Dust control

B. Related Specification Sections include but are not limited to:

1. Bidding Requirements, Contract Forms, and Conditions/Provisions of the Contract.
2. Division 1 - General Requirements.
3. Except that equipment furnished by subcontractors shall comply with requirements of pertinent safety regulations, such equipment normally furnished by the individual trades in execution of their own portions of the Work are not part of this Section.
4. Permanent installation and hookup of the various utility lines are described in other Sections.

1.2 REFERENCES [NOT USED]

1.3 ADMINISTRATIVE REQUIREMENTS

A. Temporary Utilities

1. Obtaining Temporary Service
   a. Make arrangements with utility service companies for temporary services.
   b. Abide by rules and regulations of utility service companies or authorities having jurisdiction.
   c. Be responsible for utility service costs until Work is approved for Final Acceptance.
      1) Included are fuel, power, light, heat and other utility services necessary for execution, completion, testing and initial operation of Work.
2. Water
   a. Contractor to provide water required for and in connection with Work to be performed and for specified tests of piping, equipment, devices or other use as required for the completion of the Work.
   b. Provide and maintain adequate supply of potable water for domestic consumption by Contractor personnel and the City.
3. Electricity
   a. Provide and pay for electric powered service as required for Work, including testing of Work.

1) Provide power for lighting, operation of equipment, or other use.

b. Electric power service includes temporary power service or generator to maintain operations during scheduled shutdown.

c. Install all wiring in accordance with applicable electrical codes and safety requirements.

d. Furnish, install, operate, and maintain temporary lights as are required by law or ordinance, or by good safety practices, and as are necessary for the proper protection of the public and workmen, Owner's employees, Owner's guests and invitees, or as necessary for proper performance and inspection of the Work.

4. Telephone

a. Provide emergency telephone service at Site for use by Contractor personnel and others performing work or furnishing services at Site.

1) Cellular phone service is acceptable if adequate signal is available to make and receive phone calls.

5. Sanitary Facilities

a. Provide and maintain sanitary facilities for persons on Site.

1) Comply with regulations of State and local departments of health.

b. Enforce use of sanitary facilities by construction personnel at job site.

1) Enclose and anchor sanitary facilities.

2) No discharge will be allowed from these facilities.

3) Collect and store sewage and waste so as not to cause nuisance or health problem.

4) Haul sewage and waste off-site at no less than weekly intervals and properly dispose in accordance with applicable regulation.

c. Locate facilities near Work Site and keep clean and maintained throughout Project.

d. Remove facilities at completion of Project

6. Enclosures

a. Provide and maintain for the duration of construction all scaffolds, tarpaulins, canopies, warning signs, steps, platforms, bridges, and other temporary construction necessary for proper completion of the Work in compliance with pertinent safety and other regulations.

7. Temporary Fencing

a. Provide and maintain for the duration of construction a temporary fence of design and type needed to prevent entry onto the Work by the public. A temporary fence will be required. Temporary fencing shall consist of an 8-foot tall chain link fence that is secured and locked when the Contractor is not on-site.

8. Dust Control

a. Contractor is responsible for maintaining dust control through the duration of the project.

1) Contractor remains on-call at all times

2) Must respond in a timely manner

9. Temporary Protection of Construction

a. Contractor or subcontractors are responsible for protecting Work from damage due to weather.

1.4 SUBMITTALS [NOT USED]

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE [NOT USED]

1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10 FIELD CONDITIONS [NOT USED]

1.11 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. Maintain temporary facilities and controls for duration of construction activities as needed.

3.5 REPAIR RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD SITE QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES

A. Remove all temporary facilities and controls and restore area after completion of the Work, to a condition equal to or better than prior to start of Work.

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 01 71 23
FIELD ENGINEERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Provide such field engineering services, which is defined as engineering services to be provided by the Contractor to complete the construction according to the plans and specifications, as are required for proper completion of the Work including, but not necessarily limited to:
      a. Establishing and maintaining control, lines and levels;
      b. Structural design of shores, forms, and similar items provided by the Contractor as part of his means and methods of construction.

B. Related Specification Sections include but are not limited to:
   1. Bidding Requirements, Contract Forms, and Conditions/Provisions of the Contract.
   2. Division 1 - General Requirements.

1.2 REFERENCES [NOT USED]

1.3 ADMINISTRATIVE REQUIREMENTS

A. Related Work
   1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions/Provisions, Supplementary Conditions, and Sections in Division 1 of the Specifications.
   2. Additional requirements for field engineering also may be described in other Sections of these Specifications.

B. Procedures to be adhered to, but not necessarily limited to:
   1. Locate and protect control points before starting work on the site.
   2. Preserve permanent reference points during progress of the Work.
   3. Do not change or relocate reference points or items of the Work without specific approval from the Engineer.
   4. Promptly advise the Engineer when a reference point is lost or destroyed, or requires relocation because of other changes in the Work.
      a. Upon direction of the Engineer, require the field engineer to replace reference stakes or markers.
      b. Locate such replacements according to the original survey control.

1.4 SUBMITTALS

A. Submittals shall be in accordance with General Provisions.

B. All submittals shall be approved by the City prior to delivery.

C. Upon request of the Engineer, submit:

1. Data demonstrating qualifications of persons proposed to be engaged for field engineering services.
2. Documentation verifying accuracy of field engineering work.
3. Certification, signed by the Contractor's retained field engineer, certifying that elevations and locations of improvements are in conformance or non-conformance with requirements of the Contract Documents.

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE

A. Qualifications

1. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10 FIELD CONDITIONS [NOT USED]

1.11 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION [NOT USED]

END OF SECTION

SECTION 01 75 00
STARTING OF THE SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Start-up procedures that include, but are not limited to:
   a. Furnish all labor, equipment and incidentals required to perform system start up as specified.
   b. Start up shall be considered for the start of each pumping unit.
      1) If multiple start ups are planned by the contractor for the start of multiple pumping units this specification shall apply for each start up.

B. Related Specification Sections include but are not limited to:

1. Bidding Requirements, Contract Forms, and Conditions/Provisions of the Contract.
2. Division 1 - General Requirements.

1.2 REFERENCES [NOT USED]

1.3 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.4 SUBMITTALS [NOT USED]

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE [NOT USED]

1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10 FIELD [SITE] CONDITIONS [NOT USED]

1.11 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS

A.Start Up Team

1. Design Engineer.
2. Electrical Engineer.
3. City Inspector.

4. General Contractor.
5. Mechanical Contractor.
6. Electrical Contractor.
7. Instrumentation Contractor.
8. Operator.
9. Local Multilin (protective relay) Representative.
10. Pump Manufacturer's Representative.
11. VFD and/or Soft Starter Manufacturer's Representative.
12. Control Valve Manufacture's Representative.
13. Electrical Actuator Representative.
14. Seal Manufacturer's Representative.
15. System Integrator's Representative.
16. Other Manufacturer's Representatives as required.

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION

A. Pre-Start Up Checklist

1. The Design Engineer, Contractor, inspector and any other required personnel shall meet prior to the start up to make sure the following items have been accomplished:
   a. General
      1) Review and verify the City's inspection check sheets.
      2) All electrical equipment has been installed and adjusted by the supplier as specified.
      3) All mechanical equipment specified has been installed properly and anchored. All bolts and nuts are tight.
      4) Ventilation system is operational.
      5) Heating system is operational.
      6) VFD's and Soft Starter's are operational.
      7) Air Conditioning system in the electrical room is operational.
      8) Instrumentation system is operational.
   b. Piping and Valves
      1) Suction pipe, unless submerged, is vacuum tight. Fasteners are tight at all pipe connections.
      2) Pipe supports are installed properly and strain in the equipment (particularly in valve bodies) is eliminated.
      3) Piping is level or continuously rising to prevent formation of air pockets, and air-relief valves and air bleeds are installed where specified.
      4) Harness bolts are installed properly in sleeve and expansion joint connections (unless pipe is externally restrained so that joint cannot separate).
      5) The piping has been pressure tested and all pipelines to all equipment have been flushed.
      6) Valves operate properly. Test limit switches and pressure switch operation.
      7) Pump control valves are operational and properly timed or adjusted. (Fine tune during operational test.)
      8) Both suction and discharge valves are closed.
      9) Automatic valves operate and air receivers (if any) are fully charged.

10) Pressure gauges are installed.

c. Pumps
   1) Pumps are level and there is no strain in the pump casing.
   2) Seals are adjusted and do not leak.
   3) Shaft seals are lubricated as required.
   4) The rotation arrow on the pump is in place and correct and relate arrow to the direction of the pump discharge nozzle.
   5) Coupling is installed

d. Motors
   1) Motor nameplate data (horsepower, speed, and electrical characteristics) agrees with the specifications.
   2) VFD's, Soft Starters and factory control diagrams are available at the site.
   3) The equipment has been lubricated as specified by the supplier.
   4) Confirm that the coupling between the motor and pump is disconnected. "Bump" the motor to make sure the direction of rotation is correct. Reconnect the coupling.
   5) Wiring connections are tight.
   6) Temperature overload device is operational.
   7) Guards are installed around rotating machinery.
   8) Alignment between pump and motor shafts is checked.

e. Pre-Energizing Inspection
   1) Electrical
      a. Electrical gear must be vacuumed out thoroughly to remove construction dust and debris.
      b. Every circuit breaker and disconnect switch should be opened before the utility turns on the power.
      c. Cables and circuits are identified per contract specification requirements.
      d. Switchgear key interlock scheme prevents paralleling feeders (if there is more than one feeder).
      e. Switchgear door interlock functions are:
         (1) Door cannot be opened with switch closed.
         (2) Switch cannot be closed with door open.
         (3) Access to all power fuses is possible only when switches are open.
      f. All switchgear secondary and low-voltage compartments are isolated by barriers from high-voltage compartments.
      g. Switchgear current-limiting fuses are rated in accordance with the contract documents.
      h. Switchgear safety-glass window makes disconnect *blade* visible. Stored-energy disconnect switch mechanism operates.
      i. Switchgear weatherproofing (if outdoor type), ventilation, thermostat, and heaters are operational.
      j. Switchgear protective relay settings are in accordance with manufacturers' recommendations and coordination/short-circuit protection limits. Each incoming line has time-delay over-current and one time-delay ground fault protective relay.
      k. Nameplates, warning, and "danger--high voltage" signs are installed.
      l. Perform high potential (voltage) tests at switchgear for 1 min. on primary and secondary circuits. Factory test reports on high potential tests are acceptable.

m. Switchgear schematic control diagrams are correct. See that transformer nameplate data, high-voltage warning signs, and high and low voltage compartment isolation are in place.
n. Transformer door interlocks; assure:
(1) Low-voltage compartment door can be opened first.
(2) High-voltage compartment door cannot be opened first.
o. Transformer low-voltage compartment has:
(1) No-load tap changer.
(2) Liquid level gauge on liquid fill transformer.
(3) Dial thermometer.
(4) Level and temperature alarm contact.
(5) Ground pad and proper grounding.
p. Control centers are NEMA class as specified.
q. Bus rating conforms to specifications.
r. The circuit breaker is sized properly, of the proper type, and is adjusted as specified.
s. Motor starters are sized properly and provided with proper thermal overload relays with heaters on each leg as specified.
t. Wiring and conduit from the control to the motor is sized per NEC and NEMA standards as a minimum.
u. Automatic and manual switches are furnished and operational as specified.
v. If combination motor-circuit protectors and magnetic starters are furnished, determine that the motor-circuit protectors are sized in accordance with manufacturer's recommendations. Adjust the current limiters properly.
w. Feeder circuit breakers are installed, sized, and adjusted as specified.
x. Main and tie circuit interrupters are rated as specified and capable of carrying full rated current to feed the breakers as specified.
y. Current and potential transformers are sized and electrically connected as specified.
z. All control switches are furnished and operate as required.
aa. Relay panels are furnished with subpanels, control relays, timing relays, repeat cycle timers, protective relays, phase failure relays, timers, and latching relays and are adjusted as required. Terminal block wiring and all necessary appurtenances are complete.
bb. Fuse blocks are furnished and sized properly.
cc. Elapsed-time meters are furnished and can be adjusted as specified.
dd. Manual motor starters are furnished for the low-voltage, low-horsepower, single-phase equipment and have proper current protection.
ee. Line disconnect devices or circuit breakers are furnished for manual starters.
ff. The spare parts for switchgear, VFD and soft starter are supplied as specified.

3.4 USER-DEFINED PROCESS

A. Energizing the Station

1. Start-Up Team Shall Perform the Following:

a. Close the main circuit breaker or fusible switch. This will be the first time that the switchboard bus is energized since the high-pot test (on-site or at the factory). *Never* stand in front of a circuit breaker or switch when operating it.
b. Test for correct voltage range.
c. Test for correct phase sequence.
d. Check calibration of all instrumentation equipment. Instrumentation may well have been calibrated before it left the factory, but since then it has suffered vibration and shock from transportation and dampness from sitting in a non-energized state for several months.
e. Test manual control devices. Operate start, stop, jog, etc., devices to determine if the contacts and circuit breakers respond correctly.
f. Test safety devices. Close power devices manually and manually actuate the safety device to determine if the power device trips.
g. Test automatic control systems for placing all equipment in the automatic mode and simulating operation of the various control devices to determine if the power devices function correctly. Simulation of control device operation should be accomplished as close to the process as possible. For example, it is better to apply a pressure signal to transmitter process input with a pneumatic test set than to simulate the pressure transmitter output with an electronic test set. As another example, it is better to move a valve manually to test limit switches than simply to move the limit switch arm by hand.
h. Check actual motor nameplates against motor starter application data and install correct motor overload heaters. Follow the same procedure for power fuses on high voltage motor starters.
i. Rack in high-voltage starters and circuit breakers to the operating position.
j. Bump motors. Before bumping any motor, verify that reverse rotation will not damage mechanical equipment. If mechanical equipment can be damaged by reverse rotation, open coupling or remove drive belts as applicable.

3.5 REPAIR/RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

A. Main Pump Final Checklist

1. Start Up Team Shall Check the Following:
   a. Energize the seal-water system and be sure that water is flowing to the seal box.
   b. Remove the coupling guard, separate the pump coupling half, and check the alignment between the pump and the driver.
   c. Check motor and pump lubrication.
   d. Energize the master control panel.
   e. Energize the local control button and equipment and bump the motor to determine pump rotation relative to the pump arrow and pump nozzle. If pump station is incorrect, lock out the pump at the local control, de-energize the pump control, and correct.
   f. Re-energize the pump control and push START button to bump the motor and recheck rotation.
   g. Rotate the pump shaft manually.
   h. Reassemble the pump coupling and replace the coupling guard.

B. Testing of the Main Pumps

1. Start Up Team Shall Perform the Following:
   a. Close all pressure gauges to the liquid being pumped.
   b. Energize the seal-water system and determine that the water is flowing to the seal box.
   c. Energize the pump control.
   d. Energize the START button of local control. (Note that the pumps are noisy at this shutoff condition.)
   e. Open the manually operated discharge valve slowly and fill the discharge header and the force main or transmission pipeline slowly. Check for undue motor and pump noise and vibration.
   f. Open shut-off valves for discharge and suction pressure gauges; bleed all air from the pressure gauge piping or tubing; and compare head at shut-off and flow, head, and power at operating conditions with the pump performance curve. Record data and submit to Engineer.
   g. Close the discharge shut-off valve slowly enough to avoid water hammer.
   h. De-energize the pump.
   i. Determine that check valve limit switches are operating properly.
   j. Open the discharge shut-off valve.
   k. Energize the pump and note the time of check valve opening. Readjust if required.
   l. De-energize the pump and close suction and discharge shut-off valves. Close all valves to pressure switches.
   m. After each pump has been tested individually, open all the suction and discharge valves and operate the station as specified.

3.8 SYSTEM STARTUP

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 01 77 19
CONTRACT CLOSE-OUT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. An orderly and efficient transfer of the completed Work to the Owner.

B. Related Specification Sections include but are not limited to:
   1. Bidding Requirements, Contract Forms, and Conditions/Provisions of the Contract.
   2. Division 1 - General Requirements.

1.2 REFERENCES [NOT USED]

1.3 ADMINISTRATIVE REQUIREMENTS

A. Guarantees, Bonds and Affidavits
   1. No application for final payment will be accepted until all guarantees, bonds, certificates, licenses and affidavits required for Work or equipment as specified are satisfactorily filed with the City.

B. Release of Liens or Claims
   1. No application for final payment will be accepted until satisfactory evidence of release of liens has been submitted to the City.

1.4 SUBMITTALS

A. Submit all required documentation to City's Project Representative.

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE

A. Prior to requesting inspection by the City, use adequate means to assure that the Work is completed in accordance with the specified requirements and is ready for the requested inspection.

1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10 FIELD CONDITIONS [NOT USED]

1.11 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION [NOT USED]

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 CLOSEOUT PROCEDURE

A. Prior to requesting Final Inspection, submit:
   1. Project Record Documents in accordance with Section 01 78 39
   2. Operation and Maintenance Data, if required, in accordance with Section 01 78 23
   3. Training sessions of all major electrical and mechanical equipment to the City staff.
      a. This training sessions must be conducted by manufacturers' recommended training instructors.
      b. a. Contractor shall provide 3 copies of DVD’s containing video recordings of on-site training sessions for Operations/Maintenance & Safety of 1) Pumps 2) VFDs & Switches gears 3) SCADA & PLCs 4) Valves 5) HVAC System 6) General Electrical & Mechanical Components

B. Prior to requesting Final Inspection, perform final cleaning in accordance with Conditions/Provisions of the Contract.

C. Final Inspection
   1. After final cleaning, provide notice to the City Project Representative that the Work is completed.
      a. The City will make an initial Final Inspection with the Contractor present.
      b. Upon completion of this inspection, the City will notify the Contractor, in writing within 10 business days, of any particulars in which this inspection reveals that the Work is defective or incomplete.
   2. Upon receiving written notice from the City, immediately undertake the Work required to remedy deficiencies and complete the Work to the satisfaction of the City.
   3. Upon completion of Work associated with the items listed in the City's written notice, inform the City, that the required Work has been completed. Upon receipt of this notice, the City, in the presence of the Contractor, will make a subsequent Final Inspection of the project.
   4. Provide all special accessories required to place each item of equipment in full operation. These special accessory items include, but are not limited to:
      a. Specified spare parts
      b. Adequate oil and grease as required for the first lubrication of the equipment

c. Initial fill up of all chemical tanks and fuel tanks
d. Light bulbs
e. Fuses
f. Vault keys
g. Handwheels
h. Other expendable items as required for initial start-up and operation of all equipment

D. Supporting Documentation
1. Coordinate with the City Project Representative to complete the following additional forms:
a. Final Payment Request
b. Statement of Contract Time
c. Affidavit of Payment and Release of Liens
d. Consent of Surety to Final Payment
e. Pipe Report (if required)
2. Upon review and acceptance of Final Payment Supporting Documentation, in accordance with General Provisions, City will release the Final Payment Request for payment.

3.5 REPAIR/RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Throughout progress of the Work, assemble data for inclusion in an Operation and Maintenance Manual.
   2. Upon completion of the Work, submit Operation and Maintenance Manuals to the Engineer, as described in this Section.

B. Related Specification Sections include but are not limited to:
   1. Bidding Requirements, Contract Forms, and Conditions/Provisions of the Contract.
   2. Division 1 - General Requirements.
   3. Other requirements affecting Operation and Maintenance Data may appear in pertinent other Sections of these Specifications.

1.2 REFERENCES [NOT USED]

1.3 ADMINISTRATIVE REQUIREMENTS

A. Schedule
   1. Submit manuals in final form to the City within 30 calendar days of product shipment to the project site.

1.4 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. Operation and Maintenance manuals shall be provided in electronic format on a compact disc.

1.5 INFORMATIONAL SUBMITTALS

A. Operation and Maintenance Manuals
   1. Organize operating and maintenance data into suitable sets of manageable size.
   2. A separate PDF shall be included for each individual Operation and Maintenance (O&M) manual.
      a. All O&M manuals shall be provided on a single CD.
      b. Within individual PDF's, O&M sections shall be bookmarked to allow for easy reference.
   3. At a minimum, the following types of information shall be included in O&M's manuals:
      a. Emergency instructions.
      b. Spare parts listing.
      c. Copies of warranties.
      d. Wiring diagrams (Project specific).
      e. Recommended "turn-around" cycles.

f. Inspection procedures.
g. Operating procedures
    1) Start-up, break-in, routine and normal operating instructions.
    2) Regulation, control, stopping, shut down and emergency instructions.
    3) Summer and winter operating instructions.
    4) Special operating instructions.
h. Maintenance procedures
    1) Routine operations
    2) Guide to "trouble shooting"
    3) Disassembly, repair and reassembly
    4) Alignment, adjusting and checking
i. Servicing and lubrication schedule
    1) List of lubricants required
j. Shop drawings and product data (Project specific).

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE

A. Provide operation and maintenance data by personnel with the following criteria:
    1. Trained and experienced in maintenance and operation of described products
    2. Skilled as technical writer to the extent required to communicate essential data
    3. Skilled as draftsman competent to prepare required drawings

1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10 FIELD CONDITIONS [NOT USED]

1.11 WARRANTY [NOT USED]

PART 2 - PRODUCTS [NOT USED]

PART 3 - EXECUTION [NOT USED]

END OF SECTION

SECTION 01 78 39
PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Throughout progress of the Work, maintain an accurate record of changes in the Contract Documents, as described in this Section.
   2. Upon completion of the Work, transfer the recorded changes to a set of Record Documents, as described in this Section.

B. Related Specification Sections include but are not limited to:
   1. Bidding Requirements, Contract Forms, and Conditions/Provisions of the Contract.
   2. Division 1 - General Requirements.
   3. Other requirements affecting Project Record Documents may appear in pertinent other Sections of these Specifications.

1.2 REFERENCES [NOT USED]

1.3 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.4 SUBMITTALS

A. Submittals shall be in accordance with General Provisions.

B. Approval of the current status of Project Record Documents may be a prerequisite to the City's approval of requests for progress payment and request for final payment under the Contract.

C. Prior to submitting each request for progress payment, secure the City's approval of the current status of the Project Record Documents.

D. Prior to submitting request for final payment and inspection, submit the final Project Record Documents to the City and secure his approval.

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE

A. Delegate the responsibility for maintenance of Record Documents to one person on the CONTRACTOR's staff as approved by the City.

B. Accuracy of Records
   1. Thoroughly coordinate changes within the Record Documents, making adequate and proper entries on each page of Specifications and each sheet of Drawings and other Documents where such entry is required to show the change properly.

2. Accuracy of records shall be such that future search for items shown in the Contract Documents may rely reasonably on information obtained from the approved Project Record Documents.
3. Make entries within 24 hours after receipt of information that the change has occurred.
4. Provide factual information regarding all aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive site measurement, investigation and examination.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Maintain the job set of Record Documents completely protected from deterioration and from loss and damage until completion of the Work and transfer of all recorded data to the final Project Record Documents.

B. In the event of loss of recorded data, use means necessary to again secure the data to the City's approval.
   1. Such means shall include, if necessary in the opinion of the City, removal and replacement of concealing materials.
   2. In such case, provide replacements to the standards originally required by the Contract Documents.

1.10 FIELD CONDITIONS [NOT USED]

1.11 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 CITY-FURNISHED OR CITY-SUPPLIED PRODUCTS [NOT USED]

2.2 RECORD DOCUMENTS

A. Job Set
   1. Promptly following receipt of the City’s Notice to Proceed, secure from the City at no charge to the CONTRACTOR one complete set of all Documents comprising the Contract.

B. Final Record Documents
   1. At a time nearing the completion of the Work, secure from the City at no charge to the CONTRACTOR one complete set of all Drawings in the Contract.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 MAINTENANCE DOCUMENTS

A. Maintenance of Job Set
   1. Immediately upon receipt of the job set, identify each of the Documents with the title, "RECORD DOCUMENTS - JOB SET".
   2. Preservation
      a. Considering the Contract completion time, the probable number of occasions upon which the job set must be taken out for new entries and for examination, and the conditions under which these activities will be performed, devise a suitable method for protecting the job set to the approval of the City.
      b. Do not use the job set for any purpose except entry of new data and for review by the City, until start of transfer of data to Final Project Record Documents.
      c. Maintain the job set at the sit of Work as that site is designated by the City.
   3. Making entries on Drawings
      a. Using an erasable colored pencil (not ink or indelible pencil), clearly describe the change by graphic line and note as required.
      b. Date all entries.
      c. Call attention to the entry by a "cloud" drawn around the area or areas affected.
      d. In the event of overlapping changes, use different colors for the overlapping changes.
   4. Make entries in the pertinent other Documents as approved by the City.
   5. Conversion of schematic layouts:
      a. In some cases on the Drawings, arrangements of conduits, circuits, piping, ducts, and similar items, is shown schematically and is not intended to portray precise physical layout.
         (a) Final physical arrangement is determined by the CONTRACTOR, subject to the City's approval.
         (b) However, design of future modifications of the facility may require accurate information as to the final physical layout of items which are shown only schematically on the Drawings.
      b. Show on the job set of Record Drawings, by dimension accurate to within one inch, the centerline of each run of items such as are described above.
         (a) Final physical arrangement is determined by the CONTRACTOR, subject to the City's approval.
         (b) Show, by symbol or note, the vertical location of the Item ("under slab", "in ceiling plenum", "exposed", and the like).
         (c) Make all identification sufficiently descriptive that it may be related reliably to the Specifications.

c. The City may waive the requirements for conversion of schematic layouts where, in the City's judgment, conversion serves no useful purpose. However, do not rely upon waivers being issued except as specifically issued in writing by the City.

B. Final Project Record Documents

1. The purpose of the Final Project Record Documents is to provide factual information regarding all aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive site measurement, investigation, and examination.
2. Approval of recorded data prior to transfer:
   a. Following receipt of the documents, and prior to start of transfer of recorded data thereto, secure the City's approval of all recorded data.
   b. Make required revisions.
3. Transfer of data to Drawings
   a. Carefully transfer change data shown on the job set of Project Record Drawings to the corresponding documents, coordinating the changes as required.
   b. Clearly indicate at each affected detail and other Drawings a full description of changes made during construction, and the actual location of items described above.
   c. Call attention to each entry by drawing a "cloud" around the area or areas affected.
   d. Make changes neatly, consistently, and with the proper media to assure longevity and clear reproduction.
4. Transfer of data to other Documents:
   a. If the Documents other than Drawings have been kept clean during progress of the Work, and if entries thereon have been orderly to the approval of the City, the job set of those Documents other than Drawings will be accepted as Final Project Record Documents.
   b. If any such Document is not so approved by the City, secure a new copy of that Document from the CITY, at the CITY's usual charge for reproduction and handling, and carefully transfer the change data to the new copy to the approval of the CITY.
5. Review and Submittal:
   a. Submit the completed set of Project Record Documents to the CITY as described in Paragraph 1.5-D above.
   b. Participate in review meetings as required.
   c. Make required changes and promptly deliver the Final Project Record Documents to the CITY.

C. Changes Subsequent to Acceptance

1. The CONTRACTOR has no responsibility for recording changes in the Work subsequent to Final Completion, except for changes resulting from work performed under Warranty.

3.5 [REPAIR] / [RESTORATION] [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [OR] SITE QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:

1. Provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install cast-in-place concrete.
2. The Work includes providing concrete consisting of portland cement, fine and coarse aggregate, water, and approved admixtures; combined, mixed, transported, placed, finished and cured. The Work also includes:
   a. Providing openings in concrete to accommodate the Work under this and other Sections and building into the concrete all items such as sleeves, frames, anchor bolts, inserts and all other items to be embedded.

B. Coordination:

1. Review installation procedures under other Sections and coordinate the installation of items that must be installed in the concrete.

C. Classifications Of Concrete:

1. Class A (4,000 psi) concrete shall be steel reinforced and includes the following:
   a. All concrete, unless indicated otherwise.
2. Class B (3,500 psi) concrete shall be placed without forms or with simple forms, with little or no reinforcing, and includes the following unless indicated otherwise:
   a. Concrete fill within structures.
   b. Duct banks.
   c. Unreinforced encasements.
   d. Curbs and gutters.
   e. Sidewalks.
   f. Pavement.
   g. Thrust blocking.
3. Class C (2,000 psi) concrete shall be unreinforced and used where required as concrete fill under foundations, mud slabs, filling abandoned piping and wherever “lean” concrete is required on the Drawings.
4. Class D (350 psi) flowable fill shall be unreinforced and used for filling large underground abandoned spaces and other locations identified in the Drawings.

D. Related Sections:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section. It is the Contractor's responsibility for scheduling and coordinating the Work of subcontractors, suppliers, and other individuals or entities performing or furnishing any of Contractor's Work.

E. Refer to the following Sections for site improvements concrete specifications:

1. Section 03 00 00 – Site Improvements Concrete and Concrete Reinforcing.
2. Section 03 31 00 – Site Improvements Cast-in-Place Concrete.

3. Section 03 34 13 – Controlled Low Strength Material (CLSM).
4. Section 32 13 13 – Concrete Paving.
5. Section 32 13 73 – Concrete Paving Joint Sealants.
6. Section 32 16 00 – Curbs, Gutters, Sidewalks and Driveways.

1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Mix Designer: Licensed professional engineer registered in the state of Texas.
   2. Batch Plant: Currently certified by the National Ready Mixed Concrete Association.

B. Reference Standards: Comply with the applicable provisions and recommendations of the following, except as otherwise shown or specified.
   1. ACI 214, Recommended Practice for Evaluation of Strength Test Results of Concrete.
   2. ACI 301, Specifications for Structural Concrete (includes ASTM Standards referred to herein).
   3. ACI 304, Guide for Measuring, Mixing, Transporting and Placing Concrete.
   4. ACI 305, Hot Weather Concreting.
   5. ACI 306, Cold Weather Concreting.
   6. ACI 309, Guide for Consolidation of Concrete.
   7. ACI 311, Guide for Concrete Inspection.
   8. ACI 318, Building Code Requirements for Structural Concrete.
   9. ACI 350, Code Requirements for Environmental Engineering Concrete Structures
   10. ANSI/NSF 61, Drinking Water System Components-Health Effects.
   11. AASHTO M 182, Burlap Cloth Made from Jute or Kenaf.
   12. AASHTO TP 23, Proposed Standard Method of Test for Water Content of Freshly Mixed Concrete Using Microwave Oven Drying.
   13. ASTM C 31, Practice for Making and Curing Concrete Test Specimens in the Field.
   14. ASTM C 33, Specification for Concrete Aggregates.
   15. ASTM C 39, Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   16. ASTM C 42, Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
   17. ASTM C 94, Specification for Ready-Mixed Concrete.
   18. ASTM C109, Test Method for Compressive Strength of Hydraulic Cement Mortars.
   19. ASTM C 143, Test Method for Slump of Hydraulic- Cement Concrete.
   20. ASTM C 150, Specification for Portland Cement.
   21. ASTM C 157, Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   22. ASTM C 171, Specification for Sheet Materials for Curing Concrete.
   23. ASTM C 172, Practice for Sampling Freshly Mixed Concrete.

24. ASTM C 231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
25. ASTM C 260, Specification for Air-Entraining Admixtures for Concrete.
26. ASTM C 309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
27. ASTM C 330, Specification for Lightweight Aggregates for Structural Concrete.
28. ASTM C 494, Specification for Chemical Admixtures for Concrete.
29. ASTM C 618, Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
30. ASTM C 882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
31. ASTM C 1240, Specification for Silica Flume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout.
32. ASTM E 154, Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
33. ASTM E 329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used for Construction.
34. ACI 117 Specification for Tolerances for Concrete Construction and Materials
35. ACI SP-15 Field Reference Manual
36. ASTM C138 Standard Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Concrete
37. ASTM C192 Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
38. ASTM C900 Standard Test Method for Pullout Strength of Hardened Concrete
39. ASTM C928, Standard Specification for Packaged, Dry, Rapid Harding Cementitious Materials for Concrete Repairs.
40. NSF 61 Drinking Water System Components – Health Effects

C. Concrete Testing Service:

1. Contractor shall employ, at its own expense and in accordance with Section 01 45 23, testing laboratories experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes. The same laboratory shall not be employed to both design concrete mixes and provide field testing.
    a. Testing agency shall meet the requirements of ASTM E 329 and ASTM C1077.
    b. Selection of a testing laboratory is subject to District's approval.
    c. Submit a written description of the proposed concrete testing laboratory giving qualifications of personnel, laboratory facilities and equipment, and other information that may be requested by Engineer. Field test shall be made by an ACI Concrete Field Testing Technician Grade I in accordance with ACI CPI, or District approved equal, unless exceptions to field personnel are allowed by the Engineer and/or District.
2. Materials and installed Work may require testing and retesting, as directed by Engineer, at any time during the progress of the Work. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be

done at Contractor's expense, including the retesting of rejected materials and installed Work. Failure to detect defective work or materials early will not prevent rejection if a defect is discovered later nor shall it obligate the District to final acceptance.

D. Qualifications Of Water-Reducing Admixture Manufacturer:

1. Water-reducing admixtures shall be manufactured under strict quality control in facilities operated under a quality assurance program. Contractor shall furnish copy of manufacturer's quality assurance handbook to document the existence of the program. Manufacturer shall maintain a concrete testing laboratory that has been approved by the Cement and Concrete Reference Laboratory at the Bureau of Standards, Washington, D.C.
2. Provide a qualified concrete technician employed by the admixture manufacturer to assist in proportioning the concrete for optimum use of the admixture. The concrete technician, shall advise on proper addition of the admixture to the concrete and on adjustment of the concrete mix proportions to meet changing jobsite conditions.

E. Laboratory Trial Batch

1. Each concrete mix design specified shall be verified by a laboratory trial batch, unless indicated otherwise.
2. Each trial batch shall include the following testing:
   a. Aggregate gradation for fine and coarse aggregates.
   b. Fly ash testing to verify meeting specified properties, unless the fly ash supplier provides certification by an independent testing laboratory.
   c. Slump.
   d. Air content.
   e. Compressive strength based on three cylinders each tested at seven days and at 28 days.
   f. Shrinkage test as specified herein for Class A concrete mix designs.
3. Each trial batch shall provide the following information:
   a. Project identification name and number.
   b. Date of report.
   c. Complete identification of aggregate source of supply.
   d. Tests of aggregates for compliance with specified requirements.
   e. Scale weight of each aggregate.
   f. Absorbed water in each aggregate.
   g. Brand, type and composition of cement.
   h. Brand, type and amount of each admixture.
   i. Amounts of water used in trial mixes.
   j. Proportions of each material per cubic yard.
   k. Gross weight and yield per cubic yard of trial mixtures.
   l. Measured slump.
   m. Measured air content.
   n. Compressive strength developed at seven days and 28 days, from not less than three test cylinders cast for each seven day and 28 day test, and for each design mix.
   o. Shrinkage test results where required and as specified herein.
4. The requirement for a trial batch may be waived if the required test information has been provided in a previous laboratory trial batch run on the identical mix design

within the previous two years. The same brand, type, and source of all materials must have been used.

F. Shrinkage Test:

1. Drying shrinkage tests will be made for the trial batch as specified herein.
2. Drying shrinkage specimens shall be 4-inch by 4-inch by 11-inch prisms with an effective gage length of 10-inches, fabricated, cured, dried and measured in accordance with the requirements of ASTM C 157 modified as follows: specimens shall be removed from molds at an age of 23 ±1 hours after trial batching, shall be placed immediately in water at 70°F ±3°F for at least 30 minutes, and shall be measured within 30 minutes thereafter to determine original length and then submerged in saturated lime water at 73°F ±3°F. Measurement to determine expansion expressed as a percentage of original length shall be made at age seven days. This length at age seven days shall be the base length for drying shrinkage calculations ("0" days drying age). Specimens then shall be stored immediately in a humidity control room maintained at 73°F ±3°F and 50 percent ±4 percent relative humidity for the remainder of the test. Measurements to determine shrinkage expressed as percentage of base length shall be made and reported separately for 7, 14, 21, and 28 days of drying after seven days of moist curing.
3. The drying shrinkage deformation of each specimen shall be computed as the difference between the base length (at "0" days drying age) and the length after drying at each test age. The average drying shrinkage deformation of the specimens shall be computed to the nearest 0.0001-inch at each test age. If the drying shrinkage of any specimen departs from the average of that test age by more than 0.0004-inch, the results obtained from that specimen shall be disregarded. Results of the shrinkage test shall be reported to the nearest 0.001 percent of shrinkage. Compression test specimens shall be taken in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered a part of the normal compression tests for the project. Allowable shrinkage limitations shall be as specified in Part 2, herein.

G. Sample Panels:

1. Provide sample panels of wall finishes, 12-inches by 12-inches by 3-inches thick. Perform revisions and corrective work required to produce finished concrete and surfaces as required by Engineer.
   a. Construct additional sample panels as may be required if original results are not satisfactory.
2. The continuity of color and texture for exposed concrete surfaces is of prime importance. Maintain such controls and procedures, in addition to those specified, as is necessary to provide continuous match of concrete Work with accepted samples.

H. Mock-Up Panels:

1. Fabricate mock-up panels representative of specified finished surfaces after sample form panels are approved, at locations on the site as directed by Engineer. Form, reinforce, mix, cast, cure and finish mock-up panels using selected materials and construction methods proposed for the Work. Provide mock-up panels as follows:
   a. Wall section of "L"-shaped panels, approximately 4 feet high by 3 feet each side by 8-inches thick and set on an 18-inch wide by 8-inch thick base, unless otherwise shown. Form faces to represent each specified formed surface finish.

Include not less than two form ties, two form panel intersections, one vertical construction joint and one horizontal construction joint. Construction joints are specified in Section 03 15 16, Concrete Joints, of these Specifications.

b. Column section, approximately four feet high and not less than 12-inches diameter for round sections and not less than 12-inches in least dimension for rectangular sections for each specified formed finish, unless otherwise shown. Set column sections on a 6-inch thick concrete base which extends 8-inches beyond the column. Chamfer exposed edges of rectangular sample columns.

c. Slab-on-grade section, approximately four feet square and a minimum of 4-inches thick for each applied finish, with at least one construction joint and one expansion joint, if used.

2. Reinforce mock-up panels as required to prevent cracking and to be structurally stable or as shown on the Drawings, but reinforcing steel shall not be less than 0.25 percent of the gross concrete cross section in each direction.

3. Protect mock-up panels from damage and do not remove them without written permission from Engineer. When directed, demolish mock-up panels and remove from the site.

1.3 SUBMITTALS

A. Samples: Submit samples of materials as specified and as otherwise may be requested by Engineer, including names, sources and descriptions. Submittal data shall demonstrate compliance with all requirements of this specification. Any deviations from the specifications shall be clearly noted in the submittal and justification presented for the deviation.

B. Shop Drawings: Submit for approval the following:

1. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures, bonding agents and repair materials.

2. List of concrete materials and concrete mix designs proposed for use. Include the results of all tests performed to qualify the materials and to establish the mix designs.

3. The following information, if ready-mixed concrete is used.
   a. Physical capacity of mixing plant.
   b. Trucking facilities available.
   c. Estimated average amount that can be produced and delivered to the site during a normal eight-hour day, excluding the output to other customers.

4. Manufacturer’s Certificate of Compliance:
   a. Portland Cement.
   b. Admixtures.
   c. Fly Ash.
   d. Aggregates.
   e. Bonding Agent.
   f. Bond Breakers.
   g. Patching Materials.
   h. Admixtures: Manufacturers’ Certificate of Proper Installation.

C. Laboratory Test Reports: Submit copies of laboratory test reports for concrete cylinders, materials and mix design tests. Engineer’s review will be for general

information only. Production of concrete to comply with specified requirements is the responsibility of Contractor.

D. Submit notarized certification of conformance to referenced standards when requested by Engineer.

E. Delivery Tickets: Furnish to District representative copies of all delivery tickets for each load of concrete at the time of delivery to the site. Provide items of information as specified in ASTM C 94, Section 16.1.

F. Administrative Submittals: Concrete Coordination Meeting Minutes.

G. Qualifications of Finishes: Submit qualifications of the finishing contractor and the finishers who will perform the Work.

H. Drawings: Submit concrete placement drawings showing the lift numbers, locations of all joints, concrete mix design being placed, concrete finishes, and all pertinent embedded items including embed plates and angles, sleeves, pipes, conduits, anchors, gate thimbles, etc. Where the Drawings permit the Contractor to select joint locations, show the selected dimensions on the placement drawings. Approval of the placement drawings shall not relieve the Contractor of the responsibility of placing all required embedments as specified and where shown in the Drawings. Submit information for acceptance of proposed construction joints not otherwise shown in the Drawings.

I. Submit notification of placement to the District's representative at least 24 hours in advance of concrete placement.

J. Submit a work plan for cold weather concreting and hot weather concreting describing proposed methods and procedures for complying with the requirements of this specification.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All materials used for concrete must be kept clean and free from all foreign matter during transportation and handling and kept separate until measured and placed in the mixer. Bins or platforms having hard clean surfaces shall be provided for storage. Suitable means shall be taken during hauling, piling and handling to ensure that segregation of the coarse and fine aggregate particles does not occur and the grading is not affected. Ensure that product delivery of concrete conforms to the requirements of ASTM C94 and ACI 304.

B. Cementitious Materials: Store cementitious materials in dry, weather tight buildings, bins or silos that will exclude contaminants.

C. Aggregates: Store and handle aggregates in a manner that will avoid segregation and prevent contamination with other materials or other sizes of aggregates. Store aggregates to drain freely.

D. Water and Ice: Protect mixing water and ice from contamination during storage and delivery.

E. Admixtures: Protect stored admixtures against contamination, evaporation, or damage. Provide agitating equipment for admixtures used in the form of suspensions or nonstable solutions to ensure thorough distribution of the ingredients. Protect liquid admixtures from freezing and from temperature changes that effect their characteristics. Comply with all manufacturer guidelines for proper storage and handling of the material.

1.5 CONCRETE COORDINATION MEETING

A. A Concrete Coordination Meeting shall be held to review the detailed requirements of Contractor's proposed concrete design mixes, to determine the procedures for producing proper concrete construction, and to clarify the roles of the parties involved shall be held no later than 14 days after the Notice to Proceed.

B. All parties involved in the concrete Work shall attend the meeting, including but not limited to the following:

1. Contractor's representative.
2. Testing laboratory representative.
3. Concrete subcontractor.
4. Reinforcing steel subcontractor and detailer.
5. Concrete supplier.
6. Admixture manufacturer's representative.
7. Engineer and District.

C. The Concrete Coordination Meeting shall be held at a mutually agreed upon time and place. The Engineer shall be notified no less than five days prior to the date of the Concrete Coordination Meeting.

1.6 ADMINISTRATIVE REQUIREMENTS [NOT USED]

PART 2 - PRODUCTS

2.1 CEMENTITIOUS MATERIALS

A. Cement:

1. Portland cement, ASTM C 150, Type I or Type I/II. Use portland cement made by a well-known acceptable manufacturer and produced by not more than one plant. Alternate cement sources may be used provided that a mix design has been accepted and a trial batch verifying performance has been made. All cement shall be produced by the dry-kiln process. Contractor shall provide written certification of the production of cement by the dry-kiln process.
2. Do not use cement which has deteriorated because of improper storage or handling.
3. Cement shall be in accordance with NSF 61.

B. Fly Ash Mineral Admixture:

1. Mineral admixtures, when used, shall meet the requirements of ASTM C 618 Class F, except as follows:
   a. The loss on ignition shall be a maximum of 4 percent.
   b. The maximum percent of sulfur trioxide (SO3) shall be 4.0.
2. Fly ash shall be considered to be a cementitious material.
3. Laboratory trial batches shall be tested to determine compliance with strength requirements, times of setting, slump, slump loss, and shrinkage characteristics.

4. A substitution by weight, of the portland cement by fly ash, so that the total tricalcium aluminate content of the resulting cement plus fly ash is not greater than eight percent, will be considered. However, the fly ash shall not exceed 15 percent by weight of the cement plus fly ash for Class A concrete, nor 25 percent for Class B and C concrete.
5. Fly ash shall be in accordance with NSF 61.

2.2 AGGREGATES

A. General: Aggregates shall conform to the requirements of ASTM C 33 and as herein specified.
   1. Do not use aggregates containing soluble salts or other substances such as iron sulfides, pyrite, marcasite, ochre, or other materials that can cause stains on exposed concrete surfaces.
   2. Provide aggregates in accordance with NSF 61.

B. Fine Aggregate: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances.
   1. Dune sand, bank run sand and manufactured sand are not acceptable.

C. Coarse Aggregate: Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter, as follows:
   1. Crushed stone, processed from natural rock or stone.
   2. Washed gravel, either natural or crushed. Use of slag and pit or bank run gravel is not permitted.

D. The grading of the combined aggregate shall meet the following requirements:
   1. Not more than 75 or less than 50 percent of the combined aggregate that is retained on the No. 8 sieve shall also be retained on the 3/8-inch sieve.
   2. The percent of the combined aggregate passing No. 8 sieve shall not be less than 34 nor more than 40 percent of the combined aggregate for mixtures that contain 564 lbs/yd3 of cementitious materials content. For every 94 lb variation from 564 lbs. add or deduct 2.5 percent from the percent passing the No. 8 sieve. The higher the amount of cementitious materials, the less the amount of aggregate passing the No.8 sieve aggregate required for mixture mobility and vice versa.
   3. The percent of the combined aggregate retained on any two consecutive sieves shall not be less than 14 percent of the combined aggregate.

2.3 WATER AND ICE

A. Mixing water and ice, including reprocessed water, used in the production and curing of concrete shall meet the requirements of ASTM C94 and shall be clean and free from injurious amounts of oils, acids, alkalis, organic materials or other substances that may be deleterious to concrete or steel.

2.4 CONCRETE ADMIXTURES

A. Provide admixtures produced by established reputable manufacturers, and use in compliance with the manufacturer's printed instructions. All admixtures shall be compatible and by a single manufacturer capable of providing qualified field service representation. Admixtures shall not contain thiocyanates nor more than 0.05 percent chloride ion, and shall be non-toxic in the concrete mix after 30 days. Do not use

admixtures that have not been incorporated and tested in the accepted mixes, unless otherwise authorized in writing by Engineer.

B. Air-Entraining Admixtures: ASTM C 260.

1. Product and Manufacturer: Provide one of the following:
   a. Sika Corporation.
   b. BASF.
   c. W.R. Grace & Company.

C. Water-Reducing Admixture: ASTM C 494, Type A.

1. Proportion all Class A and Class B concrete with non-air entraining, normal setting, water-reducing, aqueous solution of a modification of the salt of polyhydroxylated organic acids. The admixture shall not contain any lignin, nitrates or chlorides added during manufacture.
2. Product and Manufacturer: Provide one of the following:
   a. Euclid Chemical Company.
   b. BASF.
   c. W.R. Grace & Company.
   d. Sika Corporation.

D. High Range Water-Reducing Admixture (HRWR): ASTM C 494, Type F/G.

1. High range water-reducer shall be used in classifications of concrete, where specified, and shall be permitted, at Contractor's option, in all other classifications of concrete. It shall be added to concrete in compliance with the manufacturer's printed instructions. The specific admixture formulation shall be as recommended by the manufacturer for the project conditions. Provide one of the following:
   a. Sika Corporation.
   b. BASF.
   c. W.R. Grace & Company.
   d. Euclid Chemical Company.

E. Set-Control Admixtures: ASTM C 494, as follows:

1. Type B, Retarding.
2. Type C, Accelerating.
3. Type D, Water-reducing and Retarding.
4. Type E, Water-reducing and Accelerating.
5. Type F, Water-reducing, high range admixtures.
6. Type G, Water-reducing, high range, and retarding admixtures.

F. Calcium Chloride: Calcium chloride shall not be used.

G. Shrinkage Reducing Admixture:

1. A shrinkage reducing admixture shall be permitted to be used in the mix design where necessary to meet specified shrinkage limitations provided that specified strength requirements are met and there is no reduction in sulfate resistance and no increase in permeability.
2. Shrinkage reducing admixtures shall be one of the following:
   a. Grace Construction Products.
   b. BASF.

H. If superplasticizers are used in mix designs, the mix shall be slumped at site prior to addition of plasticizer.

I. Corrosion Inhibiting Admixtures:

1. Corrosion inhibiting admixture shall be a calcium nitrite solution containing a minimum of 30 percent calcium nitrite. It shall be added at a dosage rate of five gallons per cubic yard of concrete.
2. The quantity of mix water shall be adjusted to account for the water portion of the calcium nitrite solution.
3. As the calcium nitrite solution accelerates setting time, retarding admixtures shall be provided as required.
4. Product and Manufacturer: Provide one of the following:
   a. Grace Construction Products.
   b. BASF.
   c. Euclid Chemical Company.

2.5 PROPORTIONING AND DESIGN OF MIXES

A. Prepare concrete design mixes subject to the following minimum limitations. The final mix design proportions shall be developed by the supplier and shall meet the requirements of this specification:

Classification	Coarse Aggregate[1]		Minimum Cementitious (lbs/cy)	Maximum W/C Ratio[4]	Slump[2]	Air (%) Air	Minimum Compressive Strength[3] (psi)
	Size A	Size B					
Class “A”	#57	#8	564	0.45	4” Max.	5+/-1.5	4000
Class “B”	#57 or #67		517	0.50	4” Max.	5+/-1.5	3500
Class “C”	Any ASTM C 33		<----------no requirements---------->				2000
Class “D”	No requirements						300

1. Coarse aggregate size numbers refer to ASTM C 33. Where a size A and B are listed, it is intended that the smaller size B aggregate is to be added, replacing a portion of the coarse and /or fine aggregate, in the minimum amount necessary to make a workable and pumpable mix with a sand content not exceeding 41 percent of total aggregate.
2. The slumps listed are prior to the addition of high range water reducer (super plasticizer).
3. Mix designs shall be made for all but Class C, which does not require a trial batch, so that the compressive strength achieved for the laboratory trial batches will be no less than 125 percent of the specified design strength. This is to assure meeting the design strength for all concrete batched during the project. Design compressive strength shall be based on 28-day strengths.
4. The quantity of water to be used in the determination of the water-cementitious materials ratio shall include free water on aggregates in excess of SSD and the water portion of admixtures.

B. Use an independent testing facility acceptable to Engineer for preparing and reporting proposed mix designs.

1. The testing facility shall not be the same as used for field quality control testing.

C. Submit written reports of laboratory trial batch test results for proposed mixes of concrete to Engineer at least 15 days prior to start of Work. Do not begin concrete production until mixes have been approved by Engineer.

D. Adjustment to Concrete Mixes: Mix design adjustments may be requested by Contractor when characteristics of materials, job conditions, weather, test results, or other circumstances warrant; at no additional cost to the District and as accepted by Engineer. Laboratory test data for revised mix designs and strength results must be submitted to and accepted by Engineer before using the revised mixes.

E. Admixtures:

1. Use air-entraining admixture in all concrete, unless otherwise shown or specified. Add air-entraining admixture at the manufacturer's prescribed rate to result in concrete at the point of placement having air content within the prescribed limits.
2. Water reducing or high-range water reducing admixtures shall be used in all Class A concrete.
3. Use amounts of admixtures as recommended by the manufacturer for climatic conditions prevailing at the time of placing. Adjust quantities and types of admixtures as required to maintain quality control.

F. Slump Limits With High Range Water Reducer:

1. Slump shall not exceed that specified in item A above prior to adding high range water-reducer and shall not exceed 7.5 inches, measured at point of placement, after adding high range water reducer.

G. Shrinkage Limitation:

1. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age shall be 0.039 percent or 0.045 percent, respectively. Contractor shall only use a mix design for construction that has first met the trial batch shrinkage requirements. Shrinkage limitations apply only to Class A concretes.
2. If the trial batch results fail to meet the shrinkage limitation, the mix shall be redesigned to reduce shrinkage. Alternately, Contractor may use a higher shrinkage mix when acceptable to the Engineer provided that the amount of shrinkage reinforcement in the structures is increased as determined by the Engineer to resist the higher levels of shrinkage stresses. The additional reinforcing shall be provided at Contractor’s expense.

H. Size of Coarse Aggregate: The nominal maximum size of coarse aggregate shall be one-inch but not exceed three-fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between side forms, or one-third of the thickness of slabs or toppings

2.6 BONDING AGENT

A. Provide epoxy and epoxy-cement bonding agents as specified in Section 03 15 16, Concrete Joints.

2.7 CONCRETE CURING MATERIALS

A. Absorptive Cover: Burlap cloth made from jute or kenaf, weighing approximately 10 ounces per square yard and complying with AASHTO M 182, Class 3.

B. Curing Mats: Curing mats shall be heavy carpets or cotton mats, quilted at 4-inches on center. Curing mats shall weigh a minimum of 12 ounces per square yard when dry.

C. Moisture Retaining Cover: One of the following, complying with ASTM C 171.
   1. Waterproof paper.
   2. Polyethylene film.
   3. White burlap-polyethylene sheet.

D. Curing Compound: ASTM C 309 Type 1-D (water retention requirements):
   1. Provide fugitive dye.
   2. Product and Manufacturer: Provide one of the following:
      a. Super Aqua Cure VOX, as manufactured by The Euclid Chemical Company.
      b. Sealtight 1100, as manufactured by W.R. Meadows, Incorporated.
      c. MasterKure, as manufactured by BASF.
   3. Curing compound must be applied by roller or power sprayer.

2.8 FINISHING AIDS

A. Evaporation Retardant:
   1. Product and Manufacturer: Provide one of the following:
      a. Confilm, as manufactured by BASF.
      b. Eucobar, as manufactured by Euclid Chemical Company.
      c. SikaFilm by Sika Corporation.

2.9 CRACK INJECTION MATERIALS

A. Epoxy:
   1. Epoxy for injection shall be a low viscosity, high modulus moisture insensitive type.
   2. Products and Manufacturers: Provide one of the following:
      a. Sikadur 35, Hi-Mod L.V. and Sikadur 31, Hi-Mod Gel, as manufactured by Sika Corporation.
      b. Eucopoxy Injection Resin, as manufactured by The Euclid Chemical Company.

B. Hydrophilic Resin:
   1. Hydrophilic resin shall be an acrylic-ester based resin with a maximum viscosity of 50 cps. It shall cure into a flexible rubber-like material that has the potential for unrestrained increase in volume in excess of 100 percent in the presence of water.
   2. Products and Manufacturers: Provide one of the following:
      a. Duroseal Inject, as manufactured by BBZ USA, Inc.
      b. Sika Injection 29, by Sika Corporation.

2.10 CONCRETE REPAIR MATERIALS

A. Concrete repair mortar shall be a prepackaged polymer-modified cementitious repair mortar with the following minimum properties:
   1. Compressive strength at one day: 2000 psi (ASTM C 109).

2. Compressive strength at 28 days: 6000 psi (ASTM C 109).
3. Bond strength at 28 days: 1800 psi (ASTM C 882 modified).

B. Concrete repair mortar shall be:

1. Five Star Structural Concrete, manufactured by Five Star Products, Inc. The formulation recommended by the manufacturer for the specific application conditions shall be used.
2. SikaTop 122 Plus, SikaTop 123 Plus, SikaTop 111 Plus, or Sikacem 133, manufactured by the Sika Corporation. The formulation, among those listed, recommended by the manufacturer for the specific application conditions shall be used.
3. MasterEmaco S488 CI or S466 CI, manufactured by Master Builders Inc. The formulation, among those listed, recommended by the manufacturer for the specific application conditions shall be used.
4. Verticoat, Verticoat Supreme, or Euco SR-VO, manufactured by the Euclid Chemical Company. The formulation, among those listed, recommended by the manufacturer for the specific application conditions shall be used.

C. Cement Mortar: Cement mortar shall consist of a mix of one part cement to 1 1/2 parts sand with sufficient water to form a trowelable consistency. Minimum compressive strength at 28 days shall be 4000 psi. Where required to match the color of adjacent concrete surfaces, white portland cement shall be blended with standard portland cement so that, when dry, the patching mortar shall match the color of the surrounding concrete.

2.11 MOISTURE BARRIER

A. Moisture Barrier: ASTM E 154:

1. Provide moisture barrier cover over prepared base material or carton void form at all buildings and where shown on the Drawings. Use polyethylene membrane not less than 10 mils thick, lapping at least 9-inches at joints.

PART 3 - EXECUTION

3.1 INSPECTION

A. Contractor shall examine the substrate and the conditions under which Work is to be performed and notify Engineer, in writing, of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 CONCRETE MIXING

A. General:

1. Concrete may be produced at batch plants or it may be produced by the ready-mixed process. Batch plants shall comply with the recommendations of ACI 304, and shall have sufficient capacity to produce concrete of the qualities specified, in quantities required to meet the construction schedule. All plant facilities are subject to testing laboratory inspection and acceptance of the District.
2. Mixing:

a. Mix concrete with an approved rotating type batch machine, except where hand mixing of very small quantities may be permitted.
b. Remove hardened accumulations of cement and concrete frequently from drum and blades to assure acceptable mixing action.
c. Replace mixer blades when they have lost ten percent of their original height.
d. Use quantities such that a whole number of bags of cement is required, unless otherwise permitted.

B. Ready-Mix Concrete:

1. Comply with the requirements of ASTM C 94, and as herein specified. Proposed changes in mixing procedures, other than herein specified, must be accepted by Engineer before implementation.
   a. Plant equipment and facilities: Conform to National Ready-Mix Concrete Association "Plant and Delivery Equipment Specification".
   b. Mix concrete in revolving type truck mixers that are in good condition and which produce thoroughly mixed concrete of the specified consistency and strength.
   c. Do not exceed the proper capacity of the mixer.
   d. Mix concrete for a minimum of two minutes after arrival at the job site, or as recommended by the mixer manufacturer.
   e. Do not allow the drum to mix while in transit.
   f. Mix at proper speed until concrete is discharged.
   g. Maintain adequate facilities at the job site for continuous delivery of concrete at the required rates.
   h. Provide access to the mixing plant for Engineer at all times.

C. Maintain equipment in proper operating condition, with drums cleaned before charging each batch. Schedule rates of delivery in order to prevent delay of placing the concrete after mixing, or holding dry-mixed materials too long in the mixer before the addition of water and admixtures.

3.3 TRANSPORTING CONCRETE

A. Transport and place concrete not more than 90 minutes when ambient temperatures are below 80 degrees and 60 minutes when temperatures are above 80 degrees, after water has been added to the dry ingredients. Any time beyond that specified is subject for immediate rejection by the District’s representative.

B. Take care to avoid spilling and separation of the mixture during transportation.

C. Do not place concrete in which the ingredients have been separated.

D. Do not retemper partially set concrete.

E. Use suitable and approved equipment for transporting concrete from mixer to forms.

F. Transport and deliver concrete in equipment conforming to ASTM C94.

3.4 PREPARATION FOR CONCRETING

A. All reinforcement, installation of waterstop and positioning of embedded items shall be inspected and approved by the District’s representative a minimum of four hours prior to concrete placement.

B. Subgrade surfaces shall be thoroughly wetted by sprinkling, prior to the placing of any concrete, and these surfaces shall be kept moist by frequent sprinkling up to the time of

placing concrete thereon. The surface shall be free from standing water, mud, and debris at the time of placing concrete.

C. All reinforcing steel and embedded items shall be completely cleaned of mortar, loose rust, form release compounds, dirt, or any other substance which would interfere with proper bonding with concrete. Protective coatings on embedded aluminum items shall continuously cover the surface to be in contact with concrete. Any defects in the coating shall be repaired.

D. No concrete shall be placed in any structure until all water entering the space to be filled with concrete has been properly cut off or has been diverted by pipes, or other means, and carried out of the forms, clear of the work. No concrete shall be deposited underwater nor shall Contractor allow still water to rise on any concrete until the concrete has attained its initial set. Water shall not be permitted to flow over the surface of any concrete in such manner and at such velocity as will injure the surface finish of the concrete. Pumping or other necessary dewatering operations for removing ground water, if required, will be subject to the review of the Engineer.

E. Joint surfaces shall be prepared as required by Section 03 15 16, Concrete Joints.

3.5 CONCRETE PLACEMENT

A. General: Place concrete continuously so that no concrete will be placed on concrete that has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, provide construction joints as specified in Section 03 15 16, Concrete Joints. Deposit concrete as nearly as practical in its final location to avoid segregation due to rehandling or flowing. Do not subject concrete to any procedure which will cause segregation.

1. Screed concrete that is to receive other construction to the proper level to avoid excessive skimming or grouting.
2. Do not use concrete which becomes non-plastic and unworkable, or does not meet the required quality control limits, or which has been contaminated by foreign materials. Do not use retempered concrete. Remove rejected concrete from the job site and dispose of it in an acceptable location.
3. Do not place concrete until all forms, bracing, reinforcement, and embedded items are in final and secure position.
4. Do not place footings in freezing weather unless adequate precautions are taken against frost action.
5. Do not place footings, piers or pile caps on frozen soil.
6. Unless otherwise approved, place concrete only when Engineer is present.
7. Allow a minimum of three days before placing concrete against a slab or wall already in place.

B. Bonding For Next Concrete Pour:

1. Prepare for bonding of fresh concrete to new concrete that has set but is not fully cured, as follows:
   a. Thoroughly wet the surface, but allow no free-standing water.
   b. For horizontal surfaces place a 2-inch layer of mortar, one part sand and one part cement with water added to a flowable consistency, or a 6-inch layer of Construction Joint Grout, as specified in Section 03 60 00, Grout, over the hardened concrete surface.

c. Place fresh concrete before the mortar/grout has attained its initial set.
d. If a high range water reducer is used to increase the concrete slump to at least 6-inches, the mortar/grout layer may be omitted.

2. Bonding of fresh concrete to fully-cured hardened existing concrete shall be accomplished by using a bonding agent as specified in Section 03 15 16, Concrete Joints.

C. Concrete Conveying:

1. Handle concrete from the point of delivery and transfer to the concrete conveying equipment and to the locations of final deposit as rapidly as practical by methods that will prevent segregation and loss of concrete mix materials.

2. Provide mechanical equipment for conveying concrete to ensure a continuous flow of concrete at the delivery end. Provide runways for wheeled concrete conveying equipment from the concrete delivery point to the locations of final deposit. Keep interior surfaces of conveying equipment, including chutes, free of hardened concrete, debris, water, snow, ice and other deleterious materials.

3. Do not use chutes for distributing concrete, unless approved in writing by Engineer.
a. Provide sketches showing methods by which chutes will be employed when requesting such approval.
b. Design chutes, if permitted, with proper slopes and supports to permit efficient handling of the concrete.

4. Pumping concrete is permitted, however do not use aluminum pipe for conveying.

D. Placing Concrete Into Forms:

1. Deposit concrete in forms in horizontal layers not deeper than 18-inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place concrete at such a rate that concrete that is being integrated with fresh concrete is still plastic.

2. Do not permit concrete to free fall within the form from a distance exceeding four feet. Where high range water reducer is used to extend slump to at least 6- inches, the maximum free fall of concrete may be increased to six feet. If a 12-inch thick layer of construction joint grout, as specified in Section 03 15 16, Concrete Joints, is placed on the horizontal joint, concrete with slump extended by a high range water reducer may free fall up to eight feet in walls that are 24-inches and thicker. Use "elephant trunks" to prevent free fall and excessive splashing on forms and reinforcement. Free falls in excess of four feet shall be discontinued if there is any evidence of segregation.

3. Remove temporary spreaders in forms when concrete placing has reached the elevation of such spreaders.

4. Consolidate concrete placed in forms by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with the applicable recommended practices of ACI 309. Vibration of forms and reinforcing will not be permitted, unless otherwise accepted by Engineer.

5. Where height of concrete placement in walls exceeds 8 feet, temporary windows shall be installed in the formwork to facilitate vibration. The windows shall be properly closed when the height of concrete approaches the windows. Location,

size, and spacing of the windows shall be determined by Contractor to suit equipment used.

6. Do not use vibrators to transport concrete inside of forms. Insert and withdraw vibrators vertically at uniformly spaced locations not farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate the layer of concrete and at least 6-inches into the preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit the duration of vibration to the time necessary to consolidate the concrete and complete embedment of reinforcement and other embedded items without causing segregation of the mix.
7. Do not place concrete in beam and slab forms until the concrete previously placed in columns and walls is no longer plastic.
8. Force concrete under pipes, sleeves, openings and inserts from one side until visible from the other side to prevent voids.

E. Placing Concrete Slabs:

1. Deposit and consolidate concrete slabs in a continuous operation, within the limits of construction joints, until the placing of a panel or section is completed.
2. Consolidate concrete during placing operations using mechanical vibrating equipment, so that concrete is thoroughly worked around reinforcement and other embedded items and into corners.
3. Consolidate concrete placed in beams and girders of supported slabs, and against bulkheads of slabs on ground, as specified for formed concrete structures.
4. Bring slab surfaces to the correct level. Smooth the surface, leaving it free of humps or hollows. Do not sprinkle water on the plastic surface. Do not disturb the slab surfaces prior to beginning finishing operations.
5. Where slabs are placed in conditions of high temperature or wind that could lead to formation of plastic shrinkage cracks, an evaporation retardant shall be applied in accordance with the manufacturer's recommendations, when required by the Engineer.

F. Quality Of Concrete Work:

1. Make all concrete solid, compact and smooth, and free of laitance, cracks and cold joints.
2. All concrete for liquid retaining structures, and all concrete in contact with earth, water, or exposed directly to the elements shall be watertight.
3. Cut out and properly replace to the extent directed by Engineer, or repair to the satisfaction of Engineer, surfaces which contain cracks or voids, are unduly rough, or are in any way defective. Thin patches or plastering shall not be acceptable.
4. All leaks through concrete that exhibit any flowing water, and cracks, holes or other defective concrete in areas of potential leakage, shall be repaired and made watertight by Contractor.
5. Repair, removal, and replacement of defective concrete as directed by Engineer shall be at no additional cost to the District.

G. Cold Weather Placing:

1. Protect all concrete Work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures, in compliance with the requirements of ACI 306 and as herein specified.
2. When the air temperature has fallen to or may be expected to fall below 40°F, provide adequate means to maintain the temperature, in the area where concrete is being placed, at between 50°F and 70°F for at least seven days after placing. Provide temporary housings or coverings including tarpaulins or plastic film. Maintain the heat and protection, if necessary, to ensure that the ambient temperature does not fall more than 30°F in the 24 hours following the seven-day period. Avoid rapid dry-out of concrete due to overheating, and avoid thermal shock due to sudden cooling or heating.
3. When air temperature has fallen to or is expected to fall below 40°F, uniformly heat all water and aggregates before mixing as required to obtain a concrete mixture temperature of not less than 55°F and not more than 85°F at point of placement.
4. Do not use frozen materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials. Ascertain that forms, reinforcing steel, and adjacent concrete surfaces are entirely free of frost, snow and ice before placing concrete.
5. Do not use salt and other materials containing antifreeze agents or chemical accelerators, or set-control admixtures, unless approved by Engineer, in mix designs.

H. Hot Weather Placing:

1. For conventional concrete:
   a. When hot weather conditions exist that would seriously impair the quality and strength of concrete, place concrete in compliance with ACI 305 and as herein specified.
   b. When ambient air temperature is at or above 85°F, cool ingredients before mixing to maintain concrete temperature at the time of placement below 90°F for horizontal placements including slabs and flatwork, and below 95°F for vertical placements including walls and columns. Mixing water may be chilled, or chopped ice may be used to control the concrete temperature provided the water equivalent of the ice is calculated in the total amount of mixing water. In addition, the reduction in time from addition of mix water to placement or the use of a set retarding admixture may be required.
   c. Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that the steel temperature will not exceed the ambient air temperature immediately before embedment in concrete.
   d. Wet forms thoroughly before placing concrete.
   e. Do not place concrete at a temperature so as to cause difficulty from loss of slump, flash set, or cold joints.
   f. Do not use set-control admixtures, unless approved by Engineer in mix designs.
   g. Obtain Engineer's approval of other methods and materials proposed for use.

3.6 FINISH OF FORMED SURFACES

A. Standard Form Finish:

1. Standard form finish shall be basically smooth and even but shall be permitted to have texture imparted by the form material used. Defects shall be repaired as specified herein.
2. Use standard form finish for the following:
   a. Exterior vertical surfaces from the foundation up to one foot below grade.
   b. Vertical surfaces not exposed to view.
   c. Other areas shown.

B. Smooth Form Finish:

1. Produce smooth form finish by selecting form materials that will impart a smooth, hard, uniform texture. Arrange panels in an orderly and symmetrical manner with a minimum of seams. Repair and patch defective areas as specified herein.
2. Use smooth form finish for the following:
   a. Exterior surfaces that are exposed to view.
   b. Surfaces that are to be covered with a coating material. The material may be applied directly to the concrete or may be a covering bonded to the concrete such as waterproofing, dampproofing, painting or other similar system.
   c. Interior vertical surfaces of liquid containers.
   d. Interior and exterior exposed beams and undersides of slabs.
   e. Surfaces to receive an abrasive blasted finish.
   f. Surfaces to receive a smooth rubbed or grout cleaned finish.
   g. Other areas shown.

C. Smooth Rubbed Finish:

1. Provide smooth, Class A, rubbed finish to concrete surfaces, which have received smooth form finish and where all defects have been repaired, as follows:
   a. Rubbing of concrete surfaces not later than the day after form removal.
   b. Moistening of concrete surfaces and rubbing with carborundum brick or other abrasive until a uniform color and texture is produced. Do not apply cement grout other than that created by the rubbing process.
2. Except where surfaces have been previously covered as specified above, use smooth, Class A, rubbed finish for the following:
   a. Interior exposed walls and other vertical surfaces.
   b. Exterior exposed walls and other vertical surfaces down to one foot below grade.
   c. Interior and exterior horizontal surfaces, except exterior exposed slabs and steps.
   d. Interior exposed vertical surfaces of liquid containers down to one foot below liquid level.
   e. Other areas shown on the Drawings.

D. Abrasive Blasted Finish:

1. Provide abrasive blasted finish where shown on the Drawings.
2. Where abrasive blasted finish is indicated, it shall be applied to a smooth formed finish after the end of the curing period, with all defects repaired, to match the approved finish provided on the mock-up panel.
3. Heavy Abrasive Blasted Finish: Abrasive blast to uniformly expose coarse aggregate.
4. Light Abrasive Blasted Finish: Abrasive blast to uniformly expose fine aggregate.

E. Related Unformed Surfaces:

1. At tops of walls, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces, strike off smooth and finish with a texture matching the adjacent formed surfaces. Continue the final surface treatment of formed surfaces uniformly across the adjacent unformed surfaces, unless otherwise shown.

3.7 SLAB FINISHES

A. Float Finish:

1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when the surface water has disappeared or when the concrete has stiffened sufficiently. Check and level the surface plane to a tolerance not exceeding 1/4-inch in ten feet when tested with a ten-foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill all low spots. Uniformly slope surfaces to drains. Immediately after leveling, refloat the surface to a uniform, smooth, granular texture.
2. Use float finish for the following:
   a. Interior exposed horizontal surfaces of liquid containers, except those to receive grout topping.
   b. Exterior below grade horizontal surfaces.
   c. Surfaces to receive additional finishes, except as shown on the Drawings or specified.

B. Trowel Finish:

1. After concrete has stiffened sufficiently to permit operation and after bleed water has disappeared, hand or machine float the surface. Follow immediately by steel troweling at least twice with hand or machine trowels.
2. Consolidate the concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8-inch in ten feet when tested with a ten-foot straight edge. Grind smooth surface defects that would telegraph through applied floor covering system.
3. Use trowel finish for the following:
   a. Interior exposed slabs, unless otherwise shown or specified.
   b. Slabs to receive resilient floor finishes.

C. Non-Slip Broom Finish:

1. Immediately after float finishing, slightly roughen the concrete surface by brooming in the direction perpendicular to the main traffic route. Use fine fiber-bristle broom, unless otherwise directed by the Engineer. Coordinate the required final finish with Engineer before application.
2. Use Non-Slip Broom Finish for the following:
   a. Exterior exposed horizontal surfaces subject to light foot traffic.
   b. Interior and exterior concrete steps and ramps.
   c. Horizontal surfaces which will receive a grout topping or a concrete equipment base slab.

3.8 CONCRETE CURING AND PROTECTION

A. General:

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperature, and maintain without drying at a relatively constant temperature for the period of time necessary for hydration of the cement and proper hardening of the concrete.
2. Start initial curing after placing and finishing concrete as soon as free moisture has disappeared from the concrete surface. Keep continuously moist for not less than 72 hours. At the end of this period, initial curing may be terminated and final curing begun.
3. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least seven days and in accordance with ACI 301 procedures for a total curing period, initial plus final, of at least ten days. For concrete sections over 30-inches thick, continue final curing for an additional seven days, minimum. Avoid rapid drying at the end of the final curing period.

B. Curing Methods:

1. Water retaining and below grade structures shall be moist cured by the addition of water to maintain the surface in a continually wet condition. Other concrete shall be cured by moist curing, by moisture retaining cover curing, or by the use of curing compound (except where coatings or surface treatments are specified). Use curing compound at water retaining and below grade structures only in cold weather when temperatures are expected to be below freezing only when permitted by Engineer.
   a. For curing, use water that is free of impurities that could etch or discolor exposed, natural concrete surfaces.
2. Provide moisture curing by any of the following methods:
   a. Keeping the surface of the concrete continuously wet by covering with water.
   b. Continuous water-fog spray.
   c. Covering the concrete surface with curing mats, thoroughly saturating the mats with water, and keeping the mats continuously wet with sprinklers or porous hoses. Place curing mats so as to provide coverage of the concrete surfaces and edges, with a 4-inch lap over adjacent mats. If necessary, the curing cover shall be weighted to maintain contact with the concrete surface.
   d. At the end of the curing period apply one coat of curing compound, unless concrete surface is to receive a topping or coating or application is waived by the Engineer.
3. Provide moisture retaining cover curing as follows:
   a. Cover the concrete surfaces with the specified moisture retaining cover for curing concrete, placed in the widest practical width with sides and ends lapped at least 3-inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during the curing period using cover material and waterproof tape.
4. Provide liquid curing compound as follows:
   a. Apply the specified curing compound to all concrete surfaces when permitted by Engineer. Slabs to receive terrazzo floors, chemical resistant heavy duty concrete topping or ceramic tile or chemical hardeners, shall not be cured with liquid curing compound, but shall be moisture cured. The compounds shall be applied immediately after final finishing in a continuous operation by power spray equipment in accordance with the manufacturer's directions. Recoat

areas that are subjected to heavy rainfall within three hours after initial application. Maintain the continuity of the coating and repair damage to the coat during the entire curing period.

b. When curing compound is authorized for application to water retaining or below grade members, it shall be applied at the manufacturer's recommended coverage rate and then applied again at the same rate to provide twice the recommended coverage.

c. At the end of the curing period, curing compound shall be removed where required by the Engineer.

C. Curing Formed Surfaces:

1. Cure formed concrete surfaces, including the undersides of girders, beams, supported slabs and other similar surfaces by moist curing with the forms in place unloosened for the full curing period or until forms are removed. Where wood forms are kept in place, water shall be added to keep the forms wet. If forms are removed, continue curing by methods specified above, as applicable.

D. Curing Unformed Surfaces:

1. Initially cure unformed surfaces, such as slabs, floor topping, and other flat surfaces by using the appropriate method specified above.

2. Final cure unformed surfaces, unless otherwise specified, by utilizing methods specified above, as applicable.

E. Temperature Of Concrete During Curing:

1. When the atmospheric temperature is 40°F and below, maintain the concrete temperature between 50°F and 70°F continuously throughout the curing period. When necessary, make arrangement before concrete placing for heating, covering, insulation or housing as required to maintain the specified temperature and moisture conditions continuously for the concrete curing period. Provide cold weather protection complying with the requirements of ACI 306.

2. When the atmospheric temperature is 80°F and above, or during other climatic conditions which will cause too rapid drying of the concrete, make arrangements before the start of concrete placing for the installation of wind breaks or shading, and for fog spraying, wet sprinkling, or moisture retaining covering. Protect the concrete continuously for the concrete curing period. Provide hot weather protection complying with the requirements of ACI 305, unless otherwise specified.

3. Maintain concrete temperature as uniformly as possible, and protect from rapid atmospheric temperature changes. Avoid temperature changes in concrete which exceed 5°F in any one hour and 40°F in any 24-hour period. Provide necessary heating or cooling as required to prevent such temperature changes.

F. Protection From Mechanical Injury:

1. During the curing period, protect concrete from damaging mechanical disturbances including load stresses, heavy shock, excessive vibration, and from damage caused by rain or flowing water. Protect all finished concrete surfaces from damage by subsequent construction operations.

3.9 FIELD QUALITY CONTROL

A. The Contractor shall employ a testing laboratory in accordance with Section 01 45 23 to perform field quality control testing. Engineer will direct the number of tests and cylinders required. Contractor shall make standard compression test cylinders and entrained air tests as specified below, under the direct inspection by Engineer. Contractor shall also provide all labor, material and equipment required including, scale, glass tray, cones, rods, molds, air tester, thermometer, curing in a heated storage box, and all other incidentals required. Above will be subject to approval by Engineer. Contractor shall furnish all necessary storage, curing, and transportation required by the testing.

B. Quality Control Testing During Construction:

1. Perform sampling and testing for field quality control during the placement of concrete, as follows:
   a. Sampling Fresh Concrete: ASTM C 172.
   b. Concrete sampling for quality assurance: Concrete that is to be pumped or conveyed by bucket or crane shall be sampled at the point of discharge from the truck for information, including slump; and shall be sampled at the point of placement for acceptance of slump and air content.
   c. Slump: ASTM C 143; one test for each concrete load at point of discharge; and one for each set of compressive strength test specimens.
   d. Air Content: ASTM C 231; one for every other concrete load at point of discharge, or when required by an indication of change.
   e. Compressive Strength Tests: ASTM C 39; one set of compression cylinders for each 50 cubic yards or fraction thereof, of each mix design placed in any one day; one specimen tested at seven days, and three specimens tested at 28 days.
      1) Adjust mix if test results are unsatisfactory and resubmit for Engineer's approval.
      2) Concrete that does not meet the strength requirements is subject to rejection and removal from the Work, or to other such corrective measures as directed by Engineer, at the expense of Contractor.
   f. Compression Test Specimens: ASTM C 31; make one set of four standard cylinders for each compressive strength test, unless otherwise directed by the Engineer.
      1) Cast, store and cure specimens as specified in ASTM C 31.
   g. Water Cementitious Materials Ratio: Perform one test from each sample from which compression test specimens are taken in accordance with AASHTO TP 23.
   h. Concrete Temperature: Test hourly when air temperature is 40°F and below, and when 80°F and above; and each time a set of compression test specimens is made.
2. The testing laboratory shall submit certified copies of test results directly to Engineer and Contractor within 24 hours after tests are made.
3. Representatives of the following testing agency will inspect, sample, and/or test materials. When it appears that the material furnished or work performed fails to conform to the Contract Documents, the testing agency will immediately report such deficiency to the District's representative, Engineer, and Contractor.

4. The testing agency and its representative are not authorized to revoke, alter, relax, or release any requirements of the Contract Documents, nor to accept any portion of the Work.
5. The testing agency will report test and inspection results that pertain to the Work to the Engineer, Contractor and District's representative within 7 days after tests and inspections are performed.
6. Other Testing Services: The Contractor shall pay for the following testing services performed, when necessary and/or requested by the District:
    a. Additional testing and inspection required due to changes in materials or mixture proportions requested by the Contractor.
    b. Additional testing of materials or concrete due to failure to meet requirements of the Contract Documents.

C. Evaluation Of Quality Control Tests:

1. Do not use concrete delivered to the final point of placement, which has slump or total air content outside the specified values.
2. When water content testing indicates water-cementitious materials ratio to exceed specified requirements by more than 0.02, remaining batches needed to complete the concrete placement shall have water content decreased in the mix and water reducing admixture dosage increased as needed to bring the subsequently batched concrete within the specified water-cementitious materials ratio. Additional testing shall be done to verify compliance with the specified water-cementitious materials ratio. Concrete production for further concrete placements shall not resume until Contractor has identified the cause of the excess water in the mix and revised batching procedures and/or adjustments to mix design needed to bring water-cementitious materials ratio into conformance with specified requirements have been accepted by the Engineer.
3. Compressive strength tests for laboratory-cured cylinders will be considered satisfactory if the averages of all sets of three consecutive compressive strength tests results equal or exceed the 28-day design compressive strength of the type or class of concrete; and, no individual strength test falls below the required compressive strength by more than 500 psi.
    a. Where questionable field conditions may exist during placing concrete or immediately thereafter, strength tests of specimens cured under field conditions will be required by Engineer to check the adequacy of curing and protecting of the concrete placed. Specimens shall be molded at the same time and from the same samples as the laboratory cured specimens.
        1) Provide improved means and procedures for protecting concrete when the 28-day compressive strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders.
        2) When laboratory-cured cylinder strengths are appreciably higher than the minimum required compressive strength, field-cured cylinder strengths need not exceed the minimum required compressive strength by more than 500 psi even though the 85 percent criterion is not met.

3) If individual tests of laboratory-cured specimens produce strengths more than 500 psi below the required minimum compressive strength, or if tests of field-cured cylinders indicate deficiencies in protection and curing, provide additional measures to assure that the load-bearing capacity of the structure is not jeopardized. If the likelihood of low-strength concrete is confirmed and computations indicate the load-bearing capacity may have been significantly reduced, tests of cores drilled from the area in question will be required at Contractor's expense.

b. If the compressive strength tests fail to meet the minimum requirements specified, the concrete represented by such tests will be considered deficient in strength and subject to replacement, reconstruction or to other action approved by Engineer.

D. Testing Concrete Structure For Strength:

1. When there is evidence that the strength of the in-place concrete does not meet specification requirements, Contractor shall employ at its expense the services of a concrete testing service to take cores drilled from hardened concrete for compressive strength determination. Tests shall comply with the requirements of ASTM C 42 and the following:
   a. Take at least three representative cores from each member or suspect area at locations directed by Engineer.
   b. Strength of concrete for each series of cores will be considered satisfactory if their average compressive strength is at least 85 percent and no single core is less than 75 percent of the 28-day required compressive strength.
   c. Report test results to Engineer, in writing, on the same day that tests are made. Include in test reports, the Project Identification Name and Number, date, name of Contractor, name of concrete testing service, location of test core in the structure, type or class of concrete represented by core sample, nominal maximum size aggregate, design compressive strength, compression breaking strength and type of break (corrected for length-diameter ratio), direction of applied load to core with respect to horizontal plane of the concrete as placed, and the moisture condition of the core at time of testing.
2. Fill core holes solid with non-shrink, high strength grout, and finish to match adjacent concrete surfaces.
3. Conduct static load test and evaluations complying with the requirements of ACI 318 if the results of the core tests are unsatisfactory, or if core tests are impractical to obtain, as directed by Engineer.

3.10 MISCELLANEOUS CONCRETE ITEMS

A. Temporary Openings:

1. Openings in concrete walls and/or slabs required for passage of Work or installation of equipment and not shown on the Drawings shall be provided, but only with approval of the Engineer.
2. All temporary openings made in concrete shall be provided with waterstop in below grade or water retaining members. Continuity of required reinforcement shall be provided in a manner acceptable to the Engineer.

3. Temporary openings left in concrete structures shall be filled with concrete after the Work causing the need for the opening is in place, unless otherwise shown or directed by the Engineer. Mix, place and cure concrete as specified herein, to blend with in-place construction. Provide all other miscellaneous concrete filling shown or required to complete the Work.

B. Equipment Bases:

1. Unless specifically shown otherwise, provide concrete bases for all pumps and other equipment. Contractor shall coordinate and construct bases to the dimensions shown, or as required to meet manufacturers; requirements and Drawing elevations. Where no specific elevations are shown, bases shall be 6-inches thick and extend 3-inches outside the metal equipment base or supports. Bases shall have smooth trowel finish, unless a special finish such as terrazzo, ceramic tile or heavy duty concrete topping is required. In those cases, provide appropriate concrete finish.
2. Include all concrete equipment base work not specifically included under other Sections.
3. In general, place bases up to 1-inch below the metal base. Properly shim equipment to grade and fill 1-inch void with non-shrink grout as specified in Section 03 60 00, Grout.

C. Curbs:

1. Provide monolithic finish to interior curbs by stripping forms while concrete is still green and steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
2. Exterior curbs shall have rubbed finish for vertical surfaces and a broomed finish for top surfaces.

3.11 CONCRETE REPAIRS

A. Repair of Formed Surfaces:

1. The following defects shall be repaired in all types of formed finishes:
   a. Spalls, bugholes, honeycombs, air bubbles, rock pockets, form depressions, and other defects that are more than 1/4-inch in depth.
   b. Holes from tie rods and other form tie systems.
   c. Fins, offsets and other projections that extend more than 1/4-inch beyond the designated member surface.
   d. Structural cracks, as defined by the Engineer.
   e. Non-structural cracks, as defined by the Engineer, which are greater than 0.010-inch wide. In water retaining members, elevated slabs subject to rainfall and washdown, and below grade members, any crack that shows any amount of leakage. Where it is not possible to verify that a crack is not leaking, it shall be repaired.
2. The following defects shall be repaired in smooth finish surfaces, in addition to those listed above:
   a. Spalls, air bubbles, bugholes, honeycombs, rock pockets, form depressions, and other defects which extend to more than 1/2-inch in width in any direction, no matter how deep.
   b. Spalls, air bubbles, rock pockets, form depressions, and other defects of any size that exceed three in number in a 12-inch square or 12 in number in a three-foot square.

c. Fins, offsets and other projections shall be completely removed and smoothed.
d. Scratches and gouges in the surface.
e. Texture and color irregularities. At water retaining surfaces, texture and color irregularities need not be repaired when greater than 12-inches below the minimum normal operating water surface, except where such defects are indicative of reduced durability.

3. Where a smooth rubbed or grout cleaned finish is specified, minor surface defects repairable by the finishing process need not be repaired prior to the finish application, when approved by the Engineer.

B. Method Of Repair Of Formed Surfaces:

1. Repair and patch defective areas with cement mortar or concrete repair mortar immediately after removal of forms and as directed by Engineer. Repairs made to water bearing and buried surfaces shall be made with repair mortar only. Repairs of form tie holes on water bearing or buried surfaces shall be made with non-shrink grout as specified in Section 03 60 00, Grout.

2. Cut out honeycomb, rock pockets, voids, and holes left by tie rods and bolts, down to solid concrete but, in no case, to a depth of less than 1-inch for cement mortar and 1/2-inch for repair mortar. Make edges of cuts perpendicular to the concrete surface. Before placing the cement mortar, thoroughly clean and brush-coat the area to be patched with the specified bonding agent. Where concrete repair mortar is used, bonding agent shall be optional and the surface prepared and mortar placed per manufacturers recommendations.
   a. Repairs at exposed-to-view surfaces shall match the color of surrounding concrete, except color matching is not required for the interior surfaces of liquid containers up to one foot below liquid level. Contractor shall impart texture to repaired surfaces to match texture of existing adjacent surfaces. Provide test areas at inconspicuous locations to verify mixture, texture and color match before proceeding with the patching. Compact mortar in place and strike off slightly higher than the surrounding surface.

3. Structural cracks shall be pressure grouted using an injectable epoxy using a pumped pressure system. Apply in accordance with the manufacturer's directions and recommendations.

4. Non-structural cracks shall be pressure grouted using hydrophilic resin. Apply in accordance with the manufacturer's directions and recommendations.

5. Determination of the crack type shall be made by the Engineer.

6. Fill holes extending through concrete by means of a plunger- type gun or other suitable device from the least exposed face, using a flush stop held at the exposed face to ensure completely filling. At below grade and water retaining members, fill holes with concrete repair mortar except use a color matched cement mortar for the outer 2-inches at exposed to view surfaces.

7. Where powerwashing and/or scrubbing is not adequate, abrasive blast exposed-to-view surfaces that require removal of stains, grout accumulations, sealing compounds, and other substances marring the surfaces. Use sand finer than No. 30 and air pressure from 15 to 25 psi.

C. Repair Of Unformed Surfaces:

1. Test unformed surfaces, such as monolithic slabs, for smoothness and to verify surface plane to the tolerances specified for each surface and finish. Correct low and high areas as herein specified.
2. Test unformed surfaces sloped to drain for trueness of slope, in addition to smoothness, using a template having the required slope. Correct high and low areas as herein specified.
3. Repair finish of unformed surfaces that contain defects that adversely affect the durability of the concrete. Surface defects include crazing, cracks in excess of 0.01-inch wide, spalling, popouts, honeycomb, rock pockets, and other objectionable conditions.
4. Repair structural cracks in all structures and non-structural cracks in water-holding structures. In water-holding structures, where the dry face of the concrete member can be observed, cracks that show any rate of water flow shall be repaired. Where the dry face of the member cannot be observed, all cracks shall be repaired.

D. Methods Of Repair Of Unformed Surfaces:

1. Correct high areas in unformed surfaces by grinding, after the concrete has cured sufficiently so that repairs can be made without damage to adjacent areas.
2. Correct low areas in unformed surfaces during, or immediately after completion of surface finishing operations by cutting out the low areas and replacing with fresh concrete. Finish repaired areas to blend into adjacent concrete. Where the concrete has already set and repairs are required, sawcut around the perimeter of the area to be repaired to a 1/2-inch depth and remove concrete so that the minimum thickness of the repair is 1/2-inch. Apply specified concrete repair mortar in accordance with the manufacturer's directions and recommendations.
3. Repair defective areas, except random cracks and single holes not exceeding 1-inch diameter, by cutting out and replacing with fresh concrete. Remove defective areas to sound concrete with clean, square cuts, and expose reinforcing steel with at least 3/4-inch clearance all around. The minimum thickness of the repair shall be 1.5-inches. Dampen all concrete surfaces in contact with patching concrete and brush with the specified bonding agent. Place patching concrete while the bonding agent is still tacky. Mix patching concrete of the same materials and proportions to provide concrete of the same classification as the original adjacent concrete. Place, compact and finish as required to blend with adjacent finished concrete. Cure in the same manner as adjacent concrete.
4. Repair isolated random non-structural cracks (in members which are not below grade or water retaining), and single holes not over 1-inch diameter, by the dry-pack method. Groove the top of cracks, and cut out holes to sound concrete and clean of dust, dirt and loose particles. Dampen all cleaned concrete surfaces and brush with the specified bonding agent. Place dry-pack before the cement grout takes its initial set. Mix dry-pack, consisting of one part portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing. Compact dry-pack mixture in place and finish to match adjacent concrete. Keep patched areas continuously moist for not less than 72 hours.
5. Structural cracks shall be pressure grouted using an injectable epoxy. Apply in accordance with the manufacturer's directions and recommendations.

6. Non-structural cracks in below grade and water retaining structures shall be pressure grouted using hydrophilic resin. Apply in accordance with the manufacturer's directions and recommendations.
7. Determination of the crack type shall be made by the Engineer.
8. Assure that surface is acceptable for flooring material to be installed in accordance with manufacturer's recommendations.

E. Other Methods Of Repair:

1. Repair methods not specified above may be used if approved by Engineer.

END OF SECTION

SECTION 04 22 00
CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Concrete masonry units, custom masonry units, mortar, grout, reinforcement, spray, accessories, and cleaning agents.

B. Products Installed but Not Furnished Under This Section: Pre-fabricated items to be built into concrete unit masonry construction.

1.2 REFERENCES

A. American Society for Testing and Materials:
1. ASTM A 82 - Steel Wire, Plain, for Concrete Reinforcement.
2. ASTM A 615 - Deformed and Plain Billet-Steel Bars for Concrete Reinforcements.
3. ASTM C 33 - Concrete Aggregates.
4. ASTM C 90 - Hollow Load-Bearing Concrete Masonry Units.
5. ASTM C 129 - Non-Load-Bearing Concrete Masonry Units.
6. ASTM C 144 - Aggregate for Masonry Mortar.
7. ASTM C 150 - Portland Cement.
8. ASTM C 207 - Hydrated Lime for Masonry Purposes.
9. ASTM C 270 - Mortar for Unit Masonry.
10. ASTM C 476 - Grout for Reinforced and Non-reinforced Masonry.

B. Brick Institute of America: BIA Technical Notes 8A and 8B.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer's descriptive literature, specifications, installation instructions and application procedures.

B. Samples:
1. Masonry: Furnish two sets of individual samples of each size, shape and type of concrete masonry units including special shapes as requested by Architect.
2. Mortar:
   a. Cubes of hardened, colored mortar, approximately 4" long, for color selection by Architect. Color to match masonry units for fencing only.
   b. Cubes sized as required for testing.
3. Joint Fillers: 6" long section.
4. Anchors, Reinforcements and Ties: Submit samples as requested by Architect.

1.4 QUALITY ASSURANCE

A. Fire Resistance Rated Masonry: UL listed or certified to be in compliance with requirements for materials and installation established by governing authorities for construction and fire-resistance rating indicated

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver masonry materials to project in undamaged condition.

B. Store and handle masonry units and cementitious materials off the ground, under cover, and in a dry location to prevent their deterioration or damage due to moisture, temperature changes, contaminants, corrosion, and other causes. If units become wet, do not place until units are in an air-dried condition.

C. Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.

D. Store masonry accessories including metal items to prevent corrosion and accumulation of dirt and oil.

1.6 PROJECT CONDITIONS

A. Environmental Requirements:

1. Maintain materials and surrounding air temperature to minimum 50 degrees F prior to, during, and 48 hours after completion of masonry work.
2. Cold Weather Protection: When temperature of outside air is below 40 degrees F, pre-condition material and finish work in accordance with "Recommended Practices for Cold Weather Masonry Construction", as published by International Masonry Industry All-Weather Council.
3. Hot Weather Protection: Protect masonry construction from direct exposure to wind and sun when erected in ambient air temperature of 99 degrees F in shade with relative humidity less than 50 percent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Substitutions: Comply with Section 01630.

2.2 MATERIALS:

A. Concrete Masonry Units (Interior Units)

1. ASTM C 90, Grade N (general purpose use above and below grade in exterior walls that may or may not be exposed to moisture/weather, interior walls, back-up material), Type I moisture controlled.
2. Nominal face dimensions: 8" high x 16" long x 8”, 10” and 12” as indicated.
3. Provide standard units.
4. Provide lightweight block.
5. Special Shapes: Bond beams, lintel blocks, sash blocks, bullnose, or other shapes as required.

B. Concrete Masonry Units (Split Face Units – Exterior Exposed Units)

1. ASTM C 90, Grade N-I (for load-bearing units), Type I moisture controlled.
2. Nominal face dimensions: 8" high x 16" long x 8”, 10” and 12” as indicated.
3. Provide standard units and corners

4. Provide units made principally from portland cement and lightweight mineral aggregate per m
5. Special Shapes: Bond beams, lintel blocks, sash blocks, bullnose, or other shapes as required.
6. Basis of Design ; Featherlite Building Products.
   a. Color – Selected by Architect from the full range of colors

C. Concrete Masonry Units (Smooth Face Units – Exterior Exposed Units)

1. ASTM C 90, Grade N-I (for load-bearing units), Type I moisture controlled.
2. Nominal face dimensions: 8" high x 16" long x 8”, 10” and 12” as indicated.
3. Provide standard units and corners
4. Provide units made principally from portland cement and lightweight mineral aggregate per m
5. Special Shapes: Bond beams, lintel blocks, sash blocks, bullnose, or other shapes as required.
6. Basis of Design ; Featherlite Building Products.
   a. Color – Selected by Architect from the full range of colors
7. Moisture resisting admixture: Dry-Block Block Admixture by GCP Applied Technologies.

D. Through Wall Flashing:

1. Asphalt-Coated Copper: Manufacturer's standard 5 oz. sheet copper coated with flexible asphalt.
   a. Acceptable Products:
      1) "Cop-A-Cote" by Afco Products Co.
      2) "Type ACC Bituminous Coated" by Phoenix Building Products.
      3) "Copper Seal" by York Manufacturing, Inc.

E. Horizontal Joint Reinforcing:

1. Continuous open-web welded wire trusses, 9 gage size rods and diagonal ties, hot-dip galvanized after fabrication, welded at 16" intervals to continuous side rods forming truss design, cold drum steel complying with ASTM A 82.
2. Prefabricated corner and "tee" intersecting units.
3. Size for construction detailed.
4. Acceptable Products for Single-Wythe Walls:
   a. Dur-O- Wall by Dur-O-Wal Company.
   b. Block-Trus by AA Wire Products Company.
   c. Trus-Mesh by Hohmann and Barnard.
   d. Truss-Ty by Jim Taylor Company, Inc.

F. Control Joint Filler:

1. Concrete Masonry: Premolded rubber designed for use with standard concrete masonry units, size to fit wall width.
2. Acceptable Products:
   a. Rapid Control Joint by Dur-O-Wal Company.
   b. Blok-Tite by AA Wire Products Company.
   c. Ty-Wal Control Joint by Jim Taylor Company, Inc.

G. Reinforcing Rods: ASTM A 615, Grade 60, deformed; galvanized reinforcing for soffits and beams; rebar positioners.

H. Weeps: One of the following.

a. "Cell Vent Weep Hole" by Dur-O-Wall, Inc.
b. "Wilko" by AA Wire Products, finish color to match masonry unit.

I. Foam Insulation: Refer to Section 07210

J. Portland Cement: ASTM C 150, type I or Type III, nonstaining; use of masonry cement will not be permitted.

K. Hydrated Lime: ASTM C 207, Type

L. Mortar Aggregates:
1. ASTM C 144, free of clay or organic matter.
2. Gradation:

Sieve Size	Percent Passing
No. 4	100
No. 8	95 to 100
No. 16	60 to 100
No. 30	35 to 70
No. 50	15 to 35
No. 100	2 to 15
No. 200	0 to 2

M. Portland Cement Grout Aggregates: ASTM C 33, pea gravel uniformly graded from 3/8" to 1/2".

N. Moisture resisting mortar admixture: Dry Block Mortar Admixture by GCP Applied Technologies

O. Water: Clean and free of deleterious amounts of acids, alkalies, or organic matter, potable.

P. Compressible Filler: Soft neoprene with 5-10 durometer hardness.
Cleaning Agents:
1. Combination of surface acting agents and wetting agent for general purpose cleaning of new masonry surfaces.
2. Acceptable Products: Sure-Klean No. 600 Detergent by ProSoCo, Inc.

2.3 MIXES

A. Mortar Proportions:
1. Load-Bearing Walls (above grade walls only): ASTM C 270, Type S, 1800 psi at 28 days.
2. Load Bearing Walls (below grade walls): ASTM C 270, Type M, 2500 psi at 28 days.
3. Non-Load-Bearing Walls: ASTM C 270, Type N, 750 psi at 28 days.
4. Provide polymeric water repellant admixture at Custom Masonry Units.
5. Follow detailed manufacturer's recommendations for use of Dry-Block moisture repellent admixture.

B. Grout Proportions: Portland cement, sand, pea gravel and water proportioned to produce 3000 psi at 28 days with 9-1/2" slump when placed. Color to match masonry units.

C. Control batching procedure to ensure proper proportions by measuring materials by volume. Measurement by shovel will not be permitted.

D. Mix mortar in accordance with requirements of BIA Technical Notes 8A and 8B and grout in accordance with ASTM C 476.

E. Do not use anti-freeze compounds to lower freezing point of mortar or grout.

F. Use mortar within two hours of mixing at temperatures over 80 degrees F and two and one-half hours at temperatures under 80 degrees F.

G. Use of pre-mixed masonry cement is not permitted.

2.4 SOURCE QUALITY CONTROL

A. Mortar Tests:
1. Laboratory Compressive Strength Tests: ASTM C 270 and C 91.
2. One test during first week of operation.
3. Two tests during each successive week.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine foundation to ensure surfaces to support masonry are proper grade and elevation, and free from dirt or other deleterious matter.

B. Verify items built-in by other trades are properly located and sized.

C. Verify items to be built-in under this Section are fabricated correctly and readily available at project site.
PREPARATION

D. Concrete Masonry Units:
1. Lay only dry units, free of paint, oil, efflorescence or foreign matter.
2. Remove laitance, loose aggregate or anything that prevents bonding to foundation.

E. Reinforcement: Before placing remove ice and other coatings from reinforcement.

F. Use masonry saws to cut concrete masonry units.

G. Establish lines, levels and coursing. Protect layout aids from disturbance.

3.2 INSTALLATION

A. Pattern Bond: Running bond with vertical joints located at centerline of masonry units in alternate courses.

B. General Requirements:

1. Set units plumb, true to line and with level courses accurately spaced within allowed tolerances.
2. Do not install cracked, broken or chipped masonry units exceeding ASTM C 90 allowable requirements.
3. Adjust masonry unit to final position while mortar is soft and plastic.
4. Where adjustment must be made or if units are displaced after mortar has stiffened, remove units, clean joints and units of mortar, and replace with fresh mortar.
5. Do not pound corners and jambs to fit stretcher units after they are set in position.

C. Mortar Beds:

1. Hollow units:
    a. Lay with full mortar coverage on horizontal and vertical face shells.
    b. Provide full mortar coverage on horizontal and vertical face shells and webs where adjacent to cells or cavities to be filled with grout.
    c. Use concrete block for fill-in material.
2. Solid units:
    a. Lay with completely filled mortar joints.
    b. Do not furrow bed joints.
    c. Butter ends of solid units with sufficient mortar to fill head joints.
    d. Rock closures into place with head joints thrown against two adjacent units in place.

D. Horizontal and Vertical Face Joints:
1. Construct uniform joints, 3/8" nominal thickness.
2. Tool concave joints in exposed surfaces when thumb-print hard with round jointed slightly larger than width of joint.
3. Flush cut joints not exposed.
4. Remove mortar protruding into cells of cavities to be filled with grout.
5. Fill horizontal joints between top of non-loadbearing masonry partitions and underside of beams or slabs with flexible material.

E. Control Joints:
1. Keep clean of mortar and debris.
2. Install where indicated and at following exterior locations:
    a. Within 4'-0" of corners or offsets.
    b. At control or expansion joints in structure.
    c. At each side of openings greater than 24" wide.
    d. Place control joints at foundation walls, and materials expanding at different ratios.
    e. Space joints at 30'-0" on center maximum in uninterrupted walls.

F. Joining of Work:
1. When joining fresh masonry to set or partially set masonry construction, remove loose units and mortar, and clean exposed surface of set masonry prior to laying fresh masonry.
2. If necessary to stop off horizontal runs of masonry, rack back one-half block length in each course.
3. Do not use toothing to join new masonry to set or partially set masonry.

G. Reinforcing and Ties:
1. Bars:
    a. Reinforce each jamb of wall openings with one bar vertical.
    b. Place reinforcing bars in hollow cores vertically where indicated.
2. Horizontal Joint Reinforcing:
    a. Fully embed joint truss type reinforcement in each alternate bed joint at 16" on center.
    b. Extend joint reinforcement entire length of bed joint.
    c. Place reinforcing in course immediately above opening extending at least 16" past each side of opening.
    d. Lap reinforcement minimum 6" at ends.
    e. Bend or weld at offsets or special conditions.
3. Ties: Space 16" on center horizontally and 24" on center maximum vertical spacing

starting with first course and ending with last masonry course.

4. Provide additional ties at openings:
   a. 36" maximum spacing around perimeter.
   b. Install within 12" of opening.
5. Bonding multi-wythe wall with prefabricated joint reinforcing:
   a. Provide one cross wire tie for each 2 square feet of wall area.
   b. 24" maximum vertical spacing of joint reinforcement.

H. Flashing:

1. Clean surface to receive flashing and remove projections which might puncture or damage flashing material.
2. Seal joints with manufacturer's recommended adhesive.
3. Seal top of flashing to ensure moisture cannot infiltrate behind flashing.
4. Continue flashing around corners; ensure membrane material is not interrupted in horizontal plane at corners.
5. Wall base, window sills and opening heads:
   a. Place flashing on mortar bed and cover with mortar.
   b. Start 1/2" from outside face of wall and turn up in cavity 8" minimum.
   c. Lap joints 4" minimum.
   d. Place flashing under and behind sills.
   e. Place flashing over steel lintels.
   f. Extend flashing beyond opening jamb lines.

I. Built-In Work:

1. Install built-in items including bolts, anchors, expansion joints, inserts, frames, flashing and other items as masonry work progresses.
2. Avoid cutting and patching.
3. Solidly grout spaces around built-in items.
4. Build chases in; do not cut in.
5. Built-in items to be plumb to planes of wall.

J. Reinforced Masonry Grouting:

1. Do not place mortar under block cores at first course to allow grout to come in contact with slabs.
2. Stack wall not more than 5'-0" for each lift.
3. Grout cores.
4. If grouting is to be stopped for more than one hour, stop grout 1-1/2" from top block.
5. Build second lift and grout.
6. Filling cores with mortar as work progresses is not permitted.

K. Pointing:

1. At completion of conventional masonry unit work, fill holes in joints and tool.
2. Cut out and repoint defective joints.
3. Dry brush masonry surface after mortar has set at end of each days work and after final pointing.

3.3 ALLOWABLE TOLERANCES

A. Maximum Variation from Plumb:

1. Vertical lines and surfaces of columns and walls: 1/4" in 10'-0"; 3/8" in any story or 20'-

0" maximum and 1/2" in 40'-0".

2. External corners or control joints: 1/4" in any one story or 20'-0" maximum; 1/2" in 40'-0".

B. Maximum Variation from Plan Location of Linear Building Line or Related Portions of Columns, Walls and Partitions: 1/2" in any bay or 20'-0"; 3/4" in 40'-0".

C. Maximum Variation in Cross-Sectional Dimensions of Columns and Thicknesses of Walls: 1/4", +1/2".

3.4 CLEANING

A. Clean initially with stiff brushes and clean water.

B. When cleaning agent is required, apply cleaning agent to sample wall area of 20 square feet.
1. Do not proceed with cleaning until sample area is reviewed by Architect.
2. Scrub with acceptable cleaning agent and immediately rinse with clear water.
3. Do small sections at a time, working from top to bottom.
4. Protect sash, metal lintels and other corrosive parts when masonry is cleaned with acidic solution.

C. Leave area and surfaces clean and free of mortar spots, droppings and broken masonry.

3.5 PROTECTION OF SURFACES

A. Cover partially completed walls when work is not in progress with nonstaining waterproof covering. Maintain covering until roof structure is complete.

B. Extend cover minimum 24" down both sides and securely anchor in place.

C. After masonry work is complete, protect top of wall until cap or coping and flashing is in place.

D. Protect door jambs and corners from damage during construction.

E. Prevent grout or mortar from staining face of masonry to be left exposed or painted.

F. Protect sills, ledges and projections from droppings of mortar or other damage during construction.

G. Remove misplaced grout or mortar immediately.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 - GENERAL

PART 1.1 SUMMARY

A. Section Includes: Shop fabricated ferrous metal items, galvanized and prime painted as indicated by the Contract Documents.

PART 1.2 REFERENCES

A. American Society for Testing and Materials:
1. ASTM A 36 - Structural Steel.
2. ASTM A 53 - Hot-Dipped, Zinc-coated Welded and Seamless Steel Pipe.
3. ASTM A 153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
4. ASTM A 283 - Carbon Steel Plates, Shapes, and Bars.
5. ASTM A 307 - Carbon Steel Externally Threaded Standard Fasteners.
6. ASTM A 325 - High Strength Bolts for Structural Steel Joints.
7. ASTM A 386 - Zinc-Coating (Hot-Dip) on Assembled Steel Products.
8. ASTM A 500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes
9. ASTM B 177 - Chromium Electroplating on Steel for Engineering Use.

B. American Welding Society:
1. AWS D1.1 - Structural Welding Code - Steel.
2. AWS D1.2 - Structural Welding Code - Aluminum.
3. AWS D1.3 - Structural Welding Code - Sheet Steel.

C. Steel Structures Painting Council: SSPC - Steel Structures Painting Manual.

PART 1.3 SUBMITTALS

A. Product Data: Submitted for products used in miscellaneous metal fabrications, including paint products and grout.

B. Shop drawings detailing fabrication and erection of each metal fabrication indicated. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other sections.

C. Samples: Representative of materials and finished products as may be requested by Architect.

D. Quality Control Submittals:
1. Design Data: Submit stamped and sealed structural design calculations prepared by Professional Engineer that metal fabrications comply with specified load requirements.
2. Certificates: Certify that each welder has satisfactorily passed AWS qualification test for welding process involved and, if pertinent, has undergone recertification.

PART 1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Fabricator: Firm experienced in successfully producing metal fabrications similar to that indicated
   2. Installer: Arrange for installation of metal fabrications specified in this section by same firm that fabricated them.
   3. Engineer: Licensed to practice in state where project is located and experienced in providing engineering services of the kind indicated.
   4. Welders: Qualify welding processes and welding operators in accordance with AWS D1.1, AWS D1.2 and AWS D1.3.

PART 1.5 PROJECT SITE CONDITIONS

A. Field Measurements: Check actual locations of walls and other construction to which metal fabrications must fit, by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of Work.
   1. Where field measurements cannot be made without delaying the Work, guarantee dimensions and proceed with fabrication of products without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to guaranteed dimensions. Allow for trimming and fitting.

PART 1.6 COORDINATION

1. Coordinate prime coatings with paint and special coatings for compatibility.

PART 2 - PRODUCTS

PART 2.1 MATERIALS

A. Metal Surfaces, General: Materials, exposed to view, shall be selected for their surface flatness, smoothness, and freedom from surface blemishes, such as pitting seam marks, roller marks, rolled trade names and roughness.

B. Steel Sections: ASTM A 36.

C. Steel Tubing: ASTM A 500, Grade B, or ASTM A 501.

D. Plates: ASTM A 283.

E. Pipe: ASTM A 53, Grade B Schedule 40.

F. Bolts, Nuts, and Washers: ASTM A 325 or A 307; galvanized to ASTM A 153 for galvanized components.

G. Fasteners: Type, grade and class required for installation and assembly of miscellaneous metal items; galvanized fasteners for exterior use or where built into exterior walls.

H. Welding Materials: AWS D1.1; type required for materials being welded.

I. Primer: Tnemec 10-99, modified alkyd, gray color, 2.0 to 3.5 mils dry film thickness minimum.

J. Primer for Special Coatings: Tnemec 37-77 Chem-Prime, universal alkyd-phenolic primer, 2.0 to 3.5 mil dry film thickness.

K. Shop and Touch-Up Primer: SSPC 15, Type 1, red oxide.

L. Touch-Up Primer for Galvanized Surfaces: SSPC 20 Type I Inorganic Type II Organic zinc rich.

M. Galvanizing Repair Paint: High zinc dust content paint for re-galvanizing welds in galvanized steel; complying with MIL-P-21035 (Ships), Galvalloy galvanizing compound or ZRC Cold Galvanizing Compound.

N. Bituminous Paint: Cold-applied asphalt mastic, SSPC-Paint 12.

O. Grout:
1. Non-metallic, non-shrink type complying with CE CED-C 621. Provide grout specifically recommended by manufacturer for interior and exterior applications.
2. Acceptable Product:
   a. Crystex by L & M Construction Chemicals, Inc.
   b. Hi-Flow Grout by The Euclid Chemical Co.
   c. Master Flow 928 by Master Builders, Inc.

PART 2.2 FABRICATION

A. General:
1. Fit and shop assemble in largest practical sections, for delivery to site.
2. Fabricate items with joints tightly fitted and secured.
3. Continuously seal joined members by continuous welds.
4. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
5. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of component.
6. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication.
7. Accessories: Furnish anchors, anchor slots, sleeves, bolts, brackets, clips, inserts, angles, tubing, bar stock, plates, break metal and other miscellaneous metal necessary to cast in concrete or complete required work.

B. Finishes:
1. Prepare surfaces to be primed in accordance with SSPC SP 2.
2. Do not prime surfaces in direct contact with concrete or where field welding is required.
3. Prime paint items with one coat of paint.
4. Galvanized exterior items to minimum 1.25 oz/sq.ft. zinc coating in accordance with ASTM A 386.

PART 2.3 FABRICATION, SPECIFIC ITEM

A. Rough Hardware:
1. Furnish bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 6 sections.
2. Fabricate items to sizes, shapes, and dimensions required. Furnish malleable-iron washers for heads and nuts which bear on wood structural connections; elsewhere, furnish steel washers.

B Steel Ladders:
1. General: Fabricate ladders for the locations shown, with dimensions, spacings, details and anchorages as indicated. Comply with requirements of ANSI A14.3.
2. Siderails: Continuous steel flat bars, 1/2 inch x 2-1/2 inches, with eased edges, spaced 18 inches apart.
3. Bar Rungs: Round or square steel bars, 3/4 inch diameter, spaced 12 inches o.c.
4. Fit rungs in centerline of side rails, plug weld and grind smooth on outer rail faces.
5. Support each ladder at top and bottom and at intermediate points spaced not more than 5'-0" o.c. by means of welded or bolted steel brackets.
    a. Size brackets to support design dead and live loads indicated and to hold centerline of ladder rungs clear of the wall surface by not less than 7 inches.
    b. Extend side rails 42 inches above top rung, and return rails to wall or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, goose-neck the extended rails back to the structure to provide secure ladder access.
6. Provide non-slip surface on top of each rung, either by coating the rung with aluminum oxide granules set in epoxy resin adhesive, or by using a type of manufactured rung which is filled with aluminum oxide grout.
7. OSHA Approved Safety Cage.

C Aluminum Plate Hatches:
1. General: Fabricate hatches for the locations shown, with dimensions, spacings, details and anchorages as indicated. Comply with requirements of ANSI A14.3.
2. Cover: Formed/fabricated aluminum metal cover withstanding a live load of 40psf with a maximum deflection of 1/150 over the span.
3. Lock Rail: As indicated on drawings.

D Loose Bearing and Leveling Plates:
1. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Galvanize after fabrication.

E Loose Steel Lintels:
1. Fabricate loose structural steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
2. Weld adjoining members together to form a single unit where indicated.
3. Size loose lintels for equal bearing of one inch per foot of clear span but not less than 8 inches bearing at each side of openings, unless otherwise indicated.
4. Galvanize loose steel lintels located in exterior walls.

F Miscellaneous Framing and Supports:
1. General: Provide steel framing and supports for applications indicated or which are not a part of structural steel framework, as required to complete work.
2. Fabricate units to sizes, shapes, and profiles indicated and required to receive adjacent other construction retained by framing and supports. Fabricate from structural steel shapes, plate and steel bars of welded construction using mitered joints for field connection. Cut, drill, and tap units to receive hardware, hangers, and similar items.
   a. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.
   b. Except as otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide x 1/4 inch x 8 inches long.
3. Galvanize miscellaneous framing and supports at exterior locations.

G Miscellaneous Steel Trim:
1. Provide shapes and sizes indicated for profiles shown. Unless otherwise indicated, fabricate units from structural steel shapes, plates, and steel bars, with continuously welded joints and smooth exposed edges. Use concealed field splices wherever possible. Provide cutouts, fittings, and anchorages as required for coordination of assembly and installation with other work.
2. Galvanize miscellaneous framing and supports at exterior locations.

H Shelf and Relieving Angles:
1. Fabricate shelf and relieving angles from steel angles of sizes indicated and for attachment to framing. Provide slotted holes to receive 3/4 inch bolts, spaced not more than 6 inches from ends and not more than 24 inches o.c., unless otherwise indicated.
2. For cavity walls, provide vertical channel brackets to support shelf/relieving angles from back-up masonry and concrete. Align expansion joints in angles with indicated expansion joints in cavity wall exterior wythe.
3. Galvanize shelf angles and supports at exterior locations.

I. Frames for Overhead Door Openings and Wall Openings: Channel/Angle sections; galvanized

PART 3 - EXECUTION

PART 3.1 EXAMINATION

A. Verify that field conditions are acceptable and are ready to receive work.

B. Beginning of installation means erector accepts existing conditions.

PART 3.2 PREPARATION

A. Clean and strip primed steel items to bare metal where site welding is required.

B. Supply items required to be cast into concrete or embedded in masonry with setting templates, to appropriate sections.

PART 3.3 INSTALLATION

A. Install items plumb and level, accurately fitted, free from distortion or defects.

B. Allow for erection loads, and for sufficient temporary bracing to maintain true alignment until completion of erection and installation of permanent attachments.

C. Field weld components in accordance with AWS D1.1, D1.2 and D1.3.

D. Obtain Architect acceptance prior to site cutting or making adjustments not scheduled.

E. After erection, prime welds, abrasions, and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

PART 3.4 ERECTION TOLERANCES

A. Maximum Variation From Plumb: 1/4" for each story, non-cumulative.

B. Maximum Offset from True Alignment: 1/4".

END OF SECTION

SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Wood blocking and nailers.
2. Wood furring and grounds.
3. Plywood backing panels.
4. Nailable Roof Deck

1.2 DEFINITIONS

A. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.

B. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. SPIB: The Southern Pine Inspection Bureau.
2. WCLIB: West Coast Lumber Inspection Bureau.
3. WWPA: Western Wood Products Association.

1.3 SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
4. Include copies of warranties from chemical treatment manufacturers for each type of treatment.

B. Refer to General Conditions for additional information.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, omit grade stamp and provide certificates of grade compliance issued by grading agency.
3. Provide dressed lumber, S4S, unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).

1. Use Exterior type for exterior locations and where indicated.

B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

C. Application: Treat items indicated on Drawings, and the following:

1. Concealed blocking.
2. Plywood backing panels.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Furring.
4. Grounds.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber with 19 percent maximum moisture content and any of the following species:

1. Mixed southern pine; SPIB.
2. Western woods; WCLIB or WWPA.

C. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:

1. Mixed southern pine, No. 2 grade; SPIB.
2. Western woods, Construction or No. 2 Common grade; WCLIB or WWPA.

D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 PLYWOOD BACKING PANELS

A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch (13-mm) nominal thickness.

2.6 EXTERIOR GRADE ROOF ROOF DECK

A. 3/4” thick tongue and groove APA rated OSB nail base (ASATM C1289-95, Type V)

Acceptable Product:

a.) 23/32” Blue Ribbon OSB (Exposure 1) by Georgia-Pacific or equal.

2.7 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, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Wood Screws: ASME B18.6.1.

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

E. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, and similar supports to comply with requirements for attaching other construction.

B. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.

C. Do not splice structural members between supports, unless otherwise indicated.

D. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches (406 mm) o.c.

E. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with

function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

G. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.

H. Use common wire nails, unless otherwise indicated. 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; do not countersink nail heads, unless otherwise indicated.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

3.3 PROTECTION

A. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

SECTION 07 90 00
JOINT SEALERS

PART 1 - GENERAL

PART 1.1 SUMMARY

A. Section Includes:
1. Preparation of interior and exterior joint substrate surfaces.
2. Install sealers, primers, bond breakers, and fillers as required.
3. Install interior and exterior joint sealants.

PART 1.2 REFERENCES

A. American Society for Testing and Materials: ASTM D 1056: Flexible Cellular Materials – Sponge or Expanded Rubber.

B. Federal Specifications:
1. FS TT-S-00227E - Sealing Compound, Elastomeric Type, Multi-Component.
2. FS TT-S-00230C - Sealing Compound, Elastomeric Type, Single-Component.
3. FS TT-S-001543 - Sealing Compound, Silicone Rubber Base.
4. FF TT-S-001657 - Sealing Compound, Single-Component, Butyl Based, Solvent Release Type.

PART 1.3 SYSTEM DESCRIPTION

A. Design Requirements:
1. Exterior: Provide elastomeric joint sealants that have been produced and installed to establish and to maintain watertight and air tight continuous seals without causing staining or deterioration of joint substrates.
2. Interior: Provide joint sealants that have been produced and installed to maintain airtight continuous seals that are water resistant and cause no staining or deterioration of joint substrates.

PART 1.4 SUBMITTALS

A. Product Data: Submit manufacturer's product data, specifications, recommendations and materials.

B. Samples: Submit standard color charts for selection; furnish samples of custom colors as applicable.

C. Certificates: Submit letter of certification from manufacturer or certified test laboratory reports that materials meet the following:

1. Sealant materials are chemically compatible with each other and proposed substrate, comply with Specification requirements, and are intended for applications indicated.

2. Sealant, primers, and cleaners required for sealant installation comply with local regulations controlling use of volatile organic compounds.

D. Refer to General Conditions for additional information.

PART 1.5 QUALITY ASSURANCE

A. Qualifications - Applicator: Provide documentation of minimum three years experience

B. Pre-Installation Meeting: Prior to installation of sealant, meet at project site to review material selections, joint preparations, installation procedures and coordination with other trades. Meeting shall include the sealant Installer, Contractor, Manufacturer's representative, and representatives of other trades or subcontractors affected by sealant installation. Examine sample installations which have been prepared and determine and record whether everyone present is in agreement that the proposed installations are likely to perform as required. Notify Architect prior to meeting as to time, place and date of meeting.

PART 1.6 DELIVERY STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials in compliance with manufacturer's recommendation to prevent their deterioration or damage due to moisture, high or low temperatures, contaminates, or other causes.

PART 1.7 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with installation of joint sealants under the following conditions:
1. When ambient and substrate conditions are outside limits permitted by joint sealant manufacturer or below 40 deg. F.
2. When temperature conditions cause joint widths to be at either maximum or minimum design conditions.
3. When joint substrates are wet.

PART 1.8 WARRANTY

A. Exterior Sealants: Warrant materials and installation against air and water leakage for minimum five year period.

PART 2 - PRODUCTS

PART 2.1 MANUFACTURERS

A. Substitutions: Comply with Section 01 25 00.

PART 2.2 SEALING AND CAULKING MATERIALS

A. Polyurethane Sealant - Type No. 1:
   1. One-component, non-sag, low modulus, moisture curing, polyurethane joint sealant; FS TT-S-00230C, Class A, Type II.
   2. Acceptable Products:
      a. Dymonic by Tremco.
      b. NP-1 by Sonneborn.
      c. QSC-101 by QSC Products, Ltd.
      d. Dynatrol I by Pecora
      e. Vulkem 116 by Mameco International.

B. Polyurethane Sealant - Type No. 2: Not Used.

C. Polyurethane Sealant - Type No. 3:
   1. Two-component, low-modulus, chemically curing, cold applied, elastomeric, self-leveling, horizontal grade polyurethane joint sealant; FS TT-S-00227E, Class A, Type I or II.
   2. Acceptable Products:
      a. THC-900 by Tremco.
      b. Sonolastic SL2 by Sonneborn.
      c. Urexpan NR-200 by Pecora.
      d. QSC-231 by QSC Products, Ltd.
      e. Vulkem 245 by Mameco International.

D. Polyurethane Sealant Type - Type No. 4:
   1. Two-component, non-sag, chemically curing, cold applied, elastomeric, traffic grade polyurethane joint sealant; FS TT-S-00227E, Class A; traffic bearing horizontal joints exceeding 1 percent slope.
   2. Acceptable Products:
      a. THC-901 by Tremco.
      b. Dynatred by Pecora.

E. Polyurethane Sealant - Type No. 5: Not Used.

F. Polyurethane Sealant - Type No. 6: Not Used.

G. Acrylic Sealant - Type No. 7: Not Used.

H. Acrylic Latex Sealant - Type No. 8:
   1. One-component, solvent cured, fungicidal, readily paintable acrylic latex calk; ASTM C 834 (FS TT-S-0000230C).

2. Acceptable Products:
   a. Acrylic Latex by Tremco.
   b. Sonolac by Sonneborn.
   c. AC-20 by Pecora.

I. Silicone Sealant Type - No. 9:
   1. One-component, low-modulus, moisture cured, elastomeric, silicone joint sealant; FS TT-S-001543A.
   2. Acceptable Products:
      a. DC-790 by Dow Corning.
      b. Silpruf by General Electric.
      c. Spectrum-1 by Tremco.
      d. 864 by Pecora

J. Silicone Sealant - Type No. 10: Not Used.

K. Silicone Sealant - Type No. 11:
   1. One-component, medium modulus, moisture cured, elastomeric silicone joint sealant; FS TT-S-001543A.
   2. Acceptable Products:
      a. DC-795 by Dow Corning.
      b. Silpruf by General Electric.
      c. Spectrem-2 by Tremco.
      d. 895 by Pecora.

L. Silicone Sealant - Type No. 12:
   1. One-component, moisture cured, fungicidal, silicone joint sealant; FS TT-S-001543A.
   2. Acceptable Products:
      a. DC-786 by Dow Corning.
      b. SCS-1702 by General Electric.
      c. Proglaze by Tremco.
      d. 863 by Pecora.

M. Polyisobutylene Sealant - Type No. 13:
   1. One-component, non-skinning, non-drying, polyisobutylene synthetic rubber sealant.
   2. Acceptable Products:
      a. Curtain Wall Sealant by Tremco.
      b. BR-96 by Pecora.
      c. GC-55 by non-curing, Goal Chemical.

N. Butyl - Type No. 14:
   1. Butyl rubber polymer sealant one-component, non-sag; FS TT-S-001657, Type I.
   2. Acceptable Products:
      a. BC-158 by Pecora.
      b. PTI707 by Protecting Treatment, Inc.
      c. Butakauk by Sonneborn, Inc.
      d. Butyl Sealant by Tremco.

PART 2.3 ACCESSORIES

A. Joint Cleaner: Non-corrosive type recommended by sealant manufacturer, compatible with joint forming materials.

B. Primer: Non-staining type recommended by sealant manufacturer to suit application and substrate materials.

C. Backer Rod:
   1. Combination, closed and open, cell compatible with sealant; sized and shaped to control depth of sealant; and to maintain 25 to 50 percent compression of material, ASTM D 1056.
   2. Acceptable Product: Sof Rod by I.T.D.

D. Bond Breaker: Pressure sensitive adhesive polyethylene tape recommended by sealant manufacturer to suit application.

E. Masking Tape: Pressure sensitive adhesive paper tape.

F. Expansion Joint Filler:
   1. Closed cell polyethylene compatible with sealant.
   2. Asphalt impregnated fiberboard not acceptable.
   3. Acceptable Product: Sonofoam Closed Cell Backer-Rod by Sonneborn.

PART 2.4 MIXING

A. Mix components in accordance with manufacturer's recommendations.

PART 3 - EXECUTION

PART 3.1 EXAMINATION

A. Examine joints to be sealed for construction defects which could adversely affect execution of Work.

B. Ensure that concrete has cured 28 days minimum before commencing sealing operations.

C. Determine in conjunction with sealant manufacturer's representative if adhesion testing is necessary prior to application of materials. Submit letter of certification from sealant manufacturer accepting substrate conditions for sealant.

PART 3.2 PREPARATION

A. Clean joint surfaces using joint cleaner as necessary, free of dust, dirt, oil, grease, rust, lacquers, laitance, release agents, liquid water repellent, moisture or other matter which might adversely affect adhesion of sealants.

B. Etch concrete, masonry and plaster joint surfaces to remove excess alkalinity. Etch with 5 percent solution of muriatic acid. Neutralize with dilute ammonia solution. Rinse thoroughly with water and allow to dry.

C. Steel Surfaces: Scrape and wire brush to remove loose mill scale. Remove dirt, oil or grease by solvent cleaning. Wipe surfaces with lintless paper towels.

D. Aluminum Surfaces:
   1. Clean off temporary protective coatings.
   2. When masking tape is used for a protective cover, remove tape just prior to applying sealant.

E. Roughen joint surfaces on non-porous materials. Rub with fine abrasive cloth or wool to produce a dull sheen.

F. Mask areas adjacent to joints as necessary.

G. Apply primer as recommended by manufacturer. Do not allow primer or sealants to spill or migrate onto adjoining surfaces.

PART 3.3 APPLICATION

A. Install sealant materials in accordance with manufacturer's instructions.
B. Install backing material in joints using blunt instrument to avoid puncturing.

C. Do not twist rod while installing.

D. Install backing to form joint depth of 50 percent of joint width, minimum of 1/4" deep.

E. Apply sealant in joints using pressure gun with nozzle cut to fit joint width.

F. Deposit sealant in uniform, continuous bead.

G. Tool joints to required configuration within manufacturer's recommended setting time.

H. If masking materials are used, remove immediately after tooling.

PART 3.4 FIELD QUALITY CONTROL

A. Manufacturer's Representative:
   1. No sealants may be used unless a qualified representative is present at start up of work to advised installer of proper procedures and precautions for use of materials and to check installation.

2. Contractor shall give manufacturer notice one week prior to start-up that his presence required, to ensure proper installation of his materials.

PART 3.5 CLEANING

A. Remove excess materials adjacent to joints as Work progresses to eliminate evidence of spillage or damage to adjacent surfaces.

B. Remove and replace improperly sealed joints.

C. Clean or replace materials or surfaces that are damaged by sealing operations.

PART 3.6 SCHEDULE OF SEALANTS AND CAULKS

A. Interior and exterior building joints subject to dynamic movement, not exposed to foot or vehicular traffic: Sealant Type 9.

B. Interior and exterior horizontal joints subject to foot and vehicular traffic: Sealant Type No. 3 or 4.

C. Unexposed Windows Joints: Sealant Type No. 11 or 13.

D. Sealants in adjacent to Roof Membrane: Sealant Type 1.

E. Interior horizontal and vertical joints not subject to movement, traffic or moisture: Sealant Type No. 8.

F. Interior horizontal and vertical joints not subject to movement or traffic, subject to moisture: Sealant Type No. 12.

G. Thresholds: Sealant Type 9, 13, or 14.

PART 3.7 COLOR SCHEDULE

A. Other Exposed Locations: Manufacturer's standard color line as selected by Architect.

B. Non-exposed Locations: Manufacturer's standard.

END OF SECTION

SECTION 08 11 00
STEEL DOORS, DOOR FRAMES AND WINDOW FRAMES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulated rated hollow metal doors and frames.
2. Hollow metal window frames (for insulated glazing)

1.2 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating and finishes.

B. Shop Drawings: Include the following:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.

C. Other Action Submittals:

1. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to NFPA 252 or UL 10B.

1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

C. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9. Label each individual glazed lite.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to finish of factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (102-mm-) high wood blocking. Do not store in a manner that traps excess humidity.

1. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.7 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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. Ceco Door Products; an Assa Abloy Group company.
2. Curries Company; an Assa Abloy Group company.
3. Pioneer Industries, Inc.
4. Steelcraft; an Ingersoll-Rand company.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum A40 (ZF120) metallic coating.

D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

G. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.

H. Polyurethane Core Insulation: Doors shallbe reinforced, stiffened, insulated and sound deadened with 1 1/2 pound density polyurethane laminated to inside faces of the panels. Voids around the perimeter shall be infilled with honeycomb.

I. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 INSULATED HOLLOW METAL DOORS

A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/A250.8.

1. Design: Flush panel.
2. Insulated Core Construction: Manufacturer's standard for acheieving specified U-factor rating and compliance with ASTM E-90 & E413-87. Polyurethane Core.
   a. U-Factor Rating: 0.9
   b. R-Factor Rating: 11.1
   c. Compressive Strength: 3600 psf
3. Vertical Edges for Single-Acting Doors: Manufacturer's standard.
4. Top and Bottom Edges: Closed with flush or inverted 0.042-inch- (1.0-mm-) thick, end closures or channels of same material as face sheets.
5. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."

B. Exterior Doors: Face sheets fabricated from metallic-coated steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. 14 gage galvanized steel, SDI-100, Grade III extra heavy duty, Model 1A Full Flush, acoustical core construction with an STC Rating of 48..

C. Interior Doors: Face sheets fabricated from cold-rolled steel sheet. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model and ANSI/SDI A250.4 for physical performance level:

1. 16 cold or hot-rolled steel, SDI-100, Grade III extra heavy duty, Model 1A Full Flush, accoustical core construction with an STC Rating of 48.

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 STANDARD HOLLOW METAL FRAMES (DOORS and WINDOWS)

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Exterior Frames (14 gage): Fabricated from metallic-coated steel sheet.

1. Fabricate frames with mitered or coped corners.
2. Fabricate frames as welded units. Knock-down frames are not acceptable.

C. Interior Frames (16 gage): Fabricated from cold or hot-rolled steel sheet.

1. Fabricate frames with mitered or coped corners.
2. Fabricate frames as welded units. Knock-down frames are not acceptable.

D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (50 mm) wide by 10 inches (250 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch (1.0 mm) thick.

2.6 STOPS AND MOLDINGS

A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch (0.8 mm) thick, fabricated from same material as door face sheet in which they are installed.

B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated.

C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch (0.8 mm) thick, fabricated from same material as frames in which they are installed.

2.7 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

C. Hollow Metal Doors:

1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
2. Configure exterior doors with profile to receive recessed weatherstripping.

2. Glazed Lites: Factory cut openings in doors.

D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. Masonry Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:

        1) Two anchors per jamb up to 60 inches (1524 mm) high.
        2) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
        3) Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.
        4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high.

b. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:

1) Three anchors per jamb up to 60 inches (1524 mm) high.
2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
3) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.
5) Two anchors per head for frames above 42 inches (1066 mm) wide and mounted in metal-stud partitions.

4. Door Silencers: Except on weather-stripped doors, drill stops to receive door silencers as follows. Keep holes clear during construction.

a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

E. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

F. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Division 8 Section "Door Hardware."

1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 16 Sections.

G. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
4. Provide loose stops and moldings on inside of hollow metal work.
5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.8 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:

1. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
2. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
3. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
4. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.

C. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.

B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.

1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.

    a. At fire-protection-rated openings, install frames according to NFPA 80.
    b. Install frames with removable glazing stops located on secure side of opening.
    c. Install door silencers in frames before grouting.
    d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
    e. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
    f. Field apply bituminous coating to backs of frames that are filled with grout containing antifreezing agents.

2. Metal-Stud Partitions: Solidly pack mineral-fiber insulation behind frames.
3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
4. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:

    a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
    b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
    c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
    d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.

C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non-Fire-Rated Standard Steel Doors:
    a. Jambs and Head: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
    b. Between Edges of Pairs of Doors: 1/8 inch (3 mm) plus or minus 1/16 inch (1.6 mm).
    c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch (9.5 mm).
    d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch (19 mm).

2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.

D. Glazing: Comply with installation requirements in Division 8 Section "Glazing" and with hollow metal manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (50 mm) o.c. from each corner.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

END OF SECTION

SECTION 08 71 00
FINISH HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General Conditions, Special Requirements and Division - 1 Specification sections, apply to the work of this section.

1.2 SUMMARY:

A. This Section includes items known commercially as finish or door hardware that are required for swing doors, except special types of unique hardware specified in the same sections as the doors and door frames on which they are installed.

B. This Section includes the following:

1. Hinges
2. Lock cylinders and keys
3. Lock and latchsets
4. Flushbolts
5. Exit devices
6. Push/Pull units
7. Closers & Operators
8. Protection plates
9. Weatherstripping
10. Automatic drop seals (door bottoms)
11. Astragals or meeting seals on pairs of doors
12. Thresholds

C. Related Sections: The following sections contain requirements that relate to this section:

1. Division 8 Section “Steel Doors and Frames”.

D. Products furnished but not installed under this Section include: Hardware for aluminum entrances.

1.3 SUBMITTALS:

A. General: Submit the following in accordance with conditions of Contract and the Division 1 Specifications sections.

B. Product Data: Submit manufacturer’s technical product data for each item of door hardware, installation instructions, maintenance of operating parts are finish, and other information necessary to show compliance with requirements.

C. Final Hardware Schedule: Submit final hardware schedule in manner indicated below. Schedule

shall be coordinated with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Final Hardware Schedule Content: Based on finish hardware indicated, organize hardware schedule into "hardware sets" indicating complete designations of every item required for each door or opening. Include the following information:
    a. Type, style, function, size and finish of each hardware item.
    b. Name and manufacturer of each item.
    c. Fastenings and other pertinent information.
    d. Location of hardware set cross-referenced to indications on Drawings both on floor plans and in door and frame schedule.
    e. Explanation of all abbreviations, symbols, codes, etc. contained in schedule.
    f. Mounting locations for hardware.
    g. Door and frames sizes and materials.
    h. Keying information and Door Index
2. Submittal Sequence: Submit final schedule at earliest possible date particularly where acceptance of hardware schedule must precede fabrication of other work which is critical in the project construction schedule. Include with schedule the product data, samples, shop drawings of other work affected by finish hardware, and other information essential to the coordinated review of hardware schedule.
3. Keying Schedule: Submit separate detailed schedule indicating clearly how the Owner's final instructions on keying of locks has been fulfilled.

D. Templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.4 QUALITY ASSURANCE:

A. Single Source Responsibility: Obtain each type of hardware (latch and locksets, exits, closers, stops, coordinators & flush bolts, etc.) from a single manufacturer. No exceptions.

B. Fire-Rated Openings: Provide only door hardware (fire rated exit devices, smoke seals, closers) for fire-rated openings that complies with NFPA Standards No. 80 and requirements of authorities having jurisdiction. Provide only items of door hardware that are listed and are identical to products tested by UL, Warnock Hersey, FM, or other testing and inspecting organization acceptable to authorities having jurisdiction for use on types and sizes of doors indicated in compliance with requirements of fire-rated door and door frame labels. Hardware shall also comply with UL10C and IBC 2015.

1.5 PRODUCT HANDLING:

A. Inventory hardware jointly with representatives of the hardware supplier and the hardware installer until each is satisfied that the count is correct.

B. Deliver individually packaged hardware items at the proper times to the proper locations (shop or project site) for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with specified requirements, manufacturers offering products that may be incorporated in the Work include, but are not necessarily limited to, the following.

1. Butt Hinges:
    a. Stanley
    b. McKinney
    c. Hager
2. Continuous Hinges:
    a. Select
    b. Hagger
    c. Markar
    d. Stanley
3. Cylinders:
    a. Corbin Keyway
4. Locksets:
    a. Corbin
    b. KABA Simplex
    c. Schlage
    d. Falcon
5. Bolts:
    a. Glynn Johnson
    b. Rockwood
    c. Trimco - BBW - Quality
6. Exit/Panic Devices:
    a. Corbin-Russwin ED8200
7. Push/Pull Units:
    a. Forms & Surfaces
    b. Rockwood
    c. Trimco - BBW - Quality
8. Closers and Operators
    a. LCN
    b. Dorma 2900 Series
    c. Sargent 330 Series
    d. Corbin/Russwin DC2200 Series
9. Kick, Mop, and Armor Plates:
    a. Rockwood
    b. Trimco - BBW - Quality
    c. Ives
10. Door Stripping and Seals:
    a. National Guard Products

b. Zero
c. Reese

11. ADA Thresholds:
    a. National Guard Products
    b. Zero
    c. Reese
12. Automatic Drop Seals:
    a. National Guard Products
    b. Zero
    c. Reese

2.2 SCHEDULED HARDWARE:

A. Requirements for construction, material, cycle requirements, design, grade, function, finish, size, and other distinctive qualities of each type of finish hardware are indicated in the "Hardware Schedule" at the end of this Section. Products are identified by using hardware designation numbers of the following:

1. Manufacturer's Product Designations: The product designation and name of manufacturer are listed for each hardware type required for the purpose of establishing minimum acceptably requirements. Provide either the product designated or, where more than one manufacturer is specified under the Article "Manufacturers" in Part 2 for each hardware type, the listed comparable product of one of the other manufacturers that complies with each specified requirement as listed in the above paragraph in this specification and hardware sets. Approvals for alternate material, series, functions or manufacturers will be considered after bid date. No Exceptions.

2.3 MATERIALS AND FABRICATION:

A. Manufacturer's Name Plate: Do not use manufacturer's products that have manufacturers' name or trade name displayed in a visible location (omit removable nameplates) except in conjunction with required fire-rated labels and as otherwise acceptable to Architect.

1. Manufacturer's identification will be permitted on rim of lock cylinders and arms of closers.
2. Manufactures UL10C label requirements for identification.

B. Base Metals: Products hardware units of basic metal and forming method indicated using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser (commercially recognized) quality than specified for applicable hardware units for finish designations indicated.

C. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated.

D. Furnish screws for installation with each hardware item. Finish exposed (exposed under any condition) screws to match hardware finish or, if exposed in surfaces of other work, to match finish of this other work as closely as possible including "prepared for paint" surfaces to receive painted finish.

E. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use hex screw fasteners.

2.4 HINGES AND PIVOTS:

A. Templates: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.

B. Screws: Furnish Phillips flat-head screws complying with the following requirements:
   1. For metal doors and frames install machine screws into drilled and tapped holes.
   2. For wood doors and frames install wood screws.
   3. For fire-rated wood doors install #12 x 1-1/4 inch threaded to the head steel wood screws.
   4. Finish screw heads to match surface of hinges or pivots.

C. Hinges Pins: Except as otherwise indicated, provide hinges pins as follows:
   1. Out-swing exterior doors: Non-removable pins.
   2. Out-swing Corridor Doors: Non-removable pins.
   3. Interior Doors: Non-rising pins.

D. Number of Hinges: Provide number of hinges indicated but not less than 3 hinges for door leaf for doors 90 inches or less in height and one additional hinge for each 30 inches for additional height. No exceptions.

2.5 LOCK CYLINDERS AND KEYING:

A. Equip locks with standard cylinders.

B. Metals: Construct lock cylinder parts from brass or bronze, stainless steel or nickel silver.

C. Comply with Owner's instructions for masterkeying and, except as otherwise indicated, provide individual change key for each lock which is not designated to be keyed alike with a group of related locks.

D. Key Materials: Provide keys of nickel silver only.

E. Key Quantity: Furnish 3 change keys for each lock; 5 master keys for each master system; and 5 grandmaster keys for each grandmaster system.
   1. Deliver keys to Owner.

2.6 EXIT DEVICES:

A. Comply with ANSI A156.7. Devices shall incorporate “T” style stainless steel touchpad. Touchpad shall not extend full length of device.

B. Exterior trim shall be heavy forged design. Where indicated provide vandal resistant lever with internal spring clutch (994L). Provide truss style end cap with three point attachment to device and two point attachment to door.

C. Function, design, material, and gauge shall be as indicated. All devices shall be by one manufacturer. Insure all fire ratings are in compliance with applications.

D. All units shall be UL10C certified.

2.7 LOCKS, LATCHES, AND BOLTS:

A. Strikes: Provide manufacturer's standard wrought box strike for each latch or lock bolt, with curved lip extended to protect frame, finished to match hardware set, unless otherwise indicated.
   1. Provide curved lip strikes for locks with latchbolts as recommended by manufacturer.

B. Lock Throw: Provide 5/8-inch minimum throw of latch on pairs of doors. Comply with UL requirements for throw of bolts and latch bolts on rated fire openings.

C. Flush Bolt Heads: Minimum of ½ inch diameter rods of brass, bronze, or stainless steel with minimum 12 inch long rod for doors up to 7'-0" in height. Provide longer rods as necessary for doors exceeding 7'-0" in height.

D. Lever trim shall be of the design indicated.

2.8 CLOSERS:

A. Size of Units: Except as otherwise specifically indicated, comply with the manufacturer's recommendations for size of door control unit depending on size of door, exposure to weather, and anticipated frequency of use. Factory hand, tag, and pre-size all springs prior to jobsite delivery. No exceptions.
   1. Where parallel arms are indicated for closers, provide with solid forged extra duty arms and extra duty knuckles with integral bronze bushings.
   2. Closers shall have powder coated finish as indicated.
   3. All closers shall be LCN 4000 series, 10,000,000 cycle units.
   4. All units shall be UL10C certified.

2.9 WEATHERSTRIPPING AND SEALS:

A. General: Provide continuous weather-stripping on exterior doors. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.

B. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strip is easily replaceable and readily available from stocks maintained by manufacturer.

C. Weather-stripping at Jambs and Heads: Provide bumper-type resilient insert and metal retainer strips, surface applied unless shown as mortised or semi-mortised, and of following metal, finish, and resilient bumper material:
   1. Extruded aluminum with natural anodized finish, 0.062-inch minimum thickness of main walls and flanges.
      a. Grade A (30 deg. F to 150 deg. F, oil-resistant and self-extinguishing).

2.10 HARDWARE FINISHES:

A. Match items to the manufacturer's standard color and texture finish for the latch and lock sets (or push-pull units if no latch or lock sets).

B. Provide finishes which match those established by BHMA or, if none established, match the Architect's sample.

C. The designations used in schedules and elsewhere to indicated hardware finishes are those listed in ANSI/BHMA A156.18, "Materials and Finishes," including coordination with the traditional U.S. finishes shown certain manufacturers for their products.

1. Rust-Resistant Finish: For iron and steel base metal required for exterior work and in areas shown as "High Humidity" areas (and also when designed with the suffix - RR), provide 0.2 mil-thick copper coating on base metal before applying brass, bronze, nickel, or chromium plated finishes.

PART 3 - EXECUTION

3.1 INSTALLATION:

A. Mount hardware units at heights indicated in following applicable publications, except as specifically indicated or required to comply with governing regulations and except as otherwise directed by Architect.

1. "Recommended Locations for Builders Hardware for Standard Steel Doors and Frames" by the Door and Hardware Institute.

B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Wherever cutting and fitting is required to install hardware onto or into surfaces which are later to be to painted or finished in another way, coordinate removal, storage and reinstallation or application of surface protections with finishing work specified in the Division-9 sections. Do not install surface-mounted items until finishes have been completed on the substrate.

C. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

D. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with industry standards.

E. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant complying with requirements specified in Division 7 Section "Joint Sealers."

F. Weather-stripping and Seals: Comply with manufacturer's instructions and recommendations to the extent installation requirements are not otherwise indicated.

3.2 ADJUSTING, CLEANING, AND DEMONSTRATING:

A. Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application made.

1. Wherever hardware installation is made more than one month prior to acceptance or occupancy of a space or area, return to the work during the week prior to acceptance or occupancy, and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of

hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

B. Clean adjacent surfaces soiled by hardware installation.

C. Instruct Owner's Personnel in proper adjustment and maintenance, and programming of hardware and hardware finishes, during the final adjustment of hardware.

3.3 HARDWARE SCHEDULE:

A. General: Provide hardware for each door to comply with requirements of Section "Door and Hardware," hardware set numbers indicated in door schedule on drawings.

END OF SECTION

SECTION 09 90 00
PAINTING

PART 1 GENERAL

1.1. SUMMARY

A. Section Includes: Surface preparation and field application of paints and coatings.

B. Work not requiring finish: The following items are not required to be finished under this Section.

1. Items with factory applied final finish.
2. Aluminum, brass, bronze, chromium plate, copper, nickel and stainless steel.
3. Brick, tile, plaster, pre-cast concrete and plastic laminate.
4. Acoustical ceilings.
5. Concealed ducts, pipes and conduit.
6. Moving parts of operating units.
7. Code required labels such as UL or equipment identification plates.

1.2. REFERENCES

A. American Society for Testing and Materials:

1. ASTM D 16 - Definitions of Terms Relating to Paint, Varnish, Lacquer, and Related Products.
2. ASTM D 523 - Test Method for Specular Gloss.
3. ASTM D 2016 - Test Method for Moisture Content of Wood.

B. American Water Works Association:

1. AWWA C204 - Chlorinated Rubber-Alkyd Paint Systems for the Exterior of Above Ground Steel Water Piping.
2. AWWA D102 - Painting Steel Water Storage Tanks.

1.3. DEFINITIONS

A. Comply with ASTM D 16 for interpretation of terms used in this Section.

B. Gloss Factors: Values of various degrees of luster when tested in accordance with ASTM D 523 shall comply with following:

1. Flat: Below 5 units at 85 degree test angle.
2. Eggshell/Satin: 10 to 30 units at 60 degree test angle.
3. Semi-Gloss: 30 to 65 units at 60 degree test angle.
4. Gloss: Over 70 units at 20 degree test angle.

1.4. SUBMITTALS

A. Product Data: Furnish manufacturer's technical information, including label analysis, instruction for handling, storage, surface preparation procedures and application recommendations for each paint system including primers and sealers.

B. Shop Drawings: Submit painting schedule including manufacturer's product name, color, and substrate proposed for painting, and method of application.

C. Samples: Provide stepped samples defining each separate coat, including block fillers and

primers - of each color, texture and material to be applied on the following substrates:

1. Concrete: Provide two 4" square samples for each color and finish.
2. Concrete Masonry: Provide two 4" x 8" samples of masonry, with mortar joint in each center, for each finish and color.
3. Drywall: Provide two 12" square sample of each color and material on drywall.
4. Painted Wood: Provide two 12" square samples of each color and material on hardboard.
5. Stained or Natural Wood: Provide two 4" x 8" samples of natural and stained wood finish on actual wood surfaces.
6. Ferrous Metal: Provide two 4" square samples of flat metal and two 8" long samples of solid metal for each color and finish.

D. Quality Control Submittals: Furnish certificates from manufacturer that all products supplied comply with local regulations controlling use of volatile organic compounds (VOC's).

E. Refer to General Conditions and Section 01 33 00 for additional information.

1.5. QUALITY ASSURANCE

A. Qualifications:

1. Applicator: Company specializing in performing work of this section with minimum five years commercial and three projects of similar scope documented experience.
2. Single Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats.

B. Regulatory Requirements: Comply with Texas Air Control Board (TACB) Regulation V and requirements of governing authorities relative to volatile organic compounds (VOC) content.

C. Field Samples:

1. Prepare 3 ft. wide x 3 ft. high field sample panel illustrating each special coating color, texture, sheen, and finish.
2. Locate where directed by Architect.
3. Simulate finished lighting conditions for review of in-place work.
4. Accepted sample may remain as part of Work.
5. Final acceptance of colors will be from job applied samples.

1.6. DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site in manufacturer's sealed and labeled containers. Examine to verify acceptability.

B. Container label to include manufacturer's name, type of paint, brand name, lot number and date of manufacturer, brand code, coverage rate, surface preparation, instructions for mixing and reducing drying time, cleanup requirements, color designation, and application instructions.

C. Store paint materials at minimum ambient temperature between 45 degrees F and 90 degrees F, in ventilated area, and as required by manufacturer's instructions.

1.7. PROJECT CONDITIONS

A. Environmental Requirements:

1. Do not apply exterior coatings during rain or snow, or when relative humidity is outside humidity ranges required by paint product manufacturer.
2. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F

for exterior.

3. Minimum Application Temperature for Varnish Finishes: 65 degrees F for interior or exterior.
4. Provide lighting level of 80 foot candles measured mid-height at substrate surface.

1.8. EXTRA MATERIALS

A. Provide two gallons of each color, type, and surface texture to Owner.

B. In addition to manufacturer's label, identify each container with color, type, texture, and room location.

PART 2 PRODUCTS

2.1. MANUFACTURERS

A. Acceptable Manufacturers:
1. ICI Dulux Paints / ICI Devoe Coatings
2. Benjamin Moore

B. Substitutions: Any deviations from materials listed herein must be approved by the Owner.

2.2. MATERIALS

A. Coatings:
1. Ready mixed, except field catalyzed coatings.
2. Process pigments to soft paste consistency, capable of being readily and uniformly dispersed to homogeneous coating; good flow and brushing properties; capable of drying or curing free of streaks or sags.

B. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve finishes specified, of commercial quality.

C. Patching Materials: Latex filler.

D. Fastener Head Cover Materials: Latex filler.

PART 3 EXECUTION

3.1. EXAMINATION

A. Verification of Conditions:
1. Examine the substrates, adjoining constructions, and the conditions under which the work is to be installed. Do not proceed with the work until unsatisfactory conditions detrimental to the work have been corrected.
2. Verify that Level 5 finish as specified in Section 09 23 00 has been completed and accepted prior to application of the prime coat.
3. Verify that substrate conditions are ready to receive work as instructed by product manufacturer.
4. Test shop applied primer for compatibility with subsequent cover materials.
5. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below following maximums:
   a. Concrete and Concrete Unit Masonry: 12 percent.

b. Gypsum Wallboard: 12 percent.
c. Masonry: 12 percent.
d. Interior Wood: 15 percent, measured in accordance with ASTM D 2016.
e. Exterior Wood: 15 percent, measured in accordance with ASTM D 2016.

3.2. PREPARATION

A. General:

1. Remove or mask electrical and mechanical, plates, hardware and hardware accessories, light fixture, escutcheons, fittings, and similar items prior to preparing surfaces or finishing. Reinstall removed items by workers skilled in the trades involved.
2. Correct defects and clean surfaces which affect work of this section.
3. Schedule cleaning and surface preparation so that dust and other containments will not fall on wet, newly painted surfaces.
4. Seal with shellac marks which may bleed through surface finishes.
5. Provide barrier coats over incompatible primers or remove and reprime.

B. Surface Preparation:

1. Aluminum Surfaces Scheduled for Paint Finish: Remove surface contamination by steam or high pressure water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately following cleaning.
2. Concrete and Unit Masonry Surfaces Scheduled to Receive Paint Finish: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.
3. Exterior Wood Scheduled to Receive Paint Finish: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with tinted exterior caulking compound after prime coat has been applied.
4. Exterior Wood Scheduled to Receive Transparent Finish: Remove dust, grit, and foreign matter; seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes with tinted exterior caulking compound after sealer has been applied.
5. Galvanized Surfaces: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.
6. Glue-Laminated Beams: Prior to finishing, wash surfaces with solvent, remove grease and dirt.
7. Gypsum Board Surfaces: Fill minor defects with filler compound. Spot prime defects after repair.
8. Impervious Surfaces: Remove mildew by scrubbing with solution of tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.
9. Interior Wood Items Scheduled to Receive Paint Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats.
10. Interior Wood Items Scheduled to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats.
11. Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.
12. Plaster Surfaces: Fill hairline cracks, small holes, and imperfections with latex patching

plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.

13. Shop Primed Steel Surfaces: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Prime metal items including shop primed items.
14. Uncoated Steel and Iron Surfaces: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by power tool wire brushing or sandblasting; clean by washing with solvent. Apply treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Spot prime paint after repairs.
15. Wood and Metal Doors: Seal top and bottom edges with primer.

3.3. APPLICATION

A. Apply products in accordance with manufacturer's instructions.

B. Do not apply finishes to surfaces that are not dry.

C. Apply each coat to uniform finish.

D. Apply each coat of paint slightly darker than preceding coat.

E. Sand wood and metal lightly between coats to achieve required finish.

F. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.

G. Allow applied coat to dry before next coat is applied.

H. Where clear finishes are required, tint fillers to match wood. Work fillers into grain before set. Wipe excess from surface.

I. Prime concealed surfaces of interior and exterior woodwork with primer paint.

J. Prime concealed surfaces of interior woodwork scheduled to receive stain or varnish finish with gloss varnish reduced 25 percent with mineral spirits.

3.4. FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

A. Refer to Divisions 23, 33, and 40 for schedule of color coding and identification banding of equipment, duct work, piping, and conduit.

B. Paint shop primed equipment. Paint shop pre-finished items occurring at exposed interior areas.

C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

D. Prime and paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, and except where items are pre-finished.

E. Paint exposed air ducts and interior surfaces of air ducts that are visible through grilles and louvers with one coat of flat black paint, to visible surfaces. Paint dampers exposed behind louvers, grilles, to match face panels.

F. Paint exposed conduit and electrical equipment occurring in finished areas.

G. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.

H. Color code equipment, piping, conduit, and exposed duct work in accordance with requirements indicated. Color band and identify with flow arrows, names, and numbering.

I. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed

prior to finishing.

3.5. CLEANING

A. Collect waste material which may constitute fire hazard, place in closed metal containers and remove daily from site.

3.6. SCHEDULE - EXTERIOR SURFACES

A. Metal – Galvanized Metal:
   1. Primer:
      a. : 4030 Tru-Glaze WB Waterborne Epoxy Primer
   2. Heavy Use:
      a. 2 coats ICI: 4408 Tru-Glaze WB Waterborne Epoxy Gloss
      b. Custom Color as selected by Owner/Engineer

B. Metal – Non-galvanized Metal:
   1. Primer:
      a. : 4030 Tru-Glaze WB Waterborne Epoxy Primer
   2. Heavy Use:
      a. 2 coats ICI: 4408 Tru-Glaze WB Waterborne Epoxy Gloss
      b. Custom Color as selected by Owner/Engineer
   3. Concrete/Masonry, Opaque, Alkyd, 3 Coat: (Prep for Mural Painting by Others)
      a. One coat of block filler.
      b. Eggshell: Two coats of alkyd enamel.

3.7. SCHEDULE - INTERIOR PAINT

A. Concrete
   1. Prime coat:
      ICI 3210 Prep & Prime Gripper Multi-Purpose Water-Based Primer Sealer
   2. First and Second Finish Coat:
      2 coats ICI 4418 Tru-Glaze Waterborne Acrylic Epoxy Coating

B. Metal – Galvanized Metal:
   1. Primer:
      a. : 4030 Tru-Glaze WB Waterborne Epoxy Primer
   2. Heavy Use:
      a. 2 coats ICI: 4408 Tru-Glaze WB Waterborne Epoxy Gloss
      b. Custom Color as selected by Owner/Engineer

C. Metal – Non-galvanized Metal:
   1. Primer:
      a. : 4030 Tru-Glaze WB Waterborne Epoxy Primer
   2. Heavy Use:
      a. 2 coats ICI: 4408 Tru-Glaze WB Waterborne Epoxy Gloss
      b. Custom Color as selected by Owner/Engineer

3.8. **SCHEDULE** – COLORS: Coordinate color selections with Engineer, Architect and Owner.

END OF SECTION

SECTION 09 91 00
PIPING AND EQUIPMENT PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Furnish all labor, materials, tools and equipment required for painting of piping and equipment which are to receive finish as indicated in the schedule. This section applies to mechanical piping, valves, fittings, and electrical equipment.

B. Related Specification Sections include but are not limited to:
1. Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 1 - General Requirements.

1.2 REFERENCES

A. Definitions
1. For purposes of this painting specification, the following areas and spaces are not considered finished, occupied areas and there will be no painting therein except for doors and frames and as may be specifically scheduled in article paint schedule.
   a. Mechanical chases
   b. Spaces above suspended ceilings
   c. Under-floor crawl spaces

B. Reference Standards
1. Reference standards cited in this specification refer to the current reference standard published at the time of the latest revision date logged at the end of this specification, unless a date is specifically cited.
2. American Society for Testing and Materials (ASTM):
   a. ASTM D 16 - Definitions of Terms Relating to Paint, Varnish, Lacquer and Related Products.
   b. ASTM D 2016 - Test Method for Moisture Content of Wood.
   c. ASTM D 4258 - Practice for Surface Cleaning Concrete for Coating.
   d. ASTM D 4262 - Test method for pH of Chemically Cleaned or Etched Concrete Surfaces.
   e. ASTM D 4263 - Test method for Indicating Moisture in Concrete by The Plastic Sheet Method.
3. NACE (National Association of Corrosion Engineers) - Industrial maintenance Painting.
4. NPCA (National Paint and Coatings Association) Guide to U.S. Government Paint Specifications.
5. PDCA (Painting and Decorating Contractors of America) - Painting - Architectural Specifications Manual.
6. SSPC (Steel Structures Painting Council) - Steel Structures Painting Manual.

1.3 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.4 SUBMITTALS

A. Submittals shall be in accordance with the General Provisions.

B. All submittals shall be approved by the City prior to delivery and/or fabrication for specials.

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data

1. For each paint system used herein, furnish a Paint System Data Sheet (PSDS), Technical Data Sheets, and paint colors available (where applicable) for each product used in the paint system, except for products applied by equipment manufacturers. A sample PSDS form is appended at the end of this Section.
2. The Contractor shall also provide copies of the paint system submittals to the coating applicator.
3. Indiscriminate submittal of manufacturer's literature only is not acceptable.

B. Shop Drawings

1. Submit two 8 1/2” x 11” samples of each paint color. Samples shall be on heavy cardboard and shall be made with the actual mixed paints to be used on the project

C. Certificates

1. Where ANSI/NSF Standard 60 and 61 approval is required, submit ANSI/NSF certification letter for each coating in the system indicating product application limits on size of tank or piping, dry film thickness, number of coats, specific product tested, colors certified, and approved additives.

D. Test and Evaluation Reports

1. Provide TCLP test data for lead and other regulated heavy metals in non-recyclable, slag type abrasive blast media to be used on the Project. Acceptable abrasive test data shall indicate the abrasive manufacturer, location of manufacture, and media gradation and type. Surface preparation will not be permitted to begin until acceptable test data has been submitted.

E. Source Quality Control Submittals

1. Applicator’s Experience
   a. List of references substantiating the requirements as specified.
2. Factory Applied Coatings
   a. Manufacturer's certification stating factory applied coating systems meets or exceeds requirements specified herein.
3. If the manufacturer of finish coating differs from that of shop primer, provide both manufacturers’ written confirmation that materials are compatible.

1.6 CLOSEOUT SUBMITTALS

A. Record Documentation

1. Close-out Schedule
   a. Upon completion of work, furnish a full schedule of paint types and colors actually used and formulas for each to the Owner.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Extra Stock Materials

1. Upon completion of the work, deliver to project site 2 gallons of each type and color of paint applied to interior and exterior surfaces. Provide formula for custom match colors.

1.8 QUALITY ASSURANCE

A. Qualifications

1. Manufacturers
   a. The paint manufacturer shall provide a representative to visit the jobsite at intervals during surface preparation and painting as may be required for product application quality assurance, and to determine compliance with manufacturer's instructions and the Contract Documents, and as may be necessary to resolve field problems attributable to, or associated with, the manufacturer's products furnished under this Contract.
2. Applicators
   a. Minimum of 5 years practical experience in application of specified products. Submit a list of recent projects and names of references for those projects. The Engineer will waive the requirement for 5 years' experience, when at the discretion of the Engineer, the applicators' experience and capabilities meet the intent of the experience requirement.

B. Product Labels

1. Include manufacturer's name, type of paint, stock number, color and label analysis on label of containers.

C. Single Source Responsibility

1. Provide primers and other undercoat paint produced by same manufacturer as final coats. Use only thinners approved by paint manufacturer, and use only within recommended limits.

D. Do not paint over code-required labels, such as Underwriters' Laboratories and Factory Mutual, or equipment identification, performance rating, name or nomenclature plates. Delivery, storage, and handling

E. Inspection

1. Inspect and provide substrate surfaces prepared in accordance with the Contract Documents and the printed directions and recommendations of paint manufacturer whose product is to be applied.
2. Provide Engineer minimum 3 days' advance notice prior to start of surface preparation work or coating application work.
3. Inspection by the Engineer, or the waiver of inspection of any particular portion of the Work, shall not be construed to relieve the Contractor of responsibility to perform the Work in accordance with the Contract Documents.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements

1. Deliver paint materials in sealed original labeled containers bearing manufacturers name, type of paint, brand name, color designation and instructions for mixing.

2. Provide adequate storage facilities at minimum ambient temperature of minimum 45° F to a maximum of 90° F in well-ventilated area.
3. Where precoated items are to be shipped to the jobsite, protect coating from damage. Batten coated items to prevent abrasion.
4. Use nonmetallic or padded slings and straps in handling.
5. Items will be rejected for excessive damage.

B. Storage and Handling Requirements
1. Store paints in a suitable protected area that is heated or cooled as required to maintain temperatures within the range recommended by the paint manufacturer.

1.10 FIELD CONDITIONS

A. Environmental Requirements
1. Comply with manufacturer's recommendations as to environmental conditions under which coatings and systems can be applied.
2. Do not apply finish in areas where dust is being generated.
3. Do not perform abrasive blast cleaning whenever the relative humidity exceeds 85 percent or whenever surface temperature is less than 5 degrees F above the dew point of the ambient air.
4. Surface preparation power tools and blast equipment shall contain dust collection equipment that will prevent discharge of dust particles into the atmosphere when surface preparation work is located within enclosures or confined areas with electrical equipment, motors, instrumentation, or other equipment that may be damaged by airborne dust and particles.

1.11 WARRANTY

A. Manufacturer Warranty
1. The Contractor and coating manufacturer shall jointly and severally warrant to the City and guarantee the Work under this Section against defective workmanship and materials for a period of 2 years commencing on the date of final acceptance of the Work.
2. A warranty inspection shall be conducted 1 month prior to expiration of the warranty period. Any defective Work discovered at this date shall be corrected by the Contractor in accordance with the Contract Documents at no additional cost to the City. Other corrective measures may be required during the 2 year warranty period.

PART 2 - PRODUCTS

2.1 CITY-FURNISHED OR CITY-SUPPLIED PRODUCTS [NOT USED]

2.2 MATERIALS

A. Manufacturers
1. Manufacturer List
a. Sherwin Williams
b. Tnemec Coatings

c. Other coating manufacturers will only be considered if the product complies with an unlimited recoat window.

B. Description

1. Regulatory Requirements
   a. Products shall meet federal, state, and local requirements limiting the emission of volatile organic compounds.
   b. Coatings shall be free of lead and lead compounds.

C. Materials

1. General
   a. Whenever a material is identified by reference to manufacturer's or vendors' names, trade names, catalog number or the like, it is so identified for the purpose of establishing a standard, and material of other manufacturers or vendors which will perform adequately the duties imposed by the general design will be considered acceptable provided the material so proposed is substituted under provisions of the General Provisions. It shall not be purchased or installed by the Contractor without the Engineer's written approval.
   b. Materials Including Primer and Finish Coats shall be produced by same paint manufacturer.
   c. Thinners, Cleaners, Driers, and Other Additives may be used as recommended by paint manufacturer of the particular coating. Where coatings are required to meet ANSI/NSF Standard 60 and 61, addition of thinners, driers, and other paint additives not approved under the ANSI/NSF certification letter will not be permitted without written approval from the Engineer.
2. Products
   a. Moisture Cured Zinc Primer – Single component, moisture cured urethane based, 12 lbs. metallic zinc content per gallon minimum, unlimited recoat period.
   b. Moisture Cured Urethane – Single component, moisture cured urethane intermediate and top coat, suitable for high humidity and condensation, unlimited recoat period.
   c. Polyamide Epoxy, High Solids – Polyamide or polyamine cured epoxy suitable for immersion or buried service.
3. Colors
   a. Provide as selected by the City or Engineer. Colors will be selected by the Owner from standard manufacturer's color samples.
   b. The Contractor shall submit for approval samples of each color and finish, with the name of the manufacturer made on the same materials on which each is to be used. Approved samples will form a standard for acceptance or rejection of completed work as to color and finish. Most colors will be the inter-mixes and let downs. Mix paints as required to obtain the color scheduled.

D. Paint Schedule

1. The products listed below represent top of the line products of each manufacturer. These products are not presented as being equivalent, as there are too many variables to match each product across the board. Manufacturer's designations are:
   a. SW - The Sherwin-Williams Co.
   b. TN - Tnemec Co.
2. Above Ground Valves, Pipes, and Fittings (Non-Submerged)
   a. Surface Preparation

1) SSPC-SP1 and SSPC-SP10

b. Painting System

1) 1st Coat

a) 3.0 – 4.0 dry mils of Tnemec Series 133 Protuff Aluminum

b) 5.0 – 6.0 dry mils of Sherwin-Williams Macropoxy 646 FC epoxy @ the rate of 290 sq.ft./gal.

2) 2nd Coat

a) 1.5 – 2.0 dry mils of Tnemec Series 1029 Enduratone

b) 5.0 – 6.0 dry mils of Sherwin-Williams Macropoxy 646 FC epoxy @ the rate of 250 sq.ft./gal.

3) 3rd Coat

a) Tnemec Only: 1.5 – 2.0 dry mils of Tnemec Series 28 Color Tufcryl

3. Above Ground Valves, Pipes, and Fittings (Submerged or Intermittently Submerged)

a. Surface Preparation

1) SSPC-SP5

b. Painting System

1) 1st Coat

a) 4.0 – 5.0 dry mils of Tnemec Series 1 Omnithane

b) 3.0 – 4.0 dry mils of Sherwin -Williams Corothane 1 Galva-Pac Zinc Primer B65G11 (shop applied or field applied) @ the rate of 290 sq.ft./gal.

2) 2nd Coat

a) 5.0 – 6.0 dry mils of Tnemec Series 66 Hi-Build Epoxoline

b) 5.0 – 6.0 dry mils of Sherwin-Williams Macropoxy 646 FC Epoxy @ the rate of 175 sq.ft./gal.

3) 3rd Coat

a) 5.0 – 6.0 dry mils of Series 66 Hi-Build Epoxoline

b) 5.0 – 6.0 dry mils of Sherwin-Williams Macropoxy 646 FC Epoxy @ the rate of 175 sq.ft./gal.

4. Hydropneumatic Pressure Tanks

a. Surface Preparation

1) SSPC-SP6

b. Painting System

1) 1st Coat

a) Tnemec Series 94-H20 Hydro-Zinc applied at 2.5 dry mils.

b) Sherwin Williams Corothane 1 Galvapac Two Pack applied at 3 dry mils

2) 2nd Coat

a) Tnemec Series 73-Color Endura-Shield applied at 3.0 dry mils.

b) Sherwin Williams Acrolon 218 HS applied at 3.0 dry mils.

3) 3rd Coat

a) Tnemec Hydroflon Series 700 applied at 2.0 dry mils (Total dry mils = 7.5).

b) Sherwin Williams Fluorokem HS applied at 2.0 dry mils (Total dry mils = 8.5).

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION

A. Inspection

1. Thoroughly examine surfaces scheduled to be painted prior to commencement of work.
2. The application of finishes shall be held to denote the acceptance of surfaces and conditions by the painter and he will be responsible for producing results reasonably to be expected under the specifications. Rooms shall be swept out before application of paint, and no sweeping shall be done in or adjacent to places where the paint has not had sufficient time to dry dust-free.
3. Check each coat for the correct milage. Do not make measurement before a minimum of 8 hours after application of the coating

B. Inspection Test Equipment

1. Provide a magnetic type or electronic dry film thickness gauge to test coating thickness specified in mils, as manufactured by:
   a. Nordson Corp., Anaheim, CA, Mikrotest.
   b. DeFelsko Corp., Anaheim, CA, Positector.
   c. Or equal.
2. Provide an electrical holiday detector, low voltage, wet sponge type to test finish coatings less than 20 mils in thickness, except zinc primer, high-build elastomeric coatings, and galvanizing, for holidays and discontinuities as manufactured by:
   a. Tinker and Razor, San Gabriel, CA, Model M-1.
   b. Or equal.

3.3 PREPARATION

A. Preparation of Surfaces

1. All metal surfaces to be painted shall be sound, clean and free of mill scale, rust, dust, dirt, oil, grease, moisture or any other foreign matter which might, in any way, lessen the life or usefulness of the coating.
2. All metal surfaces shall be washed with mineral spirits to remove any dirt or grease, before applying materials. Where rust or scale is present, it shall be wire brushed, or sandpapered clean before painting. Shop coats of paint that become marred shall be cleaned and touched up.
3. Metal shall also be smooth and free from blisters, rough corners, pits, dents, or other imperfections before painting. Pits and dents shall be filled and the metal ground smooth where required.
4. When called for in the specifications or recommended by the paint manufacturer, the latest revisions of the following surface preparation specifications of the Steel Structures Painting Council shall apply:

a. Solvent Cleaning (SSPC-SP1): Removal of oil, grease, soil and other contaminants by use of solvents, emulsions, cleaning compounds, steam cleaning or similar materials and methods which involve a solvent or cleaning action.
b. Hand Tool Cleaning (SSPC-SP2): Removal of loose rust, loose mill scale and other detrimental foreign matter to degree specified by hand chipping, scraping, sanding and wire brushing.
c. Power Tool Cleaning (SSPC-SP3): Removal of loose rust, loose mill scale and other detrimental foreign matter to degree specified by power wire brushing, power impact tools or power sanders.
d. White Metal Blast Cleaning (SSPC-SP5): Blast cleaning to a gray-white uniform metallic color until each element of surface area is free of all visible residues.
e. Commercial Blast cleaning (SSPC-SP6): Blast cleaning until at least two-thirds of each element of surface area is free of all visible residues from each square inch.
f. Brush-Off blast Cleaning (SSPC-SP7): Blast cleaning to remove loose rust, loose mill scale and other detrimental foreign matter to degree specified.
g. Near White Blast Cleaning (SSPC-SP10): Blast cleaning to nearly white metal cleanliness, until at least 95 percent of each element of surface area is free of all visible residues from each square inch.

5. When called for in the specifications or recommended by the paint manufacturer, the latest revisions of the following surface preparation specifications of the National Association of Pipe Fabricators shall apply:
   a. NAPF 500-03-01 “Solvent Cleaning”
   b. NAPF 500-03-02 “Hand Tool Cleaning”
   c. NAPF 500-03-03 “Power Tool Cleaning”
   d. NAPF 500-03-04 “Abrasive Blast Cleaning of Ductile Iron Pipe”
   e. NAPF 500-03-05 “Abrasive Blast Cleaning of Cast Ductile Iron Fittings”
6. All surface preparation of new equipment and surfaces shall be assumed to be on a SSPC Grade A steel surface condition, unless specifically noted otherwise.
7. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers' recommendations for wet blast additives and first coat application shall apply.
8. Hand tool clean areas that cannot be cleaned by power tool cleaning.

B. Welds and Adjacent Areas
   1. Prepared such that there is:
      a. No undercutting or reverse ridges on the weld bead.
      b. No weld spatter on or adjacent to the weld or any other area to be painted.
      c. No sharp peaks or ridges along the weld bead.
   2. Grind embedded pieces of electrode or wire flush with the adjacent surface of the weld bead.

C. Blast Cleaning Requirements
   1. Select type and size of abrasive to produce a surface profile that meets the coating manufacturer's recommendations for the particular coating to be applied or not less than 20 percent of the specified coating thickness, whichever is more stringent.
   2. Meet applicable federal, state, and local air pollution control regulations for blast cleaning and disposition of spent aggregate and debris.

3. Do not reuse abrasive, unless abrasive is a recyclable abrasive.

D. Dehumidification

1. Where weather conditions or Project requirements dictate, Contractor shall provide and operate dehumidification equipment to maintain environmental conditions suitable for abrasive blasting and coating application as specified.
2. Contractor shall provide dehumidification equipment sized to maintain dew point temperature 5 degrees F or more below surface temperature of metal surfaces to be cleaned and painted.
3. Cleaned metal surfaces shall be prevented from flash rusting throughout the Project duration, condensation or icing shall be prevented throughout surface preparation and coating application.
4. Equipment size and power requirements shall be designed and operated by personnel trained in the operation and setup of dehumidification equipment based on Project requirements and anticipated weather conditions.
5. If required, dehumidification equipment shall operate 24 hours per day and continuously throughout surface preparation and coating application.
6. Daily maintenance requirements of the equipment shall be documented in writing and posted near the equipment for review by the Engineer.
7. Reblasting of flash rusted metal surfaces or removal of damaged coatings, as a result of equipment malfunction, shutdown, or other events that result in the loss of environmental control, will be at the sole expense of the Contractor.

E. Ventilation and Illumination

1. Adequate illumination shall be provided while work is in progress. Whenever required by the inspector, the Contractor shall provide additional illumination and necessary supports to cover all areas to be inspected. The level of illumination for inspection purposes shall be determined by the inspector.
2. Ventilation shall be used to control potential dust and hazardous conditions within confined areas. Ventilation flow rates shall be in accordance with OSHA regulations and as required to reduce air contamination to nonhazardous conditions.

F. Protection of Surfaces Not to be Painted

1. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not intended to be painted.
2. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.
3. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.
4. Mask openings in motors to prevent paint and other materials from entering the motors.

G. Paint Mixing

1. Multiple-component coatings
   a. Prepare using all of the contents of the container for each component as packaged by the paint manufacturer.
   b. No partial batches will be permitted.

c. Do not use multiple-component coatings that have been mixed shall not be used beyond their pot life.
d. Provide small quantity kits for touchup painting and for painting other small areas.
e. Mix only components specified and furnished by the paint manufacturer.
f. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

2. Keep paint materials sealed when not in use.
3. Where more than one coat of a material is applied within a given system, alternate color to provide a visual reference that the required number of coats have been applied.
4. Paints and similar materials shall be mixed in vessels of adequate capacity. All paints shall be thoroughly stirred before being taken from the containers, shall be kept stirred while using, and all ready-mixed paints shall be applied exactly from the manufacturer without addition of any kind of a drier or thinner, except as provided in manufacturer's directions or upon specific authorization.
5. Mixing, thinning and application of the coating materials shall be in exact accordance with the manufacturer's recommendations

3.4 APPLICATION

A. General

1. All work shall be done by skilled mechanics. All materials shall be evenly spread and smoothly flowed on without sags or runs, and all coats shall be thoroughly dry per the manufacturer data sheet before applying succeeding coats.
2. Apply coatings in accordance with the paint manufacturer's recommendations. Finish applied metal shall be sanded between coats with fine sandpaper to produce an even, smooth finish.
3. No exterior painting shall be done in rainy, damp, or frosty weather per the manufacturer data sheet or until the surface is thoroughly dry. No interior painting or finishing shall be permitted until the building has thoroughly dried out by natural or artificial heat.
4. Inspection: Schedule with Engineer in advance for cleaned surfaces and all coats prior to the succeeding coat.
5. Paint units to be bolted together and to structures prior to assembly or installation.
6. Shop Primed or Factory Finished Surfaces
   a. Inspection: Schedule with Engineer in advance for shop primed or factory-finished items delivered to the Site for compliance with the Specifications.
   b. Power sand areas of chipped, peeled, or abraded coating, feathering the edges. Follow with a spot primer using specified primer.
   c. For two-package or converted coatings, consult the coatings manufacturer for specific procedures as relates to top coating of products.
   d. Prior to application of finish coats, clean shop primed surfaces of dirt, oil, and grease, and apply a mist coat of specified primer, 1.0 mil dry film thickness.
   e. After welding, prepare and prime holdback areas as required for the specified paint system. Apply primer in accordance with manufacturer's instructions.
7. Manufacturer Applied Paint Systems
   a. Repair abraded areas on factory-finished items in accordance with the equipment manufacturer's directions.

b. Carefully blend repaired areas into the original finish.

B. Film Thickness

1. Applied coating system film thickness per coat shall be applied at the specified coating thickness or the manufacturer's recommended minimum thickness, whichever is greater.
2. Maximum film build per coat shall not exceed the coating manufacturer's recommendations.
3. Surfaces that are subject to immersion, condensing environments, or where specifically specified shall be stripe coated on all angles, edges, corners, threads, welds, and similar type surfaces. Stripe coat shall be an extra coat of the intermediate or topcoat material. The stripe coat shall be a separate coat of paint from coats specified under the coating system. Stripe coats shall be alternated in color similar to a full coat.

3.5 MECHANICAL AND ELECTRICAL EQUIPMENT

A. Refer to mechanical and electrical sections with respect to color coding identification banding of equipment, ducting, piping and conduit.

B. Remove grilles, covers, and access panels for mechanical and electrical systems from location and paint separately.

C. Finish paint primed equipment to color selected.

D. Prime and paint exposed insulated and bare pipes, conduits, boxes, insulated and bare ducts, hangers, brackets, collars and supports, except where items are plated or covered with a pre-finished coating.

E. Replace identification markings on mechanical or electrical equipment when painted over or spattered.

F. Paint both sides and edges of plywood backboards for electrical equipment before installing backboards and mounting equipment on them

3.6 HARDWARE

A. Remove all hardware and electric plates and thoroughly protect same before painting, as he will be held responsible for any paint spots or staining and will be required to replace same, if damaged by painting or staining.

3.7 REPAIR /RESTORATION

A. Damaged Coatings, Pinholes, and Holidays

1. Feather edges and repair in accordance with the recommendations of the paint manufacturer.
2. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

B. Unsatisfactory Application

1. If the item has an improper finish color, or insufficient film thickness, clean and topcoat surface with specified paint material to obtain the specified color and coverage. Obtain specific surface preparation information from the coating manufacturer. Hand or power sand visible areas of chipped, peeled, or abraded paint and feather the edges. Follow with primer and finish coat in accordance with the Specifications. Depending on the extent of repair and its appearance, a finish sanding and topcoat may be required.
2. Evidence of runs, bridges, shiners, laps, or other imperfections shall be cause for rejection.
3. Repair defects in coating system per written recommendations of coating manufacturer.

3.8 RE-INSTALLATION [NOT USED]

3.9 FIELD QUALITY CONTROL [NOT USED]

3.10 SYSTEM STARTUP [NOT USED]

3.11 TOUCH UP

A. On completion, carefully touch up all holidays, marred and damaged spots, and work over all surfaces that have been repaired by other trades.

3.12 CLEANING

A. General
1. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroyed at the end of each day.
2. Upon completion of the Work, remove staging, scaffolding, and containers from the Site.
3. Completely remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.
4. Damages due to over spray on buildings, vehicles, trees, or other surfaces not specified to be painted would be the responsibility of the Contractor.

3.13 CLOSEOUT ACTIVITIES [NOT USED]

3.14 PROTECTION

1. Regulatory Requirements
   a. Protect workers and comply with applicable federal, state, and local air pollution and environmental regulations for surface preparation, blast cleaning, disposition of spent aggregate and debris, coating application and dust prevention including, but not limited to the following Acts, Regulations, Standards, and Guidelines.
      1) Clean Air Act.
      2) National Ambient Air Quality Standard.
      3) Resource Conservation and Recovery Act (RCRA).
   b. Comply with applicable federal, state, and local regulations for confined space entry.
   c. Provide and operate equipment that meets explosion proof requirements.
   d. Perform painting in accordance with recommendations of the following:
      1) Paint manufacturer's instructions.

2) NACE contained in the publication, Manual for Painter Safety.

3.15 MAINTENANCE [NOT USED]

3.16 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 10 52 20
FIRE EXTINGUISERS AND CABINETS

PART 1 - GENERAL

PART 1.1 SUMMARY

A. Section Includes: Fire extinguishers, fire extinguisher cabinets and accessories.

PART 1.2 SUBMITTALS

A. Product Data: Submit descriptive literature, installation instructions and cleaning recommendations.
B. Refer to General Conditions for additional information.

PART 1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Fire extinguisher and fire extinguisher cabinets shall bear UL Label, and shall comply with applicable provisions of NFPA including the inspection and tagging of fire extinguishers; approved for intended use and locations by applicable governing authority.

PART 1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver fire extinguisher cabinets and brackets in manufacturer's original cartons, properly labeled and intact.

PART 2 - PRODUCTS

PART 2.1 MANUFACTURER

A. Acceptable Manufacturers:
1. J.L. Industries.
2. Larsen's Manufacturing Company.
3. Walter Kidde and Company.
4. Norris Industries.

B. Substitutions: Comply with Section 01 25 00.

PART 2.2 MATERIALS AND COMPONENTS

A. Surface Mounted Cabinet:
1. Door: One piece solid construction, cold-rolled steel white baked enamel steel; full glass style; with piano hinge, lock and handle.

2. Trim: One piece trim frame with joints welded and ground smooth, cold-rolled white baked enamel steel.
3. Tub: Cold-rolled white baked enamel steel; corners welded and ground smooth.
4. Glazing: Clear 1/4" acrylic.
5. Acceptable Product:
a. Non-rated Cabinet: Model No. 2712-SM by Larsen's Manufacturing Company.

B. Fire Extinguisher:
1. Type: Multi-purpose dry chemical.
2. Heavy duty cylinder with epoxy finish; chrome valve and siphon tubes, replaceable molded valve steam seal; large pressure indicating gages, pull pin; up-right squeeze-grip operation.
3. Acceptable Products:
a. UL rated 4A-60B:C, 10 lb. capacity:
1) Model No. MP10 by Larsen's Manufacturing Company.
2) Cosmic 10E by J. L. Industries.

PART 3 - EXECUTION

PART 3.1 INSTALLATION

A. Securely fasten cabinets and brackets to structure, square and plumb, in accordance with manufacturer's instruction. Install at mounting height to comply with governing authorities.

PART 3.2 FIELD QUALITY CONTROL

A. Inspection: Inspect and tag fire extinguishers as required by NFPA.

PART 3.3 SCHEDULE

A. Install cabinets, brackets and extinguishers at rate of minimum one portable fire extinguisher for each 6,000 square feet.

END OF SECTION

SECTION 23 05 00
COMMON WORK RESULTS 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. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Mechanical sleeve seals.
   5. Sleeves.
   6. Escutcheons.
   7. Grout.
   8. Equipment installation requirements common to equipment sections.
   9. Painting and finishing.
   10. Concrete bases.
   11. Supports and anchorages.

1.3 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.

F. The following are industry abbreviations for plastic materials:
   1. CPVC: Chlorinated polyvinyl chloride plastic.
   2. PE: Polyethylene plastic.
   3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Welding certificates.

1.5 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.

1.6 DELIVERY, STORAGE, AND HANDLING

A. 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.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

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. 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. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 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.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. 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.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.

C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.

2.5 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-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

F. 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).

G. 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).

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Carbon steel. Include two for each sealing element.
3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-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.

2.8 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.

E. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

I. One-Piece Wall and Ceiling PVC Split Ring, in chrome plated finish or white.

2.9 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 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 according to the following:

1. 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 with spring clips or One-piece split ring PVC.
    d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece Wall and Ceiling PVC Split Ring, in chrome plated finish or white.
    e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece Wall and Ceiling PVC Split Ring, in Chrome plated finish or white.
    f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece Wall and Ceiling PVC Split Ring, in chrome plated finish or white.
    g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece Wall and Ceiling PVC Split Ring, in chrome plated finish or white.
    h. Bare Piping in Unfinished Service Spaces: One-piece Wall and Ceiling PVC Split Ring, in chrome plated finish or white.
    i. Bare Piping in Unfinished Service Spaces: One-piece Wall and Ceiling PVC Split Ring, in chrome plated finish or white.

j. Bare Piping in Equipment Rooms: One-piece Wall and Ceiling PVC Split Ring, in chrome plated finish or white.
k. Bare Piping in Equipment Rooms: One-piece Wall and Ceiling PVC Split Ring, in chrome plated finish or white.
l. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece Wall and Ceiling PVC Split Ring, in chrome plated finish or white.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. Galvanized or black Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
   b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
      1) Seal space outside of sleeve fittings with grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. 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.

R. 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.

S. 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.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 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.

3.3 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.

3.4 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.

3.5 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

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 Section "Cast-in-Place Concrete."

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 HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 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

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 (1000 m) 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

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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for HVAC system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Equipment supports.

B. Related Sections include the following:
   1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-protection piping.
   3. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
   4. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
   5. Division 23 Section(s) "Metal Ducts" and "Nonmetal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Fiberglass pipe hangers.
   3. Thermal-hanger shield inserts.
   4. Powder-actuated fastener systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.
   3. Fiberglass strut systems. Include Product Data for components.
   4. Pipe stands. Include Product Data for components.
   5. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel." ASME Boiler and Pressure Vessel Code: Section IX.

B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.2, "Structural Welding Code--Aluminum."
   3. AWS D1.3, "Structural Welding Code--Sheet Steel."
   4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
   5. ASME Boiler and Pressure Vessel Code: Section IX.

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 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:

1. AAA Technology & Specialties Co., Inc.
2. Bergen-Power Pipe Supports.
3. B-Line Systems, Inc.; a division of Cooper Industries.
4. Carpenter & Paterson, Inc.
5. Empire Industries, Inc.
6. ERICO/Michigan Hanger Co.
7. Globe Pipe Hanger Products, Inc.
8. Grinnell Corp.
9. GS Metals Corp.
10. National Pipe Hanger Corporation.
11. PHD Manufacturing, Inc.
12. PHS Industries, Inc.
13. Piping Technology & Products, Inc.
14. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
4. Power-Strut Div.; Tyco International, Ltd.
5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig-minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. 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.

1. Manufacturers:
   a. Hilti, Inc.
   b. ITW Ramset/Red Head.
   c. Masterset Fastening Systems, Inc.
   d. MKT Fastening, LLC.
   e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated or stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:
   a. B-Line Systems, Inc.; a division of Cooper Industries.
   b. Empire Industries, Inc.
   c. Hilti, Inc.
   d. ITW Ramset/Red Head.
   e. MKT Fastening, LLC.
   f. Powers Fasteners.

2.7 PIPE STAND FABRICATION

A. Pipe Stands, General: 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.

1. Manufacturers:

a. ERICO/Michigan Hanger Co.
b. MIRO Industries.

C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

1. Manufacturers:
a. MIRO Industries.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.

1. Manufacturers:
a. ERICO/Michigan Hanger Co.
b. MIRO Industries.
c. Portable Pipe Hangers.
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: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.

1. Manufacturers:
a. Portable Pipe Hangers.
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 support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.8 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.9 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, 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 APPLICATIONS

A. Specific hanger and support requirements are specified 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 padded hangers for piping that is subject to scratching.

F. 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 (DN 15 to DN 750).
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16 (DN 100 to DN 400), 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 24 (DN 20 to DN 600), 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 (DN 15 to DN 600), if little or no insulation is required.
5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2 (DN 15 to DN 50).
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
14. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange 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 (DN 65 to DN 900), if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
17. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30 (DN 25 to DN 750), from 2 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 20 (DN 65 to DN 500), 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 (DN 50 to DN 1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24 (DN 50 to DN 600), if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN 50 to DN 750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. 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 20 (DN 20 to DN 500).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500), if longer ends are required for riser clamps.

H. 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.

I. 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.

J. 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.

K. 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 absorb 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 absorb 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 absorb 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.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel 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 building structure.

B. 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 above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. 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.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

I. 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.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. 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 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

N. Insulated Piping: Comply with the following:

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 according to ASME B31.1 for power piping and 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 (DN 100) and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) 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 (DN 8 to DN 90): 12 inches long and 0.048 inch thick.
   b. NPS 4 (DN 100): 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches long and 0.105 inch thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 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 smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 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 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 contours of welded surfaces match adjacent contours.

3.5 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.

3.6 PAINTING

A. Touch Up: 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.

B. Touch Up: 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.

END OF SECTION

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. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

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, 1/16 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. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

E. 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.

F. Fasteners: Stainless-steel rivets or self-tapping screws.

G. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.

D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Provide manufacturers standard colors as follows:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment components.
3. Yellow/Green: Combination cooling and heating equipment and components.
4. Brown: Energy reclamation equipment and components.
5. Blue: Equipment and components that do not meet any of the above criteria.
6. Red: Fire protection equipment and components.
7. For hazardous equipment, use colors and designs recommended by ANSI A13.1.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

E. 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.

F. Fasteners: Stainless-steel rivets or self-tapping screws.

G. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

H. 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 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Fiberboard.
2. Stencil Paint: Exterior, gloss, acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.6 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: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 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.

2.7 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.

2.8 TAG IDENTIFICATION SCHEME FOR LOCATING HIDDEN UTILITY

COMPONENTS

A. Tag system to allow easy identification of the location of components and equipment that are not visible from the finished space and are accessible from the ceiling grid. Provide laminated, printed tags with pin back to be fastened flush with acoustical ceiling. The pin fasteners shall be manually removable without the use of tools and shall not separate from the ceiling panels when the panels are dropped from ceiling height. Tag shall be white background with black letters 3/8” high, each tag bearing the equipment tag. Concealed equipment to be tagged shall include but not limited to the following:

1. Exhaust fan
2. VAV terminal box

3. Hot water isolation valve

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. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.

1. Identification Paint: Use for contrasting background.
2. Stencil Paint: Use for pipe marking.

C. 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.

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. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

C. 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. Refrigerant: 1-1/2 inches round.
   b. Gas: 1-1/2 inches round.
2. Valve-Tag Color:
   a. Gas: Natural.
3. Letter Color:
   a. 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 23 05 53

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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes TAB to produce design objectives for the following:
   1. Air Systems.
   2. HVAC equipment quantitative-performance settings.
   3. Kitchen hood airflow balancing.
   4. Exhaust hood airflow balancing.
   5. Sound level measuring.
   6. Verifying that automatic control devices are functioning properly.
   7. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

M. TAB: Testing, adjusting, and balancing.

N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

O. Test: A procedure to determine quantitative performance of systems or equipment.

P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within 30 days from Contractor's Notice to Proceed, submit 6 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 30 days from Contractor's Notice to Proceed, submit 6 copies of the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 30 days from Contractor's Notice to Proceed, submit 6 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

E. Sample Report Forms: Submit two sets of sample TAB report forms.

F. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by AABC.

B. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
    a. Submittal distribution requirements.
    b. The Contract Documents examination report.
    c. TAB plan.
    d. Work schedule and Project-site access requirements.
    e. Coordination and cooperation of trades and subcontractors.
    f. Coordination of documentation and communication flow.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.

2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from AABC's Standards for Testing, Adjusting, and Balancing of Environmental Systems.

E. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. 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. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

A. Special Guarantee: Provide a guarantee on AABC forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:

1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
2. Systems are balanced to optimum performance capabilities within design and installation limits.

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.

1. Contract Documents are defined in the General and Supplementary Conditions of Contract.

2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

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 equipment performance data including fan and pump curves. 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. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as water source heat pumps, to verify that they are accessible and their controls are connected and functioning.

L. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

M. Examine strainers for clean screens and proper perforations.

N. Examine automatic flow control valves for proper installation for their intended function of regulating fluid flows.

O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

P. Examine system pumps to ensure absence of entrained air in the suction piping.

Q. Examine equipment for installation and for properly operating safety interlocks and controls.

R. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices are operated by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is accordance to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

S. 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 system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Hydronic (geothermal) systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Equipment and duct access doors are securely closed.
5. Balance, smoke, and fire dampers are open.
6. Isolating and balancing valves are open and control valves are operational.
7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

D. Take and report testing and balancing measurements in inch-pound (IP).

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. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling unit components.

K. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:
    a. Measure outlet static pressure as far downstream from the fan as practicable 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 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.
2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
6. 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 modes 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 static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
      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. 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 terminal 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 terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using 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, model, and serial numbers.
   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.

3.7 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
   2. Air Outlets and Inlets: 0 to minus 10 percent.

3.8 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: As Work progresses, prepare 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.

3.9 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   1. Include a list of instruments used for procedures, along with proof of calibration.

C. 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, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of TAB firm.
   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 firm 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, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans and pump performance forms including the following:
    a. Settings for outside-, 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.

E. 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 outside, supply, return, and exhaust airflows.
2. Water flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations
5. Position of balancing devices.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
    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 (mm), and bore.
    i. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
    j. Number of belts, make, and size.
    k. Number of filters, type, and size.
2. Motor Data:
    a. 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 (mm), and bore.
f. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).

3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Filter static-pressure differential in inches wg (Pa).
f. Preheat coil static-pressure differential in inches wg (Pa).
g. Cooling coil static-pressure differential in inches wg (Pa).
h. Heating coil static-pressure differential in inches wg (Pa).
i. Outside airflow in cfm (L/s).
j. Return airflow in cfm (L/s).
k. Outside-air damper position.
l. Return-air damper position.

G. 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 (mm) o.c.
f. Make and model number.
g. Face area in sq. ft. (sq. m).
h. Tube size in NPS (DN).
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):
a. Airflow rate in cfm (L/s).
b. Average face velocity in fpm (m/s).
c. Air pressure drop in inches wg (Pa).
d. Outside-air, wet- and dry-bulb temperatures in deg F (deg C).
e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
h. Water flow rate in gpm (L/s).
i. Water pressure differential in feet of head or psig (kPa).
j. Entering-water temperature in deg F (deg C).
k. Leaving-water temperature in deg F (deg C).
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig (kPa).
n. Refrigerant suction temperature in deg F (deg C).

H. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:

1. Unit Data:
a. System identification.
b. Location.

c. Coil identification.
d. Capacity in Btuh (kW).
e. Number of stages.
f. Connected volts, phase, and hertz.
g. Rated amperage.
h. Airflow rate in cfm (L/s).
i. Face area in sq. ft. (sq. m).
j. Minimum face velocity in fpm (m/s).

2. Test Data (Indicated and Actual Values):
a. Heat output in Btuh (kW).
b. Airflow rate in cfm (L/s).
c. Air velocity in fpm (m/s).
d. Entering-air temperature in deg F (deg C).
e. Leaving-air temperature in deg F (deg C).
f. Voltage at each connection.
g. Amperage for each phase.

I. 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 (mm), and bore.
h. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).

2. Motor Data:
a. 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 (mm), and bore.
f. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm (L/s).
b. Total system static pressure in inches wg (Pa).
c. Fan rpm.
d. Discharge static pressure in inches wg (Pa).
e. Suction static pressure in inches wg (Pa).

J. 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 (deg C).

d. Duct static pressure in inches wg (Pa).
e. Duct size in inches (mm).
f. Duct area in sq. ft. (sq. m).
g. Indicated airflow rate in cfm (L/s).
h. Indicated velocity in fpm (m/s).
i. Actual airflow rate in cfm (L/s).
j. Actual average velocity in fpm (m/s).
k. Barometric pressure in psig (Pa).

K. 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 and serial numbers.
   f. Water flow rate in gpm (L/s).
   g Water pressure differential in feet of head or psig (kPa).
   h. Required net positive suction head in feet of head or psig (kPa).
   i. Pump rpm.
   j. Impeller diameter in inches (mm).
   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 (kPa).
   b. Pump shutoff pressure in feet of head or psig (kPa).
   c. Actual impeller size in inches (mm).
   d. Full-open flow rate in gpm (L/s).
   e. Full-open pressure in feet of head or psig (kPa).
   f. Final discharge pressure in feet of head or psig (kPa).
   g. Final suction pressure in feet of head or psig (kPa).
   h. Final total pressure in feet of head or psig (kPa).
   i. Final water flow rate in gpm (L/s).
   j. Voltage at each connection.
   k. Amperage for each phase.

L. Sound Measurement Reports: Record sound measurements on octave band and dBA test forms and on an NC or RC chart indicating the decibel level measured in each frequency band for both "background" and "HVAC system operating" readings. Record each tested location on a separate NC or RC chart. Record the following on the forms:

1. Date and time of test. Record each tested location on its own NC curve.
2. Sound meter manufacturer, model number, and serial number.
3. Space location within the building including floor level and room number.
4. Diagram or color photograph of the space showing the measurement location.

5. Time weighting of measurements, either fast or slow.
6. Description of the measured sound: steady, transient, or tonal.
7. Description of predominant sound source.

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.

3.10 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. Randomly 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. Measure sound levels at two locations.
   e. Measure space pressure of at least 10 percent of locations.
   f. Verify that balancing devices are marked with final balance position.
   g. Note deviations to the Contract Documents in the Final Report.

B. Final Inspection:
1. After initial inspection is complete and evidence 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 Architect.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements documented in the final report to be rechecked. The 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 the 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.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.

7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

END OF SECTION

SECTION 23 07 19
HVAC PIPING 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 insulating the following HVAC piping systems:
   1. Condensate drain piping, indoors.
   2. Refrigerant suction and hot-gas piping, indoor and outdoors.

B. Related Sections:
   1. Division 23 Section "HVAC Equipment Insulation."
   2. Division 23 Section "Duct Insulation."

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   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.
   6. Detail application of field-applied jackets.
   7. Detail application at linkages of control devices.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.
   1. Preformed Pipe Insulation Materials: 12 inches (300 mm) long by NPS 2 (DN 50).
   2. Sheet Form Insulation Materials: 12 inches (300 mm) square.
   3. Jacket Materials for Pipe: 12 inches (300 mm) long by NPS 2 (DN 50).
   4. Sheet Jacket Materials: 12 inches (300 mm) square.
   5. 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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to 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 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.

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 sizes and locations 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. 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 "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and

"Outdoor, Underground Piping Insulation 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. Calcium Silicate:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Industrial Insulation Group (IIG); Thermo-12 Gold.
2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

G. 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, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Pittsburgh Corning Corporation; Foamglas.
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.

H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

I. 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 II with factory-applied vinyl jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; SOFTR All-Service Duct Wrap.

J. Mineral-Fiber, Preformed Pipe Insulation:

1. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products. See Division 01 Section "Product Requirements."
   Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000-Degree Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.
2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, without factory-applied jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

K. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Knauf Insulation; Permawick Pipe Insulation.
   b. Owens Corning; VaporWick Pipe Insulation.

L. Pipe and tank insulation is used for large-diameter piping and vessels. ASJ is commonly used.

1. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, 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.

M. Phenolic:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Kingspan Tarec Industrial Insulation NV; Koolphen K.
b. Resolco International BV; Insul-phen.
2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
a. Preformed Pipe Insulation: ASJ.

N. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Dow Chemical Company (The); Trymer 2000 XP.
b. Duna USA Inc.; Corafoam.
c. Dyplast Products; ISO-25.
d. Elliott Company of Indianapolis; Elfoam.
2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.
3. Flame-spread index shall be 25 or less, and smoke-developed index shall be 50 or less for thickness up to 1 inch (25 mm) as tested by ASTM E 84.
4. Fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

O. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F (0.038 W/m x K) after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Dow Chemical Company (The); Styrofoam.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
a. Ramco Insulation, Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ramco Insulation, Inc.; Thermokote V.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

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. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-97.
      b. Eagle Bridges - Marathon Industries; 290.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-27.
      d. Mon-Eco Industries, Inc.; 22-30.
      e. Vimasco Corporation; 760.
   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).
   3. Use adhesive that complies 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," including 2004 Addenda.

C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).
   1. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
      a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.
   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).
   3. Use adhesive that complies 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," including 2004 Addenda.

D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. 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. Use adhesive that complies 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," including 2004 Addenda.

E. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. 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).
2. Use adhesive that complies 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," including 2004 Addenda.

F. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F (29 to plus 60 deg C).
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-96.
   b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60.

G. 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, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
   d. 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).
3. Use adhesive that complies 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," including 2004 Addenda.

H. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dow Corning Corporation; 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; Polyco VP 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).
3. Use adhesive that complies 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," including 2004 Addenda.

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
4. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
2. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
4. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
2. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
4. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
2. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
3. Solids Content: 60 percent by volume and 66 percent by weight.
4. 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. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
   3. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
   4. Color: White.

2.6 SEALANTS

A. Joint Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Permanently flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
   4. Color: White or gray.
   5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   6. Use sealants that 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," including 2004 Addenda.

B. FSK and Metal Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   4. Color: Aluminum.
   5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   6. Use sealants that 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," including 2004 Addenda.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Materials shall be compatible with insulation materials, jackets, and substrates.
   2. Fire- and water-resistant, flexible, elastomeric sealant.
   3. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
   4. Color: White.
   5. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

6. Use sealants that 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," including 2004 Addenda.

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm (0.013 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
6. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm (0.007 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perms) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for pipe.

2.9 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

2.10 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Adhesive: As recommended by jacket material manufacturer.
   2. Color: White.
   3. 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.

D. Metal Jacket:
   1. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
      a. Sheet and roll stock ready for shop or field sizing.
      b. Finish and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
      d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) 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.

E. Self-Adhesive Outdoor Jacket: 60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

F. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

G. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.11 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Width: 3 inches (75 mm).
   2. Thickness: 11.5 mils (0.29 mm).
   3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   6. 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. Width: 3 inches (75 mm).
   2. Thickness: 6.5 mils (0.16 mm).
   3. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   4. Elongation: 2 percent.
   5. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   6. 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. Width: 2 inches (50 mm).
   2. Thickness: 6 mils (0.15 mm).
   3. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
   4. Elongation: 500 percent.
   5. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
   1. Width: 2 inches (50 mm).
   2. Thickness: 3.7 mils (0.093 mm).
   3. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
   4. Elongation: 5 percent.
   5. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
   1. Width: 3 inches (75 mm).
   2. Film Thickness: 4 mils (0.10 mm).
   3. Adhesive Thickness: 1.5 mils (0.04 mm).
   4. Elongation at Break: 145 percent.
   5. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
   1. Width: 3 inches (75 mm).

2. Film Thickness: 6 mils (0.15 mm).
3. Adhesive Thickness: 1.5 mils (0.04 mm).
4. Elongation at Break: 145 percent.
5. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

2.12 SECUREMENTS

A. Bands:
1. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm) wide with closed seal.
2. 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. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

C. Wire: 0.062-inch (1.6-mm) soft-annealed, galvanized steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems 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 (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). 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 (0 and 149 deg C) 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 piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
    a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 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 (50 mm) 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 (50 mm).
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" for firestopping 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 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. 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.

3.6 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.

3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

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 block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

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 insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.7 INSTALLATION OF CELLULAR-GLASS INSULATION

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 (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, 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 (25 mm), 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 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

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 INSTALLATION OF MINERAL-FIBER INSULATION

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 (150 mm) o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, 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 (25 mm), 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 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.

2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062-inch (1.6-mm) wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.

B. 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 (150 mm) o.c.
4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. 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 block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.11 INSTALLATION OF POLYISOCYANURATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm) thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.

C. Insulation Installation on Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of polyisocyanurate 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.

3.12 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:
1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.13 INSTALLATION OF POLYSTYRENE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
   2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
   3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, and make thickness same as adjacent pipe insulation, not to exceed 1-1/2-inch (38-mm).
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed section of polystyrene insulation to valve body.
   2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   3. Install insulation to flanges as specified for flange insulation application.

3.14 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 (50-mm) overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch- (1.6-mm-) 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 (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) 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 (25-mm) overlap at longitudinal seams and end joints; for horizontal applications. 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 (50-mm) 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.

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-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches (50 mm) 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 (850 mm) or less. The 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) 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.

3.15 FINISHES

A. 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.

3.16 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 pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.17 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.

3.18 INDOOR PIPING INSULATION SCHEDULE

A. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):

1. All Pipe Sizes: Insulation shall be one of the following:
   a. Cellular Glass: 1-1/2 inches (38 mm) thick.
   b. Flexible Elastomeric: 3/4 inch (19 mm) thick.
   c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.

B. Refrigerant Suction and Hot-Gas Piping:

1. All Pipe Sizes: Insulation shall be one of the following:
   a. Cellular Glass: 1-1/2 inches (38 mm) thick.
   b. Flexible Elastomeric: 1 inch (25 mm) thick.
   c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

3.19 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Chilled Water and Brine:

1. All Pipe Sizes: Insulation shall be one of the following:
   a. Cellular Glass: 3 inches (75 mm) thick.
   b. Flexible Elastomeric: 3 inches (75 mm) thick.
   c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inches (75 mm) thick.

3.20 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. Piping, Concealed:

1. None.
2. PVC: 20 mils (0.5 mm) thick.
3. Aluminum, Smooth: 0.016 inch (0.41 mm) thick.

D. Piping, Exposed:

1. None.
2. PVC: 20 mils (0.5 mm) thick.
3. Aluminum, Smooth: 0.016 inch (0.41 mm) thick.

3.21 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. Piping, Concealed:

1. None.
2. PVC: 20 mils (0.5 mm) thick.
3. Aluminum, Smooth: 0.016 inch (0.41 mm) thick.

D. Piping, Exposed:

1. PVC: 20 mils (0.5 mm) thick.
2. Aluminum, Smooth with Z-Shaped Locking Seam: 0.016 inch (0.41 mm) thick.

END OF SECTION

SECTION 23 34 23.08
PROPELLER FANS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes adjustable blade propeller wall fans, [belt driven] [direct drive].

1.2 REFERENCE STANDARDS

A. American Bearing Manufacturers Association (ABMA):
   1. ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings
   2. ABMA 11 – Load Ratings and Fatigue Life for Roller Bearings

B. Air Movement and Control Association International, Inc. (AMCA):
   1. AMCA Standard 204 - Balance Quality and Vibration Levels for Fans
   2. AMCA Standard 210 - ASHRAE 51 - Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating
   3. AMCA Standard 300 - Reverberant Room Method for Sound Testing of Fans

C. National Electrical Manufacturers Association (NEMA):
   1. NEMA MG 1 – Motors and Generators

D. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electric Code

1.3 ACTION SUBMITTALS

A. Product Data: Include the following:
   1. Rated capacities and operating characteristics.
   2. Fan Performance Data: Fan performance curves with flow, static pressure and horsepower.
   3. Sound Performance Data: Fan sound power levels in eight octave bands and, A-weighted overall sound power level or sone values.
   4. Motor ratings and electrical characteristics.
   5. Furnished specialty components.
   6. Specified accessories.
   7. Dimensioned standard drawings indicating dimensions, weights, and attachments to other work.

1.4 INFORMATIONAL SUBMITTALS

A. Source quality-control reports.

B. Field quality-control reports.

C. ISO-9001 certificate.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Include routine maintenance, adjustment requirements, safety information, and troubleshooting guide.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: Approved ISO 9001-compliant manufacturer listed in this Section with minimum 10 years' experience in manufacture of similar products in successful use in similar applications, and with an ASME NQA-1 compliant Program.

1. Approval of Comparable Products: Submit the following in accordance with project substitution requirements, within time allowed for substitution review:
   a. Product data, including certified independent test data indicating compliance with requirements.
   b. Project references: Minimum of 5 installations not less than 5 years old, with Owner contact information.
   c. Sample warranty.
2. Substitutions following award of contract are not allowed except as stipulated in Division 01 General Requirements.
3. Approved manufacturers must meet separate requirements of Submittals Article.

B. AMCA Compliance:

1. Provide fan types tested in accordance with AMCA Standard 210 (air performance) and AMCA Standard 300 (sound performance) in an AMCA-accredited laboratory.

1.7 COORDINATION

A. Coordinate sizes and locations of supports required for fan units.

B. Coordinate sizes and locations of equipment supports, roof curbs, and roof penetrations.

1.8 FIELD CONDITIONS

A. Handling and Storage: Handle and store fan units in accordance with manufacturer's published instructions. Examine units upon delivery for damage. Store units protected from weather.

1.9 WARRANTY

A. Manufacturer's Warranty: Manufacturer's standard form in which manufacturer agrees to furnish replacement components for fan units that demonstrate defects in workmanship or materials under normal use within warranty period specified.

1. Warranty Period: 12 months from startup or 18 months from shipment by manufacturer, whichever first occurs.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Acceptable Manufacturers: ACME, GREENHECK, COOK, TWIN CITY

B. Source Limitations: Obtain propeller fans from a single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

A. Fan Performance Ratings: Sea level elevation-based

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70.

2.3 PROPELLER WALL FANS

A. Propeller Wall Fans: Belt - Driven, heavy duty propeller wall fans for general-purpose ventilation
   1. Permanently attach nameplate displaying serial number and unit information.

B. Propeller: Cast aluminum blades in cast aluminum hub, with bushing to allow adjustment of blade pitch angle. Secure wheel to motor shaft with taper lock bushing.
   1. Machine propeller to proper diameter.
   2. Statically and dynamically balance propeller.

C. Fan Shaft:
   1. Hot-rolled steel.
   2. Grind, polish and ring gauge shaft.
   3. Key shaft to wheel hub.
   4. Size shaft for first critical speed minimum 1.42 times maximum fan speed.

D. Bearings:
   1. Heavy-duty, grease lubricated, anti-friction ball or roller type, self-aligning, mounted in pillow blocks.
   2. Minimum Average Bearing Life: L-50 = 200,000 hours at the maximum fan RPM, in accordance with ABMA 9 for ball bearings and ABMA 11 for roller bearings.

E. Belt Drive:
   1. Drive Components: V-belt drive, rated for minimum 120 percent of motor nameplate horsepower, with machined, cast-iron pulleys, and heat resistant, oil resistant, static-free V-belts.
      a. Motor Pulley: Adjustable pitch for motors up to 15 HP.
      b. Motor Pulley: Fixed pitch for motors 20 HP and larger.

F. Motors: Comply with NEMA MG 1 for 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. Motor Speed: 1,800 rpm.
   3. Motor - Single Phase: Induction type, with split phase construction and capacitor start or Three Phase: Induction type. Provide heavy duty ball bearings.
   4. Enclosure Type: Open, Drip Proof (ODP).
      a. Voltage: [208] [230] [460] [575] V; [1] [3] phase; 60 Hz.
   5. Provide unfused disconnect switch, NEMA 1, selected in accordance with Division 26 section "Enclosed Switches."
      a. Ship disconnect switch loose for field mounting and wiring.

G. Frame: Formed tube steel supports welded to steel panel with formed inlet venturi and pre-punched holes for mounting anchors. Motor mounting plate bolted to frame tubes.

H. Finishes:
   1. After fabrication, deburr, clean and chemically pretreat metal parts by phosphatization.
   2. Apply two coats of following finish:

a. Air dry enamel.
b. Carbocoat 30
c. Heresite VR506 Air Dry Phenolic.
d. Dupont ASA, 70 Gray polyester.
e. Air dried epoxy.

I. Accessories:

1. Backdraft Damper, Automatic, parallel-blade type. Adjust backdraft damper to close when fan is not running. If velocity is less than 600 FPM a spring kit must be specified.
2. Motorized Damper, Endpivoted steel type. Suitable for 3/000 feet/minute (15.2 meter/second) air velocity.
3. Damper actuator suitable for [24] [115] [208] [230] [460] [575] VAC, single phase. [Provide transformer for [460] [575] V actuator.]
4. Wall Box: Painted steel, sized to match dimensions of fan panel, with mounting flange and pre-punched mounting holes. Suitable for attachment of inlet screen, backdraft damper, weather hood, outlet screen, and disconnect switch.
   a. Provide hinged fan guard.
5. Wall Collar: Painted steel, sized to match dimensions of fan mounting plate.
6. Weather Hood: Painted steel hood to shield fan opening from snow and rain. Include bird screen of galvanized wire.
7. Wire Guards: Provide welded or woven type wire to enclose [motor] [fan] size of unit.
8. Reversible Construction: Allows for 100% airflow in both exhaust and supply directions.

J. Fan Capacities and Characteristics: Refer to Drawing schedule.

2.4 SOURCE QUALITY CONTROL

A. Factory Run Test: Test run assembled fan units prior to shipment at specified operating speed or maximum RPM allowed. Statically and dynamically balance each wheel in accordance with AMCA Standard 204 "Balance Quality and Vibration Levels for Fans" to Fan Application Category BV-3, Balance Quality Grade G6.3. Obtain balance readings by electronic equipment in the axial, vertical, and horizontal directions on each set of bearings.
   a. Submit report of factory run test.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fans. Notify Engineer regarding conditions that may adversely affect installation, operation, or maintenance of fans. Proceed with installation once conditions are in accordance with manufacturer's published instructions.

3.2 PROTECTION

A. Protect adjacent construction and finished surfaces during installation and testing.

B. Except for operational testing, do not operate fan during construction.

3.3 INSTALLATION

A. Install fans in accordance with Contract documents and manufacturer's published instructions.

B. Install fan units with adequate clearances for service and maintenance.

C. Duct Connections: Drawings indicate general arrangement of ducts and duct accessories. Where indicated on Drawings, [install factory-furnished companion flanges and] make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 section "Air Duct Accessories."

D. Electrical Connections: Connect wiring in accordance with NFPA 70 and Division 26 section "Low-Voltage Electrical Power Conductors and Cables."

1. Ground and bond equipment according to Division 26 section "Grounding and Bonding for Electrical Systems."

E. Equipment Identification: Label units according to Division 23 section "Identification for HVAC Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Contractor shall retain qualified testing agency to perform field tests and inspections.

1. Verify that unit is secured to supports, and that duct and electrical connections are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
2. Verify that cleaning and adjusting are complete.
3. Disconnect fan belt 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.
4. Verify that manual and automatic volume control, and fire and smoke dampers in connected ductwork systems are in fully open position.
5. Disable automatic temperature-control actuators, energize motor, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
6. Shut unit down and reconnect automatic temperature-control actuators.
7. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Submit test and inspection reports.

3.5 ADJUSTING AND CLEANING

A. Adjust, clean, and maintain installed fan units in accordance with manufacturer's published instructions.

END OF SECTION

SECTION 23 37 14
WALL LOUVERS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. Comply with Division 1 - General requirements and referenced documents.

B. Comply with Division 23 Sections, as applicable. Refer to other divisions for coordination of work with other trades, as required.

1.2 DESCRIPTION

A. This Section covers exterior stationary storm proof louvers complete as shown on the drawings and specified herein.

1. Provide accessories, anchorage devices, and other items essential to complete the louver installation, though not specifically indicated or specified.

1.3 QUALITY ASSURANCE

A. Applicable Standards: Conform to the following:

1. Louvers shall bear the AMA Certified Rating Seal.

1.4 SUBMITTALS

A. Submit manufacturer's literature, engineering data and shop drawings in accordance with the requirements of Section 15010 - GENERAL PROVISIONS.

B. Submittal data and shop drawings shall include but not be limited to:

1. Materials of construction.
2. Installation details.
3. Sizes.
4. Color.

1.5 PRODUCT HANDLING, DELIVERY AND STORAGE

A. Delivery, handling and storage of materials covered by this specification shall conform to the requirements of Section 23 05 00 – COMMON WORK RESULTS FOR HVAC.

1.6 GUARANTEE

A. Products and workmanship specified in this section of the specification shall comply with the Guarantee Requirements of Section 23 05 00 – COMMON WORK RESULTS FOR HVAC.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum fixed blade louvers:

1. Louvers shall be extruded aluminum, stationary storm proof type, with a drain gutter in each blade. Blades and frames shall be minimum 0.1 inch thick with reinforcing bosses and shall be of 6063-T5 alloy. Head, jamb and sill shall be of one piece structural member of 6063-T5 Alloy with integral calking slot and retaining bead. Supports and blades shall have provision for expansion and contraction. All fastenings shall be stainless steel or aluminum. Louvers shall be free of all scratches, blemishes and defects. Sizes shall be as shown on the Drawings. Louvers shall have a minimum free area of 50% and a maximum pressure drop of 0.02 inches of water at 500 feet per minute air velocity.
2. Extruded aluminum with 4" rainproof blades at approximately 45 deg. Angle at 4" oc.
3. Structural supports shall be provided and designed by the louver manufacturer to carry a windload of not less than thirty-five pounds per square foot (35 psi).
4. Provide louvers with removable bird screens, consisting of aluminum frame with mitered corners and 0.063 inch (1.6 mm) diameter 1/2 inch aluminum wire mesh. Bird screen shall be attached to interior of louver with sheet metal screws or clips.
5. Provide backdraft dampers adjacent to each wall louver in all cases with exception of louvers that provide the introduction of combustion air.
6. Louver finish shall be as directed by Architect.
7. Acceptable Manufacturers: Ruskin, Construction Specialties, Airolite, American Warming and Ventilating, Greenheck, or approved equal.

B. Motorized Louvers:

1. Extruded aluminum flanged louvers with Z-shape, 4" blades at 2" oc with alternate blades adjustable.
2. Moveable blades shall have nylon bearings and vinyl gaskets.
3. Provide easily-removable interior PVC-coated galvanized ½" wire mesh birdscreen.
4. Provide spring return motor operator.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in strict accordance with the drawings, approved shop drawings and manufacturer's instructions and recommendations.

END OF SECTION

SECTION 23 82 19
MINI SPLIT SYSTEM

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 Mini-Split system and accessories.

1.3 DEFINITIONS

A. BAS: Building automation system.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, 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, 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. Ceiling suspension components.
   2. Structural members to which fan-coil units 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: For units with factory-applied color finishes.

E. Samples for Verification: For each type of fan-coil unit indicated.

F. Manufacturer Seismic Qualification Certification: Submit certification that fan-coil units, 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 fan-coil units 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. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

I. Warranty: Special warranty specified in this Section.

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 COORDINATION

A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of wall sleeves for outdoor-air intake.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Compressor failure.
   b. Condenser coil leak.
2. Warranty Period: Five years from date of Substantial Completion.

3. Warranty Period (Compressor Only): Five years from date of Substantial Completion.
4. Warranty Period (Condenser Coil Only): Five years from date of Substantial Completion.

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. Fan-Coil-Unit Filters: Furnish ten percent spare filters for each filter installed.
   2. Fan Belts: Furnish ten percent spare fan belts for each unit installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

B. In the Fan-Coil-Unit Schedule where titles below are column or row headings that 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.
   3. Basis-of-Design Product: The design for each fan-coil unit is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 CASSETTE UNITS

A. Basis-of-Design Product: Daikin or a comparable product by one of the following:

B. Manufacturers:
   1. Carrier
   2. Mitsubishi

C. Indoor Unit:
   1. The indoor unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
   2. The 4-way supply air flow can be field modified to 3-way and 2-way airflow to accommodate various installation configurations including corner installations.

3. Return air shall be through the concentric panel, which includes a resin net mold resistant filter.
4. The indoor units shall be equipped with a condensate pan and condensate pump. The condensate pump provides up to 24-13/16" of lift, measured from the drain outlet, and has a built in safety shutoff and alarm.
5. The indoor units shall be equipped with a return air thermistor.
6. The indoor unit will be powered with 208~230V/1-phase/60Hz.
7. The voltage range will be 253 volts maximum and 187 volts minimum.

D. Unit Cabinet:
1. The cabinet shall be space saving and shall be located into the ceiling.
2. Three auto-swing positions shall be available to choose from via field setting.
3. The airflow of the unit shall have the ability to shut down one or two sides allowing for simpler corner installation.
4. Fresh air intake shall be possible by way of direct duct installation to the side of the indoor unit cabinet.
5. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

E. Decoration Panel:
The unit shall be compatible with three optional decoration panels:
1. Panel to be selected by the owner.

F. Fan:
1. The fan shall be driven by a direct-drive DC motor with statically and dynamically balanced impeller and shall have three user-selectable speeds available: high, medium, and low.
2. The fan motor shall operate on 208/230 volts, 1 phase, 60 hertz with a motor output of 50W.
3. The airflow rate shall be available in high, medium, and low settings.

G. Filter:
1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

H. Coil:
1. Coils shall be of the direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond.
2. The coil shall be of a waffle louver fin and high heat exchange, rifled bore tube design to ensure highly efficient performance.
3. The coil shall be a 2-row cross fin copper evaporator coil with 22 FPI design completely factory tested.
4. The refrigerant connections shall be flare connections and the condensate will be 1 -1/32 inch outside diameter PVC.
5. A condensate pan shall be located under the coil.
6. A condensate pump with a 24-13/16" lift, measured from the drain outlet, shall be located below the coil in the condensate pan with a built in

safety alarm.

7. A thermistor will be located on the liquid and gas line.

I. Remote Condensing Units: Factory assembled and tested, consisting of compressors, condenser coils, fans, motors, refrigerant receiver, and operating controls. Construct, test, and rate condensing units according to ARI 210/240 and ASHRAE 15.

1. Casing: Steel with baked-enamel finish, removable panels for access to controls, weep holes for water drainage, and mounting holes in base.
2. Compressor: Hermetic, reciprocating type; internally isolated for vibration with factory-installed safety devices as follows:
   a. Antirecycle timer.
   b. High-pressure cutout.
   c. Low-pressure cutout or loss-of-charge switch.
   d. Internal thermal-overload protection.
   e. Current and voltage sensitive safety devices.
3. Compressor Motor: Start capacitor, relay, and contactor. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
4. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1-2004, "Energy Standard for Buildings except Low-Rise Residential Buildings."
5. Refrigerant Piping Materials: ASTM B 743 copper tube with wrought-copper fittings and brazed joints.
6. Refrigerant: R-410A.
7. Low ambient controls to permit operation down to 45 deg F.
8. Crankcase heater.
9. Charging and service fittings on exterior of casing.
10. Filter dryer.
11. Hot-gas-bypass, constant-pressure expansion valve and controls to maintain continuous refrigeration system operation at 10 percent of full load.
12. Condenser: Copper-tube, aluminum-fin coil, with liquid subcooler.
13. Condenser Fan: Direct-drive, aluminum propeller fan.
    a. Motor: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
14. Accessories: Polyethylene mounting base to provide a permanent foundation.

J. Basic Unit Controls:

1. Control voltage transformer.
2. 7-Day programmable Wall-mounting thermostat with the following features.
   a. Cool-off switch.
   b. Fan on-auto switch.
   c. Fan-speed switch.
   d. Automatic changeover.
   e. Adjustable deadband.
   f. Exposed set point.
   g. Exposed indication.
   h. Degree F indication.

K. Electrical Connection: Factory wire motors and controls for a single electrical connection.

L. Capacities and Characteristics:

1. Fan:
   a. Airflow
   b. Static Pressure
   c. Fan Speed
   d. Motor Speed
   e. Motor Horsepower
   f. Drive: Direct Belt.
2. Cooling Capacity:
   a. Total
   b. Sensible
   c. Entering-Air Dry-Bulb Temperature
   d. Entering-Air Wet-Bulb Temperature
3. Refrigerant Coil:
   a. Air-Side Pressure Loss
   b. Suction Temperature
4. Condensing Unit:
   a. Compressor Power Input
   b. Energy-Efficiency Ratio
   c. Cooling Energy Efficiency (EER) (SEER)
   d. Heating Coefficient of Performance
   e. Voltage/Phase/Hertz
   f. Full-Load Amperes
   g. Maximum Circuit Amperes
   h. Maximum Overcurrent Protection
5. Filters:
   a. Face Area
   b. Thickness: 1 inch (25 mm).
6. Electrical Characteristics for Single-Point Connection:
   a. Voltage/Phase/Hertz
   b. Full-Load Amperes
   c. Maximum Circuit Amperes
   d. Maximum Overcurrent Protection

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fan-coil units 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 fan-coil-unit installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fan-coil units level and plumb.

B. Install fan-coil units to comply with NFPA 90A.

C. Suspend fan-coil units from structure with elastomeric hangers. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.

E. Install new filters in each fan-coil unit within two weeks after 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. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect piping to fan-coil-unit factory hydronic piping package. Install piping package if shipped loose.
3. Connect condensate drain to indirect waste.
    a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

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 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. 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 and humidity 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 fan-coil units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

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. Wall and ceiling heaters with propeller fans 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. Field quality-control test reports.

E. 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."

PART 2 - PRODUCTS

2.1 WALL AND CEILING HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Berko Electric Heating; a division of Marley Engineered Products.
2. Indeeco.
3. Marley Electric Heating; a division of Marley Engineered Products.
4. QMark Electric Heating; a division of Marley Engineered Products.
5. Trane.

B. Description: An assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

C. Cabinet:

1. Front Panel: Stamped-steel louver, with removable panels fastened with tamperproof fasteners.
2. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

D. Surface-Mounting Cabinet Enclosure: Steel with finish to match cabinet.

E. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high temperature protection. Provide integral circuit breaker for overcurrent protection.

F. Fan: Aluminum propeller directly connected to motor.

1. Motor: Permanently lubricated, multispeed. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

G. Controls: Unit-mounted thermostat. Low-voltage relay with transformer kit.

H. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

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 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. Follow manufacturer's recommendations for installation clearance and service area.

3.3 CONNECTIONS

A. Comply with safety requirements in UL 1995.

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."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect 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.

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

SECTION 26 00 00
ELECTRICAL - GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials and equipment required to install, test and provide an operational, electrical system as specified and as shown on the Drawings.

B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.

C. All electrical work provided under any Division of the Specifications shall fully comply with the requirements of Division 26.

D. The work shall include furnishing, installing and testing the equipment and materials detailed in each Section of Division 26.

E. The work shall include furnishing and installing the following:

1. Electrical service from the Power Company.
2. Provide a complete raceway system, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under other Divisions. Coordinate construction schedule and electrical interface with the supplier of electrical equipment specified under other Divisions as required by the Contract Documents.
3. Provide a complete raceway system, wiring and terminations for all field-mounted instruments furnished and mounted under other Divisions, including process instrumentation primary elements, transmitters, local indicators and control panels. Lightning and surge protection equipment wiring at process instrumentation transmitters. Install vendor furnished cables specified under other Divisions as required by the Contract Documents.
4. Provide a complete raceway system for the Data Cables and specialty cable systems, including those furnished under other Divisions. Install the Data Cables and other specialty cable systems, in accordance with the system manufacturers' installation instructions. Review the raceway layout, prior to installation, with the Process Control System supplier and the cable manufacturer to ensure raceway compatibility with the systems and materials being furnished. Where redundant cables are furnished, install the cables in separate raceways as required by the Contract Documents.
5. Furnish and install precast electrical and instrumentation manholes, hand holes and light pole foundations as required by the Contract Documents. Pole foundations shall be designed and installed in accordance with the structural Divisions of these Specifications.
6. Power monitoring for the Owner’s facilities shall be performed by a new Electrical Power Monitoring and Control System (PMCS). Monitoring information from equipment specified in the individual Sections of Division 16 26, and as shown on the Drawings, shall be interfaced to the monitoring system.
7. Telephone service from the Telephone Company.

8. Coordinate the sequence of demolition with the sequence of construction to maintain plant operation in each area. Remove and demolish equipment and materials in such a sequence that the existing and proposed plant will function properly with no disruption of treatment.
9. Make modifications to existing motor control centers, switchboards, panelboards and motor controllers including installation of circuit breakers, etc., or disconnection of circuits as required to provide the power supplies to new and existing equipment to maintain the plant in operation.
10. All bidders shall visit the site of the project, prior to submitting a bid, and satisfy themselves as to any question that they might have, relating to existing equipment, condition or construction.
11. Provide standby generation to keep the Owner's process in service as required by the Contract Documents.

F. Provide all electrical relocation work associated with the relocation of equipment for the existing and new facilities, including disconnecting all existing wiring and conduits and providing new wiring and conduit to the relocated equipment as specified in Section 26 41 19.

G. Maintain the Owner's process operations during all construction including any required electrical or control system outages. Prior to bidding, obtain all needed process operational requirements and restrictions from the Owner's staff during the site visits to determine the effect the operational restrictions may have on the construction schedule and/or bid price. Verify any process related information which may be shown or specified. If the obtained information conflicts with information in the Contract Documents, notify the Engineer in writing prior to bidding. As a minimum, include in the Contract Schedule and Bid Price the following items required to comply with operational requirements:
   1. Additional Time and/or Expense
   2. Additional Expense for after-hours work,
   3. Additional equipment, materials, and personnel.
   4. Standby generation with fuel.

H. Provide all tools, equipment, supplies, and shall perform all labor required to install the equipment specified in the Contract Documents to install, test, and place into satisfactory operation in the time specified for completion in the Contract Documents. Failure of any of the participants in executing the requirements of this Contract to perform the work as specified shall not constitute an acceptable reason for the Owner to grant any change in the Contract Price or additions to the Contract Time.

I. The work includes demolition of existing electrical equipment, associated conductors and raceway. Included is the removal of duct banks and manholes. The duct banks may contain asbestos. Visit the site and determine the size of the duct banks to be removed by inspection at the manholes and other places where the conduits transition from concealed to exposed. Include all labor and expense to remove the duct banks, dispose of all asbestos materials found, provide fill dirt to replace the volume of duct bank removed and compact to 95%. Reseed grass areas and repair streets or sidewalks disturbed by the removal of duct banks shown or specified to be removed.

J. The electrical contractor will need to be a registered contractor and apply for electrical permit for work.

1.2 ELECTRICAL WORK REQUIRED IN OTHER DIVISIONS

A. No references are made to any other section which may contain work related to any other section. The Contract Documents, which is defined to include both the Drawings and the Specifications, shall be taken with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, provide such information or additional work as may be required in those references, and include such information or work as may be specified. Examine all Sections of the Specifications and Drawings and determine the power and wiring requirements and provide external wiring and raceways, as required to provide a fully functioning power, control and process control systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, provide the additional conductors, raceways and/or wiring, and include in the Contract Price and Schedule.

B. Process Divisions

1. Examine all Process Equipment Specifications and Drawings, determining power and wiring requirements. Provide external wiring and raceways, as required to provide a fully functioning Process Control System. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, furnish the additional conductors, raceways and/or wiring, with no change in Contract Price or Schedule.

C. Mechanical Divisions

1. Examine all Mechanical Equipment Specifications and Drawings, determining power and wiring requirements. Provide external wiring and raceways, as required to provide fully functioning Mechanical Equipment Control Systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, furnish the additional conductors, raceways and/or wiring with no change in Contract Price or Schedule.

D. Electric Valve Operator Divisions

1. Examine all Electric Valve Operator Equipment Specifications and Drawings, determining power and wiring requirements. Provide external wiring and raceways, as required to provide a fully functioning Electric Valve Operator Control System. If the equipment requires more conductors and/or wiring due to different equipment being supplied, furnish the additional conductors, raceways and/or wiring with no change in Contract Price or Schedule.

1.3 SUBMITTALS

A. Submit Shop Drawings, in accordance with Division 1 requirements, for equipment, materials and all other items furnished under each Section of Division 26, except where specifically stated otherwise. An individually packaged submittal shall be made for each Section and shall contain all the information required by the Section. Partial submittals will not be accepted and will be returned without review.

B. Submittals will not be accepted for Section 26 00 00.

C. Each Section submittal shall be complete, contain all the items listed in the Specification Section, and shall be clearly marked to indicate which items are applicable on each cut sheet page. The Submittal shall list any exceptions to the Specifications and Drawings, and the reason for such deviation. Shop drawings, not so checked and noted, will be returned without review.

D. Check shop drawings for accuracy and contract requirements prior to submittal to the Owner/Engineer. Errors and omissions on approved shop drawings shall not provide relief from the responsibility of providing materials and workmanship required by the Specifications and Drawings. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to Specifications and Drawings. Only one Specification Section may be made per transmittal.

E. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered, or shop work started if the related shop drawings are marked "APPROVED AS NOTED CONFIRM", "APPROVED AS NOTED RESUBMIT", “REVISE AND RESUBMIT”, “REJECTED”, or "NOT APPROVED".

F. All approved shop drawings shall be maintained on site for the Owner’s Inspector and for the Owner’s Engineer to verify at the time of delivery of equipment to the job site.

G. Up-to-date Record Drawings shall be promptly furnished when the equipment installation is complete. Payment will be withheld until Record Drawings have been furnished and approved.

H. All shop drawing submittals and all O&M submittals shall be submitted in hard copy format and in electronic format using PDF files including a Table of Contents which is indexed on DVDs. Electronic submittals are mandatory and those which are received not indexed as specified will be returned without review. Hard copy submittals may not be required if so stipulated in the Contract Documents. No change in Contract Amount or Contract Time will be allowed for delays due to unacceptable submittals.

1.4 REFERENCE CODES AND STANDARDS

A. Electric equipment, materials and installation shall comply with the National Electrical Code (NEC) and with the latest edition of the following codes and standards:

1. National Electrical Safety Code (NESC)
2. Occupational Safety and Health Administration (OSHA)
3. National Fire Protection Association (NFPA)
4. National Electrical Manufacturers Association (NEMA)
5. American National Standards Institute (ANSI)
6. Insulated Cable Engineers Association (ICEA)
7. International Society of Automation (ISA)
8. Underwriters Laboratories (UL)
9. Factory Mutual (FM)
10. Local City Amendments / Code

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

C. All material and equipment, for which a UL standard exists, shall bear a UL label. No such material or equipment shall be brought onsite without the UL label affixed.

D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents will take precedence if they are more stringent. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding, unless otherwise directed by the Owner/Engineer.

E. In accordance with the intent of the Contract Documents, compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, full compliance with all Laws and Regulations at all times,

1.5 SERVICE AND METERING

A. The power company serving this project is Oncor. Service shall be obtained at 480/277 volts, 3 phase, 4 wire, 60 Hz from an overhead line feeder furnished and installed by Oncor.

B. The power company will be responsible for the following work:
   1. Furnishing and installing the primary overhead conductors and pole line.
   2. Furnishing and installing the riser pole, primary cutouts, lightning arresters and grounding.
   3. Furnishing and installing primary cables to Oncor’s pole mounted transformers.
   4. Furnishing and installing pole mounted transformers.
   5. Termination of primary cables at the pole mounted transformers.
   6. Furnishing metering current transformers (CT's), meter and meter wiring.
   7. Termination of secondary cables to the pole mounted transformers.
   8. Furnishing meter base and enclosure.
   9. Furnishing underground service conductors from pole mounted transformers to metering transocket enclosure.

C. Include the following work in the Contract Price and Schedule:
   1. Obtain an estimate from the power company for the work described in this SERVICE AND METERING paragraph and include the cost of the power company work in the Contract Price.
   2. Furnish and install the secondary conduits from Oncor’s pole mounted transformers to metering transocket enclosure.
   3. Furnish and install secondary conduits in a steel reinforced concrete-encased duct bank from Oncor’s pole mounted transformers to metering transocket enclosure.
   4. Furnish and install a power company approved metering current transformer enclosure.
   5. Furnish and install power company approved meter base and metering transocket enclosure.
   6. Furnish and install an empty conduit with pull line from the metering C.T. enclosure to the meter enclosure. Conduit size and type shall be approved by the power company.
   7. Coordinate the electrical service installation with the Power Company.

D. Submit shop drawings for the following items to the power company for approval:
   1. Meter base.

2. Metering instrument and installation.
3. Metering Transocket Enclosure.

E. No power outages are allowed without notifying the Owner at least 14 calendar days in advance using the Owner-provided shutdown forms. Total outages of more than 15 minutes at any facility are prohibited unless approved by the Owner. Standby generation shall be provided for all outages longer than 15 minutes. Liquidated Damages will be applied as specified for outages longer than 15 minutes when caused by the Contractor's construction activities.

1.6 HAZARDOUS AREAS

A. Equipment, materials and installation in areas designated as hazardous on the Drawings shall comply with NEC Articles 500, 501, 502 and 503.

B. Equipment and materials installed in hazardous areas shall be UL listed for the appropriate hazardous area classification.

1.7 CODES, INSPECTION AND FEES

A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.

B. Obtain all necessary permits and pay all fees required for permits and inspections.

C. Make all arrangements with the power company for obtaining electrical service, include all power company charges and all labor and material required for the electrical service in the Contract Price and Schedule.

1.8 SIZE OF EQUIPMENT

A. Investigate each space in the structure through which equipment must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.

B. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.

1.9 RECORD DRAWINGS

A. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called the "Record Drawings". The Record Drawings and Specifications shall be kept up to date throughout the project.

B. The Record Drawings shall be reviewed in a meeting with the Owner/Engineer monthly.

C. Record Drawings shall accurately show the installed condition of the following items:
1. One-line Diagram(s).
2. Raceways and pull boxes.
3. Conductor sizes and conduit fills.
4. Panel Schedule(s).
5. Control Wiring Diagram(s).
6. Lighting Fixture Schedule(s).
7. Lighting fixture, receptacle and switch outlet locations.

8. Underground raceway and duct bank routing. The drawings shall include the measured width and height of the ductbank and shall survey the elevation of the top of the duct bank or record its depth of burial below grade at intervals not to exceed 50 feet along the entire length. Changes in direction between termination points shall be surveyed and recorded on the record drawings.
9. Planview, measured dimensions and locations of switchgear, distribution transformers, substations, motor control centers and panelboards.
10. Modifications to controls systems or any piece of electrical equipment including field-verified existing controls and all changes clearly identified.
11. All protective device and electrical system monitoring device settings.

D. Submit a typical example of a schedule of control wiring raceways and wire numbers, including the following information:
   1. Circuit origin, destination and wire numbers.
   2. Field wiring terminal strip names and numbers.

E. As an alternate, submit a typical example of point-to-point connection diagrams showing the same information, may be submitted in place of the schedule of control wiring raceways and wire numbers.

F. Submit the record drawings and the schedule of control wiring raceways and wire numbers (or the point-to-point connection diagram) to the Owner/Engineer.

G. Retainage will not be paid until the point-to-point connection diagrams have been furnished to the Owner/Engineer.

1.10 EQUIPMENT INTERCONNECTIONS

A. Review shop drawings of equipment furnished under other related Divisions and prepare coordinated wiring interconnection diagrams or wiring tables. Submit copies of wiring diagrams or tables with Record Drawings.

B. Furnish and install all equipment interconnections.

1.11 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be new, except where specifically identified on the Drawings to be re-used.

B. Material or equipment from a manufacturer, not submitted and approved for this project shall not be brought on site. Use of any such material or equipment, will be rejected, and shall be removed and replaced, with the approved material and equipment, with no change allowed in the Contract Price or Schedule.

C. Material and equipment shall be UL listed, where such listing exists.

D. All material, products, equipment and workmanship being furnished for the the project shall be replaced if it does not meet the requirements of Contract Documents even if installed, with no change in Contract Price or Schedule.

1.12 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, successfully complete all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will be rejected and shall be removed and replaced with no change in Contract Price or Schedule.

B. Equipment and materials shall be handled and stored in accordance with the manufacturer's instructions, and as specified in the individual Specification Sections.

1.13 WARRANTIES

A. Manufacturer's warranties shall be provided as specified in each of the Specification Sections.

1.14 EQUIPMENT IDENTIFICATION

A. Identify all equipment (disconnect switches, separately mounted motor starters, control stations, etc.) furnished under Division 26 with the name of the equipment it serves. Motor control centers, control panels, panelboards, switchboards, switchgear, junction or terminal boxes, transfer switches, etc., shall have nameplate designations as shown on the Drawings.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 INTERPRETATION OF DRAWINGS

A. The Drawings do not show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.

B. Install each three-phase circuit in a separate conduit unless otherwise shown on the Drawings.

C. Unless otherwise approved by the Owner/Engineer, conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed. Submit a Request for Information for any conduit route which is not clearly identified as concealed or exposed in the Contract Documents prior to its installation.

D. Circuits are shown as "home-runs" shall be field routed. The raceway system provided shall include all necessary fittings, supports and boxes for a complete code-compliant raceway installation. Field routed raceway shall avoid blocking access to equipment either existing or spaces planned for future equipment and shall avoid blocking personnel egress through doors or access hatches.

E. Verify the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.

F. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Determine exact locations and obtain approval from the Owner/Engineer during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Owner/Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

G. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials necessary to install and place in satisfactory operation all power, lighting and other electrical systems shown.

H. Redesign of electrical or mechanical work, which is required due to the use of a pre-approved alternate item shall include the arrangement of equipment and/or layout other than that which is specified or shown herein. All additional work and materials required shall be provided with no change in the contract price or schedule. Redesign and detailed plans shall be submitted to the Owner/Engineer for approval.

I. Raceways and conductors for lighting, switches, receptacles and other miscellaneous low voltage power and signal systems as specified are not shown on the Drawings. Raceways and conductors shall be provided as required for a complete and operating system. Refer to riser diagrams for signal system wiring. Homeruns, as shown on the Drawings, identify raceways to be run exposed and raceways to be run concealed. Raceways installed exposed shall be near the ceiling or along walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes hoists, monorails, equipment hatches, doors, windows, etc. Raceways installed concealed shall be run in the center of concrete floor slabs, above suspended ceilings, or in partitions as required.

J. Provide all conduit and conductors or data highway cables to RTU and/or PLC termination cabinets, where designated on the Drawings or otherwise required by the Specifications, the manufacture of the equipment, or submitted and approved systems. The conduit and conductors or data highway cables as shown on the interface drawings may not necessarily be shown on the floor plan.

K. Install conductors carrying low voltage signals (typically twisted shielded pair cables) in raceways totally separate from all other raceways containing power or 120-Volt control conductors. Do not combine conductors carrying low voltage signals in wireways without barriers or NEC code-compliant separation for their entire length in the wire way, and/or provide separate wireways to provide separation of the conductors. Low voltage signal conductors routed through manholes or hand holes shall be bundled and separated from other conductors.

L. Raceways and conductors for thermostats controlling HVAC unit heaters, exhaust fans and similar equipment are not shown on the Drawings. Provide raceways and conductors between the thermostats, the HVAC equipment and the motor starters for a complete and operating system. All raceways and power conductors shall be in accordance with Division 26. Raceways shall be installed concealed in all finished space and may be installed concealed or exposed in process spaces. Refer to the HVAC drawings for the locations of the thermostats and controls.

M. Raceways and conductors for the fire alarm, sound and page party systems are not shown on the Drawings. Provide raceways and conductors as required by the system manufacturer for a complete and operating system. All raceways and power conductors shall be in accordance with Division 26. Raceways shall be installed concealed in all finished spaces and may be installed exposed or concealed in process spaces.

3.2 EQUIPMENT PADS AND SUPPORTS

A. Electrical equipment pads and supports, of concrete or steel including structural reinforcing and lighting pole foundations, are shown on the Structural Drawings.

B. Electrical equipment or raceways, shall not be attached to or supported from, sheet metal walls.

C. Electrical equipment pads shall be provided for all free-standing equipment. Dimensions shall be 3-inches high. With 3-inch extension from front of equipment for equipment mounted against the wall and 3-inch extension on front and rear sections when equipment is rear accessible.

3.3 SLEEVES AND FORMS FOR OPENINGS

A. Provide and place all sleeves for conduits penetrating floors, walls, partitions, etc. Locate all necessary slots for electrical work and form before concrete is poured.

B. Unless measurements are shown on the drawings, the locations for stubbing up and terminating concealed conduits which are shown on the drawings are approximate. Exact locations are required for stubbing-up and terminating concealed conduit. Obtain shop drawings and templates from equipment vendors or other subcontractors and locate the concealed conduit before the floor slab is poured.

C. Where setting drawings are not available in time to avoid delay in scheduled floor slab pours, the Owner/Engineer may allow the installations of such conduit to be exposed. Requests for this deviation must be submitted in writing. No change in Contract Price or Schedule for such change will be allowed.

D. Seal all openings, sleeves, penetration and slots as specified in Section 26 05 33.

3.4 CUTTING AND PATCHING

A. Coordinate with Divisions 2 and 3 for cutting and patching.

B. Core drill holes in concrete floors and walls as required. Obtain written permission from the Owner/Engineer before core drilling any holes larger than two inches.

C. Schedule the installation of work to provide the minimum amount of cutting and patching.

D. Cutting or drilling holes for the installation of raceway through joists, beams, girders, columns or any other structural members is strictly prohibited. If a structural member is cut or drilled, restore the structural member to its previous condition in complete accordance with the instructions of the Structural Engineer, with no change in contract price or schedule regardless of the extent of the repairs required to restore the member to its previous condition.

E. Cut opening only large enough to allow easy installation of the conduit.

F. Patching shall be of the same kind and quality of material as was removed.

G. The completed patching work shall restore the surface to its original appearance or better.

H. Patching of waterproofed surfaces shall render the area of the patching completely waterproofed.

I. Remove rubble and excess patching materials from the premises.

J. Existing conduits are cut at the floor line of wall line, they shall be filled with grout of suitable patching material approved by the Structural Engineer.

3.5 INSTALLATION

A. Any work not installed according to the Drawings and this Section shall be subject to change as directed by the Owner/Engineer. No change in Contract Price or Schedule will be allowed for making these changes.

B. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.

C. Electrical equipment shall always be protected against mechanical or water damage. Electrical equipment shall not be stored outdoors. Electrical equipment shall be stored in dry permanent shelters as required by each Specification Section. Do not install electrical equipment in its permanent location until structures are weather-tight. If any apparatus has been subject to possible injury by water, it shall be thoroughly dried out and tested as directed by the Owner/Engineer or shall be replaced with no change in Contract Price or Schedule, at the Owner/Engineer's discretion.

D. Equipment that has been damaged shall be replaced or repaired by the equipment manufacturer, at the Owner/Engineer's discretion.

E. Repaint any damage to the factory applied paint finish using touch-up paint furnished by the equipment manufacturer. If the metallic portion of the panel or section is damaged, the entire panel or section shall be replaced, at no additional cost to the Owner.

F. NEMA 3R, 4 or 4X enclosures shall not have raceways entering from the top if the enclosure is installed in a damp or wet area. Should raceways be installed entering the top, the enclosure shall be replaced and raceways re-routed to enter the side or bottom. Conductors, if installed, shall be removed and replaced. Correction of raceways entering the top and conductor replacement shall be provided with no change in Contract Price or Schedule.

G. Conduits exiting tray in airconditioned indoor electrical rooms will enter the top of electrical enclosures. The location of these conduits shall be coordinated with the HVAC duct vents such that cold air will not blow on the conduits causing condensation which will enter the electrical enclosures. After installation, inspect the conduits while the HVAC system is running to insure no condensation is forming and entering any electrical enclosure. Re-direct the air flow if possible or re-route the conduits to avoid condensation. Conductors in re-routed conduits shall be replaced, re-terminated. retested and the operation of the equipment retested with no change in the Contract Price or Schedule.

3.6 PHASE BALANCING

A. The Drawings do not attempt to balance the electrical loads across the phases. Circuits on motor control centers and panelboards shall be field connected to result in evenly balanced loads across all phases.

B. Field balancing of circuits shall not alter the conductor color coding requirements as specified in Section 26 05 19.

3.7 MANUFACTURER’S SERVICE

A. Provide manufacturer's services for testing and start-up of the equipment as listed in each individual Specification Section. All settings, including those settings and arc flash labels required by the Power System Study, shall be made to the equipment and approved by the Owner/Engineer prior to energizing of the equipment.

B. Testing and startup shall not be combined with training. Testing and start-up time shall not be used for manufacturer’s warranty repairs.

3.8 TESTS AND SETTINGS

A. Test systems and equipment furnished under Division 26 and repair or replace all defective work. Make adjustments to the systems as specified and/or required.

B. All tests required by the individual specification Sections shall be completed prior to energizing electrical equipment. Submit a sample test form or procedure. and submit the required test reports and data to the Owner/Engineer for approval at least two weeks prior to the startup of the tested equipment. Include names of all test personnel and initial each test.

C. Check motor nameplates for correct phase and voltage. Check bearings for proper lubrication.

D. Check wire and cable terminations for tightness.

E. Check rotation of motors prior to energization. Disconnect driven equipment if damage could occur due to wrong rotation. If the motor rotates in the wrong direction, the rotation shall be immediately corrected, or tagged and locked out until rotation is corrected.

F. Verify all terminations at transformers, equipment, capacitor connections, panels, and enclosures by producing a 1 2 3 rotation on a phase sequenced motor when connected to "A", "B" and "C" phases.

G. Provide mechanical inspection, testing and setting of circuit breakers, disconnect switches, motor starters, control equipment, etc. for proper operation.

H. Check interlocking, control and instrument wiring for each system and/or part of a system to prove that the system will function properly as indicated by schematic and wiring diagrams.

I. Check the ampere rating of thermal overloads for motors and submit a typed record to the Owner/Engineer of same, including MCC cubicle location and load designation, motor service factor, horsepower, full load current and starting code letter. If inconsistencies are found, new thermal elements shall be supplied and installed.

J. Verify motor power factor capacitor ratings.

K. Testing shall be scheduled and coordinated with the Owner/Engineer at least two weeks in advance. Provide qualified test personnel, instruments and test equipment.

L. Refer to the individual equipment sections for additional specific testing requirements.

M. Make adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.

3.9 TRAINING

A. Provide manufacturer’s training as specified in each individual section of the Specifications.

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE WIRES AND CABLES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish, install and test all wire, cable and appurtenances as shown on the Drawings and as specified herein.

1.2 RELATED WORK

A. Refer to Division 26 00 00 and the Contract Drawings, for related work and electrical coordination requirements.

1.3 SUBMITTALS

A. Shop Drawings
   1. Submit catalog data of all wire and cable, connectors and accessories, specified under this Section with all selections, options and exceptions clearly indicated. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project. Unmarked cut sheets will be cause to reject the submittal and return it for revision.

B. Certified Tests
   1. Submit a test report of all installed wire insulation tests.

1.4 REFERENCE CODES AND STANDARDS

A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
   1. NFPA 70 – National Electrical Code (NEC)
   2. NEMA WC-5 – Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
   3. ANSI/TIA/EIA 606A – Standard for telecommunications Infrastructure

1.5 QUALITY ASSURANCE

A. The general construction of the wire, cables and the insulation material used shall be similar to that used for cable of the same size and rating in continuous production for at least 15 years and successfully operating in the field in substantial quantities.

B. Wire and cable with a manufacture date of greater than 12 months previous will not be acceptable.

C. Wire and cable shall be in new condition, with the manufacturer’s packaging intact, stored indoors since manufacture, and shall not have been subjected to the weather. Date of manufacture shall be clearly visible on each reel.

D. The manufacturer of these materials shall have produced similar electrical materials for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, complete all submittal requirements, and present to the Owner/Engineer prior to delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will not be permitted.,

B. Check for reels not completely restrained, reels with interlocking flanges or broken flanges, damaged reel covering or any other indication of damage. Do not drop reels from any height.

C. Unload reels using a sling and spreader bar. Roll reels in the direction of the arrows shown on the reel and on surfaces free of obstructions that could damage the wire and cable.

D. Store cable on a solid, well drained location. Cover cable reels with plastic sheeting or tarpaulin. Do not lay reels flat.

1.7 WARRANTY

A. Provide warranties, including the manufacturer's warrantee, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for two years from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. Wires and cables shall be annealed, 98% conductivity, soft drawn copper.

B. All conductors shall be Class B stranded.

C. Except for control, signal and instrumentation circuits, wire smaller than #12 AWG shall not be used.

2.2 POWER & BUILDING WIRE

A. All building wire shall be stranded copper conductors, Type XHHW-2

2.3 VARIABLE FREQUENCY DRIVE CABLE

A. Cable for use with VFDs shall be symmetrical design, three stranded Class D, tinned copper, circuit conductors with XLPE insulation, three bare copper grounds, 100% shields with 50% overlap, and overall PVC jacket. Cable shall be 2000 volt, UL 1277 Type TC, XHHW-2 rated, 90°C., IEEE 1202/383.

2.4 TRAY CABLE

A. Cable for tray use shall be stranded copper conductors, Type XHHW-2 insulation, rated as UL Type TC cable. Cable shall be sunlight resistant and approved for direct burial.

2.5 GROUNDING ELECTRODE CONDUCTOR

A. Grounding electrode conductor shall be stranded copper conductor, Type XHHW-2 with green insulation.

2.6 BONDING JUMPER

A. Bonding Jumper shall be bare tinned stranded copper conductor.

2.7 CONTROL WIRE AND CABLE

A. Control wire shall be NEC Type XHHW-2.

B. Multi-conductor control cable, shall be stranded, #14 AWG 600-volt, XHHW-2, insulated, PVC outer jacket overall, Type TC, UL rated for underground wet location.

2.8 INSTRUMENTATION CABLE

A. Cables for 4-20 ma, RTD, potentiometer and similar signals shall be PLTC rated and shall be:
   1. Single pair cable:
      a. Conductors: Two #16 AWG stranded, tinned and twisted on two-inch lay
      b. Insulation: PVC with 600-volt, 90°C rating
      c. Shield: 100% Mylar tape with drain wire
      d. Jacket: PVC with manufacturer's identification
      e. UL1685 listed for underground wet location use
   2. Three conductor (triad) cable:
      a. Conductors: Three #16 AWG stranded, tinned and twisted on two-inch lay
      b. Insulation: PVC with 600-volt, 90°C rating
      c. Shield: 100% Mylar tape with drain wire
      d. Jacket: PVC with manufacturer's identification
      e. UL1685 listed for underground wet location use
   3. Multiple pair cables (where shown on the Drawings):
      a. Conductor: Multiple pairs, #16 AWG stranded, tinned and twisted on a two-inch lay
      b. Insulation: PVC with 600-volt, 90°C rating
      c. Shield: Individual pairs shielded with 100% Mylar tape and drain wire
      d. Jacket: PVC with manufacturer's identification
      e. UL1685 listed for underground wet location use

2.9 COMMUNICATION CABLES

A. Cables for Ethernet and RS485 shall be rated and shall be:
   1. Category 5e above Grade shielded Cable
      a. Conductors: Four bonded pair #24 AWG Bare Copper
      b. Insulation: Polyolefin
      c. Shield: 100% aluminum foil polyester tape with drain wire
      d. Jacket: PVC with 600-volt rated and manufacturer's identification
      e. UL21047 and UL1666 listed for indoor and dry locations use
   2. Category 5e above Grade un-shielded Cable
      a. Conductors: Four bonded pair #24 AWG Bare Copper
      b. Insulation: Polyolefin
      c. Jacket: PVC with 300-volt rated and manufacturer's identification
      d. NEC CMR
      e. UL1666 listed for indoor and dry locations use
   3. Category 6 above Grade shielded Cable
      a. Conductors: Four bonded pair #23 AWG Bare Copper
      b. Insulation: Polypropylene

c. Shield: 100% aluminum foil polyester tape with drain wire
d. Jacket: PVC with 600-volt rated and manufacturer's identification
e. Transmission Standards: Category 6 - TIA 568.C.2
f. NEC CMR
g. Flame Test Method: UL1666 Vertical Riser listed for indoor and dry locations use

4. Category 6 above Grade un-shielded Cable
   a. Conductors: Four bonded pair #23 AWG Bare Copper
   b. Insulation: Polyolefin
   c. Jacket: PVC with 300-volt rated and manufacturer's identification
   d. Transmission Standards: Category 6 - TIA 568.C.2
   e. Nominal Velocity of Propagation: 72%
   f. Flame Test Method: UL1666 Vertical Riser listed for indoor and dry locations use
5. Category 5e below Grade shielded Cable
   a. Conductors: Four pair #24 AWG Bare Copper
   b. Insulation: Polyolefin
   c. Shield: 100% aluminum foil polyester tape with drain wire
   d. Jacket: LLPE (Linear Low Density Polyethylene) with 300-volt rated and manufacturer's identification
   e. Misc.: NEMA WC-63.1, listed for outdoor and wet locations use
   f. Water Blocking compound and listed for direct bury applications.
6. Category 5e below Grade unshielded Cable
   a. Conductors: Four pair #24 AWG Bare Copper
   b. Insulation: Polyolefin
   c. Jacket: LLPE (Linear Low-Density Polyethylene) with 300-volt rated and manufacturer's identification
   d. Misc.: NEMA WC-63.1, listed for outdoor and wet locations use.
   e. TIA-568-C.2 Category 5e compliance
   f. Water Blocking compound and listed for direct bury applications.
7. Category 6 below Grade Cable
   a. Conductors: 4 pair 23AWG Bare Copper
   b. Insulation: Polyolefin
   c. Shield: 100 percent aluminum foil polyester tape with drain wire
   d. Jacket: Polyethylene with 300 volts rated and manufacturer's identification
   e. Misc.: Gel filled and NEMA WC-63.1, listed for outdoor and wet locations use
8. 485 Communications Cable
   a. Conductors: One pair #24 AWG Tinned Copper
   b. Insulation: Polyethylene
   c. Shield: 100% aluminum foil polyester tape with tinned copper drain wire
   d. Jacket: PVC with 300-volt rated and manufacturer's identification
   e. Misc.: UL2919 listed for indoor and dry locations use

B. Color code for Ethernet communications cables shall be as follows.
   1. Green – CAT5e Phone / Data
   2. Red – CAT5e SCADA
   3. Blue – CAT6 – Phone / Data
   4. White – CAT6 - SCADA

2.10 TERMINATION MATERIALS

A. Power Conductors: Termination materials, of conductors at equipment, shall be as specified in the relevant equipment Section.

B. Control and Instrumentation Conductors (including graphic panel, alarm, low- and high-level signals): Termination connectors shall be DIN-rail-mounted one-piece molded plastic blocks with tubular-clamp-screw type, with end barriers, dual side terminal block numbers and terminal group identifiers. Terminals to be UL Listed for stranded conductor terminations. Rated for a maximum of 2 #14 stranded conductors. Color of terminals to comply with NFPA 79.

C. Motor Conductors: Motor connections with conductors #12 AWG up to #6 AWG shall be ring type compression terminations on the motor leads and secured with bolt, nut and spring washer. Connections shall be -30°C rubber insulated, half lap, and two layers minimum of Scotch 33 or equal vinyl tape. Motor terminations for conductors #8 AWG and larger shall be in accordance with paragraph “Lugs and Connectors” below. Motors provided on this project per specification 26 05 50 shall have motor terminals enclosures with bus and NEMA one-hole or two-hole pads to accommodate the conductor terminals specified herein.

D. Lugs and Connectors

1. All lugs and connectors shall be tin plated copper and shall be crimped type, installed with standard industry tooling. Lugs and connectors shall match the wire size where used, and shall be clearly identified and color coded on the connector. All connections shall be made for stranded wire and shall be made electrically and mechanically secured. The lugs and connectors shall have a current carrying capacity equal to the conductors for which they are rated and meet UL 486 requirements for 75°C. Lugs for #12 AWG up to #6 AWG shall be ring terminals. Conductors #4 AWG and larger shall be two-hole long barrel lugs with NEMA spacing. All lugs shall be the closed end construction to exclude moisture migration into the cable conductor.

2.11 SPLICE MATERIALS

A. Power Conductors: Circuits shall be pulled from terminal to terminal, without splicing, except where splicing is shown on the Drawings. No other splicing will be permitted. For wires sizes #8 AWG and smaller, provide color coded wire nuts, with metal inserts, 3M or Ideal, rubber insulated with half lap and two layers minimum of Scotch 33 tape. For wires greater than #8 AWG, provide a heat shrink insulated, color-coded, die-crimped splice lug, T&B 54XXX, or equal, rubber insulated, with half lap and two layers minimum of Scotch 33 tape.

B. Control and Instrumentation Conductors (including graphic panel, alarm, low and high level signals): No splicing of control and instrumentation conductors will be permitted.

2.12 WALL AND FLOOR SLAB OPENING SEALS

A. Wall and floor slab openings shall be sealed with "FLAME-SAFE" as manufactured by the Thomas & Betts Corp. or equal.

2.13 WIRE AND CABLE TAGS

A. Use the tagging formats for wire and cable as shown on the Drawings. Where modifications or additions are made to existing wire and cable runs, replace existing tags with new modified tags.

B. Wire tags for wire sizes, #2 AWG and smaller, shall be heat shrink type Raychem TMS-SCE, or approved equal with the tag numbers typed with an indelible marking process. Character size shall be a minimum of 1/8-inch in height. Hand written tags shall not be acceptable. Where ends are not available, attach cable tags with nylon tie cord.

C. Tags for wires larger than #2 AWG and all cables shall be thermally printed polyethylene type, Brady TLS 2200 or approved equal, nylon zip tied in accordance with the manufacturer's instructions.

D. Tags relying on adhesives or taped-on markers are not acceptable.

E. Tagging shall be done in accordance with the execution portion of these Specifications.

2.14 WIRE COLOR CODE

A. All wire shall be color coded or coded using electrical tape in sizes #8 or greater, where colored insulation is not available. Where tape is used as the identification system, it shall be applied in all junction boxes, manholes and other accessible intermediate locations as well as at each termination.

B. The following coding shall be used:

System	Wire	Color
1-Phase, 3 Wire	Phase A	Black
	Phase B	Blue
	Neutral	White
208Y/120, Volts	Phase A	Black
3-Phase, 4 Wire	Phase B	Red
	Phase C	Blue
	Neutral	White
480/277, Volts	Phase A	Brown
3-Phase, 4 Wire	Phase B	Orange
	Phase C	Yellow
	Neutral	Gray/White with one or more colored stripes

2.15 CABLE TAG COLOR CODE

A. All cable tags shall be white in color with black printing.

PART 3 - EXECUTION

3.1 GENERAL

A. Do not install conductors until the raceway system is in place. No conductor shall be installed between outlet points, junction points or splicing points, until raceway sections have been completed, and raceway covers are installed for protection of conductors from damage or exposure to the elements. Any conductor installed in an incomplete raceway system shall be removed from the raceway system and from project site. A complete inspection of such raceway sections shall be completed, before new conductors are installed.

B. Installed unapproved wire shall be removed and replaced at no additional cost to the Owner.

C. Completely swab raceway system before installing conductors. Do not use cleaning agents and lubricants which have a deleterious effect on the conductors or their insulation.

D. Pull all conductors into a raceway at one time, using wire pulling lubricant as needed to protect the wire.

E. Except for hand-pulled conductors into raceways, all wire and cable installation shall be installed with tension-monitoring equipment. Conductors which are found to have been installed without tension–monitoring shall be immediately removed from the raceways, permanently identified as rejected material, and removed from the jobsite. New conductors and cables shall be reinstalled, tagged and raceways resealed, with no change in the Contract Price or Schedule allowed.

F. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii. Where pulling compound is used, use only UL listed compound compatible with the cable outer jacket and with the raceway involved.

G. Tighten all screws and terminal bolts using torque type wrenches and/or drivers to tighten to the inch-pound requirements of the NEC and UL.

H. Single conductors and cables in manholes, hand holes, vaults, cable trays, and other indicated locations are not wrapped together by some other means such as arc and fireproofing tapes, shall be bundled throughout their exposed length with nylon, self-locking, releasable, cable ties placed at intervals not exceeding four inches on centers.

I. All wire and cable installed in cable trays shall be UL Listed as Type TC, for cable tray use.

3.2 CONDUCTORS 1000 VOLTS AND BELOW

A. Provide conductor sizes indicated on Drawings, as a minimum.

B. Use crimp connectors on all stranded conductors.

C. Soldered mechanical joints insulated with tape will not be acceptable.

D. Arrange wiring in cabinets and panels neatly cut to proper length Surplus wire shall be removed unless noted otherwise. Conductors shall be bridled or bundled and secured in an acceptable manner. Identify all circuits entering motor control centers and all other control enclosures in accordance with the conductor identification system specified herein.

E. Terminate control and instrumentation wiring with methods consistent with terminals provided, and in accordance with terminal manufacturer's instructions.

F. Attach compression lugs, larger than #6 AWG, with a tool specifically designed for that purpose which provides a complete, controlled crimp where the tool will not release until the crimp is complete. Use of plier type crimpers is not acceptable.

G. Cap spare conductors and conductors not terminated with the UL listed end caps.

H. Remove all burrs, chamfer all edges, and install bushings and protective strips of insulating material to protect the conductors passing through holes or over edges in sheet metal enclosures.

I. Provide at least 6 feet spare conductors in freestanding panels and at least two feet spare in other assemblies for all conductors which are to be terminated by others. Provide additional conductor length in any assembly where it is obvious that more conductor will be needed to reach the termination point.

J. Do not combine power conductors in the same raceway unless shown on Drawings. Do not run signal conductors carrying voltages less than 120 volts AC in the same raceway as conductors carrying higher voltages regardless of the insulation rating of the conductors. Do not share neutrals on branch circuits.

3.3 GROUNDING

A. Conduits and other raceways shall contain an equipment grounding conductor whether the raceway is metallic or not. Conduits, motors, cabinets, outlets and other equipment shall be properly grounded in accordance with NEC requirements and specification 16660 26 05 26. Ground wires exposed to mechanical damage shall be installed in rigid aluminum conduit. Make connections to equipment with solderless connections. Connections to ground rods shall be of the fused type equal to the Cadweld process.

3.4 TERMINATIONS AND SPLICES

A. No splices of wire and cable will be permitted, except where specifically permitted by the Owner/Engineer in writing, or as shown on the Drawings.

B. Power conductors: Terminations shall be made with connectors as specified. Splices, where specifically allowed as stated above, shall be made in a Termination Cabinet (TC).

C. Control Conductors: Splices of control conductors will not be permitted between terminal points. Terminations shall be made with approved terminals as specified.

D. Instrumentation Signal Conductors (including graphic panel, alarm, low and high level signals): Splices of Instrumentation conductors will not be permitted between terminal points. Terminations shall be made with connectors as specified. The shield of pair shielded and triad shielded shall be terminated on terminal strips. Provide dedicated terminal block to every conductor including shields. Double lugging terminations is not acceptable.

3.5 INSTRUMENTATION CABLES

A. Instrumentation cables shall be installed in raceways as specified. Unless specifically shown on the Drawings, all instrumentation circuits shall be installed as single shielded twisted pair cables or single shielded twisted triads. In no case shall a circuit be made up using conductors from different pairs or triads. Triads shall be used wherever three wire circuits are required.

B. Terminal blocks shall be provided at all instrument cable junction boxes, and all circuits shall be identified at such junctions.

C. Shielded instrumentation wire, coaxial cable, data highway cable, discrete I/O, multiple conductor cable, and fiber optic cables shall be run without splices between instruments, terminal boxes, or panels. The shield shall be continuous for the entire run.

D. Shields shall be grounded at the PLC/RTU. Terminal blocks shall be provided for inter-connecting shield drain wires at all junction boxes. Individual circuit shielding shall be provided with its own block.

E. Shield wire shall be wrapped and taped at the transmitter end of the signal run. Before termination, peel back the outer sheath, leaving the shield intact. Wrap the drain wire around the conductors, leaving approximately two inches exposed. Wrap the drain wire with two layers of Scotch 33 tape.

3.6 WIRE TAGGING

A. All wiring shall be tagged at all termination points and at all major access points in the electrical raceways. A termination point is defined as any point or junction where a wire or cable is physically connected. This includes terminal blocks and device terminals. A major access point to a raceway is defined as any enclosure; box or space designed for wire or cable pulling or inspection and includes pull boxes, manholes, and junction boxes.

B. Wire tags shall show both origination and destination information to allow for a wire or cable to be traced from point in the field. Information regarding its origination shall be shown in parenthesis.

C. For multiconductor cables, both the individual conductors and the overall cable shall be tagged. Conductors that are part of a multiconductor cable shall reference the cable identification number that they are a part of, as well as a unique conductor number within the cable.

3.7 CABLE TAGGING

A. All cables shall be tagged at all termination points and at all major access points in the electrical raceways as defined in the wire tag section of this Specification.

B. The cable tag shall be installed where the cable enters and leaves each access point (e.g., junction box, manhole, etc.). In cases of limited access space, a single tag may be used that shows both equipment tag origination and destination. In the case where the jacket is stripped for terminations, the tag shall be installed at the end of the jacket.

3.8 RACEWAY SEALING

A. Raceways entering junction boxes or control panels containing electrical or instrumentation equipment shall be sealed with 3M 1000NS Watertight Sealant or approved equal.

B. This requirement shall apply to for all raceways in the conduit system.

3.9 FIELD TESTS

A. Conductors under 600 volts

1. Perform insulation resistance testing of all power circuits below 1000 volts with a 1000-volt megger, in accordance with the recommendations of the wire manufacturer.
2. Prepare a written test report of the results and submit to the Owner/Engineer prior to final inspection.
3. Minimum acceptable value for insulation resistance is 100 megohms. Lower values shall be acceptable only by the Owner/Engineer's specific written approval.
4. Disconnect equipment that might be damaged by this test. Perform tests with all other equipment connected to the circuit.

B. Tests: After instrumentation cable installation and conductor termination by the instrumentation and control supplier, perform tests to ensure that instrumentation cable shields are isolated from ground, except at the grounding point in the instrumentation control panel. Remove all improper grounds.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required to install a complete Grounding and Bonding System, in strict accordance with Article 250 of the National Electrical Code (NEC), and as shown on the Drawings and specified herein.

B. The system shall include ground wires, ground rods, exothermic connections, mechanical connectors, structural steel connections, all as shown on the Drawings, and as specified herein, to provide a bonding to earth ground of all metallic materials likely to become energized.

1.2 RELATED WORK

A. Refer to Division 26 00 00 and the Contract Drawings, for related work and electrical coordination requirements.

1.3 SUBMITTALS

A. Submit to the Engineer, in accordance with Division 1 and Section 26 00 00, shop drawings and product data, for the following:
   1. Ground rods.
   2. Grounding conduit hubs.
   3. Waterpipe ground clamps.
   4. Buried grounding connections.
   5. Compression lugs.
   6. Exothermic bonding system.

B. All shop drawing submittals and all O&M submittals shall be submitted in hard copy format and in electronic format using PDF files on a CD and/or a flash drive. and shall include an indexed Table of Contents. Electronic submittals are mandatory, and any submittal received not indexed as specified will be returned without review. Hard copy submittals may not be required if so stipulated in the Contract Documents. No change in Contract Price or Schedule will be allowed for delays due to unacceptable submittals.

C. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project. Unmarked cut sheets will cause the submittal to be rejected and returned for revision.

1.4 REFERENCE CODES AND STANDARDS

A. All products and components shown on the Drawings and listed in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
   1. NFPA 70 – National Electrical Code (NEC)
   2. UL 467-2007 --Grounding and Bonding Equipment
   3. NFPA 70E – Standard for Electrical Safety in the Workplace

B. All equipment components and completed assemblies specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.5 QUALITY ASSURANCE

A. The manufacturer of these materials shall have produced similar electrical materials and equipment for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, complete all submittal requirements, and present to the Owner/Engineer prior to delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, onsite factory work, or failed factory tests will not be permitted.

B. Protect equipment during shipment, handling, and storage by suitable complete enclosures. Protect equipment from exposure to the elements and keep thoroughly dry.

1.7 WARRANTY

A. Provide warranties, including the manufacturer's warrantee, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for two years from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner

PART 2 - PRODUCTS

2.1 RACEWAYS

A. Conduit shall be as specified under Section 26 05 33.

B. All raceways, conduits and ducts shall contain equipment grounding conductors sized in accordance with the NEC. Minimum sizes shall be #12 AWG unless otherwise indicated on the drawings.

2.2 CONDUCTORS

A. Conductors shall be as specified under Section 26 05 19.

B. Equipment grounding conductors shall be tinned insulated XHHW-2 conductors. Conductors shall be green where available from the wire manufacturers or marked with green tape as specified under 26 05 19.

C. Grounding electrode conductors shall be bare tinned copper where direct buried, or encased in concrete. Bare grounding electrode conductors or lightning protection conductors where exposed to damage shall be installed in conduit. Grounding electrode conductors or lightning protection down lead conductors shown, specified or required to be installed in conduit per the NEC with no other conductors shall be bare tinned copper. Bare conductors installed in metallic conduits shall be bonded to the metallic conduit at both ends.

D. Grounding electrode conductors routed between concealed grounding electrodes or interconnecting grounding electrode counterpoise loop conductors to exposed (IE "Pigtails") shall be bare tinned copper.

2.3 GROUNDING ELECTRODES

A. Ground rods shall be 3/4-inch by 10-foot copper clad steel and constructed in accordance with UL 467. The minimum copper thickness shall be 10 mils.

B. Manufacturers for ground rods
   1. ERICO
   2. Copperweld
   3. Approved equal.

2.4 CONNECTORS AND CONNECTIONS

A. Waterpipe ground clamps shall be tinned cast bronze
   1. Manufacturers
      a. Thomas & Betts Co. Cat. JPT
      b. Burndy
      c. O.Z. Gedney Co.
      d. Cooper Power Systems
      e. Erico
      f. Harger
      g. Approved equal
      h. Provide the correct size for the pipe.

B. Other grounding system clamps, where specified or shown shall be tinned cast bronze.
   1. Manufacturers
      a. Thomas & Betts Co.
      b. Burndy
      c. O.Z. Gedney Co.
      d. Cooper Power Systems
      e. Erico
      f. Harger
      g. Approved equal.

C. All concealed grounding system or lightning protection system connections shall be by an exothermic weld process
   1. Manufacturers
      a. T&B Furseweld SCR1
      b. Burndy Thermoweld
      c. Cadweld
      d. Approved equal.
   2. Exothermic welded connections shall be used in exposed locations as specified herein.

D. Provide a Burndy Hyground Irreversible Compression System or equal in areas where the Owner's operations prevent the use of an exothermic welded connection. The use of a compression system ground connection is otherwise prohibited without written approval on a case-by-case basis from the Owner or Engineer. Permission shall be submitted through the RFI process. Compression connectors installed without permission shall be removed and replaced with exothermic weld connections with no change in the Contract Price or change in the Contract Schedule allowed.

E. All grounding connections which would require exothermic welding in a Class 1 Division 1 Area as determined by NFPA 820, or the Engineer, or the NEC Authority Having Jurisdiction shall use a Burndy Hyground Irreversible Compression System, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Route exposed grounding electrode conductors in rigid aluminum conduits to protect the conductors from damage. The rigid conduits shall be aluminum or PVC-coated aluminum conduits as specified in 26 05 33. Bond the protecting conduits to the grounding electrode conductors at both ends. Water pipe grounding connections shall not be painted. Painted connections shall be disassembled, replaced and reconnected.

B. Install equipment grounding conductors in all raceways for the power, control and instrumentation systems. Grounding conductors shall be independent conductors and shall be separate from all shield drain wires.

C. Conduits and other raceways shall contain an equipment grounding conductor whether the raceway is metallic or not. Conduits, motors, cabinets, outlets and other equipment shall be properly bonded in accordance with NEC requirements. Where ground wire is exposed to mechanical damage, install wire in rigid metallic conduit.

D. In NEC classified areas, connection of grounding electrode connections to structural steel columns shall be made with long barrel type one-hole heavy duty copper compression lugs, bolted through 1/2-inch maximum diameter holes drilled in the column web, with stainless steel hex head cap screws and nuts.

E. In new construction, bond each building column to the grounding electrode counterpoise system whether nor not specifically shown on the Drawings using grounding electrode conductors. Grounding electrode conductors rising from the counterpoise to bond to a column shall be made using an insulated conductor the same size as the conductors used to form the counterpoise. Exposed grounding electrode conductors shall be routed in rigid conduit. Bond metallic conduits as specified. Grounding electrode conductor connections to structural steel columns shall be made with as permitted by the Structural Engineer with long barrel type one-hole heavy duty copper compression lugs, bolted through 1/2-inch maximum diameter holes drilled in the column web, with stainless steel hex head cap screws and nuts. Exothermic welds are acceptable in non-classified areas if approved by the Structural Engineer.

F. Metal conduits stubbed into a motor control center shall be terminated with insulated grounding bushings and connected to the motor control center ground bus. Bond boxes mounted below motor control centers to the motor control center ground bus. Size the grounding wire in accordance with NEC Table 250.122, except that a minimum #12 AWG shall be used.

G. Liquid tight flexible metal conduit in sizes 1-1/2-inch and larger shall have bonding jumpers. Bonding jumpers shall be external, run parallel (not spiraled) and fastened with plastic tie wraps.

H. Ground transformer neutrals to the nearest available grounding electrode with a conductor sized as shown with a minimum size in accordance with NEC Article 250.66.

I. Provide power system grounding electrodes (ground rods) no closer than twice the length of the ground rod. Where a lightning protection is specified to be provided, the Contractor shall provide a dedicated lightning protection system grounding electrode (ground rod) at the end of every down lead if no counterpoise is present or shall connect directly to the power system counterpoise without driving a separate ground rod. Refer to Section 26 41 00 for lightning protection system specifications.

J. Provide a #1/0 AWG bare tinned grounding conductor the full length of each cable tray system, bond each section and tray fitting to the tray grounding conductor. Route the tray grounding conductor along the outside of the cable tray. Install no grounding clamps on the inside of the tray to avoid damage to tray conductors. Bond the tray grounding conductor to the power system counterpoise grounding electrode system at the end of the tray, or for tray systems installed in a loop configuration, bond in at least two locations at opposite sides of the tray loop. Bond every enclosure to which tray conductors are routed to the tray grounding conductor. Bond every conduit or raceway routing tray conductors away from or to the tray system to the cable tray and to the cable tray grounding conductor.

K. All equipment enclosures, motor and transformer frames, conduits systems, cable tray, cable armor, exposed structural steel and all other equipment and materials required by the NEC to be grounded, shall be grounded and bonded in accordance with the NEC.

L. Seal exposed connections between different metals with no-oxide paint, Grade A or equal.

M. Lay all underground grounding conductors' slack and, where exposed to mechanical injury, protect by pipes or other substantial guards. If guards are iron pipe, or other magnetic material, electrically connect conductors to both ends of the guard. Make connections as specified herein.

N. Care shall be taken to ensure good ground continuity, between the conduit system and equipment frames and enclosures. Where necessary, bonding jumper conductors shall be provided.

O. Ground all grounding type receptacles to the outlet boxes with a minimum, #12 AWG XHHW-2 stranded green conductor, connected to the ground terminal of the receptacle and bonded to the outlet box by means of a grounding screw.

3.2 INSPECTION AND TESTING

A. Inspect the grounding and bonding system conductors and connections for tightness and proper installation.

B. Use Biddle Direct Reading Earth Resistance Tester or equivalent test instrument to measure resistance to ground of the system. Perform testing in accordance with test instrument manufacturer's recommendations using the fall-of-potential method.

C. All test equipment shall be provided under this Section and approved by the Owner/Engineer.

D. Resistance to ground testing shall be preceded by no precipitation for a minimum of five days. Submit test results in the form of a graph showing the number of points measured (12 minimum) and the numerical resistance to ground.

E. Testing shall be performed before energizing the electrical distribution system.

F. A separate test shall be conducted for each building or system.

G. Notify the Engineer immediately if the resistance to ground for any building or system is greater than five ohms.

END OF SECTION

SECTION 26 05 29
ELECTRICAL SUPPORT HARDWARE

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install electrical support hardware, as shown on the Drawings and as specified herein.

B. Hardware shall include anchor systems, adhesive anchor systems, metal framing systems, and other electrical support systems, as shown on the Drawings and specified herein.

1.2 RELATED WORK

A. Refer to Division 26 00 00 and the Contract Drawings, for related work and electrical coordination requirements.

1.3 SUBMITTALS

A. Submit to the Owner/Engineer, in accordance with Division 1, the manufacturers' names and product designation or catalog numbers for the types of materials specified or shown on the Drawings. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project. Unmarked cut sheets will cause the submittal to be rejected and returned for revision.

B. The submittal information, for anchor systems, shall contain manufacturer's specifications and technical data including;

1. Acceptable base material conditions (i.e. cracked, un-cracked concrete)
2. Acceptable drilling methods
3. Acceptable bore hole conditions (dry, water saturated, water filled, under water)
4. Manufacturer's installation instructions including bore hole cleaning procedures and adhesive injection.
5. Cure and gel time tables
6. Temperature ranges (storage, installation and in-service).

C. All shop drawing submittals and all O&M submittals shall be submitted in hard copy format and in electronic format using PDF files on a CD and/or a flash drive and shall include an indexed Table of Contents. Electronic submittals are mandatory, and any submittal received not indexed as specified will be returned without review. Hard copy submittals may not be required if so stipulated in the Contract Documents. No change in Contract Price or Schedule will be allowed for delays due to unacceptable submittals.

D. Submittals shall also contain information on related equipment to be furnished under this Specification. Incomplete submittals not containing the required information on the related equipment will also be returned without review.

1.4 REFERENCE CODES AND STANDARDS

A. All products and components shown on the Drawings and listed in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
   1. NFPA 70 National Electrical Code (NEC)
   2. NFPA 70E Standard for Electrical Safety in the Workplace
   3. ASTM E 488-96 (2003); Standard Test Method for Strength of Anchors in Concrete and Masonry Elements, ASTM International.
   4. ASTM E 1512-93, Standard Test Methods for Testing Bond Performance of Adhesive-Bonded Anchors, ASTM International
   5. AC308; Acceptance Criteria for Post-Installed Anchors in Concrete Elements, Latest revision.
   6. SAE 316 Stainless Steel Grades

B. All equipment components and completed assemblies having a UL standard specified in this Section of the Specifications, shall bear the appropriate label of Underwriters Laboratories.

1.5 QUALITY ASSURANCE

A. The manufacturer of these materials shall have produced similar electrical materials and equipment for a minimum period of five years. When requested by the Owner/Engineer, a list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, all submittal requirements must be complete, and an approved copy of all such submittals shall be available to the Owner/Engineer prior to delivery of the equipment. Delivery of equipment not completely constructed, onsite factory work, or failed factory tests will not be permitted.

B. Materials shall be handled and stored in accordance with manufacturer's instructions.

C. Adhesive Anchor Systems.
   1. Deliver materials undamaged in Manufacturer's clearly labeled, unopened containers, identified with brand, type, and ICC-ES Evaluation Report number.
   2. Coordinate delivery of materials with scheduled installation date, minimizing storage time at job-site.
   3. Store materials under cover and protect from weather and damage in compliance with Manufacturer's requirements, including temperature restrictions.
   4. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
   5. Do not use damaged or expired materials.
   6. Storage restrictions (temperature range) and expiration date must be supplied with product

D. Metal Framing Systems
   1. Material shall be new and unused, with no signs of damage from handling.

1.7 WARRANTY

A. Provide warranties, including the manufacturer's warrantee, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for two years from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner.

PART 2 - PRODUCTS

2.1 ANCHORING SYSTEMS

A. Acceptable Manufacturers
   1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
      a. HILTI Kwik Bolt 3
      b. Approved equal
   2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. Product Description
   1. Torque controlled expansion anchor consisting of anchor body, expansion element (wedges), washer and nut. Anchor shall be used for anchor sizes less than 3/8 inch.
   2. All parts shall be 316 stainless steel materials conforming to SAE 316.
   3. UL 203 Rated.

2.2 ADHESIVE ANCHORING SYSTEMS

A. Acceptable Manufacturers
   1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
      a. HILTI HIT-RTZ with HIT-HY 200 MAX.
      b. Approved equal
   2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. Product Description
   1. Anchor body with helical cone shaped thread on the embedded end and standard threads on the exposed end, with washer and nut, inserted into Injection adhesive. Anchor shall be used for anchor sizes 3/8 inch and larger.
   2. All parts shall be 316 stainless steel materials conforming to SAE 316 standards.

2.3 STRUT SUPPORT SYSTEMS

A. Acceptable Manufacturers

1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   a. Tyco Unistrut
   b. B-Line
   c. Super-Strut
   d. Approved equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. Product Description
1. Metal framing system for use in the mounting or support of electrical systems, panels and enclosures, and including lighting fixture supports, trapeze hangers and conduit supports.
2. Components shall consist of telescoping channels, slotted back-to-back channels, end clamps all threads and conduit clamps.
3. Minimum sizes shall be 13/16-inch through 3-1/4 inch.
4. Components shall be assembled by means of flat plate fittings, 90-degree angle fittings, braces, clevis fittings, U-fittings, Z-fittings, Wing-fittings, Post Bases, channel nuts, washers, etc.
5. Field welding of components will not be permitted.
6. Unless otherwise specified or shown on the Drawings, all parts shall be 316 stainless steel material conforming to SAE 316.
7. Framing systems for chlorine and ammonia rooms shall be manufactured of structural fiberglass.

2.4 STAINLESS TIES

A. Acceptable Manufacturers
1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   a. PANDUIT
   b. PHONIX CONTACT
   c. Gardner Bender
   d. Approved Equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. Product Description
1. Cable Ties for securing and supporting of flexible raceway and conductors.
2. Self-locking mechanism.
3. Material shall be 304 Stainless Steel unless otherwise directed as shown on the drawings.

C. Locations for Use
1. Cable Ties of stainless steel to be used in wet environments, where exposed to process, or when exposed to sunlight

2. Self-locking mechanism.

PART 3 - EXECUTION

3.1 GENERAL

A. Install all equipment strictly in accordance with the manufacturer's instructions and the Contract Drawings.

B. The locations of devices are shown as general on the Drawings and may be varied within reasonable limits as to avoid any piping or other obstruction without change in the Contract Price or Schedule, subject to the approval of the Owner and Engineer. Coordinate the installation of the devices for piping and equipment clearance.

C. No electrical equipment or raceways shall be attached to or supported from, sheet metal walls.

D. Install required safety labels.

E. Electrical support channel shall be used to construct support assemblies as shown on the drawings. Horizontal braces attached to concrete or CMU walls or structural building steel are permitted if the space between the back of the support structures and the attachment points are too small to permit a walk space. No attachments to sheet metal are permitted as specified above. Incorporate additional channel materials and/or provide assemblies of double channel with enough vertical and horizontal members to from a rigid structure whether or not such additional materials or the use of double channel materials are shown or specified. Support structures shall be rigid without the use of channels to from angle supports between the back or front of the assembly and the ground. Angle supports are strictly prohibited because they provide tripping hazards. Outdoor supports structures shall be able to support the equipment with the structural strength to withstand wind gusts up to 90 mph without damage.

3.2 FIELD QUALITY CONTROL

A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.

3.3 POST INSTALLED ANCHOR SYSTEMS

A. Prior to installation of the anchor systems, the hole shall be clean and dry in accordance with the manufacturer’s instructions.

3.4 CLEANING

A. Remove all rubbish and debris from inside and around the installation. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

END OF SECTION

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SECTION 26 05 33
RACEWAYS, BOXES, ENCLOSURES, AND FITTINGS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install complete raceway systems as shown on the Drawings and as specified herein. A raceway system shall consist of materials designed expressly for containing wires and cables, including but not limited to, conduit, device bodies, conduit bodies, raceway boxes, enclosures containing electrical devices, controls and related materials.

B. Raceways and conductors that are listed on the raceway and conductor schedules are generally not shown on the Drawings, except where they are required to pass through a restricted or designated space. Raceways indicated to be run "exposed" on the schedules shall be run near the ceilings or along the walls of the areas through which they pass and shall be routed to avoid conflicts with HVAC ducts, cranes and hoists, lighting fixtures, doors and hatches, etc. Raceways indicated to be run concealed shall be run in the center of concrete floor slabs, in partitions, or above hung ceilings, as required.

1.2 RELATED WORK

A. Refer to Division 26 00 00 and the Contract Drawings, for related work and electrical coordination requirements.

1.3 SUBMITTALS

A. Submit to the Owner/Engineer, in accordance with Division 1, the manufacturers' names and product designation or catalog numbers of all materials specified.
   1. Cut sheets for each individual item shall be submitted.
   2. Each cut sheet shall be clearly marked to indicate the item submitted and/or mark out items which are not being submitted for approval. Submittals not clearly marked will be returned with the indication REVISE AND RESUBMIT as a minimum or other indication per the specifications as warranted.

B. Submit to the Owner/Engineer, certification that the electricians installing the PVC coated conduit have a five-year minimum experience, in the installation of the product.

C. All shop drawing submittals and all O&M submittals shall be submitted in hard copy format and in electronic format using PDF files on a CD and/or a flash drive and shall include an indexed Table of Contents. Electronic submittals are mandatory, and any submittal received not indexed as specified will be returned without review. Hard copy submittals may not be required if so stipulated in the Contract Documents. No change in Contract Price or Schedule will be allowed for delays due to unacceptable submittals.

D. Submittals shall also contain information on related equipment to be furnished under this Specification. Incomplete submittals not containing the required information on the related equipment will also be returned without review.

1.4 REFERENCE CODES AND STANDARDS

A. All products and components shown on the Drawings and listed in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
   1. NFPA 70 – National Electrical Code (NEC)
   2. NFPA 70E – Standard For Electrical Safety in the Workplace
   3. UL 6A – Electrical Rigid Metal Conduit
   4. ANSI C80.5 – Electrical Rigid Aluminum Conduit
   5. UL 514B – Outlet Bodies

B. All equipment components and completed assemblies specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.5 QUALITY ASSURANCE

A. The manufacturer of these materials shall have produced similar electrical materials and equipment for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly. All assemblies shall be of the same manufacturer.

C. The installer of materials specified herein, shall have a minimum of five years' experience in the installation of each type of material. Proof of experience shall be submitted, upon request of the Owner/Engineer, prior to installation.

D. Used materials are unacceptable, will be rejected and shall be removed from the job site. Used materials, if installed, shall be removed and replaced with new materials. If new materials are installed with used materials, and the removal of the used materials renders the new materials in an unacceptable condition, such as new conductors installed in used raceway components, (determined by the Engineer/Owner alone) then the new materials shall be removed along with the used materials and replaced. No increase in the Contract Price nor in Contract Schedule will be allowed.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, complete all submittal requirements, and present to the Owner/Engineer prior to delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will not be permitted.

B. Materials shall be handled and stored in accordance with manufacturer's instructions.

C. Materials shall not be stored exposed to sunlight. Such materials shall be completely covered.

D. Materials showing signs of previous use, jobsite storage at another location, or exposure to the elements or other damage will be rejected.

1.7 WARRANTY

A. Provide warranties, including the manufacturer's warrantee, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for two years from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner.

PART 2 - PRODUCTS

2.1 GENERAL

A. Raceways and fittings shall be as shown on the Drawings, with a minimum 3/4-inch trade size.

B. Device entries less than 3/4 inch shall be provided with an adaptor to connect ¾-inch or larger conduit. The following adaptors are acceptable:

1. REA12SA, Cooper Crouse Hinds or equal, for aluminum
2. ADAPT ADU302930, REDAPT or equal, for 316 stainless.

2.2 CONDUIT RACEWAY

A. PVC Coated Rigid Aluminum Conduit (CRMC)

1. PVC coated rigid aluminum conduit shall have a minimum 0.040-inch thick, polyvinyl chloride coating permanently bonded to rigid aluminum conduit and an internal chemically cured urethane or enamel coating.
2. Rigid Aluminum conduit shall be extruded from AA 6063 alloy in temper designation T-1 and shall conform to FED Spec WW-C-540C, ANSI C80.5 and UL 6A.
3. The ends of all couplings, fittings, etc. shall have a minimum of one pipe diameter in length of PVC overlap.
4. Elbows and couplings shall be PVC coated by the same manufacturer supplying the conduit PVC coating system. Elbows and couplings used with PVC coated conduit shall be furnished with a PVC coating bonded to the aluminum, the same thickness as used on the coated aluminum conduit.

B. Liquid tight Aluminum Flexible Metal Conduit (LFMC)

1. Liquid tight aluminum flexible metal conduit shall have an interlocked aluminum core, PVC jacket rated for 60 degrees C,. and meeting NEC Article 351.
2. Fittings used with liquid tight flexible aluminum conduit shall be copper-free aluminum and shall conform to FEDSPEC AA50552, and UL-514B.

C. Aluminum Flexible Metal Conduit (FMC)

1. Aluminum flexible metal conduit shall have an interlocked aluminum core, meeting NEC Article 348, UL 1and Federal Specification WW-C-566C.
2. Fittings used with aluminum flexible metal conduit shall be copper-free aluminum shall conform to FEDSPEC AA50552.

D. Rigid Aluminum Conduit (RMC)

1. Rigid Aluminum conduit shall be extruded from AA 6063 alloy in temper designation T-1 and shall conform to FED Spec WW-C-540C, ANSI C80.5 and UL 6A.

E. Rigid PVC Schedule 40 Conduit (RNC)
   1. Schedule 40 PVC Rigid Nonmetallic Conduit (RNC) shall be designed for use underground as described in the NEC, resistant to sunlight. The conduits and fittings shall be manufactured to NEMA TC-2, Federal Specification WC1094A and UL 651 specifications. Fittings shall be manufactured to NEMA TC-3, Federal Specification WC1094A and UL 514B. Conduit shall have a UL Label.

F. Rigid PVC Schedule 80 Conduit (RNC)
   1. Schedule 80 PVC Rigid Nonmetallic Conduit (RNC) shall be designed for use above ground and underground as described in the NEC, resistant to sunlight. The conduits and fittings shall be manufactured to NEMA TC-2, Federal Specification WC1094A and UL 651 specifications. Fittings shall be manufactured to NEMA TC-3, Federal Specification WC1094A and UL 514B. Conduit shall have a UL Label.

2.3 WIREWAYS

A. All wireways shall be NEMA 4X 316 stainless steel, with gasketed hinged covers and stainless steel quick-release type latches. Wireway shall have two Breather/Drains for each ten feet of wireway. Breather/Drain shall be in the bottom, near the ends of the wireway. Wireways shall have integral welded mounting lugs. Bolted-on mounting lugs are unacceptable. Provide stainless steel internal barriers to isolate signal cables from power conductors and multiconductor digital control cables.

B. Manufacturers
   1. Industrial Enclosure Corporation
   2. Cooper B Line
      a. No equal

C. Breather/Drains
   1. Eaton Crouse-Hinds 316 stainless steel
      a. No equal

2.4 RACEWAY BOXES AND EQUIPMENT ENCLOSURES

A. The term box and enclosure are synonymous for this specification. Boxes and enclosures specified herein, include terminal boxes, junction boxes pull boxes, and boxes for switch, receptacles and lighting. Enclosures used for electrical and instrumentation equipment, other than terminal boxes, shall be provided as described in this section with references to this specification in other specification sections. All raceway boxes and equipment enclosures shall be provided with a common ground point and shall be UL rated.

B. NEMA Type 4X boxes shall be 316 stainless steel or aluminum only as otherwise specified or shown with mounting lugs or brackets welded on the box, suitable for wall mounting, or have mounting feet where self-standing. Boxes for wall-mounting shall have integral welded-on mounting lugs. Enclosures with mounting feet shall have the mounting feet brackets for the attachment of mounting feet welded on. Boxes manufactured with holes intended for mounting using bolted-on mounting lugs or feet are not acceptable. Drilling through the back of the box to mount is strictly prohibited. Drilled boxes shall be removed and replaced. All boxes shall have continuously welded seams ground smooth, and shall have continuous hinged, gasketed doors. Box bodies shall not be less than 16 gauge. Boxes larger than 24 inches X 20 inches shall have a three-point type latch with handle. Boxes 24 inches X 20 inches or smaller shall have 316 stainless steel luggage type quick release latches, or three-point latch system with all components 316 stainless steel. Latch systems requiring tools to open or close are unacceptable.

C. NEMA 4X 316 Stainless Steel enclosures
   1. Use for all locations unless otherwise shown or specified
   2. Type 316 stainless steel, body and door
   3. Stainless steel continuous hinge
   4. Foam in-place gasket
   5. Single point quarter turn latches (20-inch X 24-inch and smaller). All others shall have three-point
   6. Manufacturers
      a. Enclosures housing electrical equipment may be constructed by the manufacturer of that equipment but shall meet the all the physical requirements specified herein.
      b. Eaton Crouse Hinds
      c. Hoffman
      d. Appleton Electric
      e. EMF Company
      f. NEMA Enclosures Company
      g. Cooper B Line
      h. Rittal
      i. Approved equal

D. NEMA 4X Aluminum where shown on the Drawings boxes shall be constructed as follows:
   1. Type 5052 aluminum, body and door
   2. Stainless steel continuous hinge
   3. Foam in-place gasket
   4. Single point quarter turn latches (20-inch X 24-inch and below). All others three-point latch
   5. Manufacturers
      a. Enclosures housing electrical equipment may be constructed by the manufacturer of that equipment but shall meet the all the physical requirements specified herein.
      b. Hoffman
      c. EMF Company
      d. NEMA Enclosures Company

e. Cooper B Line
f. Approved equal

E. Chemical Rooms and areas specified or shown to be corrosive: NEMA 4X nonmetallic boxes shall be constructed as follows:
1. PVC or Fiberglass reinforced polyester body and door.
2. UV inhibitors
3. UL Listed
4. RoHS compliant
5. Formed in place polyurethane gasket in continuous channel.
6. 316 Stainless steel quarter turn cover bolts with metallic handles
7. Manufacturers
a. Enclosures housing electrical equipment may be constructed by the manufacturer of that equipment but shall meet the all the physical requirements specified herein.
b. Allied Molded Products, Inc.
c. Cantex
d. Cooper
e. Hoffman
f. Hubbell-Wiegmann Non-Metallic
g. Approved equal

F. Classified Areas, NEMA 7/4X boxes (Class 1, Division 1, Groups A, B, C, and D, or as defined in NFPA 70) shall be constructed as follows:
1. Copper free cast aluminum body and cover
2. Stainless steel hinges
3. Watertight neoprene gasket
4. Stainless steel quarter turn cover bolts with metallic handles
5. Manufacturers
a. Enclosures housing electrical equipment may be constructed by the manufacturer of that equipment but shall meet the all the physical requirements specified herein.
b. Eaton Crouse-Hinds
c. Appleton Electric
d. Approved equal

G. NEMA 12 boxes where shown on the Drawings shall be constructed as follows:
1. Type 5052 aluminum, body and door
2. Stainless steel continuous hinge
3. Foam in-place gasket
4. Single point quarter turn latches (20-inch X 24-inch and below). All others three-point latch
5. Manufacturers
a. Enclosures housing electrical equipment may be constructed by the manufacturer of that equipment but shall meet the all the physical requirements specified herein.
b. Hoffman
c. EMF Company

d. NEMA Enclosures Company
e. Cooper
f. Approved equal

H. NEMA 1 or NEMA 1A boxes shall not be used.

I. Malleable iron boxes shall not be used.

2.5 DEVICE BOXES

A. Device boxes installed in aluminum raceway systems for switches and receptacle, etc., shall be copper free cast aluminum, and shall have tapered, threaded, hubs, with integral bushings. Boxes shall have internal grounding screw, and a minimum of two mounting feet. Boxes shall be type FD.

B. Manufacturers
1. Eaton Crouse-Hinds
2. Appleton
3. Approved equal

2.6 CONDUIT OUTLET BODIES

A. Conduit outlet bodies and covers shall be Form 7, copper-free aluminum, with captive screw-clamp cover, neoprene gasket and stainless-steel screws and clamps for conduits up to and including 2-1/2 inches.

B. Manufacturers
1. Eaton Crouse-Hinds Form 7 with Mark 7 wedge-nut cover
2. Appleton
3. Approved equal

C. Provide junction boxes for conduits larger than 2-1/2 inches.

D. All outlet boxes and covers for Class 1 Division 2 areas shall be rated NEMA 4X.
1. Manufacturers
a. Eaton Crouse-Hinds EA Series
b. Approved equal

2.7 CONDUIT HUBS

A. Conduit hubs for use on raceway system pull and junction boxes shall be watertight, threaded aluminum, insulated throat, stainless steel grounding screw

B. Manufacturers
1. T&B H150GRA Series
2. Approved equal

C. Conduit hubs for use on outlet boxes or boxes containing electrical or instrumentation equipment shall be watertight, threaded steel, insulated throat, hub of the female-female type, with locking nipple of male construction. Hubs shall be T&B HT Series, or approved equal. Hubs with female locking nipples, where the hub projects into the box, will not be acceptable.

2.8 GROUNDING BUSHINGS

A. Grounding bushings shall be insulated lay-in lug grounding bushings with tin-plated copper grounding path. Bushings shall have integrally molded noncombustible phenolic insulated surfaces rated 150°C. Each bushing shall be furnished with a plastic insert cap. The size of the lug shall be sufficient to accommodate the maximum ground wire size required by the NEC for the application.

B. Manufacturers
   1. O-Z/Gedney Type ABLG
   2. Approved equal

2.9 RACEWAY SEALANT

A. Raceway sealant for use in the sealing of raceway hubs, entering or terminating in boxes or enclosures where such sealing is shown or specified, shall be 3M 1000NS Watertight Sealant, or approved equal.

2.10 CONDUIT PENETRATION SEALS

A. Conduit wall and floor seals
   1. O.Z./Gedney Co. Series CSM
      a. Type CSML-XXXP shall be used for all applications that do not require a recessed sealing bushing.
      b. Type CSMI-XXXP shall be used for all applications that require a recessed sealing bushing.
   2. Approved equal

2.11 EXPANSION-DEFLECTION COUPLING

A. Combination expansion-deflection fittings with 3/4-inch axial expansion and contraction movement, 3/4-inch parallel misalignment movement, and up to 30 degrees of angular movement in any direction. It shall be copper-free aluminum, with exterior tinned copper braid bonding jumper and 316 stainless grounding straps

B. Manufacturers
   1. Eaton Crouse-Hinds Model XD
   2. Approved equal

C. Provide an aluminum cover over the fitting to protect the rubber portions from exposure to direct sun light. Secure the aluminum sun shield with a minim of two stainless steel tie wraps.

D. Nylon tie wraps are not acceptable.

2.12 EXPANSION FITTINGS

A. Expansion fittings shall provide eight-inch movement, shall be made of copper-free aluminum, with exterior tinned copper braid bonding jumper and 316 stainless grounding straps. Provide internal grounding. Nylon tie wraps are not acceptable.

B. Manufacturers
   1. Eaton Crouse-Hinds Co. Type XJGSA
   2. Approved equal

2.13 EXPLOSION-PROOF SEALS, BREATHERS AND DRAINS

A. Explosion proof fittings shall be designed for Class 1 Division 1, Group D, hazardous locations. Fittings shall be copper-free aluminum, with seals, breathers and drains. Provide type ED, or as required for the application.

B. Manufacturers
   1. Eaton Crouse-Hinds Co.
   2. Appleton Electric Co.
   3. O.Z./Gedney Co.
   4. Approved equal

2.14 KELLEMS GRIPS

A. Kellems grips cables supports shall be 316 stainless steel.

2.15 CONDUIT MOUNTING EQUIPMENT

A. Pull and junction box supports, spacers, conduit support rods, clamps, hangers, channel, nut, bolts, washers, etc. and shall be 316 stainless steel. Nylon tie wraps are not acceptable.

2.16 CONDUIT IDENTIFICATION TAGGING

A. Tag all underground conduits at all locations exiting and entering from underground, including manholes and handholes.

B. Use the tagging formats for conduits as shown on the Drawings.

C. Use the tagging formats for conduits as shown on the Drawings. Where modifications or additions are made to existing equipment replace existing tags with new modified tags.

D. Conduit identification plates shall be embossed stainless steel with stainless steel band, permanently secured to the conduit without screws. Nylon tie wraps are not acceptable.

E. Identification plates shall be as manufactured by the Panduit Corp. or equal.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATIONS

A. Unless exact locations are shown on the Drawings, coordinate the placement of raceway systems and related components with other trades and existing installations.

B. Raceway Systems for the installation of Fiber Optic Cables shall not contain conduit bodies, device boxes, or raceway boxes containing less than twelve inches of bend radius.

C. Unless shown on the Drawings or specified otherwise, the raceway type installed with respect to the location shall be as follows, including all materials:

Raceway System	Location
1. Rigid Galvanized (RSC) Type	Not acceptable for use on this Project
2. PVC Coated Aluminum (CRMC) Type	All embedded raceway bends, underground duct bank bends of more than 20 degrees, and all raceway stub-ups to a minimum of six inches above finished floor or grade and in Chlorine and Caustic rooms.
3. Liquidtight Flexible Aluminum (LFMC) Type	Raceway connection to vibrating equipment, and as shown on the Drawings in all areas.
4. Rigid Non-metallic, Schedule 40 PVC (RNC) Type	Underground encased in red dyed reinforced concrete.
5. Rigid Non-metallic, Schedule 80 PVC (RNC) Type	For use only in Chlorine and Caustic Rooms.
6. Flexible Aluminum (FMC) Type	Fixture whip connection to lighting fixtures in NEMA 12 areas (maximum 3-feet). BX or AC type prefabricated cables are not permitted.
7. Aluminum Rigid Metal (RMC) Type	All above grade areas, except for concrete embedded and those areas described in Locations 2 through 6 above.

D. All conduit of a given type shall be the product of one manufacturer.

3.2 BOX APPLICATIONS

A. All raceway junction pull and terminal boxes and electrical equipment enclosures shall have NEMA ratings for the location in which they are installed, and as specified herein.

B. The distance between each raceway entry inside the box and the opposite wall of the box shall not be less than eight times the metric designator (trade size) of the largest raceway in a row. This distance shall be increased for additional entries by the amount of the sum of the diameters of all other raceway entries in the same row on the same wall of the box. Each row shall be calculated individually, and the single row that provides the maximum distance shall be used.

C. Provide cast aluminum conduit fittings for exposed switch, receptacle and lighting outlet boxes.

D. All raceway boxes and wall – mounted electrical equipment enclosures shall be provided with factory mounting integral welded mounting lugs. Bolt-on gasketed mounting lugs attached through factory-drilled holes are not acceptable for any raceway box or electrical equipment enclosure. Drilling through the back of any box or enclosure is prohibited, and if so installed, shall be removed and replaced, with no increase in the Contract Price or Construction Schedule.

E. No penetrations shall be made in the top of boxes or electrical equipment enclosures in wet locations.

F. Boxes for use only on concealed, above ground, interior electrical wiring, in air-conditioned administrative buildings remote to the process area, may be NEMA 1 galvanized boxes as specified for such areas. All boxes used in such areas, for exposed wiring, shall be NEMA 12 aluminum or 316 stainless steel as specified above.

3.3 DEVICE BOX APPLICATIONS

A. Device boxes shall be used for mounting wiring devices such as receptacles, switches, thermostats, lighting and other permanently mounted devices. All device boxes shall be installed with a minimum of 1/4-inch air space between the back of the box and the wall or back panel on which it is installed. The space may be created with enough 316 stainless steel washers to provide the required air space or may be mounted using 316 stainless steel slotted channel.

3.4 CONDUIT OUTLET BODIES APPLICATIONS

A. Conduit outlet bodies may be used on conduits up to and including 2-1/2 inches, except where junction boxes are shown or otherwise specified. For conduits larger than 2-1/2 inches, junction boxes shall be provided.

3.5 CONDUIT HUB APPLICATIONS

A. Unless specifically stated herein or described on the Drawings, all raceways shall terminate at an outlet with a conduit hub. Locknut or double locknut terminations will not be permitted.

B. When conduits contain equipment grounding conductors the wire shall be grounded to the hub(s) associated with that grounding conductor.

3.6 INSULATED GROUNDING BUSHING APPLICATIONS

A. Insulated grounding bushings shall be provided and used to terminate raceways where the raceways enter pad-mounted electrical equipment or switchgear from the bottom where there is no wall or floor pan on which to anchor or terminate the raceway.

B. All other raceways shall terminate on enclosures with a conduit hub, except for NEMA 7/4X areas.

C. Grounding bushing caps shall remain on the bushing until the wire is ready to be pulled.

3.7 CONDUIT FITTINGS APPLICATIONS

A. Combination expansion-deflection fittings shall be installed where conduits cross structure expansion joints, and where installed in exposed conduit runs such that the distance between expansion-deflection fittings does not exceed 150 feet of conduit run. Expansion-deflection fittings are acceptable in indoor locations out of exposure to direct sunlight or other outdoor locations which are shaded.

B. Expansion-deflection fittings are not acceptable for use outdoors unless approved in writing on a case-by-case basis from the Engineer/Owner. Where combination expansion-deflection fittings with exposed non-metallic sections, are approved by the Engineer/Owner for use where exposed to sunlight or other outdoor locations which are shaded, an aluminum wrap shall be installed loosely over the non-metallic portion, extending at least two inches beyond the ends. The wrap shall be loosely secured, to permit movement, with at least two 316 SS fasteners. Nylon tie-wraps are not acceptable.

C. Provide an expansion fitting with a minimum of six inches available movement shall be installed on the exposed side of under to above grade conduit transitions. Expansion-deflection fittings shall not be provided unless approved and protected as specified above.

3.8 CONDUIT PENETRATION SEALS APPLICATIONS

A. Conduit wall seals shall be used where underground conduits penetrate walls or at other locations shown on the Drawings.

B. Conduit sealing bushings shall be used to seal conduit ends exposed to the weather and at other locations shown on the Drawings.

3.9 EXPLOSION-PROOF SEALS, BREATHERS AND DRAINS APPLICATIONS

A. Fittings consisting of sealing fittings, breathers, drains, with sealing compound and fiber, as specified herein, shall be used as required to meet all the requirements of the National Electrical Code.

3.10 CONDUIT TAG APPLICATIONS

A. All conduits shall be tagged within one foot of the entry of equipment, and wall and floor penetrations.

B. Tag all underground conduits and ducts at all locations, exiting and entering from underground, including manholes and handholes.

3.11 RACEWAY SEALING

A. All raceways entering junction boxes, terminal junction boxes, electrical equipment enclosures or control panels containing electrical or instrumentation equipment shall be connected to the box, enclosure or panel using conduit hubs and shall be sealed with Raceway Sealant, as specified herein.

3.12 PVC RACEWAY TO PVC COATED ALUMINUM RACEWAY TRANSITIONS IN CONCRETE ENCASEMENT

A. Transitions from PVC raceway to PVC coated aluminum raceway in concrete encasements shall be made as follows:

1. Terminate the PVC conduit in a threaded PVC female adapter.
2. Terminate the PVC coated aluminum conduit in a threaded male adaptor.
3. Thread the male PVC-coated aluminum conduit adaptor into the female threaded PVC adapter.

B. Tighten the joint securely, then double layer wrap the joint with two-inch vinyl electrical tape for a distance of two inches each side of the threaded joint to prevent any contact between any exposed aluminum threads and concrete.

3.13 RACEWAY INSTALLATION

A. Do not install pull wires and conductors until the raceway system is in place. No wire shall be installed between outlet points, junction points or splicing points, until all raceway sections are complete, and all raceway covers are installed for protection of conductors from damage or exposure to the elements. Conductors installed into incomplete raceway systems are considered improperly installed and are in violation of the NEC. The occurrence of wire installed in an incomplete installation, shall require the removal of such conductors from the project site, and replacement of the conductors at with no increase in Contract Price or Schedule. The raceway system shall be completed and inspected by the Engineer/Owner, before new conductors are installed.

B. No conduit smaller than 3/4-inch electrical trade size, shall be used, nor shall any have more than the equivalent of three 90-degree bends in any one run. Pull boxes shall be provided as necessary. Conduit reducers which are the same type of the raceway shall be installed where manufacturer-provided enclosures are not available with conduit hubs larger than 1/2-inch at the enclosure to terminate 3/4-inch conduit. The raceway fill shall be adjusted to accommodate the smaller opening in the manufacturer-provided enclosure. Notify the Engineer/Owner prior to the installation of the raceway into enclosures with openings smaller than the specified minimum. Raceways installed without notice are considered unacceptable and may be required to be removed at the Engineer's/Owner's discretion with no increase in the Contract Price or Schedule allowed.

C. All raceways, installed underground, shall be installed in accordance with Section 26 05 43 Underground System, and be a minimum size of two-inch trade size unless otherwise shown in the plans.

D. Raceways entering or leaving the raceway system, which could be subjected to the entry of moisture, rain or liquid of any type, shall be tightly sealed, using 3M 1000NS Watertight Sealant, or approved equal at any possible moisture entry point both before and after the installation of cables to prevent the entry of water or moisture to the Raceway System at any time. Any damage to new or existing equipment, due to the entrance of moisture from unsealed raceways, shall be corrected by complete replacement of such equipment. No increase in the Contract Price or Schedule will be allowed. Cleaning or drying of such damaged equipment will not be acceptable.

E. Conduit supports, other than for underground raceways, shall be spaced at intervals of eight feet or less, as required by the NEC and as required to obtain rigid construction. Conduits shall be supported near the entry into any enclosure in accordance with the NEC. Conduits shall not be used to support other conduits, nor shall conduits be supported from cable tray.

F. Single conduits shall be supported by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the surface.

G. Multiple runs of conduits shall be supported on trapeze type hangers with horizontal members and threaded hanger rods. The rods shall be not less than 3/8-inch diameter. Multiple conduits mounted on walls shall be supported using strut and 316 stainless steel conduit clamps, screws, nuts and washers.

H. Surface mounted panel boxes, junction boxes, conduit, etc. shall be supported as specified herein.

I. Conduit hangers shall be attached to structural steel by means of beam or channel clamps. Where attached to concrete surfaces, anchors shall be as specified in Section 26 05 29 Electrical Support Hardware.

J. No electrical equipment enclosures, boxes, terminal junction boxes or raceways shall be attached to or supported from, sheet metal walls.

K. All conduits on exposed work shall be run at right angles to and parallel with the surrounding wall and shall conform to the form of the ceiling. No diagonal runs will be allowed. Bends in parallel conduit runs shall be concentric. Offsets in conduit runs shall all be done at the same point and shall all be the same angle, so the entire installation appears to be parallel or concentric at every point. All conduits shall be run perfectly straight and true.

L. Conduits terminated into enclosures shall be perpendicular to the walls where flexible liquid tight or rigid conduits are required. The use of short seal tight elbow fittings for such terminations will not be permitted, except for connections to instrumentation transmitters, where multiple penetrations are required.

M. Conduits containing equipment grounding conductors and terminating in boxes shall have insulated throat grounding bushings. The grounding conductor shall be grounded to the box.

N. Conduits shall be installed using threaded fittings. Running threads will not be permitted.

O. Provide glued type conduit fittings on PVC conduit.

P. Conduits installed which are not in compliance with these requirements shall be removed and reinstalled at the Engineer's/Owner's discretion. If conductors are installed when the improper installation is discovered, the conductors shall be removed from the raceway, discarded and removed them from the job site, replaced, re-terminated, retagged, and retested in accordance with the specifications. The function of the system shall be retested in its entirety. No increase in Contract Time or Schedule will be allowed.

Q. Liquid tight flexible metallic conduit shall be used for the primary and secondary of transformers, generator terminations and other equipment where vibration is present. Use in other locations is not permitted, except for connections to instrumentation transmitters, where multiple penetrations are required. Liquid tight flexible metallic conduit shall have a maximum length not greater than that of a factory manufactured elbow of the conduit size being used. The maximum bending radius shall not be less than that shown in the NEC Chapter 9, Table 2, "Other Bends". BX or AC type prefabricated cables will not be permitted.

R. Seal the remaining openings or spaces of conduits passing through openings in walls or floor slabs to prevent the passage of flame or smoke where additional openings or space around the conduits are present.

S. Conduit ends exposed to the weather or corrosive gases shall be sealed with conduit sealing bushings.

T. Raceways terminating in Control Panels or enclosures outdoors or any wet or damp location or any location where plant process equipment is located, or any location not otherwise specifically designated as a dry electrical room, control room or office space, which contain electrical equipment or terminal blocks, shall not enter from the top of the enclosure. The raceways shall be sealed with a watertight sealant as specified herein. Enclosures entered from the top where top entry is prohibited, will be rejected and shall be removed and replaced regardless of the Division which contains the specification for the enclosure. The use of UL Listed conduit closures to restore the NEMA rating of the enclosure will not be accepted. Conduit entering the top of the enclosures shall be removed and re-routed to enter the enclosure from the side or bottom. Conductors installed in top entering conduits shall be pulled back to the nearest conduit body or junction box and re-routed with the conduit, provided the conductors are long enough to be re-terminated. Conductors found to be insufficient in length to be re-terminated shall be completely removed and replaced, re-tested, re-tagged, re-tested and the control function of the panel shall be re-tested. If the enclosure is provided by an OEM, the enclosure and its contents shall be returned to the OEM for a new enclosure. No increase in Contract Price nor increase in Contract Time will be allowed the Contractor for making these corrections.

U. All conduits from external sources entering or leaving a multiple compartment enclosure shall be stubbed up into the bottom horizontal wire way or other manufacturer designated area, directly below the vertical section in which the conductors are to be terminated. Conduits entering from cable tray shall be stubbed into the upper section.

V. Conduit sealing and drain fittings shall be installed in areas designated as NEMA 4X or 7 and all wet locations.

W. A conduit identification plate shall be installed on all power, instrumentation, alarm and control conduits at each end of the run and at intermediate junction boxes, manholes, etc. Conduit plates shall be installed before conductors are pulled into conduits. Exact identification plate location shall be coordinated with the Owner/Engineer at the time of installation to provide uniformity of placement and ease of reading. Conduit numbers shall be exactly as shown on the Drawings.

X. Mandrels shall be pulled through all existing conduits that will be reused and through all new conduits two inches in diameter and larger prior to installing conductors.

Y. 3/16-inch polypropylene pull lines shall be installed in all new conduits noted as spares or designated for future equipment.

Z. All conduit that may under any circumstance contain liquids such as water, condensation, liquid chemicals, etc. shall be arranged to drain away from the equipment served. If conduit drainage is not possible, conduit seals shall be used to plug the conduits at the point of attachment to the equipment.

AA. Conduits shall not cross pipe shafts, access hatches or vent duct openings. They shall be routed to avoid such present or future openings in floor or ceiling construction.

BB. The use of running threads is prohibited. Where such threads are necessary, a three-piece union shall be used.

CC. Conduits passing from heated to unheated spaces, exterior spaces, refrigerated spaces, cold air plenums, etc. shall be sealed with Watertight Sealant as specified herein.

DD. Conduits shall be located a minimum of three inches from steam or hot water piping. Where crossings are unavoidable, the conduit shall be kept at least one inch from the covering of the pipe crossed.

EE. Conduits terminating at a cable tray shall be supported independently from the cable tray. Provide a conduit support within one foot of the cable tray. The weight of the conduit shall not bear on the cable tray.

FF. Conduits entering the top of electrical equipment enclosures from cable tray or otherwise routed from above the equipment in airconditioned dry indoor spaces shall coordinate their placement with the HVAC duct vents such that cold air from the HVAC system will not blow directly on the vertical conduits causing condensation. Conduits which cannot be located away from direct exposure to cold air from the HVAC system shall be insulated to prevent condensation from forming inside the conduits or shall be re-routed. In all cases, condensation caused by cold air from the HVAC system shall be prevented from entering electrical enclosures. Equipment damaged by water from condensation shall be removed, replaced, conductors re-terminated, and its operation retested with no change in the contract price or schedule.

GG. All changes of direction on PVC coated conduit greater than 20 degrees shall be accomplished using long radius bends. Any field bends shall be made using equipment designed to prevent damage to the PVC coating.

END OF SECTION

SECTION 26 05 43
UNDERGROUND SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install a complete underground system of raceways, manholes and handholes as shown on the Drawings and as specified herein.

B. Raceways for use in structural concrete is specified in Section 26 05 33 Raceways, Boxes and Fittings.

1.2 RELATED WORK

A. No references are made to any other section which may contain work related to any other section. The Contract Documents shall be taken as a whole with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or additional work as may be required in those references, and include such information or work as may be specified.

B. Other Divisions

1. The Contractor shall be responsible for examining all Sections of the Specifications and Drawings, and shall determine the power and wiring requirements and shall provide external wiring and raceways, as required to provide a fully functioning power, control and process control systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, the Contractor shall furnish the additional conductors, raceways and/or wiring, with no change in the Contract Price, and with no increase in Contract Time.

1.3 SUBMITTALS

A. Submit to the Engineer, in accordance with Division 1 and Section 26 00 00, shop drawings and product data, for the following:

1. Manholes, handholes and associated hardware.
2. Plastic duct spacers

B. Submittals shall also contain information on related equipment to be furnished under this Specification but described in the related Sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will be returned unreviewed.

1.4 REFERENCE CODES AND STANDARDS

A. All products and components shown on the Drawings and listed in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. NFPA 70 – National Electrical Code (NEC)
2. NFPA 70E – Standard For Electrical Safety in the Workplace
3. ASTM A615/A615M-06a – Standard Specification for Deformed and Plain Carbon-Steel Bars for concrete Reinforcement
4. ASTM A48 – Standard Specification for Gray Iron Castings
5. ASTM A536 - Standard Specification for Ductile Iron Castings
6. AASHTO M306-04/ ASTM A48 – Drainage Structure Castings, Section 7.0 Proof Load Testing
7. ASTM C-850- Specifications for underground precast concrete utility structures
8. ANSI-ASC A14.5 American National Standard for Ladders – Portable Reinforced Plastic – Safety Requirements

B. All excavation, trenching, and related sheeting, bracing, etc., as shown on the Drawings and listed in these Specifications, shall comply with the following standards (unless otherwise noted):

1. Occupational Safety and Health Administration (OSHA)
   a. Excavation safety standards (29 CFR Part 1926.650 Subpart P) - Excavation.
2. American Society for Testing and Materials (ASTM)
   a. ASTM D 698a – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600kN-m/m3)).

C. All equipment components and completed assemblies specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.5 QUALITY ASSURANCE

A. The manufacturer of these materials shall have produced similar electrical materials and equipment for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The precast manholes shall be manufactured in a NPCA (National Precast Concrete Association) Certified Plant.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, onsite factory work, or failed factory tests will not be permitted.

B. Materials shall be handled and stored in accordance with manufacturer's instructions.

C. Materials shall not be stored exposed to sunlight. Such materials shall be completely covered.

D. Materials showing signs of previous or jobsite exposure will be rejected.

1.7 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for one year from date of final acceptance of the equipment. Within such period of warranty, the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment, or materials shall be performed by the Contractor at no expense to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Raceway System

1. Raceway system shall be Schedule 40 except for Primary Electrical Service which shall be schedule 80, PVC Rigid Nonmetallic Conduit (RNC), designed for use aboveground and underground as described in the NEC, resistant to sunlight. The conduits and fittings shall be manufactured to NEMA TC-2, Federal Specification WC1094A and UL 651 specifications. Minimum raceway size shall be 2 inch. Fittings shall be manufactured to NEMA TC-3, Federal Specification WC1094A and UL 514B. Conduit shall have a UL Label. Conduit shall be Carlon, Kraloy, or approved equal.
2. PVC coated rigid aluminum conduit shall have a minimum 0.040-inch thick, polyvinyl chloride coating permanently bonded to rigid aluminum conduit and an internal chemically cured urethane or enamel coating. The ends of all couplings, fittings, etc. shall have a minimum of one pipe diameter in length of PVC overlap. PVC coated conduit and fittings shall be as manufactured by Perma-Cote, Robroy Industries, Calbond or Ocal. Any field bends shall be made using equipment designed to prevent damage to the PVC coating.
3. All underground raceways of the underground system, terminating in manholes or handholes shall use terminators of the same size and type as the raceway
4. Blank Duct Plugs shall be sized for the duct installed on, and shall be TYCO Type JM-BLA-XXDXXXCR, with rubber gasket, or approved equal.
5. Duct spacers shall be as manufactured by Carlon or equal.
6. Where raceways terminate into existing and new manholes, handholes or structures, the duct bank steel shall be anchored into the manhole, handhole or structure with a Hilti HIT 150 MAX epoxy anchoring system. The termination of the duct bank steel shall utilize a minimum 24-inch length of reinforcing bar anchored not less than four inches into the manhole, handhole or structure wall, and lapped into each reinforcing bar in the duct bank.
7. Concrete encasement for raceways and duct banks shall be normal weight concrete weighing not more than 145 pounds per cubic foot with compressive strength, a minimum of 3000 pounds per square inch, or greater if required by other Divisions of the Specifications, at 28 days, Concrete shall have crushed aggregate with a maximum size of 3/4-inch, a slump of four to six inches and flow freely without the use of vibrators. Install red dye of 40 pounds per 10 cubic yards. of concrete, installed in the truck at the concrete plant.
8. Reinforcing steel shall comply with ASTM A615 Grade 60 and of a size and installation as shown on the Drawings.

B. Manholes and Handholes

1. General
   a. Manholes and handholes shall be of the precast concrete type, designed for a Class H20 load with sizes as shown on the Drawings, and as manufactured by Oldcastle Precast, Mansfield, TX, or approved equal.
2. Construction
   a. Concrete for manholes and handholes shall have a 28-day compressive strength of 5000 PSI. Cement shall be Type 1 or III. Reinforcing steel shall be Grade 60 with minimum yield strength of 60,000 PSI. Design loadings shall be H-20-44 w/impact.
   b. The top of all manholes shall be field removable and have stainless steel lifting eyes.
   c. Duct bank entries into the manhole or handhole shall be centered on the entering wall, and shall contain the appropriate number and size of duct terminators to match the corresponding duct bank.
   d. Each manhole and handhole shall have a minimum size of 1 inches by 12 inches by 2 inches deep concrete sump in the middle of the floor of the manhole or handhole, or as shown on the Drawings.
3. Manhole Covers
   a. Unless otherwise shown on the Drawings, manhole and handhole covers shall be heavy duty 36-inch machined gray iron, and AASHTO M306-04/ ASTM A48 CL35B Minimum, 40,000-pound proof load value (Class H20 X 2.5) "True Traffic" load covers, complete with frame, and "Electric" or "Communication" raised lettering recessed flush, as required, on the cover. Covers shall be V-1600-5, with drop handles as manufactured by East Jordan Iron Works, Ardmore, OK
   b. All castings shall be made in the USA, cast with the foundry's name, part number, "Made in USA", and production date (example: mm/dd/yyyy). Castings without proper markings will be rejected. Manufacturer shall certify that all castings conform to the ASTM and AASHTO Designations as specified herein. All casting shall be true to pattern in form and dimension, free from pouring faults, sponginess, cracks, blow holes and other defects in positions affecting strength and value for the service intended. Angles shall be filleted, and arises shall be sharp and true.
4. Access Hatch
   a. Where access hatches are shown on the Drawings, hatches shall be heavy duty aluminum, for H-20 load rating, sized as shown on the Drawings. Hatches shall be CHS Series as manufactured by East Jordan Iron Works, Ardmore, OK.
   b. Material shall be 6061-T6 aluminum for bars, angle and extrusions. 1/4-inch diamond plate shall be 5066 aluminum.
   c. Unit shall have a heavy duty pneumatic-spring, for ease of operation when opening cover. Cover shall be counter-balanced so that one person can easily open the hatch door.
   d. Frame shall be of extruded aluminum with a continuous 1-1/4 inch anchor flange. A dovetail groove shall be extruded into the seat of the frame with a 1/8" silicone gasket.

e. Hinges shall be of heavy-duty design, the material shall be grade 316 stainless steel, with a 3/8-inch grade 316 stainless steel pin. Hinge shall be bolted to the channel frame and diamond plate with grade 316 stainless steel bolts and nylon lock nuts. Aluminum shall be supplied with mill finish. Exterior of frame which comes in contact with concrete shall have one coat black primer.

f. Each hatch shall be supplied with a stainless steel slam lock, with the keyway protected by a threaded aluminum plug. The plug shall be flush with the top of the 1/4-inch diamond plate. The slam lock shall be fastened with grade 316 stainless steel bolts and washers.

g. Each hatch shall be equipped with a stainless steel lift handle. Lift handles shall be flush with top of 1/4-inch diamond plate.

h. Each hatch shall be supplied with a 1-1/2-inch threaded drain coupler on underside of channel frame for pipe connection.

5. Hardware

a. Cable racks shall be of the heavy duty non-metallic type with arm lengths of 8 inches, 14 inches, and 20 inches, each supporting a load of not less than 250 pounds at the outer end. Racks shall be molded in one piece of U.L. listed glass reinforced nylon, Catalog CR36N with RA08N, RA14N and RA20N arms as manufactured by Underground Devices Inc. Northbrook, IL. Cable racks shall be secured to the manhole and walls by drilled, Hilti HIT-HY 150 MAX epoxy anchoring system, with Hilti 316 stainless steel bolts. Arms for racks shall be vertically spaced not greater than 24 inches on centers.

b. Pulling irons shall be of copolymer polypropylene coated 1/2-inch diameter cable, with a rated pulling strength of 7500 pounds and a polyethylene pulling iron pocket, all recessed in the manhole wall opposite each duct entry. Pulling irons for handholes shall have the pulling iron located in the floor of the handhole near the center of the handhole opposite the duct entry. Pulling irons shall be as manufactured by M.A. Industries, Inc. Peachtree, GA. or Bowco Industries, Portland OR.

c. Manhole and handhole ladders shall be constructed of fiberglass reinforced plastic, safety yellow, 18-inch rung width with 12-inch rung spacing, rated for 375 pounds. Furnish a total of two ladders, each of a length four feet greater than the deepest manhole in the underground system.

C. Polyethylene Warning Tape

1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   a. Brady Detectable Identoline
   b. Approved Equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
3. Warning tape shall be metal detectable polyester with subsurface graphics, black letters on red tape. The tape shall meet the OSHA 1926.956(c)(1), two-inch minimum width, for location tracing.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall field verify the routing of all underground duct banks before placement. He shall modify the routing as necessary to avoid underground utilities or above ground objects. Modification or rerouting for the convenience of the Contractor, or to reduce the length of duct run as designed, will not be permitted. The Contractor shall provide any alternate routing of the duct banks to the Owner/Engineer and, after approval, shall proceed with the installation.

B. All changes of direction, less than 20 degrees, shall be made using a hotbox, strictly in conformance with the conduit manufacturer's instructions. Changes of direction greater than 20 degrees shall be accomplished using long radius bends of PVC coated rigid aluminum conduit.

C. The Contractor shall saw cut and repair existing pavements above new and modified existing duct banks. The Contractor shall provide the alternate routing of the duct banks to the Owner/Engineer and after approval shall proceed with the installation.

D. Install raceways to drain away from buildings. Raceways between manholes or handholes shall drain toward the manholes or handholes. Raceway slopes shall not be less than 3 inches per 100 feet.

E. Reinforce raceway banks as shown on the Drawings.

F. A #4/0 stranded bare tinned copper ground conductor shall be installed along the top of the rebar cage, as shown on the Drawings, for the full length of each duct run between manholes and handholes, and bonded to a ground rod in the vicinity of each manhole and handhole.

G. Lay raceway lines in trenches on compacted earth as specified herein.

H. Use plastic spacers located not more than four feet apart to hold raceways in place. Spacers shall provide not less than two-inch clearance between raceways.

I. The minimum cover for raceway banks shall be 24 inches unless otherwise permitted by the Owner/Engineer.

J. Raceway terminations at all manholes, existing and new, shall be with terminator for PVC conduit.

K. Blank duct plugs shall be used to seal the ends of all unused ducts in the duct system. Plugs shall be installed at all locations where the ducts enter and leave the manholes or handholes, and all entrances and exits to the underground system.

L. Where raceways enter or exit the Underground System, and the raceways rise to a higher elevation upon entering or leaving the System, such raceways shall be tightly sealed at the higher elevation, both before and after the installation of cables, such that there shall be no entry of water or moisture to the Underground System at any time. Raceways shall be sealed with 3M 1000NS Watertight Sealant, or approved equal.

M. No wire shall be pulled until the duct system has been completed in every detail.

N. Swab all raceways clean before installing cable.

O. Train cables in manholes and handholes and support and restrain them on cable racks. All cables passing manhole duct entrances in the manhole or handhole shall pass above all duct entrances. No cable shall pass in front of or below duct bank entrances.

P. Polyethylene Warning Tape shall be installed in the trench above each raceway or duct bank and located at the elevations shown on the Drawings.

Q. The Contractor shall tag all underground conduits at all locations, exiting and entering from underground, including manholes and handholes.

R. The minimum raceway size shall be 2-inch unless otherwise shown on the plans.

3.2 TRENCH EXCAVATION

A. The excavation shall extend to the width and depth as shown on the Drawings, or as specified, and shall provide suitable room for installing manholes, handholes, ducts and appurtenances.

B. Furnish and place all sheeting, bracing and supports.

C. Excavation shall include material of every description and of whatever substance encountered, regardless of the methods or equipment required to remove the material. Pavement shall be cut with a saw, wheel or pneumatic chisel along straight lines before excavating.

D. The Contractor shall strip and stockpile topsoil from grassed areas crossed by trenches. At the Contractor's option, topsoil may be otherwise disposed of and replaced, when required, with approved topsoil of equal quality.

E. While excavating and backfilling is in progress, traffic shall be maintained, and all utilities and other property protected, as provided for in the Contract Documents.

F. Materials shall be excavated to the depth indicated on the Drawings and in widths sufficient for installing manholes and laying the ducts. Coordinate the trench width the Details shown on the Drawings. The bottom of the excavations shall be firm and dry in all respects acceptable to the Owner/Engineer. Trench width shall be a practical minimum, but not less than 6 inches greater on each side, than the total duct section arrangement, including reinforcing steel.

G. Excavation and dewatering shall be accomplished by methods which preserve the undisturbed state of sub grade soils. The trench may be excavated by machinery to, or just below, the designated sub grade, provided that material remaining in the bottom of the trench is no more than slightly disturbed. Sub grade soils which become soft, lose or otherwise unsatisfactory as a result of inadequate excavation, dewatering or other construction methods, shall be removed and replaced by gravel fill, of aggregate as specified herein, as required by the Owner/Engineer at the Contractor's expense.

3.3 EXCAVATION BELOW GRADE AND REFILL

A. Regardless of the nature of unstable material encountered, or the groundwater conditions, trench and excavation drainage shall be complete and effective.

B. If deemed necessary by the Owner/Engineer, or as shown on the Drawings, the Contractor shall be required to deposit pea gravel for duct bedding or gravel refill for excavation below grade, directly on the bottom of the trench immediately after excavation has reached the proper depth and before the bottom of the trench has become softened or disturbed by any cause whatsoever. All excavation shall be made in open trenches. Gravel used for this purpose, shall be aggregate, as specified that is no larger than one-half the minimum clear spacing between electrical ducts, and a maximum coarse aggregate size of 3/4-inch.

3.4 BACKFILLING

A. Remove from the excavation all materials which the Owner/Engineer may deem unsuitable for backfilling.

B. Backfilling shall not commence until, not less than 48 hours after placing of any concrete embedment, have lapsed.

C. Where the duct banks are laid in the yard, the remainder of the trench, after concrete encasement, shall be filled with common fill material, void of rock or other non-porous material, in layers not to exceed eight inches in loose measure and compacted to 90% standard Proctor density at optimum moisture content of +/- 4%. The backfill shall be mounded six inches above the existing grade or as directed by the Owner/Engineer. Where a grass, loam or gravel surface exists prior to excavations in the yard, it shall be removed, conserved and replaced to the full original depth as part of the work under the duct items. In some areas, it may be necessary to remove excess material during the cleanup process, so that the ground may be restored to its original level and condition.

D. Where the duct banks are laid in paved areas or designated future paved areas, existing or designated future structures, or other existing or future utilities, the remainder of the trench above the encasement, shall be backfilled with select common fill or select fill material in layers not to exceed eight inches loose measure and compacted at optimum moisture content (+/- 3%) to 95% standard Proctor density.

E. Compaction shall be by use of hand or pneumatic tamping with tools weighing at least 20 pounds. The material being spread and compacted shall be placed in layers not over eight inches loose thick. If necessary, sprinkling shall be employed in conjunction with rolling or ramming.

F. Bituminous paving shall not be placed in backfill.

G. Water jetting will not be accepted as a means of consolidating or compacting backfill.

H. All road surfaces shall be broom finished and hose-cleaned immediately after backfilling. Dust control measures shall be employed at all times.

3.5 RESTORING TRENCH AND ADJACENT SURFACES

A. In paved areas, the edge of the existing pavement to be removed shall be cut along straight lines, and the pavement replaced with the same type and quality of the existing paving.

B. In sections where the duct bank passes through grassed areas, the Contractor shall, at his own expense, remove and replace the sod, or shall loam and reseed the surface to the satisfaction of the Owner/Engineer.

3.6 CLEANING

A. Remove all rubbish and debris from inside and around the underground system. Remove dirt, dust, or concrete spatter from the interior and exterior of manholes, handholes and structures, using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

END OF SECTION

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SECTION 26 05 50
NEMA FRAME INDUCTION MOTORS, 600 VOLTS AND BELOW

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide electric motors, accessories, and appurtenances complete and operable, in conformance with the individual driven equipment specifications and other sections of the Contract Documents.

B. The provisions of this Section shall apply to all low voltage NEMA Frame AC squirrel cage induction motors, except as indicated otherwise.

1.2 RELATED WORK

A. No references are made to any other section which may contain work related to any other section. The Contract Documents shall be taken as a whole with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or additional work as may be required in those references, and include such information or work as may be specified.

B. Other Divisions

1. The Contractor shall be responsible for examining all Sections of the Specifications and Drawings, and shall determine the power and wiring requirements and shall provide external wiring and raceways, as required to provide a fully functioning power, control and process control systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, the Contractor shall furnish the additional conductors, raceways and/or wiring, with no change in the Contract Price, and with no increase in Contract Time.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of the process equipment division of these Specifications, and as specified herein. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project. Unmarked cut sheets will be cause to reject the submittal and return it for revision.

B. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned without review.

C. Submittals shall also contain information on related equipment to be furnished under this Specification and described in the related sections listed in Related Work above. If Section 26 05 73 Power System Study is listed in the Related Work Sections listed above, a Certification shall be provided as part of the submittal, certifying that all settings and adjustments have been made on the accompanying Submittals. Incomplete submittals not containing the required information on the related equipment will be returned as "INCOMPLETE SUBMITTAL – REJECTED. No portion of an INCOMPLETE SUBMITTAL will be Approved or reviewed.

D. The following information shall be submitted with the motor drawings for review.
   1. Name of Drive
   2. Horsepower of Motor
   3. Phase
   4. Efficiency at 1/2, 3/4 and full load
   5. Voltage
   6. Power Factor at 1/2, 3/4, and full load
   7. Speed
   8. NEMA Design Starting Torque
   9. NEMA Frame and Dimensions
   10. Full Load Current
   11. Locked Rotor Current
   12. Insulation Class
   13. Temperature Rise at 1.0 Service Factor
   14. Enclosure
   15. Bearing design life
   16. Special features (i.e., space heaters, RTDs, oversize conduit box and corrosion resistant features).
   17. Nameplate Drawing with Information as listed herein.
   18. Lugs and connectors.
   19. Maximum power factor correction capacitor kVAR that can be switched with the motor.

E. Suppliers of fractional horsepower motors below frame 143T will not be required to submit operational characteristics.

F. Factory Tests. Submittals shall be made for factory tests as specified above.

G. Field Test Reports. Submittals shall be made for field tests specified herein.

H. Operation and Maintenance Manuals.
   1. Operation and maintenance manuals shall include the following information:
      a. Manufacturer's contact address and telephone number for parts and service.
      b. Instruction books and/or leaflets
      c. Recommended renewal parts list
      d. Record Documents for the information required by the submitted motor information above.

1.4 REFERENCE STANDARDS

A. Motors shall be designed, built, and tested in accordance with the latest revision of the following standards:

1. National Electrical Manufacturers Association Inc. (NEMA)
   a. NEMA MG-1 - Motors and Generators.
   b. NEMA MG-1 Part 9 – Sound Power Limits and Measurement Procedures.
   c. NEMA MG-2 - Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.
2. National Fire Protection Association (NFPA)
   a. NFPA-70 - National Electrical Code.
3. Underwriters Laboratories, Inc. (UL)
   a. UL-1004 - Electric Motors.
4. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
   a. IEEE Std. 1 - General Principles for Temperature Limits in the Rating of Electric Equipment.
   b. IEEE Std 43 - Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
   c. IEEE Std. 112 – Standard Test Procedure for Polyphase Induction Motors and Generators.
   d. IEEE Std. 275 - Recommended Practice for Thermal Evaluation of Insulation Systems for AC Electric Machinery Employing Form-wound Pre-insulated Stator Coils, Machines Rated 6,900 V and Below.
   e. IEEE Std. 429 - Standard Test Procedure for the Evaluation of Sealed Insulation Systems for AC Electric Machinery Employing Form-wound Stator Coils.
   f. IEEE Std. 1349 – Guide for the Application of Electric Motors in Class 1, Div 2 Hazardous Locations.
5. Anti-Friction Bearing Manufacturer's Association Inc. (AFBMA):
   a. AFBMA-9 & 11 - Load Ratings and Fatigue Life for Roller Bearings.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.5 DEFINITIONS

A. Motors specified herein are three-phase, squirrel cage induction type for 1/2 HP and above, and single phase for less than 1/2 HP, except as specifically specified elsewhere in these Specifications.

B. The word "Drive" shall be construed to mean the driven equipment, i.e. pump, hoist, fan, compressor, or adjustable frequency drive connected with the motor.

C. If there is inconsistency of size on different Drawing sheets or between Drawings and other sections of Specifications, relating to the horsepower designation, then the larger size shall be required.

1.6 QUALITY ASSURANCE

A. Motor Compatibility. The Contractor shall satisfy himself that the motor included with the drive is compatible with driven equipment and complies with these Specifications. In the event that the motors described in these Specifications cannot be applied to the application or equipment offered, the Contractor may submit an exception, stating clearly the deviations and the reasons for such deviations. The acceptance or rejection of such deviations shall be at the sole discretion of the Owner/Engineer.

B. When motors are furnished with driven equipment, the driven equipment supplier shall be responsible for mounting the motor and driven equipment as a complete unit, correctly aligned and coupled with the coupling or sheave specified on the driven equipment data sheet, and for designing vibration, special, or unbalanced forces resulting from equipment operation.

C. Motors manufactured more than 24 months prior to the date of this Contract will not be acceptable. Date of manufacture, of each motor shall be on the nameplate.

1.7 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will not be permitted.,

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the Contractor and Owner. The instructions shall include detailed assembly instructions including but not limited to wiring interconnection diagrams, rigging for lifting, skidding, jacking and moving using rolling equipment to place the equipment, bolt torqueing requirements for bus and all other components which require the installation of bolted connections, and instructions for storing the equipment prior to energizing.

C. Protect equipment during shipment, handling, and storage by suitable complete enclosures. Protect equipment from exposure to the elements and keep thoroughly dry.

D. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repaint damaged painted surfaces to the satisfaction of the Owner/Engineer.

E. If motors are shipped as an integral part of the associated mechanical equipment, the motors shall be stored and handled in accordance with the manufacturer’s instructions

F. If motors are shipped separately, the motor shall be installed in its permanent, finished location shown on the Drawings within 14 calendar days of arriving onsite. If the equipment cannot be installed within 14 calendar days, the equipment shall not be delivered to the site, but stored offsite, at the Contractor’s expense, until such time that the site is ready for permanent installation of the equipment. Motors stored off site shall not be included in any pay applications. Payment for motors will not be allowed until delivered to the job site.

G. Provide temporary electrical power and operate space heaters, during storage and after motors are installed in permanent location, until equipment is placed in service. Unless stored in a heated air-conditioned space, space heaters shall be energized within 24 hours of arrival. Failure to energize space heaters as required shall constitute improper storage and the motors are subject to rejection and are subject to be returned to the Factory for inspection and re-testing. Improperly stored motors may be inspected and tested in the field. The choice to return equipment or conduct an inspection and test in the field lie solely with the Engineer / Owner. No pay applications for improperly stored motors will be accepted prior to receiving the manufacture's report of inspection, testing and certification that the motors are acceptable for installation with full warrantee still in force. All expenses to return and re-ship to the job site or inspect and test in the field shall be borne by the Contractor with no change in Contract Price or Contract Time allowed.

H. The motor shaft shall be rotated on a monthly basis, if such is recommended or required by the motor manufacturer; the date recorded, and copies of the record provided to the Owner/Engineer and the manufacturer. The manufacturer shall confirm receipt of the rotation record.

1.8 WARRANTY

A. Where the equipment manufacturer furnishes the motor and control as an integral part of the equipment package, the motor(s) shall have the same warranty as the equipment package. For all other motors, the motor manufacturer shall warrant the motor to be free from defects in material and workmanship for not less than three years from date of final acceptance of the associated equipment. Within such period of warranty, the Manufacturer shall promptly furnish all material and labor necessary to return the motor to new operating condition. Any warranty work requiring shipping or transporting of the motor shall be performed by the motor manufacturer, at no expense to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. General Electric
   2. TECO – Westinghouse
   3. Baldor Reliant

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.2 GENERAL REQUIREMENTS

A. Each motor provided shall have an Identification Tag Number, conforming to the numbering system and equipment name shown on the Drawings.

B. Specific motor data such as horsepower, speed, enclosure type, etc., is specified under the detailed specification for the mechanical equipment with which the motor is supplied.

C. The motor manufacturer's nameplates shall be engraved or embossed on stainless steel and fastened to the motor frame with stainless steel screws or drive pins. Nameplates shall indicate clearly all of the items of information enumerated in NEMA Standard MG-1, as applicable, including but not limited to the following information:

1. Horsepower (output).
2. RPM at full load.
3. Time rating.
4. Frequency.
5. Number of phases.
6. Model number.
7. Rated voltage.
8. Service factor.
9. Full load amps.
10. Insulation class.
11. NEMA design letter.
12. NEMA code letter.
13. Temperature Rise at 1.0 Service Factor.
14. NEMA Frame size.
15. Motor Weight
16. Date of manufacture.
17. Thermal protection (if supplied).
18. Nominal Efficiency
19. Enclosure

D. Where frequent starting occurs, the design for frequent starting duty shall be equal to the duty service required by the driven equipment.

E. Hazardous Environments

1. Motors located in hazardous classified areas shall be provided with a box for potting compound to seal connections in accordance with NEMA MG 1.
2. Class I, Division 1: Totally-enclosed fan-cooled, explosion-proof, UL listed and labeled. Motors shall be UL rated for operation with VFD units for VFD applications.
3. Class I, Division 2: Motors shall comply with IEEE 1349 for construction and temperature rise.
4. Class II, Division 1, Groups E, F, and G: Totally enclosed fan-cooled, dust-ignition proof, UL listed and labeled.
5. Class III: Totally enclosed fan-cooled. Motor shall be capable of operating at full rating without exceeding the maximum surface temperatures as limited by NEC 503.

F. Altitude: Under 3300 feet. For applications above 3300 feet, motors shall be specifically designed and certified for operation at the specific altitude.

G. Motors shall have sufficient horsepower and torque capacity to drive the equipment without overloading under all conditions, without exceeding the nameplate rating of the motor and without use of the service factor.

H. Motors shall have a breather drain in each end bracket of the TEFC motor enclosure. Stainless steel automatic breather drains shall be provided in the lowest part of both end brackets to allow drainage of condensation.

I. Motors shall be slide rail mounted for all belt or chain-driven applications.

J. Air inlets and outlets shall be protected by vermin-proof, corrosion resistant louvers. The air inlets shall be located on end or side as required by the application.

K. Motors shall have an oversized, gasketed, cast iron conduit box, field adjustable in 90-degree increments unless the box contains equipment, diagonally split with tapped NPT threaded conduit entrance hole, and shall exceed the minimum volumes defined in IEEE 841-2001. Neoprene conduit box cover gasket and neoprene lead seal gasket with flexible nipples to ensure the seal is maintained as the leads are moved shall be furnished. Provision for grounding shall be provided in the conduit box utilizing a mounted clamp-type lug. Provide the size and number of threaded conduit openings or integral conduit hubs for the conduits containing the motor power conductors. Provide one hole lugs for connection to conductors #12 AWG through #8 AWG. Provide termination pads to terminate NEMA two-hole long barrel lugs for conductors #6 AWG and larger.

L. Motor frames, end brackets, and conduit box shall be of cast-iron.

M. Provide lifting lugs on the motor frame.

N. Motors shall be NEMA Design B standard, unless otherwise specified in the process equipment division of these Specifications.

O. Service factor shall be 1.15 for all motors.

1. In sizing motors, no portion of a motor’s service factor above 1.0 shall be used in normal continuous operation of the motor.

P. Motors shall be of the Energy Efficient type, and shall meet or exceed efficiencies as listed in the Table at the end of this Specification. (Part 4)

Q. All motors shall be continuous time rated suitable for operation in a 40°C ambient, unless specified otherwise in the process equipment division of these Specifications.

R. Unless otherwise indicated or specified, motors shall be totally enclosed fan cooled (TEFC), for all applications. See the process equipment division of these Specifications for pumps and other equipment that require additional enclosure requirements.

S. All TEFC Motors shall have corrosion resistant enclosures, fan, cover, epoxy paint, corrosion resistant fittings and stainless steel or aluminum nameplates similar to “Mill and Chemical”, “Corro-Duty”, “Chemical Processing” motors, or equal.

T. Motors are to be bi-directional. If the fan must be unidirectional, it shall be the motor manufacturer's responsibility to obtain the direction required from the drive manufacturer.

U. Guards

1. Exposed moving parts shall be provided with guards in accordance with the requirements of OSHA. Guards shall be fabricated of flattened expanded metal screen, 3/4-inch No. 10, to provide visual inspection of moving parts without removal of the guard.

2. Guards shall be galvanized after fabrication and shall be designed to be readily removable to facilitate maintenance of moving parts. Windows shall be provided in the guard for access to the lubricating fittings.

2.3 FRACTIONAL HORSEPOWER MOTORS – LESS THAN 1/2 HORSEPOWER

A. Motor voltage shall be single phase, 115 volts, 60 Hertz, unless otherwise shown on the Drawings.

B. Enclosures shall be TEFC or TENV.

C. Motors shall have NEMA standard Class "F" insulation with a maximum temperature rise of 90°C above a 40°C ambient, on a continuous operation or intermittent duty, at nameplate horsepower.

D. Motors shall have a built-in manual or automatic reset thermal protector, or an integrally mounted, enclosed manual reset, motor overload switch.

2.4 MOTORS 1/2 HORSEPOWER AND LARGER

A. Motor voltage shall be three-phase, single voltage, as shown on the Drawings, and in compliance with IEEE 841 (Mill & Chemical).

B. Motors shall have NEMA standard Class "F" insulation with a maximum temperature rise of 90°C above a 40°C ambient, on a continuous operation or intermittent duty, at nameplate horsepower.

C. Motors shall have non-hygroscopic encapsulated windings of copper. Motor leads shall be Class F rated, with permanent identification.

D. Motor rotors and assembly, shall be dynamically balanced.

E. Motors less than 15 HP shall have a locked rotor inrush not exceeding MG-1. Motors 15 HP and larger shall have a locked rotor inrush kVA` not exceeding Code G (6.29 kVA/HP).

F. Motors shall meet or exceed the Minimum Guaranteed Efficiencies, listed in the Table of Part 4 of this Section, at the approximate nameplate current values at 460 volts.

G. The motor insulation system for motors controlled with Variable Frequency Drives (VFDs) shall have full capability to handle the common mode voltage conditions imposed by the VFD. Motor insulation system shall conform to all of the requirements of the latest version of NEMA MG1, Part 31 for peak voltage withstand capability.

H. All motors controlled with VFDs or soft starters shall have a minimum 1600 Volt insulation systems.

I. The critical speed of the shaft and rotor assembly shall exceed the operating speed by a minimum of 10%.

J. The no-load sound pressure level, based on the A-weighted scale at three feet, when measured in accordance with NEMA MG1 Section 1 Part 9, shall not exceed the values listed in Table 9-1.

K. Vibration limits shall not exceed 0.2-inches/second at any frequency.

L. Motors shall have a minimum of one grounding pad on each motor frame. Motors larger than 75 HP shall have a minimum of two brass grounding pads on each motor frame.

M. Bearings

1. Motors 1/2 through 5 HP shall have permanently lubricated sealed antifriction ball-bearings with L10 lifetime of 50,000 hours.
2. Motors larger than 5 HP shall have oil or grease-lubricated antifriction ball-bearings with L10 lifetime of 50,000 hours.
3. Vertical motor thrust and guide bearings shall conform to AFBMA standards and shall have L10 lifetime ratings as specified for ball-bearings of the same horsepower range. Down thrust information shall be provided to the motor manufacturer by the equipment supplier.
4. Anti-friction motor bearings shall be designed to be regreasable and initially shall be filled with grease suitable for the motor ambient temperature specified.
5. Grease lubricated bearings, except those specified to be factory sealed and lubricated, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary. Grease supply fittings shall be standard hydraulic type as manufactured by the Alemite Division of the Stewart Warner Corporation.
6. Sealed bearings shall be contact seal (lip) or non-contact labyrinth type.
7. Motors operating on VFDs shall have the opposite drive end bearing insulated and a shaft grounding brush installed at the drive end of the motor.

N. Space Heaters

1. Space heaters shall be supplied with all three-phase motors and shall conform to the following:
   a. Heaters shall be of the cartridge or flexible wrap around type installed within the motor enclosure adjacent to core iron. Heaters shall be rated for 120 volts, single phase with wattage as required. The heater wattage and voltage shall be embossed on the motor nameplate. Power leads for heaters shall be brought out at the motor accessory lead junction box. Provide integral conduit hubs or threaded openings 3/4-inch minimum.

O. Stator Temperature Detection

1. Winding temperature detectors of the bi-metallic switch type shall be provided for all NEMA Frame motors 100 HP and up, and for all NEMA Frame motors controlled by variable frequency drives. Provide the detectors factory installed, embedded, with leads terminating in the main conduit box. Device shall protect the motor against damage from overheating caused by single phasing, overload, high ambient temperature, abnormal voltage, locked rotor, frequent starts or ventilation failure. The switch shall have normally closed contacts. Not less than three detectors shall be furnished with each motor.
2. Winding temperature detectors of the resistance-type temperature detector type shall be provided for all motors larger than 200 HP. Each detector shall be of the 100-ohm platinum type. Each phase winding shall have two detectors for a total of six. Install the detectors between stator coils where the highest temperature will occur. Where motor protective relays are shown or specified, terminate and connect all six RTDs. Where other protective devices are shown or used, terminate the number of pairs as shown on the Drawings or specified.
3. Wire all temperature detectors to a separate terminal box on the motor. Terminal box shall be weatherproof NEMA 4 with barrier-type screw-post terminals.

P. Bearing Temperature Detection

1. Where specified elsewhere or shown on the Drawings, bearing temperature detectors of the resistance temperature detector type (RTD) shall be provided in motor bearing for all motors larger than 200 HP. For vertical motors, provide a detector in each thrust bearing and lower radial guide bearing. Each detector shall be of the 100-ohm platinum type.
2. Mechanical equipment bearing temperature detectors are specified elsewhere in these Specifications. Connect the bearing RTDs to the terminal box containing the stator RTDs where stator RTDs are specified. Where no stator RTDs are specified, provide a separate terminal box for the bearing RTDs.

2.5 FACTORY TESTING

A. Motors rated 100 HP and larger shall be standard motor tested. Except where specific testing or witnessed shop tests are required by the specifications for driven equipment, factory test reports may be copies of routine test reports of electrically duplicate motors. Test report shall indicate test procedure and instrumentation used to measure and record data. Test report shall be certified by the motor manufacturer's test personnel and be submitted to the Engineer for approval.

B. As specified herein, provide a complete test per NEMA MG1 and IEEE Standard 112, consisting of the following:
   1. Full Load Heat Run
   2. Temperature Test (Actual loading method)
   3. Performance Test
   4. Locked Rotor Test
   5. No Load Saturation
   6. Speed Torque
   7. Winding Resistance (A 118 and 43)
   8. High Potential
   9. Noise Test (A 85)

C. Balance and vibration shall meet NEMA standards MG1-12.05 and MG1-12.06.

D. The following motors shall receive a complete motor test as specified above:
   1. Equipment Motor I.D. _____
   2. Equipment Motor I.D. _____
   3. Equipment Motor I.D. _____

E. The motors shall be tested at the factory of manufacture, and in the operating position of operation.

2.6 WITNESS TESTING

A. The Owner/Engineer will witness the Factory Tests for each of the following Equipment Units:
   1. Equipment Unit I.D. _____
   2. Equipment Unit I.D. _____
   3. Equipment Unit I.D. _____

B. The number of Owner/Engineer persons witnessing the tests will be two persons.

C. Under no circumstances will the equipment be approved for shipment, nor will the equipment be accepted by the Owner, if witness testing is specified, and the equipment is shipped without the testing being witnessed.

D. If a test must be re-run due to failure in meeting the specified requirements, the witness expenses for the re-test shall be borne by the Contractor. Retesting on the same trip shall be only at the option of the Owner/Engineer.

E. The Owner/Engineer, who is witnessing the testing, shall approve all travel arrangements, including the airline selected, flight times, hotel selected, testing agenda, etc.

F. An interpreter/guide shall be provided if English is not widely spoken, or in areas where English is not the native language. Security shall be provided as required to insure the safety of the Engineer's/Owner's personnel.

G. All locally incurred expenses, arrangements for local transportation, lodging, meals, interpreter and security shall be made by and paid by the host manufacturer in the country in which the testing is to take place. The Owner/Engineer shall have direct communications with the person who is responsible for local arrangements and has the authority to pay for those expenses prior to leaving the Dallas / Fort Worth location, or other designated location. Provide a local telephone number of the person who is responsible for all local arrangements and who has the authority to authorize payment for locally incurred expenses prior to departure.

H. The Contractor shall submit the testing agenda for approval at least 30 days prior to the test date, or the test date shall be rescheduled, with no change in the Contract price or time. The agenda shall include a detailed list of all tests to be done.

I. Where travel is over night, testing shall not start on the arrival day.

J. Travel Documents

1. The Contractor shall be responsible to obtain Letters of Invitation and other documentation required to obtain a visa into the host country. The Contractor shall obtain the visa itself and directly pay for the cost of a visa service and the fee that the host country charges for the visa.
2. The Contractor shall use a visa service located in the Dallas / Fort worth area to handle the Owner/Engineer's passports who are traveling to witness the test, and to pay all expenses for the visa service company and the cost of the visa required by the host country.

K. Owner/Engineer Travel Expenses

1. Owner/Engineer representatives shall not have to provide for any out of pocket expenses related to the trip, transportation, meals or incidentals that would require later reimbursement.
2. The Contractor shall provide, and pay for, all air travel fare, including ground shuttle or taxi, to and from the Owner/Engineer's office or residence. Air fare inside the Continental United States shall be non-stop if available, Coach Class or better, from Dallas / Fort Worth. Air fare outside the Continental United States shall be non-stop if available, Business Class or better, from DFW.
3. Ground transportation at any destination shall be provided by the host Original Equipment Manufacturer (OEM). The Owner/Engineer persons shall not be required to drive in a foreign country under any circumstances.

4. The Contractor shall provide for hotel, meals, travel, security, and incidentals including but not limited to international cell phone and internet access to be paid for by the host OEM at the testing location, whose equipment is being tested. The host OEM shall have the authority to resolve any expense problems. If the Hotel offers restaurants, those charges shall be covered in the Hotel expenses. If meals are not offered at the Hotel, transportation to restaurants and the cost of those meals shall be provided by the host OEM.
5. Access to an international cell phone shall be provided while out of the Continental United States.
6. Access to the internet shall be provided while out of the Continental United States.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractor shall install motors in accordance with the manufacturer's instructions.

B. Make a visual and mechanical inspection.

C. Check for physical damage.

D. Compare equipment nameplate information with single line diagram and report any discrepancies.

E. Inspect for proper mounting, grounding, connection, and lubrication.

F. Inspect each motor for the proper installation, rated voltage, phase and speed.

G. Check for proper phase and ground connections. Check to see that multi-voltage motors are connected for the proper voltage.

H. Motor connections shall be ring type compression terminations on the motor leads and secured with bolt, nut and spring washer. Connections shall be rubber Scotch 33 tape insulated, half lapped with a minimum of two layers of tape, minimum.

I. All lugs and connectors shall be copper and shall be crimped type, with standard industry tooling. Lugs and connectors shall match the wire size where used, and shall be clearly identified and color coded on the connector. All connections shall be made for stranded wire and shall be made electrically and mechanically secured. The lugs and connectors shall have a current carrying capacity equal to the conductors for which they are rated and meet UL 486 requirements for 75°C. Lugs for conductors #1/0 AWG and larger shall be two-hole lugs with NEMA spacing. The lugs shall be of closed end construction to exclude moisture migration into the cable conductor.

J. Space heaters shall be continuously energized as specified.

3.2 TESTS

A. Test for proper rotation prior to connection to the driven equipment.

B. Test the insulation (megger test) of all new motors, 10 HP and above, in accordance with NEMA MG-1. Test voltage shall be 1000 volts AC plus twice the rated voltage of the motor.

C. For motors 300 HP and larger, test duration shall be for ten minutes with resistances tabulated every 15 seconds for the first minute and then every minute for the next ten. The megohm rating at the end of the ten minutes shall be at least twice as high as the 1-minute reading. Dielectric absorption ratio and polarization index shall be calculated.

D. Perform a rotation test to ensure proper shaft direction.

E. Where a motor is inverter fed, the direction of rotation shall be checked by momentary application of voltage to the motor, to confirm that the phase sequence is the same as the incoming power to the inverter.

F. Measure running current and evaluate relative to load conditions and nameplate full load amperes.

G. Inspect for unusual mechanical or electrical noise or signs of overheating during initial test run.

H. Monitor motors during startup and commissioning to record operating amps, voltage and operating vibration levels.

I. Submit test report and all recorded field data. Submit copies of the raw data recorded in the field, signed by the person recording the data, and typewritten reports certified by the Contractor. The motors will not be accepted until the reports are submitted and approved.

1 **PART 4 - TABLE OF MOTOR EFFICIENCIES**

MOTOR FULL-LOAD EFFICIENCIES							
	2-POLE (3600 RPM)		4-POLE (1800 RPM)		6 POLE (1200 RPM)		8 POLE (900 RPM)
HP	Min. Efficiency		Min. Efficiency		Min. Efficiency		Min. Efficiency
1.0	72.0		80.0		77.0		70.0
1.5	80.0		81.5		82.5		74.0
2.0	81.5		81.5		84.0		80.0
3.0	82.5		85.5		85.5		81.5
5.0	85.5		85.5		85.5		82.5
7.5	87.5		87.5		87.5		82.5
10.0	88.5		87.5		87.5		86.5
15.0	89.5		89.5		88.5		87.5
20.0	88.5		89.5		88.5		87.5
25.0	89.5		91.0		90.2		87.5
30.0	89.5		91.0		90.2		89.5
40.0	90.2		91.7		91.7		89.5
50.0	91.0		91.7		91.7		90.2
60.0	91.7		92.4		92.4		90.2
75.0	91.7		93.0		92.4		91.7
100.0	92.4		93.6		93.0		91.7
125.0	93.6		93.6		93.0		92.4
150.0	93.6		94.1		94.1		92.4
200.0	94.1		94.1		94.1		93.0
250.0	94.5		94.1		94.1		93.6
300.0	94.5		94.5		94.1		--
350.0	94.5		94.5		94.1		--
400.0	94.5		94.5				--
450.0	94.5		94.5				--
500.0	94.5		95.0				--

2 **END OF SECTION**

SECTION 26 05 73
POWER SYSTEM STUDY

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide a Power System Study for the electrical power system, including a Short Circuit Study, Coordination Study, Arc Flash Hazard Study, and additional studies as listed below.

B. The electrical power system shall be deemed to include the utility company's transformer, the Owner's entire power distribution system, all new system components, including any on-site standby generation. The short circuit and coordination study reports shall provide an evaluation of the electrical power systems and the model numbers and settings of the protective relays or devices and metering or motor monitoring devices for setting by the Contractor. The Study shall include settings for all motor protective relays and electric system monitoring devices.

C. The Study shall model all electrical equipment down to and including 480-Volt utilization equipment. All motors shall be modeled individually, including disconnect switches, if present.

D. Additional Studies

1. Motor Starting Voltage Drop Study

E. Obtain and provide all pertinent data necessary for the successful completion of the Power System Studies, including information on all new equipment and wiring pertinent to the Study. This includes all cable and raceway data, data for new motors, data from all new switchgear, motor control centers, panel boards, and separately mounted fuses, starters and circuit breakers. Obtain all new protective device information to include all present settings. Obtain any needed data or information from Contract Documents, various suppliers, the Electric Utility and from conducting his own field investigations. If during field investigations conflicts between the Contract Documents and the field conditions are encountered, immediately notify the Owner/Engineer for a resolution to the conflict. Copies of the data obtained, shall be organized and submitted to the Owner/Engineer at the same time of transmittal to the Study Engineer, to show that all the requested data gathering work has been completed.

1.2 RELATED WORK

A. Refer to Division 26 00 00 and the Contract Drawings, for related work and electrical coordination requirements.

B. Provide all the information required, to the Study Engineer in a timely manner.

1.3 SUBMITTALS

A. No later than four weeks after Contract Award, provide a submittal of the name and qualifications of the Study Engineer, for approval. No submittals required under this section will be accepted until this requirement is met, and if submitted will be returned without review.

B. Provide the following additional submittals:

1. Preliminary Study: The first submittal shall consist only of the Short Circuit Study results and equipment evaluation, based upon sound engineering reasonable assumptions, where known values are not available. This submittal shall be used by the Study Engineer to ascertain the short circuit current rating of the related equipment. This submittal shall be made and approved prior to any shop drawing submittal being reviewed for electrical equipment for which the results of this preliminary study are required. The submittal and approval of the Preliminary Study is a critical milestone in the Construction Schedule. Failure to submit an acceptable study in a timely manner may delay the Project Schedule. No exceptions will be made for the specified sequence of the submittal of the Study prior to the submittal of shop drawings, and any delays caused by a late submittal of the Study will not be a cause for the Engineer / Owner to allow any extension of the Contract Time or Contract Price.
2. Final Study: The final submittal shall be the Final Study and shall include all items listed under "Scope of Work" in this Section. No electrical equipment for which the results of the final study are required, shall be energized until such results have been reviewed and approved by the Engineer / Owner, and applied to such electrical equipment, and certified as Settings Complete by the manufacturer's field representative. This submittal is required to include a PDF of the study and a copy of the SKM raw data input files on a CD and/or a flash drive.

C. Upon completion of the studies, submit the studies for approval to the Owner/Engineer. The study submittal shall include all the input and output data files in electronic format for use directly with the specified study software. The Study shall include an actual size sample of an Arc Flash and Shock Hazard label with typical information shown. Allow not less than three calendar weeks for review of the both the Preliminary and Final Studies by the Owner/Engineer. The submittal shall not contain unresolved questions, conflicts or selective device coordination conflicts. A submittal containing such questions or conflicts will be returned unreviewed, and shall not be resubmitted until such questions or conflicts have been resolved. Delays in the Construction Schedule due to the submittal of unacceptable Power System Studies will not be a cause for the Engineer / Owner to approve any changes in the Contract Time or Contract Price.

D. The completed, sealed, and signed studies, with all known issues resolved, shall be submitted to the Owner/Engineer for approval, not less than 30 days prior to site delivery of any equipment containing protective devices requiring selections and settings for certification by the manufacturer. Final copies shall be in electronic form (Adobe PDF formatted files). SKM data files, including any custom forms, labels, formats, and libraries, shall be provided at the same time in electronic format as specified herein. All individual arc flash labels, ready for installation, shall be provided with this submittal.

E. Submit for approval, a manufacturer's conducted training agenda for all training specified herein. Training agenda shall not be submitted until final approval of the Operation and Maintenance Manual

1.4 REFERENCE CODES AND STANDARDS

A. The specified studies shall be in accordance with the latest versions of the following codes and standards.

1. IEEE Standard 1584 – IEEE Guide for Performing Arc-Flash Hazard Calculations, Including Amendment 1584a.

2. NFPA-70E - Standard for Electrical Safety Requirements for Employee Workplaces.
3. ANSI/NFPA 70 – National Electrical Code

B. The studies shall be performed using SKM Power Tools Electrical Engineering Analysis Software for Windows.

1.5 QUALITY ASSURANCE

A. The studies shall be performed by an Electrical Engineering Services firm, who is regularly engaged in power system studies. The studies shall be performed by a Licensed Professional Electrical Engineer(PE) in the regular employment of the firm with proficiency in electrical power systems engineering and shall seal and sign the final completed power system studies. The Study Engineer shall be licensed to practice engineering in the State of Texas.

B. The PE shall comply with the State PE Law in the submittal of the Preliminary and Final Studies. The Preliminary Study shall bear the name and registration number of the PE who will be sealing the work along with the statement acceptable to the State PE Board which indicates the work is “Preliminary, Not for Construction” and is “Issued for Review”. The final report shall bear the Engineer’s Seal, Registration Number, Original Signature and Date in accordance with the State PE Laws.

C. Computer Model Revision Control

1. The Study Engineer shall check out and receive from the Owner, prior to executing the Study, the base model computer file to be used with the SKM System Analysis computer program. The Study Engineer shall be responsible for the return of this computer file to Owner upon completion of the Study and acceptance of the Report by the Owner/Engineer. Field verify all existing protective equipment, protective device settings and conductors shown in the model which are in series with the new equipment all the way from the Utility and or Generator power sources to the connection point of the new equipment. Field verify the name plate data on all existing motors connected to the same bus or any upstream bus which is in series with the new equipment. The same criterion applies to all existing equipment modified under this Contract. Notify the Owner/Engineer of any discrepancies discovered which exist between the Owner’s power system model and existing field conditions prior to the submittal of any Studies for review.
2. The Study Engineer shall incorporate the Study conducted for this Contract into the overall base model computer file. The updated file shall be returned to the Engineer for review along with the Report Submittal. It is unacceptable to add the branches of the new equipment provided under this Contract in a stand-alone or separated configuration from the overall power system and adding in the available fault current at the point of attachment. All revisions and the addition of all new equipment shall be tied into the existing power system model by the Study Engineer.
3. The Study Engineer shall forward the updated base model computer files to the Owner with the submittal of the Preliminary Study for the Engineer to check, and again the final model shall be submitted upon approval of the Final Report Submittal. This shall constitute checking this file back in to the Owner. Should the Report Submittal be rejected for any reason, the base model computer file shall be checked out again and returned to the Study Engineer for further use.

1.6 SCHEDULE OF WORK

A. The selection of the Study Engineer shall be submitted to the Owner/Engineer for approval in a timely manner, in accordance with the time specified. The Study shall be completed and submitted in the phases as specified above.

B. The completed studies, with all known issues resolved, shall be submitted to the Owner/Engineer for approval, as specified above.

PART 2 - STUDIES

2.1 ELECTRICAL ENGINEERING SERVICES FIRMS

A. The work experience resume of the Study Engineers who will be doing the work and the Professional Engineer who will be sealing the Final Study shall be submitted along with his / her PE registration number in the State where the equipment is to be installed. Subject to compliance with the Contract Documents, the following services firms are acceptable:

1. Cutler Hammer Engineering Services
2. General Electric Co. Engineering Services
3. Schneider Electric Engineering Services
4. Allen Bradley Co. Engineering Services
5. Approved Equal

2.2 SHORT CIRCUIT AND COORDINATION STUDY

A. Provide a complete short circuit study. Include three phase, phase-to-ground calculations and X/R ratios. Provide an equipment interrupting or withstand evaluation based on the actual equipment and model numbers provided on this project including any existing equipment modified in any way under this project. The Contractor shall field verify the name plate data of all existing transformers, protective device equipment and the size and length of any existing conductors in series with the new or modified equipment in the Contract. Conductor lengths in concealed conduit shall be estimated to the best of the Contractor's ability from field observations and any available existing conformed to construction record drawings. Generic devices or values are not acceptable. Normal system operating method, alternate operation, and operations that could result in maximum fault conditions, shall be thoroughly addressed in the study. Provide single phase to ground and three phase to ground fault information. The study shall assume all motors are operating at rated voltage with the exception that motors, clearly identified as "standby," shall not be included. Electrical equipment bus impedances shall be assumed as zero. Short circuit momentary duties and interrupting duties shall be calculated on the basis of maximum available fault current at the switchgear busses, switchboard busses, motor control centers and panelboards. The study shall be performed using actual available short circuit currents as obtained from the Electric Utility. An assumption of infinite bus for the purposes of the Preliminary or Final study is not acceptable.

B. Provide an equipment evaluation study to determine the adequacy of the fault bracing of all bus from the panel board level up to the main switchgear or protective device. Include circuit breakers, controllers, surge arresters, busway, switches, and fuses by tabulating and comparing the short circuit ratings of these devices with the available fault currents.

C. Provide a protective device coordination study. The study shall include all electrical equipment provided under this Contract, including Control Panels containing power and protection equipment lighting panels and power panels. The Study shall include any upstream or downstream equipment that has an impact on the Coordination Study. The study shall show transformer damage curves, cable short circuit-withstand curves and motor starting curves. The phase overcurrent and ground fault protection shall be included, as well as settings for all other adjustable protective devices. All motor monitoring relays and protective or monitoring devices that are a part of a supplier's equipment, such as soft starters or adjustable frequency drives shall be included. Include the last protective device in the Electric Utilities' system feeding each facility being considered. Include all medium voltage switchgear, distribution switchboards, motor control centers and 480 Volt panelboard main circuit breakers. Complete the short circuit study down to the main breaker or largest feeder on all on all 480 Volt panelboards. Panelboard branch circuit devices need not be considered. The phase overcurrent and ground-fault protection shall be included, as well as settings for all other adjustable protective devices. All motor monitoring relays and protective or monitoring devices that are a part of a supplier's equipment, such as soft starters or adjustable frequency drives, shall be included. Include the last protective device in the Electric Utilities system feeding each facility being considered.

D. Selective device coordination is required between protective devices in equipment specified in each Section of the Electrical Specifications, and between each piece of electrical equipment supplied for this project. Include settings for the protective devices in existing equipment feeding any piece of new equipment. If the Study Engineer, during his work, determines that selective coordination cannot be obtained in or between pieces of existing and new equipment as specified, the Owner/Engineer shall immediately be notified, Provide the supporting information to the Owner/Engineer for resolution of the problem.

E. Projects executed in phases may not have the new equipment provided under earlier phases on site when this study is being done. Obtain the shop drawings from the Owner for that equipment and include that data in this study. Obtain study data done by the Study Engineer doing any studies under previous phases and include that data in this study. Clearly indicate what information was obtained from the Owner. This is acceptable only for the preliminary phases of this study. The final study shall include actual information on equipment provided under the earlier phases, including fault studies and protective device coordination.

F. As a minimum, each short circuit study shall include the following:

1. One-Line Diagram: The presentation of the One Line Diagram shall be on one or more 22 x 34-inch drawings with match lines if on multiple sheets, using font sizes which are easily readable. Include the following information and activities listed below:
    a. Location and function of each protective device in the system, such as relays, direct-acting trips, fuses, etc.
    b. Type designation, current rating, range or adjustment, manufacturer's style and catalog number for all protective devices.

c. Power and voltage ratings, impedance, primary and secondary connections (Delta, Wye, Grounded Wye, Zig-Zag, etc.) of all transformers. Use the ratings of the actual transformers being provided where available. The Final Study shall use the name plate information on the transformers provided. Use the actual name plate information on all existing transformers. Generic transformer data on new or existing transformers are not acceptable.
d. The type, manufacturer, and ratio of all instrument transformers energizing each relay shall be included on both existing and new instrument transformers. Field verify this information on all existing protective devices which are in series with the new equipment provided under this Contract.
e. Nameplate ratings of all motors and generators with their sub transient reactance. Field verify the name plate information of all existing generator providing power to the new equipment, and field verify the name plate motor information on all motors connected to the bus of existing equipment which is in series with the new equipment.
f. Sources of short circuit currents such as utility ties, generators, synchronous motors, and induction motors. Provide short circuit studies using each source of power separately. The study shall determine if there is sufficient short circuit current to adequately cause interruption of a protective device using the weaker power source (typically local generation), and shall determine if the equipment can safely interrupt the fault if the greater power source is connected. Additional short circuit calculations shall include emergency as well as normal switching conditions as well as normal and emergency power sources described here in.
g. All significant circuit elements such as transformers, cables, breakers, fuses, reactors, etc. shall be included.
h. The time-current setting of existing adjustable relays and direct-acting trips, if applicable. The Contractor shall field verify the information as specified herein.
i. Arrange for the shutdown of the equipment requiring field verification with the Owner, Investigations shall be done at a time, including after hours if necessary, which do not significantly interrupt the Owner's process operations.

2. Impedance Diagram: The presentation of the Impedance Diagram shall be on one or more 22 x 34-inch drawings with match lines if on multiple sheets, using font sizes which are easily readable. Include the following:
a. Available fault current or impedance from the utility company.
b. Local generated capacity impedance.
c. Transformer and/or reactor impedances.
d. Cable impedances.
e. System voltages.
f. Grounding scheme (resistance grounding, solid grounding, or no grounding).

3. Calculations: Include the following:
a. Determine the paths and situations where short circuit currents are the greatest. Assume bolted faults and calculate the three-phase and line-to-ground short circuits of each case.
b. Calculate the maximum and minimum fault currents.

G. Provide Time-Current Curves (TCC) on 8-1/2 x 11 log-log paper.

1. The Time Current Curves shall be presented in series only. Parallel branches shall not appear on the same TCC presentation.

2. Do not put more than one branch of protective devices on any one coordination curve.
3. Show a maximum of five devices in series on one TCC. Include a one-line diagram and the names of each protective device in the branch on the coordination curve drawing. Use the same color for the same protective device appearing on different TCC presentations.
4. Provide separate drawings for ground fault coordination curves.
5. Use the names designated in the Contract Documents.
6. Include motor starting curves and transformer inrush and damage curves, and cable short circuit withstand curves.

H. The study shall include the selection and sizing of the type of low resistance ground (LRG) system and all associated components, including the selection of the appropriate relay to detect a single line to ground fault. The study shall also recommend the minimum size of cables to attach the electrical service to the LRG system.

I. The high resistance grounding system shall be sized such that a single phase can be grounded, and the system still continues to operate while the ground fault alarm is being locally displayed and transmitted to SCADA.

2.3 ARC FLASH HAZARD STUDY

A. The Power System Study shall include an Arc Flash Hazard Study that shall present the level of arc flash hazard for each item of electrical equipment, and the appropriate level of protection required per OSHA standards.

B. The analysis shall be performed with the aid of computer software intended for the purpose, to calculate Arc-Flash Incident Energy (AFIE) levels and flash protection boundary distances.

C. The analysis shall be performed under each possible condition and shall identify the worst-case Arc-Flash condition. The preliminary report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

D. The calculations shall be performed in accordance with IEEE 1584 and safe approach requirements determined in accordance with NFPA-70E. (Latest versions)

E. Results of the Analysis shall be submitted in tabular form on an Excel spread sheet, and shall include, device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, personal-protective equipment and AFIE levels. The analysis shall be presented on paper and included with the specified electronic format files.

F. After approval of the Study, provide the Arc Flash Hazard Warning Labels. The Study Engineer shall oversee the installation of the required labels for each item of electrical equipment furnished on the project and for each item of existing equipment for which the arc flash hazard has changed. A typical warning label shall be submitted with the Study for approval, and shall include the information listed below, at minimum.
1. Flash Hazard Protection Boundary.
2. Limited Approach Boundary.
3. Restricted Boundary.
4. Incident Energy Level.
5. Required Personal Protective Equipment Rating.

6. Type of Fire Rated Clothing.

G. Labels shall be affixed to the enclosures, in a readily visible location, for all power-handling equipment as follows.
   1. Switchgear
      a. One label for the line side of the main breaker
      b. One label for the load side of the main breaker (switchgear bus)
      c. One label on each vertical section, indicating the data for the switchgear bus
   2. MCCs
      a. One label for the line side of the main breaker
      b. One label for the load side of the main breaker (MCC bus)
      c. One label on each vertical section, indicating the data for the MCC bus
   3. Switchboards
      a. One label for each switchboard operated at 480 Volts or above
      b. Label to indicate data for line side of the main breaker
   4. Panelboards
      a. One label for each panelboard operated at 480 Volts or above
      b. Label to indicate data for line side of the main breaker
   5. Control panels, including combination starters
      a. Single label at each unit operated at 480 Volts or above.
      b. Label to indicate data for the line side of the disconnect device.
   6. Disconnect switches
      a. Single label at each disconnect switch operated at 480 Volts or above.
      b. Label to indicate data for the line side of the switch

H. Size of each label shall be not less than 4 inches wide and 3 inches tall.

PART 3 - EXECUTION

3.1 FIELD SERVICES

A. Label Installation Certification
   1. When the label installation is complete, the Contractor, the Contractor's Study Engineer and the Owner/Engineer shall jointly inspect each location and show to the Owner/Engineer's satisfaction that labels are installed in all the specified locations, and in any additional recommended locations indicated in the Study.

B. Training
   1. Provide the services of the Arc-Flash Training Engineer to conduct a training program for the Owner's personnel. The class shall include the following:
      a. The class shall be held for not less than one eight-hour day for each shift of maintenance and operational personnel.
      b. The care, application and use of protective personal equipment described by the warning signs installed on the project.
      c. Conduct training at a location onsite to be designated d by the Owner. Include class sessions in the field at equipment locations as may be required for instruction.
      d. Applicable information from the Power System Study shall be provided to the attendees.

e. Submit a detailed class syllabus to the Engineer/Owner for review and approval prior to holding the training class.

2. Provide the services of the Power System Study Engineer to conduct power system operation training for the Owner's personnel. The class shall include the following:
   a. The class shall be held for not less than one eight-hour day for each shift of maintenance and operational personnel.
   b. Instruction in the safe operation of the power system for both new electrical power distribution equipment included in the study and existing power distribution equipment which is in series with the new equipment.
   c. The safe operation of electrical equipment Kirk Key interlocks.
   d. Power system switching which avoids configurations that may exceed equipment short circuit ratings, or that may cause other undesirable or danger if certain circuits are paralleled.
   e. Provide handout materials including one-line diagrams and O&M information for each person in attendance.
   f. Submit a detailed class syllabus to the Engineer/Owner for review and approval prior to holding the training class.

C. The cost of Field Services shall be included in the Contract Price and the schedule for training shall be included in the Contract Schedule.

D. The Owner reserves the right to videotape the training for the Owner's use.

END OF SECTION

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SECTION 26 22 13
DISTRIBUTION DRY-TYPE TRANSFORMERs

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install single-phase and three-phase general purpose individually mounted dry-type transformers of the two-windings type, self-cooled as specified herein, and as shown on the Drawings.

B. The provisions of this Section shall apply to all dry-type distribution transformers, except as indicated otherwise.

1.2 RELATED WORK

A. No references are made to any other section which may contain work related to any other section. The Contract Documents shall be taken as a whole with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or additional work as may be required in those references, and include such information or work as may be specified.

B. Other Divisions

1. The Contractor shall be responsible for examining all Sections of the Specifications and Drawings, and shall determine the power and wiring requirements and shall provide external wiring and raceways, as required to provide a fully functioning power, control and process control systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, the Contractor shall furnish the additional conductors, raceways and/or wiring, with no change in the Contract Price, and with no increase in Contract Time.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Division 1, Section 26 00 00 and as specified herein.

B. Submittals for equipment and materials, furnished under this Section of the Specifications, will not be accepted prior to approval of the Power System Study specified under Section 26 05 73. Submittals made prior to such approval will be returned without review. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project. Unmarked cut sheets will be cause to reject the submittal and return it for revision without review.

C. Submittals shall also contain information on related equipment to be furnished under this Specification but described in the related sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will also be returned without review.

D. All equipment supplied under this Section of the Specifications shall be products of the same Manufacturer, and shall be contained in one single submittal. Partial submittals will be returned without review. Submittals shall also contain information on related equipment to be furnished under this Specification but described in the related sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will also be returned without review.

E. Equipment specified in Process Equipment and Mechanical Equipment Divisions, and supplied as an integral part of a process equipment manufacturer's package, but referred to this Section for component details, shall be submitted with the manufacturer's package in those Divisions.

F. Shop Drawings and Product Data. For each transformer specified under this Section, submit the following information:
   1. Outline dimensions and weights
   2. Typical/Design test data
   3. Transformer ratings including:
      a. kVA
      b. Primary and secondary voltage
      c. Taps
      d. Basic impulse level (BIL) for equipment over 600 volts
      e. Design impedance
      f. Insulation class and temperature rise
      g. Sound level.
   4. Product data sheets
   5. Connection diagrams
   6. Installation information
   7. Date of manufacture for each transformer
   8. Seismic Certification
   9. Where applicable the following additional information shall be submitted to the Engineer:
      a. Specified accessories

G. Operation and Maintenance Manuals.
   1. Operation and Maintenance Manuals shall include the following information:
      a. Manufacturer's contact address and telephone number for parts and service.
      b. Instruction books and/or leaflets
      c. Recommended renewal parts list
      d. Record Drawings of information required by the Submittals part of this Section.
      e. Project record drawings clearly indicating operating features and including as-built shop drawings, outline drawings, and schematic and wiring diagrams.

1.4 REFERENCE STANDARDS

A. The dry-type transformer(s) and all components shall be designed, manufactured and tested in accordance with the latest applicable NEMA and ANSI standards as follows;
   1. DOE 2016 Energy Efficiency Standards, 10 CFR Part 431
   2. ANSI C57.96 2004 Guide for Loading Dry-Type Distribution and Power Transformers
   3. ASTM D635 – Standard Test Method for Insulation Materials

4. NEMA ST20
5. UL 1561
6. IEEE-519
7. IEEE-597
8. NFPA 70 – National Electrical Code

1.5 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of ten years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly. All assemblies shall be of the same manufacturer. Equipment that is manufactured by a third party and "brand labeled" shall not be acceptable.

C. All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.

D. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.

E. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

F. Transformers manufactured more than 24 months prior to the date of this Contract will not be acceptable.

G. Transformers shall meet the US Department of Energy (DOE) 2016 Energy Efficiency Standards 10 CFR Part 421.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will not be permitted.,

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the Contractor and Owner/Engineer

C. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.

D. Equipment shall be equipped to be handled by crane. Where cranes are not available, equipment shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

E. Equipment shall be installed in its permanent finished location shown on the Drawings within seven calendar days of arriving onsite. If the equipment cannot be installed within seven calendar days, the equipment shall not be delivered to the site, but stored offsite, at the Contractor's expense, until such time that the site is ready for permanent installation of the equipment.

F. Where space heaters are provided in equipment, provide temporary electrical power and operate space heaters during jobsite storage, and after equipment is installed in permanent location, until equipment is placed in service.

1.7 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for one year from date of final acceptance of the equipment. Within such period of warranty, the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Contractor at no expense to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. ABB
   2. Eaton
   3. Square D

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.2 RATINGS

A. The ratings of the transformer shall be as follows:

1.	kVA Rating:	As shown on the Drawings.
2.	Impedance:	ANSI Standard Tolerance
3.	HV:	As shown on the Drawings.
4.	LV:	As shown on the Drawings.
5.	LV:	As shown on the Drawings.

2.3 CONSTRUCTION

A. Insulation Systems
   1. Transformer insulation system shall be as follows:
      a. Up to 15 kVA, three-phase and single-phase: UL recognized 180°C rated insulation system, encapsulated with 115°C rise.
      b. 15 kVA, and above, three-phase and single-phase: UL recognized 200°C rated insulation system, ventilated, with 115°C rise.
   2. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40°C maximum ambient, and a 24-hour average ambient of 30°C
   3. All insulation materials shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.
   4. Windings shall have a BIL of 10 kV minimum.

B. Core and Coil Assemblies

1. Transformer core shall be constructed with high-grade, non-aging, silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the nominal tap voltage. The core laminations shall be tightly clamped and compressed. Coils shall be wound of electrical grade copper with continuous wound construction.
2. Transformer coil assembly shall be impregnated with non-hydroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture; the core shall be coated with HAPs (Hazardous Air Pollutants) free water reducible electrical varnish to give good corrosion resistance. The assembly shall be installed on vibration-absorbing pads.
3. On single and three-phase units rated 15 kVA and below, the core and coil assembly shall encapsulation system shall minimize the sound level. Enclosure construction shall be encapsulated, non-ventilated 316 stainless steel enclosure, with lifting eyes.
4. On single and three-phase units, rated above 15 kVA, the core and coil assembly shall be ventilated, weatherproof 316 stainless steel enclosure. All ventilation openings shall be protected against falling dirt. The assembly shall be installed on vibration-absorbing pads.
5. Terminals shall be welded to the leads of the coils for better conductivity, less maintenance and lower risk of hot spots. Terminals shall not be spot welded or bolted to the coil leads.
6. The neutral bus shall be configured to accommodate 200% of the rated current.

C. Taps

1. Three-phase transformers rated 15 through 500 kVA shall be provided with six 2-1/2% taps, two above and four below rated primary voltage
2. All single-phase transformers, and three-phase transformers rated below 15 kVA and above 500 kVA, shall be provided with the manufacturer’s standard tap configuration.

D. Isolation Pad

1. Each transformer, pad-mounted, bracket-mounted, or suspended, shall utilize double deflecting neoprene mounting vibration isolators as manufactured by Mason Industries Type ND, sized according to rated capacities.

E. Finish

1. Enclosures, other than stainless steel, shall be finished with ANSI Gray color, weather-resistant enamel.

F. Accessories

1. On ventilated outdoor units provide suitable weather shields over ventilation openings.
2. Lug kits shall be provided by the Manufacturer of the transformer.

G. Electrostatic Shielding

1. Where shown on the drawings, provide shielded isolation transformers with an electrostatic shield consisting of an independent single full width electrostatic shield consisting of a single turn of copper placed between the primary and secondary winding and grounded to the housing of the transformer.
   a. Electrostatic shield shall provide primary-to-secondary winding capacitance between 24 and 18 picofarads over the range of 100 Hz to 20 kHz.
   b. Electrostatic shielding shall provide the following minimum attenuation when tested per MIL Std. 220A, Method of Insertion Loss Measurement, with matched impedance no load technique.
   c. Common mode noise attenuation: Minus 80 dBA minimum at 0.1 kHz to 1.5 kHz,
      1) Common mode noise attenuation: Minus 55 dBA minimum at 1.51 kHz to 100 kHz.
      2) Normal mode (Transverse mode) noise attenuation: Minus 35 dBA minimum at 1.5 kHz to 10 kHz

2.4 FACTORY TESTING

A. The following standard factory tests shall be performed on the equipment provided under this section. All tests shall be in accordance with the latest applicable ANSI and NEMA standards.
   1. Ratio tests at the rated voltage connection and at all tap connections
   2. Polarity and phase relation tests on the rated voltage connection
   3. Applied potential tests
   4. Induced potential test
   5. No-load and excitation current at rated voltage on the rated voltage connection

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractors shall install all equipment per the manufacturer's recommendations and the contract drawings.

B. Securely connect all neutrals and transformer enclosures to ground.

3.2 FIELD ADJUSTMENTS

A. Adjust taps to deliver appropriate secondary voltage.

3.3 FIELD TESTING

A. Measure primary and secondary voltages for proper tap settings.

END OF SECTION

SECTION 26 24 14
LOW VOLTAGE GENERATOR QUICK CONNECT CABINET

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:
   1. Equipment for docking a generator and connecting to an electrical load, transfer switch or distribution equipment.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of Low Voltage Generator Quick Connect Cabinet indicated, include English dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, enclosure types, and finishes.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified testing agency.

B. Field quality-control reports.
   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.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:
   1. Manufacturer's written instructions for maintaining Low Voltage Generator Quick Connect Cabinet .

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. 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.

C. UL (Underwriters Laboratories, Inc.) Standards

D. cUL (Underwriters Laboratories of Canada) Standards

E. Comply with NFPA 70.

1.7 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 (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
   2. Altitude: Not exceeding 6600 feet (2010 m).

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Indicate method of providing temporary electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.
   3. Comply with NFPA 70E.

1.8 COORDINATION

A. Coordinate layout and installation of Low Voltage Generator Quick Connect Cabinet, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9 GUARANTEE/WARRANTY

A. The equipment installed under this contract shall be left in proper working order. Replace, without additional charge, new work or material which develops defects from ordinary use within two years unless a longer period is specified elsewhere, from substantial completion

B. New materials and equipment shall be guaranteed against defects in composition, design or workmanship. Guarantee certificates shall be furnished.

PART 2 - PRODUCTS

2.1 LOW VOLTAGE GENERATOR QUICK CONNECT CABINET

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. TRYSTAR Product Family: Low Voltage Generator Quick Connect Cabinet
   2. TRYSTAR Model No.: GDS-125W-LM-ACDIS2
   3. Engineer's Approved Equal
      a. Must be UL 1008 Listed
         1) No 508 or 891 Listing Acceptable

2.2 GENERAL REQUIREMENTS

A. Enclosures:
   1. Wall Mounted cabinet.

2. Front, and side accessible for maintenance.
3. Bottom, top, side, & back accessible for cabling.
4. Rated for environmental conditions at installed location:
   a. Outdoor Locations: NEMA 250, Type 4X 316 Stainless Steel
5. Front Cover:
   a. Hinged.
   b. Gasketed.
   c. Pad-lockable latch
6. Finishes: 316 Stainless Steel

B. Phase, Neutral, and Ground Buses:
   1. Material: Tin-plated hard-drawn copper
   2. Equipment Ground Bus: 100% of Phase Size
   3. Ground Bus: 25% of phase size.
   4. Round edges on bus.

C. Bus Connectors:
   1. Located behind access plates.

D. Inputs Connectors:
   1. Located inside front cover.
   2. Cam style mounted on plate.
   3. Protective Caps

E. Hinged cable access door on bottom of unit.

F. Padlockable front access cable trap door to reduce cable theft.

G. Voltage & Phase:
   1. 277/480V – 3 phase – 4 Wire

H. Amperage
   1. 1200A

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive Low Voltage Generator Quick Connect Cabinet for compliance with 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. Wall Mounted: Install Low Voltage Generator Quick Connect Cabinet on structural supports with adequate weight requirements, 4-inch (100-mm) nominal thickness. Comply with requirements specified in Division 03 Sections.
   1. Install dowel rods to connect. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.

2. For Low Voltage Generator Quick Connect Cabinet , install epoxy-coated anchor bolts that 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 Low Voltage Generator Quick Connect Cabinet.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

C. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: A qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Acceptance Testing Preparation:
1. Test insulation resistance for each Low Voltage Generator Quick Connect Cabinet, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. 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.
3. Perform the following infrared scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each Low Voltage Generator Quick Connect Cabinet. Remove front panels so joints and connections are accessible to portable scanner.
4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Prepare test and inspection reports, including a certified report that identifies Low Voltage Generator Quick Connect Cabinet and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install panelboard(s) as specified herein and as shown on the Drawings.

B. The provisions of this Section shall apply to all panelboards, except as indicated otherwise.

1.2 RELATED WORK

A. No references are made to any other section which may contain work related to any other section. The Contract Documents shall be taken as a whole with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or additional work as may be required in those references, and include such information or work as may be specified.

B. Other Divisions

1. The Contractor shall be responsible for examining all Sections of the Specifications and Drawings, and shall determine the power and wiring requirements and shall provide external wiring and raceways, as required to provide a fully functioning power, control and process control systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, the Contractor shall furnish the additional conductors, raceways and/or wiring, with no change in the Contract Price, and with no increase in Contract Time.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Division 1, Section 26 00 00 and as specified herein.

B. Provide systems engineering to produce coordination curves, showing coordination between breakers and/or fuses submitted, such that protective device coordination is accomplished. Such curves and settings shall be included as a part of these submittals.

C. Submittals shall also contain information on related equipment to be furnished under this Specification but described in the related Sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will also be returned without review. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project. Unmarked cut sheets will be cause to reject the submittal and return it for revision without review.

D. Shop Drawings and Product Data. The following information shall be submitted to the Engineer:

1. Master drawing index
2. Front view elevation
3. Top view
4. Nameplate schedule
5. UL Listing of the completed assembly
6. Conduit entry/exit locations
7. Assembly ratings including:
   a. Short-circuit rating
   b. Voltage
   c. Continuous current
8. Major component ratings including:
   a. Voltage
   b. Continuous current
   c. Interrupting ratings
9. Descriptive bulletins
10. Product data sheets.
11. Cable terminal sizes.

E. Operation and Maintenance Manuals.

1. Operation and maintenance manuals shall include the following information:
   a. Manufacturer's contact address and telephone number for parts and service.
   b. Instruction books and/or leaflets
   c. Recommended renewal parts list
   d. Record Documents for the information required by the Submittals paragraph above.

1.4 REFERENCE CODES AND STANDARDS

A. The low voltage panelboard assembly and all components in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. UL 67 - Panelboards
2. UL 50 - Cabinets and Boxes
3. NEMA PB-1 2006 - Panelboards
4. Fed. Spec. W-P-115C

1.5 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of ten years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly. All assemblies shall be of the same manufacturer. Equipment that is manufactured by a third party and "brand labeled" shall not be acceptable.

C. All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.

D. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

E. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, onsite factory work, or failed factory tests will not be permitted.

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the Contractor and Owner. The instructions shall include detailed assembly instructions including but not limited to wiring interconnection diagrams, rigging for lifting, skidding, jacking and moving using rolling equipment to place the equipment, bolt torqueing requirements for bus and all other components which require the installation of bolted connections, and instructions for storing the equipment prior to energizing.

C. Equipment shall be stored indoors and protected from moisture, dust and other contaminants.

D. Equipment shall not be installed until the location is finished and protected from the elements.

1.7 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for one year from date of final acceptance of the equipment. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Contractor at no expense to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable.

1. ABB
2. Eaton
3. Square D

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.2 RATINGS

A. The service voltage, overall short circuit withstand and interrupting rating of the equipment and components shall be as shown on the Drawings, except that the minimum interrupting rating shall be 22,000 amperes RMS symmetrical for 240/120 volt single- phase or 208Y/120 volt three-phase. The minimum interrupting for 480Y/277 volt three-phase shall be 65,000 amperes RMS symmetrical. Panelboards employing series connected ratings for main, feeder and branch devices are not acceptable and shall not be provided.

B. Panelboards shall be UL listed and labeled as suitable for use as service equipment.

C. Where the panelboard is shown or specified to contain a surge protective device (SPD), the complete panelboard, including the SPD, shall be UL67 listed.

D. Panelboards shall be designed for continuous operation, at rated current, in a 40°C ambient.

E. For additional ratings and construction notes, refer to the Drawings.

2.3 CONSTRUCTION

A. General

1. Refer to the Drawings for actual layout and location of equipment and components, and other required details.
2. A nameplate shall be provided listing manufacturer's name, panel type and rating. Nameplates shall be engraved, laminated impact acrylic, matte finish, not less than 1/16-inch thick by 3/4-inch by 2-1/2-inch, Rowmark 322402, or equal. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X 1/2 inch, or equal. Prior to installing the nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residues has been removed. Epoxy adhesive or foam tape is not acceptable.

B. Enclosures

1. General
   - ***a.*** Each enclosure shall be provided with a legend pocket on the inner door.
   - ***b.*** Enclosures shall not have holes or knockouts.
2. NON-METALLIC
   - ***a.*** Chemical Rooms. NEMA 4X constructed as follows:
     - **1)** PVC or Fiberglass reinforced polyester body and door.
     - **2)** UV inhibitors
     - **3)** Luggage type quick release latches
     - **4)** Foam-in-place gasketed doors
3. ALUMINUM
   - ***a.*** NEMA 4X Aluminum
     - **1)** Type 5052 aluminum, body and door
     - **2)** Stainless steel hinge pins
     - **3)** Foam in-place gasket
4. NEMA 12
   - ***a.*** NEMA 12 Steel
     - **1)** Mild Steel body and door

2) Stainless steel hinge Pins

5. Not otherwise Defined
   a. Where an enclosure is not otherwise defined or shown on the Drawing
      1) NEMA 4X Stainless Steel
      2) Type 316 stainless steel, body and door
      3) Stainless steel hinges
      4) Foam in-place gasket
6. NEMA 1 or NEMA 1A boxes shall not be used.

C. Surface Protective Devices (SPDs)

1. Where panelboards are shown or specified to include an SPD, the panelboard manufacturer shall be the manufacturer of the Type 2 SPD, and the SPD shall be located within the panelboard, unless otherwise shown on the Drawings. Refer to Section 26 43 13 for specifications of the SPDs, and the required submittals to be included under this Section. Submittals not containing the required information in Section 26 43 13 will be returned un-reviewed.
2. The SPD shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs. The SPD shall be interfaced to the panelboard via a direct bus bar connection. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options. See Section 26 43 13 for additional requirements.

D. Exteriors

1. Unless otherwise noted, all panels shall be designed for surface mounting.
2. Hinged doors covering all circuit breaker handles shall be provided on all panels.
3. Doors shall have semi flush type cylinder lock and catch, except that doors over 48 inches in height shall have a vault handle and three-point latch, complete with lock, arranged to fasten door at top, bottom and center. Door hinges shall be concealed. Furnish two keys for each lock. All locks shall be keyed alike; directory frame and card having a transparent cover shall be furnished on each door.

E. Interiors

1. At least four studs for mounting the panelboard interior shall be furnished.
2. Interiors shall be so designed that circuit breakers can be replaced without disturbing adjacent units and without removing the main bus connectors and shall be so designed that circuits may be changed without machining, drilling or tapping.
3. All interiors shall be completely factory assembled with circuit breakers, wire connectors, etc. All wire connectors, except screw terminals, shall be of the anti-turn solderless type and all shall be suitable for copper wire of the sizes indicated.

F. Busses

1. All busses, including neutral busses and ground bars, shall be of tin plated copper. Neutral busses shall be full size. Phase bussing shall be full height without reduction. Cross connectors shall be tin plated copper.
2. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.
3. Spaces for future circuit breakers shall be bussed for the maximum device that can be fitted into them.
4. Equipment ground bars, of tin-plated copper, shall be furnished.

5. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. Branch circuits shall be numbered by the manufacturer.

2.4 CIRCUIT BREAKERS

A. Panelboards shall be equipped with circuit breakers with frame size and trip settings as shown on the Drawings.

B. Circuit breakers shall be molded case, bolt-on type.

C. Each circuit breaker used in 208Y/120-volt, three phase, or 120/240 volt single phase, panelboards shall have an interrupting capacity of not less than 22,000 amperes, RMS symmetrical.

D. Each circuit breaker used in 480Y/277 volt and 480 volt panelboards shall have an interrupting capacity of not less than 65,000 amperes, RMS symmetrical.

E. Circuit breakers shall be as manufactured by the panelboard manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount boxes for surface mounted panelboards so there is at least 1/2-inch air space between the box and the wall.

B. Connect panelboard branch circuit loads so that the load is distributed as equally as possible between the phase busses.

C. Type circuit directories giving location and nature of load served. Install circuit directories in each panelboard.

END OF SECTION

SECTION 26 24 19
LOW VOLTAGE MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install assemblies of low voltage motor control centers (MCCs), together with appurtenances, complete and operable, as specified herein and as shown on the Contract Drawings.

B. Automatic transfer switches, automatic transfer schemes, variable frequency drives, SPDs and programmable controllers shall be factory installed by the motor control center manufacturer as shown on the Drawings.

C. Motor control centers shall be sized to include all equipment, spares and spaces shown on the Drawings.

1.2 RELATED WORK

A. Refer to Division 26 00 00 for related work and electrical coordination requirements.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Division 1, Section 26 00 00 and as specified herein.

B. All shop drawing submittals and all O&M submittals shall be submitted in hard copy format and in electronic format using PDF files on a CD and/or a flash drive including a Table of Contents which is indexed on DVDs. Electronic submittals are mandatory and those which are received not indexed as specified will be returned without review. Hard copy submittals may not be required if so stipulated in the Contract Documents. No change in Contract Amount or Contract Time will be allowed for delays due to unacceptable submittals.

C. Provide systems engineering to produce coordination curves, showing coordination between protective devices and breakers and/or fuses submitted, such that protective device coordination is accomplished. Such curves and settings shall be included as a part of these submittals.

D. Submittals shall also contain information on related equipment to be furnished under this Specification but described in the related sections to which reference is made in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will be returned unreviewed.

E. Provide original equipment manufacturer (OEM) created equipment shop drawings, including all wiring diagrams, created in the manufacturer's Engineering department. All equipment shop drawings shall bear the original equipment manufacturer's logo, drawing file numbers, and shall be maintained on file in the OEM's archive file system. Photocopies of the Engineer's ladder schematics are unacceptable as shop drawings.

F. Submit to the Owner/Engineer, shop drawings and product data, for the following:

1. Equipment outline drawings showing elevation and plan views, dimensions, weight, shipping splits and metering layouts. Indicate all options, special features, ratings and deviations from the Specifications.
2. Conduit entrance drawings, including floor penetrations.
3. Bus arrangement drawings.
4. Unit summary tables showing detailed equipment description and nameplate data for each compartment.
5. Product data sheets and catalog numbers for overcurrent protective devices, motor starters, control relays, control stations, meters, pilot lights, etc. List all options, trip adjustments and accessories furnished specifically for this project. Clearly mark each sheet to indicate which items apply and/or those items that do not apply. Unmarked cut sheets will cause rejection of the submittal and its return for revision.
6. Provide control systems engineering to produce custom unit elementary drawings showing interwiring and interlocking between units and to remotely mounted devices. Show wire and terminal numbers. Indicate special identifications for electrical devices per the Drawings.
7. Master drawing index
8. Front view elevation
9. Floor plan
10. Top view
11. Single line
12. Schematic diagram, including manufacturer's selections of component ratings, and CT and PT ratios.
13. Nameplate schedule
14. UL Listing of the completed assembly.
15. Component list with detailed component information, including original manufacturer's part number.
16. Conduit entry/exit locations
17. Assembly ratings including:
    a. Short-circuit rating
    b. Voltage
    c. Continuous current
18. Major component ratings including:
    a. Voltage
    b. Continuous current
    c. Interrupting ratings
19. Descriptive bulletins
20. Product data sheets.
21. Number and size of cables per phase, neutral if present, ground and all cable terminal sizes.
22. Key interlock scheme drawing and sequence of operations
23. Busway connection and amperage rating.
24. Instruction and renewal parts books.
25. Itemized list of spare parts furnished specifically for this project, including quantities, description and part numbers.

G. Harmonic distortion calculations for Variable Frequency Drives (VFDs).

H. Factory Tests. Submittals shall be made for factory tests specified herein.

I. Field Test Reports. Submittals shall be made for field tests specified herein.

J. Operation and Maintenance Manuals.

1. Operation and maintenance manuals shall include the following information:
   a. Manufacturer's contact address and telephone number for parts and service.
   b. Instruction books and/or leaflets
   c. Recommended renewal parts list
   d. Record Documents for the information required by the Submittals paragraph above.

K. Submit for approval, a manufacturer's conducted training agenda for all training specified herein. Training agenda shall not be submitted until final approval of the Operation and Maintenance Manual.

1.4 REFERENCE CODES AND STANDARDS

A. The low voltage motor control centers and all components in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. NEMA Standard ICS 2 – 2000 Industrial Control and Systems
2. UL 845 – Electric Motor Control Centers
3. NEMA Standard SG-3 – Low Voltage Power Circuit Breakers
4. NFPA 70 – National Electrical Code (NEC)
5. NFPA 70E – Standard For Electrical Safety in the Workplace
6. UL 1008 – Transfer Switches
7. UL 991 - Tests for Safety-Related Controls Employing Solid-State Devices
8. NFPA 110 – Emergency and Standby Power Systems
9. NEMA ICS 10 – AC Transfer Switch Equipment
10. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems

B. All equipment components and completed assemblies specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.5 QUALITY ASSURANCE

A. The manufacturer of the equipment provided shall have produced similar equipment for a minimum period of ten years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The manufacturer of the assembly provided shall be the manufacturer of the major components within the assembly. All assemblies provided shall be manufactured by the same manufacturer. Equipment that is manufactured by a third party and "brand labeled" will not be acceptable.

C. All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.

D. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.

E. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, complete all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, onsite factory work, or failed factory tests will not be permitted.

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the Contractor and Owner/Engineer.

C. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.

D. Equipment shall be equipped to be handled by crane. Where cranes are not available, equipment shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

E. Equipment shall be installed in its permanent finished location shown on the Drawings within seven calendar days of arriving onsite. If the equipment cannot be installed within seven calendar days, the equipment shall not be delivered to the site, but stored offsite, until such time that the site is ready for permanent installation of the equipment with no change in Contract Price or Schedule.

F. Space heaters provided in equipment shall be provided with temporary electrical power to operate during jobsite storage and after equipment is installed in permanent location. Space heater operation shall be continuous until equipment is powered and placed in service.

1.7 WARRANTY

A. Provide warrantees, including the manufacturer’s warrantee, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for two years, from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Eaton
2. ABB
3. Rockwell Automation

4. Siemens
5. Schneider Electric/Square D

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.2 RATINGS

A. The service voltage, overall short circuit withstand and interrupting rating of the equipment and devices shall be as shown on the Drawings. Main and feeder circuit protective devices shall be fully rated for the specified short circuit duty. Systems employing series connected ratings for main and feeder devices shall not be used. Motor starter units shall be tested and UL labeled for the specified short circuit duty in combination with the motor branch circuit protective device.

B. The continuous current rating of the main horizontal bus shall be as shown on the Drawings. Vertical busses shall be sized for the structure load and shall have a minimum rating of 300 amperes.

C. Motor control centers, including devices, shall be designed for continuous operation at rated current in a 40°C ambient temperature.

D. For additional ratings and construction notes, refer to the Drawings.

2.3 CONSTRUCTION

A. General

1. Refer to Drawings for: actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.
2. Control units shall be arranged as shown on the Drawings.
3. Provide a factory-installed dedicated Point of Utilization Device (SPD) specified in Section 26 43 13, Individual Control Panel and Related Equipment Protection (Type 3), and Section 26 17 13, Power Metering and Protective Relays when the equipment contains a programmable logic controller (PLC) or a uninterruptible power supply (UPS) or Protective Relay devices, or is otherwise indicated on the drawings.
4. Nameplates
   a. External

1) Furnish nameplates for each device as specified herein and as indicated on the Drawings. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. There shall be a master nameplate that indicates equipment ratings, manufacturer's name, shop order number and general information. Cubicle nameplates shall be mounted on the front face. Nameplates shall be engraved, laminated impact acrylic, matte finish, not less than 1/16-inch thick by 3/4-inch by 2-1/2-inch, Rowmark 322402. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X 1/2 inch, or equal. Prior to installing the nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residue has been removed. Epoxy adhesive or foam tape is not acceptable.

b. Internal
   1) Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification, corresponding to appropriate designations on manufacturer's wiring diagrams.

c. Special
   1) Identification nameplates shall be white with black letters, caution nameplates shall be yellow with black letters, and warning nameplates shall be red with white letters.

5. Control Devices and Indicators
   a. All operating control devices, indicators, and instruments shall be securely mounted on the panel door. All controls and indicators shall be 30-millimeter, corrosion resistant, NEMA 4X/13, anodized aluminum or reinforced plastic. Booted control devices are not acceptable. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.
   b. Indicator lamps shall be LED type. For all control applications, indicator lamps shall incorporate a push-to-test feature. Lens colors shall be as follows:
      1) Red for ON, Valve OPEN, and Breaker CLOSED.
      2) Green for OFF, Valve CLOSED and Breaker OPEN.
      3) Amber for FAIL.
      4) Blue for READY
      5) White for POWER ON.
   c. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, etc.) shall be as shown on the Drawings. Units shall have the number of positions and contact arrangements, as required. Each switch shall have an extra dry contact for remote monitoring.
   d. Pushbuttons, shall be as follows:
      1) Red for STOP, Valve OPEN, Breaker OPEN and mushroom Red for EMERGENCY STOP.
      2) Green for START, Valve CLOSE and Breaker CLOSE.
      3) Black for RESET.
   e. Furnish nameplates for each device. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. Device mounted nameplates are not acceptable.

f. The manufacturer shall not remove, reuse, alter, or replace original equipment nameplates or equipment tags associated with equipment or components supplied by the manufacturer's suppliers and sub-suppliers.

6. Control and Instrument Power Transformers
   a. Control power transformers, encapsulated, shall be provided where shown on the Drawings. Transformer shall be sized for the entire load, including space heaters, plus 25% spare capacity, and shall be not less than 100 VA. Provide a load calculation showing the sizing of the control power transformer complies with this requirement.
   b. Control power transformers shall be 120 volts grounded secondary. Primary side of the transformer shall be fused in both legs. One leg of the transformer secondary shall be solidly grounded while the other leg shall be fused.

B. Enclosures

1. Structures shall be NEMA Type 1A unless noted otherwise on the Drawings.
2. Motor control centers shall consist of a series of metal enclosed, free standing, dead front vertical sections bolted together to form double wall construction between sections. Individual vertical sections shall be nominally 90 inches high, 20 inches wide and 20 inches deep unless otherwise shown on the Drawings. Vertical sections shall be mounted on steel channel sills. Bottom channel sills shall be mounted front and rear of the vertical sections extending the full width of each shipping split. Top of each section shall have removable plates with lifting angle. MCCs shall be constructed to allow field installation of additional sections to each end and shall be provided with full depth cover plates (rodent barriers) at each end of the motor control center channel sills.
3. Provide continuous top and bottom horizontal wireways extending the full width of the lineup, isolated from the horizontal bus. Provide a four-inch wide, full height, vertical wire way in each section, equipped with a hinged door and cable supports. Vertical wire way shall be isolated from the bus and device compartments. Wireways or other metal member's openings shall have rolled edges or protective grommets.
4. All cables shall enter and exit underground from the bottom of the structure, unless otherwise shown on the Drawings.
5. Provide individual, flange formed, pan type door with concealed hinges and quarter turn latches for each device compartment and future space. Doors shall be removable. Door removal shall not be required to withdraw starter units or feeder tap devices.
6. Motor control centers shall be designed for mounting against the wall or back-to-back with another MCC. All wiring, bus joints and other mechanical parts requiring tightening or other maintenance shall be accessible from the front or top.
7. Each vertical section shall be divided into no more than six compartments which shall contain a feeder breaker, combination motor control unit, or other control assemblies connected to a common vertical power bus.
8. Vertical sections shall contain horizontal wire ways at top and bottom of the structure. The design shall be such to permit a continuous wiring trough from end to end of the entire width of the motor control center. End vertical sections shall have cover plates, which can be easily removed to allow continuation of wire ways and horizontal bus extensions for future addition of vertical sections.

9. The vertical section shall also have a continuous vertical raceway extending the full height of the structure and shall intersect with the horizontal raceways. This wire way shall be provided with barriers which completely isolate the wire way from the bus compartments, the controller compartment, and the adjacent vertical units. The wire way shall have its own separate hinged door.
10. Combination motor control units (Size 5 and smaller), as well as other electrical assemblies, including feeder tap units (225 ampere and smaller), shall be provided with appropriately rated stab assemblies for draw out (plug-in) type construction.
11. Plug in provisions shall include a positive guide rail system and stab shrouds to insure alignment of stabs with the vertical bus. The stab shall be designed to increase bus contact pressure during a fault. The stab design shall assure a consistent low-resistance contact with the vertical bus, even after repeated insertions and removals. The unit shall be equipped with a lockout mechanism to lock the drawer in an extended or stabbed position for maintenance and testing. Each draw out compartment shall have a separate hinged removable door.
12. Each unit compartment shall be provided with an individual front hinged door. Motor control and feeder units shall be interlocked mechanically with a unit disconnect device to prevent unintentional opening of the door while unit is energized. An interlock between the unit disconnect and the structure shall prevent the removal or reinsertion of the unit when the unit is in the "ON" position. Means shall be provided for releasing the interlock for intentional access and/or application of power. Pad locking arrangements shall permit locking the disconnect device in the "OFF" position.
13. The MCC shall be furnished as a completely factory assembled unit where transportation facilities and installation requirements permit. Minimize shipping splits if required.
14. All painted steel work shall be treated with a primer coat and a finish coat, or bonderized and finished with a coat of baked enamel at the factory, such that no field painting will be required except for "touching up" of damaged areas. Color shall be manufacturer’s standard.
15. Furnish documentation with the equipment as follows: Compartments containing panel boards shall have a card holder on the inside of the door with the branch circuits clearly identified. Compartments containing motor starters shall each have an overload heater section table posted inside the door. All control compartments shall have a pocket on the inside of the door with a copy of the appropriate schematic and wiring diagram.
16. Where the motor control center is shown outdoors the construction shall be NEMA 3R and shall be as follows:
    a. The MCC shall be non-walk-in weatherproof construction of basic indoor equipment enclosed in a weatherproof enclosure. Gasket all covers, provide filters for ventilation louvers and a sloped roof.
    b. The MCC shall be supported on a heavy gauge, welded steel channel base extending around all four sides, constructed to exclude rodents, vermin, and dust.
    c. All non-current carrying metal parts of the control center assembly shall be cleaned of all weld spatter and other foreign material and given a heat cured, phosphatized chemical pretreatment to inhibit rust.

d. Roof structure shall be watertight with a continuous drip edge channel on the front. Roof shall slope to the rear for water drainage. Holes for lifting eyes shall be blind tapped.
e. Provide tamper resistant, pad lockable, weathertight, gasketed cubicle doors and switch handle covers, with stainless steel hinge pins.
f. Each vertical section shall have heavy duty, 240 volts AC, space heaters, thermostat controlled, of sufficient capacity to prevent condensation with the equipment de-energized, while operating at half their rated voltage. Heaters shall be provided with perforated metal guards and a circuit breaker disconnect. 120-volt AC control power shall be provided from the MCC.

C. Construction

1. Provide individual compartments for each removable combination starter and feeder tap device unit. Each vertical section shall accommodate a maximum of six compartments. Steel barriers shall isolate the top, bottom and sides of each compartment from adjacent units and wireways. Removable units shall connect to the vertical bus in each section with tin plated, self-aligning, pressure type copper plug connectors. Size 6 and larger starter units may be wired directly to the bus. Removable units shall be aligned in the structure on guide rails or shelves and secured with a cam latch mechanism or racking screw.
2. Provide individual, isolated compartments for fixed mounted devices such as circuit breakers, cable lugs, metering, relaying and control devices. Main and bus tie circuit breakers shall be wired directly to the main horizontal bus. All bus connections shall be fully rated.
3. Provide the following features:
   a. Provision to padlock removable units in a partially withdrawn TEST position, with the bus stabs disengaged.
   b. Provision to padlock unit disconnect handles in the OFF position with up to three padlocks.
   c. Mechanical interlock with bypass to prevent opening unit door with disconnect in the ON position, or moving disconnect to the ON position while the unit door is open.
   d. Mechanical split type terminal blocks for disconnecting external control wiring.
   e. Auxiliary contact on unit disconnect to isolate control power when fed from an external source.
   f. Disconnect operating handles and control devices.

D. Bus Systems

1. The bus support system shall be high dielectric strength, low moisture absorbing high impact material.
2. Bus bracing shall be minimum 65,000 amperes RMS symmetrical, and be equal to or exceed the value shown on the Drawings.
3. Busses shall have uniform cross-sectional area throughout their length. Tapered bus will not be acceptable.
4. All bolted bus mating surfaces and splicing material shall be the same plated material as the bus.
5. The main horizontal bus shall extend the entire length of the motor control center. The main bus bars shall be rated as shown on the Contract Drawings but shall not be less than 600 amperes.

6. Main horizontal bus: Tin plated copper, bolted joints, accessible from the front of the structure, fully rated throughout the lineup, and factory insulated by taping. All field assembled joints shall be taped after installation, equal to the factory bus taping.
7. Vertical section bus: Tin plated copper, full height, totally insulated and isolated by labyrinth design barrier of glass-reinforced polyester, or sandwich insulated/isolated busses, with shutters to cover stab openings when units are withdrawn. Provide fish tape barriers to isolate bottom wireways from lower ends of vertical bus. Bus shall be provided in each vertical draw out section.
8. Vertical busses used for a tie circuit breaker or tie feeder lugs shall be rated for a continuous capacity equivalent to the main horizontal bus rating.
9. Horizontal ground bus: Provide a 300A minimum, continuous tin-plated copper ground bus in each section equipped with lugs for termination of feeder and branch circuit ground conductors. Connect to ground bus in adjacent sections with splice plates. Provide ground bolted connectors for 2/0 AWG minimum wire at each end of the bus.

E. Wiring

1. Wiring: Stranded tinned copper, minimum size #14 AWG, with 600 volt, 90°C, flame retardant, Type SIS cross-lined polyethylene insulation, NEMA Class II, Type B. Line side power wiring shall be sized for the full rating or frame size of the connected device. All conductors #1/0 AWG and larger shall be terminated with long barrel NEMA two-hole lugs.
2. Identification: Numbered sleeve type wire markers at each termination point, color coding per NEMA standards and the NEC. Foreign voltage control wiring shall be yellow.
3. All control wiring to draw out units shall be run through split type terminal blocks (draw out) which can be split to allow easy unit removal. Motor “T” leads shall bolt directly to starter or overloads and shall not utilize split type terminal blocks. Terminal blocks shall be of the fully shielded, tubular screw clamp type, resilient collar design to eliminate loose connections. Terminal blocks shall be nickel or tin plated and have exposed wire numbering corresponding to the connected wires. Terminals shall have a maximum of two wires per terminal.
4. All wiring shall be neatly bundled with ty-raps and supported to wire way supports. Control wiring shall be bundled separately from power wiring. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.
5. Where “shipping splits” are required between the control compartments and the starter cubicles, interconnecting jumper wires shall be provided for field re-connection.
6. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.
7. In general, all conduit entering or leaving a motor control center shall be stubbed up into the bottom horizontal wire way directly below the vertical section in which the conductors are to be terminated or shall enter the motor control center from the top. Conduits shall not enter the motor control center from the side unless approved in writing by the Owner/Engineer.

8. All field wiring and all field-installed internal wiring shall be tagged and coded with an identification number as shown on the Drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE, or equal.

F. Main Section

1. The MCC main sections shall include the main and tie breakers, metering and power feeder entrance to the MCC. Where a power feeder entrance is shown on the Drawings, the power feeder entrance section shall be provided. Provide bus extensions and compression lugs for number and size of incoming cables as shown on the Drawings. Where main and tie breakers are shown to be key interlocked, interlocks shall be Kirk-Key type.
2. Where Kirk-Key arrangements are used, the Kirk keyed interlocks shall be Kirk HD Series (Heavy Duty) 316 Series of 316 stainless steel or approved equal.

G. Surge Protective Devices

1. Furnish where shown on the Drawings, or specified herein, a manufacturer provided and installed, Low Voltage Surge Protective Devices (SPD) (Type 2), as specified in Section 26 27 13 of these Specifications. Connection to the MCC shall be with a surge rated disconnect, mounted integral to the MCC.

H. Main Circuit Protective Devices

1. Unless otherwise shown on the Drawings, single main or main-tie-main circuit breakers, with a frame rating of 1200 amperes or less, shall be molded case (MCCB), three-pole, 600 volt, fixed type, manually operated with stored energy closing mechanism. Trip device shall be solid state with adjustable long time, short time with short time i2t switch, adjustable instantaneous settings, and adjustable ground fault settings with i2t switch. A remote energy-reduction maintenance switch with local indication connected to the instantaneous setting shall be provided to reduce the setting to minimum to reduce arc flash during equipment maintenance
2. Insulated case and molded breakers shall have a UL 489 listing.

I. Feeder Protective Devices (Non-Motor Loads)

1. Unless otherwise shown on the Drawings, feeder circuit breakers, 1200 ampere down to 250-ampere, shall be molded case, three-pole, 600-volt, fixed type, manually operated with stored energy closing mechanism. Trip device shall be solid state with adjustable long time pickup, adjustable instantaneous and overload, short circuit and indicator lights. On breakers rated 1200 amperes, provide a remote energy-reduction maintenance switch with local indication connected to the instantaneous setting shall be provided to reduce the setting to minimum to reduce arc flash during equipment maintenance
2. Unless otherwise shown on the Drawings, feeder circuit breakers, less than 250 ampere- frame, shall be molded case, three-pole, 600-volt, fixed type, manually operated with over-center toggle mechanism.
3. All circuit breakers shall have trip units of the modular type for easy changing of trip range.
4. All Main and Feeder circuit breakers shall have provision for padlocking in the OFF position.

J. Interlocks

1. Electrical, mechanical and Kirk-Key interlocks shall be provided on breakers where shown on the Drawings.
2. Where Kirk-Key arrangements are used, the Kirk keyed interlocks shall be Kirk HD Series (Heavy Duty) 316 Series of 316 stainless steel or approved equal.

K. Control and Instrument Power Transformers.

1. Control power transformers shall be provided where shown on the Drawings. Transformer shall be sized for the entire load, including space heaters, plus 25% spare capacity. Provide a load calculation showing that the sizing of the control power transformer complies with this requirement.
2. Control power transformers shall be 120-volt grounded secondary. Primary side of the transformer shall be fused in both legs. One leg of the transformer secondary shall be solidly grounded while the other leg shall be fused.

L. Furnish lugs for incoming line feeders, sizes as shown on the Drawings. Allow adequate clearance for bending and terminating of cable size and type specified.

2.4 MOTOR CONTROLLERS

A. General

1. The Drawings indicate the approximate horsepower and intended control scheme of the motor driven equipment. Provide the NEMA size starter, circuit breaker trip ratings, control power transformers and thermal overload heater element ratings matched to the motors and control equipment supplied, in compliance with the NEC and the manufacturer's heater selection tables. All variations necessary to accommodate the motors and controls as actually furnished shall be made without extra cost to the Owner.
2. Motor starters shall be as shown on the Drawings. All motor starters shall be combination units, full voltage non-reversing (FVNR), with adjustable instantaneous trip magnetic only circuit breakers, or motor circuit protectors (MCP), unless otherwise specified or shown on the Drawings. NEMA starter sizes and breaker trip ratings shall be as required for the horsepower indicated but shall be in no case less than NEMA Size 1. If the manufacturer of the equipment utilizing the motor, supplies a motor horsepower larger than that shown on the Drawings, the Contractor shall supply a motor starter sufficient in size to control the motor supplied. International (IEC) starters shall not be acceptable.
3. Each motor starter shall have a 120-volt operating coil unless otherwise noted.
4. NEMA Size 5 and smaller shall be draw out design with stab-on connectors engaging the vertical buses. Larger units shall be of the fixed (bolt-in) design.
5. Overload relays shall be standard Class 20, ambient compensated, manually reset by pushbutton located on front of the compartment door. A normally closed contact shall be directly used in the start circuit and a normally open contact shall be wire to a terminal board for overload alarm.
6. Control power transformers shall be 120-volt grounded secondary. Primary shall be fused with slow blow fuses in each phase. One leg of the transformer secondary shall be solidly grounded while the other leg shall be fused. The transformer shall be oversized for auxiliary loads as indicated on drawings, but in no case be smaller than 100 VA.

7. Combination starters shall include a motor circuit protector (MCP) in series with a motor controller and an overload protective device. The MCP shall have an adjustable magnetic trip range in percent of rated continuous current and a trip test feature. MCP's shall be labeled in accordance with UL489.
8. Where indicated on the Control Schematic title, motor starter logic shall be contained in a PLC with Modbus TCP Ethernet Communications. The PLC shall not be affected by VFD frequency interference. The PLC shall be programmed by the manufacturer using the control schematics shown on the Drawings.

B. Magnetic Motor Starters
1. Motor starters shall be two or three pole, single or three-phase as required, 60 Hertz, 600 volt, magnetically operated, full voltage non reversing except as shown on the Drawings. NEMA sizes shall be as required for the horsepower shown on the Drawings. IEC rated starters are unacceptable.
2. Each motor starter shall have a 120-volt operating coil, and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as shown on the Drawings. A minimum of one normally open and one normally closed auxiliary contacts shall be provided in addition to the contacts shown on the Drawings.
3. Overload relays shall be adjustable, ambient compensated and manually reset.
4. Control power transformers shall be sized for additional load of 100 VA or an additional 10% whichever is larger. Transformer primary shall be equipped with slow blow fuses. Control power transformers shall not be located behind other components and shall be accessible for removal or replacement without removing any other component.
5. Built in control stations and indicating lights shall be furnished where shown on the Drawings.
6. All wires shall be terminated on terminal blocks and shall be tagged.
7. The control compartment shall have a copy of the appropriate schematic and wiring diagram.

C. Combination Magnetic Motor Starters
1. Motor starters shall be a combination motor circuit protector and contactor, two or three pole, single or three-phase as required, 60 Hertz, 600 volt, magnetically operated, full voltage non reversing unless otherwise shown on the Drawings. NEMA starter sizes shall be as shown on the Drawings. If the motor supplied by the equipment supplier is larger than that shown on the Drawings, supply a larger starter size corresponding to the motor supplied. Motor circuit protectors shall be molded case with adjustable magnetic trip only. They shall be specifically designed for use with magnetic motor starters. Motor circuit protectors shall be current limiting type, with additional current limiters if required. IEC rated starters are unacceptable.
2. Each motor starter shall have a 120-volt operating coil, and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as shown on the Drawings. A minimum of one normally open and one normally closed auxiliary contacts shall be provided in addition to the contacts shown on the Drawings.
3. Overload relays shall be adjustable, ambient compensated and manually reset.

4. Control power transformers shall be sized for additional load of 100 VA or an additional 10% whichever is larger. Transformer primary shall be equipped with time delay fuses.
5. Built in control stations and indicating lights shall be furnished where shown on the Drawings.
6. All wires shall be terminated on terminal blocks and shall be tagged.
7. The control compartment shall have a copy of the appropriate schematic and wiring diagram.

D. Combination Contactors

1. Combination contactors shall be a circuit breaker and contactor, 600 Volt, three-pole, 60 Hertz, magnetically operated. NEMA size shall be as required for the kilowatt ratings shown on the Drawings, but shall be not less than NEMA size 1.
2. Contactors shall have a 120-volt operating coil and control power transformer. Furnish the control power transformer with extra capacity for the unit heater fan.
3. Combination Contactors used for lighting control shall be as specified herein, magnetically operated, with the number of channels and poles as shown on the Drawings. Each contactor shall be controlled by an Astronomic Time Clock Tyco Model TC-100, or approved equal.

E. Control Relays

1. Control relays shall be 300-volt, industrial rated, plug-in socket type, housed in a transparent polycarbonate dust cover, designed in accordance with UL Standard 508 for motor controller duty. Continuous contact rating shall be 10 amperes resistive, 1/4 HP at 120 volts AC, operating temperature minus 10 to plus 55°C. Provide spare normally open and normally closed contacts. Relays shall be Potter & Brumfield KRP Series or equal with neon coil indicator light. Timing relays shall be 300-volt, solid state type, with rotary switch to select the timing range. Pneumatic timing relays are unacceptable.

2.5 METERING AND PROTECTIVE RELAYS

A. Where an elapsed time meter is specified or shown on the Drawings, a six digit, non-resettable elapsed time meter shall be installed on the face of each motor starter. Meter shall be as specified in Section 26 27 13.

B. A 100VA minimum UPS shall be provided, powered from the control power transformer to provide control power to the feeder management relays and power quality meters.

C. Furnish where shown on the Drawings, a Power Quality Meter (PM1), for each Main or Feeder Breaker, as shown on the Drawings and as specified in Section 26 27 13 Power Metering and Protective Relays.

2.6 REMOTE MONITORING AND CONTROL INTERFACE

A. General: All control and interconnection points from the equipment to the plant control and monitoring system shall be brought to a separate connection box. No field connections shall be made directly to the equipment control devices. Functions to be brought out shall be as described in the Control Strategies in Section 40 61 96.

B. Discrete control or status functions shall be form C relays with contacts rated at 120 volts AC. Analog signals shall be isolated from each other.

C. Equipment functions to be directly interfaced to the Plant Control and Monitoring System, shall be designed for operation with an Ethernet Connection.

D. The equipment manufacturer shall factory enter the proper IP Address for such connection. Upon request by the Contractor, the Owner/Engineer will provide the proper Internet Protocol Address (IP Address), to be configured by the equipment manufacturer.

E. Refer to Section 40 61 93 Instrumentation Input Output List for monitored parameters.

F. Communication

1. For remote monitoring, one of the following communication capabilities shall be provided:
   a. One integral 10/100BaseT Ethernet port supporting Modbus TCP, Ethernet IP and SNMP protocols.
   b. One media protocol converter, interfacing the provided equipment to a 10/100BaseT Ethernet port supporting Modbus TCP, Ethernet IP and SNMP.
2. The protocol interface shall implement the following:
   a. All data shall be available and/or mirrored within the Modbus 4x or "Holding Register" memory area.
   b. Register 4x00001 shall exist and be readable to allow simple, predictable "comm tests".
3. The media protocol converter shall meet the following criteria:
   a. The converter shall support 10/100Base-T Ethernet. The serial port speed (baud rate) shall support 230kbps. The protocol shall support Modbus TCP, Ethernet IP, DF1, and Modbus RTU/ASCII. Protocol shall be Web Browser configurable.
   b. Operating limits shall be 0-60°C, with humidity range minimum of 5-90%. Shock capability on the serial port shall be ESD +15 kV air gap meeting IEC 1000-4-2. Power requirements shall be 9-30 volts DC at 0.5 amperes minimum.
   c. The converter shall have LED status for serial, signals, power, and Ethernet.
   d. The converter housing shall be UL 1604, Class 1 Div. 2, DIN Rail mountable. The converter shall have DB-9M port connection, with screw terminals, to the input.
   e. Converter shall be Digi One IAP, or approved equal.

2.7 ACCESSORIES

A. Provide the following accessories.

1. Furnish and install a non-conducting switchboard floor mat, minimum 3/8-inch-thick by 3 feet wide, meeting ANSI/ASTM D-178-01 Type 2 Class 3, Wearwell 702 or equal, and extending the full length of the equipment lineup.

2.8 SPARE PARTS

A. Provide the following spare parts:

1. Three – Control fuses of type used.
2. One dozen each of cover bolts, spring nuts and door fasteners.
3. One quart or 12 aerosol cans of touch-up paint.

B. Spare parts shall be boxed or packaged for long term storage and clearly identified on the exterior of package. Identify each item with manufacturers name, description and part number

2.9 FACTORY TESTING

A. The Motor Control Center shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer's routine shop tests and any other additional operational test to insure the workability and reliable operation of the equipment.

B. Prior to factory testing, the manufacturer shall check to see that all selections and settings required by the Power System Study Engineer have been performed.

C. Factory test equipment and test methods shall conform with the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards.

D. The operational test shall include the proper connection of supply and control voltage and, as far as practical, a mockup of simulated control signals and control devices shall be fed into the boards to check for proper operation.

E. The manufacturer shall provide three certified copies of factory test reports as specified in Paragraph 1.03F.

PART 3 - EXECUTION

3.1 MANUFACTURER'S REPRESENTATIVE

A. Provide the services of a qualified factory-trained manufacturer's field engineer to assist in installation and start-up of the equipment specified under this Section for a period of not less than two working days, with not less than one working day per motor control center. The manufacturer's field engineer shall provide technical direction and assistance in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

B. Provide three copies of the manufacturer's field-testing report.

3.2 INSTALLER'S QUALIFICATIONS

A. Provide an installer who shall be specialized in installing low voltage motor control centers with minimum five years documented experience. Experience documentation shall be submitted for approval prior to beginning work on this project.

3.3 EXAMINATION

A. Examine installation area to assure there is enough clearance to install the equipment.

B. Housekeeping pads shall be included for the motor control centers as detailed on the Drawings except for motor control centers which are to be installed adjacent to an existing unit. Housekeeping pads for these (if used) shall match the existing installation.

C. Check concrete pads and baseplates for uniformity and level surface.

D. Verify that the equipment is ready to install.

E. Verify field measurements are as instructed by manufacturer.

3.4 INSTALLATION

A. Install all equipment per the manufacturer's recommendations and Contract Drawings.

B. Install required safety labels.

3.5 FIELD QUALITY CONTROL

A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.

3.6 FIELD ADJUSTING

A. Adjust all circuit breakers, switches, access doors, operating handles for free mechanical and electrical operation as described in manufacturer's instructions.

B. The Power Monitoring and Protective Relays shall be set in the field by a qualified representative of the manufacturer, in accordance with settings designated in a coordinated study of the system as required in Section 26 05 73 Power System Study. All such settings, including the application of arc flash labels, shall have been made and Approved by the Owner/Engineer, prior to energizing of the equipment.

C. Return spare Kirk keys to the Owner after final acceptance.

3.7 FIELD TESTING

A. Provide a manufacturer’s field engineer who shall make all electrical field tests recommended by the manufacturer. Disconnect all connections to solid-state equipment prior to testing.

B. Megger and record phase to phase and phase to ground insulation resistance of each bus section. Megger, for one minute, at minimum voltage of 1000 volts DC. Measured Insulation resistance shall be at least 100 megohms. In no case shall the manufacturer’s maximum test voltages be exceeded.

C. Complete the following test forms:

1. Motor Control Center Test Report: Before energizing the motor control center, perform megohm meter tests. The measurements shall be made on all phase busing and the data checked for conformance with typical manufacturer’s data. The tests shall adhere to manufacturer’s testing recommendations for the proper testing methods and test voltage levels for each piece of equipment. Readings that fall below manufacturer’s recommended values will not be acceptable. Provide any necessary remedial action before the busing is energized. A data sheet and test report shall be submitted to the Owner/Engineer for each MCC and shall be reviewed and approved prior to energization of the MCC. The test report shall include the following equipment information:
    a. MCC (SB or PNL) Name and number:
    b. MCC (SB or PNL) manufacturer
    c. MCC (SB or PNL) Nameplate data:
        1) Volts:
        2) Horizontal bus amps:
        3) Main breaker amps:
    d. Insulation test (measured):
        1) Phase A-B:
        2) Phase B-C:
        3) Phase C-A:
        4) Phase A-G:
        5) Phase B-G:
        6) Phase C-G:

e. Equipment disconnected during test:
f. Date of test:
g. Tested by:

D. Test reports showing unsatisfactory results may require the removal of all defective or suspected materials, equipment and/or apparatus, and their replacement with new items as determined by the Owner/Engineer with no change in the Contract Price or Schedule allowed. Retesting, if required by the Owner/Engineer shall be done with no change in Contract Price or Schedule.

E. Test each key interlock system for proper functioning.

F. The manufacturer's field engineer shall perform field measurements, of both the voltage and current harmonic distortion at the point of common coupling with operating conditions to determine compliance with the Specifications.

3.8 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

3.9 EQUIPMENT PROTECTION AND RESTORATION

A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

3.10 MANUFACTURER'S CERTIFICATION

A. Provide a qualified factory-trained manufacturer's representative who shall personally inspect the equipment at the jobsite and shall certify in writing that the equipment has been installed, adjusted, and tested, in accordance with the manufacturer's recommendations, including all settings designated in the Power System Study.

B. Provide three copies of the manufacturer's representative's certification.

3.11 TRAINING

A. Provide manufacturer's services for training of plant personnel in operation and maintenance of the equipment furnished under this Section.

B. The training shall be for a period of not less than one eight-hour day.

C. The cost of training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.

D. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.

E. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, motor starters, protective devices, metering, and other major components.

F. The Owner reserves the right to videotape the training sessions for the Owner's use.

END OF SECTION

SECTION 26 27 13
POWER METERING AND PROTECTIVE RELAYS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section of the Specifications describes the requirements for power metering and protective relays to be furnished under other Sections of the Specifications to which reference is made in the Related Work paragraph of this Section.

B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.

1.2 RELATED WORK

A. Refer to Division 26 00 00 and the Contract Drawings, for related work and electrical coordination requirements.

1.3 SUBMITTALS

A. Refer to Division 26 00 00 for media and format for shop drawing submittals.

B. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project. Unmarked cut sheets will cause the submittal to be rejected and returned for revision.

C. Submittals shall also contain information on related equipment to be furnished under this Specification. Incomplete submittals not containing the required information on the related equipment will also be returned without review.

D. Submit catalog data for all items supplied from this specification Section as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc., enough to confirm that the meter or relay provides every specified requirement. Any options or exceptions shall be clearly indicated.

E. Operation and Maintenance Manuals.

1. Operation and Maintenance manuals shall include the following information:
    a. Manufacturer’s contact address and telephone number for parts and service.
    b. Instruction books and/or leaflets
    c. Recommended renewal parts list
    d. Record Documents for the information required by the Submittals above.

1.4 REFERENCE CODES AND STANDARDS

A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. NEMA/ISCI – 109 Transient Overvoltage Withstand Test
2. IEEE Std. 472/ANSI C37.90A Surge Withstand Capability Tests
3. IEC 255.4 Surge Withstand Capability Tests

B. All meters, relays and associated equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.

C. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

1.5 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. Equipment submitted shall fit within the space or location shown on the Drawings. Equipment which does not fit within the space or location is not acceptable.

C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.6 WARRANTY

A. Provide warrantees, including the manufacturer's warrantee, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for three years from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner

PART 2 - PRODUCTS

2.1 GENERAL

A. Metering and Protective Relay Enclosures
   1. Enclosures for meters and protective relays located within the associated equipment shall have the same Enclosure Types as specified for the associated equipment.

B. Settings
   1. Refer to Section 26 05 73 Power System Study for relay settings.

2.2 MOTOR PROTECTION SYSTEM (MP4)

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Multilin 469
   2. Schweitzer Engineering Laboratories Model SEL-710
   3. No equal

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Minimum ANSI Functions

ANSI Function	Description	Setting
14	Speed Switch	[Enabled] [Not Used]

ANSI Function	Description	Setting
19	Reduced Voltage Start	[Enabled] [Not Used]
27	Under voltage	[<85%] [Not Used]
32	Jam/Acceleration	[Enabled] [Not Used]
37	Undercurrent/Under voltage	[Per motor vendor recommendation] [Not Used]
38	Bearing Temperature	[Enabled] [Not Used]
46	Current Unbalance	[Enabled] [Not Used]
47	Voltage Unbalance / Phase Reversal / Phase Failure	[Enabled] [Not Used]
49	Stator Temperature	[Enabled] [Not Used]
50	Instantaneous Current	According to protective device coordination study
50G	Instantaneous Ground Current	According to protective device coordination study
51	Overcurrent	According to protective device coordination study
51G	Ground Overcurrent	According to protective device coordination study
55	Power Factor	[Enabled] [Not Used]
59	Overvoltage	[>115%] [Not Used]
66	Starts per Hour	Set in field per manufacturer requirements
81	Frequency	[<59.5 Hz; >60.5 Hz] [Not Used]
86	Overcurrent Lockout	[Enabled] [Not Used]
87	Differential Protection	[Enabled] [Not Used]

D. General

1. All circuit boards shall have a harsh environment conformal coating to resist H2S gas and other corrosive agents, including humidity.

E. Protection and Control

1. Thermal model biased with RTD and negative sequence current feedback
2. Start supervision and inhibit
3. Locked rotor / mechanical jam
    a. The relay shall protect the rotor during stall and acceleration. The stall/acceleration curve shall be voltage compensated and a speed switch input shall be available. The stator protective thermal model shall combine inputs from positive and negative sequence currents and RTD winding feedback. The model shall be dynamic in nature in order to follow the loading and temperature of the motor.
4. Voltage compensated acceleration
5. Under voltage, overvoltage
6. Under frequency
7. Stator differential protection
    a. Differential protection using CT inputs (6) from both sides of the machine winding Voltage transformer inputs shall be used to provide over voltage, under voltage, voltage phase reversal, over frequency and under frequency functions.
8. Thermal overload
9. Over temperature 12 RTD's
10. Phase and ground overcurrent
11. Current unbalance
12. Power Elements
    a. Power factor
    b. Reactive power
    c. Under power
    d. Reverse active power
    e. Over torque
13. Torque protection
14. Reduced voltage starting control

F. Monitoring and Metering
1. Metering Functions
    a. A, V, W, Var, VA, PF, Hz, kWh, VARh, and kW demand
    b. The system shall include complete power metering. An event record shall store the last 40 events. Sixteen cycles of waveform data shall be stored each time a trip occurs. A simulation feature shall be available for testing the function.
2. Torque, temperature
3. Event recorder
4. Oscillography and data logger
5. Statistical information and learned motor data
6. Motor starting reports

G. Inputs and Outputs
1. 12 RTDs, programmable
2. Five predefined and four assignable digital inputs
3. Six output relays
4. Four analog inputs

5. Four programmable analog outputs

H. Memory
   1. Memory shall be non-volatile and programming shall remain intact upon power failure.
   2. Interface software shall be provided in a Windows® format.

I. User Interface
   1. A 40-character LCD display and associated keypad to provide access to actual values and set points.

J. Control Power:
   1. Range of available control power: DC: 90-300 VDC; AC: 70-265 VAC, 48 to 62 Hz.
   2. LO Range: DC: 20-60 VDC; AC: 20-48 VAC, 48 to 62 Hz.

K. Communication
   1. For remote monitoring, the following communication ports shall be provided:
      a. One Industry Standard port for meter and relay programming using a laptop computer.
      b. One RS-485 port.
      c. One integral 10/100BaseT Ethernet port . The connection shall support Modbus TCP, Ethernet IP and SNMP. Where an integral port is not available, provide a media protocol converter as specified herein.
      d. The manufacturer shall factory enter the proper IP Address for such connection. Upon request by the Contractor, the Owner/Engineer will provide the proper Internet Protocol Address (IP Address), to be configured by the equipment manufacturer.
   2. The protocol interface shall implement Modbus TCP Protocol with the following as minimum capabilities:
      a. All data shall be available and/or mirrored within the Modbus 4x or "Holding Register" memory area.
      b. Register 4x00001 shall exist and be readable to allow simple, predictable "comm tests".
      c. Software tools shall function properly with slaves' only supporting Modbus functions 3, 4 and 16. Requiring support of diagnostic function 8 is not acceptable.
      d. Software tools shall be configurable to write a single register as either function 6 or 16.
      e. Software tools shall allow setting the Modbus/TCP "Unit Id" to be a value other than zero. This is required for Ethernet-to-Serial bridging.
   3. The media protocol converter shall meet the following criteria:
      a. The converter shall support 10/100Base-T Ethernet. The serial port speed (baud rate) shall support 230kbps. The protocol shall support Modbus TCP, Ethernet IP, DF1, and Modbus RTU/ASCII. Protocol shall be Web Browser configurable.
      b. Operating limits shall be 0-60°C, with humidity range minimum of 5-90%. Shock capability on the serial port shall be ESD +15 kV air GAP meeting IEC 1000-4-2. Power requirements shall be 9-30VDC at 0.5A minimum.
      c. The converter shall have LED status for serial, signals, power, and Ethernet.

d. The converter housing shall be UL 1604, Class 1 Div 2, DIN Rail mountable. The converter shall have DB-9M port connection, with screw terminals, to the input.
e. Converter shall be Digi One IAP, or approved equal.

2.3 POWER QUALITY METER (PM1)

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. GE Multilin PQMII Power Quality Meter
   2. Schweitzer Engineering Laboratories Model SEL-735
   3. No equal

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. General
   1. All circuit boards shall have a harsh environment conformal coating to resist H2S gas and other corrosive agents, including humidity.

D. Monitoring and Metering
   1. Metering Functions with accuracy of 0.2% for A & V and 0.4% for power parameters
      a. A, V, VA, W, VAR, KWH, KVARH, KVAH, PF, Hz
      b. W, VAR, A, VA Demand
      c. A, V Unbalance
   2. Power Analysis Functions.
      a. Total Harmonic Distortion
      b. Individual harmonics
      c. Waveform capture
      d. Historical data
      e. Minimum and maximum metered values complete with time and date
      f. Record of last 40 events
      g. Two independent data logs

E. User Interface and Programming
   1. Integrated keypad to access actual values and set points.
      a. 2 - line, 40 character illuminated display for use with keypad. The display shall have:
         1) Variable scrolling rates.
         2) Front mounted LEDs to display alarms, communication status, relay status, simulation mode, self-test failure, and set point access status.
         3) Relay reset button to clear alarm and auxiliary conditions.
   2. The meter shall have one alarm output relay with Form C contacts.
   3. Relay output shall be through alarm, auxiliary and pulse output functions.
   4. The meter shall provide a user configurable pulse output based on KWH, KVARH or KVAH.
   5. The meter shall provide a pulse input for demand synchronization.
   6. The meter shall include a simulation mode capability for testing the functionality and meter response to programmed conditions without the need for external inputs.

7. The relay shall include a power systems option consisting of harmonic analysis, triggered trace memory waveform capture, event record and data logger functions.

F. Control Power:
1. Range of available control power: DC: 88-300 VDC; AC: 70-265 VAC, 48 to 62 Hz.
2. LO Range: DC: 20-60 VDC; AC: 20-48 VAC, 48 to 62 Hz.

G. Communication
1. For remote monitoring, the following communication ports shall be provided:
   a. One Industry Standard port for meter and relay programming using a laptop computer.
   b. One RS-485 port.
   c. One integral 10/100BaseT Ethernet port . The connection shall support Modbus TCP, Ethernet IP and SNMP. Where an integral port is not available, provide a media protocol converter as specified herein.
   d. The manufacturer shall factory enter the proper IP Address for such connection. Upon request by the Contractor, the Owner/Engineer will provide the proper Internet Protocol Address (IP Address), to be configured by the equipment manufacturer.
2. The protocol interface shall implement ModbusTCP Protocol with the following as minimum capabilities:
   a. All data shall be available and/or mirrored within the Modbus 4x or "Holding Register" memory area.
   b. Register 4x00001 shall exist and be readable to allow simple, predictable "comm tests".
   c. Software tools shall function properly with slaves' only supporting Modbus functions 3, 4 and 16. Requiring support of diagnostic function 8 is not acceptable.
   d. Software tools shall be configurable to write a single register as either function 6 or 16.
   e. Software tools shall allow setting the Modbus/TCP "Unit Id" to be a value other than zero. This is required for Ethernet-to-Serial bridging.
3. The media protocol converter shall meet the following criteria:
   a. The converter shall support 10/100Base-T Ethernet. The serial port speed (baud rate) shall support 230kbps. The protocol shall support Modbus TCP, Ethernet IP, DF1, and Modbus RTU/ASCII. Protocol shall be Web Browser configurable.
   b. Operating limits shall be 0-60°C, with humidity range minimum of 5-90%. Shock capability on the serial port shall be ESD +15 kV air GAP meeting IEC 1000-4-2. Power requirements shall be 9-30VDC at 0.5A minimum.
   c. The converter shall have LED status for serial, signals, power, and Ethernet.
   d. The converter housing shall be UL 1604, Class 1 Div 2, DIN Rail mountable. The converter shall have DB-9M port connection, with screw terminals, to the input.
   e. Converter shall be Digi One IAP, or approved equal.

2.4 ACCESSORIES

A. Furnish nameplates for each device as indicated on drawings. Color schemes shall be as indicated on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment specified herein shall be factory installed, field adjusted, tested and cleaned as an integral part of equipment specified elsewhere in these Specifications.

B. Enclosure Mounting Requirements:

1. Mount all wall-mounted enclosures with an air gap between the enclosure and wall or mounting plate. Create the air space with slotted channel or several stainless steel washers which together will make at least a ¼-inch space.
2. Provide mounting feet for floor mounted enclosures.
3. Mount all enclosures with integral welded-on mounting lugs. Drilling through the back of any enclosure to provide a mounting means is prohibited. Any enclosure drilled to provide a mounting means will be rejected and shall be replaced with no change in Contract Time or Price even if the enclosure installation is complete with raceway attached and conductors installed.
4. Penetrations in any enclosures with a NEMA 3R, 4 or 4X rating which is located in any wet or damp area or in any process area whether it appears to be dry or not shall be in the sides or bottom only. Top penetrations in any enclosure located as described herein shall not be done for any reason, including raceway entries or equipment mounting. Top penetrations by the Contractor or by the original equipment manufacturer in the factory are all prohibited. Any enclosure with a top penetration located in the areas specified will be rejected and shall be removed and replaced, even if it requires a return to the factory. Raceway penetrating the top shall be re-routed and re-installed. All installed conductors in re-routed raceway shall be removed and re-routed in the re-routed raceway. Conductors found to be too short to be re-terminated shall be removed back to their source or load as the case may be, and shall be replaced. Splicing is prohibited and unacceptable. All specified corrective measures shall be provided with no change in Contract Time or Price.

END OF SECTION

SECTION 26 27 26
LIGHT SWITCHES AND RECEPTACLES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment, and install wiring devices as shown on the Drawings and as specified herein.

B. Provide all interconnecting conduit and branch circuit wiring for receptacle circuits in accordance with the NEC.

1.2 RELATED WORK

A. Refer to Division 26 00 00 and the Contract Drawings, for related work and electrical coordination requirements.

1.3 SUBMITTALS

A. Shop Drawings

1. Submit catalog data of all switches, receptacles and other specified items under this Section, with all options, application locations and exceptions clearly indicated. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project. Unmarked cut sheets will be cause to reject the submittal and return it for revision.

1.4 REFERENCE STANDARDS

A. Wiring devices shall comply with the requirements of the National Electrical Code (NEC) and shall be Underwriters Laboratories (UL) labeled.

1.5 QUALITY ASSURANCE

A. The manufacturer of these materials shall have produced similar electrical materials and equipment for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly. All assemblies shall be of the same manufacturer.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will not be permitted.,

B. Equipment shall be handled and stored in accordance with manufacturer's instructions.

C. Equipment shall be stored indoors and protected from moisture, dust and other contaminants.

D. Equipment shall not be installed until the location is finished and protected from the elements.

1.7 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for one year from date of final acceptance of the equipment. Within such period of warranty, the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the Manufacturers listed in each product category are acceptable.

B. The listing of specific manufacturers does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed are not relieved from meeting these specifications in their entirety.

2.2 RATINGS

A. The service voltage, shall be as shown on the Drawings. The overall short circuit withstand and interrupting rating of the equipment and devices shall be equal to or greater than the overall short circuit withstand and interrupting rating of the feeder device immediately upstream of the equipment.

2.3 MATERIALS

A. Wall switches shall be heavy duty, industrial specification grade, toggle action, flush mounting quiet type. All switches shall conform to the latest revision of Federal Specification WS 896.

1. Manufacturer
   a. Cooper (catalog number as listed)
   b. Hubbell, Inc.
   c. Pass & Seymour, Inc.
   d. Approved equal
2. Single pole, 20 Amp, 120/277 Volt – (Cooper 2221V)
3. Double pole, 20 Amp, 120/277 Volt – (Cooper. 2222V)
4. Three way, 20 Amp, 120/277 Volt – (Cooper 2223V)
5. Four way, 20 Amp, 120/277 Volt – (Cooper 2224V)
6. Single pole, 20 Amp, 120/277 Volt - key operated - (Cooper AH1191N)
7. Single pole, 20 Amp, 120 Volt - red pilot-lighted handle – (Cooper 2221PL)
8. Single pole, 20 Amp, 120 Volt, clear lighted handle – (Cooper 2221LTV)
9. Momentary contact, three position, 2 circuit, center off – (Cooper 1995V)

B. Fluorescent wall box dimmer switch for 120/277 Volt control of rapid start fluorescent lamps with a dimming range of 100% to 0.5% light for 120-volt and 100% to 1% light for 277-volt.

1. Manufacturers
   a. Lutron Electronics Co., Inc.
   b. Lithonia Control Systems
   c. Valmont Electric, Inc.

d. No Approved equal.

C. Explosion-proof single pole factory sealed switches shall be for 20 Amps, 120/277 volts, mounted in copper free aluminum boxes.
   1. Manufacturers
      a. Crouse-Hinds EDS Series
      b. Appleton Electric Co.
      c. Killark
      d. No Approved equal.

D. Receptacles shall be heavy duty, corrosion resistant, specification grade of the following types and manufacturer or equal. Receptacles shall conform to Fed Spec WC596.
   1. Manufacturers
      a. Cooper (catalog numbers as listed)
      b. Hubbell, Inc.
      c. Pass & Seymour, Inc.
      d. No Approved equal
   2. Duplex, 20 Amp, 125 Volt, 2 Pole, 3 Wire Grounding, high impact, arc and moisture resistant yellow nylon construction, heavy nickel plating on metal parts; (Cooper 5362CRY
   3. Single, 20 Amp, 250 Volt, 2 Pole, 3 Wire; (Cooper 5461GY)

E. Weatherproof covers
   1. Die cast aluminum. Plastic or other non-metallic in-use covers are not acceptable.
   2. Weatherproof while-in-use rating
   3. Manufacturers
      a. Eaton Catalog No. WIUMH/V
      b. Thomas & Betts
      c. Approved equal

F. Special purpose
   1. Manufacturers
      a. Cooper (catalog number as listed)
      b. Hubbell
      c. Pass & Seymour
      d. Approved equal
   2. Clock hanger single, 15 Amp, 125 Volt, 2 Pole, 3 Wire, with hanging hook on device plate. (Cooper 452)
   3. Single, corrosion resistant locking, 20 Amp, 125 Volt, 2 Pole, 3 Wire; Cooper, Catalog No. CRL520R and plug (Cooper CRL520P)
   4. Single twist-lock, 30 Amp, 125 Volt, 1 Phase, 3 Wire; Cooper, Catalog No. CRL530R; plug. (Cooper CRL530P)
   5. Single twist-lock, 20 Amp, 250 Volt, 1 Phase, 3 Wire; Cooper, Catalog No. CRL620R; plug. (Cooper CRL620P) similar by Hubbell, Inc.; Pass & Seymour, Inc. or equal.
   6. Single twist-lock, 30 Amp, 250 Volt, 1 Phase, 3 Wire; Cooper, Catalog No. CRL630R; plug. (Cooper CRL630P)

G. Explosion-proof receptacles and plugs

1. Manufacturers
   a. Appleton Electric (Catalog number as listed)
   b. Crouse-Hinds
   c. Hubbell Inc.
   d. No Approved equal.
2. Single, 20 Amp, 125 Volt, 1 Phase, 3 Wire. (Appleton EFSC175-2023 and plug ECP-2023)
3. Duplex, 20 Amp, 125 Volt, 1 Phase, 3 Wire. (Appleton EFSC275-2023 and plug, ECP-2023)
4. Single, 20 Amp, 250 Volt, 1 Phase, 3 Wire. (Appleton EFSC175-20232 and plug ECP-20232)
5. Duplex, 20 Amp, 250 Volt, 1 Phase, 3 Wire. (Appleton EFSC275-20232 and plug ECP-20232)

H. Device Plates
1. Plates for indoor flush mounted devices shall be of the required number of gangs for the application involved and shall be as follows:
   a. Administration type buildings: Smooth, high impact nylon of the same manufacturer and color as the device. Final color to be as selected by the Architect.
   b. Where permitted in other areas of the plant, flush mounted devices in cement block construction shall be Type 302 high nickel (18-8) stainless steel of the same manufacturer as the devices.
2. Plates for indoor surface mounted device boxes shall be cast metal of the same material as the box, Crouse-Hinds No. DS23G and DS32G, or equal.
3. Oversized plates shall be installed where standard plates do not fully cover the wall opening.
4. Device plates for switches mounted outdoors or indicated as weatherproof shall be gasketed, cast aluminum with provisions for padlocking switches "On" and "Off", Crouse Hinds No. DS185, or equal.
5. Multiple surface mounted devices shall be ganged in a single, common box and provided with an adapter, if necessary, to allow mounting of single gang device plates on multi-gang cast boxes.
6. Engraved device plates shall be provided where required.
7. Weatherproof, gasketed cover for GFI receptacle mounted in a FS/FD box
   a. Manufacturers
      1) Cooper, Catalog No. 4501-FS
      2) Hubbell, Inc.
      3) Pass & Seymour, Inc.
      4) No Approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Switches and receptacles shall be installed flush with the finished wall surfaces in areas with stud frame and gypsum board construction, in dry areas with cement block construction or when raceways are shown as concealed on the Drawings.

B. Do not install flush mounted devices in areas designated DAMP, WET or WET/CORROSIVE on the Drawings. Provide surface mounted devices in these areas.

C. Provide weatherproof devices covers in areas designated WET or WET/CORROSIVE on the Drawings.

D. Unless otherwise shown on the Drawings, wall switches and other wall mounted controls shall be installed at 54 inches AFF.

E. Convenience receptacles shall be 36 inches above the floor unless otherwise shown.

F. Convenience receptacles installed outdoors and in rooms where equipment may be hosed down shall be 36 inches above floor or grade. Switches shall be ganged together under one cover plate.

G. The location of all devices is shown, in general, on the Drawings and may be varied within reasonable limits so as to avoid any piping or other obstruction without extra cost, subject to the approval of the Owner. Coordinate the installation of the devices for piping and equipment clearance.

H. Convenience receptacles and light switches shall be connected using stranded pig tails and spring fork insulated lugs. Feed-through wiring of receptacles is prohibited.

3.2 FIELD QUALITY CONTROL

A. Test wiring devices to ensure electrical continuity of grounding. Energize the circuit to demonstrate compliance with the requirements.

END OF SECTION

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SECTION 26 28 16
LOW VOLTAGE ENCLOSED CIRCUIT BREAKERS AND DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The Contractor shall furnish and install low voltage enclosed circuit breakers and disconnect switches, together with appurtenances, complete and operable, as specified herein and as shown on the Contract Drawings.

B. All equipment specified in this Section of the Specifications shall be the product of one manufacturer and shall be factory constructed and assembled by that manufacturer.

1.2 RELATED WORK

A. No references are made to any other section which may contain work related to any other section. The Contract Documents shall be taken as a whole with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or additional work as may be required in those references, and include such information or work as may be specified.

B. Other Divisions

1. The Contractor shall be responsible for examining all Sections of the Specifications and Drawings, and shall determine the power and wiring requirements and shall provide external wiring and raceways, as required to provide a fully functioning power, control and process control systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, the Contractor shall furnish the additional conductors, raceways and/or wiring, with no change in the Contract Price, and with no increase in Contract Time.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Division 1, Section 26 00 00 and as specified herein.

B. Submittals for equipment and materials, furnished under this Section of the Specifications, will not be accepted prior to approval of the Power System Study specified under Section 26 05 73. Submittals made prior to such approval will be returned unreviewed.

C. Submittals shall also contain information on related equipment to be furnished under this Specification but described in the related Sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will also be returned without review. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project. Unmarked cut sheets will be cause to reject the submittal and return it for revision without review.

D. The original equipment manufacturer shall create all equipment shop drawings, including all wiring diagrams, in the manufacturer's Engineering department. All equipment shop drawings shall bear the original equipment manufacturer's logo, drawing file numbers, and shall be maintained on file in the original equipment manufacturer's archive file system. Photocopies of the Engineer's ladder schematics are unacceptable as shop drawings.

E. Submit to the Owner/Engineer, shop drawings and product data, for the following:

1. Product data sheets and catalog numbers for overcurrent protective trip devices on circuit breakers and switches, relaying, meters, pilot lights, etc. The manufacturer's name shall be clearly visible on each cut sheet submitted. List all options, trip adjustments and accessories furnished specifically for this project.
2. Provide control systems engineering to produce custom unit elementary drawings showing interwiring and interlocking between components and to remotely mounted devices. Include and identify all connecting equipment and remote devices on the schematics. The notation "Remote Device" will not be acceptable. Show wire and terminal numbers. Indicate special identifications for electrical devices per the Drawings.
3. Provide plan and elevation drawings of each controller or enclosure, with dimensions, exterior and interior views, showing component layouts, controls, terminal blocks, etc..
4. Schematic diagram
5. Nameplate schedule
6. UL Listing of the completed assembly.
7. Component list with detailed component information, including original manufacturer's part number.
8. Conduit entry/exit locations
9. Assembly ratings including:
   a. Short-circuit rating
   b. Voltage
   c. Continuous current
10. Major component ratings including:
    a. Voltage
    b. Continuous current
    c. Interrupting ratings
11. Number and size of cables per phase, neutral if present, ground and all cable terminal sizes.
12. Key interlock scheme drawing and sequence of operations
13. Busway connection and amperage rating.
14. Instruction and renewal parts books.

F. Factory Tests. Submittals shall be made for factory tests specified herein.

G. Field Test Reports. Submittals shall be made for field tests specified herein.

H. Operation and Maintenance Manuals.

1. Operation and maintenance manuals shall include the following information:
   a. Manufacturer's contact address and telephone number for parts and service.
   b. Instruction books and/or leaflets

c. Recommended renewal parts list
d. Record Documents for the information required by the Submittals paragraph above.

I. The manufacturer shall submit for approval, a training agenda for all training specified herein. Training agenda shall not be submitted until final approval of the Operation and Maintenance Manual.

1.4 REFERENCE CODES AND STANDARDS

A. All products and components shown on the Drawings and listed in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
   1. NEMA Standard AB1 – Molded Case Circuit Breakers, Molded Case Switches and Circuit Breaker Enclosures
   2. NFPA 70 – National Electrical Code (NEC)
   3. NFPA 70E – Standard For Electrical Safety in the Workplace
   4. IEEE 242 – Protection and Coordination of Industrial and Commercial Power Systems
   5. IEEE 399 – Power Systems Analysis
   6. UL 489 – Molded Case Circuit Breakers and Circuit Breaker Enclosures
   7. UL 1066 – Low Voltage AC and DC Power Circuit Breakers Used in Enclosures.

B. All equipment components and completed assemblies specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.5 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of ten years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly. All assemblies shall be of the same manufacturer. Equipment that is manufactured by a third party and “brand labeled” shall not be acceptable.

C. All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.

D. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

E. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, or equipment which failed any factory tests, will not be permitted.

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the Contractor and Owner. The instructions shall include detailed assembly instructions including but not limited to wiring interconnection diagrams, rigging for lifting, skidding, jacking and moving using rolling equipment to place the equipment, bolt torqueing requirements for bus and all other components which require the installation of bolted connections, and instructions for storing the equipment prior to energizing.

C. Equipment shall be stored indoors and protected from moisture, dust and other contaminants.

D. Equipment shall not be installed until the location is finished and protected from the elements.

1.7 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for one year from date of final acceptance of the equipment. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment or components shall be performed by the Contractor at no expense to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Eaton
2. ABB
3. Square D

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. All equipment furnished under this Section shall be of the same manufacturer.

2.2 RATINGS

A. The service voltage, shall be as shown on the Drawings. The overall short circuit withstand and interrupting rating of the equipment and devices shall be equal to or greater than the overall short circuit withstand and interrupting rating of the feeder device immediately upstream of the circuit breaker or switch. Systems employing series connected ratings for main and feeder devices shall not be used.

B. Circuit breakers, safety switches and associated devices shall be designed for continuous operation at rated current in a 40°C ambient temperature.

C. Furnish heavy duty Mill rated devices.

D. For additional ratings and construction notes, refer to the Drawings.

2.3 CONSTRUCTION

A. General

1. Refer to Drawings for: actual layout and location of equipment and components; current ratings of devices, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.
2. Furnish lugs for incoming wiring, sizes as shown on the Drawings. Allow adequate clearance for bending and terminating of cable size and type specified, Lugs for #12 AWG up to #6 AWG shall be ring terminals. Conductors #4 AWG and larger shall be two-hole long barrel lugs with NEMA spacing. All lugs shall be the closed end construction to exclude moisture migration into the cable conductor. See also Section 26 05 19 Wires and Cables (1000 Volt Maximum) for additional requirements.
3. Built in control stations and indicating lights shall be furnished where shown on the Drawings.
4. Furnish nameplates for each device as indicated in Drawings. Nameplates shall be engraved, laminated impact acrylic, matte finish, not less than 1/16-inch thick by 3/4-inch by 2-1/2-inch, Rowmark 322402. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X 1/2 inch, or equal. Prior to installing the nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residue has been removed. Epoxy adhesive or foam tape is not acceptable.

B. Enclosures

1. General
   a. Provide 316 SS hardware for all enclosures.
   b. All enclosure doors shall have bonding studs. The enclosure interior shall have a bonding stud.
   c. Enclosures shall not have holes or knockouts for conduit entry.
   d. All panels installed outdoors shall have a factory applied, suitable primer and final coat of weatherproof white paint.
   e. All enclosures shall be provisioned with hardware for a padlock.
   f. All enclosures shall have integral welded mounting lugs.
   g. See Section 26 05 33 Raceways, Boxes and Fittings for additional requirements.
2. NEMA 7/4X
   a. Class 1, Division 1, Groups A, B, C, and D, or as defined in NFPA 70). Boxes shall be constructed as follows:
      1) Copper free cast aluminum body and cover
      2) Stainless steel hinges
      3) Watertight neoprene gasket
      4) Stainless steel cover bolts
      5) All penetrations shall be factory drilled and tapped.
3. NON METALLIC
   a. Chemical Rooms. NEMA 4X constructed as follows:
      1) PVC or Fiberglass reinforced polyester body and door.
      2) UV inhibitors
      3) Luggage type quick release latches
      4) Foam-in-place gasketed doors

4. ALUMINUM
   a. NEMA 4X Aluminum
      1) Type 5052 aluminum, body and door
      2) Stainless steel hinge
      3) Foam in-place gasket
      4) Single point quarter turn latches
5. NEMA 12
   a. NEMA 12 Steel
      1) Mild steel body and door
      2) Stainless steel hinges
      3) Foam in-place gasket
      4) Single point quarter turn latches
6. NEMA 4X Stainless Steel were not otherwise Defined
   a. Where an enclosure is not otherwise defined or shown on the Drawing
      1) NEMA 4X Stainless Steel
      2) Type 316 stainless steel, body and door
      3) Stainless steel hinge
      4) Foam in-place gasket
      5) Single point quarter turn latches
7. NEMA 1 or NEMA 1A boxes shall not be used.
8. Malleable iron boxes shall not be used.
9. Provide a flange mounted, or through the door, disconnect operating handle with mechanical interlock having a bypass that will allow the enclosure door to open only when the circuit breaker or switch is in the OFF position. The circuit breaker or switch shall have the capability of being bypassed after the door has been opened.

C. Internal Wiring
1. Wiring: Stranded tinned copper, minimum size No. 14 AWG, with 600 Volt, 90°C, flame retardant, Type SIS thermosetting 600-volt insulation, NEMA Class II, Type B wiring. Line side power wiring shall be sized for the full rating or frame size of the connected device.
2. All wiring shall be tagged and coded with an identification number as shown on the Drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE, or equal. Wire tags shall be machine-printed. Wire tags relying on adhesives of any type are unacceptable.
3. All wiring shall be neatly bundled with tie wraps and supported to wire way supports. Control wiring shall be bundled separately from power wiring. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.

D. Field Installed Internal Wiring

1. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring. Wiring shall not be supported using adhesive supports. Adhesive wire supports are unacceptable, and if installed shall be removed and replaced with a non-adhesive support with no increase in Contract Price or Time.
2. All field wiring shall be tagged and coded with an identification number. Coding shall be typed on a heat shrinkable tube applied to each end of the wire. The marking shall be a permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE, or equal. Wire tags shall be machine-printed. Wire tags relying on adhesives of any type are unacceptable.
3. In general, all conduit entering or leaving equipment shall be stubbed up into the bottom of the enclosure directly below the area in which the conductors are to be terminated, or from the top if shown on the Drawings and not located in a wet, damp or any process area. Conduits shall not enter the side unless approved in writing by the Owner/Engineer.

2.4 CIRCUIT BREAKERS

A. Molded Case Circuit Breakers (MCCB's)
1. Unless otherwise shown on the Drawings, circuit breakers 225 ampere frame rating and larger, shall be molded case (MCCB), three-Pole, 600-volt, fixed type, with stored energy closing mechanism. Breakers shall be manually operated unless indicated as electrically operated (EO) on the Drawings. Trip device shall be solid state with adjustable long time pickup, and delay; adjustable short time pickup and delay; short time i2t switch; adjustable instantaneous pickup, adjustable ground fault pickup and delay, and ground fault delay and pickup trips for selective tripping.
2. Unless otherwise shown on the Drawings, circuit breakers less than 225 ampere frame rating shall be molded case, three-Pole, 600-volt, fixed type, manually operated with stored energy closing mechanism. Circuit breakers shall have inverse time and instantaneous tripping characteristics.
3. Where shown on the Drawings or specified in the Contract Documents, breakers shall be rated for 100% continuous duty, and shall carry a UL 489 listing.

2.5 DISCONNECT SWITCHES

A. Disconnect switches shall be heavy duty, quick make, quick break, visible blades, 600-volt, three-pole with full cover interlock, interlock defeat and flange mounted operating handle.

2.6 FUSED DISCONNECT SWITCHES

A. Fused disconnect switches shall be heavy duty, quick make, quick break, visible blades, 600 volt, three-pole with full cover interlock, interlock defeat and flange mounted operating handle.

B. Fuses shall be rejection type, 600 volts, 200,000 A.I.C., dual element, time delay, Bussman Fusetron, Class RK 5 or equal.

2.7 MOTOR ISOLATION SWITCHES

A. For motors up to and including 100 horsepower, the isolating switch shall be a horsepower rated, quick make, quick break, visible blades, 600 volt, three pole motor circuit switch, in an enclosure as listed above and sized for the motor as shown on the Drawings. The switch shall be plainly marked “Do not operate under load”.

B. For motors greater than 100 horsepower, the isolating switch shall be a current rated, quick make, quick break, visible blades, 600 volt, three pole motor circuit switch, in an enclosure as listed above and sized for the motor as shown on the Drawings. The switch shall be plainly marked “Do not operate under load”.

C. Where a switch status auxiliary contact is shown on the Drawings, the auxiliary contact shall be early break (opens before the switch is opened) and early make (closes before the switch is closed). The auxiliary contact shall be rated 5 amperes at 480 volts.

2.8 DOUBLE THROW MANUAL TRANSFER SWITCH

A. Manual transfer switches shall be heavy duty, quick make, quick break, visible blades, 600-volt, three-pole, fused or non-fused as shown on the Contract Documents, with flange mounted operating handle.

2.9 FACTORY TESTING

A. The circuit breakers and disconnects shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer’s routine shop tests and any other additional operational test to insure the workability and reliable operation of the equipment.

B. Factory test equipment and test methods shall conform with the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards, and shall be subject to the Owner/Engineer’s approval.

PART 3 - EXECUTION

3.1 INSTALLER’S QUALIFICATIONS

A. Installer shall be specialized in installing low voltage circuit breakers and disconnect switches with minimum five years documented experience. Experience documentation shall be submitted for approval prior to beginning work on this project.

3.2 EXAMINATION

A. Examine installation area to assure there is enough clearance to install the equipment.

B. Verify that the equipment is ready to install.

C. Verify field measurements are as instructed by manufacturer.

3.3 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and Contract Drawings.

B. Install required safety labels.

C. Conduit entry into the top of any NEMA 4/4X rated enclosure in any outdoor, damp, wet or process area is strictly prohibited. Any enclosure entered from the top will be removed, the conduit and conductors re-routed, or conductors replaced if too short. No increase in Contract Price or Contract Time will be allowed.

3.4 FIELD QUALITY CONTROL

A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.

3.5 FIELD ADJUSTING

A. Adjust all circuit breakers, switches, access doors, operating handles for free mechanical and electrical operation as described in manufacturer's instructions.

B. The Power Monitoring and Protective Devices shall be set in the field by a qualified representative of the manufacturer, retained by the Contractor, in accordance with settings designated in a coordinated study of the system as required in Section 26 05 73 Power System Study. All such settings, including the application of arc flash labels, shall have been made and Approved by the Owner/Engineer, prior to energizing of the equipment.

3.6 FIELD TESTING

A. Perform all electrical field tests recommended by the manufacturer. Disconnect all connections to solid-state equipment prior to testing.

B. Megger and record phase to phase and phase to ground insulation resistance. Megger, for one minute, at minimum voltage of 1000 volts DC. Measured Insulation resistance shall be at least 100 megohms. In no case shall the manufacturer’s maximum test voltages be exceeded.

C. Test the ground fault protection system using a high current injection method.

D. Test the rating plug for correct rating.

3.7 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

3.8 EQUIPMENT PROTECTION AND RESTORATION

A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

END OF SECTION

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SECTION 26 29 23
LOW VOLTAGE VARIABLE FREQUENCY DRIVES (VFDs)

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install separately enclosed low voltage adjustable frequency drives, together with appurtenances, complete and operable, as specified herein and as shown on the Contract Drawings. The terms, VFD, ASD. AFD and Inverter are used synonymously.

B. All equipment supplied under this Section of the Specifications shall be products of the same Manufacturer and shall be contained in one single submittal. Partial submittals will be returned unreviewed. Submittals shall also contain information on related equipment to be furnished under this Specification but described in the related Sections listed in the Related Work paragraph herein. Incomplete submittals not containing the required information on the related equipment will also be returned unreviewed.

C. Equipment specified in the Process Equipment Division and supplied as an integral part of a process equipment manufacturer's package, but referred to this Section for component details, shall be submitted with the manufacturer's package submittal under the Process Equipment Sections.

D. The minimum requirements for functionality, and control and alarm inputs and outputs, are specified herein. Additional requirements shall be as specified in the Process Equipment Division, Instrumentation Division Equipment, Mechanical Division Equipment and the Contract Drawings.

E. Coordinate the VFD and the motor it drives and provide a certification that the VFD is suitable for the application.

1.2 RELATED WORK

A. Refer to Division 26 00 00 for related work and electrical coordination requirements.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Division 1, Section 26 00 00 and as specified herein.

B. Submittals for equipment and materials, furnished under this Section of the Specifications, will not be accepted prior to approval of the Power System Study specified under Section 26 05 73. Submittals made prior to such approval will be returned unreviewed.

C. Submittals shall also contain information on related equipment to be furnished under this Specification but described in the related sections to which reference is made in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will be returned unreviewed.

D. Unmarked cut sheets will cause rejection of the submittal and its return for revision.

E. All equipment shop drawings, including all wiring diagrams, shall be created in the original equipment manufacturer's Engineering department. All equipment shop drawings shall bear the original equipment manufacturer's logo, drawing file numbers, and shall be maintained on file in the original equipment manufacturer's archive file system. Photocopies of the Engineer's ladder schematics are unacceptable as shop drawings.

F. Submit for approval, a manufacturer's conducted training agenda for all training specified herein. Training agenda shall not be submitted until final approval of the Operation and Maintenance Manual.

G. Submit to the Owner/Engineer, shop drawings and product data, for the following:

1. Product data sheets and catalog numbers for all components of the drives, including motor contactors, drive components, control relays, control stations, meters, pilot lights, etc. The manufacturer's name shall be clearly visible on the each cut sheet submitted. List all options, trip adjustments and accessories furnished specifically for this project. Clearly mark each sheet to indicate which items apply and/or those items that do not apply.
2. Provide drive performance specifications. Submit a manufacturer's harmonics test on each type of drive being furnished. The test may be on a similar unit with identical components.
3. Provide control systems engineering to produce custom unit elementary drawings showing interwiring and interlocking between components and to remotely mounted devices. Include and identify all connecting equipment and remote devices on the schematics. The notation "Remote Device" shall not be acceptable. Show wire and terminal numbers. Indicate special identifications for electrical devices per the Drawings.
4. Provide plan and elevation drawings of each controller or enclosure, with dimensions, exterior and interior views, showing component layouts, controls, terminal blocks, etc.
5. Schematic diagram, including manufacturer's selections of component ratings, and CT and PT ratios.
6. Nameplate schedule
7. UL Listing of the completed assembly
8. Component list with detailed component information, including original manufacturer's part number.
9. Conduit entry/exit locations
10. Assembly ratings including:
    a. Short-circuit rating
    b. Voltage
    c. Continuous current
    d. Trip curves for each specified product
11. Major component ratings including:
    a. Voltage
    b. Continuous current
    c. Interrupting ratings
12. Number and size of cables per phase, neutral if present, ground and all cable terminal sizes.
13. Instruction and renewal parts books.

H. Certification that the VFD being supplied is suitable for the application.

I. Factory Tests. Submittals shall be made for factory tests specified herein.

J. Field Test Reports. Submittals shall be made for field tests specified herein.

K. Operation and Maintenance Manuals.

1. Operation and maintenance manuals shall include the following information:
   a. Manufacturer's contact address and telephone number for parts and service.
   b. Instruction books and/or leaflets
   c. Recommended renewal parts list
   d. Record Documents for the information required by the Submittals paragraph above.

1.4 REFERENCE CODES AND STANDARDS

A. All products and components shown on the Drawings and listed in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. NEMA Standard ICS 2 – 2000 Industrial Control and Systems
2. NFPA 70 – National Electrical Code (NEC)
3. NFPA 70E – Standard for Electrical Safety in the Workplace
4. IEEE 519 (latest revision) - Guide for Harmonic Control and Reactive Compensation of static Power Converters
5. UL 489 – Standard for Safety for Molded-Case Circuit Breakers
6. UL 508C – Power Conversion Equipment
7. NEMA ICS 2 – Starters, Contactors, Overload Relays, Rated Not More Than 200 Volts AC or 750 Volts DC.
8. NEMA ICS 6 – Industrial Control and Systems Enclosures
9. NEMA ICS 7.0 – Industrial Controls & Systems for VFD
10. IEC 61200-2 – Vibration Levels
11. IEC 61800-02 and -3 – Adjustable Speed Electrical Power Drive Systems
    a. Fulfill all EMC immunity requirements
12. EN 50082-1 and -2 – Test Standards

B. In the case of conflict between the requirements of this Section and those of the listed documents, the requirements of this Section shall prevail.

C. All equipment components and completed assemblies specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.5 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of ten years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly. All assemblies shall be of the same manufacturer. Equipment that is manufactured by a third party and "brand labeled" will not be acceptable.

C. All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.

D. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.

E. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

F. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, complete all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, onsite factory work, or failed factory tests will not be permitted.

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two copies of these instructions shall be included with the equipment at time of shipment and shall be made available to the Contractor and Owner/Engineer.

C. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.

D. Equipment shall be installed in its permanent finished location shown on the Drawings within seven calendar days of arriving onsite. If the equipment cannot be installed within seven calendar days, the equipment shall not be delivered to the site, but stored offsite until such time that the site is ready for permanent installation of the equipment with no change in the Contract Price or Schedule. Payment will not be approved for equipment stored off site.

E. Where space heaters are provided in equipment, provide temporary electrical power and operate space heaters during storage, and after equipment is installed in permanent location, until equipment is placed in service.

1.7 WARRANTY

A. Provide warrantees, including the manufacturer’s warrantee, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for five years from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Eaton

2. ABB
3. Schneider/Square-D
4. Rockwell Automation/Allen-Bradley

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. All equipment furnished under this Section shall be of the same manufacturer.

2.2 RATINGS

A. Service Conditions

1. The Drawings indicate the approximate horsepower and intended control scheme of the motor driven equipment. Provide the VFD, auxiliary components and equipment where shown or specified, and matched to the motors and control equipment supplied, in compliance with the NEC. All variations necessary to accommodate the motors and controls as actually furnished shall be made without extra cost to the Owner.
2. The service voltage shall be as shown on the Drawings. The overall short circuit withstand and interrupting rating of the VFD and devices shall be equal to or greater than the overall short circuit withstand and interrupting rating of the feeder device immediately upstream of the adjustable frequency drives. Adjustable frequency drives shall be tested, and UL labeled for the specified short circuit duty in combination with the motor branch circuit protective device.
3. The drive shall be UL and cUL listed and not require external fuses. The drive shall also be CE labeled and comply with standards EN 61800-3 for EMC compliance and EN 61800-2 for low voltage compliance.
4. The drive shall be capable of operating in compliance with IEEE 519-1992.
5. Input power: Selectable for 200-240 or 380-480 VAC, 3-phase power input.
6. Input frequency: 57 to 63 Hz.
7. Ambient temperature: -10°C to 50°C (Enclosed).
8. Elevation: Up to 3300 feet above mean sea level.
9. Relative humidity: Up to 90% non-condensing.

B. The VFD, for both constant and variable torque applications, shall be sized for a motor one NEMA size larger than the motor being supplied.

C. The VFD output shall be 100% rated current continuous, suitable for operation of the driven equipment over a 30:1 speed range without overloading or low speed cogging. Drives shall be capable of a continuous overload up to 110% rated current and a maximum 150% overload for 1 minute. Starting torque shall be matched to the load.

D. Rated output voltage shall be programmable for motor ratings from 180 to 240 volts, or from 320 to 480 volts.

E. The Drive shall be able to operate after a voltage dip below 175 VAC on 230 VAC input power and 310 VAC on 460 VAC input power for 15 milliseconds at 85% full load current without any disturbances in output power delivered to the load.

F. The VFD output voltage shall vary with frequency to maintain a constant volts/hertz ratio up to base speed (60 hertz) output. Constant or linear voltage output shall be supplied at frequencies greater than base speed (60 hertz).

G. The VFD overload current rating shall be 110% of rated current for one minute for variable torque applications and 150% of rated current for constant torque applications, in an ambient temperature of 104ºF.

H. The VFD shall have an efficiency at full load and speed that exceeds 95% for VFDs below 15 HP and 97% for drives 15 HP and above. The efficiency shall exceed 90% at 50% speed and load.

I. The true power factor shall be 0.95 or better at any speed, measured at drive input terminals.

J. The voltage regulation shall be plus or minus 1% of rated value, no load to full load.

K. Output Frequency Drift shall be not more than plus or minus 0.5% from setpoint.

L. VFDs shall withstand five cycle transient voltage dips of up to 15% of rated voltage without an undervoltage trip or fault shutdown, while operating a variable torque load.

M. Line notching, transients, and harmonics on the incoming line shall not affect drive performance.

N. The VFDs shall meet IEC 61200-2 for vibration levels.

O. The VFDs shall be able to withstand voltage variations of -15% to +10% and imbalance up to 3% without tripping or affecting drive performance.

P. For additional requirements and construction notes, refer to the Drawings.

2.3 CONSTRUCTION

A. General

1. Refer to Drawings for: actual layout and location of equipment and components; current ratings of devices, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.
2. Control units shall be arranged as shown on the Drawings.
3. Surge Protective Devices
   a. Furnish where shown on the Drawings, or specified herein, a manufacturer provided and installed, a Low Voltage Surge Protective Device (SPD), as specified in Section 26 43 13 of these Specifications.
   b. Connection to the switchgear shall be with a surge rated disconnect, mounted integral to the switchgear.
   c. Except for VFD components, where the equipment contains a programmable logic controller (PLC) or an uninterruptible power supply (UPS), the equipment manufacturer shall furnish factory installed, a dedicated Point of Utilization Device (SPD), with disconnecting means, as specified in Section 26 43 13, Individual Control Panel and Related Equipment Protection (Type 3).
4. Where Kirk-Key arrangements are used, the Kirk keyed interlocks shall be Kirk HD Series (Heavy Duty) 316 Series of 316 stainless steel or approved equal.
5. Nameplates
   a. External

1) Nameplates shall be engraved, laminated impact acrylic, matte finish, not less than 1/16-in thick by 3/4-in by 2-1/2-in, Rowmark 322402. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X 1/2", or equal. Prior to installing the nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residue has been removed. Epoxy adhesive or foam tape is not acceptable.
2) Provide a master nameplate that indicates equipment ratings, manufacturer's name, shop order number and general information. Cubicle nameplates shall be mounted on the front face, on the rear panel and inside the assembly, visible when the rear panel is removed.
3) Provide permanent warning signs as follows:
   a) "Danger- High Voltage- Keep Out" on all doors.
   b) "Warning- Hazard of Electric Shock - Disconnect Power Before Opening or Working On This Unit" on main power disconnect.

b. Internal
1) Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification, corresponding to appropriate designations on manufacturer's wiring diagrams.

c. Special
1) Identification nameplates shall be white with black letters, caution nameplates shall be yellow with black letters, and warning nameplates shall be red with white letters.

6. Control Devices and Indicators
a. All operating control devices, indicators, and instruments shall be securely mounted on the panel door. All controls and indicators shall be 30mm, corrosion resistant, NEMA 4X/13, anodized aluminum or reinforced plastic. Booted control devices are not acceptable. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.
b. Indicator lamps shall be LED type. For all control applications, indicator lamps shall incorporate a push-to-test feature. Lens colors shall be as follows:
1) Red for ON, Valve OPEN, and Breaker CLOSED.
2) Green for OFF, Valve CLOSED and Breaker OPEN.
3) Amber for FAIL.
4) Blue for READY
5) White for POWER ON.
c. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, etc.) shall be as shown on the Drawings. Units shall have the number of positions and contact arrangements, as required. Each switch shall have an extra dry contact for remote monitoring.
d. Pushbuttons, shall be as follows:
1) Red for STOP, Valve OPEN, Breaker OPEN and mushroom Red for EMERGENCY STOP.
2) Green for START, Valve CLOSE and Breaker CLOSE.
3) Black for RESET.

e. Furnish nameplates for each device. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. Device mounted nameplates are not acceptable.
f. The manufacturer shall not remove, reuse, alter, or replace original equipment nameplates or equipment tags associated with equipment or components supplied by the manufacturer's suppliers and sub-suppliers.
g. Control and Instrument Power Transformers
   1) Control power transformers shall be provided where shown on the Drawings. Transformer shall be sized for the entire load, including space heaters, plus 25% spare capacity. Provide a load calculation showing that the sizing of the control power transformer complies with this requirement.
   2) Control power transformers shall be 120 volts grounded secondary. Primary side of the transformer shall be fused in both legs. One leg of the transformer secondary shall be solidly grounded while the other leg shall be fused.

7. A failure alarm with horn and beacon light shall be provided when required or specified. Silence and Reset buttons shall be furnished. Alarm horn and beacon shall be by Federal Signal; Crouse-Hinds, or equal, NEMA 4X for all areas except for NEMA 7 areas, which shall be NEMA 7 cast aluminum.
8. Where specified or shown on the Drawings, a six-digit, non-resettable elapsed time meter shall be installed on the face of each motor starter. Meter shall be as specified in Section 26 27 13.
9. Each VFD shall have an HMCP or thermal magnetic circuit breaker, as shown on the Drawings, to provide a disconnect means. VFDs above 75HP shall have a solid-state circuit breaker. Disconnecting means shall have a through the door lockable handle, mechanically interlocked with the enclosure door. The disconnect shall not be mounted on the door. The handle position shall indicate ON, OFF, and TRIPPED condition. The handle shall have provisions for padlocking in the OFF position with at least three (3) padlocks. Interlocks shall prevent unauthorized opening or closing of the VFD door with the disconnect handle in the ON position. Door handle interlock shall be defeatable only by qualified maintenance personnel.
10. Each VFD shall have the application specific, Hand-Off-Remote and Auto-Manual selector switches for local and remote Auto-Manual operation, provisions to accept a remote dry contact closure to start and stop the drive with the drive control system in the AUTO mode, provisions to accept a 4-20 mA dc input signal for remote speed control, and other input, output and communications interfaces as shown on the Drawings. Inputs shall be isolated at the drive and active with the drive control system in the AUTO mode.
11. Each VFD shall be microprocessor based with an LED and LCD display to monitor operating conditions. The Drive display section shall allow for local operation and setting of Drive function codes and display fault indication and reasons associated with the fault. The LED display shall offer nine different display settings and the LCD shall have the capacity to display five lines of information at a time. The keypad shall be capable of copying, uploading and downloading drive function codes. Displays and settings shall be as specified for each of the horsepower ranges of VFDs.
12. Where shown on the Drawings, furnish a motor over-current relay, or other protective or monitoring relays, as specified herein, to provide information to the Owner's Multilin PMCS based HMI system.

13. Where shown on the Drawings, the VFD shall have an AC output contactor to provide a means for positive disconnection of the drive output from the motor terminals.
14. Where shown on the Drawings, furnish a three-contactor assembly, including a drive input disconnect, an VFD input isolation contactor, bypass contactor and an VFD output contactor that is electrically and mechanically interlocked with the bypass contactor. This circuit shall include control logic, status lights and motor over-current relays. The complete bypass system shall have controls, pilot lights, etc., as shown on the Drawings

B. Enclosures
   1. General
      a. Each enclosure shall incorporate a removable back panel, and side panels, on which control components shall be mounted. Back panel shall be secured to the enclosure with collar studs for wall mounted enclosures, and 316 SS hardware for free standing enclosures.
      b. All free-standing enclosures shall be provided with feet of the same construction as the enclosure.
      c. The enclosure door shall be interlocked with the main circuit breaker by a panel mounted cable driven operating mechanism.
      d. Back panel shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any components.
      e. All enclosure doors shall have bonding studs. The enclosure interior shall have a bonding stud.
      f. Each enclosure shall be provided with a documentation pocket on the inner door.
      g. Enclosures shall not have holes or knockouts.
      h. Provide manufacturer's window kits where shown on the Drawings.
      i. All panels installed outdoors shall have a factory applied, suitable primer and final coat of weatherproof white paint.
      j. All enclosures shall be padlockable.
   2. NEMA 7/4X
      a. Class 1, Division 1, Groups A, B, C, and D, or as defined in NFPA 70). Boxes shall be constructed as follows:
         1) Copper free cast aluminum body and cover
         2) Stainless steel hinges
         3) Watertight neoprene gasket
         4) Stainless steel cover bolts
         5) All penetrations shall be factory drilled and tapped.
      b. Manufacturers
         1) Cooper Crouse Hinds Type EJB, Style C
         2) Appleton Electric Type AJBEW
         3) Approved Equal
   3. NON-METALLIC
      a. Chemical Rooms. NEMA 4X constructed as follows:
         1) PVC or Fiberglass reinforced polyester body and door.
         2) UV inhibitors
         3) Luggage type quick release latches
         4) Foam-in-place gasketed doors
      b. Manufacturers

1) Hoffman Polypro
2) Hubbell-Wiegmann Non-Metallic
3) Approved Equal

4. ALUMINUM
   a. NEMA 4X Aluminum
      1) Type 5052 aluminum, body and door
      2) Stainless steel continuous hinge
      3) Foam in-place gasket
      4) Single point quarter turn latches (20”x24” and below). All others 3-point latch
   b. Manufacturers
      1) Hoffman Comline
      2) EMF Company
      3) NEMA Enclosures Company
      4) Hammond Company
      5) Approved Equal
5. NEMA 12
   a. NEMA 12 Aluminum
      1) Type 5052 aluminum, body and door
      2) Stainless steel continuous hinge
      3) Foam in-place gasket
      4) Single point quarter turn latches (20”x24” and below). All others 3-point latch
   b. Manufacturers
      1) Hoffman Comline
      2) EMF Company
      3) NEMA Enclosures Company
      4) Hammond Company
      5) Approved Equal
6. Not Defined
   a. Where an enclosure is not otherwise defined or shown on the Drawing
      1) NEMA 4X 316 Stainless Steel
      2) Type 316 stainless steel, body and door
      3) Stainless steel continuous hinge
      4) Foam in-place gasket
      5) Single point quarter turn latches (20”x24” and below). All others 3-point latch
   b. Manufacturers
      1) Hoffman Concept Series
      2) EMF Company
      3) NEMA Enclosures Company
      4) Hammond Company
      5) Approved Equal
7. NEMA 1 or NEMA 1A boxes shall not be used.
8. Malleable iron boxes shall not be used.

C. Cooling Fans

1. Fans shall be furnished for VFDs, as required by the manufacturer, to provide air circulation and cooling. The fan shall be controlled by a thermostat and shall operate only when the drive is "ON" and for a cool-down period after the drive has stopped. Otherwise the fan shall not run when the drive is "OFF". Louvers, if provided, shall have externally removable filters. The filter shall be metallic and washable.
2. Fan motors shall be protected by an input circuit breaker. Metal squirrel cage ball bearing, three phase fan motors with 10-year design life shall be used in the drive design. Plastic muffin fans are not acceptable. Fan power shall be obtained from a tap on the main control power transformer.
3. A "loss of cooling" fault shall be furnished. In the event of clogged filters or fan failure, the drive shall produce an alarm and then, in a predetermined time, shut down safely without electronic component failure.
4. Redundant fans shall be provided in the drive design as backup in the event of fan failure.

D. Internal Wiring

1. Wiring: Tinned stranded copper, minimum size No. 14 AWG, with 600 Volt, 90-degree C, flame retardant, Type MTW thermoplastic insulation, NEMA Class II, Type B wiring. Line side power wiring shall be sized for the full rating or frame size of the connected device.
2. Identification: Numbered sleeve type wire markers at each termination point, color coding per NEMA standards and the NEC. Foreign voltage control wiring shall be yellow.
3. All wiring shall be tagged and coded with an identification number as shown on the Drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type like Raychem TMS-SCE, or equal.
4. All wiring shall be neatly bundled with ty-raps and supported to wire way supports. Control wiring shall be bundled separately from power wiring. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.

E. Field Installed Internal Wiring

1. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.
2. All field wiring shall be tagged and coded with an identification number. Coding shall be typed on a heat shrinkable tube applied to each end of the wire. The marking shall be a permanent, non-smearing, solvent-resistant type like Raychem TMS-SCE, or equal
3. In general, all conduit entering or leaving equipment shall be stubbed up into the bottom of the enclosure directly below the area in which the conductors are to be terminated, or from the top if shown on the Drawings. Conduits shall not enter the side unless approved in writing by the Owner/Engineer.

F. Control Relays

1. Control relays shall be 300-volt, industrial rated, plug-in socket type, housed in a transparent polycarbonate dust cover, designed in accordance with UL Standard 508 for motor controller duty. Continuous contact rating shall be 10 amperes resistive, 1/4 HP at 120 VAC, operating temperature -10 to +55°C. Provide spare N.O. & N.C. contacts. Relays shall be equipped with neon coil indicator light. Timing relays shall be 300 Volt, solid state type, with rotary switch to select the timing range. All relays provided in the equipment shall be NEMA rated. IEC rated relays are not acceptable.

2.4 ADJUSTABLE FREQUENCY DRIVES (VFDS) FOR MOTORS LARGER THAN 60 HP

A. General

1. Each drive shall be a minimum 18-pulse, IGBT based sinusoidal PWM type AC Drive capable of operating a squirrel cage induction motor with a full load current equal to or less than the continuous output of the Drive. The drive panel shall incorporate a phase shift transformer and a minimum 18 pulse converter. Regulator technology shall be software configurable to either V/Hz (single or multi motor) mode or Sensorless Dynamic Torque Vector mode (single motor). Full, closed loop flux vector control shall be available for constant torque applications. In V/Hz mode at base speed (60 hertz) and below, the Drive shall operate in constant volts per hertz mode. Above base speed (60 hertz), the Drive may selectively operate in either a constant volt per hertz mode or a constant voltage extended frequency mode.
2. The VFD shall be able to start into a spinning motor. The VFD shall be able to determine the motor speed in any direction and resume operation without tripping. If the motor is spinning in the reverse direction, the VFD shall start into the motor in the reverse direction, bring the motor to a controlled stop, and then accelerate the motor to the preset speed.
3. The Drive shall maintain set frequency regardless of load fluctuations.
4. The Drive shall be able to operate after a voltage dip below 175 VAC on 230 VAC input power and 310 VAC on 460 VAC input power for 15 milliseconds at 85% full load current without any disturbances in output power delivered to the load. If power exceeds this level, six different modes or active and inactive restart modes shall be available. The decrease in motor speed shall be adjustable in the event of a momentary power outage.
5. The Drive shall have a programmable start frequency, adjustable from 0.1 to 60 hertz, with a 1 hertz resolution and with a holding time adjustable from 0.1 to 10 seconds.
6. The Drive shall have IGBT soft switching and a low noise control power supply system to reduce the noise from the drive.
7. The Drive shall have a frequency bias (starting frequency) function programmable from -120 to +120 Hz of maximum frequency, with 0.1 Hz resolution.
8. Drive frequency gain shall be programmable from 0-200%, with 0.1% resolution.

9. The Drive shall be capable of motor slowdown or stop by selectable regenerative (to the DC link) dynamic braking while following one of the four selectable deceleration ramps, and control the braking torque by setting its value from 0, 20 to 150%, 999 (no limit) of Drive rating. It shall also be capable of changing the rate of deceleration automatically by stopping the braking action long enough to avoid Drive over-voltage trip.
10. The Drive shall can start into a rotating load (forward or reverse) and shall smoothly accelerate or decelerate to the set point without experiencing component damage.
11. The Drive shall can stop by selectable DC injection braking. It shall be adjustable from 0 to 100% braking level and have a programmable starting frequency for DC braking (0.2-60 hertz) and programmable braking time (0.1 to 30.0 seconds).
12. The Drive shall have a start Frequency Setting that incorporates a Holding Time at the Frequency Setting, adjustable up to 10 seconds in duration.
13. The Drive shall provide at least three selectable skip frequencies with programmable band widths, adjustable 0 to 30 Hz, which shall not allow operation at or near mechanical resonance speeds.
14. The Drive shall provide selectable slip compensation, which shall sense output current and adjust output
15. The Drive shall have Droop operation, balancing drooping characteristics to speed and load variations. This function shall be adjustable from –9.9 to 0.0 Hz.
16. The Drive shall have a selectable Torque Limiting function for both motoring and braking that shall sense an overload condition and shall reduce frequency and current temporarily until the load reaches acceptable levels. If the overload condition is not settled in the proper amount of time, the Drive shall trip on overload. The Torque Limiting shall be programmable from 20-150% of Drive rated motor torque (30 HP an below) and from 20-150% of Drive rated motor torque (40 HP and above), with 1% resolution.
17. The Drive shall have a selectable electronic inverse time thermal overload function as required by NEC and UL Standard 991 for an AC Induction Motor (Refer to applicable codes for specific installation requirements). The overload shall be programmable from 20 - 135% of Drive rated current.
18. The Drive shall have an over-voltage protection function that operates if supply voltage rises above rated value or by motor's regeneration.
19. The Drive shall treat short circuits in either the output load or the output module as an over-current.
20. If the Drive heat sink temperature exceeds approximately 100ºC, the Drive shall shut down on over temperature fault.
21. The Drive shall provide output ground fault protection.

B. Control and Monitor Interface

1. The Control shall have a graphic back-lit liquid crystal display (LCD) which can be configured to display frequency, current, function code set points, or drive status and fault codes. It shall display lines with characters of text, providing display at a minimum of:
   a. Monitor
   b. Operate
   c. Parameter setup

d. Actual parameter values
e. Active faults
f. Fault history
g. LCD adjustments

2. Setups and Adjustments
   a. Start command from keypad, remote or communications port
   b. Speed command from keypad, remote or communications port
   c. Motor direction selection
   d. Maximum and minimum speed limits
   e. Acceleration and deceleration times, two settable ranges
   f. Critical (skip) frequency avoidance
   g. Torque limit
   h. Multiple attempt restart function
   i. Multiple preset speeds adjustment
   j. Catch a spinning motor start or normal start selection
   k. Programmable analog output
   l. DC brake current magnitude and time
   m. PID process controller

3. System Interfaces
   a. Remote manual/auto
   b. Remote start/stop
   c. Remote forward/reverse
   d. Remote preset speeds
   e. Remote external trip
   f. Remote fault reset
   g. Process control speed reference interface, 4-20mA DC
   h. Potentiometer and 1-10VDC speed reference interface
   i. Programming interface port.

C. Outputs – A minimum of two discrete programmable digital outputs, one programmable open collector output, and one programmable analog output shall be provided, with the following available at minimum:

1. Programmable relay outputs with one set of Form C contacts for each, selectable with the following available at minimum:
   a. Fault
   b. Run
   c. Ready
   d. Reversed
   e. Jogging
   f. At speed
   g. Torque Limit Supervision
   h. Motor rotation direction opposite of commanded
   i. Over-temperature

2. Programmable open collector output with available 24VDC power supply and selectable with the following available at minimum:
   a. Fault
   b. Run
   c. Ready
   d. Reversed
   e. Jogging

f. At speed
g. Torque Limit Supervision
h. Motor rotation direction opposite of commanded
i. Over-temperature

3. Programmable analog output signal, selectable with the following available at minimum:
a. Motor current
b. Output frequency
c. Frequency reference
d. Motor speed
e. Motor torque
f. Motor power
g. Motor voltage
h. DC-bus voltage
i. AI1 (Analog Input 1)
j. AI2 (Analog Input 2)

2.5 METERING AND PROTECTIVE RELAYS

A. A 100VA minimum UPS shall be provided, powered from the control power transformer to provide control power to the feeder management relays and power quality meters.

B. Furnish where shown on the Drawings, a Motor Protection System (MP4), as shown on the Drawings, and as specified in Section 26 27 13 Power Metering and Protective Relays.

C. Furnish where shown on the Drawings, a Power Quality Meter (PM1), for each Main or Feeder Breaker, as shown on the Drawings and as specified in Section 26 27 13 Power Metering and Protective Relays.

2.6 REMOTE MONITORING AND CONTROL INTERFACE

A. General: All control and interconnection points from the equipment to the plant control and monitoring system shall be brought to a separate connection box. No field connections shall be made directly to the equipment control devices. Functions to be brought out shall be as specified in the Instrumentation Divisions.

B. Discrete control or status functions shall be form C relays with contacts rated at 120 volts AC. Analog signals shall be isolated from each other.

C. Equipment functions to be directly interfaced to the Plant Control and Monitoring System, shall be designed for operation with an Ethernet Connection.

D. The equipment manufacturer shall factory enter the proper IP Address for such connection. Upon request by the Contractor, the Owner/Engineer will provide the proper Internet Protocol Address (IP Address), to be configured by the equipment manufacturer.

E. Refer to the Instrumentation Divisions for monitored parameters.

F. Communication

1. For remote monitoring, one of the following communication capabilities shall be provided:
a. One integral 10/100BaseT Ethernet port supporting Modbus TCP, Ethernet IP and SNMP protocols.

b. One media protocol converter, interfacing the provided equipment to a 10/100BaseT Ethernet port supporting Modbus TCP, Ethernet IP and SNMP.

2. The protocol interface shall implement the following:
   a. All data shall be available and/or mirrored within the Modbus 4x or "Holding Register" memory area.
   b. Register 4x00001 shall exist and be readable to allow simple, predictable "comm tests".
3. The media protocol converter shall meet the following criteria:
   a. The converter shall support 10/100Base-T Ethernet. The serial port speed (baud rate) shall support 230kbps. The protocol shall support Modbus TCP, Ethernet IP, DF1, and Modbus RTU/ASCII. Protocol shall be Web Browser configurable.
   b. Operating limits shall be 0-60 degrees C, with humidity range minimum of 5-90 percent. Shock capability on the serial port shall be ESD +15 kV air GAP meeting IEC 1000-4-2. Power requirements shall be 9-30VDC at 0.5A minimum.
   c. The converter shall have LED status for serial, signals, power, and Ethernet.
   d. The converter housing shall be UL 1604, Class 1 Div 2, DIN Rail mountable. The converter shall have DB-9M port connection, with screw terminals, to the input.
   e. Converter shall be Digi One IAP, or approved equal.

2.7 SPARE PARTS

A. Provide the following spare parts:
   1. Three – Control fuses of type used.
   2. Three – Power fuses of type used.

B. Spare parts shall be boxed or packaged for long term storage and clearly identified on the exterior of package. Identify each item with manufacturers name, description and part number

2.8 FACTORY TESTING

A. The VFDs shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer’s routine shop tests and any other additional operational test to insure the workability and reliable operation of the equipment.

B. Prior to factory testing, submit confirmation that the manufacturer has checked and verifies that all selections and settings required by the Power System Study Engineer have been performed.

C. Factory test equipment and test methods shall conform with the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards.

D. The operational test shall include the proper connection of supply and control voltage and, as far as practical, a mockup of simulated control signals and control devices shall be fed into the boards to check for proper operation.

2.9 WITNESS TESTING

A. The Owner/Engineer will witness the Factory Tests for each of the following Equipment Units:
   1. Equipment Unit I.D. _____
   2. Equipment Unit I.D. _____
   3. Equipment Unit I.D. _____

B. The number of Owner/Engineer persons witnessing the tests will be xxxxx persons.

C. Under no circumstances, will the equipment be approved for shipment, nor will the equipment be accepted by the Owner, if witness testing is specified, and the equipment is shipped without the testing being witnessed.

D. If a test must be re-run due to failure in meeting the specified requirements, the witness expenses for the re-test shall be borne by the Manufacturer or Vendor. Retesting on the same trip shall be only at the option of the Owner/Engineer.

E. The Owner/Engineer, who is witnessing the testing, shall approve all travel arrangements, including the airline selected, flight times, hotel selected, testing agenda, etc.

F. An interpreter/guide shall be provided if English is not widely spoken, or in areas where English is not the native language.

G. The Owner/Engineer shall have direct communications with the person who is responsible for local arrangements and has the authority to pay for those expenses prior to leaving the [Owner's Project] location, or other designated location.

H. Submit the testing agenda for approval at least 30 days prior to the test date, or the test date shall be rescheduled, with no change in the Contract price or time. The agenda shall include a detailed list of all tests to be done.

I. Where travel is over night, testing shall not start on the arrival day.

J. Travel Documents
   1. Obtain Letters of Invitation and other documentation required to obtain a visa into the host country. Obtain the visa itself and directly pay for the cost of a visa service and the fee that the host country charges for the visa.
   2. Use a visa service located in the [XXX] area to handle the Owner/Engineer's passports who are traveling to witness the test, and to pay all expenses for the visa service company and the cost of the visa required by the host country.

K. Owner/Engineer Persons Travel Expenses
   1. Owner/Engineer representatives shall not have to provide for any out of pocket expenses related to the trip, transportation, meals or incidentals that would require later reimbursement.
   2. Provide, and pay for, all air travel fare, including ground shuttle or taxi, to and from the Owner/Engineer's office or residence. Air fare inside the Continental United States shall be non-stop if available, Coach Class or better, from [XXX]. Air fare outside the Continental United States shall be non-stop if available, Business Class or better, from [XXX].

3. Ground transportation at any destination shall be provided by the host Original Equipment Manufacturer (OEM). The Owner/Engineer persons shall not be required to drive in a foreign country under any circumstances.
4. Provide for hotel, meals, travel and incidentals to be paid for by the host OEM at the testing location, whose equipment is being tested. The host OEM shall have the authority to resolve any expense problems. If the Hotel offers restaurants, those charges shall be covered in the Hotel expenses. If meals are not offered at the Hotel, transportation to restaurants and the cost of those meals, shall be provided by the host OEM.
5. Access to an international cell phone shall be provided while out of the Continental United States.
6. Access to the internet shall be provided while out of the Continental United States.

PART 3 - EXECUTION

3.1 MANUFACTURER'S REPRESENTATIVE

A. Provide the services of a qualified factory-trained manufacturer's field engineer to assist in the installation and start-up of each type of the equipment specified below for a period of not less than two working days, with not less than one working day per VFD. The manufacturer's field engineer shall provide technical direction and assistance in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein.

3.2 INSTALLER'S QUALIFICATIONS

A. Provide an installer who shall be specialized in installing low voltage adjustable frequency drives with minimum five years documented experience. Experience documentation shall be submitted for approval prior to beginning work on this project.

3.3 EXAMINATION

A. Examine installation area to assure there is enough clearance to install the equipment.

B. Housekeeping pads shall be included for the floor mounted motor controllers as detailed on the Drawings except for motor controllers which are to be installed adjacent to an existing unit. Housekeeping pads for these (if used) should match the existing installation.

C. Check concrete pads and baseplates for uniformity and level surface.

D. Verify that the equipment is ready to install.

E. Verify field measurements are as instructed by manufacturer.

3.4 INSTALLATION

A. Install all equipment per the manufacturer's recommendations and Contract Drawings.

B. Install required safety labels.

3.5 FIELD QUALITY CONTROL

A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.

3.6 FIELD ADJUSTING

A. Adjust all circuit breakers, switches, access doors, operating handles for free mechanical and electrical operation as described in manufacturer's instructions.

B. The Power Monitoring and Protective Relays shall be set in the field by a qualified representative of the manufacturer, in accordance with settings designated in a coordinated study of the system as required in Section 26 05 73 Power System Study. All such settings, including the application of arc flash labels, shall have been Approved by the Owner/Engineer, printed and attached to the equipment prior to energizing of the equipment.

3.7 FIELD TESTING

A. The VFD manufacturer’s field engineer shall perform all electrical field tests recommended by the manufacturer and make all control adjustments required for the individual application of the drive.

B. Submit the results of all specified tests to the Engineer/Owner within five business days for approval and for their permanent records.

3.8 CLEANING

A. Remove all rubbish and debris from inside and around the motor controllers. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

3.9 EQUIPMENT PROTECTION AND RESTORATION

A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

3.10 MANUFACTURER’S CERTIFICATION

A. Provide the services of a qualified factory-trained manufacturer's representative who shall certify in writing that the equipment has been installed, adjusted, including all settings designated in the Power System Study, and tested in accordance with the manufacturer's recommendations.

B. Provide three copies of the manufacturer's representative's certification.

3.11 TRAINING

A. Provide manufacturer's services for training of plant personnel in operation and maintenance of the adjustable frequency drives furnished under this Section.

B. The training for each type of equipment shall be for a period of not less than one eight-hour day.

C. The cost of the training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.

D. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.

E. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, motor starters, protective devices, metering, and other major components.

F. The Owner reserves the right to videotape the training sessions for the Owner’s use.

END OF SECTION

SECTION 26 29 87
ELECTRICAL CONTRACTOR PROVIDED CONTROL PANELS (ECPs)

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install functional control panels to manually or automatically operate control systems as specified in the detailed requirements of this Section, and logic and schematics as shown on the Electrical Drawings.

B. Submittals for Electrical Control Panels, not clearly specified as Control Panels by the Electrical Contractor, shall be submitted under the Section of the Specifications specified in the Process Equipment Division or Mechanical Equipment Division, and shall not be submitted under this Section. Control Panels for those Divisions, shall meet the requirements of Section 26 29 86 Mechanical Equipment Manufacturer's Control Panels, and shall be submitted as a part of the Mechanical Equipment manufacturer's submittals or Process Equipment Division Submittals. Control panels specified within the Instrumentation Sections of Division 40 shall be submitted as a part of the Instrumentation submittals.

1.2 RELATED WORK

A. No references are made to any other section which may contain work related to any other section. The Contract Documents shall be taken as a whole with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or additional work as may be required in those references, and include such information or work as may be specified.

B. Other Divisions

1. The Contractor shall be responsible for examining all Sections of the Specifications and Drawings, and shall determine the power and wiring requirements and shall provide external wiring and raceways, as required to provide a fully functioning power, control and process control systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, the Contractor shall furnish the additional conductors, raceways and/or wiring, with no change in the Contract Price, and with no increase in Contract Time.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Division 1, Section 26 00 00 and as specified herein.

B. Provide systems engineering to produce coordination curves, showing coordination between breakers and/or fuses submitted, such that protective device coordination is accomplished. Such curves and settings shall be included as a part of these submittals.

C. Submittals shall also contain information on related equipment to be furnished under this Specification but described in the related Sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will also be returned unreviewed.

D. The original equipment manufacturer shall create all equipment shop drawings, including all wiring diagrams, in the manufacturer's Engineering department. All equipment shop drawings shall bear the original equipment manufacturers logo, drawing file numbers, and shall be maintained on file in the original equipment manufacturer's archive file system. Photocopies of the Engineer's ladder schematics are unacceptable as shop drawings.

E. Submit to the Owner/Engineer, shop drawings and product data, for the following:

1. Product data sheets and catalog numbers for overcurrent protective devices, motor starters, control relays, control stations, meters, pilot lights, etc. The manufacturer's name shall be clearly visible on each cut sheet submitted. List all options, trip adjustments and accessories furnished specifically for this project. Clearly mark each sheet to indicate which items apply and/or those items that do not apply.
2. Provide control systems engineering to produce custom unit elementary drawings showing inter-wiring and interlocking between components and to remotely mounted devices. Include and identify all connecting equipment and remote devices on the schematics. The notation "Remote Device" will not be acceptable. Show wire and terminal numbers. Indicate special identifications for electrical devices per the Drawings.
3. Equipment outline drawings showing elevation, plan and interior views, front panel arrangement, dimensions, weight, shipping splits, conduit entrances and anchor bolt pattern. Indicate all options, special features, ratings and deviations from this Section.
4. Schematic diagram, including manufacturer's selections of component ratings, and CT and PT ratios.
5. Power and control schematics including external connections. Show wire and terminal numbers, and color-coding.
6. Instruction and replacement parts books.
7. As-built final drawings.
8. Documentation that the panel assembly facility is a UL-508 certified panel shop.
9. Facsimile of the UL label that is to be applied to the completed panel.
10. Furnish complete Bill of Materials indicating manufacturer's name and part numbers.
11. Manufacturer's cut sheets for every component used in the panel assembly adequately marked to show the items being included. The manufacturer's name shall be clearly visible on each cut sheet submitted.
12. Assembly ratings including:
    a. Short-circuit rating
    b. Voltage
    c. Continuous current
13. Major component ratings including:
    a. Voltage
    b. Continuous current
    c. Interrupting ratings

14. Cable terminal sizes.
15. Instruction and renewal parts books.

F. Factory Tests. Submittals shall be made for factory tests specified herein.

G. Field Test Reports. Submittals shall be made for field tests specified herein.

H. Operation and Maintenance Manuals.
   1. Operation and maintenance manuals shall include the following information:
      a. Manufacturer's contact address and telephone number for parts and service.
      b. Instruction books and/or leaflets
      c. Recommended renewal parts list
      d. Record Documents for the information required by the Submittals paragraph above.

I. The manufacturer shall submit for approval, a training agenda for all training specified herein. Training agenda shall not be submitted until final approval of the Operation and Maintenance Manual.

1.4 REFERENCE CODES AND STANDARDS

A. All products and components shown on the Drawings and listed in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
   1. NEMA Standard ICS 2 – 2000 Industrial Control and Systems
   2. NFPA 70 – National Electrical Code (NEC)
   3. NFPA 70E – Standard for Electrical Safety in the Workplace
   4. NFPA 79 – Electrical Standard for Industrial Machinery
   5. UL 508/508A – Industrial Control Enclosures

B. All equipment specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.5 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The control panels shall be assembled in a UL-508 certified facility. A submittal of documentation certifying that the panel fabrication facility is a UL-508 certified facility, is required. A UL label shall be affixed to the inside of the external door by the panel fabrication assembly. Submit a facsimile of the UL label in the submittal information.

C. All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.

D. Control Panels submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.

E. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

F. Equipment components and devices shall be UL labeled wherever UL standards exist for such equipment. The completed control panel shall be UL Labeled in accordance with UL 508 and 508A and other applicable UL standards. The panel shall also be UL labeled for the environment in which it is to be placed. A UL label shall be affixed to the inside of the external door by the panel fabrication assembly. Submit a facsimile of the UL label in the submittal information.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, onsite factory work, or failed factory tests will not be permitted.

B. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the Contractor and Owner/Engineer.

C. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Breakers and accessories shall be packaged and shipped separately.

D. Equipment shall be installed in its permanent finished location shown on the Drawings within seven calendar days of arriving onsite. If the equipment cannot be installed within seven calendar days, the equipment shall not be delivered to the site, but stored offsite, at the Contractor’s expense, until such time that the site is ready for permanent installation of the equipment.

E. Where space heaters are provided in equipment, provide temporary electrical power and operate space heaters during storage, and after equipment is installed in permanent location, until equipment is placed in service.

1.7 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for one year from date of final acceptance of the equipment. Within such period of warranty, the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Manufacturer, at no expense to the Owner.

PART 2 - PRODUCTS

2.1 MATERIAL MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following material Manufacturers are acceptable for items not specifically specified else ware:

1. General Electric Co.
2. Eaton / Cutler-Hammer
3. Square D Co.
4. Allen Bradley

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Materials listed above are not relieved from meeting these Specifications in their entirety.

2.2 RATINGS

A. The service voltage shall be as specified and as shown on the Drawings. The overall short circuit withstand and interrupting rating of the equipment and devices shall be equal to or greater than the overall short circuit withstand and interrupting rating of the feeder device immediately upstream of the Control Panel, but not less than 22,000 amperes RMS symmetrical at 480/277 volts, this includes all circuit breakers and combination motor starters. Systems of motor controllers employing series connected ratings for main and feeder devices shall not be used. Motor starter units shall be tested and UL 508A labeled for the specified short circuit duty in combination with the motor branch circuit protective device.

B. There shall be selective device coordination between the Main Breaker, Feeder Breakers and control circuit protective devices. When using a circuit breaker or fuses as a main protective device, the instantaneous trip levels of the main protective device shall be higher than the available fault current to the control panel. If fuses are utilized in the control panel design, the protective devices for three-phase loads shall contain single phase protection of such equipment. If a fault occurs in the circuit of one load of a design with a backup load, the feeder protective device shall not remove both loads from the control system.

C. Use ground fault sensing on grounded wye systems.

D. The complete control panel assembly shall be UL certified or carry a UL listing for "Industrial Control Panels".

E. The control panel shall meet all applicable requirements of the National Electrical Code.

F. Motor controllers, including associated devices, shall be designed for continuous operation at rated current in a 40°C ambient temperature.

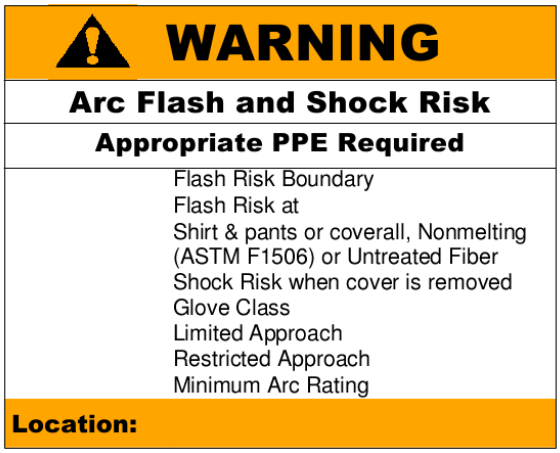
G. For additional ratings and construction notes, refer to the Drawings.

H. The Manufacturer shall produce and install on each panel, an Arc Flash Warning Label listing the various Flash Hazard Protection Boundaries, calculated from NFPA 70E, Annexes, as listed below:

1. Flash Hazard Protection Boundary.
2. Limited Approach Boundary.
3. Restricted Boundary.
4. Incident Energy Level.
5. Required Personal Protective Equipment Class.
6. Type of Fire Rated Clothing.

I. Provide an Arc Flash Warning Label, printed in color and affixed to the front of each panel provided.

J. Shown below is a typical label. Size of each label shall be not less than 6 inches wide and 4 inches tall.



2.3 CONSTRUCTION

A. General

1. Refer to Drawings for: actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.
2. Control units shall be arranged as shown on the Drawings.
3. Except for VFD equipment, where the equipment contains a programmable logic controller (PLC) or a uninterruptible power supply (UPS), the equipment manufacturer shall furnish factory installed, a dedicated Point of Utilization Device (SPD), as specified in Section 26 43 13, Individual Control Panel and Related Equipment Protection (Type 3).
4. Where Kirk-Key arrangements are used, the Kirk keyed interlocks shall be Kirk HD Series (Heavy Duty) 316 Series, made of 316 stainless steel, or approved equal.
5. Nameplates
   a. External
      1) Nameplates shall be engraved, laminated impact acrylic, matte finish, not less than 1/16-inch thick by 3/4-inch by 2-1/2-inch, Rowmark 322402. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X 1/2 inches, or equal. Prior to installing the adhesive nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residue has been removed. Epoxy adhesive or foam tape is not acceptable.
      2) There shall be a master nameplate that indicates supply voltage equipment ratings, short circuit current rating, manufacturer's name, shop order number and general information. Cubicle nameplates shall be mounted on the front face, on the rear panel and inside the assembly, visible when the rear panel is removed.
      3) Provide permanent warning signs as follows:
         a) "Danger- High Voltage- Keep Out" on all doors.
         b) "Warning- Hazard of Electric Shock - Disconnect Power Before Opening or Working On This Unit" on main power disconnect or disconnects.
   b. Internal

1) Provide the panel with a UL 508A label.
2) Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification, corresponding to appropriate designations on manufacturer's wiring diagrams.

c. Special
1) Identification nameplates shall be white with black letters, caution nameplates shall be yellow with black letters, and warning nameplates shall be red with white letters.

6. Control Devices and Indicators
a. All operating control devices, indicators, and instruments shall be securely mounted on the panel door. All controls and indicators shall be 30-millimeter, corrosion resistant, NEMA 4X/13, anodized aluminum or reinforced plastic. Booted control devices are not acceptable. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.
b. Indicator lamps shall be LED type. For all control applications, indicator lamps shall incorporate a push-to-test feature. Lens colors shall be as follows:
1) Red for ON, Valve OPEN, and Breaker CLOSED.
2) Green for OFF, Valve CLOSED and Breaker OPEN.
3) Amber for FAIL.
4) Blue for READY
5) White for POWER ON.
c. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, etc.) shall be as shown on the Drawings. Units shall have the number of positions and contact arrangements, as required. Each switch shall have an extra dry contact for remote monitoring.
d. Pushbuttons, shall be as follows:
1) Red for STOP, Valve OPEN, Breaker CLOSE and mushroom Red for EMERGENCY STOP.
2) Green for START, Valve CLOSE and Breaker OPEN.
3) Black for RESET.
e. Furnish nameplates for each device. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. Device mounted nameplates are not acceptable.

7. Control and Instrument Power Transformers
a. Control power transformers shall be provided where shown on the Drawings. Transformer shall be sized for the entire load, including space heaters, plus 25% spare capacity, and shall be not less than 100 VA.
b. Control power transformers shall be 120 volt grounded secondary. Primary side of the transformer shall be fused in both legs. One leg of the transformer secondary shall be solidly grounded while the other leg shall be fused.

8. A failure alarm with horn and beacon light shall be provided when required or specified. Silence and reset buttons shall be furnished. Alarm horn and beacon shall be by Federal Signal; Crouse-Hinds, or equal, NEMA 4X for all areas except for NEMA 7 areas, which shall be NEMA 7/4X cast aluminum.

9. Where specified or shown on the Drawings, a six digit, non-resettable elapsed time meter shall be installed on the face of each motor starter. Meter shall be as specified in Section 26 27 13.

B. Enclosures
   1. General
      a. Each enclosure shall incorporate a removable back panel, and side panels, on which control components shall be mounted. Back panel shall be secured to the enclosure with collar studs for wall mounted enclosures, and 316 SS hardware for free standing enclosures.
      b. All free standing enclosures shall be provided with feet of the same construction as the enclosure.
      c. The enclosure door shall be interlocked with the main circuit breaker by a panel mounted cable driven operating mechanism.
      d. Back panel shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any components.
      e. All enclosure doors shall have bonding studs. The enclosure interior shall have a bonding stud.
      f. Each enclosure shall be provided with a documentation pocket on the inner door.
      g. Enclosures shall not have holes or knockouts.
      h. Provide manufacturer's window kits where shown on the Drawings.
      i. All panels installed outdoors shall have a factory applied, suitable primer and final coat of weatherproof white paint.
      j. All enclosures shall be padlockable.
   2. NEMA 7/4X
      a. Class 1, Division 1, Groups A, B, C, and D, or as defined in NFPA 70). Boxes shall be constructed as follows:
         1) Copper free cast aluminum body and cover
         2) Stainless steel hinges
         3) Watertight neoprene gasket
         4) Stainless steel cover bolts
         5) All penetrations shall be factory drilled and tapped.
      b. Manufacturers
         1) Cooper Crouse Hinds Type EJB, Style C
         2) Appleton Electric Type AJBEW
         3) Approved Equal
   3. NON METALLIC
      a. Chemical Rooms. NEMA 4X constructed as follows:
         1) PVC or Fiberglass reinforced polyester body and door.
         2) UV inhibitors
         3) Luggage type quick release latches
         4) Foam-in-place gasketed doors
      b. Manufacturers
         1) Hoffman Polypro
         2) Hubbell-Wiegmann Non-Metallic
         3) Approved Equal
   4. ALUMINUM
      a. NEMA 4X Aluminum
         1) Type 5052 aluminum, body and door
         2) Stainless steel continuous hinge
         3) Foam in-place gasket
         4) Single point quarter turn latches (20 inches X 24 inches and below). All others three-point latch

b. Manufacturers
   1) Hoffman Comline
   2) EMF Company
   3) NEMA Enclosures Company
   4) Hammond Company
   5) Approved Equal

5. NEMA 12
   a. NEMA 12 Aluminum
      1) Type 5052 aluminum, body and door
      2) Stainless steel continuous hinge
      3) Foam in-place gasket
      4) Single point quarter turn latches (20 inches X 24 inches and below). All others three-point latch
   b. Manufacturers
      1) Hoffman Comline
      2) EMF Company
      3) NEMA Enclosures Company
      4) Hammond Company
      5) Approved Equal

6. NEMA 12
   a. NEMA 12 Mild Steel
      1) Mild Steel, body and door painted ANSI 61 Gray
      2) Stainless steel continuous hinge pin
      3) Foam in-place gasket
      4) Single point quarter turn latches (20-inches x 24-inches and below). All others three-point latch
   b. Manufacturers
      1) Hoffman
      2) EMF Company
      3) NEMA Enclosures Company
      4) Hammond Company
      5) Approved Equal

7. Otherwise Not Defined NEMA 4X Stainless Steel
   a. Where an enclosure is not otherwise defined or shown on the Drawing
      1) NEMA 4X 316 Stainless Steel
      2) Type 316 stainless steel, body and door
      3) Stainless steel continuous hinge
      4) Foam in-place gasket
      5) Single point quarter turn latches (20-inches x 24-inches and below). All others three-point latch
   b. Manufacturers
      1) EMF Company
      2) NEMA Enclosures Company
      3) Hammond Company
      4) Rittal
      5) Approved Equal

8. NEMA 1 or NEMA 1A boxes shall not be used.

9. Malleable iron boxes shall not be used.

C. Environmental Conditioning

1. Condensation Control
    a. A self-contained enclosure condensation heater with thermostat and fan shall be mounted inside the control panel, if panel is mounted outdoors or in a non-air-conditioned space.
        1) Enclosure heaters shall be energized from 120 volt, single-phase power supply and sized to prevent condensation within the enclosure.
        2) Locate enclosure heaters to avoid overheating electronic hardware or producing large temperature fluctuations on the hardware.
        3) Enclosure heaters shall have an internal fan for heat distribution and shall be controlled with adjustable thermostats. The thermostat shall have an adjustment range of 40°F to 90°F. Provide a circuit breaker or fused disconnect switch within the enclosure.
        4) Enclosure heaters shall be Hoffman type DAH or equal.
    b. Strip heaters may be provided if they are 240-volt rated, powered at 120 volts AC and do not have a surface temperature higher than 60°C. Strip heaters and thermostats shall be as manufactured by Chromalox or equal.
        1) Strip heaters shall be Chromalox, Type OT, 1.5-inches wide, 240 volts, single phase, 150 watts, energized at 120 volts, with rust resisting iron sheath, Catalog No. OT-715, Product Code No. 129314, or equal. Provide sufficient wattage in heaters to prevent condensation should the interior temperature of the enclosure drop below the dew point.
        2) A control thermostat mounted inside the control Panel shall be Chromalox, Type WR, single stage, Catalog No. WR-80, Product Code No.263177, or equal.
        3) The strip heater terminals shall be guarded by a protective terminal cover.
        4) High temperature connecting lead wire shall be used between the thermostat and the heater terminals. Wire shall be #12 AWG stranded, nickel-plated copper with Teflon glass insulation and shall be the product of Chromalox, Catalog No. 6-CFI-12, Product Code No. 263783, or equal.
    c. Each panel shall have a 1/2-inch stainless steel condensate drain, installed on a stainless steel conduit hub, HGTZ Series, T&B or equal, in the bottom of the enclosure. Drain shall be O-Z GedneyDBB-50SS, or equal.
2. Corrosion Control
    a. Provide corrosion protection in each control panel with a corrosion-inhibiting vapor capsule
    b. Manufacturers
        1) Northern Instruments; Model Zerust VC
        2) Hoffman Engineering; Model A-HCI
        3) Approved equal.
3. Panel Interior Ambient Control
    a. The manufacturer shall provide ambient temperature control within the panel to maintain internal temperatures below the maximum operating temperatures of the panel components. an ambient temperature range of -20° C to 40°C.
    b. The manufacturer shall provide panel internal heat rise calculations to show that the panel internal temperatures will be maintained below the maximum operating temperatures of the panel components.

c. The calculation shall show all the internal and external heat gain loads, the expected internal temperature rise in degrees C above the specified ambient, If the specified temperature range cannot be met, an air conditioning system shall be provided with sufficient capacity to maintain the temperature within the specified limits. Panels, for which the calculated heat rise exceeds 40°C., shall have an air conditioning system, sized as required to reduce the heat rise to 40°C. or less, without violating the NEMA rating of the enclosure.

d. The air conditioner shall have the following features:
   1) Use CFC-free R134a refrigerant.
   2) Have fully gasketed flanges on all four mounting edges for a watertight seal that maintains NEMA 4X rating of the panel.
   3) Thermostatic low temperature control to provide energy efficient operation and prevents over-cooling.
   4) EMI/RFI suppressor to minimize transient spikes during compressor on/off cycling.
   5) Separated blower-driven evaporator and condenser air systems for closed loop cooling.
   6) UL listed.
   7) Stainless steel enclosure.
   8) Internal corrosion resistant coating.
   9) Low ambient kit.
   10) Short cycle protector.
   11) Manufacturers
      a) Hoffman
      b) Thermo Electric
      c) Approved equal.

4. Enclosure Fans
   a. Fans shall be furnished for soft start starters and VFDs, as required by the manufacturer, to provide air circulation and cooling. Fans shall be controlled by a temperature switch. The fan shall operate only when the drive is “ON” and for a cool-down period after the drive has stopped Otherwise the fan shall not run when the drive is “OFF”. Louvers, if provided, shall have externally removable filters. The filter shall be metallic and washable.
   b. Fan motors shall be protected by an input circuit breaker. Metal squirrel cage ball bearing, three phase fan motors with 10-year design life shall be used in the drive design. Plastic muffin fans are not acceptable. Fan power shall be obtained from a tap on the main control power transformer.
   c. A “loss of cooling” fault shall be furnished. In the event of clogged filters or fan failure, the drive shall produce an alarm and then, in a predetermined time, be shut down safely without electronic component failure by the temperature switch.
   d. Redundant fans shall be provided in the drive design as backup in the event of fan failure.

D. Internal Wiring
   1. Power and control wiring shall be tinned stranded copper, minimum size #14 AWG, with 600 volt, 90°C, flame retardant, Type MTW thermoplastic insulation. Line side power wiring shall be sized for the full rating or frame size of the connected device, and as shown on the Drawings.
   2. Analog signal wires shall be 600 Volt Class, insulated stranded tinned copper, twisted shielded #16 AWG pair.

3. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks. Field wiring shall not be terminated directly on any panel-mounted device.
4. All wiring shall be tagged and coded with an identification number as shown on the Drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE, or equal.
5. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover. Plan wire routing such that no low twisted shielded pair cable conducting analog 4-20 mA signals or low voltage analog signals are routed in the same wire trough as conductors carrying discrete signals or power. The following trough color code shall be used.
   a. Black: for all 480-volt AC circuits
   b. Grey: 24-volt DC circuit
   c. White: 120-volt AC circuits
   d. Blue: intrinsically safe circuits
6. All control panel wiring shall use the following color code.
   a. Black: AC power at line voltage
   b. Red: switched AC power
   c. Orange: May be energized while the main disconnect is in the off position
   d. White: AC neutral
   e. Orange/white stripe or white/orange stripe: separate derived neutral
   f. Red/white stripe or white/red stripe: switched neutral
   g. Green or green w/ yellow tracer: ground/earth ground
   h. Blue: Ungrounded DC power
   i. Blue/white stripe or white/blue stripe: DC grounded common
   j. Brown: 480V AC three phase - phase A
   k. Orange: 480V AC three phase - phase B
   l. Yellow: 480V AC three Phase - phase C
   m. Purple: common for analog signal wiring
   n. Brown: positive leg of an analog signal

E. Field Installed Internal Wiring

1. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.
2. All field wiring shall be tagged and coded with an identification number. Coding shall be typed on a heat shrinkable tube applied to each end of the wire. The marking shall be a permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE, or equal
3. In general, all conduit entering or leaving equipment shall be stubbed up into the bottom of the enclosure directly below the area in which the conductors are to be terminated, or from the top if shown on the Drawings. Conduits shall not enter the side unless approved in writing by the Owner/Engineer.

F. Terminal Blocks

1. Terminal blocks shall be DIN-rail-mounted one-piece molded plastic blocks with tubular-clamp-screw type and end barriers. Terminal blocks shall be rated for 600 volts except for control and instrumentation circuits, or 4-20 mA analog signal conductors.
2. Provide 600 volt rated terminal blocks for any conductor carrying any voltage over 120 volts to ground.
3. Provide 600 volt rated strap screw terminal blocks for any power conductors carrying over 20 amperes, at any voltage. Terminals shall be double sided and supplied with removable covers to prevent accidental contact with live circuits.
4. Power conductors carrying over 20 amperes, at any voltage shall be terminated to strap-screw type terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated. Do not terminate more than one conductor in any lug, and do not land more than two conductors under any strap-screw terminal point.
5. Terminals shall have permanent, legible identification, clearly visible with the protective cover removed. Each terminal block shall have 20% spare terminals, but not less than two spare terminals.
6. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating common or ground conductors.
7. Twisted shielded pair or triad cables shall have each individual conductor and shield drain wire landed on individual terminal blocks. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating the shield drain wire conductors.
8. Control circuits, 120 volts and below, and 4-20 mA analog signal conductors shall be terminated with manufacturer's recommended insulated connectors.
9. Provide an AC ground bar bonded to the panel enclosure (if metal) with 20% spare terminals.
10. Provided ground terminal blocks for each twisted-shielded pair drain wire.

2.4 SERVICE ENTRANCE DEVICE

A. Where the Control Panel is rated and used as a service entrance panel, the manufacturer shall furnish factory installed in the Control Panel, a dedicated (SPD) (Type 2), permanently connected, Surge Protective Device on the load side of the service entrance panel, as specified in Section 26 43 13 Low Voltage AC Surge Protective Devices (SPDs).

2.5 MAIN CIRCUIT PROTECTIVE DEVICE

A. Unless otherwise shown on the Drawings, the main circuit protective device shall be a molded case (MCCB), three Pole, 600 volt, fixed type, manually operated with stored energy closing mechanism. Trip device shall be solid state with adjustable long time pickup, and delay; adjustable short time pickup and delay; short time i2t switch; adjustable ground fault pickup and delay, and ground fault delay and pickup trips for selective tripping.

B. Provide a flange mounted main power disconnect operating handle with mechanical interlock having a bypass that will allow the panel door to open only when the switch is in the OFF position. Where panels are shown or specified with inner and outer doors, disconnecting handles and controls shall be located on the inner door.

2.6 MOTOR CONTROLLERS

A. Manufacturers

1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   a. Eaton
   b. General Electric Company
   c. Allen Bradley
   d. Square D
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. General

1. The Drawings indicate the approximate horsepower and intended control scheme of the motor driven equipment. Provide the NEMA size starter, circuit breaker trip ratings, control power transformers and thermal overload heater element ratings matched to the motors and control equipment actually supplied, in compliance with the NEC and the manufacturer's heater selection tables. All variations necessary to accommodate the motors and controls as actually furnished shall be made without extra cost to the Owner.
2. Furnish lugs for incoming wiring, sizes as shown on the Drawings. Allow adequate clearance for bending and terminating of cable size and type specified.
3. A NEMA rated magnetic motor starter shall be furnished for each motor. Each motor starter shall be provided with a motor circuit protector (MCP), or circuit breaker, and equipped to provide undervoltage release and overload protection on all three phases. The short circuit protective device shall have an adjustable magnetic trip range up to 1400% of rated continuous current and a trip test feature. MCPs shall be labeled in accordance with UL489. NEMA starter sizes and breaker trip ratings shall be as required for the horsepower indicated, but shall be in no case less than NEMA Size 1. If the manufacturer of the equipment utilizing the motor, supplies a motor horsepower larger than that shown on the Drawings, the Contractor shall supply a motor starter sufficient in size to control the motor supplied.
4. A mechanical disconnect mechanism, with bypass, shall be installed on each motor circuit protector, capable of being locked in the "OFF" position to provide a means of disconnecting power to each motor. Disconnects mechanisms shall be located inside the enclosure such that the main circuit breaker handle is the only device interlocked with the panel door.
5. Each motor starter shall have a 120-volt operating coil unless otherwise noted.
6. Overload relays shall be standard Class 20, ambient compensated, manually reset by pushbutton located on front of the starter door. A normally closed contact shall be directly used in the start circuit and a normally open contact shall be wire to a terminal board for overload alarm.
7. All interfaces between control panel and remote devices shall be isolated via an interposing relay. Interposing relays shall have contacts rated for 250 volts AC and 10 amperes continuous. Relays shall be Control Relays as specified herein.

C. Magnetic Motor Starters

1. Motor starters shall be two or three pole, single or three phase as required, 60 Hertz, 600 volts, magnetically operated, full voltage non reversing. NEMA sizes shall be as required for the horsepower shown on the Drawings.
2. Each motor starter shall have a 120-volt operating coil, and control power transformer. Starters shall have motor overload protection in each phase. Auxiliary contacts shall be provided as shown on the Drawings. A minimum of one normally open and one normally closed auxiliary contacts shall be provided in addition to the contacts required.
3. Overload relays shall be adjustable, ambient compensated and manually reset.
4. Built in control stations and indicating lights shall be furnished where shown on the Drawings.
5. All wires shall be terminated on terminal blocks and shall be tagged.
6. Provide as built wiring diagram and post it in a protective cover inside the cell.

D. Contactors

1. Contactors shall be a circuit breaker and contactor, 600 volt, three-pole, 60 Hertz, magnetically operated. NEMA size shall be as required for the kilowatt ratings required for the equipment provided, but shall be not less than NEMA size 1.
2. Contactors shall have a 120 volt operating coil and control power transformer. Furnish the control power transformer with extra capacity for the unit heater fan.
3. Combination Contactors used for lighting control shall be as specified herein, magnetically operated, with the number of channels and poles as shown on the Drawings. Each contactor shall be controlled by an Astronomic Time Clock Tyco Model TC-100 or approved equal, 3000 VA photo control Precision Controls Model T-368-AL or approved equal, or a combination of both clock and photo control, all as shown on the Drawings. The photocell shall be separately located as shown on the Drawings. The photocell enclosure shall be as required by the area classification.

E. Control Relays

1. Control relays shall be 300 volt, industrial rated, plug-in socket type, housed in a transparent polycarbonate dust cover, designed in accordance with UL Standard 508 for motor controller duty. Continuous contact rating shall be 10 amperes resistive, 1/4 HP at 120 volt AC, operating temperature minus 10 to plus 55°C. Provide spare normally open and normally closed contacts. Relays shall be Potter & Brumfield KRP Series or equal with neon coil indicator light. Timing relays shall be 300 Volt, solid state type, with rotary switch to select the timing range.

F. Elapsed Time Meter

1. A six digit, non-resettable elapsed time meter shall be installed on the face of each motor starter. Meter shall be as specified in Section 26 27 13.

2.7 PROGRAMMABLE LOGIC CONTROLLER (PLC)

A. Where the control panel contains a programmable logic controller (PLC) for programming of the control logic, as shown on the Drawings, the PLC shall be as specified in Section 40 63 00 Programmable Logic Controllers. The manufacturer shall provide the address list, and the interface to connect to the Owner's plant monitoring system for monitoring of the PLC's operation.

B. Provide a scripted program file for all PLCs.

C. The equipment manufacturer shall furnish factory installed, a dedicated Point of Utilization Device (SPD), as specified in Section 26 43 13 Individual Control Panel and Related Equipment Protection (Type 3).

D. The manufacturer shall provide the address list and an Ethernet interface to connect to the Owner's plant monitoring system for monitoring of the PLC's operation.

2.8 OPERATION INTERFACE TERMINAL (OIT)

A. Where the control panel contains an Operation Interface Terminal as shown on the Drawings, for interfacing to the control logic, the manufacturer shall provide the address list, and an Ethernet and serial interface, to connect to the related PLC for monitoring and control of the PLC's operation. The OIT shall be as specified in Section 40 62 63 Operations Interface Terminal.

B. Provide a scripted application and fully documented setup for all OITs.

C. The equipment manufacturer shall furnish factory installed, a dedicated Point of Utilization Device (SPD), as specified in Section 26 43 13 Individual Control Panel and Related Equipment Protection (Type 3).

D. The manufacturer shall provide the address list and an Ethernet interface to connect to the Owner's plant monitoring system for monitoring of the PLC's OIT interface.

2.9 REMOTE MONITORING AND CONTROL INTERFACE

A. General: All control and interconnection points from the equipment to the plant control and monitoring system shall be brought to a separate connection box. No field connections shall be made directly to the equipment control devices. Functions to be brought out shall be as described in the Control Strategies in Section 40 61 96.

B. Discrete control or status functions shall be form C relays with contacts rated at 120 volts AC. Analog signals shall be isolated from each other.

C. Equipment functions to be directly interfaced to the Plant Control and Monitoring System, shall be designed for operation with an Ethernet Connection.

D. The equipment manufacturer shall factory enter the proper IP Address for such connection. Upon request by the Contractor, the Owner/Engineer will provide the proper Internet Protocol Address (IP Address), to be configured by the equipment manufacturer.

E. Refer to Section 40 61 93 Instrumentation Input Output List for monitored parameters.

F. Communication

1. For remote monitoring, one of the following communication capabilities shall be provided:
   a. One integral 10/100BaseT Ethernet port supporting Modbus TCP, Ethernet IP and SNMP protocols.
   b. One media protocol converter, interfacing the provided equipment to a 10/100BaseT Ethernet port supporting Modbus TCP, Ethernet IP and SNMP.
2. The protocol interface shall implement the following:
   a. All data shall be available and/or mirrored within the Modbus 4x or "Holding Register" memory area.
   b. Register 4x00001 shall exist and be readable to allow simple, predictable "comm tests".

c. Software tools shall function properly with slaves' only supporting Modbus functions 3, 4 and 16. Requiring support of diagnostic function 8 is not acceptable.
d. Software tools shall be configurable to write a single register as either function 6 or 16.
e. Software tools shall allow setting the Modbus/TCP "Unit Id" to be a value other than zero. This is required for Ethernet-to-Serial bridging.

3. The media protocol converter shall meet the following criteria:
   a. The converter shall support 10/100Base-T Ethernet. The serial port speed (baud rate) shall support 230kbps. The protocol shall support Modbus TCP, Ethernet IP, DF1, and Modbus RTU/ASCII. Protocol shall be Web Browser configurable.
   b. Operating limits shall be 0-60 degrees C, with humidity range minimum of 5-90 percent. Shock capability on the serial port shall be ESD +15 kV air GAP meeting IEC 1000-4-2. Power requirements shall be 9-30VDC at 0.5A minimum.
   c. The converter shall have LED status for serial, signals, power, and Ethernet.
   d. The converter housing shall be UL 1604, Class 1 Div 2, DIN Rail mountable. The converter shall have DB-9M port connection, with screw terminals, to the input.
   e. Converter shall be Digi One IAP, or approved equal.

2.10 SPARE PARTS

A. Provide the following spare parts for each control panel in the quantities specified:
   1. One box- replacement fuses, all types and sizes used
   2. One replacement lamp, of each color, for pilot lights
   3. One of each color replacement lens caps for pilot lights
   4. One starter coil for each NEMA size furnished
   5. One, Three-pole set of replacement overload heaters of each size range used
   6. One, Three-pole set of starter contacts of each [NEMA] size used.
   7. One can of aerosol touch-up paint.

B. Spare parts shall be boxed or packaged for long term storage. Identify each item with manufacturer's name, description and part number on the exterior of the package.

2.11 FACTORY TESTING

A. The entire control panel shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer's routine shop tests and any other additional operational test to insure the workability and reliable operation of the equipment.

B. Factory test equipment and test methods shall conform with the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards.

C. The operational test shall include the proper connection of supply and control voltage and, as far as practical, a mockup of simulated control signals and control devices shall be fed into the boards to check for proper operation.

D. Factory test equipment and test methods shall conform to the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards, and shall be subject to the Owner/Engineer's approval.

PART 3 - EXECUTION

3.1 INSTALLER'S QUALIFICATIONS

A. Installer shall be specialized in installing this type of equipment with minimum 5 years documented experience. Experience documentation shall be submitted for approval prior to beginning work on this project.

3.2 EXAMINATION

A. Examine installation area to assure there is enough clearance to install the equipment.

B. Housekeeping pads shall be included for the floor mounted motor controllers as detailed on the Drawings with the exception of motor controllers which are to be installed adjacent to an existing unit. Housekeeping pads for these (if used) should match the existing installation.

C. Check concrete pads and baseplates for uniformity and level surface.

D. Verify that the equipment is ready to install.

E. Verify field measurements are as instructed by manufacturer.

3.3 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and Contract Drawings.

B. Conduit hubs for use on raceway system pull and junction boxes shall be watertight, threaded aluminum, insulated throat, stainless steel grounding screw, as manufactured by T&B H150GRA Series, or equal.

C. Conduits entering a control Panel or box containing electrical equipment, shall not enter the enclosure through the top.

D. Install required safety labels.

3.4 RACEWAY SEALING

A. Where raceways enter junction boxes or control panels containing electrical or instrumentation equipment, all entrances shall be sealed with 3M 1000NS Watertight Sealant, or approved equal.

B. This requirement shall be strictly adhered to for all raceways in the conduit system.

3.5 FIELD QUALITY CONTROL

A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.

C. Provide one set of as-built panel drawings laminated, in each panel pocket.

3.6 FIELD ADJUSTING

A. Adjust all circuit breakers, switches, access doors, operating handles for free mechanical and electrical operation as described in manufacturer's instructions.

B. The Power Monitoring and Protective Relays shall be set in the field by a qualified representative of the manufacturer, retained by the Contractor, in accordance with settings designated in a coordinated study of the system as required in Section 26 05 73 Power System Study. All such settings, including the application of arc flash labels, shall have been made and Approved by the Owner/Engineer, prior to energizing of the equipment.

3.7 FIELD TESTING

A. Perform all electrical field tests recommended by the manufacturer. Disconnect all connections to solid-state equipment prior to testing.

B. Megger and record phase to phase and phase to ground insulation resistance. Megger, for one minute, at minimum voltage of 1000 volts DC. Measured Insulation resistance shall be at least 100 megohms. In no case shall the manufacturer's maximum test voltages be exceeded.

C. Test each key interlock system for proper functioning.

D. Test all control logic before energizing the motor or equipment.

3.8 CLEANING

A. Remove all rubbish and debris from inside and around the motor controllers. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

3.9 EQUIPMENT PROTECTION AND RESTORATION

A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

3.10 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall personally inspect the equipment at the jobsite and shall certify in writing that the equipment has been installed, adjusted, and tested, in accordance with the manufacturer's recommendations, including all settings designated in the Power System Study.

B. The Contractor shall provide three copies of the manufacturer's representative's certification.

3.11 TRAINING

A. Provide manufacturer's services for training of plant personnel in operation and maintenance of the soft start starters furnished under this Section.

B. The training for each type of equipment shall be for a period of not less than one eight-hour day.

C. The cost of training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.

D. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.

E. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, motor starters, protective devices, metering, and other major components.

F. The Owner reserves the right to videotape the training sessions for the Owner’s use.

END OF SECTION

SECTION 26 41 00
LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The contractor shall provide all labor, materials, equipment and incidentals as shown, specified, and required to furnish and install a lightning protection system that fully meets the UL Standards listed herein. The Contractor shall provide an inspection of each new structure, or modified existing structure, by Underwriters Laboratories and shall obtain a Master Label for each new or modified structure

B. The Contractor shall employ the services of a licensed lightning protection systems engineering company to design and install the lightning protection system and prepare detailed installation drawings and material specifications. The system shall include ground wires, ground rods, exothermic connections, mechanical connectors, structural steel connections, all as shown on the Drawings, and as specified herein, to provide a bonding to earth ground of all metallic materials likely to become energized. Compliance with all provisions of Section 26 05 26 shall be included under this specification.

C. The Franklin Rod system shall be used. Other systems such as the early streamer emission (ESE) are not acceptable

D. The Bid Price shall be in complete compliance with the Contact Documents. Any exception shall be included in the bid with a detailed explanation that clearly indicates the paragraph of this Specification and / or the item in the Drawings to which the exception applies. The Contractor shall explain in detail the reasons for the exception. The inclusion of an exception and its explanation as specified shall not constitute any obligation on the part of the Engineer / Owner to accept the Bid Price with the exception.

E. This Specification shall have precedence over any conflict in the bidder's submittals and / or descriptive information and the Contract Documents unless an exception is made at the time of bidding as specified herein, and the bid price is accepted with the bidder's exception by the Engineer / Owner.

F. The Contractor shall provide all tools, equipment, supplies, and shall perform all labor required to install the equipment specified in the Contract Documents in order to install, test, and place into satisfactory operation in the time specified for completion in the Contract Documents. Failure of any of the Contractors sub-contractors or suppliers to perform the work as specified shall not constitute an acceptable reason for the Owner to grant any change in the Contract Price or additions to the Contract Time.

1.2 RELATED WORK

A. No references are made to any other section which may contain work related to any other section. The Contract Documents shall be taken as a whole with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or additional work as may be required in those references, and include such information or work as may be specified.

B. Other Divisions

1. The Contractor shall be responsible for examining all Sections of the Specifications and Drawings, and shall determine the power and wiring requirements and shall provide external wiring and raceways, as required to provide a fully functioning power, control and process control systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, the Contractor shall furnish the additional conductors, raceways and/or wiring, with no change in the Contract Price, and with no increase in Contract Time.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:

1. Complete design drawings, for each structure and the site, showing the type, size, and locations of all grounding, down conductors, through roof/through wall assemblies, roof conductors and air terminals, shall be submitted to the Engineer for approval.

B. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project. Unmarked cut sheets will be cause to reject the submittal and return it for revision.

C. All shop drawing submittals and all O&M submittals shall be submitted accordance with Division 1.

1.4 REFERENCE CODES AND STANDARDS

A. All products and components shown on the Drawings and listed in this specification shall be designed, manufactured, and installed according to latest revision of the following standards (unless otherwise noted):

1. NFPA 70 – National Electrical Code (NEC)
2. NFPA 780 – Lightning Protection Code
3. LPI 175 - Lightning Protection Institute Installation Standard
4. UL 96A – Installation Requirements for Lightning Protection Systems

B. All equipment specified in this Section of the Specifications shall bear the appropriate label of Underwriters Laboratories.

1.5 QUALITY ASSURANCE

A. The manufacturer of the lightning protection system equipment shall have produced similar equipment for a minimum period of five years and the lightning protection engineering company shall have been designing and installing lighting protection systems for at least five years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The lightning protection system shall conform to the requirements and standards for lightning protection system of the LPI, UL and NFPA. Standard requirements

C. All components and material shall be new and of the latest field proven design and in current production. Obsolete components or components scheduled for immediate discontinuation shall not be used.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, complete all submittal requirements, and present to the Owner/Engineer prior to delivery of the equipment and materials, an approved copy of all such submittals.

B. Protect equipment and materials during shipment, handling, and storage by suitable complete enclosures. Protect equipment from exposure to the elements and keep thoroughly dry.

C. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repaint damaged painted surfaces to the satisfaction of the Owner/Engineer.

1.7 WARRANTY

A. The Manufacturer shall warrant the system and equipment to be free from defects in material and workmanship for one year from date of final acceptance of the equipment. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Manufacturer, at no expense to the Owner.

PART 2 - PRODUCTS

2.1 SUPPLIERS

A. Subject to compliance with the Contract Documents, the following Suppliers are acceptable:
   1. Bonded Lightning / Advanced Lightning Technology, Argyle, Texas
   2. Hicks Lightning Protection, Ponder, Texas
   3. VFC, Inc. Grapevine, Texas
   4. Approved Equal

B. The listing of specific suppliers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

2.2 GENERAL

A. The system to be furnished under this specification shall be the standard product of manufacturers regularly engaged in the production of lightning protection equipment and shall be the manufacturer's latest approved design. Lightning protection system installers / designers shall be certified by the Lightning Protection Institute for the work. Submit LPI training and qualifications for each designer and installer. The installation shall be in full compliance with UL 96A and NFPA 780. Should conflict between the two standards be discovered and at issue for the project, submit the issue to the Engineer for resolution.

B. All equipment shall be new and of a design and construction to suit the application where it is used in accordance with accepted industry standards and LPI, UL, and NFPA standard requirements.

C. At the point where an electrical service of 1000 Volts or less is generated, a surge protection device shall be provided and installed, complying with UL96A, for a UL Master Label Certificate of Inspection. The surge protection device shall comply with UL Standard 1449 Third Edition, as a Type 1 or Type 2 lightning rated unit of 20ka or more, as specified in Section 26 43 13.

2.3 MATERIALS

A. Class I Class II materials may be utilized for Class I structures, not exceeding 75 feet above grade. All other structures shall utilize Class II materials.

B. Unless otherwise specified herein, all materials shall be tin plated copper with 316 stainless steel fasteners (nuts, bolts, washers and anchors) , and used in accordance with LPI, UL and NFPA code requirements.

C. Aluminum materials, with 316 stainless steel fasteners (nuts, bolts, washers and anchors), shall be used only on aluminum, galvalume or galvanized metal structures. Where aluminum, galvalume or galvanized metal parapet caps are used, the entire roof lightning protection equipment shall utilize aluminum components. Approved transitional components shall be used for transitions to aluminum materials. Down leads and grounding shall utilize tinned copper with the bimetal transition occurring at the bi-metal through roof assembly.

D. All air terminal bases for flat roof areas shall be the adhesive type.

E. Conductors shall be tinned copper, (aluminum where installed on aluminum roofs). Provide conductors with their wire size, stranding, and weight in accordance with NFPA 780.

F. Conductor fasteners shall be an approved type of non-corrosive metal, and have ample strength to support conductors. Cable fasteners shall be of the adhesive type.

G. All cable connecters shall be tin coated copper cast bronze with screw pressure type 316 stainless steel bolts, washers and nuts.

H. Where any part of a protection system is exposed to potential mechanical injury, protect it by covering it with PVC conduit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All materials shall be installed by experienced workmen that specialize in this type of work. The lightning protection system shall be installed per approved shop drawings and UL and NFPA recommended practices.

B. Install air terminals on structure steel framework bonded to the down coming cables. Unless otherwise specified herein, all materials shall be tin plated copper with 316 stainless steel fasteners (bolts, nuts, washers and anchors) , and used in accordance with LPI, UL and NFPA code requirements. Conduit shall be as specified under Section 26 05 33.

C. Bond structure steel framework as required by NFPA 780 and UL 96A.

D. Bond all metal pipes and metal structures as required by NFPA 780 and UL 96A..

E. All concealed conductors shall be installed in Schedule 40 PVC conduit.

F. Provide a dedicated lightning protection system ground rod at the ground end of each down lead in accordance with NFPA 780 4.13.1.1(1). If a grounding counterpoise loop is present, bond each lightning protection system down lead to the nearest power system grounding electrode (ground rod) which is a part of the counterpoise in accordance with NFPA 780 4.13.1.1(2). Exothermically weld each down lead to the ground rod. All down lead conductors shall be installed without splice from the roof lightning protection conductors to the dedicated lightning protection system ground rod.

G. All concealed lightning protection system connections shall be exothermically welded. The only exception shall be for lightning protection systems installed in NEC Classified areas as determined by NFPA 820, the Engineer or the NEC Authority Having Jurisdiction.

H. All components of the system, on or above the roof, shall be connected to the system ground.

3.2 TESTING

A. Employ the services of a UL field inspector, for inspection of the system upon completion of the installation. The Contractor shall assume full responsibility for the correctness of the installation and shall make any and all corrections and additions deemed necessary by the UL inspector. The Contractor shall pay for all costs of the UL inspection and any subsequent re-inspections as required.

B. Inspection and testing to be performed by personnel regularly engaged in the installation and testing of Master Labeled lightning protection systems.

C. Inspect the system for proper installation.

D. Test the complete system for continuity to the electrical grounding system.

E. An application shall be made to the Underwriters Laboratories Inc. for inspection and certification, and shall be delivered to the Engineer, confirming that all concealed components have been monitored during job construction.

F. A UL Certification shall be provided for each and every new structure, including all parts of existing structures that are expanded, as defined by NFPA 780 and UL 96A. A Master Label shall be obtained for all structures where the service voltage is less than 1000 VAC.

G. All inspections shall be done by a third party inspector in person on site by a UL or LPI certified inspector. Self-inspection by the lightning protection system designer or installer is not acceptable. Photographic inspection is not acceptable. All lightning protection system inspections shall be witnessed by the Engineer / Owner. Unwitnessed inspections are not acceptable and shall be re-done if not witnessed with no change in the Contract Price or Contract Time.

END OF SECTION

SECTION 26 41 19
ELECTRICAL DEMOLITION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish, install and test all equipment, wiring and appurtenances as may be required to perform the electrical demolition shown on the Drawings and as specified herein.

B. Make all required field verifications specified and/or as necessary to determine all the requirements as specified for the continued operation of the Owners facilities during the construction process prior to bidding. All costs and time required to perform the work shall be included in the Contract Price and Schedule.

1.2 RELATED WORK

A. Refer to Division 26 00 00 and the Contract Drawings, for related work and electrical coordination requirements.

1.3 SCHEDULES

A. Schedule all required shutdowns with the Owner/Engineer to coordinate the system demolition and installation of temporary facilities with the Owner's operational requirements.

1.4 STANDARDS

A. Temporary wiring of systems to maintain operation of facilities while undergoing modifications and demolition shall be provided in accordance with:

1. American National Standards Institute / National Fire Protection Association (ANSI/NFPA), No. 70 – National Electrical Code (NEC), Article No. 590 – Temporary Wiring.

1.5 QUALITY ASSURANCE

A. Verify field measurements and circuiting arrangements are as shown on the Drawings.

B. Verify that abandoned wiring and equipment serve only abandoned facilities.

C. Demolition drawings are based on casual field observation and existing record documents. Discrepancies shall be reported to the Owner/Engineer before disturbing the existing installation.

D. Beginning demolition, signifies the existing conditions have been accepted and warrants that service to equipment and items not scheduled or indicated for removal will be maintained. Temporary shutdowns and demolishing of any equipment shall be arranged and approved by the Owner to not interrupt critical process operations.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for patching and extending work shall be as specified in individual Sections.

2.2 DESIGN AND CONSTRUCTION

A. Provide temporary electrical conductors and raceway as required to maintain continued operation in accordance with the Owner's operational requirements and meeting the requirements of the NEC.

PART 3 - EXECUTION

3.1 PREPARATION

A. Disconnect electrical systems in walls, floors and ceilings scheduled for removal.

B. Coordinate utility service outages with the Utility Company. Continuous service to operating equipment shall be provided as required by the Owner's process operational needs which may include the temporary use of portable generation as specified herein.

C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.

D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Obtain permission from the Owner/Engineer at least one week in advance, before partially or completely disabling system.

E. The Owner's process operations shall continue without interruption throughout the project demolition and construction as required by the Owner and/or regulating bodies including but not limited to the EPA, and State or Local authorities having jurisdiction.

1. As required to meet the Owner's process requirements, provide on-site generation with the capacity and voltage required by the Owner's power system to prevent process interruptions unacceptable to the Owner. Include all engine-generator fluids and fuel and rental expenses for the duration required by the work in the Contract Price.
2. Examine the Contract Documents and make any site visits necessary, including interviews with Owner's Personnel to determine what process are required to remain in service prior to bidding. Include all costs to keep the required process in operation including all materials, labor, expenses required by the electric Utility serving the project site and on-site generation in the Contract Price and Schedule. The determination of the requirements for continued process operations prior to bidding is required. No increase in Contract Time or Price will be allowed if this requirement is not met.
3. If failure to provide adequate power to keep the process in operation which causes a regulatory body to levy fines against the Owner, Owner shall be reimbursed. No increase in Contract Price for such expenses will be accepted.

3.2 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

A. Remove, relocate and extend existing installations to accommodate new construction.

B. Remove abandoned wiring from the load to the source of supply.

C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces to match the existing surfaces.

D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit serving them is abandoned and removed. Provide blank cover for abandoned outlets which are not removed.

E. Disconnect and remove abandoned panelboards and distribution equipment. Remove all associated conduit and conductors and the supporting means. Patch the wall, floor, or other surfaces where the equipment and associated raceway were attached to match the existing surfaces.

F. Disconnect and remove electrical devices associated with mechanical equipment that has been removed. Remove all associated raceway and conductors. Patch the wall, floor, or other surfaces where the electrical devices and associated raceway were attached to match the existing surfaces.

G. Repair adjacent construction and finishes damaged during demolition and extension work.

H. Maintain access to existing installations which remain active. Modify installation or provide access to panels as appropriate.

I. Where the demolition or revision of any portion of a raceway or box in the raceway system, in classified area, causes the raceway system of the area to no longer comply with the classification or specification requirements of the area, provide and install such boxes, fittings, etc. as may be necessary to return the raceway system to compliance with the classification of the area and with these specifications.

J. Extend existing installations using materials and methods as specified for new work. Using existing raceways is acceptable where extension of existing raceways is shown or specified only if the existing raceways are in accordance with the specifications for the new raceways. Replace existing raceways which do not meet these specifications.

K. All work shall be done in an orderly and careful manner. Hold noise, dust, and vibration to a minimum and conduct the work to avoid any damage to the surroundings. Remove all items and parts as shown and noted on the Drawings and as otherwise may be required to be removed to complete the work as specified.

L. Salvaged Equipment and Materials

1. The Owner shall have the right to retain any or all electrical and instrumentation equipment shown or specified to be removed from the site.
2. Prior to starting demolition, the Contractor and Owner/Engineer shall jointly visit the areas of demolition and the Owner/Engineer will designate those items that are to remain the property of the Owner.

3. Equipment and material designated by the Owner to remain the property of the Owner shall be removed from the work area and transported to a designated location on the site and stored for the Owner's use. Store on wood runners raised above the surrounding grade and cover with weather resistant covering and tie securely or store inside Owner furnished storage as directed by the Owner/Engineer.
4. Take necessary precautions in removing Owner designated property to prevent damage during the demolition process. Remove steel structural members by unbolting, cutting welds, or cutting rivet heads and punching shanks through holes. Do not use a cutting torch to separate the Owner's equipment or material unless approved by the Owner/Engineer.
5. If possible, items to be salvaged shall be removed in one piece or in a manner that does not impact their reuse. Loose components may be removed separately. Controls and electrical equipment may be removed from the equipment and handled separately. Large units may be handled separately.

M. Material removed from the construction site during demolition, and any equipment not otherwise designated to remain the property of the Owner in accordance with the pre-demolition identification process shall become the property of the Contractor and shall be promptly removed from the construction site.

N. Refurbish and replace any existing facility to be left in place which is damaged by the demolition operations with no change in Contract Price or Schedule. The repair of such damage shall result in the parts being returned to such a condition which is at least equal to that found at the start of the Work.

3.3 CLEANING AND REPAIR

A. Clean and repair existing materials and equipment which remain or are to be reused.

B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.

END OF SECTION

SECTION 26 43 13
LOW VOLTAGE AC SURGE PROTECTIVE DEVICES (SPDs)

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section of the Specifications describes the requirements for low voltage AC surge protective devices (SPDs 1Kv and less), to be furnished under other Sections of the Specifications.

B. All equipment described herein shall be submitted, and factory installed, as an integral part of equipment specified elsewhere in these Specifications.

1.2 RELATED WORK

A. Refer to Division 26 00 00 for related work and electrical coordination requirements.

1.3 SUBMITTALS

A. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned unreviewed. Unmarked cut sheets will cause rejection of the submittal and its return for revision.

B. Submittals shall also contain information on related equipment to be furnished under this Specification but described in the related sections to which reference is made in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will be returned unreviewed.

C. Submit catalog data for all items supplied from this specification Section as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc., enough to confirm that the SPD provides every specified requirement. Any options or exceptions shall be clearly indicated, with the reason for such deviations. Acceptance of any deviation will be at the sole discretion of the Owner/Engineer. Shop drawings, not so checked and noted, will be returned unreviewed.

D. The submittals shall include:

1. Dimensional drawing of each SPD type.
2. UL 1449 Third Edition Listing, Standard for Safety, Surge Protective Devices, documentation. Provide verification that the SPD complies with the required ANSI/UL 1449 3rd Edition listing by Underwriters Laboratories (UL) or other Nationally Recognized Testing Laboratory (NRTL).
3. UL 1283 Listing, Electromagnetic Interference Filters, documentation.
4. ANSI/IEEE C6241 and C6245, Category C3 (20kV-1.2/50, 10kA-8/20µs waveform) clamping voltage test results.

E. Operation and Maintenance Manuals.

1. Operation and Maintenance manuals shall include the following information:
   a. Manufacturer’s contact address and telephone number for parts and service.
   b. Instruction books and/or leaflets
   c. Recommended renewal parts list

d. Record Documents for the information required by the Submittals above.

1.4 REFERENCE CODES AND STANDARDS

A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):
   1. UL 1449 Third Edition – Surge Protective Devices
   2. UL 1283 Electromagnetic Interference Filters
   3. ANSI/IEEE C62.41.2-2002 – IEEE Recommended Practice on Characterization of Surge Voltages in Low Voltage AC Power Circuits
   4. ANSI/IEEE C62.45-2002 – IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.
   5. NEC Article 285 - Surge Protective Devices
   6. NEMA/ISCI – 109 Transient Overvoltage Withstand Test
   7. IEEE Std. 472/ANSI C37.90A Surge Withstand Capability Tests
   8. IEC 255.4 Surge Withstand Capability Tests

B. All SPDs and their installation shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.

C. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

1.5 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The manufacturer of the SPD shall be the same as the manufacturer of the service entrance and distribution equipment in which the devices are installed and shipped. The protected electrical equipment, after installation of the SPD, shall be fully tested and certified to the following UL standards:
   1. UL 67 - Panelboards.
   2. UL 845 - Motor Control Centers.
   3. UL 891 - Switchboards.
   4. UL 1558 - Low Voltage Switchgear.

C. For the equipment specified herein, the manufacturer shall be ISO 9001 or 9002 certified.

1.6 WARRANTY

A. Provide warrantees, including the manufacturer’s warrantee, for the equipment specified and the proper installation thereof, to be free from defects in material and workmanship for two years from date of final acceptance of the equipment and its installation. Within such period of warranty, all material and labor necessary to return the equipment to new operating condition shall be provided. Any warranty work requiring shipping or transporting of the equipment shall be provided at no expense to the Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable (Type 1 and Type 2):
   1. Cutler Hammer.
   2. ABB
   3. Square D
   4. Allen Bradley
   5. No equal.

B. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable (Type 3):
   1. Edco SLAC Series
   2. Phoenix Contact
   3. Brick Wall Model PWOM20
   4. No equal.

2.2 SERVICE ENTRANCE AND DISTRIBUTION EQUIPMENT

A. General
   1. All SPDs shall be internal to the equipment being protected. Externally housed SPDs will not be acceptable.
   2. All SPDs shall be marked with a short-circuit current rating and shall meet or exceed the available fault current at the connection point.
   3. UL 1449 Usage Classifications.
      a. Type 1 – Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service equipment overcurrent device, and intended to be installed without an external overcurrent protective device.
      b. Type 2 – Permanently connected SPDs intended for installation on the load side of service equipment overcurrent device; including SPDs located at the branch panel.
      c. Type 3 – Point of utilization SPDs, installed at a minimum conductor length of 10 meters (30 feet) from the electrical service panel to the point of utilization, for example cord connected, direct plug-in, receptacle type and SPDs installed at the utilization equipment being protected. The distance (10 meters) is exclusive of conductors provided with or used to attach SPDs.
   4. Construction of Type 1 and Type 2.
      a. Fully Integrated Component Design: All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality will not be accepted.

b. Overcurrent Protection: The unit shall contain thermally protected MOVs. The thermally protected MOVs shall have a thermal protection element packaged together with the MOV in order to achieve overcurrent protection of the MOV. The thermal protection element shall disconnect the MOV(s) from the system in a fail-safe manner should a condition occur that would cause them to enter a thermal runaway condition.

c. Maintenance Free Design: The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries are not acceptable. SPDs requiring any maintenance of any sort such as periodic tightening of connections are not acceptable.

d. Balanced Suppression Platform: The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating replaceable SPD modules are not acceptable.

e. Electrical Noise Filter: Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method.

f. Internal Connections: No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.

g. Power and ground connections shall be prewired within the protected equipment.

h. Local Monitoring: Visible indication of proper SPD connection and operation shall be provided. The indicator lights shall indicate which phase as well as which module is fully operable. The status of each SPD module shall be monitored on the front cover of the enclosure as well as on the module. A push-to-test button shall be provided to test each phase indicator. Push-to-test button shall activate a state change of dry contacts for testing purposes.

i. Surge Counter: The SPD shall indicate user how many surges have occurred at the location. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. To prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of two seconds in order to clear the surge count total. The ongoing surge count shall be stored in non-volatile memory or UPS backup.

j. Remote Monitoring: For remote monitoring, the SPDs shall provide the same discrete and analog signal and control functions as specified for local monitoring and the surge counter, to a terminal strip for outgoing connection to a PLC as shown on the Drawings. The functions shall be converted as specified for interface to the monitored equipment.

k. The voltage surge suppression system shall incorporate thermally protected metal-oxide varistors (MOVs) as the core surge suppression component for the service entrance and all other distribution levels. The system shall not utilize silicon avalanche diodes, selenium cells, air gaps, or other components that may crowbar the system voltage leading to system upset or create any environmental hazards.

l. SPD shall be Listed in accordance with UL 1449 Third Edition and UL 1283, Electromagnetic Interference Filters.
m. Integrated surge protective devices (SPD) shall be Component Recognized in accordance with UL 1449 Third Edition, Section 37.3.2 and 37.4 at the standard's highest short circuit current rating (SCCR) of 200 kA, including intermediate level of fault current testing.
n. SPD shall be tested with the ANSI/IEEE Category C High exposure waveform (20kV-1.2/50µs, 10kA-8/20µs).
o. SPD shall provide suppression for all modes of protection: L-N, L-G, and N-G in WYE systems (7 Mode).

5. Construction of Type 3.
a. Fully Integrated Component Design: All of the SPD's components and diagnostics shall be contained within one discrete assembly. SPDs or individual SPD modules that must be ganged together in order to achieve higher surge current ratings or other functionality will not be accepted.
b. Maintenance Free Design: The SPD shall be maintenance free and shall not require any user intervention throughout its life. SPDs containing items such as replaceable modules, replaceable fuses, or replaceable batteries are not acceptable. SPDs requiring any maintenance of any sort such as periodic tightening of connections are not acceptable.
c. Electrical Noise Filter: Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be up to 50 dB from 10 kHz to 100 MHz using the MIL-STD-220A insertion loss test method.
d. Internal Connections: No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be soldered, hardwired with connections utilizing low impedance conductors.
e. Power and ground connections shall be prewired within the protected equipment.
f. Local Monitoring: Visible indication of proper SPD connection and operation shall be provided. The indicator light shall indicate that the module is fully operable. The status of each SPD module shall be monitored on the front cover of the module.
g. SPD shall be Listed in accordance with UL 1449 Third Edition and UL 1283, Electromagnetic Interference Filters.
h. SPD shall be tested with the ANSI/IEEE Category C High exposure waveform (20kV-1.2/50µs, 10kA-8/20µs).

B. Applications.
1. Service Entrance Rated Equipment (Type 1).
a. This applies to switchgear, switchboards, panelboards, motor control centers, and other devices installed as service entrance equipment where the SPD is to be permanently connected between the secondary of the service transformer and the line side of the service equipment overcurrent device.
b. Service entrance located SPDs shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category C environments.
c. The SPD shall be of the same manufacturer as the equipment
d. The SPD shall be factory installed inside the equipment, at the assembly point, by the original equipment manufacturer
e. Locate the SPD on the load side of the main disconnect device, as close as possible to the phase conductors and the ground/neutral bars.

f. The SPD shall be connected through a UL approved disconnecting means. The disconnect shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
g. The SPD shall be integral to the equipment as a factory standardized design.
h. All monitoring and diagnostic features shall be visible from the front of the equipment.

2. Distribution Equipment Applications (Type 2).
   a. This applies to switchgear, switchboards, panelboards, motor control centers, and other non-service entrance equipment where the SPD is to be permanently connected on the load side of the equipment overcurrent device.
   b. The SPD shall be of the same manufacturer as the equipment.
   c. The SPD shall be included and mounted within the equipment by the manufacturer.
   d. The manufacturer shall size and provide the overcurrent and disconnecting means for the SPD.
   e. The SPD units shall be tested and demonstrate suitability for application within ANSI/IEEE C62.41 Category B environments.
   f. The SPD shall be located within the panelboard, unless otherwise shown on the Drawings. SPDs shall be installed immediately following the load side of the main breaker. SPDs installed in main lug only panelboards shall be installed immediately following the incoming main lugs.
   g. The SPD shall not limit the use of through-feed lugs, sub-feed lugs, and sub-feed breaker options.
   h. All monitoring and diagnostic features shall be visible from the front of the equipment.

3. Individual Control Panel and Related Equipment Protection (Type 3).
   a. Locate the SPD on the load side of the ground and neutral connections.
   b. The SPD shall be connected through a disconnect circuit breaker or fuse as shown on the drawings. The disconnecting means shall be located in immediate proximity to the SPD. Connection shall be made via bus, conductors, or other connections originating in the SPD and shall be kept as short as possible.
   c. All monitoring and diagnostic features shall be visible from the front of the equipment.

4. Mechanical Equipment Manufacturer's Provided Control Panels (MEMs) and Electrical Manufacturer's Provided Control Panels (OEMs) Applications (Type 1, Type 2, and Type 3)
   a. Where any such panel is installed as service entrance equipment, a Type 1 SPD shall be installed.
      1) The same requirements for other service entrance equipment listed above apply to this application except for the requirement that the Type 1 SPD shall not be required to be of the same manufacturer as the panel.
   b. Where any such panel is installed as non-service entrance equipment, but within 50' of wire length of the incoming power line when that line is overhead.
      1) The same requirements for other non-service entrance equipment listed above apply to this application except for the requirement that the Type 2 SPD shall not be required to be of the same manufacturer as the panel.
      2) Where a Type 1 SPD is installed, a Type 2 SPD is not required on the same panel unless otherwise specifically shown on the drawings.

c. Where any such panel includes a PLC, a Type 3 SPD shall be installed.
   1) The same requirements for other individual control panel and related equipment listed above apply to this application.
   2) The SPD shall be integral to the MEM or OEM panel, as a factory standardized design.

C. Ratings
   1. Unit Operating Voltage: Refer to drawings for operating voltage and unit configuration.
   2. SPD shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.
   3. Minimum surge current rating shall be 240 kA per phase (120 kA per mode) for service entrance and 120 kA per phase (60 kA per mode) for distribution applications.
   4. UL 1449 clamping voltage must not exceed the following: Voltage Protection Rating (VPR)

Voltage	L-N	L-G	N-G
240/120	1200/800V	800V	800V
208Y/120	800V	800V	800V
480Y.277	1200V	1200V	1200V
600Y/347	1500V	1500V	1500V

   5. Pulse life test: Capable of protecting against and surviving 5000 ANSI/IEEE Category C High transients without failure or degradation of clamping voltage by more than 10%.
   6. Minimum UL 1449 3rd edition withstand Nominal Discharge Current (In) rating to be 20kA per mode

2.3 ACCESSORIES

A. Furnish nameplates for each device as indicated on drawings. Color schemes shall be as indicated on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment specified herein shall be factory installed, field adjusted, tested and cleaned as an integral part of equipment specified elsewhere in the individual equipment Specification.

B. Types 1 and 2 shall be grounded and bonded as a part of the individual equipment as specified in the individual equipment Section. Type 3 shall be grounded and bonded in accordance with the SPD manufacturer's instructions.

END OF SECTION

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SECTION 26 50 00
LIGHTING SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals required and install a complete lighting system ready for operation as shown on the Drawings and as specified herein.

1.2 RELATED WORK

A. No references are made to any other section which may contain work related to any other section. The Contract Documents shall be taken as a whole with every section related to every other section as required to meet the requirements specified. The organization of the Contract Documents into specification divisions and sections is for organization of the documents themselves and does not relate to the division of suppliers or labor which the Contractor may choose to employ in the execution of the Contract. Where references are made to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or additional work as may be required in those references, and include such information or work as may be specified.

B. Other Divisions

1. The Contractor shall be responsible for examining all Sections of the Specifications and Drawings, and shall determine the power and wiring requirements and shall provide external wiring and raceways, as required to provide a fully functioning power, control and process control systems. If the equipment requires more conductors and/or wiring, due to different equipment being supplied, the Contractor shall furnish the additional conductors, raceways and/or wiring, with no change in the Contract Price, and with no increase in Contract Time.

1.3 SUBMITTALS

A. Submittals shall be made in accordance with the requirements of Division 1, Section 26 00 00 and as specified herein. All cut sheets shall be clearly marked to indicate which products are being submitted for use on this project. Unmarked cut sheets will be cause to reject the submittal and return it for revision.

B. Submittals shall also contain information on related equipment to be furnished under this Specification but described in the related sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will be returned without review.

C. Manufacturer's technical information for the materials proposed for use in the systems.

D. For all light pole foundations shown to be installed in earth, provide installation and anchoring drawings that are stamped and sealed by a licensed engineer in the state of Texas. The soil condition shall be assumed to be disturbed earth. If compaction is assumed, a compaction test shall be performed on all foundation locations, showing the minimum field density assumed in the foundation design.

E. Submit manufacturer's name and catalog data for all lighting equipment specified in this Section and on the lighting fixture schedule.

F. Shop drawings: Clearly indicate luminaire type, name of the job. Contractor shall endeavor to submit all luminaires, drivers and integral controls shop drawings at one time, in one package. Any re-submittals shall include all luminaire, driver and integral controls previously rejected or requiring further information. Specialty SSL, custom, or modified fixtures may be submitted as a separate package.

G. Shop Drawings: Reproductions of the Contract Drawings are not acceptable as shop drawings.

H. Product Data: Provide dimensions, ratings and specific catalog number and identification of items and accessories and performance data.

I. Shop Drawings: Indicate any dimensions and components for each luminaire that are not a standard product of the manufacturer.

J. Wiring Diagrams – as needed for special operation or interaction with other system(s).

K. Photometric Data: Where indicated below or for substitutions, supply complete photometric data for the fixture, including optical performance, rendered by NVLAP approved laboratory developed according to the methods of the Illuminating Engineering Society of North America. Submit electronically, in IESNA LM-63 standard format. Types XX and YY.

L. Submit photometric data for all substitute luminaries. Photometric reports are not required from specified manufacturer unless noted in paragraph H above.

M. Specification Sheets: If lacking sufficient detail to indicate compliance with Contract Documents, standard specification sheets will not be accepted. This includes, but is not limited to, luminaire type designation, manufacturer's complete catalog number, voltage, LED type, CCT, CRI, specific driver information, system efficacy, L70 life rating, and any modifications necessary to meet the requirements of the Contract Documents.

N. Substitutions shall include complete photometric data as outlined in paragraph H above, and point-by-point calculations for the specific conditions on the project. Samples shall be required for consideration of any substitutions and must be submitted in accordance with the terms outlined in paragraph below.

O. Working Samples of all substitutions: Samples shall be 120-volt with cord and plug attached, and shall include specified LEDs and all modifications necessary to meet the requirements specified in the Contract Documents.

P. Energy Efficiency:

1. Submit documentation for Energy Star qualifications for equipment provided under work of this Section.
2. Submit data indicating luminaire efficiency.
3. Submit data indicating Ballast Efficacy Factor (BEF).
4. Submit data indicating Luminaire Efficacy rating (LER).
5. Submit data indicating color rendition index of light source.

Q. Submit environmental data in accordance with Table 1 of ASTM E2129 for products provided under work of this Section.

R. Manufacturer's technical information for the materials proposed for use in the systems.

1.4 REFERENCE CODES AND STANDARDS

A. All lighting fixtures shall be in accordance with the National Fire Protection Association (NFPA) NFPA 70 “National Electrical Code” (NEC), and shall be constructed in accordance with the latest edition of the Underwriters Laboratories (UL) "Standards for Safety, Electric Lighting Fixtures".

B. National Energy Policy Act of 2005, Public Law No. 109-58.

C. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002.

D. NFPA 70 - National Electrical Code; National Fire Protection Association; 2008.

E. IESNA LM-79-08 IESNA - Approved Method for Electrical and Photometric.

F. Measurements of Solid State Lighting Products; 2008.

G. IESNA LM-80-08 IESNA - Approved Method for Measuring Lumen Maintenance of LED Light Sources.

H. IESNA LM-80-08 IESNA - Approved Method for Measuring Lumen Maintenance of LED Light Sources.

I. IESNA TM-21-2011 – Projecting Long Term Lumen Maintenance of LED Light Sources.

J. UL 8750 – Light Emitting Diode (LED) Equipment for Use in Lighting Products.

K. OSHA 29CFR1910.7 – Luminaires shall be listed by national recognized testing laboratory approved by United Stated Department of Labor, Occupational Safety and Health Administration (OSHA).

1.5 QUALITY ASSURANCE

A. All fixtures shall be of the energy-efficient type.

B. The manufacturer of these materials shall have produced similar lighting fixtures for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar systems shall be provided demonstrating compliance with this requirement.

C. The luminaires shall be manufactured in accordance with a manufacturer quality assurance (QA) program. The QA program shall include two types of quality assurance: (1) design quality assurance and (2) production quality assurance. The production quality assurance shall include statistically controlled routine tests to ensure minimum performance levels of the modules built to meet this specification. These tests shall include: CCT, CRI, Lumen output and wattage. Tests shall be recorded, analyzed and maintained for future reference.

D. QA process and test results documentation shall be kept on file for a minimum period of seven years.

E. LED luminaire designs not satisfying design qualification testing and the production quality assurance testing performance requirements described below shall not be labeled, advertised, or sold as conforming to this specification.

F. Equipment submitted shall fit within the space shown on the Drawings. Equipment which does not fit within the space is not acceptable.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner/Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, onsite factory work, or failed factory tests will not be permitted.

B. Protect equipment during shipment, handling, and storage by suitable complete enclosures. Protect equipment from exposure to the elements and keep thoroughly dry.

C. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Repaint damaged painted surfaces to the satisfaction of the Owner/Engineer.

D. Equipment shall be installed in its permanent location shown on the Drawings within seven calendar days of arriving onsite. If the equipment cannot be installed within seven calendar days, the equipment shall be stored on site in a dry heated and air conditioned space. If there is no such storage space on site, the equipment shall not be delivered to the site, but stored offsite, at the Contractor's expense, until such time that the site is ready for permanent installation of the equipment.

1.7 WARRANTY

A. The Manufacturer shall warrant the system and equipment to be free from defects in material and workmanship for one year from date of final acceptance of the equipment. Within such period of warranty the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Contractor at no expense to the Owner.

B. The manufacturer shall provide a warranty against loss of performance and defects in materials and workmanship for the Luminaires for a period of five years after acceptance of the Luminaires. Warranty shall cover all components comprising the luminaire. All warranty documentation shall be provided to customer prior to the first shipment.

C. The equipment shall be warranted to be free from defects in workmanship, design, and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the unit(s) restored to service at no additional cost (including parts, labor, and travel expenses) to the Owner.

D. The manufacturer's warranty period shall run concurrently with the Contractor's warranty period. No exception to this provision shall be allowed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Lighting fixture manufacturers and types as required by the "Lighting Fixture Schedule" on the Drawings. The catalog numbers are given as a guide to the design and quality of fixture desired. Equivalent designs and equal quality fixtures of other manufacturers will be acceptable upon approval by the Owner/Engineer.

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Where specified to match existing fixtures, fixtures of the same manufacturer and type shall be installed.

2.2 LIGHTING FIXTURES

A. General

1. All lamps shall be of one manufacturer and shall be as manufactured by Osram/Sylvania Electric Products, Inc.; General Electric Co.; North American Philips Lighting Corp. or equal.
2. All ballasts shall be UL listed, ETL certified, Class "P", high power factor (minimum 0.90).
3. Ballasts shall have an "A" sound rating or better.
4. All ballasts used in exterior applications shall have a minimum starting temperature of 0°F unless otherwise specified.
5. All interior ballasts shall have a minimum starting temperature of 50°F.
6. Ballasts shall be parallel wired type and designed to operate the number and length of lamps specified.
7. The total harmonic distortion (THD) of each ballast shall be 10% or less.
8. Ballasts shall have a minimum ballast factor of 0.88 = N and as specified in the fixture schedule.
9. Ballasts shall have nominal power factor 0.90 or higher.
10. Ballasts shall have a maximum lamp current crest factor of 1.4.
11. Ballast shall provide normal rated life for the lamp specified.
12. All electronic ballasts shall be warranted for parts and replacement for five full years from the date of installation.
13. All ballasts shall be as manufactured by G.E., Advance, Model Mark V, similar by Osram/Sylvania; MagneTek or equal.
14. Where the equipment contains a programmable logic controller (PLC) or an uninterruptible power supply (UPS), the equipment manufacturer shall furnish factory installed, a dedicated Point of Utilization Device (SPD), as specified in Section 26 43 13, Individual Control Panel and Related Equipment Protection (Type 3).

B. Fixed Mount

1. Fluorescent Fixtures
   a. Lamps
      1) Furnish high lumen fluorescent lamps where listed.
      2) Linear fluorescent lamps shall be T8 or T5 as required by the fixture, rapid/instant start, tri-phosphor, minimum CRI 86, and compact types all as shown on the Fixture Schedule"
   b. Ballasts

1) All linear fluorescent light fixtures shall have an electronic ballast unless otherwise noted on the Lighting Fixture Schedule.

2. High Pressure Sodium Fixtures
   a. Lamps
      1) Dual arc tube HPS as shown on the "Lighting Fixture Schedule."
      2) High pressure sodium lamps shall be clear, non-cycling, and of the size and type as shown on the Lighting Fixture Schedule.
   b. Ballasts
      1) High pressure sodium ballasts shall be of the constant wattage type, with multi-tap windings, of the correct size and voltage for the fixture it is to serve as shown on the Lighting Fixture Schedule.
3. Metal Halide Fixtures
   a. Lamps
      1) Metal halide lamps shall be clear pulse-start, and of the size and type as shown on the Lighting Fixture Schedule.
   b. Ballasts
      1) Pulse-start metal halide ballasts shall be of the constant wattage auto-transformer type, with a minimum efficiency of 88%, for lamp wattages from 150 watts to 500 watts.
      2) Non-pulse start electronic ballasts shall have an efficiency of 92% for wattages greater than 250 watts and a minimum efficiency of 90% for wattages less than or equal to 250 watts.
4. Incandescent Fixtures
   a. Lamps
      1) Incandescent lamps shall be compact fluorescent self-ballasted, minimum 1000 hours.

C. LED Luminaires
   1. Each luminaire shall consist of an assembly that utilizes LEDs as the light source. In addition, a complete luminaire shall consist of a housing, LED array, and electronic driver (power supply) and integral controls as per this specification.
   2. Each luminaire shall be designed to operate at an average operating temperature of 25°C.
   3. The operating temperature range shall be 0°C to +25°C. Each luminaire shall meet all parameters of this specification throughout the minimum operational life when operated at the average operating temperature.
   4. Nominal luminaire dimensions: refer to light fixture schedules.

D. Luminaire Construction:
   1. Luminaire housing to have no visible welding, screws, springs, hooks, rivets, bare LEDs or plastic supports.
   2. The luminaire shall be a single, self-contained device, not requiring onsite assembly for installation. The power supply and circuit board for the luminaire shall be integral to the unit.
   3. Luminaires shall be fabricated from post painted cold rolled steel and shall be a rigid structure with integral T-bar clips.
   4. Finish: Polyester powder coat painted with 92% high-reflective paint after fabrication.

5. Reflector: rugged one-piece cold rolled steel with embossed multi-facets, echoing the frequency of the refractor prisms to distribute soft light at multiple angles, without flashing thus reducing high luminance contrast.
6. End caps shall be sloped at 70 degrees to create depth.
7. Luminaire to have smooth transition between T-bar and reflector arch. No doorframe or exposed hardware.
8. Polymeric materials (if used) of enclosures containing either the power supply or electronic components of the luminaire shall be made of UL94VO flame retardant materials. Luminaire lenses are excluded from this requirement.
9. Integral Grid Clips required on recessed mounted luminaires along with integral tie wire mounting points.
10. Luminaire to have air removal capability as specified.
11. The assembly and manufacturing process for the SSL luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration.

E. LED Sources

1. LEDs shall be manufactured by:
   a. Nichia
   b. Samsung
   c. Osram
2. Lumen Output – minimum initial lumen output of the luminaire shall be as follows for the lumens exiting the luminaire in the 0-90 degree zone - as measured by IESNA Standard LM-79-08 in an accredited lab. Exact tested lumen output shall be clearly noted on the shop drawings.
3. Lumen output shall not decrease by more than 20% over the minimum operational life of 50,000 hours.
4. Individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the entire luminaire.
5. LED Boards shall be suitable for field maintenance or service from below the ceiling with plug-in connectors. LED boards shall be upgradable.
6. Light Color/Quality
   a. Correlated Color temperature (CCT) range as per specification, between 3500K, 4100K and 5000K shall be correlated to chromaticity as defined by the absolute (X,Y) coordinates on the 2-D CIE chromaticity chart.
   b. The color rendition index (CRI) shall be 80 or greater.
   c. Color shift over 6,000 hours shall be <0.007 change in u' v' as demonstrated in IES LM80 report.

F. Power Supply and Driver

1. Driver: AccuDrive, 120-277 Volt, UL Listed, CSA Certified, Sound Rated A+. Driver shall be greater than 80% efficient at full load across all input voltages. Input wires shall be #18 AWG solid copper minimum.
2. Driver shall be suitable for full-range dimming. The luminaire shall be capable of continuous dimming without perceivable flicker over a range of 100% to 5% of rated lumen output with a smooth shutoff function. Dimming shall be controlled by a 0-10 volt signal.
3. Driver shall be UL listed.

4. Maximum stand-by power shall be one watt.
5. Driver disconnect shall be provided where required to comply with codes.
6. The electronics/power supply enclosure shall be internal to the SSL luminaire and be accessible per UL requirements.
7. The surge protection which resides within the driver shall protect the luminaire from damage and failure for transient voltages and currents as defined in ANSI/IEEE C64.41 2002 for Location Category A, where failure does not mean a momentary loss of light during the transient event.

G. Electrical
1. Operation Voltage - The luminaire shall operate from a 50 or 60 Hertz ±3 Hertz AC line over a voltage ranging from 120 volts AC to 277 volts AC. The fluctuations of line voltage shall have no visible effect on the luminous output. The standard operating voltages are 120 volts AC, 277 volts AC, 347 volts AC.
2. Power Factor: The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output.
3. THD: Total harmonic distortion (current and voltage) induced into an AC power line by a luminaire shall not exceed 20% at any standard input voltage.
4. Surge Suppression: The luminaire shall include surge protection to withstand high repetition noise and other interference.
5. RF Interference: The luminaire and associated onboard circuitry must meet Class A emission limits referred in Federal Communications Commission (FCC) Title 47, Subpart B, Section 15 Non-Consumer requirements for EMI/RFI emissions.
6. Electrical connections between normal power and driver must be modular utilizing a snap fit connector. All electrical components must be easily accessible after installation and be replaceable without removing the fixture from the ceiling.
7. All electrical components shall be RoHS compliant.

H. Exit Sign: UL listed. Provide with automatic power failure device with integral self-testing module and fully automatic high/low trickle charger in a self-contained power pack. Battery shall be sealed electrolyte type; shall operate unattended; and require no maintenance, including no additional water, for a period of not less than five years. LED exit sign shall have emergency run time of 1-1/2 hours (minimum). The light emitting diodes shall have rated lamp life of 70,000 hours (minimum). All exit sign fixtures shall be rated maximum of five watts per fixture.

I. Photometric Requirements
1. Luminaire performance shall be tested as described herein.
2. Luminaire performance shall be judged against the specified minimum illuminance in the specified pattern for a particular application.
3. Luminaire lighting performance shall be adjusted (depreciated) for the minimum life expectancy (Section 2.2.5).
4. The performance shall be adjusted (depreciated) by using the LED manufacturer's data or the data from the IESNA Standard TM-21 test report, which ever one results in a higher level of lumen depreciation.
5. The luminaire may be determined to be compliant photometrically, if:
   a. The initial minimum illuminance level is achieved in 100% of the area of the specified lighting pattern.
   b. The measurements shall be calibrated to standard photopic calibrations.

c. Add specific project requirements.

J. Thermal Management

1. The thermal management (of the heat generated by the LEDs) shall be of sufficient capacity to assure proper operation of the luminaire over the expected useful life (Section 1.2.9 c).
2. The LED manufacturer's maximum junction temperature for the expected life (Section 1.2.9 c) shall not be exceeded at the average operating ambient (Section 1.2.4).
3. The LED manufacturer's maximum junction temperature for the catastrophic failure shall not be exceeded at the maximum operating ambient (Section 1.2.5).
4. The luminaire shall have an UL IC rating.
5. The Driver manufacturer's maximum case temperature shall not be exceeded at the maximum operating ambient. Thermal management shall be passive by design. The use of fans or other mechanical devices shall not be allowed.

K. Emergency Lighting Battery Units

1. Emergency lighting units shall be as specified in the Lighting Fixture Schedule shown on the Drawings.
2. Battery units shall be of the self-contained, fully automatic type with sealed lead acid batteries, volt-meters.
3. Unit enclosures shall be compatible to their environment and units shall comply with the requirements of NFPA 70 (NEC).
4. It shall be the responsibility of the contractor to provide all necessary mounting hardware.
5. Shall be factory installed and provide a range of 800 to 1400 lumens of light for 90 minutes. Output is based on the size and wattage of the luminaire.
6. Integral or remote test switch shall be provided as per specification.

L. Flexible Fixture Hangers

1. Flexible fixture hangers used in non-hazardous areas shall be type ARB and flexible fixture supports used in hazardous areas shall be Type EFH as manufactured by the Crouse-Hinds Co., similar by Appleton Electric Co; Killark a Division of Hubbell Inc.; or equal.
2. Where required in Section 26 00 00 – ELECTRICAL GENERAL PROVISIONS, all pendent-mounted and recessed in suspended ceilings, recessed lighting fixtures shall be provided with four anti-sway supports to meet Type II seismic requirements.

M. Portable Fixtures

1. Explosion-proof Portable Handlamp
   a. An explosion-proof handlamp complete with heavy duty, Type S0, 50-foot cord and plug shall be furnished. The handlamp shall be manufactured by Appleton Electric Co.; the plug shall be manufactured by Appleton Electric Co., similar to Daniel Woodhead Co. or equal.
2. Vapor-tight Portable Handlamp
   a. A vapor-tight handlamp with reflector shall be furnished complete with 50-foot cord and grounding plug. The handlamp shall be manufactured by Daniel Woodhead Co., similar by Appleton Electric Co. or equal.

N. Emergency Lighting Battery Units

1. Emergency lighting units and remote lighting heads shall be as specified in the Lighting Fixture Schedule shown on the Drawings.
2. Battery units shall be of the self-contained, fully automatic type with sealed lead acid batteries, volt-meters and time delay relays where used in H.I.D. lighted areas.
3. Unit enclosures shall be compatible to their environment and units shall comply with the requirements of NFPA 70 (NEC).
4. All necessary mounting hardware shall be provided.

O. Flexible Fixture Hangers

1. Flexible fixture hangers used in non-hazardous areas shall be type ARB and flexible fixture supports used in hazardous areas shall be Type ECHF as manufactured by the Crouse-Hinds Co., similar by Appleton Electric Co.; Killark Electrical Mfg. Co. or equal.

P. Lamp Changing Equipment

1. Lamp changing equipment shall be able to handle BT-37, ED-18, ED-23-1/2 and ED-28 type H.I.D. lamps in open luminaries.
2. Equipment shall consist of three five-foot steel poles each similar and equal to McGill Catalog No. 160-P and two lamp holders similar and equal to McGill Catalog Nos. 158C and 161C.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The location of lighting fixtures shown on the Drawings is approximate. The Contractor shall install the lighting fixtures after major ducts and piping are installed, to avoid conflicts. He shall install the fixtures to avoid shadows and blocking of light, relocating the fixtures as necessary, at no cost to the Owner.

B. Each fixture shall be a completely finished unit with all components, mounting and/or hanging devices necessary, for the proper installation of the particular fixture in its designated location and shall be completely wired ready for connection to the branch circuit wires at the outlet.

C. All flush mounted fixtures shall be supported from the structure and shall not be dependent on the hung ceilings for their support.

D. Fixtures noted to be installed flush in suspended ceilings shall be of mounting types suited for the type ceiling involved. Troffers (2 X 4), provided in suspended ceiling grids, shall be installed with safety clips to hold the fixture securely in the ceiling grid. It shall be the responsibility of the Contractor to verify the ceiling types prior to ordering fixtures.

E. Flexible fixture hangers shall be used for all pendant mounted fixtures. Fixtures two feet long and larger shall be supported with a minimum of two fixture hangers.

F. Conduit run in areas with hung ceilings shall be installed in the space above the hung ceiling as close to the structure as possible. Conduits shall be supported from the structure.

G. Exterior lighting poles shall be mounted plumb.

H. Fixture locations are shown on the Drawings in approximate locations; however exact locations shall be coordinated so as to avoid conflicts with HVAC ducts, equipment and other obstacles.

3.2 REPLACEMENT

A. Lamps (except for H.I.D.) used during the building construction, prior to two weeks from completion of the work, shall be removed and replaced with new lamps.

3.3 CLEANING UP

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from lens enclosures.

1. For cleaning acrylic lenses or diffusers, use a feather duster or dry cotton cheesecloth to rid the lens/diffuser of any minor dust. For fingerprints, smudges, or other dirt present, use an ammonia-based cleaner (such as Windex) and wipe carefully with cotton cheesecloth (so as to avoid injury from any prismatic texture of the lens).
2. Job site contamination may not necessarily be removed using the above recommendations. In that case the lens would need to be replaced.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Plastic dust cover bags to be provided with new parabolic reflector lighting fixtures shall be removed after all construction activity that may cause dust formation on reflector surfaces has been completed.

E. All fixtures shall be left in a clean condition, free of dirt and defects, before acceptance by the Owner/Engineer.

END OF SECTION

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SECTION 31 25 00
SEDIMENTATION AND EROSION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Installation, maintenance, removal and area cleanup related to sedimentation control work as shown on the Drawings and as specified herein. The work shall include, but not necessarily be limited to; installation of temporary access ways and staging areas, silt fences, sediment protection at storm drain inlets, sediment removal and disposal, device maintenance, removal of temporary devices, temporary mulching, erosion control blankets and final cleanup.

B. Related Specification Sections include but are not limited to:
   1. Bidding Requirements, Contract Forms, and Conditions/Provisions of the Contract.
   2. Division 1 - General Requirements.

1.2 REFERENCES

A. Reference Standards
   1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
   2. ASTM Standard:
      a. ASTM D3786, Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method
      b. ASTM D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
      c. ASTM D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile
      d. ASTM D4833, Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
   3. Texas Commission on Environmental Quality (TCEQ) TPDES General Permit No. TXR150000
   4. TxDOT Departmental Material Specifications (DMS)
      a. DMS-6230 “Temporary Sediment Control Fence Fabric”

1.3 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.4 SUBMITTALS

A. Within 10 days after award of Contract, the Contractor shall submit to the City for approval, technical product literature for all commercial products to be used for sedimentation and erosion control.

B. Storm Water Pollution Prevention Plan (SWPPP)

C. TCEQ Notice of Intent (NOI) for Storm Water Discharges Associated with Construction Activity under the TPDES General Permit

D. Construction Site Notice

E. TCEQ Notice of Termination (NOT) for Storm Water Discharges Associated with Construction Activity under the TPDES General Permit

F. Notice of Change (if applicable)

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE

A. The Contractor shall be responsible for the timely installation of all sedimentation control devices necessary to prevent the movement of sediment from the construction site to off-site areas or into the stream system via surface runoff or underground drainage systems. Measures in addition to those shown on the Drawings necessary to prevent the movement of sediment off-site shall be installed, maintained, removed, and cleaned up at the expense of the Contractor. No additional charges to the City will be considered

1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10 FIELD CONDITIONS [NOT USED]

1.11 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 CITY-FURNISHED [OR] CITY-SUPPLIED PRODUCTS [NOT USED]

2.2 MATERIALS

A. Rock Filter Dams

1. Aggregate

a. Furnish aggregate with hardness, durability, cleanliness and resistance to crumbling, flaking and eroding acceptable to the Engineer.

b. Provide the following:

1) Types 1, 2 and 4 Rock Filter Dams

a) Use 3 to 6-inch aggregate.

2) Type 3 Rock Filter Dams

a) Use 4 to 8-inch aggregate.

2. Wire

a. Provide minimum 20-gauge galvanized wire for the steel wire mesh and tie wires for Types 2 and 3 rock filter dams

b. Type 4 dams require:

1) Double-twisted, hexagonal weave with a nominal mesh opening of 2½ inches x 3 ¼ inches
2) Minimum 0.0866-inch steel wire for netting
3) Minimum 0.1063-inch steel wire for selvages and corners
4) Minimum 0.0866 inch for binding or tie wire

B. Geotextile Fabric
1. Place the aggregate over geotextile fabric meeting the following criteria:
a. Tensile Strength of 250 pounds, per ASTM D4632
b. Puncture Strength of 135 pounds, per ASTM D4833
c. Mullen Burst Rate of 420 psi, per ASTM D3786
d. Apparent Opening Size of No. 20 (max), per ASTM D4751

C. Sandbag Material
1. Furnish sandbags meeting Section 2.5 except that any gradation of aggregate may be used to fill the sandbags.

D. Stabilized Construction Entrances
1. Provide materials that meet the details shown on the Drawings and this Section.
a. Provide crushed aggregate for long and short-term construction exits.
b. Furnish aggregates that are clean, hard, durable and free from adherent coatings such as salt, alkali, dirt, clay, loam, shale, soft or flaky materials and organic and injurious matter.
c. Use 3 to 5-inch coarse aggregate with a minimum thickness of 12 inches.
d. The aggregate shall be placed over a geotextile fabric meeting the following criteria:
1) Tensile Strength of 300 pounds, per ASTM D4632
2) Puncture Strength of 120 pounds, per ASTM D4833
3) Mullen Burst Rate of 600 psi, per ASTM D3786
4) Apparent Opening Size of No. 40 (max), per ASTM D4751

E. Embankment for Erosion Control
1. Provide rock, loam, clay, topsoil or other earth materials that will form a stable embankment to meet the intended use.

F. Sandbags
1. Provide sandbag material of polypropylene, polyethylene or polyamide woven fabric with a minimum unit weight of 4 ounces per square yard, a Mullen burst-strength exceeding 300 psi, and an ultraviolet stability exceeding 70 percent.
2. Use natural coarse sand or manufactured sand meeting the gradation given in Table 1 to fill sandbags.
3. Filled sandbags must be 24 to 30 inches long, 16 to 18 inches wide, and 6 to 8 inches thick.

Table 1
Sand Gradation

Sieve #	Maximum Retained (% by Weight)
4	3 percent
100	80 percent
200	95 percent

G. Temporary Sediment Control Fence

1. Provide a net-reinforced fence using woven geo-textile fabric.
2. Logos visible to the traveling public will not be allowed.
   a. Fabric
      1) Provide fabric materials in accordance with DMS-6230, "Temporary Sediment Control Fence Fabric."
   b. Posts
      1) Provide essentially straight wood or steel posts with a minimum length of 48 inches, unless otherwise shown on the Drawings.
      2) Soft wood posts must be at least 3 inches in diameter or nominal 2 x 4 inch
      3) Hardwood posts must have a minimum cross-section of 1-1/2 x 1-1/2 inch
      4) T- or L-shaped steel posts must have a minimum weight of 1.3 pounds per foot.
   c. Net Reinforcement
      1) Provide net reinforcement of at least 12-1/2 gauge galvanized welded wire mesh, with a maximum opening size of 2 x 4 inch, at least 24 inches wide, unless otherwise shown on the Drawings.
   d. Staples
      1) Provide staples with a crown at least 3/4 inch-wide and legs 1/2 inch long.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. Storm Water Pollution Prevention Plan

1. Develop and implement the project's Storm Water Pollution Prevention Plan (SWPPP) in accordance with the TPDES Construction General Permit

TXR150000 requirements. Prevent water pollution from storm water runoff by using and maintaining appropriate structural and nonstructural BMPs to reduce pollutants discharges to the MS4 from the construction site.

B. Control Measures

1. Implement control measures in the area to be disturbed before beginning construction, or as directed. Limit the disturbance to the area shown on the Drawings or as directed.

2. Control site waste such as discarded building materials, concrete truck washout water, chemicals, litter and sanitary waste at the construction site.

3. If, in the opinion of the Engineer, the Contractor cannot control soil erosion and sedimentation resulting from construction operations, the Engineer will limit the disturbed area to that which the Contractor is able to control. Minimize disturbance to vegetation.

4. Immediately correct ineffective control measures. Implement additional controls as directed. Remove excavated material within the time requirements specified in the applicable storm water permit.

5. Upon acceptance of vegetative cover by the City, remove and dispose of all temporary control measures, temporary embankments, bridges, matting, falsework, piling, debris, or other obstructions placed during construction that are not a part of the finished work, or as directed.

C. Do not locate disposal areas, stockpiles, or haul roads in any wetland, water body, or streambed.

D. Do not install temporary construction crossings in or across any water body without the prior approval of the appropriate resource agency and the Engineer.

E. Provide protected storage area for paints, chemicals, solvents, and fertilizers at an approved location. Keep paints, chemicals, solvents, and fertilizers off bare ground and provide shelter for stored chemicals.

F. Installation and Maintenance

1. Perform work in accordance with the TPDES Construction General Permit TXR150000.

2. When approved, sediments may be disposed of within embankments, or in areas where the material will not contribute to further siltation.

3. Dispose of removed material in accordance with federal, state, and local regulations.

4. Remove devices upon approval or when directed.

a. Upon removal, finish-grade and dress the area.

b. Stabilize disturbed areas in accordance with the permit, and as shown on the Drawings or directed.

5. The Contractor retains ownership of stockpiled material and must remove it from the project when new installations or replacements are no longer required.

G. Rock Filter Dams for Erosion Control

1. Remove trees, brush, stumps and other objectionable material that may interfere with the construction of rock filter dams.
2. Place sandbags as a foundation when required or at the Contractor's option.
3. For Types 1, 2, 3, and 5, place the aggregate to the lines, height, and slopes specified, without undue voids.
4. For Types 2 and 3, place the aggregate on the mesh and then fold the mesh at the upstream side over the aggregate and secure it to itself on the downstream side with wire ties, or hog rings, or as directed.
5. Place rock filter dams perpendicular to the flow of the stream or channel unless otherwise directed.
6. Construct filter dams according to the following criteria, unless otherwise shown on the Drawings:
    a. Type 1 (Non-reinforced)
        1) Height - At least 18 inches measured vertically from existing ground to top of filter dam
        2) Top Width - At least 2 feet
        3) Slopes - At most 2:1
    b. Type 2 (Reinforced)
        1) Height - At least 18 inches measured vertically from existing ground to top of filter dam
        2) Top Width - At least 2 feet
        3) Slopes - At most 2:1
    c. Type 3 (Reinforced)
        1) Height - At least 36 inches measured vertically from existing ground to top of filter dam
        2) Top Width - At least 2 feet
        3) Slopes - At most 2:1
    d. Type 4 (Sack Gabions)
        1) Unfold sack gabions and smooth out kinks and bends.
        2) For vertical filling, connect the sides by lacing in a single loop–double loop pattern on 4- to 5-inches spacing. At 1 end, pull the end lacing rod until tight, wrap around the end, and twist 4 times. At the filling end, fill with stone, pull the rod tight, cut the wire with approximately 6 inches remaining, and twist wires 4 times.
        3) For horizontal filling, place sack flat in a filling trough, fill with stone, and connect sides and secure ends as described above.
        4) Lift and place without damaging the gabion.
        5) Shape sack gabions to existing contours.
    e. Type 5

1) Provide rock filter dams as shown on the Drawings.

H. Construction Entrances

1. When tracking conditions exist, prevent traffic from crossing or exiting the construction site or moving directly onto a public roadway, alley, sidewalk, parking area, or other right of way areas other than at the location of construction entrances.

2. Place the exit over a foundation course, if necessary.

a. Grade the foundation course or compacted subgrade to direct runoff from the construction exits to a sediment trap as shown on the Drawings or as directed.

3. At drive approaches, make sure the construction entrance is the full width of the drive and meets the length shown on the Drawings.

a. The width shall be at least 14 feet for 1-way and 24 feet for 2-way traffic for all other points of ingress or egress or as directed by the Engineer.

I. Earthwork for Erosion Control

1. Perform excavation and embankment operations to minimize erosion and to remove collected sediments from other erosion control devices.

a. Excavation and Embankment for Erosion Control Measures

1) Place earth dikes, swales or combinations of both along the low crown of daily lift placement, or as directed, to prevent runoff spillover.

2) Place swales and dikes at other locations as shown on the Drawings or as directed to prevent runoff spillover or to divert runoff.

3) Construct cuts with the low end blocked with undisturbed earth to prevent erosion of hillsides.

4) Construct sediment traps at drainage structures in conjunction with other erosion control measures as shown on the Drawings or as directed.

5) Where required, create a sediment basin providing 3,600 cubic feet of storage per acre drained, or equivalent control measures for drainage locations that serve an area with 10 or more disturbed acres at 1 time, not including offsite areas.

b. Excavation of Sediment and Debris

1) Remove sediment and debris when accumulation affects the performance of the devices, after a rain, and when directed.

J. Sandbags for Erosion Control

1. Construct a berm or dam of sandbags that will intercept sediment-laden storm water runoff from disturbed areas, create a retention pond, detain sediment and release water in sheet flow.

2. Fill each bag with sand so that at least the top 6 inches of the bag is unfilled to allow for proper tying of the open end.

3. Place the sandbags with their tied ends in the same direction.

4. Offset subsequent rows of sandbags 1/2 the length of the preceding row.
5. Place a single layer of sandbags downstream as a secondary debris trap.
6. Place additional sandbags as necessary or as directed for supplementary support to berms or dams of sandbags or earth.

K. Temporary Sediment-Control Fence

1. Provide temporary sediment-control fence near the downstream perimeter of a disturbed area to intercept sediment from sheet flow.
2. Incorporate the fence into erosion-control measures used to control sediment in areas of higher flow. Install the fence as shown on the Drawings, as specified in this Section, or as directed.
    a. Post Installation
        1) Embed posts at least 18 inches deep, or adequately anchor, if in rock, with a spacing of 6 to 8 feet and install on a slight angle toward the run-off source.
    b. Fabric Anchoring
        1) Dig trenches along the uphill side of the fence to anchor 6 to 8 inches of fabric.
        2) Provide a minimum trench cross-section of 6 x 6 inches
        3) Place the fabric against the side of the trench and align approximately 2 inches of fabric along the bottom in the upstream direction.
        4) Backfill the trench, then hand-tamp.
    c. Fabric and Net Reinforcement Attachment
        1) Unless otherwise shown under the Drawings, attach the reinforcement to wooden posts with staples, or to steel posts with T-clips, in at least 4 places equally spaced.
        2) Sewn vertical pockets may be used to attach reinforcement to end posts.
        3) Fasten the fabric to the top strand of reinforcement by hog rings or cord every 15 inches or less.
    d. Fabric and Net Splices
        1) Locate splices at a fence post with a minimum lap of 6 inches attached in at least 6 places equally spaced, unless otherwise shown under the Drawings.
            a) Do not locate splices in concentrated flow areas.
        2) Requirements for installation of used temporary sediment-control fence include the following:
            a) Fabric with minimal or no visible signs of biodegradation (weak fibers)
            b) Fabric without excessive patching (more than 1 patch every 15 to 20 feet)

c) Posts without bends

d) Backing without holes

3.5 REPAIR /RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING

A. Waste Management

1. Remove sediment, debris and litter as needed.

3.11 CLOSEOUT ACTIVITIES

A. Erosion control measures remain in place and are maintained until all soil disturbing activities at the project site have been completed.

B. Establish a uniform vegetative cover with a density of 70 percent on all unpaved areas, on areas not covered by permanent structures, or in areas where permanent erosion control measures (i.e. riprap, gabions, or geotextiles) have been employed.

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE

A. Install and maintain the integrity of temporary erosion and sedimentation control devices to accumulate silt and debris until earthwork construction and permanent erosion control features are in place or the disturbed area has been adequately stabilized as determined by the Engineer.

B. If a device ceases to function as intended, repair or replace the device or portions thereof as necessary.

C. Perform inspections of the construction site as prescribed in the Construction General Permit TXR150000.

D. Records of inspections and modifications based on the results of inspections must be maintained and available in accordance with the permit.

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 32 01 17
ASPHALT PAVING OVERLAY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes

1. This item shall govern for application of a hot-mix asphalt concrete pavement overlay as a surface course as shown in the plans. The course shall be composed of a compacted mixture of mineral aggregate and asphaltic material mixed in a mixing plant. The overlay shall be constructed on the previously completed and approved base course in accordance with the required lines, grades, and typical sections shown in the plans or established in the field by the Owner.

B. Related Specification Sections include but are not necessarily limited to

1. Bidding Requirements, Contract Forms, and Conditions/Provisions of the Contract.
2. Division 1 - General Requirements.

1.2 REFERENCES

A. Reference Standards

1. Texas Department of Transportation (TxDOT) Standards

1.3 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.4 SUBMITTALS [NOT USED]

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data

1. Asphalt Mix Design
2. Tack Coat Material

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE

A. General 1.

1. Locations for testing will be determined by the City Public Works Construction Inspector.
2. Materials must conform to City of North Richland Hills Approved Water Materials List.

B. Testing Requirements, reference Section 01 45 29 - Testing and Laboratory Services and the City of North Richland Hills General Design Standards for Testing Procedures

1. Subgrade – Not Applicable for Overlays
   a. Proctor Analysis

b. Moisture content and compaction shall be tested every 300 linear feet per lane

2. Asphalt
   a. Compaction
   b. Temperature of asphalt
3. Pavement cores – taken every 300 linear feet per lane
   a. Tested for thickness

1.9 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.10 FIELD [SITE] CONDITIONS [NOT USED]

1.11 WARRANTY [NOT USED]

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [OR] OWNER-SUPPLIEDPRODUCTS [NOT USED]

2.2 MATERIALS

A. Aggregates.
   1. Mineral aggregates shall be comprised of fine aggregate, coarse aggregate, and when required, a mineral filler.

B. Paving Mixture.
   1. Asphaltic materials for the paving mixture shall be determined by the Contractor and approved by the Owner after design tests have been made, using the mineral aggregates proposed to be used in the mixture.

C. Tack Coat.
   1. Furnish CSS-1H per TxDOT Item 300

D. Paving Mixture.
   1. Type D, Fine Surface per TxDOT Item 340

2.3 EQUIPMENT

A. Contractor shall provide machinery, tools, and equipment necessary for proper execution of the work. Owner shall approve such equipment as to type and condition prior to the Contractor beginning construction operations on which the equipment is to be used. All machinery, tools, and equipment shall be maintained in a satisfactory and workmanlike manner.

2.4 ACCESSORIES [NOT USED]

2.5 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. Application of Base Course.

1. When specified on plans, contractor shall apply a base course prior to application of surface course.

B. Tack Coat.

1. Apply tack coat to the newly laid base course or existing pavement prior to applying the surface course. The surface shall be dry and clean. Apply tack coat at a rate of 0.10 gallons per square yard unless otherwise directed by the Owner. The vertical surfaces of existing pavements, gutter, and all structures in actual contact with asphalt mixtures shall be coated with a thin, complete tack coating. Tack coat shall not be applied more than 2,000 feet ahead of paver. Contractor shall provide signs and flaggers, as necessary, to ensure traffic does not drive on the tack coat. No application of tack coat shall be allowed when the air temperature is below 50°F and falling. Placement shall be allowed when the air temperature is above 40°F and rising. Temperature shall be taken in the shade away from artificial heat sources.

C. Placing.

1. No application of asphalt leveling course shall be allowed when the air temperature is below 50°F and falling. Placement shall be allowed when the air temperature is above 40°F and rising. Temperature shall be taken in the shade away from artificial heat sources.
    a. The minimum laydown temperature of the material shall be 275°F. Asphalt surface course shall be applied by an approved paving machine wherever practical. The material shall be spread as soon as possible after arriving at the site and before the mixture cools to an unworkable consistency. Hand methods may be used in inaccessible areas. When placed by hand, loads shall not be dumped any faster than can be properly distributed. During placing and spreading of the hot-mix asphalt material, Contractor shall take care to prevent the spilling of material onto adjacent, pavement, gutters, or structures.

D. Compaction.

1. Rolling with a 3-wheel and tandem roller shall start longitudinally at the sides and proceed toward the center of the surface course, overlapping on successive trips by at least half the width of the rear wheels, with the alternate trips being of varying lengths. Rolling shall continue until no further compression can be obtained and all roller marks are eliminated. The motion of the rollers shall be slow enough at all times to avoid displacement of the asphaltic material. If displacement should occur, it shall be corrected at once by the use of rakes and fresh asphaltic mixtures where required. The roller shall not be allowed to stand on the surface when it has not been fully compacted and allowed to cool. To prevent adhesion to the roller, the wheels shall be kept thoroughly moistened with water, but an excess of water shall not be permitted.
    a. The compacted surface course shall be the thickness specified on plans and in bid item. The relative density of the course shall not be less than 92%.
    b. With Owner approval, a vibratory steel wheel roller may be substituted for the 3-wheel roller and tandem roller.
    c. The finished surface shall be smooth and meet the line, grade, and cross section requirements. When tested with a 16-ft straightedge placed parallel to the centerline of the roadway, the finished surface shall not deviate in excess of 1/16” per foot from the nearest point of contact. The maximum ordinate measured form the face of straightedge shall not exceed 1/4” at any point.

3.5 [REPAIR] / [RESTORATION] [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [OR] SITE QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 32 90 00
PLANTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. All labor, material, equipment and services necessary to provide all landscape planting, and related items complete in place, as shown on the Drawings and specified, herein.
2. Fine grading, steel edging, soil preparation, gravel groundcover, planting, clean-up, and all other miscellaneous items related to landscaping as shown on the drawings.

B. Related Specification Sections include but are not limited to:

1. Bidding Submittal and Information, Contract Forms and Conditions of the Contract
2. Division 1 - General Requirements.

1.2 REFERENCES

A. Reference Standards

1. Reference standards cited in this Section refer to the current reference standard published at the time of the latest revision date logged at the end of this Section unless a date is specifically cited.
2. Standardized Plant Names, 1942 Edition, American Joint Committee on Horticulture Nomenclature.
3. American Standards for Nursery Stock, Latest Edition, American Association of Nurserymen.

1.3 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.4 SUBMITTALS

A. Submittals shall be in accordance with the General Provisions.

B. All submittals shall be approved by the City prior to delivery.

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data

1. The Contractor shall submit specifications of any item being used on site upon the request of the City and Landscape Architect.

B. Samples

1. Contractor shall supply City and Landscape Architect with a sample of all supplied materials accompanied by analytical data from an approved laboratory source illustrating compliance or bearing the manufacturer's guaranteed analysis.

1.6 CLOSEOUT SUBMITTALS [NOT USED]

1.7 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE

A. Qualifications

1. Workmen
   a. Provide at least one person who shall be present at all times during execution of this portion of the Work, who shall be thoroughly familiar with the type of materials being installed and the proper materials and methods for their installation, who speaks understandable English, and who shall direct all work performed under this Section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements

1. Deliver packaged materials to site in original unopened containers bearing manufacturer's guaranteed chemical analysis, name, trademark, and conformance to State Law.
2. Deliver all plants with legible identification labels.
   a. Trees and bundles of containers of like shrubs, or groundcover plants, shall have legible identification labels.
   b. State correct plant name and size indicated on plant list.
   c. Use durable waterproof labels with water-resistant ink which will remain legible for at least 60 days.
3. Protect plant material during and after delivery to prevent damage to root ball or desiccation of leaves.

B. Storage and Handling Requirements

1. Store plant material in shade and protect from weather.
2. Storage at the site is allowed, however, Contractor accepts full responsibility for damage, theft, or vandalism.
3. Any plant material balled or burlapped, not installed within 24 hours of delivery shall be healed in until such time as it is installed.
4. Maintain and protect plant material not to be planted within four (4) hours in a healthy, vigorous condition.
5. The Contractor is cautioned to exercise care in handling, loading, unloading and storing of plant materials. Plant materials that have been damaged in any way will be discarded and if installed, shall be replaced with undamaged materials at the Contractor's expense.

1.10 FIELD CONDITIONS

A. Perform actual planting only when weather and soil conditions are suitable in accordance with locally accepted practice.

B. Install trees, shrubs, and liner stock plant material before grassing is commenced.

C. Contractor shall note that rock and/or construction materials from previous site use may be encountered on some areas of the site. Rock or construction material excavation shall be included as part of bid.

1.11 WARRANTY

A. Plant Guarantee

1. All trees, shrubs, vines, and groundcovers will be guaranteed for a twelve (12) month period after Final Acceptance. The Contractor will replace all dead or defective materials upon notification (weather permitting) with plants of the same kind and size as those originally planted. Plants, including trees, which have partially died so that shape, size, or symmetry has been damaged, shall be considered subject to replacement, and the opinion of the City and Landscape Architect will be final. At the direction of the City and Landscape Architect, plants may be replaced at the start of the next planting or digging season, but in such cases, Contractor will remove dead plants within two (2) working days.
2. All replacement work (including materials, labor and equipment) will be done at no cost to the Owner. Any damage, such as ruts in lawn or bed areas, that occurs when Contractor makes replacements, will be repaired immediately by the Contractor.
3. The guarantee will not apply where plants die after Final Acceptance because of injury by storms, drowning, drought, hail, freeze, insects, disease, mechanical injury by humans or machines, and theft.

PART 2 - PRODUCTS

2.1 GENERAL

A. All materials shall be of standard, approved and first-grade quality and shall be in prime condition when installed and accepted. Any commercially processed or packaged material shall be delivered to the site in the original unopened container bearing the manufacturer's guaranteed analysis.

B. Product Manufacturer's name(s) and/or model numbers are used herein to set a standard of quality and are not intended to be a restraint of trade or prevent submittals of other manufacturer's products of equal quality.

2.2 MATERIALS

A. Compost Mix

1. "A Professional Bedding Soil" as produced by Living Earth Technologies, Inc., 1808 W. Northwest Highway, Dallas, Texas (phone: 214/869-4332) composed of 45% Compost, 45% Composted Pine Bark, and 10% Sandy Loam, or approved equal.

B. Tree Backfill Fertilizer

1. 13.13.13 analysis bulk fertilizer

C. Tree Shrub, Groundcover, and Seasonal Color Fertilizer

1. Provide commercial balanced slow release fertilizer (Osmocote), delivered to the site in bags labeled with the manufacturer's guaranteed analysis. If stored on the site, protect fertilizer from the elements at all times.

D. Tree, Shrub, and Groundcover Planting Tablets

1. Shall be slow-released type with potential acidity of not more than 5% by weight containing the following percentages of nutrients by weight:
   a. 20% nitrogen

b. 10% phosphoric acid
c. 5% potash

E. Plant Material

1. Plant names indicated, comply with "Standardized Plant Names" as adopted by the latest edition of the American Joint Committee of Horticultural Nomenclature. Names of varieties not listed conform generally with names accepted by the nursery trade. Provide stock true to botanical name and legibly tagged.
2. Plant material shall meet and/or exceed grades and standards set forth by the Texas Association of Nurserymen. All plants shall have a normal habit of growth and shall be sound, healthy, vigorous and free of insect infestations, plant diseases, sunscalds, fresh abrasions of the bark, excessive abrasions, or other objectionable disfigurements. Tree trunks shall be sturdy and have well "hardened" systems and vigorous and fibrous root systems that are not root or pot-bound. In the event of disagreement as to condition of root system, the root condition of the plants furnished by the Contractor in containers will be determined by removal of earth from the roots of not less than two or more than two percent of the total number of plants of each species or variety. Where container-grown plants are from several sources, the roots of not less than two plants of each species or the variety from each source will be inspected. In case the sample plants inspected are found defective, the City and Landscape Architect reserves the right to reject the entire lot or lots of plants represented by the defective samples. Any plants rendered unsuitable for planting because of this inspection will be considered as samples and will be provided at the expense of the Contractor.
3. The size of the plants will correspond with that normally expected for species and variety of commercially available nursery stock or as specified on Drawings. The minimum acceptable size of all plants measured before pruning with the branches in normal position, shall conform to the measurements, if any, specified on the drawings in the list of plants to be furnished. Plants larger in size than specified may be used with the approval of the City and Landscape Architect, but the use of larger plants will make no change in Contract price. If the use of larger plants is approved, the ball of earth, container size, or spread of roots for each plant will be increased proportionately.
4. Provide "specimen" plants with a special height, shape, or character of growth. Tag specimen trees or shrubs at the source of supply. Plants may be inspected by the City and Landscape Architect and reviewed at the place of growth, for compliance with specification requirement for quality, size, and variety. Such approval shall not impair the right of inspection and rejection upon delivery at the site or during the progress of the work.
5. Field-selected or Nursery Grown Balled and Burlapped Tree Stock (B&B): Dig balled and burlapped plants with, natural balls of earth of sufficient diameter and depth to encompass the fibrous and feeding root system necessary for full recovery of the plant. Provide 10" of root ball per 1" caliper of trunk (measured 6" above grade level for trees 4" caliper and less and 12" above grade for larger trees). If a tree is of multi-trunk variety, the caliper of the tree is the average caliper of all its trunks. Cracked or mushroomed balls are not acceptable. Selectively remove 1/2 to 2/3 of twig growth.
6. Container-grown Stock (General): Grown in a container for sufficient length of time for the root system to have developed to hold the soil together, firm and whole.
   a. No plants shall be loose in the container.

b. Container stock shall not be pot bound.

7. Container-grown Tree Stock: Grown in a container from seedling stage and complies with Paragraph 2.1 - G-6, Container-grown Stock requirements.
8. Containerized Tree Stock: Grown in a container for not less than one (1) year and complies with Paragraph 2.1 - G-6, Container-grown Stock requirements.
9. Plants planted in rows shall be matched in form, height and overall character.
10. Shrubs and small plants shall meet the requirements for spread and height indicated in the plant list.
    a. The measurements for height shall be taken from the ground level to the average height of the top of the plant and not the longest branch.
    b. Single stemmed or thin plants will not be accepted. Side branches shall be generous, well-twigged, and the plant as a whole well-bushed to the ground.
    c. Plants shall be in a moist, vigorous condition, free from dead wood, bruises, or other root or branch injuries.
11. Pruning: At no time shall trees or plant materials be pruned, trimmed or topped prior to delivery and any alteration of their shape shall be conducted only with the approval and when in the presence of the City and Landscape Architect.
12. All plants not conforming to the requirements herein specified, shall be considered defective and such plants, whether in place or not, shall be marked as rejected and immediately removed from the site of the work and replaced with new plants at the Contractor's expense. The plants shall be of the species, variety, size and conditions specified herein or as shown on the Drawings. Under no conditions will there be any substitutions of plants or sizes listed on the accompanying plans, except with the express consent of the City and Landscape Architect.

F. Tree Paint: Morrison Tree Seal, Cabort Tree Paint, or equal.

G. Water: Furnished by Owner; transport as required.

H. Mulch Topdressing: Shall be shredded, fine textured, hardwood mulch as approved by City and Landscape Architect. Minimum 2" layer spread uniformly.

I. Steel Edging and Stakes: 3/16" x 4" Ryerson 'Estate' edging, as manufactured by Joseph Ryerson Co., Inc., Houston, Texas (phone 713-675-6111), or approved equal.

J. Soil Saver/Jute Mesh (if required): Heavy weight (green) jute mesh as manufactured by Jim Walls Company, 12820 Hillcrest Road, Dallas, Texas 75230, or approved equal. Install on all groundcover or shrub bed slopes greater than 3:1 slope.

K. Anchoring Materials: In-ground type tree anchors approved by the City and Landscape Architect or the city’s designated representative.

L. Gravel Mulch (if applicable): 3/4" to 1-1/2" native washed stone. Install 3" layer over layer of filter fabric (to be approved by City and Landscape Architect). Provide sample of gravel mulch for City and Landscape Architect approval.

M. Other Materials: All other materials, not specifically described but required for a complete and proper installation, shall be as selected by the Contractor subject to the approval of the City and Landscape Architect.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL

A. Tests and Inspections

1. City and Landscape Architect reserves the right to take and analyze samples of materials for conformity to specifications at any time. Contractor shall furnish samples upon request by City and Landscape Architect.

B. Non-Conforming Work

1. Rejected materials shall be immediately removed from the site at Contractor's expense. Cost of testing of materials not meeting Specifications shall be paid by Contractor.

C. Coordination of Other Tests and Inspections

1. Plants to be supplied by Contractor shall be subject to inspection and approval of City and Landscape Architect at place of growth or upon delivery for conformity to Specifications. Such approval shall not impair the right of inspection and rejection during progress of the work. Inspection and tagging of plant material by the City and Landscape Architect is for design intent only and does not constitute the City and Landscape Architect's approval of the plant materials in regards to their health and vigor. The health and vigor of the plant material is the sole responsibility of the Contractor. Submit written request for inspection of plant material at place of growth to City and Landscape Architect. Written request shall state the place of growth and quantity of plants to be inspected. City and Landscape Architect reserves the right to refuse inspection at this time if, in their judgment, a sufficient quantity of plants is not available for inspection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Preinstallation Testing

1. Obtain City and Landscape Architect certification that final grades to +0.10' have been established prior to commencing planting operations. Provide for inclusion of all amendments, settling, etc. Landscape Contractor shall be responsible for shaping all planting areas as indicated on Plans or as directed by City and Landscape Architect.

B. Evaluation and Assessment

1. Inspect trees, shrubs and groundcover plant material for injury, insect infestation and trees and shrubs for improper pruning.
2. Do not begin planting of trees until deficiencies are corrected or plants replaced.

3.2 PREPARATION

A. Soil Preparation for Groundcover, Shrub Beds

1. Excavate existing soil, if necessary, and add to complete shrub, groundcover, and seasonal color beds the following:
   a. 4" layer of Compost Mix
   b. 14-14-14 slow release fertilizer (Osmocote) at a rate of 5 lbs./100 sq.ft.

2. Spread materials uniformly and cultivate thoroughly by means of a mechanical tiller. Till to a minimum depth of 8".

B. Final Grades

1. Minor modifications to grade may be required to establish the final grade.
2. Finish grading shall ensure proper drainage of the site as determined on Drawings.
3. All areas shall be graded so that the final grades will be 1" below adjacent paved areas, curbs, valve boxes, edging, clean-outs, drains, manholes, etc., or as indicated on Plans.
4. At time of planting, the top 6" of all areas to be planted or seeded shall be free of stones, stumps, or other deleterious matter 1" in diameter or larger, and shall be free from all wire, plaster, or similar objects that would be a hindrance to planting or maintenance.

C. Removal

1. Disposal of any unacceptable or excess soil shall be the sole responsibility of the Contractor. Excess soil may be spoiled on-site per direction of Owner.

3.3 INSTALLATION

A. General:

1. Actual planting shall be performed during those periods when weather and soil conditions are suitable and in accordance with locally accepted practice, as approved by the City and Landscape Architect.
2. Only as many plants as can be planted and watered on that same day shall be distributed in a planting area.
3. Containers shall be opened and plants shall be removed in such a manner that the ball of earth surrounding the roots is not broken and they shall be planted and watered as herein specified immediately after removal from the containers. Containers shall not be opened prior to placing the plants in the planting area.

B. Layout of Major Plantings

1. Locations for plants and outlines of areas to be planted shall be marked on the ground by the Contractor before any plant pits are dug. All such locations shall be approved by the City and Landscape Architect. If underground construction or utility line is encountered in the excavation of planting areas, other locations for planting may be selected by the City and Landscape Architect. Layout shall be accomplished by flagged grade stakes Indicating plant names and specified container size on each stake. It shall be the Contractor's responsibility to confirm with the City and Landscape Architect superintendent and governing agencies the location and depth of all underground utilities, and obstructions.

C. Excavation

1. Excavation for planting shall include the stripping and stacking of all acceptable topsoil encountered within the areas to be excavated for trenches, tree holes, plant pits and planting beds.
2. Excess soil generated from the planting holes and not used as backfill, or in establishing the final grades may be spoiled on-site per direction of Owner.
3. Protect all areas from excessive compaction when trucking plants or other material to the planting site.

4. Tree and shrub pits shall be excavated to allow the root ball to set on undisturbed soil and excavated to the following diameters:

Plant Size	Pit Diameter
a. Up to 5-gallon container	12” greater than root ball diameter
b. 5-gallon container and larger (including trees)	24” greater than root ball diameter

5. All excavated holes shall have vertical sides with roughened surfaces.
6. All holes for trees and large shrubs shall be tested for water retention prior to tree or shrub installation. After hole is excavated, it is to be filled with water to the top of the excavation. If, after 24 hours, the hole still holds water, the Contractor shall excavate an additional 6" from the bottom of hole. The Contractor shall then install 6" of native washed gravel covered on the top (and up a minimum of 12" on the sides of the hole) with filter fabric. The Contractor shall also install a capped 3" diameter PVC sump which will extend from near the bottom of the rock layer to 3" above the proposed finish grade so the hole can be evacuated through mechanical means.

D. Planting Trees:

1. Container Removal:
   a. Cut cans (if applicable) with an acceptable can cutter. Remove tree from plastic container or box carefully so container can be re-used.
   b. Do not injure root ball.
2. Center tree in pit.
3. Face plants with fullest growth into prevailing wind, or away from building facade.
4. Set plants plumb and hold rigidly in position until soil has been tamped firmly around ball.
5. Tree Pit Backfill:
   a. Tree backfill should be composed of 5 parts existing soil excavated from the hole to one part Soil Amendment, thoroughly mixed with 5 lbs. per cubic yard tree backfill fertilizer. Tree backfill to be mechanically mixed prior to backfill operations.
6. Set tree in upright position in the center of the hole and compact the backfill mixture around the ball or roots. Thoroughly water each plant after back filling. After planting trees not in beds, surround the pits with a 3" height berm.
7. Plant Tablets:
   a. After the water has completely drained from the plant pit, planting tablets shall be placed in the top 3" of the plant pit, four tablets per every foot of rootball diameter per tree.
   b. Planting tablets shall be set with each plant on the top of the rootball while the plants are still in their containers so the required number of tablets to be used in each hole can be easily verified by the City and Landscape Architect.
8. Pruning: Pruning shall be limited to the minimum necessary to remove injured twigs and branches or to limb-up trees as directed by the City and Landscape Architect. Pruning may not be done prior to delivery of plants. Cuts over 3/4" in diameter shall be painted with tree paint.

9. Newly planted trees must be anchored the first year to help the tree become established. Some flexibility must be provided to allow the stem and root system to develop strength. For trees up to a 4" caliper diameter, use a minimum of two in-ground tree anchors; 4" - 8" use a minimum of three in-ground tree anchors. Information about in-ground tree anchoring products can be found at the website www.treestaple.com. This product and its web site are offered as an example of one type of tree anchoring system to establish a standard of quality. Similar products with equal specifications will be accepted.

E. Planting Shrubs:

1. Container Removal:
   a. Cut cans on two sides with an acceptable can cutter. Do not cut cans with spade or ax.
   b. Do not injure root system.
2. Center plant in pit or trench.
3. Face plants with fullest growth into prevailing wind, or away from building facade.
4. Set plants plumb and hold rigidly in position until soil has been tamped firmly around ball or roots.
5. Fill holes with backfill composed of 50% soil taken from the hole and 50% Soil Amendment, thoroughly mixed.
6. Set plant in upright position in the center of the hole and compact the backfill mixture around the ball or roots. Thoroughly water each plant after back filling. After shrubs not in beds, surround the pits with a 3" height berm.
7. Plant Tablets:
   a. After the water has completely drained from plant pit, planting tablets shall be placed in the top 3" of the plant pit as indicated:
      1) One tablet per one-gallon container and two-gallon container
      2) Two tablets per five-gallon container
   b. Planting tablets shall be set with each tablet on the top of the rootball while the plants are still in their containers so the required number of tablets to be used in each hole can be easily verified by the City and Landscape Architect.
8. Pruning shall be limited to the minimum necessary to remove injured twigs and branches. Pruning may not be done prior to delivery of plants.

F. Planting Groundcover:

1. Space the plants evenly as indicated on the Drawings, staggering.
2. After planting is completed, cover the bed uniformly with a minimum 2" layer of mulch topdressing.
3. Thoroughly water entire planting bed.

G. Grass Installation:

1. Sod Grass:
   a. All areas to receive sod must be roto-tilled to a depth of 2” (inches), cleaned of any rocks, bricks or other debris and fine graded before sod is planted.
   b. Sod must be fresh and free of any weeds. Sod may not sit on palettes for more than 48 hours without being planted. Any sod allowed to sit on palettes for more than 24 hours is subject to rejection by the City and Landscape Architect and will be replaced at contractor’s expense.
   c. All sod is to be planted in a “running bond” pattern.

d. All sod planted on the site must be watered and rolled with a grass roller the same day it is planted.

2. Grass seed:
   a. All areas to receive grass seed must be roto-tilled to a depth of 2”(inches), cleaned of any rocks, bricks or other debris, and fine graded before seed is spread.
   b. All seed must be distributed in a uniform fashion as per product manufacturer's or grower’s recommendations.
   c. All areas that have been seeded must remain moist for 7 to 10 days from the time of the first watering or until seed has germinated. Seed that is allowed to dry before germination will be subject to replacement at Contractor’s expense. It is the Contractor’s responsibility to coordinate site watering.

3.4 SITE QUALITY CONTROL

A. Site Tests and Inspections

1. When observations are conducted by someone other than the City and Landscape Architect, the Contractor shall show evidence in writing of when and by whom these observations were made.
2. No site visits shall commence without all items noted in previous Observation Reports either completed or remedied unless such compliance has been waived by the Owner and/or City and Landscape Architect.

3.5 CLEANING

A. After all planting operations have been completed, remove all trash, excess soil, empty plant containers and rubbish from the property. All scars, ruts or other marks in the ground caused by this work shall be repaired and the ground left in a neat and orderly condition throughout the site. Contractor shall pick up all trash resulting from this work on a daily basis. All trash shall be removed completely from the site.

B. The Contractor shall leave the site area broom-clean and shall wash down all paved areas within the Contract area, leaving the premises in a clean condition.

3.6 MAINTENANCE

A. Maintain the trees, shrubs, groundcovers, and sod grass until Final Completion and Acceptance of the entire project.

B. Maintenance shall include pruning, cultivating, weeding, watering, and application of appropriate insecticides and fungicides necessary to maintain plant free of insects and disease.

1. Re-set settled plants to proper grade and position. Restore planting saucer and adjacent material and remove dead material.
2. Correct defective work as soon as possible after deficiencies become apparent and weather and season permits.
3. Deep-water trees, plants, and groundcover beds within the first 24 hours of initial planting, and not less than twice per week until final acceptance

3.7 ATTACHMENTS

END OF SECTION

SECTION 33 01 10
CLEANING AND ACCEPTANCE TESTING OF WATER MAINS

PART 1 - GENERAL

1.1 SUMMARY

A. General
   1. Cleaning, disinfecting, and testing of water mains, valves, and appurtenances prior to making permanent connections to the distribution system to meet the standards established by the Water Utilities Department and the requirements of Chapter 290 of the Texas Administrative Code (TAC) established by the Texas Commission on Environmental Quality (TCEQ).

B. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. The work performed and the materials furnished in accordance with this Item are subsidiary to the structure or Items being placed and no other compensation will be allowed.

1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this Section refer to the current reference standard published at the time of the latest revision date logged at the end of this Section unless a date is specifically cited.
   2. American Water Works Association/American National Standards Institute (AWWA/ANSI):
      a. C651, Disinfecting Water Mains.
      b. C655, Field De-Chlorination.
   3. Texas Administration Code:
      a. Chapter 290, (30 TAC §290), Public Drinking Water.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Engage a qualified independent testing agency to perform testing and prepare test reports in accordance with Section 01 45 29.

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the City prior to delivery.

C. Submittals
   1. Water mains

a. Cleaning Plan – Prior to the start of construction, submit a water main cleaning plan detailing the methods and schedule, including:
   1) A detailed description of cleaning procedures
   2) Pigging entry and exit ports for mains 20-inch and larger
   3) Flushing procedures
   4) Plans and hydraulic calculations to demonstrate adequate flushing velocities, or demonstrate conformance with the conditions outlined in AWWA C651 Table 3
   5) Control of water
   6) Disposal
b. Disinfection Plan – prior to the start of construction submit a disinfection plan, including:
   1) Method of mixing and introducing chlorine
   2) Flushing
   3) Bacteriological sampling
   4) De-chlorination in accordance with AWWA C655
   5) Disposal of chlorinated water

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS

A. Test and Evaluation Reports
   1. All test reports generated during testing.

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING [NOT USED]

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY

A. Manufacturer Warranty
   1. Manufacturer's Warranty shall be in accordance with Division 0 and Division 1.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [OR] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 PRODUCT TYPES

A. Pigs
   1. Open cell polyurethane foam body
   2. Densities between 2 pounds per cubic foot up to 8 pounds per cubic foot
   3. May be wrapped with polyurethane spiral bands
   4. Abrasives are not permitted, unless expressly approved by the City in writing for the particular application.
   5. Must pass through a reduction up to 65 percent of the cross-sectional area of the nominal pipe diameter.

6. Able to traverse standard piping arrangements such as 90-degree bends, tees, crosses, wyes, and gate valves.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 ERECTION/INSTALLATION/APPLICATION [NOT USED]

3.5 REPAIR/RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

A. Hydrostatic Testing

1. Hydrostatically test all water mains and force mains intended to be pressurized to meet the following criteria:
    a. Furnish and install corporations for proper testing of the main.
        1) Furnish adequate and satisfactory equipment and supplies necessary to make such hydrostatic tests.
    b. The City will furnish water required for the testing at its nearest City water main.
    c. Gradually fill the section of main to be tested with water, carefully expelling the air and apply the specified pressure.
    d. Test Pressure
        1) PVC, Ductile Iron, and HDPE water mains
            a) Not less than 1.25 (187 psi minimum) times the stated working pressure of the water main measured at the highest elevation along the test section
            b) Not less than 1.5 (225 psi minimum) times the stated working pressure at the lowest elevation of the test section.
        2) Bar-Wrapped Steel Cylinder Type and Buried Steel water mains
            a) Not less than 1.25 (250 psi minimum) times the stated working pressure of the water main measured at the highest elevation along the test section.
            b) Not less than 1.5 (300 psi minimum) times the stated working pressure at the lowest elevation of the test section.
    e. Test Conditions
        1) Install main and backfill prior to hydrostatic testing.
        2) Test Duration
            a) Water mains: 2 hours

b) Special Considerations for HDPE mains: Under no circumstances should the total time for initial pressurization and time at test pressure exceed 8-hours at 1.5 times the system pressure rating.

3) Add water as necessary to sustain the required test pressure.

4) Fire Hydrants: Test fire hydrants to the fire hydrant valve.

a) Leave the isolation valve on the fire hydrant lead line open during the hydrostatic testing.

5) Service Lines: Test service lines to curb stop

a) Leave the corporation stop on the service line open during the hydrostatic testing.

6) Close isolation valves for air release valves.

7) Makeup water must come from a fixed 55-gallon container that does not have a water source.

f. Measure all water used in the pressure test through an approved meter, or measure the difference in volume within a 55-gallon container.

1) Do not test against existing water distribution valves unless expressly provided for in the Drawings or approved by the City.

2) If the City denies approval to test against existing water distribution system valve, then plug and test the pipe at no additional cost.

g. Hydrostatic Test Failures

1) For any main that fails to pass hydrostatic test:

a) Identify the cause.

b) Repair the leak.

c) Restore the trench and surface.

d) Retest.

(1) For HDPE, allow pipe to relax for a period of 8-hours before beginning next test.

2) All costs associated with repairing the main to pass the hydrostatic test is the sole responsibility of the Contractor and included in the price per linear foot of pipe.

3) If the City determines that an existing system valve is the cause for the failed hydrostatic test, the Contractor shall make provisions to test the main without the use of the system valve.

a) No additional payment will be made to the Contractor if the existing valve is unable to sustain the hydrostatic test. All work required to facilitate suitable test conditions shall be included in the price per linear foot of pipe.

2. Allowable Leakage

a. Water Mains

1) No pipe installation should be accepted if the amount of makeup water is greater than that determined using the following formula:
In inch-pound units,

$$L = \frac{SD\sqrt{P}}{148{,}000}$$

Where:

L = testing allowance (make up water), gallons per hour
S = length of pipe tested, ft.
D = nominal diameter of pipe, in.
P = average test pressure during the hydrostatic test, psi

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING

A. General

1. Clean water mains prior to bacteriological testing.
   a. Pig all 20-inch to 36-inch water mains.
   b. Pigging may be required for water mains smaller than 16-inch upon repeated failed bacteriological tests.
   c. Pig or manually sweep 42-inch and larger mains.
   d. Flushing in lieu of pigging is only permitted when specifically designated in the Drawings or if pigging is deemed impractical with approval from the City.

B. Pigging Method

1. Prepare main for installation and removal of pig, including:
   a. Furnish all equipment, material and labor to satisfactorily expose cleaning wye, remove cleaning wye covers, etc.
   b. Where expulsion of the pig is required through a dead-ended conduit:
      1) Prevent backflow of purged water into the main after passage of the pig.
      2) Install a mechanical joint to provide a riser out of the trench on 12-inch and smaller mains to prevent backwater re-entry into the main.
      3) Additional excavation of the trench may be performed on mains over 12-inches to prevent backwater re-entry into the main.
      4) Flush any backflow water that inadvertently enters the main in accordance with flushing method approved by City.
   c. Flush short dead-end pipe sections not swabbed by a pig in accordance with flushing method approved by City.
   d. Once pigging is complete:
      1) Pigging wyes shall remain in place unless otherwise specified in the Contract Documents.
      2) Install blind flanges or mechanical joint plugs on cleaning wye.
      3) Plug and place blocking at other openings.
      4) Backfill.
      5) Complete all appurtenant work necessary to secure the system and proceed with disinfection.

C. Flushing Method

1. Prepare the main by installing temporary blow-offs at appropriate locations, of sufficient sizes and numbers, and with adequate flushing to achieve a minimum velocity in the main of 3.0 feet per second.
   a. Minimum blow-off sizes for various main sizes are as follows:
      1) 4-inch through 8-inch main – 3/4-inch blow-off
      2) 10-inch through 12-inch main – 1-inch blow-off
      3) 16-inch and greater main – 2-inch blow-off
   b. Flushing shall be subject to the following limitations:
      1) Limit the volume of water for flushing to 3 times the volume of the water main.
      2) Do not unlawfully discharge chlorinated water.
      3) Do not damage private property.
      4) Do not create a traffic hazard.

c. Once Flushing is complete:
   1) Plug all corporation stops used for flushing.

D. Daily Main Cleaning
   1. Wipe joints and then inspect for proper installation.
   2. Sweep each joint and maintain cleanliness during construction.
   3. Install a temporary, water-tight plug on all exposed mains at the end of each working day or at the end of an extended period of work stoppage.
   4. Follow procedures of AWWA C651 for preventing contamination during installation of new water main.

E. Disinfection
   1. General
      a. Disinfection of the main shall be accomplished by the "continuous feed" method or the "slug" method as determined by the Contractor.
      b. The free chlorine amounts shown are minimums. The Contractor may require higher rates.
         1) Use calcium hypochlorite granules as the source of chlorine.
      c. Continuous Feed Method
         1) Apply water at a constant rate in the newly laid main.
            a) Use the existing distribution system or other approved water source.
         2) At a point not more than 10 feet downstream from the beginning of the main, dose the water entering the new main with chlorine.
            a) Free chlorine concentration: 25 mg/L minimum, or as required by AWWA C651, whichever is greater.
            b) Do not cease chlorine applications until the entire main is filled with heavily chlorinated water.
         3) Retain chlorinated water in the main for at least 24 hours.
            a) During this time, operate valves and hydrants in the treated section to disinfect the appurtenances.
            b) Prevent the flow of chlorinated water back into active mains.
            c) Residual at the end of the 24-hour period: 10 mg /L free chlorine, minimum, for the treated water in all portions of the main.
         4) Test the chlorine residual prior to flushing operations.
            a) If the chlorine residual exceeds 4 mg/L, the water shall remain in the main until the chlorine residual is less the 4 mg/L.
            b) The Contractor may choose to evacuate the water into water trucks or another approved storage facility.
               (1) Treat any evacuated water with Sodium Bisulfate, another de-chlorination chemical, or method appropriate for potable water and approved by the City until the chlorine residual is reduced to 4 mg/L or less.
            c) After the specified chlorine residual is obtained, the water may be discharged into the drainage system or utilized by the Contractor.
         5) Flush the heavily chlorinated water from the main and dispose of in a manner and at a location accepted by the City in accordance with AWWA C651.
      d. Slug Method
         1) Water from the existing distribution system, or other approved water supply, shall flow at a constant rate in the main.

2) At a point not more than 10 feet downstream from the beginning of the main, dose the water entering the new main with chlorine.
   a) Free chlorine concentration: 100 mg/L minimum, AWWA C651 whichever is greater.
   b) Apply chlorine continuously and for a sufficient amount of time to develop a solid column or "slug" of chlorinated water. Ensure exposure of all interior surfaces to "slug" for a minimum of 3 hours.
3) Operate the fittings and valves as the chlorinated water flows past to disinfect the appurtenances.
4) Prevent the flow of chlorinated water back into active mains.
5) Flush the heavily chlorinated water from the main and dispose of in a manner and at a location accepted by the City.
6) Upon completion, test the chlorine residual remaining in the main.
   a) Maintain chlorine levels of 4 mg/l or less.

2. Contractor Requirements
   a. Furnish all equipment, material and labor to satisfactorily prepare the main for the disinfection method approved by the City, including adequate provisions for sampling.
   b. Make all necessary taps into the main to accomplish chlorination of a new line, unless otherwise specified in the Contract Documents.
   c. After satisfactory completion of the disinfection operation, as determined by the City, remove surplus pipe at the chlorination and sampling points, plug the remaining pipe, backfill and complete all appurtenant work necessary to secure the main.

F. Dechlorination
   1. General. All chlorinated water shall be de-chlorinated before discharge into the environment. Use chemical amounts, as listed in ANSI/AWWA C651: "Disinfecting Water Mains", to neutralize the residual chlorine concentrations using de-chlorination procedures listed in ANSI/AWWA C655: "Field De-Chlorination". Continue de-chlorination until chlorine residual is non-detectable.
   2. Testing. Continuously test for the chlorine residual level immediately downstream of the de-chlorination process during the entire discharge of the chlorinated water. Periodically conduct chlorine residual testing and check for possible fish kills at locations where discharged water enters the existing watershed.
   3. Fish Kill Coordination: In the event a fish kill occurs associated with the discharge of water from the distribution system or any other construction activities:
      a. Immediately alter activities to prevent further fish kills.
      b. Immediately notify City inspector.
      c. Coordinate with City to properly notify TCEQ.
      d. Any fines assessed by TCEQ (or local, state of federal agencies) for fish kills will be the responsibility of the Contractor.

G. Bacteriological Testing (Water Sampling)
   1. General
      a. Make provisions for and furnish all material for the test specimens.
      b. Notify the City when the main is suitable for sampling.
      c. Engage a qualified independent testing agency to perform testing and prepare test reports in accordance with Section 01 45 23.

d. Obtain water samples from a suitable tap in the presence of the City for analysis by independent testing agency, unless otherwise specified in the Contract Documents.
    1) No hose or fire hydrant shall be used in the collection of samples.

2. Water Sampling
    a. Complete microbiological sampling prior to connecting the new main into the existing distribution system in accordance with AWWA C651.
    b. Collect samples for bacteriological analysis in sterile bottles treated with sodium thiosulfate.
    c. Collect 2 consecutive sets of acceptable samples, taken at least 24 hours apart, from the new main.
    d. Collect at least 1 set of samples from every 1,000 linear feet of the new main (or at the next available sampling point beyond 1,000 linear feet as designated by the City), plus 1 set from the end of the main and at least 1 set from each branch.
    e. If trench water has entered the new main during construction or, if in the opinion of the City, excessive quantities of dirt or debris have entered the new main, obtain bacteriological samples at intervals of approximately 200 linear feet.
    f. Obtain samples from water that has remained in the main for at least 16 hours after formal flushing.

3. Repetition of Sampling
    a. Unsatisfactory test results require a repeat of the disinfection process and re-sampling as required above until a satisfactory sample is obtained.

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 33 01 12
JOINT BONDING AND ELECTRICAL ISOLATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Joint bonding requirements for electrical continuity of:
      a. Concrete pressure pipe (bar-wrapped steel cylinder or pre-stressed)
      b. Mortar coated steel pipe
      c. Dielectrically coated steel pipe
      d. Ductile iron pipe
   2. Electrical isolation devices for installation at:
      a. Connections to existing piping
      b. Laterals
      c. Cased crossings
      d. Tunnels
      e. Selected below grade to above ground piping transitions

B. Related Specification Sections include but are not limited to
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. The work performed and the materials furnished in accordance with this Item are subsidiary to the structure or Items being placed and no other compensation will be allowed.

1.3 REFERENCES

A. Abbreviations
   1. THHN – Thermoplastic High Heat Resistance Nylon Coated
   2. AWG – American Wire Gauge

B. Reference Standards
   1. Reference standards cited in this Section refer to the current reference standard published at the time of the latest revision date logged at the end of this Section, unless a date is specifically cited.
   2. ASTM International (ASTM).
      a. A366, Standard Specification for Commercial Steel (CS) Sheet, Carbon, (0.15 Maximum Percent) Cold-Rolled
   3. American Water Works Association (AWWA):
      a. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4 IN through 144 IN.
   4. NACE International (NACE).
   5. NSF International (NSF):
      a. 61, Drinking Water System Components – Health Effects.
      b. 372, Drinking Water System Components – Lead Content.

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the City prior to delivery.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data

1. Manufacturer's catalog cut sheets shall be submitted for each item.
   a. Include the manufacturer's name and provide sufficient information to show the materials meet Contract Document requirements for:
      1) Flange Isolation
      2) Bonding Clips for Concrete Cylinder Pipe
2. Where more than 1 item or catalog number appears on a catalog cut sheet, clearly identify the item proposed.

B. Test and Evaluation Reports

1. Record results of Post-Installation Thermite Weld Inspection and submit to City for approval prior to backfilling.
2. Record results of bonded joint testing and submit to City for approval prior to backfilling.
3. Record results of continuity test for casing to carrier pipe and submit to City for approval prior to backfilling.

1.7 CLOSEOUT SUBMITTALS

A.Test and Evaluation Reports

1. All test reports generated during testing.

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. Protect all parts such that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.
2. Protect all equipment and parts against any damage during a prolonged period at the site.
3. Prevent plastic and similar brittle items from being directly exposed to sunlight or extremes in temperature.
4. Secure and maintain a location to store the material in accordance with Section 01 66 00.

1.11 FIELD CONDITIONS [NOT USED]

1.12 WARRANTY

A. Manufacturer Warranty

1. Manufacturer's Warranty shall be in accordance with Division 0 and Division 1.

PART 2 - PRODUCTS

2.1 CITY-FURNISHED [NOT USED]

2.2 EQUIPMENT, PRODUCT TYPES, MATERIALS

A. Joint Bonding and Electrical Isolation Materials to be incorporated into the project include, but are not limited to:
   1. Electrical continuity bonds
   2. Flange isolation assemblies
   3. Casing spacers
   4. Casing end seals

B. Electrical Continuity Bonds
   1. Applications for Electrical Continuity Bonding include:
      a. Bonding across bolted joint assemblies
      b. Bonding across gasketed joint assemblies

C. Flange Isolation
   1. Required applications of dielectric flange isolation assemblies include, but are not limited to, selected locations where new piping is mechanically connected to existing piping.
   2. Gasket
      a. Isolate and seal gasket
      b. G-10 Epoxy Glass material
      c. Full face
      d. 1/8-inch thickness
      e. Minimum of one (1) EDPM sealing element placed in a tapered groove.
      f. NSF 61 and 372 certified
      g. Minimum of 800 volts/mil dielectric strength is required.
      h. Flange shall seal for the test pressure without leaking.
   3. Sleeves
      a. Provide full length mylar sleeves.
   4. Washers
      a. Provide double G-10 washer sets.

D. Electrical Bond Wires
   1. Electrical bond wires are to be a minimum No. 4 AWG, 7 stranded, copper cable with THHN wire insulation.
   2. Remove 1 inch of THHN wire insulation from each end of the bond wire.
   3. Thermite weld the bond wires to the pipeline.

E. Electrical Bond Clip
   1. Weld 3 ASTM A366 steel bonding clips, each approximately 0.13 inches thick, 2.5 inches long, and 1.25 inches wide, with 1/8-inch fillet welds to the bell and spigot of adjacent pre-stressed concrete cylinder pipe or steel pipe with rubber gasketed joints.

2. Manufacture clips to maintain continuity regardless of small deflections of finished joints.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

A. Preparation of Concrete Pipe for Bonding
   1. General
      a. Fabrication
         1) Establish electrical continuity between metallic components of pipe and joints.
      b. Acceptable Methods
         1) Establish electrical continuity as indicated in the Contract Documents.
   2. Criteria for Electric Continuity
      a. Tensile Wire
         1) Pipe manufacturer is to obtain a resistance no greater than 0.03 ohms between any wire and steel joint ring at end of pipe farthest from chosen wire.
         2) Manufacturer is to report values obtained and method of measurement.
      b. Internal Pipe Joint Components
         1) Pipe manufacturer is to obtain resistance of less than 0.03 ohms between any component and steel pipe cylinder.
   3. Tensile Wire Continuity
      a. Establish continuity between tensile wire coils and steel cylinder on embedded cylinder type pre-stressed pipe by tightly wrapping tensile wire over longitudinal mild steel straps during pipe manufacture.
      b. Use and install 2 continuous straps 180 degrees apart longitudinally along the pipe.
         1) These straps must maintain electrical continuity between metallic components.
      c. Use steel straps made of mild steel and free of grease, mill scale, or other high resistance deposits.
      d. Make longitudinal straps electrically continuous with pipe cylinder by steel fasteners of suitable dimensions placed between steel cylinder and longitudinal straps.
         1) Connect fasteners so as to remain intact during pipe fabrication process.
   4. Steel Cylinder Continuity
      a. Establish continuity of all joint components and steel cylinder.
         1) These components include anchor socket brackets, anchor socket, spigot ring, and bell ring.
      b. If mechanical contact does not provide a resistance of less than 0.03 ohms between components, tack weld component to provide electrical continuity.

B. Preparation of Steel Pipe for Bonding
   1. Bonding wires are not required for welded steel pipe.
   2. Mechanical jointed steel pipe requires the installation of bond wires across the joint as shown on the Drawings.

C. Preparation of Ductile Iron Pipe for Bonding
   1. Install insulated bond wires as shown on the Drawings.

3.4 INSTALLATION

A. Installation of Electrical Continuity Bonds by Thermite Welding
   1. Inspection
      a. Use continuous bond wires with no cuts or tears in the insulation covering the conductor.
   2. General
      a. Attach bond wires at required locations by thermite welding process.
   3. Thermite Welding Methods
      a. Perform thermite welding of bond wires to piping in the following manner:
         1) Clean and dry pipe to which the wires are to be attached.
         2) Use grinding wheel to remove all coating, mill scale, oxide, grease, and dirt from an area approximately 3 inches square.
            a) Grind surface to bright metal.
         3) Remove approximately 1 inch of insulation from each end of wire to be thermite welded to pipe exposing clean, oxide-free copper for welding.
         4) Select proper size thermite weld mold as recommended by manufacturer. Place wire or strap between graphite mold and the prepared metal surface.
         5) Place metal disk in bottom of mold.
         6) Pour thermite weld charge into the mold. Squeeze bottom of cartridge to spread ignition powder over charge.
         7) Close mold cover and ignite starting powder with flint gun.
         8) After exothermic reaction, remove thermite weld mold and gently strike weld with a hammer to remove weld slag.
         9) Pull on wire or strap to assure a secure connection.
         10) If weld is not secure or the bond breaks, repeat procedure with new wire.
         11) If the weld is secure, coat all bare metal and weld metal with Stopaq CZ tape.
         12) Provide the minimum number of bond wires as shown on Drawings for steel or ductile iron pipe.
   4. Post-Installation Thermite Weld Inspection
      a. Contractor is responsible for all testing.
      b. All testing is to be performed by or under the supervision of certified NACE personnel.
      c. Visually examine each thermite weld connection for strength and suitable coating prior to backfilling.
      d. Measure resistance through selected bonded joints with a digital low resistance ohmmeter (DLRO).
         1) Resistance of 0.001 ohms or less is acceptable.
         2) If the above procedure indicates a poor-quality bond connection, reinstall the bond.
         3) Record results and submit to City for approval prior to backfilling.

5. Backfilling of Bonded Joints
    a. Perform backfilling of bonded piping in manner that prevents damage to the bonds and all connections to the metallic structures.
    b. Use appropriate backfill material to completely cover the electrical bond.
    c. Provide protection so that future construction activities in the area will not destroy the bonded connections.
    d. If construction activity damages a bonded connection, install new bond wire.

B. Installation of Pipeline Flange Isolation Devices

1. Placement
    a. Install isolation joints at the locations shown on the Drawings.
2. Assembly
    a. Place gasket, sleeves, and washers as recommended by the manufacturer.
    b. Follow manufacturer's recommendations for even tightening to proper torque.
3. Testing
    a. Immediately after an electrical isolation fitting has been installed, Contractor to perform testing for electrical isolation effectiveness with the City present.
4. Painting
    a. Do not use metal base paints on electrical isolation devices.
5. Encapsulation
    a. Encapsulate below-grade isolation joints with the Denso Densyl Tape system after the isolation joint has been tested for effectiveness.

3.5 REPAIR [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

A. Testing of Joint Continuity Bonds and Isolation Joints

1. After the completion of the continuity bonding of individual joints, but before the pipe is backfilled, test each bonded joint for electrical continuity.
2. Impress a DC current on the pipe on 1 side of the joint being tested using a portable 12-volt battery and a driven ground rod. Connect battery with positive terminal connected to the ground rod and negative terminal connected to the pipe section under test.
    a. The magnitude of test current is not important as long as it causes a change in pipe-to-soil potential on the section of pipe that is in the test current circuit.
3. Measure the pipe-to-soil potential on each side of the isolation joint using a high impedance voltmeter and portable copper/copper sulfate reference electrode with the test current “on” and “off”.
4. A joint is considered electrically continuous if the “on” and “off” potentials are the same on either side of the joint under test.
5. Use this same procedure to test individual isolation joints.
    a. The joint is considered effective if the pipe-to-soil potential is <u>not</u> the same when measured on each side of the joint when the test current is “on”.
6. Record results and submit in accordance with this Section.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 33 05 05
UTILITY TRENCH EXCAVATION, EMBEDMENT AND BACKFILL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Excavation, Embedment and Backfill for:
      a. Pressure Applications
         1) Water Distribution or Transmission Main
         2) Wastewater Force Main
         3) Reclaimed Water Main
      b. Gravity Applications
         1) Wastewater Gravity Mains
         2) Storm Sewer Pipe and Culverts
         3) Storm Sewer Precast Box and Culverts
   2. Including:
      a. Excavation of all material encountered, including rock and unsuitable materials
      b. Disposal of excess unsuitable material
      c. Site specific trench safety
      d. Pumping and dewatering
      e. Embedment
      f. Concrete encasement for utility lines
      g. Backfill
      h. Compaction

B. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 – General Requirements

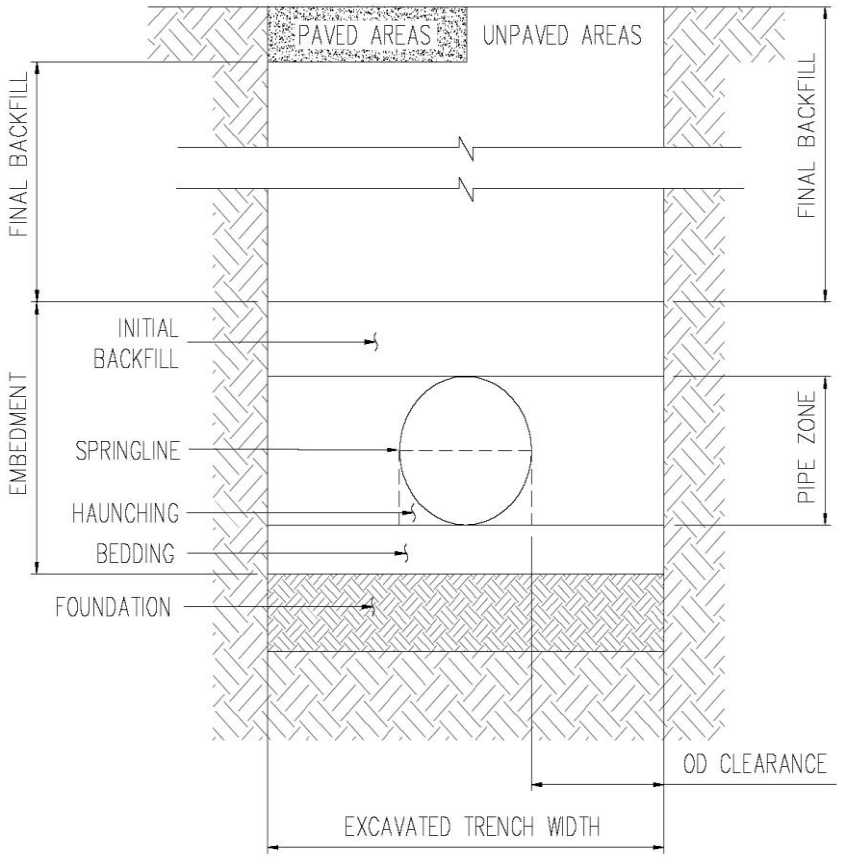
1.2 PRICE AND PAYMENT PROCEDURES

A. Trench Safety Plan - Payment shall be made at the lump sum price for the work performed, engineering or other professional services provided, and materials furnished in accordance with this item.

B. Trench Safety Implementation - Payment for trench safety shall be by the lineal feet of trench regardless of depth.

1.3 REFERENCES

A. Definitions
   1. General – Definitions used in this section are in accordance with Terminologies ASTM F412 and ASTM D8 and Terminology ASTM D653, unless otherwise noted.
   2. Definitions for trench width, backfill, embedment, initial backfill, pipe zone, haunching bedding, springline, pipe zone and foundation are defined as shown in the following schematic:



3. Deleterious materials – Harmful materials such as clay lumps, silts and organic material
4. Excavated Trench Depth – Distance from the surface to the bottom of the bedding or the trench foundation
5. Final Backfill Depth
   a. Unpaved Areas – The depth of the final backfill measured from the top of the initial backfill to the surface
   b. Paved Areas – The depth of the final backfill measured from the top of the initial backfill to bottom of permanent or temporary pavement repair

B. Reference Standards

1. Reference standards cited in this Specification refer to the current reference standard published at the time of the latest revision date logged at the end of this Specification, unless a date is specifically cited.
2. ASTM Standards:
   a. C33, Standard Specification for Concrete Aggregates.
   b. C40, Standard Test Method for Organic Impurities in Fine Aggregates for Concrete.
   c. C88, Standard Test Method for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
   d. C94, Standard Specification for Ready-Mixed Concrete.
   e. C123, Standard Test Method for Lightweight Particles in Aggregate.

f. C131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
g. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregate.
h. C142, Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
i. D448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
j. C535, Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
k. D698, Test Methods for Laboratory Compaction Characteristics of Soil Using Stand and Effort (12,400 ft-lb/ft3 600 Kn-m/M3)).
l. D1632, Standard Practice for Making and Curing Soil-Cement Compression and Flexure Test Specimens in the Laboratory.
m. D1633, Standard Test Methods for Compressive Strength of Molded Soil-Cement Cylinders.
n. D1556, Standard Test Method for Density and Unit Weight of Soils in Place by Sand Cone Method.
o. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
p. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
q. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

3. Occupational Safety and Health Administration (OSHA)
   a. 29 CFR, Part 1926-Safety Regulations for Construction, Subpart P: Excavations.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Field Tests and Inspections
   1. Engage a qualified independent testing agency to perform material evaluation tests and prepare test reports in accordance with Section 01 45 29.
   2. Make provisions for and furnish all material for the test specimens.

B. Coordination
   1. Utility Company Notification
      a. Notify area utility companies at least 48 hours in advance, excluding weekends and holidays, before starting excavation.
      b. Request the location of buried lines and cables in the vicinity of the proposed work.

C. Sequencing
   1. Sequence work for each section of the pipe installed to complete the embedment and backfill placement on the day the pipe foundation is complete.
   2. Sequence work such that proctors are complete in accordance with ASTM D698 prior to commencement of construction activities.

D. Excavation Protection
   1. Excavation protection shall be in strict compliance with OSHA excavation safety standards (29 CFR Part 1926 Subpart P Safety and Health regulations for Construction).

2. Submit three (3) copies of a site-specific trench safety plan prepared by a licensed Professional Engineer in the State of Texas to the City prior to construction in accordance with Section 01 33 00.
    a. The City will not review the submittal. Receipt of submittal is confirmation that the Contractor has prepared a trench safety plan as required by state and federal law.
    b. The City assumes no responsibility for trench safety and shall be held harmless under the indemnification clause of the General Conditions.
3. Any changes in the trench excavation plan after initiation of construction will not be cause for an extension of time and will require a new submittal to the City.
4. The Contractor accepts sole responsibility for compliance with all applicable safety requirements.

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the City prior to construction.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Submittals
    1. Designated storage area affidavit for storage on private property, if applicable.

B. Shop Drawings
    1. Provide detailed drawings and explanation for groundwater and surface water control, if required.
    2. Trench Safety Plan in accordance with Article 1.4.
    3. Stockpiled excavation and/or backfill material
        a. Provide a description of the storage of the excavated material only if the Contract Documents do not allow storage of materials in the right-of-way or the easement.

1.7 CLOSEOUT SUBMITTALS

A. Test and Evaluation Reports
    1. All test reports generated during testing.

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage
    1. Within Existing Rights-of-Way (ROW)
        a. Soil may NOT be stored within existing ROW unless specifically allowed in the Contract Documents.
        b. Do not block drainage ways, inlets or driveways.
        c. Provide erosion control in accordance with Section 31 25 00.
        d. When the Work is performed in active traffic areas, store materials only in areas barricaded as provided in the traffic control plans.

e. In non-paved areas, do not store material on the root zone of any trees or in landscaped areas.

2. Designated Storage Areas
   a. If the Contract Documents do not allow the storage of spoils within the ROW, then secure and maintain an adequate storage location.
   b. Provide an affidavit that rights have been secured to store the materials on private property.
   c. Provide erosion control in accordance with Section 31 25 00.
   d. Do not block drainage ways.

B. Deliveries and haul-off - Coordinate all deliveries and haul-off.

1.11 FIELD [SITE] CONDITIONS

A. Existing Conditions
   1. Any data which has been or may be provided on subsurface conditions is not intended as a representation or warranty of accuracy or continuity between soils. It is expressly understood that neither the City nor the Engineer will be responsible for interpretations or conclusions drawn there from by the Contractor.
   2. Data is made available for the convenience of the Contractor.

1.12 WARRANTY

A. Manufacturer Warranty
   1. Manufacturer's Warranty shall be in accordance with Division 0 and Division 1.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [OR] OWNER-SUPPLIED PRODUCTS

2.2 MATERIALS

A. Materials
   1. Acceptable Embedment Material
      a. Durable crushed rock.
      b. Meets the gradation of Class 1A in accordance with ASTM D2321.
      c. Free from significant silt clay or unsuitable materials.
   2. Acceptable Backfill Material
      a. In-situ or imported soils classified as CL, CH, SC, SM, or GC in accordance with ASTM D2487
      b. Free from deleterious materials, boulders over 3 inches in size and organics
      c. Can be placed free from voids
      d. 25 – 50 Percent Retained on No. 4 Sieve
      e. 50 –80 Percent Retained on No. 40 Sieve
      f. Plasticity Index 15 Maximum
   3. Blended Backfill Material
      a. In-situ soils classified as SP, GP or GM in accordance with ASTM D2487
      b. Blended with in-situ or imported Acceptable Fill material to meet the requirements of an Acceptable Backfill Material
      c. Free from deleterious materials, boulders over 3 inches in size and organics
      d. Can be placed free from voids

e. 25 – 50 Percent Retained on No. 4 Sieve
f. 50 –80 Percent Retained on No. 40 Sieve
g. Plasticity Index 15 Maximum

4. Unacceptable Backfill Material
   a. In-situ soils classified as ML, MH, PT, OL or OH in accordance with ASTM D2487.
5. Select Fill
   a. Classified as SC or CL in accordance with ASTM D2487
   b. Free from deleterious materials, boulders over 3 inches in size and organics
   c. Can be placed free from voids
   d. 25 – 50 Percent Retained on No. 4 Sieve
   e. 50 –80 Percent Retained on No. 40 Sieve
   f. Plasticity Index 15 Maximum
6. Cement Stabilized Sand (CSS)
   a. Sand
      1) Clean and durable, in accordance with grading requirements for fine aggregates of ASTM C33 and the following requirements:
         a) Classified as SW, SP, or SM by the United Soil Classification System of ASTM D2487
         b) Deleterious materials
            (1) Clay lumps, ASTM C142, less than 0.5 percent
            (2) Lightweight pieces, ASTM C123, less than 5.0 percent
            (3) Organic impurities, ASTM C40, color no darker than standard color
            (4) Plasticity index of 4 or less when tested in accordance with ASTM D4318.
   b. Minimum of 4 percent cement content of Type I/II portland cement
   c. Water
      1) Potable water, free of soils, acids, alkalis, organic matter or other deleterious substances, in accordance with the requirements of ASTM C94
   d. Mix in a stationary pug mill, weigh-batch, or continuous mixing plant.
   e. Strength
      1) 50 to 150 psi compressive strength at 2 days in accordance with ASTM D1633, Method A
      2) 200 to 250 psi compressive strength at 28 days in accordance with ASTM D1633, Method A
      3) The maximum compressive strength in 7 days shall be 400 psi.
         a) Backfill that exceeds the maximum compressive strength shall be removed by the Contractor for no additional compensation.
   f. Random samples of delivered product will be taken in the field at point of delivery for each day of placement in the work area. Specimens will be prepared in accordance with ASTM D1632.
7. Trench Geotextile Fabric
   a. Soils other than ML or OH in accordance with ASTM D2487
      1) Needle punch, nonwoven geotextile composed of polypropylene fibers
      2) Fibers shall retain their relative position
      3) Inert to biological degradation
      4) Resist naturally occurring chemicals
      5) UV Resistant

6) Mirafi 140N by Tencate, or approved equal

b. Soils Classified as ML or OH in accordance with ASTM D2487

1) High-tenacity monofilament polypropylene woven yarn
2) 8 to10 percent open area
3) Fibers shall retain their relative position
4) Inert to biological degradation
5) Resist naturally occurring chemicals
6) UV Resistant
7) Mirafi FW402 by Tencate, or approved equal

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION

A. Verification of Conditions

1. Review all known, identified or marked utilities, whether public or private, prior to excavation.
2. Locate and protect all known, identified and marked utilities or underground facilities as excavation progresses.
3. Notify all utility owners within the project limits 48 hours prior to beginning excavation.
4. The information and data shown in the Drawings with respect to utilities is approximate and based on record information or on physical appurtenances observed within the project limits.
5. Coordinate with the Owner(s) of underground facilities.
6. Immediately notify any utility owner of damages to underground facilities resulting from construction activities.
7. Repair any damages resulting from the construction activities.

B. Notify the City immediately of any changed condition that impacts excavation and installation of the proposed utility.

3.3 PREPARATION

A. Protection of In-Place Conditions

1. Pavement
   a. Conduct activities in such a way that does not damage existing pavement that is designated to remain.
      1) Where desired to move equipment not licensed for operation on public roads or across pavement, provide means to protect the pavement from all damage.
   b. Repair or replace any pavement damaged due to the negligence of the contractor outside the limits designated for pavement removal at no additional cost to the City.

2. Drainage
   a. Maintain positive drainage during construction and re-establish drainage for all swales and culverts affected by construction.
3. Trees
   a. When operating outside of existing ROW, stake permanent and temporary construction easements.
   b. Restrict all construction activities to the designated easements and ROW.
   c. Flag and protect all trees designated to remain in accordance with Section 31 10 00.
   d. Conduct excavation, embedment and backfill in a manner such that there is no damage to the tree canopy.
   e. Prune or trim tree limbs as specifically allowed by the Drawings or as specifically allowed by the City.
      1) Pruning or trimming may only be accomplished with equipments specifically designed for tree pruning or trimming.
   f. Remove trees specifically designated to be removed in the Drawings in accordance with Section 31 10 00.
4. Above ground Structures
   a. Protect all above ground structures adjacent to the construction.
   b. Remove above ground structures designated for removal in the Drawings.
5. Traffic
   a. Maintain existing traffic
   b. Do not block access to driveways or alleys for extended periods of time unless:
      1) Alternative access has been provided
      2) Proper notification has been provided to the property owner or resident
      3) It is specifically allowed in the traffic control plan
   c. Use traffic rated plates to maintain access until access is restored.
6. Traffic Signal – Poles, Mast Arms, Pull boxes, Detector loops
   a. Notify TxDOT or Ector County Traffic Services a minimum of 48 hours prior to any excavation that could impact the operations of an existing traffic signal.
   b. Protect all traffic signal poles, mast arms, pull boxes, traffic cabinets, conduit and detector loops.
   c. Immediately notify the TxDOT or Ector County Traffic Services if any damage occurs to any component of the traffic signal due to the contractors activities.
   d. Repair any damage to the traffic signal poles, mast arms, pull boxes, traffic cabinets, conduit and detector loops as a result of the construction activities.
7. Fences
   a. Protect all fences designated to remain.
   b. Leave fence in the equal or better condition as prior to construction.

3.4 INSTALLATION

A. Excavation

1. Excavate to a depth indicated on the Drawings.
2. Trench excavations are defined as unclassified. No additional payment shall be granted for rock or other in-situ materials encountered in the trench.
3. Excavate to a width sufficient for laying the pipe in accordance with the Drawings and bracing in accordance with the Excavation Safety Plan.
4. The bottom of the excavation shall be firm and free from standing water.

a. Notify the City immediately if the water and/or the in-situ soils do not provide for a firm trench bottom.
b. The City will determine if any changes are required in the pipe foundation or bedding.

5. Unless otherwise permitted by the Drawings or by the City, the limits of the excavation shall not advance beyond the pipe placement so that the trench may be backfilled in the same day.
6. Over Excavation
   a. Fill over excavated areas with the specified bedding material as specified for the specific pipe to be installed.
   b. No additional payment will be made for over excavation or additional bedding material.
7. Unacceptable Backfill Materials
   a. In-situ soils classified as unacceptable backfill material shall be separated from acceptable backfill materials.
   b. If the unacceptable backfill material is to be blended in accordance with this Specification, then store material in a suitable location until the material is blended.
   c. Remove all unacceptable material from the project site that is not intended to be blended or modified.
8. Rock – No additional compensation will be paid for rock excavation or other changed field conditions.

B. Shoring, Sheeting and Bracing
1. Engage a Licensed Professional Engineer in the State of Texas to design a site specific excavation safety system in accordance with Federal and State requirements.
2. Excavation protection systems shall be designed according to the space limitations as indicated in the Drawings.
3. Furnish, put in place and maintain a trench safety system in accordance with the Excavation Safety Plan and required by Federal, State or local safety requirements.
4. If soil or water conditions are encountered that are not addressed by the current Excavation Safety Plan, engage a Licensed Professional Engineer in the State of Texas to modify the Excavation Safety Plan and provide a revised submittal to the City.
5. Do not allow soil, or water containing soil, to migrate through the Excavation Safety System in sufficient quantities to adversely affect the suitability of the Excavation Protection System. Movable bracing, shoring plates or trench boxes used to support the sides of the trench excavation shall not:
   a. Disturb the embedment located in the pipe zone or lower
   b. Alter the pipe's line and grade after the Excavation Protection System is removed
   c. Compromise the compaction of the embedment located below the spring line of the pipe and in the haunching

C. Water Control
1. Surface Water
   a. Furnish all materials and equipment and perform all incidental work required to direct surface water away from the excavation.

2. Ground Water
    a. Furnish all materials and equipment to dewater ground water by a method which preserves the undisturbed state of the subgrade soils.
    b. Do not allow the pipe to be submerged within 24 hours after placement.
    c. Do not allow water to flow over concrete until it has sufficiently cured.
    d. Engage a Licensed Engineer in the State of Texas to prepare a Ground Water Control Plan if any of the following conditions are encountered:
        1) A Ground Water Control Plan is specifically required by the Contract Documents
        2) If in the sole judgment of the City, ground water is so severe that an Engineered Ground Water Control Plan is required to protect the trench or the installation of the pipe which may include:
            a) Ground water levels in the trench are unable to be maintained below the top of the bedding
            b) A firm trench bottom cannot be maintained due to ground water
            c) Ground water entering the excavation undermines the stability of the excavation.
            d) Ground water entering the excavation is transporting unacceptable quantities of soils through the Excavation Safety System.
    e. In the event that there is no bid item for a Ground Water Control and the City requires an Engineered Ground Water Control Plan due to conditions discovered at the site, the contractor will be eligible to submit a change order.
    f. Control of ground water shall be considered subsidiary to the excavation when:
        1) No Ground Water Control Plan is specifically identified and required in the Contract Documents
    g. Ground Water Control Plan installation, operation and maintenance
        1) Furnish all materials and equipment necessary to implement, operate and maintain the Ground Water Control Plan.
        2) Once the excavation is complete, remove all ground water control equipment not called to be incorporated into the work.
    h. Water Disposal
        1) Dispose of ground water in accordance with City policy or Ordinance.
        2) Do not discharge ground water onto or across private property without written permission.
        3) Disposal shall not violate any Federal, State or local regulations.

D. Embedment and Pipe Placement

1. Water Lines
    a. The entire embedment zone shall be of uniform material.
    b. Class 1A crushed rock shall be used for embedment of the water line.
    c. Provide trench geotextile fabric at any location where crushed rock or fine crushed rock come into contact with utility sand or other sources of fines.
    d. Place evenly spread bedding material on a firm trench bottom.
    e. Provide firm, uniform bedding.
        1) Additional bedding may be required if ground water is present in the trench.
    f. Place pipe on the bedding according to the alignment shown on the Drawings.
    g. The pipe line shall be within:
        1) ±3 inches of the elevation on the Drawings.
    h. Place and compact embedment material to adequately support haunches in accordance with the pipe manufacturer’s recommendations.

i. Place remaining embedment including initial backfill to a minimum of 6 inches, but not more than 12 inches, above the pipe.
j. Where gate valves are present, the initial backfill shall extend to up to the valve nut.
k. Compact the embedment and initial backfill to 95 percent Standard Proctor ASTM D 698.
l. Place trench geotextile fabric on top of the initial backfill.
m. Place marker tape and tracer wire on top of the trench geotextile fabric in accordance with Section 33 05 97.

2. Water Services (Less than 2 Inches in Diameter)
a. The entire embedment zone shall be of uniform material.
b. Utility sand shall be generally used for embedment.
c. Place evenly spread bedding material on a firm trench bottom.
d. Provide firm, uniform bedding.
e. Place pipe on the bedding according to the alignment of the Plans.
f. Compact the initial backfill to 95 percent Standard Proctor ASTM D698.

E. Trench Backfill

1. At a minimum, place backfill in such a manner that the required in-place density and moisture content is obtained, and so that there will be no damage to the surface, pavement or structures due to any trench settlement or trench movement.
a. Meeting the requirement herein does not relieve the responsibility to damages associated with the Work.

2. Backfill Material
a. Final Backfill
1) Backfill with:
a) Acceptable backfill material
b) Blended backfill material, or
c) Select backfill material, CSS, or CLSM when specifically required
b. Backfill for service lines:
1) Backfill for water lines shall be the same as the requirement of the main that the service is connected to.

3. Required Compaction and Density
a. Final backfill (depths less than 15 feet)
1) Compact native backfill material, blended backfill material or select backfill to a minimum of 95 percent of Standard Proctor density in accordance with ASTM D698 at moisture content within -2 to +4 percentage points of the optimum moisture.
2) CSS or CLSM requires no compaction.
b. Final backfill (depths 15 feet and greater/under existing or future pavement)
1) Compact select backfill to a minimum of 98 percent Standard Proctor in accordance with ASTM D698 at moisture content within -2 to +4 percentage points of optimum moisture.
2) CSS or CLSM requires no compaction.
c. Final backfill (depths 15 feet and greater/<u>not</u> under existing or future pavement)
1) Compact native backfill material, blended backfill material, or select backfill to a minimum of 98 percent Standard Proctor in accordance with ASTM D698 at moisture content within -2 to +4 percentage points of optimum moisture.
2) CSS or CLSM requires no compaction.

4. Saturated Soils
   a. If in-situ soils consistently demonstrate that they are greater than 5 percent over optimum moisture content, the soils are considered saturated.
   b. Flooding the trench or water jetting is strictly prohibited.
   c. If saturated soils are identified in the Drawings or Geotechnical Report in the Appendix, Contractor shall proceed with Work following all backfill procedures outlined in the Drawings for areas of soil saturation greater than 5 percent.
   d. If saturated soils are encountered during Work but not identified in Drawings or Geotechnical Report in the Appendix:
      1) The Contractor shall:
         a) Immediately notify the City.
         b) Submit a Contract Claim for Extra Work associated with direction from City.
      2) The City shall:
         a) Investigate soils and determine if Work can proceed in the identified location.
         b) Direct the Contractor of changed backfill procedures associated with the saturated soils that may include:
            (1) Imported backfill
            (2) A site specific backfill design
5. Placement of Backfill
   a. Use only compaction equipment specifically designed for compaction of a particular soil type and within the space and depth limitation experienced in the trench.
   b. Flooding the trench or water setting is strictly prohibited.
   c. Place in loose lifts not to exceed 8 inches.
   d. Compact to specified densities.
   e. Compact only on top of initial backfill, undisturbed trench or previously compacted backfill.
   f. Remove any loose materials due to the movement of any trench box or shoring or due to sloughing of the trench wall.
6. Backfill Means and Methods Demonstration
   a. In the presence of the City, perform standard proctor test in accordance with ASTM D698.
   b. The results of the standard proctor test must be received prior to beginning excavation.
   c. Upon commencing of backfill placement for the project the Contractor shall demonstrate means and methods to obtain the required densities.
   d. Demonstrate Means and Methods for compaction including:
      1) Depth of lifts for backfill which shall not exceed 8 inches
      2) Method of moisture control for excessively dry or wet backfill
      3) Placement and moving trench box, if used
      4) Compaction techniques in an open trench
      5) Compaction techniques around structure
   e. Provide a testing trench box to provide access to the recently backfilled material.
7. Varying Ground Conditions
   a. Notify the City of varying ground conditions and the need for additional proctors.

b. The City may require additional proctors at its discretion.
c. Significant changes in soil conditions will require an additional Means and Methods demonstration.

3.5 REPAIR [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

A. Field Tests and Inspections
1. Engage a qualified independent testing agency to perform material evaluation tests and prepare test reports in accordance with Section 01 45 23.
2. Make provisions for and furnish all material for the test specimens.
3. Density Testing of Backfill
a. In accordance with ASTM D6938.
b. Provide testing trench protection for trench depths in excess of 5 feet.
c. Place, move and remove testing trench protection as necessary to facilitate any City performed tests.
d. For final backfill depths less than 15 feet and trenches of any depth not under existing or future pavement:
1) Perform density testing twice per working day when backfilling operations are being conducted.
2) The testing lab shall take a minimum of 3 density tests of the current lift in the available trench.
e. For final backfill depths 15 feet and greater deep and under existing or future pavement:
1) Perform density testing twice per working day when backfilling operations are being conducted.
2) The testing lab shall take a minimum of 3 density tests of the current lift in the available trench.
3) The testing lab will remain onsite sufficient time to test 2 additional lifts.
f. Make the excavation available for City performed tests.
g. Provide results to the City's Inspector upon completion of the testing.
h. Provide a formal report to the City within 48 hours including:
1) Location of test by station number
2) Time and date of test
3) Depth of testing
4) Field moisture
5) Dry density
6) Proctor identifier
7) Percent Standard Proctor density

4. Density of Embedment
    a. Storm sewer boxes that are embedded with native backfill material, blended backfill material, cement modified backfill material or select material will follow the same testing procedure as backfill.
    b. Test fine crushed rock or crushed rock embedment in accordance with ASTM D6938 or ASTM D1556.

B. Non-Conforming Work
    1. Remove and replace all non-conforming work.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 33 05 19
DUCTILE IRON PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ductile Iron Pipe 3-inch through 64-inch for potable water, wastewater and reuse applications

B. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 33 01 10 – Cleaning and Acceptance Testing of Water Mains
   4. Section 33 01 12 – Joint Bonding and Electrical Isolation
   5. Section 33 05 05 – Utility Trench Excavation, Embedment and Backfill
   6. Section 33 14 05 – Bolts, Nuts, and Gaskets
   7. Section 33 14 10 – Ductile Iron Fittings

1.2 PRICE AND PAYMENT PROCEDURES

A. The work performed and the materials furnished in accordance with this Item are subsidiary to the structure or Items being placed and no other compensation will be allowed.

1.3 REFERENCES

A. Definitions
   1. Gland or Follower Gland
      a. Non-restrained, mechanical joint fitting
   2. Retainer Gland
      a. Mechanically restrained mechanical joint fitting, consisting of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of AWWA/ANSI C153/A21.53.

B. Reference Standards
   1. Reference standards cited in this Section refer to the current reference standard published at the time of the latest revision date logged at the end of this Section unless a date is specifically cited.
   2. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125 and 250).
   3. ASTM International (ASTM):
      a. A536, Standard Specification for Ductile Iron Castings.
      b. A674, Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.

4. American Water Works Association (AWWA):
   a. M41, Ductile-Iron Pipe and Fittings.
5. American Water Works Association/American National Standards Institute (AWWA/ANSI):
   a. C104/A21.4, Cement–Mortar Lining for Ductile-Iron Pipe and Fittings.
   b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
   c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   e. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   f. C150/A21.50, Thickness Design of Ductile-Iron Pipe.
   g. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water.
   h. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
   i. C600, Installation of Ductile-Iron Water Mains and their Appurtenances.
6. International Organization for Standardization (ISO):
   a. 8179-1, Ductile Iron Pipes, Fittings, Accessories and their Joints – External Zinc-Based Coating – Part 1: Metallic Zinc with Finishing Layer.
7. NSF International (NSF):
   a. 61, Drinking Water System Components - Health Effects.
   b. 372, Drinking Water System Components – Lead Content.
8. Society for Protective Coatings (SSPC):
   a. PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the City prior to delivery and/or fabrication.

1.6 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. Product Data
   1. Ductile Iron Pipe
      a. Pressure or special thickness class
      b. Interior lining
      c. Exterior coating
      d. Joint type
   2. Polyethylene encasement and tape
      a. Planned method of installation
      b. Polyethylene type
      c. Polyethylene thickness
   3. Interior Lining
      a. If other than cement mortar lining in accordance with AWWA/ANSI C104/A21.4, provide:
         1) Material.
         2) Application Recommendations.
         3) Field touch-up procedures.
   4. Thrust Restraint

a. Retainer glands
b. PVC joint harnesses
c. Other means

5. Gaskets
   a. In accordance with Section 33 14 05.
6. Isolation Flanges
   a. In accordance with Section 33 01 12.
7. Bolts and Nuts
   a. Mechanical Joints
      1) Provide bolts and nuts in accordance with Section 33 14 05.
   b. Flanged Joints
      1) In accordance with AWWA/ANSI C115/A21.15.
      2) Provide bolts and nuts in accordance with Section 33 14 05.

B. Shop Drawings

1. For 16-inch and 20-inch diameter Ductile Iron Pipe used in the water distribution system or wastewater force mains, provide:
   a. Thrust restraint calculations for all fittings, valves and deflections sealed by a Professional Engineer Licensed in Texas.
   b. Lay schedule sealed by a Professional Engineer Licensed in Texas including:
      1) Pipe class
      2) Joint type
      3) Fittings
      4) Stationing
      5) Transitions
      6) Joint deflection
2. For 24-inch and greater diameter Ductile Iron Pipe used in the water distribution system or wastewater force mains, provide:
   a. Wall thickness design calculations sealed by a Professional Engineer Licensed in Texas including:
      1) Working Pressure
      2) Surge Pressure
      3) Deflection
   b. Thrust restraint calculations for all fittings, valves, and deflections sealed by a Professional Engineer Licensed in Texas.
   c. Lay drawings (with schedule) sealed by a Professional Engineer Licensed in Texas including:
      1) Pipe class
      2) Joint type
      3) Fittings
      4) Stationing
      5) Transitions
      6) Joint deflection

C. Certificates

1. Furnish an affidavit certifying the Ductile Iron Pipe meets the provisions of this Section, all inspections have been made, and that all tests have been performed in accordance with AWWA/ANSI C151/A21.51.

2. Furnish an affidavit certifying the Ductile Iron Fittings meet the provisions of this Section and meet the requirements of AWWA/ANSI C110/A21.10 or AWWA/ANSI C153/A21.53.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. Qualifications
   1. Manufacturers
      a. Finished pipe shall be the product of 1 manufacturer.
         1) Change orders, specials, and field changes may be provided by a different manufacturer upon City approval.
      b. Pipe manufacturing operations (pipe, lining, and coatings) shall be performed under the control of the manufacturer.
      c. Fittings manufacturing operations (fittings, lining, and coatings) shall be performed under the control of the manufacturer.
      d. Ductile Iron Pipe
         1) Manufactured in accordance with AWWA/ANSI C151/A21.51
            a) Perform quality control tests and maintain results as outlined within standard to assure compliance.
            b) Hydrostatically test each pipe segment to 500 psi for a minimum duration of 10 seconds.
      e. Ductile Iron Fittings
         1) Manufactured in accordance with AWWA/ANSI C110/A21.10 or AWWA/ANSI C153/A21.53.
            a) Perform quality control tests and maintain results as outlined within standards to assure compliance.

B. Preconstruction Testing
   1. The City may, at its own cost, subject random lengths of pipe and random fittings for testing by an independent laboratory for compliance with this Section.
      a. The compliance test will be performed in the United States.
      b. Any visible defects or failure to meet the quality standards herein will be grounds for rejecting the entire order.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements
   1. Secure and maintain a location to store the material in accordance with Section 01 66 00.
   2. Store and handle in accordance with the guidelines as stated in AWWA M41.

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY

A. Manufacturer Warranty
   1. Manufacturer’s Warranty shall be in accordance with Division 0 and Division 1.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [OR] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 EQUIPMENT, PRODUCT TYPES AND MATERIALS

A. Ductile Iron Pipe

1. In accordance with AWWA/ANSI C111/A21.11, AWWA/ANSI C150/A21.15 and AWWA/ANSI C151/A21.51.
2. All pipe shall meet the requirements of NSF 61 and 372.
3. Pipe shall have a lay length of 18 feet or 20 feet except for special fittings or closure pieces and as necessary to comply with the Drawings.
4. As a minimum the following pipe classes apply. The Drawings or the pressure and deflection design criteria may require a higher wall thickness, but in no case should the pipe classes be less than the following:

Diameter (inches)	Min Pressure Class (psi)
3 through 30	350

1. Pipe markings shall meet the minimum requirements of AWWA/ANSI C151/A21.51. Minimum pipe markings shall be as follows:
   a. "DI" or "Ductile" shall be clearly labeled on each pipe
   b. Weight, pressure, or special thickness class, and nominal thickness of each pipe
   c. Year and country pipe was cast
   d. Manufacturer's mark
2. Pressure and Deflection Design
   a. Pipe design shall be based on trench conditions and design pressure class specified in the Drawings.
   b. Pipe shall be designed according to the methods indicated in AWWA/ANSI C150/A21.50, AWWA/ANSI C151/A21.51, and AWWA M41 for trench construction, using the following parameters:
      1) Unit Weight of Fill (w) = 130 pcf
      2) Live Load = AASHTO HS 20
      3) Trench Depth = 12 feet minimum, or as indicated in Drawings
      4) Bedding Conditions = Type 4
      5) Working Pressure (P_w) = 150 psi
      6) Surge Allowance (P_s) = 100 psi
      7) Design Internal Pressure (P_i) = P_w + P_s or 2:1 safety factor of the actual working pressure plus the actual surge pressure, whichever is greater.
         a) Test Pressure
            (1) No less than 1.25 minimum times the stated working pressure (187 psi minimum) of the pipeline measured at the highest elevation along the test section.
            (2) No less than 1.5 times the stated working pressure (225 psi minimum) at the lowest elevation of the test section.
      8) Maximum Calculated Deflection (D_x) = 3 percent
      9) Restrained Joint Safety Factor (S_f) = 15 percent

c. Trench depths shall be verified after existing utilities are located.
   1) Vertical alignment changes required because of existing utility or other conflicts shall be accommodated by an appropriate change in pipe design depth.
   2) In no case shall pipe be installed deeper than its design allows.

3. Provisions for Thrust
   a. Pipes greater than 12-inch
      1) All pipe joints and fittings shall be restrained.
      2) Concrete blocking is not required.
   b. Pipes 12-inch and smaller
      1) Provide concrete blocking as indicated in the construction documents.
      2) Mechanically restrain all bends, tees, plugs, or other fittings with retainer glands in accordance with this Section.
      3) Restrain all joints within casing pipe.
      4) No thrust restraint contribution allowed for the restrained length of pipe within the casing.
      5) Utilize restrained joints for a sufficient distance from each side of the bend, tee, plug, valve, or other fitting to resist thrust developed at the design pressure of the pipe. For the purpose of thrust, the following shall apply:
         a) Calculate valves as dead ends.
         b) Restrained Joint Safety Factor (S_f) = 1.5
         c) Design Internal Pressure (P_i) = P_w + P_s
            (1) P_w = 150 psi and P_s = 100 psi, or
            (2) 2:1 safety factor of the actual working pressure plus the actual surge pressure, whichever is greater.
         d) Restrained joints consist of approved mechanical restrained or push-on restrained joints as listed in this Section.
         e) The distance for thrust restraint shown on the Drawings is the minimum restraint and does not relieve the manufacturer from calculating the restraint needs as specified herein.
            (1) In no case shall the restrained distance be less than indicated on the Drawings.
      6) Thrust restraint design
         a) The length of pipe with restrained joints to resist thrust forces shall be the complete responsibility of the pipe manufacturer in accordance with AWWA M41 and the following:
            (1) Calculate the weight of earth (W_e) as the weight of the projected soil prism above the pipe.
               (a) Soil Density
               (b) Unsaturated soil conditions = 110 pounds per cubic foot (maximum value to be used)
               (c) Locations with groundwater = buoyant weight for the backfill below the water table

4. Joints
   a. In accordance with AWWA/ANSI C111/A21.11.
   b. Push-On Joints
   c. Mechanical Joints
   d. Push-On Restrained Joints
      1) Restraining Push-on joints by means of a special gasket is not permitted

2) Push-on Restrained Joint bell and spigot
   a) Only those products listed in this Section.
   b) Pressure rating shall exceed the working and test pressure of the pipe line.

e. Flanged Joints
   1) In accordance with AWWA/ANSI C115/A21.15 and ASME B16.1, Class 125.

f. Flange bolt circles and bolt holes in accordance with ASME B16.1, Class 125.

g. Field fabricated flanges are prohibited.

5. Gaskets
   a. Provide Gaskets in accordance with Section 33 14 05.

6. Isolation Flanges
   a. Flanges required by the drawings to be Isolation Flanges shall conform to Section 33 01 12.

7. Bolts and Nuts
   a. Mechanical Joints
      1) Provide bolts and nuts in accordance with Section 33 14 05.
   b. Flanged Ends
      1) Meet requirements of AWWA C115.
         a) Provide bolts and nuts in accordance with Section 33 14 05.

8. Ductile Iron Pipe Exterior Coatings
   a. All buried ductile iron shall have an asphaltic coating, minimum of 1 mil thick, on the pipe exterior, unless otherwise specified in the Contract Documents.
   b. All above ground ductile iron shall be painted in accordance with Section 09 91 00.

9. Polyethylene Encasement
   a. Polyethylene encase all buried Ductile Iron Pipe and Fittings as follows:
      1) 12-inch and smaller
         a) Inner Layer - 8 mil V-Bio polyethylene in accordance with AWWA/ANSI C105/A21.5
         b) Outer Layer - 4 mil high density cross-laminated (HDCL) polyethylene encasement in accordance with AWWA/ANSI C105/A21.5 and ASTM A674.
      2) 16-inch and larger
         a) 8 mil V-Bio polyethylene conforming to AWWA/ANSI C105/A21.5
   b. Use only virgin polyethylene material.
   c. Marking: At a minimum of every 2 feet along its length, the mark the polyethylene film with the following information:
      1) Manufacturer's name or trademark
      2) Year of manufacturer
      3) AWWA/ANSI C105/A21.5
      4) Minimum film thickness and material type
      5) Applicable range of nominal diameter sizes
      6) Warning – Corrosion Protection – Repair Any Damage
   d. Minimum widths

Polyethylene Tube and Sheet Sizes for Push-On Joint Pipe

Nominal Pipe Diameter (inches)	Min. Width – Flat Tube (inches)	Min. Width – Sheet (inches)

3	14	28
4	14	28
6	16	32
8	20	40
10	24	48
12	27	54
14	30	60
16	34	68
18	37	74
20	41	82
24	54	108
30	67	134
36	81	162
42	81	162
48	95	190
54	108	216
60	108	216
64	121	242

10. Ductile Iron Pipe Interior Lining
    a. Cement Mortar Lining
        1) Line all Ductile Iron Pipe for potable water with a cement mortar lining.
            a) In accordance with AWWA/ANSI C104/A21.04, NSF 61, and 372.
    b. Ceramic Epoxy or Epoxy Linings
        1) Line all Ductile Iron Pipe for use in wastewater applications with a ceramic epoxy or epoxy lining.
        2) Apply lining at minimum of 40 mils DFT.
        3) Due to the tolerances involved, the gasket area, and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum, using a joint compound as supplied by the manufacturer.
            a) Apply the joint compound by brush to ensure coverage.
            b) Care should be taken that the joint compound is smooth without excess buildup in the gasket seat or on the spigot ends.
            c) Coat the gasket seat and spigot ends after the application of the lining.
        4) Surface preparation shall be in accordance with the manufacturer's recommendations.
        5) Check thickness using a magnetic film thickness gauge in accordance with the method outlined in SSPC PA 2.
        6) Test the interior lining of all pipe barrels for pinholes with a non-destructive 2,500-volt test.
            a) Repair any defects prior to shipment.
        7) Mark each fitting with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

8) For all Ductile Iron Pipe in wastewater service where the pipe has been cut, coat the exposed surface with the touch-up material as recommended by the manufacturer
   a) The touch-up material and the lining shall be of the same manufacturer.

2.3 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. General
   1. Install pipe, fittings, specials, and appurtenances in accordance with this Section, AWWA C600, AWWA M41, and the pipe manufacturer's recommendations.
   2. Lay pipe and fittings to the lines and grades indicated in the Drawings.
   3. Excavate and backfill trenches in accordance with Section 33 05 05.
   4. At the close of each operating day:
      a. Keep the pipe clean and free of debris, dirt, animals, and trash – during and after the laying operation.
      b. Effectively seal the open end of the pipe using a gasketed night cap.
   5. Embed Ductile Iron Pipe and Fittings in accordance with Section 33 05 05.

B. Pipe Handling
   1. Haul and distribute pipe and fittings at the project site.
   2. Handle piping with care to avoid damage.
      a. Inspect each joint of pipe and reject or repair any damaged pipe prior to lowering into the trench.
      b. Do not handle the pipe in such a way that will damage the interior lining.
      c. Use only nylon ropes, slings, or other lifting devices that will not damage the surface of the pipe for handling the pipe.

C. Joint Making
   1. Mechanical Joints
      a. Bolt the follower ring into compression against the gasket with the bolts tightened down evenly then cross torqued in accordance with AWWA C600.
      b. Overstressing of bolts to compensate for poor installation practice will not be permitted.
   2. Push-on Joints
      a. Install Push-on joints in accordance with AWWA/ANSI C111/A21.11.
      b. Wipe gasket seat inside the bell clean of all extraneous matter.
      c. Place the gasket in the bell in the position specified by the manufacturer.
      d. Apply a thin film of non-toxic vegetable soap lubricant to the inside of the gasket and the outside of the spigot prior to entering the spigot into the bell.

1) Do not apply lubricant to the bell socket or the surface of the gasket in contact with the bell socket.

e. When using a field cut plain end piece of pipe, refinish the field cut and scarf in accordance with AWWA C600.

3. Flanged Joints
   a. Use erection bolts and drift pins to make flanged connections.
      1) Do not use undue force or restraint on the ends of the fittings.
      2) Apply even and uniform pressure to the gasket.
   b. The fitting must be free to move in any direction while bolting.
      1) Install flange bolts with all bolt heads faced in one direction.
4. PVC Joint Harness
   a. Install joint harness in accordance with manufacturer requirements.
   b. Provide full 360-degree contact with restrainer and pipe.
   c. Do not distort the pipe when installing the restrainer.
5. Joint Deflection
   a. Deflect the pipe only when necessary to avoid obstructions or to meet the lines and grades and shown in the Drawings.
   b. In accordance with AWWA C600 Table 3.
   c. The maximum deflection allowed is 50 percent of that indicated in AWWA C600.

D. Polyethylene Encasement Installation

1. Preparation
   a. Remove all lumps of clay, mud, cinders, etc., on pipe surface prior to installation of polyethylene encasement.
      1) Prevent soil or embedment material from becoming trapped between pipe and polyethylene.
   b. Fit polyethylene film to contour of pipe to ensure a snug, but not tight, encasement with minimum space between polyethylene and pipe.
      1) Provide sufficient slack in contouring to prevent stretching polyethylene where it bridges irregular surfaces, such as bell-spigot interfaces and bolted joints or fittings, and to prevent damage to polyethylene due to backfilling operations.
      2) Secure overlaps and ends with adhesive tape and hold.
   c. For installations below water table and/or in areas subject to tidal actions, seal both ends of polyethylene tube with adhesive tape at joint overlap.
2. Tubular Type (Method A)
   a. Cut polyethylene tube to length approximately 2 feet longer than pipe section.
   b. Slip tube around pipe, centering it to provide 1-foot overlap on each adjacent pipe section, and bunching it accordion-fashion lengthwise until it clears pipe ends.
   c. Lower pipe into trench and make up pipe joint with preceding section of pipe.
   d. Make shallow bell hole at joints to facilitate installation of polyethylene tube.
   e. After assembling pipe joint, overlap polyethylene tube, pull bunched polyethylene from preceding length of pipe, slip it over end of the new length of pipe and wrap until it overlaps joint at end of preceding length of pipe.
   f. Secure overlap in place.
   g. Take up slack width at top of pipe to make a snug, but not tight, fit along barrel of pipe, securing fold at quarter points.

h. Repair cuts, tears, punctures, or other damage to polyethylene.
i. Proceed with installation of next pipe in same manner.

3. Tubular Type (Method B)
   a. Cut polyethylene tube to length approximately 1 foot shorter than pipe section.
   b. Slip tube around pipe, centering it to provide 6 inches of bare pipe at each end.
   c. Take up slack width at top of pipe to make a snug, but not tight, fit along barrel of pipe, securing fold at quarter points; secure ends.
   d. Before making up joint, slip 3-foot length of polyethylene tube over end of proceeding pipe section, bunching it accordion-fashion lengthwise.
   e. After completing joint, pull 3-foot length of polyethylene over joint, overlapping polyethylene previously installed on each adjacent section of pipe by at least 1 foot; make each end snug and secure.

4. Sheet Type
   a. Cut polyethylene sheet to a length approximately 2 feet longer than piece section.
   b. Center length to provide 1-foot overlap on each adjacent pipe section, bunching it until it clears the pipe ends.
   c. Wrap polyethylene around pipe so that it circumferentially overlaps top quadrant of pipe.
   d. Secure cut edge of polyethylene sheet at intervals of approximately 3 feet.
   e. Lower wrapped pipe into trench and make up pipe joint with preceding section of pipe.
   f. Make shallow bell hole at joints to facilitate installation of polyethylene.
   g. After completing joint, overlap and secure ends.
   h. Repair cuts, tears, punctures, or other damage to polyethylene.
   i. Proceed with installation of next section of pipe in same manner.

5. Pipe-Shaped Appurtenances
   a. Cover bends, reducers, offsets, and other pipe-shaped appurtenances with polyethylene in same manner as pipe and fittings.

6. Odd-Shaped Appurtenances
   a. When it is not practical to wrap valves, tees, crosses, and other odd-shaped pieces in tube, wrap with flat sheet or split length polyethylene tube by passing sheet under appurtenances and bringing it up around body.
   b. Make seams by bringing edges together, folding over twice and taping down.
   c. Tape polyethylene securely in place at the valve stem and at any other penetrations.

7. Repairs
   a. Repair any cuts, tears, punctures, or damage to polyethylene with adhesive tape or with short length of polyethylene sheet or cut open tube, wrapped around fitting to cover damaged area and secured in place.

8. Openings in Encasement
   a. Provide openings for branches, service taps, blow-offs, air valves, and similar appurtenances by making an X-shaped cut in polyethylene and temporarily folding back film.
   b. After appurtenance is installed, tape slack securely to appurtenance and repair cut, as well as other damaged area in polyethylene with tape.
   c. Service taps may also be made directly through polyethylene, with any resulting damaged areas being repaired as described above.

9. Junctions between Wrapped and Unwrapped Pipe:
    a. Where polyethylene-wrapped pipe joins an adjacent pipe that is not wrapped, extend polyethylene wrap to cover adjacent pipe for distance of at least 3 feet.
    b. Secure end with circumferential turns of tape.
    c. Wrap service lines of dissimilar metals with polyethylene or suitable dielectric tape for minimum clear distance of 3 feet away from Cast or Ductile Iron Pipe.

E. Blocking

1. Install concrete blocking for all 16-inch and smaller fittings, at all bends, tees, crosses, and plugs as indicated in the Drawings.
2. Provide and install concrete in accordance with Sections 03 00 00 and 03 30 00.
3. Place the concrete blocking so as to rest against firm undisturbed trench walls, normal to the thrust.
4. In no instance should the supporting area for each block be smaller than those specified in Drawings. Each block shall be sufficient to withstand the thrust, including water hammer, which may develop.
5. Each block shall rest on a firm, undisturbed foundation or trench bottom. If the Contractor encounters soil that appears to be different than that which was used to calculate the blocking according to the Drawings, the Contractor shall notify the Engineer prior to the installation of the blocking.

F. Detectable Markers

1. Install detectable markers in accordance with Section 33 05 05.

3.5 REPAIR/RESTORATION

A. Patching

1. Excessive field-patching is not permitted of lining or coating.
2. Patching of lining or coating will be allowed where area to be repaired does not exceed 100 square inches and has no dimensions greater than 12 inches.
3. In general, there shall not be more than 1 patch on either the lining or the coating of any 1 joint of pipe or any 1 fitting.
4. Wherever necessary to patch the pipe or fittings:
    a. Make patch with cement mortar as previously specified for interior joints.
    b. Do not install patched pipe until the patch has been properly and adequately cured and approved for laying by the City.
5. Promptly remove rejected pipe or fittings from the site.

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [OR] SITE QUALITY CONTROL

A. Potable Water Mains

1. Hydrostatic testing of water mains:
    a. Hydrostatically test the mains in accordance with Section 33 01 10.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING

A. Potable Water Mains

1. Cleaning, disinfection, and bacteriological testing of water mains:
    a. Clean, flush, pig, disinfect, and bacteriological test the mains in accordance with Section 33 01 10.

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 33 14 05
BOLTS, NUTS, AND GASKETS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. All nuts, bolts and gaskets associated with pressurized water utility lines including:
      a. T-Bolts and Nuts
      b. Flange Bolts and Nuts
      c. Threaded Rods
      d. Push-on Gaskets
      e. Mechanical Joint Gaskets
      f. Flange Gaskets
      g. Flange Isolation Kits

B. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 33 01 12 – Joint Bonding and Electrical Isolation
   4. Section 33 05 19 – Ductile Iron Pipe
   5. Section 33 14 10 – Ductile Iron Fittings

1.2 PRICE AND PAYMENT PROCEDURES

A. The work performed and the materials furnished in accordance with this Item are subsidiary to the structure or Items being placed and no other compensation will be allowed.

1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this Section refer to the current reference standard published at the time of the latest revision date logged at the end of this Section unless a date is specifically cited.
   2. American Iron and Steel Institute (AISI).
   3. American Society of Mechanical Engineers (ASME):
      a. PCC-1-2012 Guidelines for Pressure Boundary Bolted Flange Joint Assembly.
   4. American Society of Testing and Materials (ASTM):
      a. A193, Standard Specification for Alloy-Steel and Stainless-Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
      b. A194, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
      c. A242, Standard Specification for High-Strength Low-Alloy Carbon Structural Steel.
      d. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.

5. American Water Works Association (AWWA):
   a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   b. C115, Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges.
   c. C207, Steel Pipe Flanges for Waterworks Service – Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
   d. C217, Microcrystalline Wax and Petrolatum Tape Coating Systems for Steel Water Pipe and Fittings.
   e. C600, Installation of Ductile-Iron Mains and Their Appurtenances.
   f. M11, Steel Pipe.
   g. M41, Ductile-Iron Pipe and Fittings.
6. Fastener Quality Act (FQA):
   a. Public Law 106-34 (P.L. 106-34).
7. NSF International (NSF):
   a. 61, Drinking Water System Components - Health Effects.
   b. 372, Drinking Water System Components - Lead Content.
8. Society for Protective Coating (SSPC) Surface Preparation Standards (SP):
   a. SP1, Solvent Cleaning.
   b. SP2, Hand Tool Cleaning.
   c. SP3, Power Tool Cleaning.
   d. SP5, White Metal Blast Cleaning.
   e. SP10, Near White Blast Cleaning.

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the City prior to delivery and/or fabrication for specials.

1.6 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. Product Data
   1. Bolts and nuts for mechanical and or flange joints
   2. Gaskets

B. Certificates
   1. Furnish an affidavit certifying that all fasteners, excluding T-Bolts, shall conform to the Fastener Quality Act (FQA) (P.L. 106-34).

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. Qualifications
   1. Manufacturers
      a. Fastener manufacturing operations (bolts, nuts, gaskets, and coatings) shall be performed under the control of the manufacturer.

b. All gaskets shall be in accordance with the latest revisions NSF 61, NSF 372, and the requirements of this Section.

B. Preconstruction Testing

1. The City may, at its own cost, subject random fittings for destructive testing by an independent laboratory for compliance with this Specification.
   a. The compliance test shall be performed in the United States.
   b. Any visible defects or failure to meet the quality standards herein will be grounds for rejecting the entire order.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. Secure and maintain a location to store the material in accordance with Section 01 66 00.

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY

A. Manufacturer Warranty

1. Manufacturer's Warranty shall be in accordance with Division 0 and Division 1.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [OR] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 EQUIPMENT, PRODUCT TYPES AND MATERIALS

A. Regulatory Requirements

1. All fasteners, excluding T-Bolts, shall be in accordance with the Fastener Quality Act (FQA) (P.L. 106-34), including the marking requirements.

B. T-Bolts and Nuts

1. Standard T-bolt and Nut
   a. High strength, corrosion-resistant, low-carbon weathering steel in accordance with AWWA/ANSI C111/A21.11 and ASTM A242
2. Stainless Steel T-bolt with Stainless Steel Nut
   a. Stainless Steel T-bolt and Nut in accordance with AISI 304.

C. Flange Bolts and Nuts

1. Steel Bolts and Nuts
   a. Meet the requirements of AWWA C207
   b. Bolts: ASTM A193, Grade B7 (AISI 4140, 4142, or 4105)
   c. Nuts and Washers: ASTM A194, Grade 2H Heavy Hex nuts and washers

D. Threaded Rods

1. Meet requirements of AWWA C207
2. Rods: ASTM A193, Grade B7
3. Nuts and Washers: ASTM A194, Grade 87 Nuts and Washers

E. Push-on Gaskets

1. In accordance with physical and marking requirements specified in ANSI/AWWA C111/A21.11.
2. In accordance with NSF 61 and 372.
3. Free from porous areas, foreign material, and other defects that make them unfit for intended use.
4. Size and shape required to provide an adequate compressive force against the plain end and socket after assembly to affect a positive seal under all combinations of joint and gasket tolerances.
5. Rubber gaskets shall be made of vulcanized styrene butadiene rubber SBR, unless otherwise specified in Drawings.

F. Mechanical Joint Gaskets
1. In accordance with the physical and marking requirements specified in ANSI/AWWA C111/A21.11.
2. In accordance with the latest revisions NSF 61 and 372.
3. Free from porous areas, foreign material, and other defects that make them unfit for intended use.
4. Rubber gaskets shall be made of vulcanized styrene butadiene rubber SBR, unless otherwise specified in Drawings.

G. Flange Gaskets
1. Class E Flanges
a. Full face
b. Manufactured true to shape from minimum 80 durometer SBR rubber stock of a thickness not less than 1/8 inch
c. Virgin stock
d. In accordance with the physical and test requirements specified in AWWA/ANSI C111/A21.11.
e. All gaskets shall be in accordance with the latest revisions NSF 61 and 372.
f. Finished gaskets shall have holes punched by the manufacturer and shall match the flange pattern in every respect.
g. Frayed cut edges are not acceptable.
h. Field cut sheet gaskets are not acceptable.

H. Hydrocarbon Resistant Gaskets
1. Furnish Viton® (Fluorocarbon) Rubber, or approved equal, hydrocarbon resistant gaskets, when required.

I. Flange Isolation Kits
1. In accordance with Section 33 01 12.
2. For bolts used with isolation sleeves in accordance with Section 33 01 12, threading must extend to bolt head with no grip to ensure sleeves fit properly.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. Mechanical Joints
   1. Assemble mechanical joints in accordance with ANSI/AWWA C111/A21.11 Appendix A, AWWA C600, and AWWA Manual M41.
   2. Use Standard Nuts and Bolts.
      a. Stainless Steel Bolts with Stainless Steel Nuts shall only be used when specifically required in the Drawings.
      b. Above ground nuts and bolts shall be painted in accordance with Section 09 91 00.

B. Flanged Joints
   1. Install in accordance with ASME PCC-1-2012.
   2. During assembly, tighten nuts gradually and equally using a three-pass method in accordance with ASME PCC-1-2012.
      a. First pass
         1) Tighten the nuts to 50 percent at diametrically opposite sides to prevent misalignment and to ensure that all bolts carry equal loads.
      b. Second pass
         1) Tighten the nuts to 100 percent again in a diametrically opposite pattern.
         2) Allow a minimum of 1 hour to pass to provide time for settlement between bolts and nuts and gasket relaxation.
      c. Third pass
         1) Check each bolt in a clockwise pattern. Each nut should be tightened until it will no longer turn. This step compensates for elastic interaction and brings all bolts into parity.
   3. The threads of the bolts should protrude a minimum of 1/2-inch from the nuts.

C. Flanged Joints with Isolation Kit
   1. Flange Isolation Kits installed in accordance with Section 33 01 12.
   2. Prior to backfilling connection, verify Electrical Isolation in accordance with Section 33 01 12.

D. Threaded Rod
   1. Install as part of joint harness assembly in accordance with AWWA Manual M11.
   2. Space rods evenly around the pipe.
   3. During assembly, tighten nuts gradually and equally using a three-pass method in accordance with ASME PCC-1-2012.
      a. For the first pass, tighten the nuts to 50 percent at diametrically opposite sides to prevent misalignment and to ensure that all bolts carry equal loads.
      b. For the second pass, tighten the nuts to 100 percent again in a diametrically opposite pattern.
   4. The threads of the bolts should protrude a minimum of ½-inch from the nuts.
   5. Paint above ground joint harness assembly in accordance with Section 09 91 00.

3.5 REPAIR [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

A. Field Inspections

1. All buried flanges and joint harnesses require City inspection prior to installation of embedment and backfill.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 33 14 10
DUCTILE IRON FITTINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ductile Iron Fittings 3-inch through 64-inch for potable water, wastewater, and other liquids for use with Ductile Iron Pipe and Polyvinyl Chloride (PVC) Pipe
   2. All mechanical joint fittings shall be mechanically restrained using restrained wedge type retainer glands.

B. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 33 01 10 – Cleaning and Acceptance Testing of Water Mains
   4. Section 33 01 12 – Joint Bonding and Electrical Isolation
   5. Section 33 05 05 – Utility Trench Excavation, Embedment and Backfill
   6. Section 33 05 19 – Ductile Iron Pipe
   7. Section 33 14 05– Bolts, Nuts, and Gaskets

1.2 PRICE AND PAYMENT PROCEDURES

A. The work performed and the materials furnished in accordance with this Item are subsidiary to the structure or Items being placed and no other compensation will be allowed.

1.3 REFERENCES

A. Definitions
   1. Gland or Follower Gland
      a. Non-restrained, mechanical joint fitting
   2. Retainer Gland
      a. Mechanically restrained mechanical joint fitting, consisting of multiple gripping wedges incorporated into a follower gland meeting the applicable requirements of AWWA/ANSI C153/A21.53.

B. Reference Standards
   1. Reference standards cited in this Section refer to the current reference standard published at the time of the latest revision date logged at the end of this Section unless a date is specifically cited.
   2. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125 and 250).
   3. ASTM International (ASTM):
      a. A536, Standard Specification for Ductile Iron Castings.
      b. A674, Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.

4. American Water Works Association (AWWA):
   a. M41, Ductile-Iron Pipe and Fittings.
5. American Water Works Association/American National Standards Institute (AWWA/ANSI):
   a. C104/A21.4, Cement–Mortar Lining for Ductile-Iron Pipe and Fittings.
   b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
   c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   e. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   f. C150/A21.50, Thickness Design of Ductile-Iron Pipe.
   g. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast, for Water.
   h. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
   i. C600, Installation of Ductile-Iron Water Mains and their Appurtenances.
6. International Organization for Standardization (ISO):
   a. 8179-1, Ductile Iron Pipes, Fittings, Accessories and their Joints – External Zinc-Based Coating – Part 1: Metallic Zinc with Finishing Layer.
7. NSF International (NSF):
   a. 61, Drinking Water System Components - Health Effects.
   b. 372, Drinking Water System Components – Lead Content.
8. Society for Protective Coatings (SSPC):
   a. PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the City prior to delivery and/or fabrication.

1.6 ACTION SUBMITTALS / INFORMATIONAL SUBMITTALS

A. Product Data
   1. Ductile Iron Fittings
      a. Pressure class
      b. Interior lining
      c. Joint types
   2. Polyethylene encasement and tape
      a. Planned method of installation
      b. Polyethylene type
      c. Polyethylene thickness
   3. Interior Lining
      a. If other than cement mortar lining in accordance with AWWA/ANSI C104/A21.4, provide:
         1) Material.
         2) Application Recommendations.
         3) Field touch-up procedures.
   4. Thrust Restraint
      a. Retainer glands
      b. PVC joint harnesses

c. Other means

5. Gaskets
   a. Provide Gaskets in accordance with Section 33 14 05.
6. Isolation Flanges
   a. Flanges required by the drawings to be Isolation Flanges shall conform to Section 33 01 12.
7. Bolts and Nuts
   a. Mechanical Joints
      1) Provide bolts and nuts in accordance with Section 33 14 05.
   b. Flanged Joints
      1) In accordance with AWWA/ANSI C115/A21.15.
      2) Provide bolts and nuts in accordance with Section 33 14 05.
8. Flange Coatings
   a. Connections to Steel Flanges
      1) Buried connections with Steel Flanges shall be in accordance with Section 33 14 05.

B. Certificates

1. Furnish an affidavit certifying the Ductile Iron Fittings meet the provisions of this Section and meet the requirements of AWWA/ANSI C110/A21.10 or AWWA/ANSI C153/A21.53.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. Qualifications

1. Manufacturers
   a. Fittings manufacturing operations (fittings, lining, and coatings) shall be performed under the control of the manufacturer.
   b. Ductile Iron Fittings shall be manufactured in accordance with AWWA/ANSI C153/A21.53.
      1) Perform quality control tests and maintain the results as outlined in these standards to assure compliance.

B. Preconstruction Testing

1. The City may, at its own cost, subject random fittings for destructive testing by an independent laboratory for compliance with this Specification.
   a. The compliance test shall be performed in the United States.
   b. Any visible defects or failure to meet the quality standards herein will be grounds for rejecting the entire order.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. Secure and maintain a location to store the material in accordance with Section 01 66 00.
2. Store and handle in accordance with the guidelines as stated in AWWA M41.

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY

A. Manufacturer Warranty
   1. Manufacturer's Warranty shall be in accordance with Division 0 and Division 1.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [OR] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 EQUIPMENT, PRODUCT TYPES AND MATERIALS

A. Ductile Iron Fittings
   1. In accordance with AWWA/ANSI C110/A21.10 and AWWA/ANSI C153/A21.53.
   2. All fittings for potable water service shall be in accordance with NSF 61 and 372.
   3. Ductile Iron Fittings, at a minimum, shall meet or exceed the pressures rating of the pipe which the fitting is connected, unless specifically indicated in the Drawings.
   4. Fittings Markings
      a. Meet the minimum requirements of AWWA/ANSI C151/A21.51.
      b. Minimum markings shall include:
         1) "DI" or "Ductile" cast or metal stamped on each fitting
         2) Applicable AWWA/ANSI standard for that the fitting
         3) Pressure rating
         4) Number of degrees for all bends
         5) Nominal diameter of the openings
         6) Year and country fitting was cast
         7) Manufacturer's mark
   5. Fitting body types shall be as indicated below:

Nominal Diameter (inches)	Allowable Fitting Body Type
18" and Smaller	AWWA C153 (Compact Body) AWWA C110 (Full Body)
20" and Larger	AWWA C110 (Full Body)

   6. Joints
      a. Mechanical Joints with mechanical restraint
         1) In accordance with AWWA/ANSI C111/A21.11 and applicable parts of ANSI/AWWA C110/A21.10.
         2) Minimum retainer gland rated working pressure:
            a) Ductile Iron Pipe
               (1) 3-inch – 16-inch, 350 psi
               (2) 18-inch – 48-inch, 250 psi
            b) PVC C900
               (1) 3-inch – 16-inch, 305 psi
               (2) 18-inch – 30-inch, 250 psi
            c) Ratings are for water pressure and must include a minimum safety factor of 2 to 1 in all sizes.

3) Retainer glands shall have specific designs for Ductile Iron and PVC and be easily differentiated.
4) Gland body, wedges and wedge actuating components shall be cast from Grade 65-45-12 ductile iron material in accordance with ASTM A536.
5) Mechanical joint restraint shall require conventional tools and installation procedures as outlined in AWWA C600, while retaining full mechanical joint deflection during assembly as well as allowing joint deflection after assembly.
6) Proper actuation of the gripping wedges shall be ensured with torque limiting twist off nuts.
7) A minimum of 6 wedges shall be required for 8-inch diameter PVC pipe.

b. Flanged Joints
1) AWWA/ANSI C115/A21.15, ASME B16.1, Class 125
2) Flange bolt circles and bolt holes in accordance with ASME B16.1, Class 125.
3) Field fabricated flanges are prohibited.

c. PVC Joint Harness
1) Restrainer
a) Manufactured for use with C900 PVC pipe bells.
b) Grade 65-45-12 ductile iron material in accordance with ASTM A536.
2) Restraining rods and bolts in accordance with Section 33 14 05.
3) Clamping bolts and nuts in accordance with flange bolt and nut requirements as indicated in Section 33 14 05.

d. Restrained Flange Adapters
1) ASTM A536 and ANSI/AWWA C110/A21.10
2) Flange bolt circles and bolt holes in accordance with ASME B16.1, Class 125.
3) Field fabricated flanges are prohibited.
4) Minimum 2 to 1 Safety Factor

7. Gaskets
a. Provide Gaskets in accordance with Section 33 14 05.

8. Isolation Flanges
a. Flanges required by the drawings to be Isolation Flanges shall conform to Section 33 01 12.

9. Bolts and Nuts
a. Mechanical Joints
1) Provide bolts and nuts in accordance with Section 33 14 05.
2) Above ground nuts and bolts shall be painted in accordance with Section 09 91 00.

b. Flanged Ends
1) Meet requirements of AWWA C115.
2) Provide bolts and nuts in accordance with Section 33 14 05.
a) Above ground nuts and bolts shall be painted in accordance with Section 09 91 00.

10. Ductile Iron Fitting Exterior Coatings
a. All above ground Ductile Iron Fittings shall be painted in accordance with Section 09 91 00.

11. Polyethylene Encasement

a. Polyethylene encase all buried Ductile Iron Pipe and Fittings as follows:
   1) 12-inch and smaller
      a) Inner Layer - 8 mil V-Bio polyethylene in accordance with AWWA/ANSI C105/A21.5
      b) Outer Layer - 4 mil high density cross-laminated (HDCL) polyethylene encasement in accordance with AWWA/ANSI C105/A21.5 and ASTM A674.
   2) 16-inch and larger
      a) 8 mil V-Bio polyethylene conforming to AWWA/ANSI C105/A21.5
b. Use only virgin polyethylene material.
c. Marking: At a minimum of every 2 feet along its length, the mark the polyethylene film with the following information:
   1) Manufacturer's name or trademark
   2) Year of manufacturer
   3) AWWA/ANSI C105/A21.5
   4) Minimum film thickness and material type
   5) Applicable range of nominal diameter sizes
   6) Warning – Corrosion Protection – Repair Any Damage
d. Minimum widths

Polyethylene Tube and Sheet Sizes for Push-On Joint Fittings

Nominal Fittings Diameter (inches)	Min. Width – Flat Tube (inches)	Min. Width – Sheet (inches)
3	14	28
4	14	28
6	16	32
8	20	40
10	24	48
12	27	54
14	30	60
16	34	68
18	37	74
20	41	82
24	54	108
30	67	134
36	81	162
42	81	162
48	95	190
54	108	216
60	108	216
64	121	242

12. Ductile Iron Fittings Interior Lining
    a. Cement Mortar Lining
       1) Line all Ductile Iron Fittings for potable water with a cement mortar lining.
          a) In accordance with AWWA/ANSI C104/A21.04, NSF 61, and 372.

b. Ceramic Epoxy or Epoxy Linings
   1) Ductile Iron Fittings for use in wastewater applications shall be lined with a Ceramic Epoxy or Epoxy lining.
   2) Apply lining at minimum of 40 mils DFT.
   3) Due to the tolerances involved, the gasket area, and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum, using a joint compound as supplied by the manufacturer.
      a) Apply the joint compound by brush to ensure coverage.
      b) Care should be taken that the joint compound is smooth without excess buildup in the gasket seat or on the spigot ends.
      c) Coat the gasket seat and spigot ends after the application of the lining.
   4) Surface preparation shall be in accordance with the manufacturer's recommendations.
   5) Check thickness using a magnetic film thickness gauge in accordance with the method outlined in SSPC PA 2.
   6) Test the interior lining of all pipe barrels for pinholes with a non-destructive 2,500-volt test.
      a) Repair any defects prior to shipment.
   7) Mark each fitting with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.
   8) For all Ductile Iron Fittings in wastewater service where the pipe has been cut, coat the exposed surface with the touch-up material as recommended by the manufacturer
      a) The touch-up material and the lining shall be of the same manufacturer.

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. General
   1. Install fittings, specials and appurtenances as specified herein, as specified in AWWA C600, AWWA M41, and in accordance with the fittings manufacturer's recommendations.
   2. Lay fittings to the lines and grades as indicated in the Drawings.
   3. Excavate and backfill trenches in accordance with 33 05 05.
   4. Embed Ductile Iron Fittings in accordance with 33 05 05.

B. Joint Making
   1. Mechanical Joints with required mechanical restraint
      a. All mechanical joints require mechanical restraint.

b. Bolt the retainer gland into compression against the gasket, with the bolts tightened down evenly then cross torqued in accordance with AWWA C600.
c. Overstressing of bolts to compensate for poor installation practice will not be permitted.

2. Push-on Joints (restrained)
   a. All push-on joints shall be restrained push-on type.
   b. Install Push-on joints as defined in AWWA/ANSI C111/A21.11.
   c. Wipe clean the gasket seat inside the bell of all extraneous matter.
   d. Place the gasket in the bell in the position prescribed by the manufacturer.
   e. Apply a thin film of non-toxic vegetable soap lubricant to the inside of the gasket and the outside of the spigot prior to entering the spigot into the bell.
   f. When using a field cut plain end piece of pipe, refinished the field cut and scarf to conform to AWWA M-41.

3. Flanged Joints
   a. Use erection bolts and drift pins to make flanged connections.
      1) Do not use undue force or restraint on the ends of the fittings.
      2) Apply even and uniform pressure to the gasket.
   b. The fitting must be free to move in any direction while bolting.
      1) Install flange bolts with all bolt heads faced in 1 direction.

4. Joint Deflection
   a. Deflect the pipe only when necessary to avoid obstructions or to meet the lines and grades and shown in the Drawings.
   b. The deflection of each joint must be in accordance with AWWA C600 Table 3.
   c. The maximum deflection allowed is 50 percent of that indicated in AWWA C600.
   d. The manufacturer's recommendation may be used with the approval of the Engineer.

C. Polyethylene Encasement Installation

1. Preparation
   a. Remove all lumps of clay, mud, cinders, etc., on pipe surface prior to installation of polyethylene encasement.
      1) Prevent soil or embedment material from becoming trapped between pipe and polyethylene.
   b. Fit polyethylene film to contour of pipe to ensure a snug, but not tight, encasement with minimum space between polyethylene and pipe.
      1) Provide sufficient slack in contouring to prevent stretching polyethylene where it bridges irregular surfaces, such as bell-spigot interfaces and bolted joints or fittings, and to prevent damage to polyethylene due to backfilling operations.
      2) Secure overlaps and ends with adhesive tape and hold.
   c. For installations below water table and/or in areas subject to tidal actions, seal both ends of polyethylene tube with adhesive tape at joint overlap.

2. Tubular Type (Method A)
   a. Cut polyethylene tube to length approximately 2 feet longer than pipe section.
   b. Slip tube around pipe, centering it to provide 1-foot overlap on each adjacent pipe section, and bunching it accordion-fashion lengthwise until it clears pipe ends.
   c. Lower pipe into trench and make up pipe joint with preceding section of pipe.

d. Make shallow bell hole at joints to facilitate installation of polyethylene tube.
e. After assembling pipe joint, overlap polyethylene tube, pull bunched polyethylene from preceding length of pipe, slip it over end of the new length of pipe and wrap until it overlaps joint at end of preceding length of pipe.
f. Secure overlap in place.
g. Take up slack width at top of pipe to make a snug, but not tight, fit along barrel of pipe, securing fold at quarter points.
h. Repair cuts, tears, punctures, or other damage to polyethylene.
i. Proceed with installation of next pipe in same manner.

3. Tubular Type (Method B)
   a. Cut polyethylene tube to length approximately 1 foot shorter than pipe section.
   b. Slip tube around pipe, centering it to provide 6 inches of bare pipe at each end.
   c. Take up slack width at top of pipe to make a snug, but not tight, fit along barrel of pipe, securing fold at quarter points; secure ends.
   d. Before making up joint, slip 3-foot length of polyethylene tube over end of proceeding pipe section, bunching it accordion-fashion lengthwise.
   e. After completing joint, pull 3-foot length of polyethylene over joint, overlapping polyethylene previously installed on each adjacent section of pipe by at least 1 foot; make each end snug and secure.
4. Sheet Type
   a. Cut polyethylene sheet to a length approximately 2 feet longer than piece section.
   b. Center length to provide 1-foot overlap on each adjacent pipe section, bunching it until it clears the pipe ends.
   c. Wrap polyethylene around pipe so that it circumferentially overlaps top quadrant of pipe.
   d. Secure cut edge of polyethylene sheet at intervals of approximately 3 feet.
   e. Lower wrapped pipe into trench and make up pipe joint with preceding section of pipe.
   f. Make shallow bell hole at joints to facilitate installation of polyethylene.
   g. After completing joint, overlap and secure ends.
   h. Repair cuts, tears, punctures, or other damage to polyethylene.
   i. Proceed with installation of next section of pipe in same manner.
5. Pipe-Shaped Appurtenances
   a. Cover bends, reducers, offsets, and other pipe-shaped appurtenances with polyethylene in same manner as pipe and fittings.
6. Odd-Shaped Appurtenances
   a. When it is not practical to wrap valves, tees, crosses, and other odd-shaped pieces in tube, wrap with flat sheet or split length polyethylene tube by passing sheet under appurtenances and bringing it up around body.
   b. Make seams by bringing edges together, folding over twice and taping down.
   c. Tape polyethylene securely in place at the valve stem and at any other penetrations.
7. Repairs
   a. Repair any cuts, tears, punctures, or damage to polyethylene with adhesive tape or with short length of polyethylene sheet or cut open tube, wrapped around fitting to cover damaged area and secured in place.
8. Openings in Encasement

a. Provide openings for branches, service taps, blow-offs, air valves, and similar appurtenances by making an X-shaped cut in polyethylene and temporarily folding back film.
b. After appurtenance is installed, tape slack securely to appurtenance and repair cut, as well as other damaged area in polyethylene with tape.
c. Service taps may also be made directly through polyethylene, with any resulting damaged areas being repaired as described above.

9. Junctions between Wrapped and Unwrapped Pipe:
a. Where polyethylene-wrapped pipe joins an adjacent pipe that is not wrapped, extend polyethylene wrap to cover adjacent pipe for distance of at least 3 feet.
b. Secure end with circumferential turns of tape.
c. Wrap service lines of dissimilar metals with polyethylene or suitable dielectric tape for minimum clear distance of 3 feet away from Cast or Ductile Iron Pipe

D. Blocking

1. Install concrete blocking for all 16-inch and smaller fittings, at all bends, tees, crosses, and plugs as indicated in the Drawings.
2. Provide and install concrete in accordance with Sections 03 00 00 and 03 30 00.
3. Place the concrete blocking so as to rest against firm undisturbed trench walls, normal to the thrust.
4. In no instance should the supporting area for each block be smaller than those specified in Drawings. Each block shall be sufficient to withstand the thrust, including water hammer, which may develop.
5. Each block shall rest on a firm, undisturbed foundation or trench bottom. If the Contractor encounters soil that appears to be different than that which was used to calculate the blocking according to the Drawings, the Contractor shall notify the Engineer prior to the installation of the blocking.

3.5 REPAIR/RESTORATION

A. Patching

1. Excessive field-patching is not permitted of lining or coating.
2. Patching of lining or coating will be allowed where area to be repaired does not exceed 100 square inches and has no dimensions greater than 12 inches.
3. In general, there shall not be more than 1 patch on either the lining or the coating of any 1 joint of pipe or any 1 fitting.
4. Wherever necessary to patch the pipe or fittings:
a. Make patch with cement mortar as previously specified for interior joints.
b. Do not install patched pipe until the patch has been properly and adequately cured and approved for laying by the City.
5. Promptly remove rejected pipe or fittings from the site.

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [OR] SITE QUALITY CONTROL

A. Potable Water Mains

1. Hydrostatic testing of water mains:
a. Hydrostatically test the mains in accordance with Section 33 01 10.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING

A. Potable Water Mains

1. Cleaning, disinfection, and bacteriological testing of water mains:
   a. Clean, flush, pig, disinfect, and bacteriological test the mains in accordance with Section 33 01 10.

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 33 14 20
RESILIENT SEATED (WEDGE) GATE VALVE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Resilient Seated (Wedge) Gate Valves 4-inch through 48-inch for use with potable water mains
      a. 24-inch and larger valves may require an integral bypass

B. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 33 14 05 – Bolts, Nuts, and Gaskets
   4. Section 33 05 19 – Ductile Iron Pipe

1.2 PRICE AND PAYMENT PROCEDURES

A. The work performed and the materials furnished in accordance with this Item are subsidiary to the structure or Items being placed and no other compensation will be allowed.

1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this Section refer to the current reference standard published at the time of the latest revision date logged at the end of this Section unless a date is specifically cited.
   2. American Association of State Highway and Transportation Officials (AASHTO).
   3. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
   4. American Iron and Steel Institute (AISI).
   5. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
      c. A536, Standard Specification for Ductile Iron Castings.
      d. B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   6. American Water Works Association/American National Standards Institute (AWWA/ANSI):
      a. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
      b. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

c. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
d. C509, Resilient-Seated Gate Valves for Water Supply Service.
e. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
f. C550, Protective Interior Coatings for Valves and Hydrants.
g. C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 IN through 60 IN, for Water Transmission and Distribution.

7. NSF International (NSF):
   a. 61, Drinking Water System Components - Health Effects.
   b. 372, Drinking Water System Components – Lead Content.

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the City prior to delivery and/or fabrication.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data

1. Resilient Seated (Wedge) Gate Valve
   a. Pressure rating
   b. Coating system
   c. Dimensions, weights, material list, and detailed drawings
   d. Joint type
   e. Maximum torque recommended by the manufacturer for the valve size
2. Polyethylene encasement and tape
3. Thrust Restraint
   a. Retainer glands
   b. Thrust harnesses
   c. Any other means
4. Instructions for field repair of fusion bonded epoxy coating
5. Gaskets

B. Certificates

1. Furnish an affidavit certifying all Resilient Seated (Wedge) Gate Valves meet the provisions of this Section, all inspections have been made and that all tests have been performed in accordance with AWWA C509 or AWWA C515.
2. Furnish an affidavit certifying Resilient Seated (Wedge) Gate Valve manufacturer has 5 years experience manufacturing Resilient Seated Gate Valves of similar service and size with experience record.
3. Furnish an affidavit certifying Resilient Seated (Wedge) Gate Valve manufacturer owns or controls any foreign factory/foundry that supplies valve casings and can certify that the Resilient Seated (Wedge) Gate Valve manufacturer is in control of quality control at the foreign factory/foundry.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Manufacturer Warranty
   1. Manufacturer's Warranty shall be in accordance with Division 0 and Division 1.

1.9 QUALITY ASSURANCE

A. Qualifications
   1. Manufacturers
      a. Valves 16-inch and larger shall be the product of 1 manufacturer for each project.
         1) Change orders, specials, and field changes may be provided by a different manufacturer upon City approval.
      b. For valves less than 16-inch, each valve size shall be the product of 1 manufacturer, unless approved by the City.
         1) Change orders, specials, and field changes may be provided by a different manufacturer upon City approval.
      c. Valves shall be in accordance with AWWA C509 or AWWA C515.
      d. For valves equipped with a bypass, the bypass valve must be of the same manufacturer as the main valve.
      e. Resilient Seated Gate Valves shall be new.
      f. Resilient Seated Gate Valve Manufacturer shall not have less than 5 years of successful experience manufacturing Resilient Seated Gate Valves of similar service and size and be able to demonstrate an experience record that is satisfactory to the City.
         1) Experience record will be thoroughly investigated by the City, and acceptance will be at the sole discretion of the City.
      g. Casings for Resilient Seated Gate Valve, such as valve body, wedge, and bypass, that are not manufactured within the United States of America, shall be manufactured by factories/foundries that are owned or controlled (partial ownership) such that the Resilient Seated Gate Valve Manufacturer can control and guarantee quality at the foreign factory/foundry.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements
   1. Protect all parts so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.
   2. Protect all equipment and parts against any damage during a prolonged period at the site.
   3. Protect the finished surfaces of all exposed flanges with wooden blank flanges.
   4. Protect finished iron or steel surfaces not painted to prevent rust and corrosion.
   5. Prevent plastic and similar brittle items from being directly exposed to sunlight or extremes in temperature.
   6. Secure and maintain a location to store the material in accordance with Section 01 66 00.

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY

A. Manufacturer Warranty
   1. Manufacturer's Warranty shall be in accordance with Division 1.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [OR] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 EQUIPMENT, PRODUCT TYPES AND MATERIALS

A. Description
   1. Regulatory Requirements
      a. Valves shall be new and in accordance with AWWA C509, AWWA C515 and this Section.
      b. All valve components in contact with potable water shall conform to the requirements of NSF 61 and 372.

B. Materials
   1. Valve Body
      a. Valve body: Ductile iron per ASTM A536
      b. Flanged ends: Furnish in accordance with AWWA/ANSI C115/A21.15.
      c. Mechanical Joints: Furnish with outlets in accordance with AWWA/ANSI C111/A21.11.
      d. Valve interior surfaces: Fusion bonded epoxy coated, minimum 5 mils, in accordance with AWWA C550.
      e. Valve exterior surfaces: Fusion bonded epoxy coated, minimum 5 mils, in accordance with AWWA C550.
      f. Buried valves:
         1) Polyethylene encasement: Furnish in accordance with Section 33 14 10.
   2. Wedge (Gate)
      a. Resilient wedge: Rated at 250 psig cold water working pressure
      b. 1 piece, fully encapsulated with a permanently bonded EPDM rubber.
   3. Gate Valve Bolts and Nuts
      a. Bonnet, Stuffing Box and Gear Box - Hex head bolt, and hex nut:
         1) Buried Service – AISI 304 stainless steel
         2) Non-buried Service
            a) 4-inch through 12-inch valves – Steel ASTM A307 Gr. B, Zinc Plate per ASTM B633, SC3
            b) 16-inch and larger – AISI 304 stainless steel
   4. Bolts and Nuts
      a. Mechanical Joints
         a) Provide bolts and nuts in accordance with Section 33 14 05.
      b. Flanged Ends
         1) In accordance with AWWA C115 or AWWA C207 depending on pipe material.
         2) Provide bolts and nuts in accordance with Section 33 14 05.

3) Provide flanged isolation kits when connecting to buried steel or concrete pressure pipe in accordance with Section 33 01 12.

5. Joints
   a. Valves: flanged, mechanical-joint, or any combination of these as specified on the Drawings or in the project Specifications
      1) Flanged-joints: AWWA/ANSI C115/A21.15, ASME B16.1, Class 125
         a) Flange bolt circles and bolt holes in accordance with ASME B16.1, Class 125.
         b) Field fabricated flanges are prohibited.
      2) Steel or concrete pressure pipe
         a) Use flange-joints unless otherwise specified in the Contract Documents.
      3) Ductile Iron or PVC pressure pipe
         a) Use mechanical joints with mechanically restrained retainer glands in accordance with Section 33 14 05, unless otherwise specified in the Contract Documents.
6. Operating Nuts
   a. Supply for buried service valves
   b. 1-15/16-inch square at the top, 2-inch at the base, and 1-3/4-inch high
   c. Cast an arrow showing the direction of opening with the word "OPEN" on the operating nut base.
   d. To open, the operating nut shall be turned to the left (counter-clockwise) direction.
      1) Paint nut black per AWWA specifications
   e. Connect the operating nut to the shaft with a shear pin that prevents the nut from transferring torque to shaft or gear box that exceeds the manufacturer's recommended torque.
   f. Furnish handwheel operators for non-buried service or when shown in the Drawings.
7. Gearing
   a. Gate valves 20-inch and larger: Equip with a spur gear.
   b. Bevel gears for horizontally mounted valves are not allowed.
   c. The spur gear shall be designed and supplied by the manufacturer of the valve as an integral part of the gate valve.
8. Gaskets
   a. Provide gaskets in accordance with Section 33 14 05.
9. Valve Stem
   a. Provide valves with non-rising stem.

2.3 ACCESSORIES

A. Provide the following accessories as part of the gate valve installation:

1. Extension Stem: Provide a keyed solid extension stem of sufficient length to bring the operating nut up to within 1 foot of the surface of the ground, when the operating nut on the gate valve is 3 feet or more beneath the surface of the ground.
   a. Extension stems are not required on City stock orders.
   b. Do not bolt or attach extension stem to the valve-operating nut.
   c. Provide extension stem of cold rolled steel with a cross-sectional area of 1 square inch, fitting loosely enough to allow deflection.

2. Furnish joint components such as gaskets, glands, lubricant, bolts, and nuts in sufficient quantity for assembly of each joint.
3. Cast iron valve boxes and covers for buried service gate valves
   a. Each valve box for 4-inch through 16-inch valves shall be 2-piece, 5 ¼-inch shafts, screw type, consisting of a top section and a bottom section.
   b. Design valve box covers to be easily removed to provide access to valve operating nut.
   c. Design valve box covers to stay in position and resist damage under AASHTO HS 20 traffic loads.
   d. Cast each cover with the word "WATER", "RECLAIMED", or "SEWER" in raised letters on the upper surface.
   e. Cast iron valve boxes and covers shall be in accordance with ASTM A48, Class 35B.
      1) Valve box covers shall be round for potable water applications and square for reclaimed water applications.
   f. Box extension material shall be AWWA C900 PVC or ductile iron.
4. Refer to Section 33 05 97 for tracer wire requirements.

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. General
1. All valves shall be installed in vertical position when utilized in normal pipeline installation.
2. Valves shall be placed at line and grade as indicated on the Drawings.
3. For buried applications, Polyethylene encasement shall be in accordance with Section 33 14 10.
4. Terminate tracer wire in gate valve box with tracer wire clips.

3.5 REPAIR/RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [OR] SITE QUALITY CONTROL

A. Field Inspections
1. Before acceptance of the installed valve, allow City to operate the valve.
   a. City will be assessing the ease of access to the operating nut within the valve box and ease of operating the valve from a fully closed to fully opened position.
   b. If access and operation of the valve meet the City's criteria, valve will be accepted as installed.

2. All buried flanges require City inspection prior to installation of embedment and backfill.

B. Non-Conforming Work

1. If access and operation of the valve or its appurtenances does not meet City's criteria, Contractor will remedy the situation until it meets City's criteria, at Contractor's expense.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 33 14 21
AWWA RUBBER-SEATED BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. AWWA Rubber-Seated Butterfly Valves 16-inch through 72-inch for transmission, distribution system and plant applications (buried or above ground installation) as specified herein and shown on the Drawings

B. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements
   3. Section 33 01 12 – Joint Bonding and Electrical Isolation
   4. Section 33 14 05 – Bolts, Nuts, and Gaskets

1.2 PRICE AND PAYMENT PROCEDURES

A. The work performed and the materials furnished in accordance with this Item are subsidiary to the structure or Items being placed and no other compensation will be allowed.

1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this Section refer to the current reference standard published at the time of the latest revision date logged at the end of this Section unless a date is specifically cited.
   2. American National Standards Institute (ANSI):
      a. B1.1, Unified Inch Screw Thread Series.
   3. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125 and 250).
   4. ASTM International (ASTM):
      a. A536, Standard Specification for Ductile Iron Castings.
   5. American Water Works Association/American National Standards Institute (AWWA/ANSI):
      a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   6. American Water Works Association (AWWA):
      a. C207, Steel Pipe Flanges for Waterworks Service – Sizes 4 IN through 144 IN.
      b. C115, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
      c. C504, Rubber-Seated Butterfly Valves.
      d. C550, Protective Interior Coatings for Valves and Hydrants.
   7. NSF International (NSF):
      a. 61, Drinking Water System Components - Health Effects.

b. 372, Drinking Water System Components – Lead Content.

8. Society for Protective Coatings/NACE International (SSPC/NACE):
   a. SP 10/NACE No. 2, Near-White Blast Cleaning.

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the City prior to delivery and/or fabrication.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data

1. Rubber-Seated Butterfly Valves stating:
   a. Material
   b. Valve and Actuator Coating System
   c. Working pressure rating
   d. Test pressure rating
   e. Valve classification
   f. Valve Seat Type and bonding method to disc or body
   g. Valve-port diameter
   h. Valve Torque required
   i. Actuator Type and maximum torque
   j. Total net assembled weight
   k. Valve operator and extension stems
   l. Opening direction

B. Shop Drawings

1. For below grade applications:
   a. Cast-in-place concrete cradle with shop drawing requirements set forth in Section 03 31 00.

C. Certificates

1. Furnish an affidavit certifying all AWWA Rubber-Seated Butterfly Valves meet the provisions of this Section and have been hydrostatically tested at the factory and meet the requirements of AWWA C504.
2. Furnish an affidavit certifying the coating for all AWWA Rubber-Seated Butterfly Valves meets the provisions of this Section and meets the requirements of AWWA C504.
3. Furnish an affidavit certifying AWWA Rubber-Seated Butterfly Valve manufacturer owns or controls any foreign factory/foundry that supplies valve casings and can certify the Rubber-Seated Butterfly Valve manufacturer is in control of quality control at the foreign factory/foundry.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Operation and Maintenance Manual

1. Furnish Operation and Maintenance Manual in accordance with Division 1.

1.9 QUALITY ASSURANCE

A. Qualifications

1. Manufacturers
   a. Rubber-Seated Butterfly Valves and manual actuators of the same size shall be the product of 1 manufacturer for each project.
      1) Change orders, specials, and field changes may be provided by a different manufacturer upon City approval.
   b. Rubber-Seated Butterfly Valves shall be in conformance with AWWA C504.
   c. Casings for Rubber-Seated Butterfly Valves not manufactured within the United States of America shall be manufactured by factories/foundries that are owned or controlled (partial ownership) such that the Rubber-Seated Butterfly Valve Manufacturer can control and guarantee quality at the foreign factory/foundry.
2. The AWWA Rubber-Seated Butterfly Valve shall be the product of a manufacturer regularly engaged in the manufacturing of AWWA Rubber-Seated Butterfly Valves having similar service and size.
3. Unit Responsibility
   a. All equipment specified under this Section is to be furnished by the valve manufacturer who is responsible for the adequacy and compatibility of all unit components including, but not limited to, the valve, actuator, and extension stems.
   b. Any component of each complete unit not provided by the valve manufacturer shall be designed, fabricated, tested, and installed by factory-authorized representatives experienced in the design and manufacture of the equipment.
      1) This includes, but is not limited to, coordination of the torque required to properly operate the valve.
      2) This does not relieve the Contractor of the overall responsibility for this portion of the work.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. Protect all parts such that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.
2. Protect all equipment and parts against any damage during a prolonged period at the site.
3. Protect the finished surfaces of all exposed flanges by wooden blank flanges.
4. Protect finished iron or steel surfaces not painted to prevent rust and corrosion.
5. Prevent plastic and similar brittle items from being directly exposed to sunlight or extremes in temperature.
6. Secure and maintain a location to store the material in accordance with Section 01 66 00.

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY

A. Manufacturer Warranty

1. Manufacturer's Warranty shall be in accordance with Division 0 and Division 1.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [OR] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 EQUIPMENT, PRODUCT TYPES, AND MATERIALS

A. Description

1. Regulatory Requirements
   a. AWWA Rubber-Seated Butterfly Valves shall be new and in accordance with AWWA C504 and this Section.
   b. All AWWA Rubber-Seated Butterfly Valve components in contact with potable water shall be in accordance with the requirements of NSF 61 and 372.

B. Materials

1. Valve Body
   a. Provide short-body, ductile iron ASTM A536 Grade 65-45-12 valve body or fabricated steel ASTM A36.
2. Joints
   a. Flanged end:
      1) Class 125 Standard flanged face ends
      2) Drilled in accordance with ASME B16.1 standard for cast iron flanges
      3) Designed for the test pressure of the valve
      4) Used with Buried Steel Pipe or Concrete Pressure Pipe unless otherwise noted in the Contract Documents.
         a) Provide with flange isolation kits in accordance with Section 33 01 12.
   b. Mechanical joint end:
      1) In accordance with AWWA/ANSI C111/A21.11.
      2) Used with Ductile Iron Pipe unless otherwise noted in the Contract Documents.
3. Bolts and Nuts
   a. Flanged Ends
      1) In accordance with AWWA C115 or AWWA C207 depending on pipe material.
      2) Provide bolts and nuts in accordance with Section 33 14 05.
   b. Tapped Bolts
      1) Butterfly Valve manufacturer to provide tapped bolts with ANSI B1.1 UNC thread.
4. Gaskets
      1) Provide gaskets in accordance with Section 33 14 05.
5. Discs
   a. Ductile iron ASTM A536 Grade 64-45-12 or fabricated steel ASTM A36.
      1) Disc and shaft connection shall be made with tapered pins of either monel or stainless steel.
6. Valve Shaft Requirements:
   a. Type 304 stainless steel
   b. 1-piece unit or stub-shaft type
      1) Insert stub shaft into the valve disc hubs for distance of 1.5 times the shaft diameter.

c. Minimum diameter in accordance with AWWA C504
d. Horizontal orientation

7. Shaft Seals
   a. Self-compensating V-type packing with a minimum of 4 sealing rings.
   b. Design shall allow adjustment or replacement without removing the valve shaft.
   c. Match shaft seal material type to the valve seat material type.
8. Valve Bearings
   a. Valve shaft bearings shall be non-metallic and permanently lubricated.
9. Valve Seat
   a. Seats on Body (for transmission projects only)
      1) The seat shall be a Buna-N or EPDM for water and shall be molded in and bonded to the valve body.
      2) Provide a 360 degree continuous, uninterrupted seating surface.
      3) Field adjustable around the full 360 degrees circumference and replaceable without dismantling the actuator, disc or shaft and without removing the valve from the line.
      4) The seat shall be retained in the valve body by mechanical means without retaining rings, segments, screws or hardware of any kind in the flow stream.
      5) The seat shall contain an integral shaft seal protecting the valve bearings and packing from any line debris.
      6) Rubber seats shall be field adjustable and replaceable.
   b. Seats on Disc (for transmission or water facility)
      1) The seat shall be a Buna-N or EPDM for water and shall be molded in and bonded to the disc.
      2) Resilient seats shall be located on the valve disc and shall provide a 360 degree continuous, uninterrupted seating surface.
      3) Seats shall be mechanically retained with a stainless steel retaining ring and stainless steel cap screws which shall pass through both the resilient seat and the retaining ring.
      4) The resilient seat's mating surface shall be to a 360 degree continuous uninterrupted stainless steel body seat ring.
      5) Rubber seats shall be field adjustable and replaceable.
10. Performance / Design Criteria
    a. Valve Classification shall be Class 250B
11. Polyethylene Encasement
    Buried valves: Provide with polyethylene encasement in accordance with AWWA/ANSI C105/A21.5.
    1) Polyethylene encasement: Furnish in accordance with Section 33 14 10.

C. Finishes
1. Unless otherwise specified in the Contract Documents, exterior and interior metallic surfaces of each valve shall be shop fusion bonded epoxy coated in accordance with AWWA C550.
2. Painting and Coatings
   a. All surfaces of the valve shall be clean, dry, and free from grease before applying paint or coating.

b. The valve interior and exterior surfaces, except for the seating surfaces, shall be provided with the manufacturer's standard coating or as specified in the Contract Documents.
c. All internal exposed surfaces that are susceptible to corrosion shall be coated with a Polyamide cured, rust inhibiting epoxy.
d. Surfaces to be coated shall be prepared and sand-blasted in accordance with SSPC SP 10/NACE No. 2.
e. Final coating thickness shall be 16-mils minimum.
f. All surfaces shall be inspected for proper dry film thickness using a magnetic dry film thickness gauge.
g. Tests for invisible holidays shall be conducted using a low voltage, wet sponge holiday or leak detector.

D. Marking for Identification
1. For each Rubber-Seated Butterfly Valve, clearly mark with the following information:
a. Valve size
b. Class for which it is designated
c. Name of manufacturer
d. Date of manufacturer

2.3 ACCESSORIES

A. Rubber-Seated Butterfly Valves shall have the following accessories provided as part of the valve installation:
1. Place below grade Rubber-Seated Butterfly Valves within a concrete cradle in accordance with the Drawings and Section 03 31 00.
2. Manual Actuators
a. Provide all valves with manual actuators, unless otherwise specified in the Drawings.
b. Open valves by turning the actuator counter-clockwise and close valves by turning the actuator clockwise.
c. Manual actuators shall be fully greased, packed, and have adjustable stops in the open and closed position.
1) The actuator shall have an adjustable mechanical stop which will withstand an input torque of 450 foot-pounds against the stop.
2) The actuator shall have a built-in packing leak bypass to eliminate possible packing leakage into the actuator housing.
d. Butterfly valves in a vault shall be furnished with a 2-inch operating nut.
1) The actuator shall be placed in a vault as indicated on the Drawings and have extension to the top of the vault.
e. Butterfly valves in plant, pump station, or tank service applications located above ground shall be provided with a 16-inch minimum diameter handwheel operator.
1) Handwheels shall be painted black.
f. Valve Position Indicator
1) Provide position indicator with mechanical dial indicator as follows:
a) Highly visible
b) Containing "Open" and "Closed" legend at the end of a 90-degree arc
c) Pointer to show the disc position (Closed-0 degree and Open-90 degree)

d) Arc graduated in degrees

g. Worm Gear: Provide valves with worm gear, as follows:
1) In accordance with AWWA C504.
2) Worm gear drive sleeve and worm shaft shall be of solid, 1-piece design; bolted segments or pinned worms will not be acceptable. Drive sleeve shall include an integral spline to accept a removable bottom-entry spline bushing for valve shaft connection.
3) If required for torque purposes, spur gear reducers may be provided for increased torque outputs and to reduce handwheel diameter. Worm gear operator shall include handwheel with maximum 80-pound rim pull or a 2-inch AWWA Nut with a maximum 150 ft.-lbs required input torque.
4) Materials of Construction
a) Housing: Ductile Iron
b) Drive sleeve: Bronze
c) Worm: Alloy steel with splined input drive connection
d) Bearings: Heavy duty tapered roller bearings
e) Finish: Thermostatically Applied Polyester Powdercoat
f) Fasteners: Stainless steel
5) Manual gears shall be capable of being field retrofit with an electric motor operator in the future without major modifications.
a) With spur gear removed, splined worm gear input shaft and motor adapter flange shall be easily added to accept a multi-turn "torque-only" electric valve actuator.
(1) Supplier shall include the Number of Turns required to complete on Open-to-Close stroke in the Equipment Submittal.

3. Extension Stem
a. Provide keyed solid extension stem of sufficient length to bring the operating nut up to within 1 foot of the surface of the ground, when the operating nut on the valve is 3 feet or more beneath the surface of the ground
1) Not required for City stock orders.
2) Do not bolt or attach extension stems to the valve-operating nut.
3) Extension stems shall be of cold rolled steel with a cross-sectional area of 1 square-inch, fitting loosely enough to allow deflection.

4. Joint components such as gaskets, glands, lubricant, bolts, and nuts shall be furnished in sufficient quantity for assembly of each joint.

2.4 SOURCE QUALITY CONTROL

A. Tests and Inspections
1. Each valve shall be shop tested for leaks in the closed position with the valve horizontal.
a. The upper surface of the valve disc shall be visible and covered with a pool of water at 0 psi pressure.
b. Air pressure equivalent to the design rating of the valve shall be applied to the lower face of the disc for at least 5 minutes with no indication of leakage (i.e. bubbles in the water pool) during the test period.

2. The valve body shall be hydrostatically tested at twice the rated pressure for 10 minutes with the valve in the slightly open position.
a. During this test, there shall be no leakage or seeping through the valve body, weld, or valve trunnions.

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. General

1. All Rubber-Seated Butterfly Valves shall be installed in accordance with the instructions of the manufacturer and as shown on the Drawings.
2. For buried applications, Rubber-Seated Butterfly Valves shall be directly buried in a concrete cradle in accordance with the Drawings.
3. For buried applications, Polyethylene encasement shall be in accordance with Section 33 14 10.
4. All excavations shall be backfilled in accordance with Section 33 05 05.

3.5 REPAIR / RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD [OR] SITE QUALITY CONTROL

A. Field Inspections

1. Provide the City the opportunity to operate the valve prior to acceptance of the installed Rubber-Seated Butterfly Valve.
   a. The operator will assess the ease of access to the operating nut within the valve box and ease of operating the valve from a fully closed to fully opened position.
   b. If access and operation of the Rubber-Seated Butterfly Valve meet the City's criteria, the valve will be accepted as installed.

B. Non-Conforming Work

1. If access and operation of the valve or its appurtenances does not meet the City's criteria, the Contractor will remedy the situation until it meets the City's criteria, at the Contractor's expense.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 33 14 25
CONNECTION TO EXISTING WATER MAINS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Connection to existing water mains to include, but not limited to:
      a. Cutting in a tee for a branch connection
      b. Extending from an existing water main
      c. Installing a tapping sleeve and valve

B. Related Specification Sections include, but are not necessarily limited to:
   1. Division 0 – Bidding Requirements, Contract Forms, and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. The work performed and the materials furnished in accordance with this Item are subsidiary to the structure or Items being placed and no other compensation will be allowed.

1.3 REFERENCES

A. Reference Standards
   1. Reference standards cited in this Section refer to the current reference standard published at the time of the latest revision date logged at the end of this Section unless a date is specifically cited.
   2. American Water Works Association (AWWA):
      a. C206, Field Welding of Steel Water Pipe.
   3. NSF International (NSF):
      a. 61, Drinking Water System Components – Health Effects.
      b. 372, Drinking Water System Components – Lead Content.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Pre-installation Meetings
   1. Required for any connections to an existing City water distribution system main that requires a shutdown of some part of the water system.
   2. May also be required for connections that involve shutting water service off to certain critical businesses/operations, dictated at the City's discretion.
   3. Schedule a pre-installation meeting a minimum of 2 weeks prior to proposed time for the work to occur.
   4. Contractor, City Inspector, and Water Utility Representative(s) are required to attend meeting.
   5. At the meeting:

a. Review work procedures as submitted and any adjustments made for current field conditions.
b. Verify that all valves and plugs to be used have adequate thrust restraint or blocking.
c. Schedule a test shutdown with the City.
d. Schedule the date for the connection to the existing system.

B. Scheduling

1. Schedule work to make all connections to existing 16-inch and larger mains:
   a. During the period from November through April, unless otherwise approved by the City
   b. During normal business hours from Monday through Friday, unless otherwise approved by the City
2. Schedule by 1:00 P.M. a minimum of 2 business days prior to planned disruption to the existing water system.
   a. In the event that other water system activities do not allow the existing main to be dewatered at the requested time, schedule work to allow the connection at an alternate time acceptable to the City.
      1) If water main cannot be taken out of service at the originally requested time, coordination will be required with the City to discuss rescheduling and compensation for mobilization.
      2) No additional payment will be provided if the schedule was altered at the Contractor's request.

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the City prior to delivery and/or fabrication for specials.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Submittals

1. Provide a detailed sequence of work for 16-inch or larger connections which require shutdowns (critical connections may be required at smaller sizes per City discretion) that includes:
   a. Results of exploratory excavation
   b. Dewatering
   c. Procedure for connecting to the existing water main
   d. Time period for completing work from when the water is shut down to when the main is back in service
   e. Testing and repressurization procedures
2. Welders that are assigned to work on connection to concrete cylinder or steel pipe must be certified and provide Welding Certificates, upon request, in accordance with AWWA C206.

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

A. All valve components in contact with potable water shall be in accordance with NSF 61 and NSF 372.

B. In accordance with the reduction of lead in Drinking Water Act, any product designed for dispensing potable water shall meet both the NSF 61 and NSF 372 test standards via third-party testing and certification.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements

1. Protect parts so that no damage or deterioration occurs during a prolonged delay from the time of shipment until installation is completed.
2. Protect all equipment and parts against any damage during a prolonged period at the site.
3. Protect the finished surfaces of all exposed flanges using wooden flanges
4. Protect finished iron or steel surfaces not painted to prevent rust and corrosion.
5. Prevent plastic and similar brittle items from being exposed to direct sunlight and extremes in temperature.
6. Secure and maintain a location to store the material in accordance with Section 01 66 00.

1.11 FIELD [SITE] CONDITIONS [NOT USED]

1.12 WARRANTY

A. Manufacturer Warranty

1. Manufacturer’s warranty shall be in accordance with Division 0 and Division 1.

PART 2 - PRODUCTS

2.1 OWNER-FURNISHED [OR] OWNER-SUPPLIED PRODUCTS [NOT USED]

2.2 EQUIPMENT, PRODUCT TYPES AND MATERIALS

A. Description

1. Regulatory Requirements
   a. Tapping Sleeves shall meet or exceed AWWA C223 and the requirements of this Specification.
   b. All valve components in contact with potable water shall conform to the requirements of NSF 61.

B. Tapping Sleeve Materials

1. Body
   a. Body: Carbon Steel per ASTM A283 Grade C, ASTM A285 Grade C, ASTM A36 Steel or equal

b. Finish: fusion bonded epoxy coating to an average 12 mil thickness. Fusion applied per AWWA C213.
c. All buried tapping sleeves shall be provided with polyethylene encasement in accordance with AWWA/ANSI C105/A21.5.
1) Polyethylene encasement shall be in accordance with Section 33 14 10.

2. Flange
a. Carbon Steel per ASTM A36 in accordance with AWWA C207 and ASME B16.1 Class 125.
b. Recessed for tapping valve per MSS SP-60

3. Bolts and Nuts
a. Flanged Ends
1) Meet requirements of AWWA C115 or AWWA C207 depending on pipe material.
2) Provide bolts and nuts in accordance with Section 33 14 10.

4. Gaskets
a. Provide gaskets in accordance with Section 33 14 10.

5. Test Plug
a. ¾-inch NPT carbon steel with square head and fusion bonded epoxy coating

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION

A. Verification of Conditions

1. Verify by exploratory excavation, if needed, that existing water main is as depicted in the Drawings and that the location is suitable for a connection to the existing water main.
a. Excavate and backfill trench for the exploratory excavation in accordance with 33 05 05.

2. Verify that all equipment and materials are available on–site prior to the shutdown of the existing main.

3. Pipe lines shall be completed, tested and authorized for connection to the existing system in accordance with Section 33 01 10.

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. General

1. Contractor is responsible for providing valve crew to open and close valves under the supervision of the City. The City will not provide a valve crew to assist with opening and closing of valves.

2. Upon disruption/shutdown of the existing water main, continue work until the connection is complete and the existing water main is back in service.
3. At no point should the pump station be unable to pump water.

B. Procedure

1. Connection to an existing unpressurized water main:
   a. Expose the proposed connection point in accordance with Section 33 05 05.
   b. Verify the existing water main is suitable for the proposed connection.
   c. Remove existing dead-end plug/cap on the water main in order to make the connection.
   d. Place trench foundation and bedding in accordance with 33 05 05.
   e. Prevent embedment, backfill, soil, water, or other debris from entering the water main.
   f. Establish thrust restraint as provided for in the Drawings.
   g. Clean and disinfect the water main associated with the connection in accordance with Section 33 01 10. This includes the length of pipe from the point of connection, back to the existing valve.
   h. Place embedment to the top of the pipe zone.
   i. Re-pressurize the water main.
   j. Directionally flush the connection in accordance with Section 33 01 10.
   k. Open all remaining valves.
2. Connection to an existing water main that requires a shutdown of some part of the water system:
   a. Verify with City all required equipment and materials are on the site as necessary to perform the connection.
   b. Expose the proposed connection point in accordance with Section 33 05 05.
   c. Dewater the existing water line so the chlorinated water is not unlawfully discharged.
   d. Maintain the water that may bleed from existing valves or plugs during installation within the work area to a reasonable level.
      1) Control the water in such a way that it does not interfere with the proper installation of the connection or create a discharge of chlorinated water.
   e. Dechlorinate any discharged, chlorinated water in accordance with Section 33 01 10.
   f. Cut and remove existing water main to make the connection.
   g. Verify the existing water main is suitable for the proposed connection.
   h. Install required connection.
   i. Place trench foundation and bedding in accordance with 33 05 05.
   j. Prevent embedment, backfill, soil, water, or other debris from entering the water main.
   k. Establish thrust restraint as provided for in the Drawings.
   l. Clean and disinfect the water main associated with the connection in accordance with Section 33 01 10.
   m. Place embedment to the top of the pipe zone.
   n. Re-pressurize the water main with City present.
   o. Directionally flush the connection in accordance with Section 33 01 10.
   p. Open all remaining valves with City present.

3.5 REPAIR/RESTORATION [NOT USED]

3.6 REPAIR/RESTORATION [NOT USED]

3.7 RE-INSTALLATION [NOT USED]

3.8 FIELD [OR] SITE QUALITY CONTROL [NOT USED]

3.9 SYSTEM STARTUP [NOT USED]

3.10 ADJUSTING [NOT USED]

3.11 CLEANING [NOT USED]

3.12 CLOSEOUT ACTIVITIES [NOT USED]

3.13 PROTECTION [NOT USED]

3.14 MAINTENANCE [NOT USED]

3.15 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 33 14 30
COMBINATION AIR VALVE ASSEMBLIES FOR POTABLE WATER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. 1-inch to 8-inch Combination Air-Release and Air/Vacuum Valve Assemblies (Combination Air Valves) for potable water systems including:
      a. Combination air-release and air/vacuum valve
      b. Tap to water main
      c. Lead-free Inlet piping and appurtenances
      d. Vent piping and appurtenances
      e. Vault enclosure and appurtenances

B. Related Specification Sections include but are not limited to:
   1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
   2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. The work performed and the materials furnished in accordance with this Item are subsidiary to the structure or Items being placed and no other compensation will be allowed.

1.3 REFERENCES

A. Definitions
   1. Combination Air Valve: A device having the features of both an air-release valve and an air/vacuum valve
   2. Inlet: The opening at the base of the Combination Air Valve mechanism through which air and water from the pipeline enters
   3. Inlet Piping: The piping and appurtenances between the pipeline and the valve inlet
   4. Lead-free: Lead-free pipes and plumbing fittings and fixtures shall contain less than 0.25 percent lead in accordance with the reduction of Lead in Drinking Water Act (P.L. 111-380)
   5. Orifice: The opening in the Combination Air Valve mechanism through which air is expelled from or admitted into the pipeline or piping system. Some valves may have multiple orifices
   6. Outlet: The opening at the top of Combination Air Valve mechanism, including the orifice, through which air enters or exits the Air Valve
   7. Vent Piping: The piping and appurtenances from the Combination Air Valve outlet to its termination point outside the vault

B. Reference Standards
   1. Reference standards cited in this Section refer to the current reference standard published at the time of the latest revision date logged at the end of this Section unless a date is specifically cited.

2. American Iron and Steel Institute (AISI).
3. ASTM International (ASTM):
   a. A536, Standard Specification for Ductile Iron Castings.
4. American Water Works Association (AWWA):
   a. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   b. M51, Air-Release, Air/Vacuum, and Combination Air Valves.
5. NSF International (NSF):
   a. 61, Drinking Water System Components - Health Effects.
6. Reduction of Lead in Drinking Water Act
   a. Public Law 111-380 (P.L. 111-380)

1.4 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the City prior to delivery and/or fabrication.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Product Data
   1. Combination Air Valves
      a. Application type
      b. Working pressure rating
      c. Test pressure rating
      d. Surge pressure rating
      e. Inlet size
      f. Small orifice size
      g. Large orifice size
   2. Valve vault and appurtenances
   3. Tapping appurtenances
   4. Isolation valves
   5. Fittings
   6. Vent piping
   7. Vent cover and/or enclosure
   8. Vent enclosure and/or pipe bollard protection

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE

A. Qualifications
   1. Manufacturers
      a. Combination Air Valves of the same size shall be the product of 1 manufacturer, unless approved by the City.
      b. Combination air valves shall be in conformance with AWWA C512.

B. Certifications

1. Obtain an Affidavit of Compliance from the valve manufacturer in accordance with AWWA C512.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Storage and Handling Requirements
   1. Protect all parts such that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.
   2. Protect all equipment and parts against any damage during a prolonged period at the site.
   3. Protect the finished surfaces of all exposed flanges by wooden blank flanges.
   4. Protect finished iron or steel surfaces not painted to prevent rust and corrosion.
   5. Prevent plastic and similar brittle items from being directly exposed to sunlight or extremes in temperature.

1.11 FIELD CONDITIONS [NOT USED]

1.12 WARRANTY

A. Manufacturer Warranty
   1. Manufacturer's Warranty shall be in accordance with Division 0 and Division 1.

PART 2 - PRODUCTS

2.1 CITY-FURNISHED PRODUCTS [NOT USED]

2.2 MATERIALS

A. Manufacturers
   1. Manufacturer List
      a. A.R.I. Flow Control Accessories, Ltd.
         1) Model D-060 Combination Air Valves – 2" to 8"
      b. Val-Matic
         1) Combination Air Valve – Single Body – 1" to 8"
      c. Approved Equal
      d. Substitution requests for manufacturers or models not indicated above shall be processed in accordance with Section 01 25 00.
   2. The Combination Air Valve shall be new and the product of a manufacturer regularly engaged in the manufacturing of air release/air vacuum valves having similar service and size.

B. Description
   1. Regulatory Requirements
      a. Combination Air Valves in accordance with the requirements of AWWA C512 and this Section.
      b. All Combination Air Valve components in contact with potable water shall conform to the requirements of NSF 61 and NSF 372.

C. Performance / Design Criteria
   1. Capacities

a. Water Application = Potable Water
b. Working Pressure from 10 psi to 220 psi
c. Test Pressure = 225 psi
d. Surge Pressure = 100 psi minimum, unless stated otherwise in the Contract Documents
e. Size
1) Each orifice size must be sufficient to meet the requirements set forth in AWWA M51 and specified in the Drawings.

2. Function
a. High volume discharge during pipeline filling
b. High volume intake through the large orifice
c. Pressurized air discharge
d. Surge Dampening/Controlled discharge rates
1) The valve shall have an integral surge alleviation mechanism which shall operate automatically to limit transient pressure rise or shock induced by closure due to high velocity air discharge or the subsequent rejoining of the separated water columns. The limitation of the pressure rise shall be achieved by decelerating the approaching water prior to valve closure.

D. Materials
1. Combination Air Valve
a. Internal parts
1) Non-corroding material such as stainless steel or high-density polyethylene
b. Valve body
1) AISI 304 stainless steel or ASTM A536 ductile iron
2) Equipped with intake and discharge flanges
c. Inlet/Discharge orifice area
1) Equal to the nominal size of the valve

E. Finishes
1. Finish Materials
a. Supply all ductile iron Combination Air Valves with a factory applied fusion bonded epoxy coating with a final coating thickness of 16 mils minimum.

2.3 ACCESSORIES

A. For 1-inch and 2-inch Combination Air Valve Assemblies:
1. Tap
a. Provide 4-inch flanged outlet with blind flange and threaded tap (C.C. thread with flare) of same size as valve.
b. Provide corporation stop of same size as valve.
2. Inlet Piping and Isolation Valve
a. Same size as valve assembly between the tap and the isolation valve with the following:
1) Threaded, lead-free brass piping
2) Threaded, lead-free brass elbows
3) Threaded, lead-free brass 1/4 turn ball valve.
3. Vent Piping
a. Hot-dip galvanized steel piping and fittings in accordance with ASTM A123, same size as valve assembly.

1) Underground piping should be threaded and include a pipe union inside enclosure to allow disassembly.
2) Provide frangible connection at ground level designed to be breakable upon impact.
3) Pipe to extend a minimum 2 feet above ground level.

4. Vent Screen
   a. Stainless Steel (AISI 304)
5. Vent Piping - Dropover Enclosure
   a. Channell SPH-1420 thermoplastic enclosure, or approved equal.

B. For 3-inch to 8-inch Combination Air Valve Assemblies:

1. Tap
   a. Buried Steel or Concrete Pressure Pipe:
      1) Fabricated flanged outlet
         a) 24-inch outlet for 24-inch water mains
         b) 30-inch outlet for 30-inch and larger water mains
      2) Fabricated steel reducing flange of same size as valve assembly.
      3) Provide flange isolation kit between isolation valve and reducing flange in accordance with Section 33 01 12.
   b. Ductile Iron or PVC Pipe:
      1) Mechanical joint by flanged ductile iron tee in accordance with Section 33 14 10.
         a) Outlet same size as main for 24-inch and smaller water mains
         b) 30-inch flanged outlet for 30-inch and larger water mains
      2) Ductile iron blind flange with threaded by flanged spool piece of same size as valve assembly.
2. Isolation Valves
   a. Flange by flange resilient seated gate valve with hand wheel in accordance with Section 33 14 20, of same size as valve assembly.
3. Vent Piping
   a. Ductile iron piping and fittings in accordance with Section 33 14 10.
      1) Size pipe to match size of valve assembly outlet, but no less than 4-inch diameter.
      2) Provide flange joints for all pipe and fittings, except for 1 mechanical joint solid sleeve inside enclosure to allow disassembly.
      3) Provide frangible connection at ground level designed to be breakable upon impact.
      4) Pipe to extend a minimum 2 feet above ground level.
4. Vent Screen
   a. Stainless Steel (AISI 304)
5. Vent Piping - Dropover Enclosure
   a. Channell SPH-1420 thermoplastic enclosure, or approved equal
6. Vault
   a. Provide a flat top, cast-in-place, or precast concrete manhole in accordance with the Drawings.
   b. Secure Air Valve to vault wall using a galvanized or stainless-steel bracket manufactured by Grinell, or equal, in accordance with the Drawings.
   c. Provide 4-inch PVC drain pipe and crushed rock in accordance with Section 33 05 05 and the Drawings.

7. Pipe Embedment
    a. Concrete encase water main entirely beneath proposed vault in accordance with Section 33 05 05.

C. Finishes
1. Steel pipe and fittings shall be hot-dip galvanized in accordance with ASTM A123.
2. Ductile iron pipe and fittings shall be coated and lined in accordance with Section 33 14 10.

2.4 SOURCE QUALITY CONTROL

A. Tests and Inspections
1. Test and inspect Combination Air Valves in accordance with AWWA C512.

B. Markings
1. Mark each Combination Air Valve in accordance with AWWA C512.

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION [NOT USED]

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. General
1. Install in accordance with manufacturer's recommendations and as shown on the Drawings.
2. Above ground and vault interior ductile iron piping and valves shall be painted in accordance with City requirements, unless otherwise stated in the Drawings.
3. Wrap all buried ductile iron pipe and fittings with polyethylene encasement in accordance with Section 33 11 10.

3.5 REPAIR [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL

A. Field Inspections
1. Ensure both the large and small orifices connect to the vent piping.
2. The valve shall perform as intended with no deformation, leaking or damage of any kind for the pressure ranges indicated.
3. Before acceptance of the installed valve, provide the City the opportunity to inspect and operate the valve.
    a. The City will assess the ease of operating the ball valves and corporation stops, where applicable.
4. The Combination Air Valve assembly shall be free from any leaks.

B. Non-Conforming Work

1. If access and operation of the valve or its appurtenances does not meet the City's criteria, the Contractor will remedy the situation until it meets the City's criteria, at the Contractor's expense.

3.8 SYSTEM STARTUP [NOT USED]

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES [NOT USED]

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS [NOT USED]

END OF SECTION

SECTION 40 05 65
TILTED DISC CHECK VALVES

PART I - GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, equipment and incidentals required to completely install and put into operation, tilted disc check valves with top mounted oil dashpot as specified herein and shown on the drawings.

1.2 REFERENCES

A. American Water Works Association (AWWA)
   1. AWWA C508 – Swing-Check Valves for Waterworks Service

B. American Society for Testing and Materials (ASTM)
   1. ASTM A48 - Gray Iron Castings
   2. ASTM A126 - Gray Iron Castings for Valves, Flanges, and Pipe Fittings
   3. ASTM A436 - Austenitic Gray Iron Castings
   4. ASTM A536 - Ductile Iron Castings.

1.3 ADMINISTRATIVE REQUIREMENTS [NOT USED]

1.4 SUBMITTALS

A. Submittals shall be in accordance with Section 01340.

B. All submittals shall be approved by the Engineer or the Owner prior to delivery.

1.5 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS

A. Technical bulletins and brochures on tilted disc check valves with top mounted oil dashpot.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Manual

B. Manufacturer’s Certification

1.7 MAINTANENCE MATERIAL SUBMITTALS [NOT USED]

1.8 QUALITY ASSURANCE

A. The Contractor shall cause all equipment specified under this section to be furnished by the valve manufacturer who shall be responsible for the adequacy and compatibility of all valve components including top mounted oil dashpot. Any component of each complete unit not provided by the valve manufacturer shall be designed, fabricated, testing, and installed by factory-authorized representatives experienced in the design and manufacture of the valve equipment. This requirement, however, shall not be construed as relieving the Contractor of the overall responsibility for this portion of the work.

1.9 DELIVERY, STORAGE, AND HANDLING

A. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation.

B. All equipment and parts must be properly protected against any damage during a prolonged period at the site.

C. Finished iron or steel surfaces not painted shall be properly protected to prevent rust and corrosion.

D. Storage and Protection: Take special care to prevent plastic and similar brittle items from being directly exposed to the sun, or exposed to extremes in temperature, preventing any deformation.

1.10 FIELD CONDITIONS

A. The equipment to be provided under this section shall be suitable for installation and operation inside a pump station. Outside ambient temperatures range between 10 and 105□F, and reported water temperatures vary between 50 and 80□F. Relative humidity is expected to range between 5 and 100 percent.

1.11 WARRANTY

A. The equipment shall be warranted to be free from defects in workmanship, design and materials. If any part of the equipment should fail during the warranty period, it shall be replaced and the unit(s) restored to service at no expense to the Owner. Warranty shall be for a period of two years and begin on the Date of Final Acceptance.

PART II - PRODUCTS

2.01 TILTED DISC CHECK VALVES

A. Manufacturers
   a. The following manufacturers are acceptable
      i. Val-Matic (Series 9600T)
      ii. Pratt

B. Description
   1. The tilted disc check valve body shall consist of two (2) halves with an O-ring seal bolted together at a central diagonal flange, inclined at an angle of 55-degrees.

C. Performance/Design Criteria
   1. Provide inspection ports both upstream and downstream.
   2. Provide an indicator that shows the disk position at all times.
   3. Working Pressure – 150 psi

D. Materials
   1. Body and Disc - Ductile Iron
   2. Disc Ring - Stainless Steel
   3. Seat Ring - Stainless Steel
   4. Pivot Pin - Stainless Steel with Stainless Steel Bushing

2.02 TOP MOUNTED OIL DASHPOT

A. The dashpot shall be a Top Mounted Oil Dashpot and shall be directly connected to the disc. The Dashpot shall provide free open and full control of the valve disc during closure to reduce the potential for reversal.

B. Provide a stainless steel coupling designed to provide a self-aligning connection between the dashpot assembly and the rod that connects to the tilted disc. Removal of the dashpot assembly for maintenance while the check valve remains under pressure is required.

C. The first stage shall allow free closure for the first 90% of the disc's stroke while the second stage controls the final 10% of the disc's closure.

D. The Top Mounted Oil Dashpot shall be self contained with an air gap spacer to prevent the possibility of the hydraulic fluid entering the line media.

PART 3 - EXECUTION

A. All tilted disc check valves with top mounted dashpot shall be installed in accordance with the instructions of the manufacturer and as shown on the drawings.

B. Installation and adjustment shall be checked and approved by a manufacturer's factory representative. After acceptance, the representative shall address a letter to the Engineer outlining all installation and start up procedures. The letter shall include a statement that the valves are installed per the manufacturer's recommendations. The manufacturer or his qualified representative shall conduct training session for the Owner's personnel in the operation and maintenance of the valves.

END OF SECTION

SECTION 40 61 00
INSTRUMENTATION AND CONTROL - GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The General Contractor, also known as the "Contractor", shall be responsible for all work and shall provide the services of a Process Control Systems Integrator (PCSI), as a first-tier subcontractor, who shall perform all work necessary to select, furnish, configure, customize, debug, install, connect, calibrate, and place into operation all instrumentation hardware specified within this Division.

B. Furnish all labor, materials and equipment required to provide, install, test, and make operational, a Process Instrumentation and Control System as specified herein and related specifications, and as shown on the Drawings.

C. The work shall include furnishing, installing and testing the equipment and materials detailed in each Section of Division 40 Instrumentation Sections.

D. Equipment furnished as a part of other Divisions and shown on the Instrumentation and/or Electrical Drawings shall meet the Specification requirements of the overall Instrumentation System under the Instrumentation Sections of Division 40.

E. The Contractor is advised that the existing pump station facility is currently in operation which will continue to be in operation throughout the execution of this Contract. The Contractor shall schedule and conduct all work so as to minimize interference with system operation and maintenance. The Contractor shall develop and submit for review a detailed system startup plan that illustrates the strategy to be used for minimizing disruption to operation during system installation, cutover, and startup.

F. The PCSI shall be responsible for all network communication between the North Richland Hills Operation Control Center (OCC) and the existing Conn Pump Station under this Contract.

G. The PCSI shall perform all Human-Machine Interface (HMI), and Programmable Logic Controller (PLC) work related to this project. The existing HMI system is InTouch by Wonderware. Work to program and/or reconfigure the polling engine at the OCC to communicate with the existing Conn Pump Station shall be the responsibility of the PCSI.

H. The Contractor shall coordinate and schedule all required testing with the PCSI, Engineer, and Owner.

I. The work shall include but not be limited to the following:

1. Make connections, including field connections and interfacing between instrumentation, controllers, control devices, control panels and instrumentation furnished under other Divisions. The Contractor shall coordinate his construction schedule and instrumentation and control interface with the supplier of instrumentation and control equipment specified under other Divisions.

2. Make wiring terminations for all field-mounted instruments furnished and mounted under other Divisions, including process instrumentation primary elements, transmitters, local indicators and control panels. Install vendor furnished cables specified under other Divisions.
3. Auxiliary and accessory devices necessary for system operation or performance, such as transducers, interposing relays, signal conditioners, intrinsic safety barriers, and signal current isolators, to interface with existing equipment or equipment provided by others under other Sections of these specifications, shall be included whether they are shown on the Drawings or not.
4. Equipment shall be fabricated, assembled, installed, and placed in proper operating condition in full conformity with detail drawings, specifications, engineering data, instructions, and recommendations by the equipment manufacturer as approved by the Engineer.
5. The PCSI shall furnish equipment which is the product of one manufacturer to the maximum practical extent. Where this is not practical, the Contractor shall obtain approval from Owner/Engineer.
6. All materials, equipment, labor, and services necessary to achieve the monitoring and control functions described herein shall be provided in a timely manner so that the monitoring and control functions are available when the equipment is ready to be placed into service.
7. Provide all instrumentation work associated with the relocation of equipment from the existing facility to the new facility, including disconnecting all existing wiring and conduits and terminating, calibrating, and placing into service any relocated equipment.
8. Coordinate the sequence of construction to maintain pump station operation in each area such that the existing pump station will function properly with no disruption of operation.
9. All bidders shall visit the site of the project, prior to submitting a bid, to attain an overall understanding of the project scope, relating to existing equipment, condition, or construction.
10. Provide new equipment such as instrumentation, and other control related equipment as shown on Drawings.
11. Provide, install, and make operational the new PLC Control Panels located in the new Electrical Room; complete with PLC racks, controller, analog and discrete I/O cards, communication cards, power supplies, surge suppressors and interposing relays including all required accessories as specified in the contract documents.
12. Provide, install and make operational all networking devices, including all required accessories as specified in the contract documents.
13. Provide, install and make operational a new UPS complete with UPS bypass switch, including all required accessories as specified in the contract documents. The new UPS shall be properly sized to provide conditioned UPS power to the new PLC enclosure.
14. Provide, install and make operational all communication cables as required to communicate between the new PLC Control Panel, Generator Control Panel, Power Monitors (PQMs), specified in contract documents.

15. The PCSI shall program the new PLC to achieve the monitoring and control capability from the North Richland Hills Operation Control Center. The PLC code for the pump station shall be programmed in such a way that will monitor and accept control commands from Operation Control Center.
16. The PCSI shall conduct a series of workshops to solicit Owner's input during the overall system configuration and integration process. These workshops are fully outlined in Section 40 68 60 and shall include the following:
    a. HMI Graphics Workshop
    b. Control Strategy and I/O database development workshop
    c. Reports and Contents Workshop

1.2 RELATED WORK

A. Where references are made to the Related Work paragraph in each Specification Section, referring to other Sections and other Divisions of the Specifications, the Contractor shall provide such information or work as may be required in those references, and include such information or work as may be specified.

B. All Instrumentation work related to Process and Mechanical Divisions equipment that is shown on the Instrumentation Drawings shall be provided under Division 40 Instrumentation Sections.

C. All instrumentation Equipment and work provided under any other Divisions of the Specifications shall fully comply with the requirements of Division 40 Instrumentations Sections.

D. Related Sections
    1. Section 40 61 21 Instrumentation Testing and System Commissioning
    2. Section 40 61 26 Instrumentation System Training
    3. Section 40 61 90 Field Instrumentation List
    4. Section 40 61 93 Field Input-Output List
    5. Section 40 61 96 Control Loop Descriptions
    6. Section 40 63 00 Programmable Logic Controller (PLC) Systems
    7. Section 40 66 00 Communications Interface Equipment and Systems
    8. Section 40 66 33 Fiber Optic Data Network
    9. Section 40 67 00 Instrumentation Control Panels
    10. Section 40 68 60 Application Services
    11. Section 40 71 00 Field Instrumentation
    12. Section 40 78 00 Panel Mounted Control Devices

1.3 SUBMITTALS

A. General Submittal Requirements:
    1. Shop drawings shall be submitted as detailed herein. Shop drawings shall demonstrate that the equipment and services to be furnished comply with the provisions of these specifications and shall provide a complete record of the equipment as manufactured, delivered, installed and placed in service.
    2. Submittals shall be complete and shall give equipment specifications, details of connections, wiring, ranges, installation requirements, and specific dimensions. Submittals consisting of only general sales literature shall not be acceptable.

3. Submittals shall be bound in separate three-ring binders, with an index and sectional dividers, and with all included drawings reduced to a maximum size of 11-inches by 17-inches, then folded to 8.5-inches by 11-inches for inclusion inside the binder. Maximum binder thickness shall be 3 inches.
4. The shop drawings title block shall include, as a minimum, the PCSI's registered business name and address, Owner and project name, drawing name, revision level, and shall identify personnel responsible for the content of the drawing.
5. Incomplete or partial submittals not complying with the submittal requirements outlined in this Section will be returned without review.
6. Each Section submittal shall be complete, contain all the items listed in the Specification Section, and shall be clearly marked to indicate which items are applicable on each cut sheet page. The Submittal shall list any exceptions to the Specifications and Drawings, and the reason for such deviation. Shop drawings, not so checked and noted, will be returned un-reviewed.
7. The Contractor shall check shop drawings for accuracy and Contract Requirements prior to submittal to the Engineer. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Specifications and Drawings. Shop drawings shall be stamped with the date checked and a Statement indicating that the shop drawings conform to Specifications and Drawings. Only one Specification Section submittal will be allowed per transmittal unless sections are indicated for grouping in the individual sections.
8. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered or shop work started if shop drawings are marked "APPROVED AS NOTED CONFIRM", "APPROVED AS NOTED RESUBMIT" or "NOT APPROVED".
9. At a minimum, the following separate submittals as listed in the table below shall be submitted:

Submittal index	Submittal Title	Location/Governing Specifications
1	O&M Manual Outline	40 61 00-1. 3
2	O&M Manuals System Hardware Maintenance	40 61 00-1.3
3	O&M Manuals System Administrator	40 61 00-1.3
4	O&M Manuals System Operator	40 61 00-1.03
5	Project Plan, Schedule, and Deviation List *This submittal shall be submitted and approved before any additional submittals will be accepted.*	40 61 00-1.3
6	Field Input/output (I/O) List	40 61 93

Submittal index	Submittal Title	Location/Governing Specifications
7	HMI Graphics Screens	40 61 00-1.3 40 68 60
8	Control Narratives	40 61 00-1.3 40 61 96 40 68 60
9	Reports & Contents	40 61 00-1.3
10	System Testing Startup Plan	40 61 21
11	System Testing Testing Plan & Schedule	40 61 21
12	UFT and WFT Reports	40 61 21-3
13	Test Procedures	40 61 21
14	Training	40 61 26
15	Programmable Logic Controller (PLC) Systems	40 63 00
16	Field Instruments	40 71 00 40 61 90
17	Control Panels	40 67 00
28	Panel Mounted Equipment	40 78 00
29	Communications Interface Equipment and Systems	40 66 00 40 66 33
30	Final Documentation/Record Drawings	40 61 00 40 68 60

B. Submittal Process

1. Submit Shop Drawings, in accordance with Division 1 requirements, for equipment, materials and all other equipment specified under each Instrumentation Section of Division 40, except where specifically stated otherwise. An individually packaged submittal shall be made for each Section and shall contain all the information required by that Section, unless specifically directed otherwise by the submittal requirements of that section. Partial submittals will not be accepted and will be returned without review.

C. Shop Drawings, O&M Manuals, and other documentation shall be submitted as listed in each of the individual Instrumentation Specification Sections.

1. Submit operations and maintenance data for equipment furnished under this Division, in accordance with Division 1. The manuals shall be prepared specifically for this installation and shall include catalog data sheets, drawings, equipment lists, descriptions, parts list and operating and maintenance instructions.
2. Manuals shall include the following as a minimum:
   a. A comprehensive index.
   b. A complete "As-Built" set of approved shop drawings.
   c. All control panel “As-Built” drawings shall be drawn to scale with all control panel subcomponents shown and identified
   d. A complete list of the equipment supplied, including serial numbers, ranges and pertinent data.

e. A table listing of the "as left" settings for all timing relays and alarm and trip setpoints.
f. System schematic drawings "As-Built", illustrating all components, piping and electric connections of the systems supplied under this Division.
g. Detailed service, maintenance and operation instructions for each item supplied.
h. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
i. The operating instructions shall also incorporate a functional description of the entire system, with references to the systems schematic drawings and instructions.
j. Complete parts list with stock numbers.
k. All final O&M manual shall be provided with searchable PDF files with soft bookmarks to the left of the document. The O&M manual shall also be provided with its native format. (i.e. MS Word, Unity PLC programs, etc.) Provide three paper copies and five electronic copies of O&M on USB Jump Drive/CD-ROMs.
l. At least 90 days prior to the start of Factory Demonstration Testing, the Contractor shall submit a preliminary outline of all O&M submittals for review.
m. After 30 days upon completion of the Factory Demonstration Test, the Contractor shall provide preliminary copies of all O&M manuals for review. These preliminary O&M shall be approximately 90% complete contain sufficient details for Owner/Engineer to review the scope of the manuals.

3. System Maintenance Manuals:
   a. The manual shall be detailed to the component level, including assemblies, subassemblies, and other related components. It shall contain a detailed analysis of each major component so that maintenance personnel can effectively service, inspect, maintain, adjust, troubleshoot, and repair the equipment. Each manual shall include a Table of Contents, arranged in systematic order, and divided into separate sections.
   b. The manual shall also include all applicable visual examinations, hardware testing, diagnostic hardware/software routines. Instruction on how to load and use any test and diagnostic programs and any special or standard test equipment shall be included.
4. System Administrator’s Manuals:
   a. This manual shall be provided to assist the Owner’s system administrator to maintain the SCADA system, it shall include details on all aspects of HMI, networking, PLC system maintenance. It also describes in details the overall system configuration for the equipment provided. Functional description shall include algorithms necessary to fully understand the functions. The material shall be organized for quick access to each detailed description of the system administrator’s procedure. This manual shall be limited only to the description and procedures for functions that are performed by the Owner’s system administrator.
   b. As a minimum, the system administrator’s Manual shall include the following:
      1) Network configuration, routing, switching, etc.
      2) Data Concentrator configuration, specific memory address locations for read/write.
      3) HMI graphic screen and database modifications.
      4) HMI specific trending modifications and ad-hoc trending.
      5) PLC program functionality

5. System Operator's Manuals:
    a. This manual shall be provided to assist the Operator to properly operate the system. The manual shall be written in non-technical English and shall be organized for quick access to each detailed description of the operator's procedure. This manual shall be limited to the description and procedures that are performed by the SCADA system Operator.
    b. This manual shall serve as a complete instruction to the system and equipment and shall describe in detail the Operator interfaces and operator procedures.
    c. This manual shall be provided for each specific process area.
    d. In addition to the Operator interaction sequences, the following shall be provided, as a minimum:
        1) Summary description of all major functions
        2) Presentation of data on displays
        3) Description of how the operator interface with equipment monitoring and control and how to set control parameters such as lead/lag sequencing, flow, and level control setpoints, etc.
        4) Description of how the system and equipment react to situations such as heavy alarming, loss of communication links, heavy operator interaction, and loss of power and restoration of power.
        5) Description of how the systems and equipment react to system failures such as loss of CPU, loss of mass storage, loss of operator/machine display capabilities, and loss of communication.
        6) Description of the hardware configuration and device switching capabilities.
        7) Description of every message and alarm that the system and equipment are capable of outputting and explanation of what the message indicates and what action the system operator should take.
        8) Description on how to generate and print reports

D. Record Drawings shall be furnished within 14 calendar days when the equipment installation is complete. Payment will be withheld until Record Drawings have been furnished and approved. The PCSI shall provide markups on all Process and Instrumentation Contract Drawings.

E. At the time of delivery of the equipment, the Contractor shall have an approved shop drawing in his possession for the Owner's Inspector and Owner's Engineer's verifications.

F. Project Plan, Schedule and Deviation List Submittal

1. Submit, as soon as possible following PCSI's receipt of Notice to Proceed, a Project Plan, Schedule and Deviation List Submittal. The Project Plan, Schedule and Deviation List Submittal shall be made and approved before any further submittals will be accepted and prior to scheduling of the first PCSI coordination meeting. The Project Plan, Schedule and Deviation List Submittal shall, as a minimum, contain the following:
    a. Overview of the Process Control System, clearly describing the PCSI's understanding of the project work and interfaces to other systems; and including a preliminary system architecture drawing and proposed project work schedule detailing all PCSI's work activities. Description of PCSI's understanding of the work shall be an original write-up authored by the PCSI. Copying of the Scope of Work included herein shall not be acceptable.

b. Approach to work clearly describing how the PCSI intends to execute the work, including detailed discussion of switchover, startup, replacement of existing equipment with new, and other tasks as required by these specifications as applicable.
c. PLC software, and PLC hardware submittal information shall be included solely for determining compliance with the requirements of the Contract Documents prior to beginning development of application programming. Review and approval of software and hardware systems as part of this Project Plan stage shall not relieve the PCSI of meeting all the functional and performance requirements of the system as specified herein. Substitution of manufacturer or model of these systems after the submittal is approved shall not be permitted without prior Engineer approval.
d. Details of personnel assigned to the project and organizational structure including the PCSI's project manager, project engineer, and lead project technicians. Include resumes of each key individual and specify in writing their commitment to this project.
e. Preliminary coordination meeting agendas as specified herein.
f. Preliminary training plan
g. Samples of shop drawings to be submitted in conformance with the requirements of the Specifications shall be submitted. At a minimum include samples of panel fabrication drawings, loop, and I/O wiring diagrams.

2. Exceptions to the Specifications or Drawings shall be clearly defined in a separate Deviation List. The Deviation List shall consist of a paragraph by paragraph review of the Specifications indicating acceptance or any proposed deviations, the reason for exception, the exact nature of the exception and the proposed substitution so that an evaluation may be made by the Engineer. The acceptability of any device or methodology submitted as an "equal' or "exception" to the specifications shall be at the sole discretion of the Engineer. If no exceptions are taken to the Specifications or Drawings, the PCSI shall make a statement indicating so. If there is no statement included by the PCSI, it shall be interpreted by the Engineer to mean that no exceptions are taken.
3. A Project Schedule shall be prepared and submitted using an ISO/IEC 26300:2006 formatted file. The schedule shall be prepared in Gantt chart format clearly showing task linkages for all tasks and identifying critical path elements. The PCSI's schedule shall be based on and coordinated with the Contractor's schedule and must meet all field installation, testing, and startup milestones in those schedules. Soft version of the schedule using Microsoft Project shall also be submitted monthly.
4. The PCSI schedule shall illustrate all major project milestones including the following:
a. Schedule for all subsequent project submittals: include in the time allotment, the time required for Contractor submittal preparation, Engineer's review, and a minimum of two complete review cycles.
b. Proposed dates for all required project Coordination Meetings.
c. Hardware purchasing, fabrication, and assembly (following approval of related submittals)
d. Software purchasing and configuration (following approval of related submittals)
e. Shipment of all instrumentation and control system equipment
f. Installation of all instrumentation and control system equipment

g. Duration and dates for all required testing activities. Testing schedule shall include submittal of test procedures a minimum of 30 days prior to commencement of testing. Schedule shall also include submittal of completed documentation of testing activities for review and approval by the Engineer prior to equipment shipment, startup, or subsequent project work.

h. The PCSI shall arrange the schedule to develop, test, troubleshoot, and train the Owner's staff on the PLC and HMI application and systems. The timing of these coordination efforts shall be determined by the PCSI; however, the PCSI shall include all necessary costs to accommodate the minimum time slots in their overall project schedule. All time allotments shall exclude any legal holidays, or days lost due to delays caused by the Contractor or PCSI.

i. Include a schedule for system cutover, startup, and/or placing in service for each major system. At a minimum, include the schedule for each site with details on all major components and sub-components provided under this Contract.

j. Schedule for all training including submittal and approval of O&M manuals, factory training, and field training

1.4 REFERENCE CODES AND STANDARDS

A. Instrumentation equipment, materials and installation shall comply with the National Electrical Code (NEC) and with the latest edition of the following codes and standards:

1. National Electrical Safety Code (NESC)
2. National Electrical Manufacturers Association (NEMA)
3. Insulated Cable Engineers Association (ICEA)
4. The International Society of Automation (ISA)
5. Underwriters Laboratories (UL)
6. UL 508, the Standard of Safety for Industrial Control Equipment
7. UL 508A, the Standard of Safety for Industrial Control Panels
8. UL 50, the Standard of Safety for Enclosures for Electrical Equipment.
9. Factory Mutual (FM)
10. All equipment and installations shall satisfy applicable Federal, State, and local codes.

B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

C. All material and equipment, for which a UL standard exists, shall bear a UL label. No such material or equipment shall be brought onsite without the UL label affixed.

D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents shall take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Contractor, unless otherwise directed by the Owner/Engineer.

E. In accordance with the intent of the Contract Documents, the Contractor accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, the Contractor's responsibility to comply with all Laws and Regulations at all times

F. All control panels shall be constructed and the labeling shall be affixed in a UL 508 facility.

1.5 PROCESS CONTROL SYSTEMS INTEGRATOR (PCSI)

A. The Contractor shall provide the services of a pre-approved Process Control Systems Integrator (PCSI) for all work under the instrumentation sections of this and related Divisions, as described in this section and related sections.

B. Where shown on the Bid Documents, the Contractor shall name the proposed PCSI. Only approved suppliers, as listed herein, will be accepted.

C. Qualifications

1. The PCSI shall be a "systems house," regularly engaged in the design and installation of control and instrumentation systems and their associated subsystems as they apply to the municipal water or wastewater industry. For the purposes of this and other applicable Divisions, a "systems house" shall be interpreted to mean an organization that complies with all the following criteria:
2. Employs a registered professional Control Systems Engineer or Electrical Engineer in the state of Texas to supervise or perform the work required by this Specification Section.
3. Employs personnel on this project who have successfully completed a manufacturer’s training course on the hardware configuration and implementation of the specific programmable controllers, computers, and software proposed for this project.
4. Has been in the water industry performing the type of work specified in this specification section for a minimum of five (5) continuous years and has continuous service contract performing work with the City of Richland Hills in the last three years.
5. The PCSI shall maintain a fully equipped office/production facility with full-time employees capable of fabricating, configuring, installing, calibrating, troubleshooting, and testing the system specified herein. Qualified repair personnel shall be available and capable of reaching the facility within 24 hours.
6. PCSI shall have an Electrical Contractor’s license in the State of Texas.
7. Staff proposed shall have the following specific certifications:
   a. Schneider family of PLCs using EcoStruxure Control Expert Software, and Wonderware Software.
   b. Cisco Ethernet switches, firewalls, and routers.

D. The PCSI responsible for SCADA integration shall have worked directly with the City of North Richland Hills within the last 3 years and have direct knowledge of the current SCADA programming. The pre-approved PCSIs are as follows:

1. WHECO Controls
   8501 Jacksboro Highway
   Fort Worth, Texas 76135
   Attn: Kent Meyerhoeffer, Phone: 817-560-3263

E. The listing of specific PCSI organizations above does not imply acceptance of their products and capabilities that do not meet the specified ratings, features, and functions. PCSI's listed above are not relieved from meeting these specifications in their entirety.

1.6 HAZARDOUS AREAS

A. Equipment, materials and installation in areas designated as hazardous on the Drawings shall comply with NEC Articles 500, 501, 502 and 503.

B. Equipment and materials installed in hazardous areas shall be UL listed for the appropriate hazardous area classification.

1.7 CODES, INSPECTION AND FEES

A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.

B. Obtain all necessary permits and pay all fees required for permits and inspections.

1.8 SIZE OF EQUIPMENT

A. Investigate each space in the structure through which equipment must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.

B. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.

1.9 RECORD DRAWINGS

A. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called the "Record Drawings". The Record Drawings and Specifications shall be kept up to date throughout the project.

B. Complete Record Drawings, including all Drawings and diagrams specified in this Section under the "Submittals" paragraph shall be submitted. These Drawings shall include all termination points on all equipment the control system is connected to, including terminal points of equipment not supplied by the PCSI.

C. As-built documentation shall include information from submittals, as described in this Specification, updated to reflect the as-built system. Any errors in or modifications to the system resulting from the Factory and/or Functional Acceptance Tests shall be incorporated into this documentation.

1.10 EQUIPMENT INTERCONNECTIONS

A. Review shop drawings of equipment furnished under other related Divisions and prepare coordinated wiring interconnection diagrams or wiring tables. Submit copies of wiring diagrams or tables with Record Drawings.

B. Furnish and install all equipment interconnections.

1.11 MATERIALS AND EQUIPMENT

A. Materials and equipment shall be new, except where specifically identified on the Drawings to be re-used.

B. The Contractor shall not bring onsite, material or equipment from a manufacturer, not submitted and approved for this project. Use of any such material or equipment, will be rejected, removed and replaced by the Contractor, with the approved material and equipment, at his own expense.

C. Material and equipment shall be UL listed, where such listing exists.

D. The Contractor shall be responsible for all material, product, equipment and workmanship being furnished for the duration of the project. Equipment shall be replaced if it does not meet the requirements of the Contract Documents.

1.12 DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. Two (2) copies of these instructions shall be included with the equipment at time of shipment and shall be made available to the Contractor and Owner.

B. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Accessories shall be packaged and shipped separately.

C. Equipment shall be equipped to be handled by crane. Where cranes are not available, equipment shall be suitable for skidding in place on rollers using jacks to raise and lower the groups.

D. Equipment shall be installed in its permanent, finished location shown on the Drawings within seven (7) calendar days of arriving onsite. If the equipment cannot be installed within seven (7) calendar days, the equipment shall not be delivered to the site, but stored offsite, at the Contractor’s expense, until such time that the site is ready for permanent installation of the equipment.

E. Where space heaters are provided in equipment or control panels, provide temporary electrical power and operate space heaters during jobsite storage and after equipment is installed in permanent location, until equipment is placed in service.

1.13 WARRANTIES

A. The system warranty shall consist of a full scope in-place warranty. The warranty duration shall be 24 months beyond final acceptance of the entire system. All software and hardware components that are part of the completed system shall be covered by the warranty. The Contractor shall coordinate any warranties provided by third party suppliers. All warranty and maintenance services shall be included in the Contract price.

B. Refer to other Sections for supplemental warranty requirements.

C. Corrective maintenance

1. The Contractor shall provide the services of factory-trained service technicians for the purpose of performing corrective maintenance on all system hardware and software. The period of coverage for each piece of equipment shall begin upon initial equipment purchase or manufacture and shall continue for 24-month after final acceptance or until expiration of the manufacturer's warranty, whichever period is longer.

2. The Contractor shall provide a 24-hour, 7-day/week-service hotline for telephone notification of system malfunctions. Within 2 hours from notification by the Owner of defective SCADA operation, the Contractor shall have a qualified service representative establish telephone contact with the Owner's maintenance personnel to discuss short-term corrective measures.
3. If it is not possible to correct the defective operation as a result of the telephone contact, the Contractor shall have a qualified service representative at the location of the installed SCADA System within 24 hours from initial notification. The service representative shall perform all necessary inspections and diagnostic tests to determine the source of the defect and to establish a corrective action plan. The corrective action plan shall be developed such that the defect is corrected as quickly as possible and with the least impact on the operation of the Owner’s facilities.
4. Prior to beginning any repair or replacement procedure, the Contractor shall review the corrective action plan with the Owner in order to inform him of the planned course of action and to allow assessment of any impact that course of action might have on the operation of the Owner’s facilities. At Owner's option, Owner maintenance personnel may participate in any corrective maintenance procedures.
5. If possible, the service representative shall replace or repair the defective component before leaving the site using spare parts inventory delivered with the system. If spare parts are not available on site, the Contractor shall obtain parts within 48 hrs. Otherwise, the corrective action plan shall include a detailed schedule for the planned course of action.
6. Once the defect has been corrected, the corrective action plan shall be updated indicating the source of the defect and specific corrective action taken. A copy of the updated corrective action plan shall be delivered to the Owner on the day the work is performed. Any spares from the onsite supply of spares used by the Contractor in correcting the system malfunction shall be replaced within 15 days.
7. If 24-hour response time is not provided, or other corrective maintenance requirements are not met by the Contractor, the Owner shall have the right to obtain corrective maintenance from other sources and charge the Contractor in the amount of all Owner’s costs plus alternate service providers invoice, plus 25% of the aggregate amount.
8. The Owner, at Owner's option, may elect to employ its own maintenance staff to locate and remove a defective component. In this case, the Owner will return the defective component to a repair location as instructed by the Contractor. The Contractor shall repair or replace the defective component and return the properly working unit to the Owner within 15 days.

D. Software maintenance

1. After any equipment has been placed in service and tested, Owner or Owner’s designated party shall be permitted to add, modify, and delete Owner provided software. Performance of such actions by the Owner shall not release the Contractor from satisfying any guarantee or maintenance requirements, or any other specified requirements.
2. Programmable Logic Controller (PLC) firmware shall be kept up-to-date during construction with the latest version available up to final acceptance of the system. The firmware updates shall include both CPU and network card.

1.14 EQUIPMENT IDENTIFICATION

A. Identify equipment (control panels, control stations, instruments, etc.) furnished under instrumentation sections of Division 40 with the name of the equipment it serves. Control panels, Instruments, meters junction or terminal boxes, etc., shall have nameplate designations as shown on the Drawings.

B. Nameplates shall be engraved, laminated impact acrylic, black lettering on a white background, matte finish, not less than 1/16-in thick by 3/4-in by 2-1/2-in, Rowmark 322402. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X ½", no equal. Prior to installing the nameplates, the metal surface shall be thoroughly cleaned, with a 70% alcohol solution, until the metal surface residue has been removed. Epoxy adhesive or foam tape is not acceptable.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 COORDINATION MEETINGS

A. The PCSI shall schedule and administer a minimum of three (3) mandatory Coordination Meetings. The PCSI shall make arrangements for meetings; prepare agendas and distribute copies to participants at least one (1) week before scheduled meetings. The meetings shall be held at the Contractor's field office at the site and shall include, as a minimum, attendance by the Owner, Engineer, Contractor's Project Engineer, PCSI's Project Engineer, and the Electrical Subcontractor.

1. The first coordination meeting shall be held in advance of the first PCSI shop drawing submittals (Project Plan and I/O List). The purpose of the first meeting shall be for the PCSI to:
   a. Summarize their understanding of the project
   b. Discuss any proposed substitutions or alternatives
   c. Schedule testing and delivery milestone dates
   d. Provide a forum for the PCSI and Owner to coordinate hardware and software related issues
   e. Request any additional information required from the Owner and/or Engineer.
   f. The PCSI shall bring a draft version of shop drawings to the meeting to provide the basis for the Owner's and Engineer's input into their development.
2. The second coordination meeting shall be held after the Field Instruments, Hardware and Software Submittals, and Panel Layout Drawing/Wiring Diagrams/Loop Drawing Submittal package has been reviewed by the Engineer and returned to the PCSI. The purpose of the second meeting shall be to discuss:
   a. Review comments made on the submittal packages.
   b. Refine scheduled milestone dates.
   c. Coordinate equipment installation activities.
   d. Provide a forum for any additional coordination.
3. The third coordination meeting shall be held one month prior to witnessed factory testing. The purpose of the third coordination meeting is to discuss any remaining coordination requirements.

4. A typical agenda may include, but shall not be limited to, the following:
   a. Review minutes of previous meetings
   b. Review of work progress
   c. Field observations, problems, and decisions
   d. Identification of problems which may impede planned progress
   e. Review of submittal schedule and submittal status
   f. Review of off-site fabrications and delivery schedules
   g. Maintenance of progress schedule
   h. Corrective measures to regain projected schedules
   i. Planned activities for subsequent work period
   j. Coordination of projected progress
   k. Maintenance of quality and work standards
   l. Effect of proposed changes on progress schedule and coordination
   m. Other business relating to project work

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Instrumentation and accessory equipment shall be installed in accordance with the manufacturer's instructions. The locations of equipment, transmitters, alarms and similar devices indicated are approximate only. Exact locations of all devices shall be as approved by the Engineer during construction. All information relevant to the placing of process control work shall be obtained in the field. In case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

B. The P&IDs and Drawings indicate the intent of the interconnection between the individual instruments. Any exceptions should be noted. Two complete sets of approved shop drawings shall be kept at the jobsite during all onsite construction. Both sets shall be marked up identically to reflect any modifications made during field installation or start-up.

C. All equipment used in areas designated as hazardous shall be designed for the Class, Group and Division as required for the locations as shown on the Drawings and specified in Division 26. All work shall be in strict accordance with codes and local rulings.

D. The instrumentation installation details on the Contract Drawings indicate the designed installation for the instruments specified. Where specific installation details are not specified or shown on the Drawings, the American Petroleum Institute (API) Recommended Practice 550 shall be followed as applicable.

E. Unless specifically indicated, direct reading or electrical transmitted instrumentation shall not be mounted on process piping. Instrumentation shall be mounted on instrument racks or stands. All instrumentation connections shall be provided with shutoff and drain valves. For differential pressure transmitter, 3-valve manifolds for calibrations, testing and blow down service shall also be provided. For chemical or corrosive fluids, diaphragm seals with flushing connections shall be provided.

F. All piping tubing to and from field instrumentation shall be provided with necessary unions, calibrations and test tees, couplings, adaptors, and shut-off valves. Process tubing shall be installed to slope from the instrument towards process for gas measurement service and from the process toward the instrument for liquid measurement service. Provide drain/vent valves or fittings at any process tubing points where the required slopes cannot be maintained.

G. Brackets and hangers required for mounting of equipment shall be provided. They shall be installed as shown and not interfere with any other equipment.

H. The shield on each process instrumentation cable shall be continuous from source to destination and be grounded at only one ground point for each shield.

I. Investigate each space in the building through which equipment must pass to reach its final locations. If necessary, ship material in sections sized to permit passing through restricted areas in the building. Provide on-site service to oversee the installation, the location and placement of system components, their connections to the process equipment panels, cabinets and devices, subject to the Engineer's approval. Certify that field wiring associated with his/her equipment is installed in accordance with best industry practice. Schedule and coordinate work under this section with that of the electrical work specified under applicable Section of Division 26.

J. Provide local electrical shutoffs and disconnects for all instruments requiring 120 VAC power. Electrical disconnects shall be suitable rated disconnect switches or manual motor starters as specified under Division 26.

K. Provide sun shields for equipment mounted outdoors in direct sunlight. Sunshields shall include standoffs to allow air circulation around the cabinet. Orient equipment outdoors to face North or as required to minimize the impact of glare on LED, LCD or other digital readouts.

3.3 MANUFACTURER'S SERVICE

A. Provide manufacturer's services for testing and start-up of the equipment as listed in each individual Specification Section.

B. Testing and startup shall not be combined with training. Testing and start-up time shall not be used for manufacturer's warranty repairs.

C. Check interlocking, control and instrument wiring for each system and/or part of a system to prove that the system will function properly as indicated by schematics, wiring diagrams and Control Descriptions.

D. Testing shall be scheduled and coordinated with the Owner/Engineer at least two weeks in advance. Provide qualified test personnel, instruments and test equipment.

E. Refer to the individual Instrumentation Equipment Sections for additional specific testing requirements.

F. Make adjustments to the systems and instruct the Owner's personnel in the proper operation of the systems.

3.4 TESTING

A. Make the tests and checks prior to energizing instrumentation equipment in accordance with Section 40 61 21, and the individual Specification sections.

B. Testing shall be scheduled and coordinated with the Owner/Engineer at least two weeks in advance. Provide qualified test personnel, instruments and test equipment, including manufacturer's services, as specified in the individual Specification sections.

C. Where test reports show unsatisfactory results, the Owner/Engineer will require the removal of all defective or suspected materials, equipment and/or apparatus, and their replacement with new items, all at no cost to the Owner. The Contractor shall bear all cost for any retesting.

3.5 TRAINING

A. The Contractor shall provide training as specified in Section 40 61 26.

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SECTION 40 61 21
INSTRUMENTATION TESTING AND SYSTEM COMMISSIONING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide all testing and commissioning equipment, materials, incidentals, and labor, necessary to perform and coordinate the system check-out and startup, commissioning, field testing and overall training for the new SCADA System.

B. The Contractor's Process Control Systems Integrator (PCSI) shall supervise and/or perform the requirements of this Section. As part of these services, the PCSI shall include, for those systems that are installed through a third party, the services of an authorized manufacturer's representative shall check the equipment installation and place that portion of the equipment in operation. The manufacturer's representative shall be thoroughly knowledgeable about the installation, operation, and maintenance of the manufacturer's equipment.

C. The Contractor's proposed system shall undergo a comprehensive system test process to demonstrate that the system performs as an integrated unit to meet the requirements of this specification. The Contractor, as a normal course of system development, shall conduct all element, subsystem, and system tests necessary to ensure the proper operation of the system at various stages of system development. This type of testing will normally be unwitnessed; however, the Owner's Project Team reserves the right to witness these tests if concerns arise about the progress of system implementation.

D. Witnessed Factory Acceptance Test (WFT) shall be conducted on the SCADA System that includes the Top-end HMI and the PLC. All graphics, I/O database, controls, alarms, security, and historical database for the PLC to be programmed shall be tested.

1.2 SYSTEM CHECKOUT AND START-UP

A. The Contractor shall develop a specific plan for commissioning the new PLC with monitoring and control from the North Richland Hills Operation Control Center (OCC). No commissioning activities shall be performed until the system checkout and startup plan has been successfully reviewed and approved by the Owner/Engineer. All commissioning work shall be closely coordinated with Operational Staff.

B. The Contractor is advised that the existing SCADA system is currently operational and performing monitoring and control functions remote sites; therefore, any disruption to current system operation shall not be acceptable and work shall be coordinated with at least 3-days advanced notice.

C. The following describes the overall system checkout and sequencing and is intended to use as guideline for their system checkout. The General Contractor shall coordinate a separate meeting with the Owner/Engineer to work out the exact startup sequence for site prioritization. A preliminary startup plan shall then be submitted for review. The startup plan shall be successfully reviewed prior to commencing commissioning activities.

D. Base Control System Installation Checkout:

1. Field installation of the pump station shall begin with the installation and testing of the communication network equipment. Installation and integrated testing of the pump station into the overall wide area network shall be completed and certified by the Contractor prior to delivery of the control system components. After delivery, the Contractor shall install all control system components except the PLCs. The Contractor shall complete base system testing to verify the radio communication network, general user interface functions, and other general system functions. This testing shall be accomplished without affecting operation of the existing system or the overall operation of the Owner's facility.
2. During base control system checkout, the Contractor shall be responsible for coordinating this work with Owner staff. Owner staff shall coordinate the Contractor's work with Owner operations, provide access to Owner facilities and equipment, and observe the base control system installation and checkout work.

E. PLC Installation and Checkout:

1. Once the base system (communication network) has been successfully installed, tested, and demonstrated to the Owner/Engineer, field installation and checkout of the PLC shall begin. The following is a guideline of the series of steps involved with the checkout of the PLC.
2. After the pump station control panel has been installed and communications established, the Contractor shall perform tests to verify that communications between the OCC HMI and PLC are functional. Any network or software communication driver issues encountered shall be properly identified and corrected.
3. Next, the Contractor shall perform an I/O check from the field instrument to the PLC.
4. The Contractor shall then perform an end-to-end (field termination to HMI) check, to check each physical I/O point connected to the PLC as defined herein.
5. Once end-to-end point testing has been completed, the processes at the PLC shall be switched to remote manual control so an operator can control the process equipment using the SCADA system HMI.
6. Next, any control software associated with the PLC shall be activated and tested, one function at a time. If application software issues are found, the software configuration shall be "debugged" and the problem corrected. Appropriate tests shall be repeated after the problem is corrected. Once the control software in the PLC has been tested and debugged, that PLC shall remain one line.
7. During PLC installation and checkout, the Contractor shall provide a minimum of two (2) personnel on site full-time. The Owner shall observe the Contractor's work associated with startup of the new PLC and shall provide support for process operations.
8. Upon the complete installation of the PLC on the network, the network monitoring test identified above, under Base Control System Installation Checkout shall be repeated. The test shall include test between HMI, PLC, and other key devices on the network. Any anomalies identified shall be corrected

F. Control System Level Checkout:

1. During this testing phase, the Owner shall operate the SCADA System in remote manual or automatic. The Contractor shall provide two (2) qualified personnel on-site during this phase to diagnose and correct any base Control System problems discovered, as well as to conduct further testing activities. Owner shall observe the Contractor's work and shall provide support for process operations to facilitate testing.

G. Contractor shall provide all test equipment necessary to perform the test during System checkout and startup.

H. Contractor and/or system supplier shall be responsible for initial operation of the pump station and shall make any required changes, adjustment, or replacements for operation, monitoring, and control of the pump station operation and equipment necessary to perform the functions intended.

I. Contractor shall furnish to Engineer two copies of an installation inspection report certifying that all equipment has been correctly installed and are operating properly. The report shall be signed by the Contractor's representatives.

1.3 SUBMITTALS

A. Submittal Process

1. Submit Shop Drawings, in accordance with Division 1 requirements, and as further specified herein. An individually packaged submittal shall be made for this section and shall contain all of the information required. Partial submittals will not be accepted and will be returned un-reviewed.
2. Each Section submittal shall be complete, contain all of the items listed in the Specification Section, and shall be clearly marked to indicate which items are applicable on each cut sheet page. The Submittal shall list any exceptions to the Specifications and Drawings, and the reason for such deviation. Shop drawings, not so checked and noted, will be returned un-reviewed.
3. The Contractor shall check shop drawings for accuracy and Contract Requirements prior to submittal to the Engineer. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by the Specifications and Drawings. Shop drawings shall be stamped with the date checked and a Statement indicating that the shop drawings conform to Specifications and Drawings. Only one Specification Section submittal will be allowed per transmittal unless sections are indicated for grouping in the individual sections.
4. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered or shop work started if shop drawings are marked "APPROVED AS NOTED CONFIRM", "APPROVED AS NOTED RESUBMIT" or "NOT APPROVED".

B. Startup Plan Submittal:

1. The Contractor shall submit a startup plan for Owner/Engineer review. Upon successful review, the Contractor shall coordinate with Operations on an agreed upon date and time for commissioning the pump station.
2. Commissioning (i.e. I/O and equipment checkout) shall be limited to a maximum downtime of 24 Hrs. It is permissible for the Contractor to prepare electrical and control panel work in advance; however, the operation of the existing PLC and communication functionalities shall remain intact.

C. Testing Plan and Schedule Submittal:

1. Within two (2) weeks following PCSI's receipt of Notice to Proceed, submit a Testing Plan and Schedule Submittal. The Testing Plan shall be made and approved before any testing shall be accepted. The Testing Plan, Schedule submittal shall, as a minimum, contain the following:
   a. Overview of the Process Control System, clearly describing the PCSI's understanding of the project work and interfaces to other systems and including a preliminary system architecture drawing and proposed project work schedule detailing all PCSI's work activities.
   b. Approach to work clearly describing how the PCSI intends to execute the work, including detailed discussion of switchover, startup, replacement of existing equipment with new, and other tasks as required by these specifications as applicable.
   c. Preliminary software and hardware submittal information shall be included solely for determining compliance with the requirements of the Contract Documents prior to beginning development of application programming. Review and approval of software and hardware systems as part of this Project Plan stage shall not relieve the PCSI of meeting all the functional and performance requirements of the system as specified herein. Substitution of manufacturer or model of these systems after the submittal is approved shall not be permitted without prior Engineer approval.
   d. Details of personnel assigned to the project and organizational structure including the PCSI's project manager, project engineer, and lead project technicians. Include resumes of each key individual and specify in writing their commitment to this project.
   e. Preliminary coordination meeting agendas as specified herein.
   f. Preliminary training plan.
   g. Samples of shop drawings to be submitted in conformance with the requirements of the Specifications shall be submitted. At a minimum include samples of panel fabrication drawings, loop, and I/O wiring diagrams.
2. Exceptions to the Specifications or Drawings shall be clearly defined in a separate Deviation List. The Deviation List shall consist of a paragraph by paragraph review of the Specifications indicating acceptance or any proposed deviations, the reason for exception, the exact nature of the exception and the proposed substitution so that an evaluation may be made by the Engineer. The acceptability of any device or methodology submitted as an "equal' or "exception" to the specifications shall be at the sole discretion of the Engineer. If no exceptions are taken to the Specifications or Drawings, the PCSI shall make a statement indicating so. If there is no statement included by the PCSI, it shall be interpreted by the Engineer to mean that no exceptions are taken.
3. A Project Schedule shall be prepared and submitted using an ISO/IEC 26300:2006 formatted file. The schedule shall be prepared in Gantt chart format clearly showing task linkages for all tasks and identifying critical path elements. The PCSI's schedule shall be based on and coordinated with the Contractor's schedules and must meet all field installation, testing, and startup milestones in those schedules.
4. The PCSI schedule shall illustrate all major project milestones including the following:

a. Schedule for all subsequent project submittals: include in the time allotment, the time required for Contractor submittal preparation, Engineer's review, and a minimum of two complete review cycles.
b. Proposed dates for all required project Coordination Meetings.
c. Hardware purchasing, fabrication, and assembly (following approval of related submittals).
d. Software purchasing and configuration (following approval of related submittals).
e. Shipment of all instrumentation and control system equipment.
f. Installation of all instrumentation and control system equipment.
g. Duration and dates for all required testing activities. The testing schedule shall include submittal of test procedures a minimum of 30 days prior to commencement of testing. The schedule shall also include submittal of completed documentation of testing activities for review and approval by the Engineer prior to equipment shipment, startup, or subsequent project work.
h. The PCSI shall arrange the schedule to develop, test, troubleshoot, and train the Owner’s staff on the control system network, PLC and HMI applications. The timing of these coordination efforts shall be determined by the PCSI. The PCSI shall include all necessary costs to accommodate the minimum time slots in their overall project schedule. All time allotments shall exclude any legal holidays, or days lost due to delays caused by the Contractor.
i. Include a schedule for system cutover, startup, and/or placing in service for each individual site under this Contract. At a minimum, include the schedule for all work on the primary Operations Control Center, network testing between OCC and the PLC, HMI, PLC programming timeline, Wonderware screens, PLC testing, and all other related tests.
j. Schedule for all training including submittal and approval of O&M manuals, factory training, and field training.

1.4 COMMISSIONING

A. Following the network, instrumentation and control system checkout and start-up, the Contractor shall perform a complete system test in the presence of the Owner/Engineer to verify that all equipment and software is operating properly as a fully integrated system, and that the intended monitoring and control functions of the pump station are fully implemented and operational.
   1. Commissioning shall begin only after networking equipment, all instruments and control panels are installed, wired and previously tested by the Contractor, in accordance with Paragraph 1.2 of this Section.
   2. Contractor shall submit to the Engineer a schedule for Commissioning, including a proposed start date, at least three weeks in advance.

B. Commissioning shall include, as a minimum, the following checks:
   1. All wiring shall be checked at each termination point for correct wire size, type, color, termination and wire number.
   2. All instruments and devices shall be checked to verify compliance with the specifications and approved shop drawings. The calibration of analog devices shall be verified including the zero and span.
   3. Analog wiring shall be checked for correct polarity and ground continuity at each termination point in the loop.

4. All analog loops shall be verified at each termination point at 0%, 25%, 50%, 75%, and 100% signal levels.

C. Contractor shall provide the following documentation for use during the Commissioning effort.
   1. Complete panel schematic and internal point-to-point wiring interconnect drawings.
   2. Complete electrical control schematics in accordance with JIC standards.
   3. Complete panel layout drawings.
   4. Complete field wiring diagrams.
   5. Complete instrument loop diagrams.
   6. Completed Calibration/Recalibration Certificates for all field and panel devices that require adjustment or calibration.
   7. Contractor shall provide one set of Commissioning documentation for the Owner's personnel, one set for the Engineer’s use, one set for field use, and the required number of sets for the Contractor's use.
   8. The drawings corrected and modified during Commissioning shall form the basis for the "As-Built" record drawing requirement.

D. Pump station hardware and software shall be thoroughly tested to verify proper operation as an integrated system. System testing shall include, as a minimum, the following:
   1. All digital inputs shall be activated at the field element to verify proper response to the status change on graphic displays, reports, and in automatic control algorithms.
   2. All analog inputs shall be tested at the field transmitter over a full range to verify proper response on graphic displays, reports, and in automatic control algorithms.
   3. All digital and analog outputs shall be forced to verify proper control operation.
   4. Communications, including RTU fiber Optics data link, PLC I/O card status, and locally interfaced Ethernet devices, shall be tested between all components.
   5. Alarm displays and printing shall be tested for all analog and digital alarm points.
   6. All automatic control algorithms shall be completely tested over various ranges and input conditions to verify proper operation. Graphic displays shall be observed to verify proper response to automatic control operations.
   7. All historical data collection, trending, computation, totalizers and reporting functions shall be checked and tested to confirm proper operation and accuracy of the data.

E. Any defects or problems found during the Commissioning effort or field test shall be corrected by the Contractor and then retested to demonstrate proper operation.

F. Following testing and demonstration of all system functions, the new SCADA system shall be fully operational for a continuous 48-hour period. The Field Demonstration Test specified below shall not begin until the continuous 48-hour proving run has been successfully completed and Owner and Engineer agree that the Field Test can begin.

1.5 TESTS (GENERAL)

A. The PCSI shall test all equipment at the factory prior to shipment. Unless otherwise specified in the individual specification sections, all equipment provided by the PCSI shall be tested at the as a single fully integrated system.

B. The PCSI shall provide all testing hardware and software for the Un-witnessed and Witnessed Factory Tests as outlined under this Specification Section. PLC hardware shall be provided with the latest PLC program loaded for the tests.

C. The PCSI shall provide a temporary standalone HMI server for the test, loaded with the Wonderware Intouch application, with the version currently in use by the Owner, to check out graphic screens for remote monitoring and control functionality. In addition, the PCSI shall provide any simulation logic at the PLC level to test automatic control. Manually forcing inputs and outputs shall not be permitted for automatic control testing.

D. As a minimum, the testing shall include the following:
   1. Un-witnessed Factory Test (UFAT)
   2. Witnessed Factory Test (WFAT)
   3. Operational Readiness Test (ORT)
   4. Functional Demonstration Test (FDT)
   5. 30-Day Site Acceptance Test (SAT)

E. Each test shall be in the cause and effect format. The person conducting the test shall initiate an input (cause) and, upon the system's or subsystem's producing the correct result (effect), the specific test requirement shall be satisfied.

F. All tests shall be conducted in accordance with prior Engineer-approved procedures, forms, and check lists. Each specific test shall be described and followed by a section for sign off by the appropriate party after its status completion.

G. Copies of these sign off test procedures, forms, and check lists will constitute the required test documentation.

H. Provide all special testing materials and equipment. Wherever possible, perform tests using actual process variables, equipment, and data. Where it is not practical to test with real process variables, equipment, and data, provides suitable means of simulation. Define these simulation techniques in the test procedures.

I. The General Contractor shall require the Integration Subcontractor to coordinate all testing with the Engineer, all affected Subcontractors, and the Owner.

J. The Owner/Engineer reserves the right to test or retest all specified functions whether or not explicitly stated in the prior approved Test Procedures.

K. The Engineer's decision shall be final regarding the acceptability and completeness of all testing.

L. No equipment shall be shipped to the Project Site until the Engineer has received all test results and approved the system as ready for shipment.

M. The PCSI shall furnish the services of servicemen, all special calibration and test equipment and labor to perform the field tests.

N. Correction of Deficiencies
   1. All deficiencies in workmanship and/or items not meeting specified testing requirements shall be corrected to meet specification requirements at no additional cost to the Owner.

2. Testing, as specified herein, shall be repeated after correction of deficiencies is made until the specified requirements are met. This work shall be performed at no additional cost to the Owner.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 UNWITNESSED FACTORY TEST (UFT)

A. The entire system, except primary elements, final control elements, and field mounted transmitters, shall be interconnected and tested to ensure the system operates as specified. All analog and discrete input/output points not interconnected at this time shall be simulated to ensure proper operation of all alarms, monitoring devices/functions, and control devices/functions.

B. All panels and assemblies shall be inspected and tested to verify that they are in conformance with related submittals, specifications, and Contract Drawings.

C. The Contractor shall submit to the Owner/Engineer review, the system architecture diagrams as staged in the factory for testing. This diagram shall include all major components such as servers, workstations, data concentrators, control panels, radio communication network, cellular modems, networking devices, etc.

D. During the tests, all digital system hardware and software shall have operated continuously or five days without a failure to verify the system is capable of continuous operation. The un-witnessed test results shall be submitted to the Engineer for review prior to the start of the Witnessed Factory Test (WFT).

E. Test report to be submitted for review shall include all test procedures with a section for signoff and dated. In addition, a system configuration and serialization of all hardware and software provided for the project shall be submitted for review.

3.2 WITNESSED FACTORY TEST (WFT)

A. Before scheduling the Witnessed Factory Test, the PCSI must determine through his own test and quality assurance program that the equipment is ready for shipment to the jobsite.

B. All system tests specified for the Un-Witnessed Factory Test shall be repeated.

C. The WFT will be a conducted at the PCSI facility.

D. After the Un-witnessed Factory Test report has been successfully reviewed, the PCSI shall notify the Engineer and Owner in writing that the system is ready for the Witnessed Factory Test. The Engineer and/or Owner shall schedule a test date within 30 days of receipt of the "Ready to Test" letter. At the time of notification, the PCSI shall submit any revisions to the detailed test procedure previously approved by the Engineer.

E. This test shall verify the functionality, performance, and stability of the hardware and software. The system must operate continuously for 100 hours without failure before the test shall be judged successful. Successful completion of this test, as determined by the Engineer, shall be the basis for approval of the system to be shipped to the site.

F. The various tests performed during the Witnessed Factory Test shall be designed to demonstrate that hardware and software fulfill all the requirements of the Specifications and Contract drawings. The test conditions shall resemble, as closely as possible, the actual installed conditions. Any additional hardware or software that may be required to successfully verify system operation shall be supplied at no cost to the Owner.

G. The Contractor shall be responsible to simulate the I/O signals for any equipment or device communicating with pump station PLC by using a computer system with appropriate simulation software to implement the memory map in the protocol as specified elsewhere. Simulating the I/O signals by forcing them from the PLC programming software will not be acceptable.

H. If simulation code is utilized in the PLC, all such simulation code shall be self-contained in clearly marked program modules dedicated to simulation. After all testing is completed as described herein and in other Specification sections, all simulation code shall be removed from the PLC. Embedding simulation code directly into program modules that are to remain operational for process control shall not be allowed

I. Tests to be performed shall include, but not be limited to, the following:

1. System configuration and serialization verification. A soft and hard copy of the system configuration inventory list of all project deliverables print on 11x17 pages, annotated to reflect this verification shall be included for factory test. The list shall include at least the following:
    a. Manufacturer's name, part number, and serial number
    b. Quantity of units supplied with deliverable system/subsystem
    c. System documentation provided
    d. Applicable cabinet, rack number or slot, and cables
2. The organization of the inventory list shall include provision for annotating each item with forecast and actual dates for:
    a. Review (documentation)
    b. Shipping and delivery (all items except documentation)
    c. Factory demonstration test (hardware and software)
    d. Site Demonstration Test (hardware and software)
    e. Final Acceptance (spares, documentation, etc.)
    f. Delivery (Training Courses)
    g. The inventory list shall be computer-maintained to simplify updating and review using Microsoft Excel program.
3. Inspection of all deliverables of the project, including PLC, Power supply, Instruments, network equipment, communication equipment, cables etc.
4. Demonstrate operability of all equipment
5. Demonstrate operability of the control data communication network under anticipated full load conditions
6. 100 percent point check of I/O, including wiring
7. Demonstrate the ability to monitor and change at least 20 pieces of digital and analog data in each PLC from the HMI software at all operator workstations
8. Demonstrate the ability of workstation to print reports on network printers
9. Demonstrate a catastrophic failure and recovery of PLC.
10. Demonstrate procedure for backing up the PLC; reload using a backup; and completely restoring PLC from a backup.

11. Demonstrate the ability of workstation to print alarm/events on the local printer. During the test for a period of time equal to at least 20 percent of the test duration, the Engineer's and/or Owner's representative shall have unrestricted access to the system.

J. All deficiencies identified during these tests shall be corrected and retested prior to completing the Witnessed Factory Test as determined by the Owner/Engineer.

K. The following documentation shall be made available to the Engineer at the test site both before and during the Witnessed Factory Test:
   1. All Contract Drawings and Specifications, addenda, and change orders
   2. Master copy of the test procedure
   3. List of the equipment to be tested including make, model, and serial number
   4. Design-related hardware submittal applicable to the equipment being tested
   5. Software licenses

L. The daily schedule during these tests shall be as follows:
   1. Morning meeting to review the day's test schedule
   2. Scheduled tests and signoffs
   3. Evening meetings to review the day's test results and to review or revise the next day's test schedule
   4. Unstructured testing period by the witnesses

M. All test data and procedures followed during testing shall be logged and certified copies of the logs shall be provided to the Engineer and Owner.

3.3 OPERATIONAL READINESS TEST (ORT)

A. Prior to startup and the Functional Demonstration Test, the entire system shall be certified (inspected, tested, and documented) that it is READY for operation. The Input / Output test shall be a witnessed by the OWNER/ENGINEER.

B. Loop/Component Inspections and Tests: The entire system shall be checked for proper installation, calibrated, and adjusted on a loop-by-loop and component-by-component basis to ensure that it is in conformance with related submittal's and these Specifications.
   1. The Loop/Component Inspections and Input / Output Tests shall be implemented using Engineer-approved forms and check lists.
      a. Each loop shall have a Loop Status Report to organize and track its inspection, adjustment, and calibration. These reports shall include the following information and check off items with space for sign off by the PCSI.
         1) Project Name
         2) Loop Number
         3) Tag Number for each component
         4) Check offs/sign offs for each component
      b. Tag/identification
      c. Installation
      d. Termination – wiring
      e. Termination – tubing
      f. Calibration/adjustment – Check offs/sign offs for the loop
      g. Panel interface terminations
      h. I/O interface terminations

i. I/O signal operation
j. Inputs/outputs operational: received/sent, processed, and adjusted.
k. Total loop operation – Provide space for comments
l. Each active Analog Subsystem element and each I/O module shall have a Component Calibration Sheet. These sheets shall have the following information, spaces for data entry, and a space for sign off by the PCSI:
    1) Project Name
    2) Loop Number
    3) Component Tag Number of I/O Module Number
    4) Component Code Number Analog System
    5) Manufacturer (for Analog system element)
    6) Model Number/Serial Number (for Analog system)
    7) Summary of Functional Requirements:
        a) Indicators and Recorders: Scale and chart ranges
        b) Transmitters/Converters: Scale and chart ranges
        c) Computing Elements: Function
        d) Controllers: Action (direct/reverse) control Modes (PID)
        e) Switching Elements: Unit range, differential
        f) (FIXED/ADJUSTABLE), Preset (AUTO/MANUAL)
        g) I/O Modules: Input or output

2. Calibrations:
    a. Analog Devices: Required and actual inputs and outputs at 0, 25, 50, 75, and 100 percent of span, rising and falling
    b. Discrete Devices: Required and actual trip points and reset points
    c. Controllers: Mode settings (PID)
    d. I/O Modules: Required an actual inputs or outputs for 0, 25, 50, 75, and 100 percent of span, rising and falling.
        1) Provide space for comments
        2) Space for sign off by the PCSI.
3. The Contractor shall maintain the Loop Status Reports and Component Calibration Sheets at the job-site and make them available to the Engineer/Owner at any time.
4. These inspections and tests require witnessing by the OWNER/ENGINEER. The Engineer will review and initial all Loop Status Sheets and Component Calibration Sheets and spot-check their entries periodically and upon completion of the Operational Readiness Test. Any deficiencies found shall be corrected.

3.4 FUNCTIONAL DEMONSTRATION TEST (FDT)

A. Prior to startup and the 30-Day Test, the entire installed instrument and control system shall be certified that it is ready for operation. All preliminary testing, inspection, and calibration shall be complete as defined in the Operational Readiness Tests.

B. Once the facility has been started up and is operating, a witnessed Functional Demonstration Test shall be performed on the complete system to demonstrate that it is operating and in compliance with these Specifications. Each specified function shall be demonstrated on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.

C. Loop-specific and non-loop-specific tests shall be the same as specified under Functional Demonstration Tests except that the entire installed system shall be tested and all functionality demonstrated.

D. Updated versions of the documentation specified to be provided for during the tests shall be made available to the Engineer at the job-site both before and during the tests. In addition, one copy of all O&M Manuals shall be made available to the Engineer at the job-site both before and during testing.

E. The daily schedule specified to be followed during the tests shall also be followed during the Functional Demonstration Test.

F. The system shall operate for 100 continuous hours without failure before this test shall be considered successful.

G. Demonstrate communication failure and recovery

3.5 30-DAY SITE ACCEPTANCE TEST (SAT)

A. After completion of the Operational Readiness and Functional Demonstration Tests for all sites, the PCSI shall be responsible for operation of the entire system for a period of 30 consecutive days, under conditions of full plant process operation, without a single non-field repairable malfunction.

B. During this test, plant operating and PCSI personnel shall be present as required. For this test, the PCSI is expected to provide personnel who have an intimate knowledge of the system hardware and software.

C. While this test is proceeding, the Owner shall have full use of the system. Only plant operating personnel shall be allowed to operate equipment associated with live plant processes.

D. Any malfunction during the tests shall be analyzed and corrected by the PCSI. The Engineer and/or Owner will determine whether any such malfunctions are sufficiently serious to warrant a repeat of this test.

E. During this 30-consecutive day test period, any malfunction which cannot be corrected within 24 hours of occurrence by PCSI personnel, or more than two similar failures of any duration, will be considered a non-field-repairable malfunction.

F. Upon completion of repairs by the PCSI, the test shall be repeated as specified herein.

G. In the event of rejection of any part or function, the PCSI shall perform repairs or replacement within 90 days.

H. The total availability of the system shall be greater than 99.5 percent (99.5%) during this test period. Availability shall be defined as:

Availability = (Total Testing Time-Down Time) / Total Testing Time

I. Down times due to power outages or other factors outside the normal protection devices or back-up power supplies provided shall not contribute to the availability test times above.

J. Upon successful completion of the 30-day site acceptance test and subsequent review and approval of complete system final documentation, the system shall be considered substantially complete, and the one-year warranty period shall commence.

END OF SECTION

SECTION 40 61 26
INSTRUMENTATION SYSTEM TRAINING

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Provide all equipment, materials, incidentals and labor, necessary to perform and coordinate the overall system training for the Process Control System.

B. The Process Control Systems Integrator (PCSI) shall perform the requirements of this section.

C. As part of these services, the PCSI shall include, for those services of an authorized manufacturer's representative to provide training as set forth within this section and related sections of the specifications.

1.2 RELATED WORK

A. Refer to Section 40 61 00 Instrumentation and Controls - General Provisions

1.3 SUBMITTALS

A. The PCSI shall prepare and submit a complete overall Process Control System training plan.

B. The training plan shall include:

1. Definitions, objectives, and target audience of each course
2. Schedule of training courses included proposed dates, duration and locations of each class.
3. A complete copy of all proposed handouts and training materials. Training information shall be bound and logically arranged with all materials reduced to a maximum size of 11-inch by 17-inch, then folded to 8.5-inch by 11-inch for inclusion into the binder.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 TRAINING

A. General:

1. The cost of training programs for the Owner’s personnel shall be included in the Contract price. The training and instruction shall be directly related to the system being supplied. The training program shall represent a comprehensive program covering all aspects of the operation and maintenance of the system.
2. All onsite instructors must be intimately familiar with the operation and control of the Owner’s facilities.
3. All Technicians, Operators, Engineers, and Managers of the facility shall require training on the Process Control System (PCS). The training courses shall address operation, maintenance, and troubleshooting of the system provided. The courses shall be designed specifically for the type of personnel attending, such as operators, engineers, etc.

4. All training schedules shall be coordinated with and at the convenience of the Owner. Shift training may be required to correspond to the Owner's working schedule.
5. Provide detailed training manuals to supplement the training courses. The manuals shall include specific details of equipment supplied and operations specific to the project. The manuals shall be provided for each student. Provide electronic copy of each training manual in PDF format for Owner's future use.
6. The trainer shall make use of teaching aids, manuals, slide/video presentations, etc. After the training services, all training materials shall be delivered to Owner.
7. The Owner reserves the right to videotape all training sessions. All training tapes shall become the sole property of the Owner.

B. The training courses listed as follows shall, as a minimum, be provided:

Course Description	Course Duration (hours)	Number of Trainees
SCADA System Monitoring and control	4	3
PLC Hardware/Software (2 sessions, 4 students each)	4 hrs per Session	4 per session
Field and Panel Instruments	2	3
Operator (Pre-Startup)	2	5
Operator (Post-Startup)	2	5

C. Control System Training:
1. Human Machine Interface (HMI):
   a. Provide training for the Owner's personnel in the functionality, maintenance, and troubleshooting, of the installed Control System. The training shall be held before the Functional Demonstration Test (FDT), but not more than two months before.
   b. Training personnel shall be intimately familiar with the control system equipment, its manipulation, and configuration. Training personnel shall command knowledge of system debugging, program modification, troubleshooting, maintenance procedure, system operation, and programming, and shall be capable of transferring this knowledge in an orderly fashion to technically oriented personnel.
   c. Training and instruction shall be specific to the system that is being supplied.
   d. Training shall consist of classroom and hands-on instruction utilizing the Owner's system.
   e. Detailed training shall be provided on the actual configuration and implementation for this contract. Training shall cover all aspects of the system that will allow the Owner's personnel to maintain, modify, troubleshoot, and develop future additions/deletions to the system. The training shall cover the following subjects, as a minimum:

1) System overview
2) System hardware components and specific equipment arrangements
3) System startup, shut down, load, backup, and historical archival/retrieval procedures
4) Specific application configuration covering the overall design and implementation of the applications provided under this contract. The intent is to make the student fully knowledgeable in all aspects of the system provided.
5) Periodic maintenance
6) Troubleshooting and diagnosis
7) Network configuration, communications, and operation
8) SCADA system hardware operating system operation and maintenance
9) System backups and reload procedures
10) Ethernet/IP and TCP/IP addressing procedures

2. Programmable Logic Controller (PLC) Hardware and Software:
   a. Provide training for the Owner's personnel in the operation, maintenance, troubleshooting, etc. with the PLC hardware and software system. The training shall be held before the FDT, but not more than two months before.
   b. Training and instruction shall be specific to the system that is being supplied.
   c. Training shall consist of classroom and hands-on instruction utilizing the Owner's system.
   d. Detailed training shall be provided on the actual configuration and implementation for this contract. Training shall cover all aspects of the system that will allow the Owner's personnel to maintain, modify, troubleshoot, and develop future additions/deletions to the system. The training shall cover the following subjects, as a minimum:
      1) PLC System overview
      2) PLC System hardware components and specific equipment arrangements
      3) PLC System startup, shut down, load, backup, and historical archival/retrieval procedures
      4) Specific application configuration covering the overall design and implementation of the applications provided under this contract. The intent is to make the student fully knowledgeable in all aspects of the system provided.
      5) Periodic maintenance
      6) Troubleshooting and diagnosis down to the I/O card level.
      7) Network configuration, communications, and operation.

D. Field Training:
   1. Field Instruments:
      a. Provide a minimum of one 8-hour hardware training and instruction on the maintenance of the field instrumentation. This training shall be conducted before the Functional Demonstration Test, but no more than one month before and at a time suitable to the Owner. This training shall take place at the Owner's facility. As a minimum, the following shall be included:
         1) Training in standard hardware maintenance for the instruments provided
         2) Specific training for the actual instrumentation configuration to provide a detailed understanding of how the equipment and components are arranged, connected, and set up for this contract
         3) Test, adjustment, and calibration procedures

4) Troubleshooting and diagnosis
5) Periodic maintenance

2. Panel Instruments:
   a. Provide a minimum of one 4-hour hardware training and instruction in the maintenance of the panel instrumentation. Training should be conducted before the Functional Demonstration Test, but not more than one month before and at a time suitable to the Owner. This training shall be provided at the Owner's facility and at a minimum the following shall be included:
      1) Training in standard hardware maintenance for the instruments provided
      2) Specific training for the actual instrumentation configuration to provide a detailed understanding of how the equipment and components are arranged, connected, and configured for this contract
      3) Test, adjustment, and calibration procedures
      4) Troubleshooting and diagnosis
      5) Periodic maintenance
3. Operator Training:
   a. Training personnel shall be intimately familiar with both the Control System and the Process Equipment. The PCSI shall provide trainers that are familiar with the designed operations and how the control system executes the operation.
   b. One or two operator training session (Pre-Startup) for operators shall be held 1 week before system startup. An additional one or two operator training session (Post-Startup) for operators shall be held one week after system startup. Sessions will be held in four-hour blocks.
   c. Plant Operator field training shall be held at the convenience of the Owner. The PCSI shall be prepared to hold this training during the day, late at night, or very early in the morning to accommodate the Owner's shift schedule.
   d. Plant Operator field training shall be structured specifically for operations type personnel. Training personnel shall be prepared to show the operators how to operate the plant from the Control System level in the event of Control Room equipment failure. Additionally, printing reports on demand, copying graphic displays, signing-on the system, creating graphic generated trends, etc. shall be discussed.
   e. Plant Operator field training shall be introductory in nature during pre-startup training and more in-depth and detailed during post-startup training.
   f. The PCSI shall, at a minimum, have the following teaching aids available for distribution during Plant Operator field training sessions:
      1) Preliminary O&M Manuals (pre-startup); Final O&M Manuals (post-startup).
      2) Process, Mechanical, and Instrumentation Diagrams as presented in the Contract documents.
      3) Daily syllabus.
      4) Fifty percent of all Plant Operator field training shall be "hands on" utilizing the installed Control System to the fullest extent possible. The PCSI shall ascertain the operability of the Control System before commencing training. Training performed using a non-functioning Control System shall be rejected and repeated.

END OF SECTION

40 61 90 PROCESS INSTRUMENTATION LIST

PART 1 GENERAL

1.01 SCOPE OF WORK

A. This section includes a summary of the process instrumentation list.

1.02 RELATED WORK

A. Refer to section 40 61 00 Instrumentation General Provisions including coordination meetings required between various parties involved with controls programming.

B. Refer to Section 40 61 96 Control Loop Descriptions for additional information.

1.03 SUBMITTALS

A. Refer to Section 40 68 60 Applications Services and Section 40 61 00 Instrumentation general provisions.

1.04 SYSTEM DESCRIPTION

A. The process instrumentation list provides a summary of the major process instrumentation requirements as utilized within the control loops represented in the Contract Documents. Additional process instrumentation shall be provided as required to fully implement the strategies as described in these specifications and as recommended be the process and mechanical equipment division suppliers.

B. The process instrumentation list are not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions, but are rather intended to supplement and complement the drawings and other specification sections. The Process Instrumentation List shall not be considered equal to a bill of materials.

C. Provide instrumentation hardware and software as necessary to perform control functions specified herein and as shown on drawings.

1.05 PROCESS INSTRUMENTATION LISTING

A. The new process instrumentation list shall be as follows:

Item	Instrument Tag	Description	PLC	Type	Specification	Range or Setpoint	Comment
1	PI-1011-1A	Conn Pump Station Pump No.1 Inlet Pressure Gauge	PLC-1000-1	Pressure Gauge	40 71 00	0.5 - 8 PSI	New instrument
2	PSL-1011-1	Conn Pump Station Pump No.1 Inlet Pressure Switch Low	PLC-1000-1	Pressure Switch	40 71 00	2 PSI	New instrument;
3	PI-1011-1B	Conn Pump Station Pump No.1 Discharge Pressure Gauge	PLC-1000-1	Pressure Gauge	40 71 00	75-95 PSI	New instrument
4	PSH-1011-1	Conn Pump Station Pump No.1 Discharge Pressure Switch High	PLC-1000-1	Pressure Switch	40 71 00	96 PSI	New instrument
5	PI-1012-1A	Conn Pump Station Pump No.2 Inlet Pressure Gauge	PLC-1000-1	Pressure Gauge	40 71 00	0.5 - 8 PSI	New instrument
6	PSL-1012-1	Conn Pump Station Pump No.2 Inlet Pressure Switch Low	PLC-1000-1	Pressure Switch	40 71 00	2 PSI	New instrument
7	PI-1012-1B	Conn Pump Station Pump No.2 Discharge Pressure Gauge	PLC-1000-1	Pressure Gauge	40 71 00	75-95 PSI	New instrument
8	PSH-1012-1	Conn Pump Station Pump No.2 Discharge Pressure Switch High	PLC-1000-1	Pressure Switch	40 71 00	96 PSI	New instrument
9	PI-1013-1A	Conn Pump Station Pump No.3 Inlet Pressure Pressure Gauge	PLC-1000-1	Pressure Gauge	40 71 00	0.5 - 8 PSI	New instrument
10	PSL-1013-1	Conn Pump Station Pump No.3 Inlet Pressure Switch Low	PLC-1000-1	Pressure Switch	40 71 00	2 PSI	New instrument
11	PI-1013-1B	Conn Pump Station Pump No.3 Discharge Pressure Gauge	PLC-1000-1	Pressure Gauge	40 71 00	75-95 PSI	New instrument
12	PSH-1013-1	Conn Pump Station Pump No.3 Discharge Pressure Switch High	PLC-1000-1	Pressure Switch	40 71 00	96 PSI	New instrument
13	TIT-1000-1	Conn Pump Station Ambient Temperature	PLC-1000-1	Temperature Transmitter	40 71 00	0-135 DegF	New instrument
14	FIT-1020-1	Conn Pump Station Valve Vault Flow Meter	PLC-1000-1	Electro-Magnetic	40 71 00	0-12,000 GPM	New instrument
15	PIT-1020-1	Conn Pump Station Distribution Pressure	PLC-1000-1	Pressure Transmitter	40 71 00	0-150 PSI	New Instrument
16	LIT-1000-1	Conn Pump Station Tank Level	PLC-1000-1	Radar	40 71 00	9-25 feet	New Instrument, Low level cut off at 8-FT

1.06 CALIBRATION INSTRUMENTATION LISTING

A. All of the process instruments shall require calibration and shall be submitted under this section utilizing calibrations forms such as the following example.

CALIBRATION CERTIFICATE					
Tag Number/Loop Number:					
Loop Description					
Instrument Location					
Manufacturer					
Model Number					
Adjustable Range					
Calibrated (Scaled) Range					
Remarks					
Installation Per Manufacturer's Requirements?			**Yes**		**No**
Installation Per Contract Documents?			**Yes**		**No**
If "No", explain					
Calibration Test:					
	Input (Units)		Output (Units)		Accuracy
0%					
25%					
50%					
75%					
100%					
Switch Test	Switch Point Upscale		Switch Point Downscale		Setting Deadband
Setpoint 1					
Setpoint 2					
Setpoint 3					
I hereby certify that the above information is correct and accurate, to the best of my knowledge, and that the instrument indicated above has been supplied, installed, calibrated, and tested in accordance with the manufacturer's recommendations and the Contract Documents, unless otherwise noted. Receipt of this Calibration Certification shall in no way imply acceptance of any work or instrument supplied as a part of this Contract.					
Contractor's Signature:			Date:		

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 INSTALLATION

A. All Process Instruments listed shall be supplied as specified herein and shall be installed, field adjusted and tested as an integral part of the overall control systems specified elsewhere in these Specifications.

END OF SECTION

SECTION 40 61 93
FIELD INPUT/OUTPUT LIST

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section includes instrumentation input/output list.

1.2 RELATED WORK

A. Refer to Section 40 61 00 Instrumentation and Controls General Provisions including coordination meetings required between various parties involved with controls programming.

B. Refer to Section 40 61 96 Control Loop Descriptions for additional information.

1.3 SUBMITTALS

A. Refer to Section 40 68 60 Applications Services and Section 40 61 00 Instrumentation and Controls General Provisions.

1.4 SYSTEM DESCRIPTION

A. The instrumentation input/output list provides the minimum physical signal requirements of the control loops represented in the Contract Documents. Additional soft signals as required to fully implement the strategies as described in these specifications shall be included.

B. The input/output listing is not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions but are rather intended to supplement and complement the drawings and other specification sections. The input/output listing shall not be considered equal to a bill of materials.

C. Provide instrumentation hardware and software as necessary to perform Input/output monitoring/control functions specified herein and as shown on drawings.

1.5 INPUT/OUTPUT LISTING

A. The instrumentation input/output listing shall include all signals as shown on the drawings and the following as a minimum.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 INSTALLATION

A. All inputs/outputs listed shall be programmed in the system as specified herein and shall be installed, field adjusted and tested as an integral part of equipment specified elsewhere in these Specifications.

END OF SECTION

Item No.	Point Tagname	Tag Description	PLC	DI	DO	AI	AO	NOTES
1	LIT_1000_1_LI	Conn Pump Station GST Level	PLC-1000-1			1		
2	PIT_1020_1_PI	Conn Pump Station Valve Vault Pressure	PLC-1000-1			1		
3	FIT_1020_1_FI	Conn Pump Station Valve Vault Flow	PLC-1000-1			1		
4	LSH_1000_1_LAH	Conn Pump Station Valve Vault Flood	PLC-1000-1	1				
5	LSL_1000_1_LAL	Conn Pump Station GST Low Level	PLC-1000-1	1				
6	VLV_1000_1_ZH	Conn Pump Station GST Fill Valve Open	PLC-1000-1	1				
7	VLV_1000_1_ZL	Conn Pump Station GST Fill Valve Closed	PLC-1000-1	1				
8	VLV_1000_1_ZC	Conn Pump Station GST Fill Valve Position Command	PLC-1000-1				1	
9	VLV_1000_1_ZI	Conn Pump Station GST Fill Valve Position	PLC-1000-1			1		
10	VLV_1000_1_YL	Conn Pump Station GST Fill Valve Local/Remote	PLC-1000-1	1				
11	VLV_1000_1_XA	Conn Pump Station GST Fill Valve Fault	PLC-1000-1	1				
12	PMP_1011_1A_MY	Conn Pump Station Pump 1 E-Stop	PLC-1000-1	1				
13	PMP_1011_1_YL	Conn Pump Station Pump 1 In Remote	PLC-1000-1	1				
14	PMP_1011_1_MN	Conn Pump Station Pump 1 Running	PLC-1000-1	1				
15	PMP_1011_1_MD	Conn Pump Station Pump 1 Remote Start	PLC-1000-1		1			
16	PMP_1011_1_MF	Conn Pump Station Pump 1 VFD Fail	PLC-1000-1	1				
17	PMP_1011_1_MB	Conn Pump Station Pump 1 Remote Stop	PLC-1000-1		1			
18	PMP_1011_1B_MY	Conn Pump Station Pump 1 Remote E-Stop	PLC-1000-1	1				
19	PMP_1011_1_SI	Conn Pump Station Pump 1 Speed Feedback	PLC-1000-1			1		
20	PMP_1011_1_SC	Conn Pump Station Pump 1 Speed Setpoint	PLC-1000-1				1	
21	PMP_1011_1_PAL	Conn Pump Station Pump 1 Low Suction Pressure	PLC-1000-1	1				
22	PMP_1011_1_PAH	Conn Pump Station Pump 1 High Discharge Pressure	PLC-1000-1	1				
23	PMP_1011_1_TAH	Conn Pump Station Pump 1 High Temperature	PLC-1000-1	1				
24	PMP_1012_1A_MY	Conn Pump Station Pump 2 E-Stop	PLC-1000-1	1				
25	PMP_1012_1_YS	Conn Pump Station Pump 2 In Remote	PLC-1000-1	1				
26	PMP_1012_1_MN	Conn Pump Station Pump 2 Running	PLC-1000-1	1				
27	PMP_1012_1_MD	Conn Pump Station Pump 2 Remote Start	PLC-1000-1		1			
28	PMP_1012_1_MF	Conn Pump Station Pump 2 VFD Fail	PLC-1000-1	1				
29	PMP_1012_1_MB	Conn Pump Station Pump 2 Remote Stop	PLC-1000-1		1			
30	PMP_1012_1B_MY	Conn Pump Station Pump 2 Remote E-Stop	PLC-1000-1	1				
31	PMP_1012_1_SI	Conn Pump Station Pump 2 Speed Feedback	PLC-1000-1			1		
32	PMP_1012_1_SC	Conn Pump Station Pump 2 Speed Setpoint	PLC-1000-1				1	
33	PMP_1012_1_PAL	Conn Pump Station Pump 2 Low Suction Pressure	PLC-1000-1	1				
34	PMP_1012_1_PAH	Conn Pump Station Pump 2 High Discharge Pressure	PLC-1000-1	1				
35	PMP_1012_1_TAH	Conn Pump Station Pump 2 High Temperature	PLC-1000-1	1				
36	PMP_1013_1A_MY	Conn Pump Station Pump 3 E-Stop	PLC-1000-1	1				
37	PMP_1013_1_YS	Conn Pump Station Pump 3 In Remote	PLC-1000-1	1				
38	PMP_1013_1_MN	Conn Pump Station Pump 3 Running	PLC-1000-1	1				
39	PMP_1013_1_MD	Conn Pump Station Pump 3 Remote Start	PLC-1000-1		1			
40	PMP_1013_1_MF	Conn Pump Station Pump 3 VFD Fail	PLC-1000-1	1				
41	PMP_1013_1_MB	Conn Pump Station Pump 3 Remote Stop	PLC-1000-1		1			
42	PMP_1013_1B_MY	Conn Pump Station Pump 3 Remote E-Stop	PLC-1000-1	1				
43	PMP_1013_1_SI	Conn Pump Station Pump 3 Speed Feedback	PLC-1000-1			1		
44	PMP_1013_1_SC	Conn Pump Station Pump 3 Speed Setpoint	PLC-1000-1				1	

Item No.	Point Tagname	Tag Description	PLC	DI	DO	AI	AO	NOTES
45	PMP_1013_1_PAL	Conn Pump Station Pump 3 Low Suction Pressure	PLC-1000-1	1				
46	PMP_1013_1_PAH	Conn Pump Station Pump 3 High Discharge Pressure	PLC-1000-1	1				
47	PMP_1013_1_TAH	Conn Pump Station Pump 3 High Temperature	PLC-1000-1	1				
48	TIT_1000_1_TAH	Conn Pump Station Electrical Room Temperature	PLC-1000-1			1		
49	PLC_1000_1A_XA	Conn Pump Station PLC Panel Intrusion	PLC-1000-1	1				
50	PLC_1000_1A_JA	Conn Pump Station PLC Panel DC Fail	PLC-1000-1	1				
51	PLC_1000_1B_JA	Conn Pump Station PLC Panel AC Fail	PLC-1000-1	1				
52	UPS_1000_1B_JA	Conn Pump Station PLC Panel UPS Fail	PLC-1000-1	1				
53	UPS_1000_1A_JA	Conn Pump Station PLC Panel UPS on Battery	PLC-1000-1	1				
54	SCP_1000_1A_XA	Conn Pump Station Security Panel Door Intrusion	PLC-1000-1	1				
55	EB_1000_1A_XA	Conn Pump Station Electrical Room Door Intrusion	PLC-1000-1	1				
56	LSL_1000_1_LAL	Conn Pump Station GST Low Level Lockout	PLC-1000-1	1				
			Total	**38**	**6**	**8**	**4**	
			with 20% Spare	**45**	**7**	**10**	**5**	

SECTION 40 61 96
CONTROL LOOP DESCRIPTIONS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This section includes instrumentation control descriptions that will be implemented in the PLC for the Conn Pump Station.

B. The design intent is that the control strategies will be developed into PLC-based programming consistent with the Owner's standards.

C. All programming required for a fully functioning and integrated system as described herein and related section shall be the responsibility of the Process Control Systems Integrator (PCSI). The PCSI will provide the Programmable Logic Controller (PLC) programming, Human-Machine Interface (HMI) software configuration, database development, report development, testing, startup, training, and warranty associated with control system and equipment provided under this project. These shall include, but are not limited to, the following:

1. The PCSI shall schedule workshops in accordance with Section 40 61 00, Instrumentation and Controls – General Provisions.
2. The new PLC program shall be properly commented with detail descriptions describing all functionality contained each program section. All main program sections, User-Defined Function Blocks (UDFBs), subsections, subroutines, equipment control, instrumentation monitoring, automatic control functionality, etc. shall be commented.
3. Configuration of HMI graphic screens and polling engine to poll the Conn Pump Station.
4. The new PLC program shall be able to accept remote start/stop commands, open/close commands, pump lead/lag selection, control setpoints, etc. from the Operations Control Center (OCC). All alarm functionality shall reside in the PLC where these alarm limit parameters can be individually set within the HMI. Each alarm limit shall be enabled/disabled from the OCC.

1.2 RELATED WORK

A. Section 40 61 00 - Instrumentation and Control: General Provisions.

B. Section 40 61 21 – Instrumentation Testing and System Commissioning.

C. Section 40 68 60 - Application Services.

1.3 DEFINITIONS

A. AFD: Adjustable frequency drive.

B. HMI: Human machine interface.

C. H/O/A: Hand-Off-Automatic.

D. L/O/R: Local-Off-Remote.

E. OCC: Operations Control Center.

F. PLC: Programmable logic controller.

G. PCSI: Process Control System Integrator.

1.4 SUBMITTALS

A. Submittal Process

1. Submittals shall be made in accordance with the requirements of Division 1, Sections 40 61 00, 40 68 60, and as specified herein.
2. Submittals require information on related programming to be furnished under this Specification and described in the related Sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will be returned without review.
3. The programming to interface the electrical equipment to the Owner's Control System shall be submitted as described herein and related specifications.

B. Submittal Content

1. All submittals shall bear the PCSI's logo, drawing file numbers, and shall be maintained on file in the PCSI's archive file system. Photocopies or electronically created copies of the Engineer's diagrams, control descriptions, or specifications are unacceptable as shop drawings and shall be returned without review.

C. Required Submittals

1. All work described herein shall be incorporated into a work plan submittal as defined in Related Work sections.
2. Shop Drawings
   a. Shop Drawings shall include the following:
      1) Control strategy for the PLC to be programmed. The control strategy shall indicate sufficient detail to be clearly understood by the Owner's representative and include I/O tag names (hardwired and virtual) for all data as submitted within the memory maps as specified herein.
      2) A Communication Memory Map shall be submitted and include specific Tag Names, Data type, expected range, and Modbus register. These Maps shall fully document all communication exchanges and other data changes via peer-to-peer communication (if required) over the Ethernet network.
   b. Data Communications Interconnecting Diagrams
      1) Provide interconnecting diagrams showing Data connections between equipment and include polling rate/frequency at which the data will be transmitted.
3. Factory Tests.
   a. Submittals shall be made for factory tests as specified in Section 40 61 21 Instrumentation Testing and System Commissioning. Owner/Engineer approval of required factory tests is required prior to shipment of the equipment.
4. Field Tests.
   a. Submittals shall be made for field tests as specified herein.
5. Operation and Maintenance Manuals.
   a. Operation and maintenance manuals shall be provided for Pump station PLC and shall include at least the following information:
      1) PCSI's contact address and telephone number for service.
      2) Instruction books and/or leaflets.
      3) Recommended system maintenance procedures.

4) Record Documents for the information required by the Submittals paragraph above and related sections of the contract documents.
5) Control narratives that fully describe all monitoring and control functionality of the remote station.
6) Separate section for all field I/O databases.
7) Separate section for all pseudo/virtual databases.
8) Printed version of PLC program shall be provided and formatted so that program logic is presented on a single page without spanning between pages (i.e. no timer module is half shown on one page and the remainder on the next page).
9) Final Copies of Programs shall be provided for each individual PLC to include both electronic and printed formats. Electronic version of O&M shall be provided in searchable PDF format. PLC programs shall be fully documented as directed by the owner/engineer.

1.5 SYSTEM DESCRIPTION

A. The control loop descriptions provide the functional requirements of the control loops represented in the Contract Documents. Descriptions are provided as follows:
   1. Control system overview and general description.
   2. Major equipment to be controlled.
   3. Major field-mounted instruments (does not include local gauges).
   4. Local monitoring and control functions.
   5. Remote manual control functions.
   6. Remote automatic control functions/interlocks.
   7. Major indications and alarms to be provided for the PLC and the OCC.

B. The control loop descriptions are not intended to be an inclusive listing of all elements and appurtenances required to execute loop functions but are rather intended to supplement and complement the Drawings and other specification sections.

C. Provide descriptions of instrumentation hardware and/or software as necessary to describe the performance of control functions specified herein and shown on drawings.

1.6 SYSTEM CONTROL PANELS

A. The PLC control panel shall be programmed by the PCSI.

B. The programming shall follow the control descriptions as specified herein. Coordination of the various programs shall be the responsibility of the PCSI.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL SCADA CONTROL REQUIREMENTS

A. General
   1. All PLC programming and HMI configuration shall be performed in accordance with the Owners' Tag Naming Standards.

2. All calculations, alarms, and/or shutdown point determinations based on analog values, timer functions, numeric manipulations, etc. shall be accomplished in the PLC and not in the HMI.
3. All analog I/O points and related values shall be scaled within the PLC at remote station, to an IEEE 32-bit floating point value and displayed at the HMI systems.
4. The pump station PLC shall sync the Real Time Clocks with the HMI SCADA server device on a daily basis.

B. Safety, Monitoring, and Control Features

1. Alarms
   a. All open/close valves, gates and motors monitored by the PLC shall have a maximum time value allowed to either open/close or start/stop. Failure to achieve the control function within this maximum time value shall result in a discrepancy alarm for each piece of equipment. An alarm will be calculated in the PLC and shown in the HMI software for indication of the control function failure (e.g. Pump FAIL TO START, Valve FAIL TO CLOSE, etc.). These time delay values will be set during startup and are not operator configurable.
   b. The integrity of all analog signals shall be checked within the PLC. For any analog signal that is under range, over range, or otherwise invalid (broken loop), an alarm shall be indicated in the PLC and shown in the HMI. The Operator will acknowledge and correct the situation in order for control to revert to normal.
   c. All analog input points, with the exception of pump speed, shall have High-High, High, Low, and Low-Low alarms generated in the PLC. Each of these alarms shall further be independently enabled and disabled as well as have the alarm set-points configurable from the HMI.
   d. Each individual field analog device shall have an overall alarm inhibit function such that in the event of a faulty signal, the operator from the HMI may inhibit all alarms. When the operator removes the inhibit signal, the updates shall resume and alarms that were enabled previously shall again be re-enabled.
   e. Each individual field analog device shall have the ability to be configured to hold last good value upon detection of a broken loop.
   f. When the PLC program's AFD pump control speed does not match the AFD pump speed feedback within tolerance after a certain time delay, an alarm will be generated at the PLC and shown at the HMI to indicate the discrepancy. The discrepancy alarm setting is hardcoded in the PLC during startup.
   g. All discrepancy alarms shall be latched at the control level where they are originated (e.g. alarms that are determined in the PLC are latched in the PLC). All discrepancy alarms can be reset from the HMI.
   h. Un-commanded change alarms shall be generated at the PLC when a piece of equipment changes state without being commanded.
2. All analog input points shall have zero clamp capability within the PLC. For example, if flow is below 10 gpm set in the PLC, the actual value displayed on the HMI shall be shown as "0.00" and not totalized.
3. Totalize all pump run times in the PLC and monitor on the HMI. Provide two different run times, one of which shall be non-resettable accumulated runtime while the other shall be the runtime since last reset. The reset shall be time and date stamped with values stored in the PLC and displayed at the HMI. Runtime shall be displayed in the format of XXXXXXX.X which is scaled in hours and fraction thereof.

4. Totalize all pump starts in the PLC and monitor on the HMI. Provide two different starts indications, one of which shall be non-resettable accumulated starts while the other shall be the number of starts since last reset. The Reset shall be time and date stamped with values stored in the PLC and displayed at the HMI.
5. Totalize all analog flow readings in the PLC and display at the HMI. Flow totalization shall reset daily at midnight. The PLC shall also account for the totalized value upon transition to daylight savings time. The HMI shall display current day flow total and previous day flow total.
6. On a daily basis, the HMI shall initiate a time synchronization routine to synchronize its time with the new PLC. Time synchronization shall occur at 3:05 A.M. to account for daylight savings time.
7. The PLC shall monitor I/O module faults and provide fault indication to the HMI when a fault is present for each I/O module.
8. "Interlock" is a field status point that is hardwired directly to a local control panel or motor starter. This condition must be satisfied in order for the associated machine to be operated and to remain in operation. This point may be wired in parallel to the control system for remote monitoring, but the safety control functionality does not require PLC intervention. An example is a high discharge pressure that will cause a pump to stop if it is running and will not allow the pump to start if the condition is preexisting. In specific situations, an interlock may involve peer-to-peer communications between PLCs instead of hardwiring if specifically defined as such.
9. "Permissive" can be either a field status point that is hardwired directly to a local control panel or it can be a logical control point from the control system. It is a requirement to start a machine, but is not necessary for the machine to continue operation once it is started. An example is a high sump level switch that will start a sump pump, but the sump pump will continue operating even after the high sump level switch is cleared. Typically, the sump pump would continue operating until a low sump level switch is opened to stop the pump. In this case, the low sump level switch could be considered an "interlock" depending on how it is connected.

C. Trending

1. During startup, the PCSI shall confirm that trending is operational through to the Historian Database.
2. Analog points:
   a. All analog I/O points associated with the PLC shall be configured in the HMI software for historical trending.
   b. All pseudo (calculated) analog values, such as run times, accumulated flows, kW, speed set points, etc. shall be configured in the HMI software for historical trending.
3. Set points: All process variable set-points shall be configured in the HMI software for historical trending.
4. Discrete points: The PCSI shall submit all discrete points recommended to be historically recorded. Recommendations to be based upon the following guidelines:
   a. All motor Start/Stop commands, valve Open/Close commands, etc.
   b. Various critical discrete alarm conditions such as High Level.
   c. Owner will choose which specific discrete points to be configured for recording in the Historian and made available to the HMI. The ASP shall configure the specific points for trending as directed.

D. Operator Entry

1. Operator entries require password-protected controlled access to the HMI. This security system limits the level of access to various functions by individuals. The PCSI shall duplicate the current HMI configuration conventions throughout all new application programming.
2. Entries made by the Operator (such as operation modes, set points, etc.) shall be displayed on the process screens for information.
3. All Operator changes shall be logged by the HMI software and shall include the point that was adjusted, HMI station where the change was made, the Operator that made the change, and the date and time of change.
4. The HMI shall provide the ability to clamp/limit all operator entered set points. All such set points are to be between minimum and maximum values. These minimum and maximum values shall be adjustable by users with supervisory level access from the HMI.

E. Control Modes

1. Local: This mode is available only with those pieces of equipment (motors, valves, etc.) that have an H/O/A, L/O/R, or similar switch. In this mode, all remote control (remote manual or remote automatic) functions associated with that piece of equipment are disabled, including any PLC-based safety permissives. Operations staff can set or adjust the following functions from the local control devices (e.g. pushbuttons, hand switch, etc.):
    a. Start/Stop Motors
    b. Open/Close Valves
    c. Open/Close Gates
    d. Adjust Motor Speed
    e. The following list summarizes the safety monitoring and control features active in this mode:
        1) Permissives (conditions that must be met in order for a machine to begin operation)
            a) H/O/A (L/O/R) Switch must be in HAND (Local) position
        2) Interlocks (conditions that must be met in order for a machine to begin or continue operation)
            a) Additional interlocks are dependent hardwired points associated with each individual loop.
        3) Alarms Displayed on graphical user interfaces (HMI, OIT, etc.)
            a) Fail to Operate (Open, Close, Start, Stop, etc.) are disabled.
            b) UNAVAILABLE shall be displayed in the HMI when a piece of monitored equipment is not in REMOTE/AUTO.
            c) Additional alarms are dependent on each individual loop and may still be active in the HMI.
2. Computer (Remote) Manual: In this mode, all automatic functions associated with a specific control loop are disabled except for safety interlocks and alarms. Provisions shall be provided to allow Operations staff to access the following functions remotely from the HMI:
    a. Start/Stop Motors
    b. Open/Close Valves or Gates – All valves that are electrically actuated are to have the ability to be manually controlled from the HMI.
    c. Adjust Motor Speed.

d. The following list summarizes the safety monitoring and control features active in this mode:
   1) Permissives (conditions that must be met in order for a machine to begin operation)
      a) Field equipment HOA (L/O/R) Switch must be in AUTO (Remote) position.
      b) Computer Mode (soft switch) must be in MANUAL.
   2) Interlocks (conditions that must be met in order for a machine to begin or continue operation)
      a) No active alarms.
      b) Additional interlocks are dependent on each individual loop.
   3) Alarms Displayed on graphical user interfaces (HMI, OIT, etc.)
      a) Fail to Operate (Open, Close, Start, Stop, Not at Speed, etc.).
      b) Additional alarms are dependent on each individual loop.

3. Computer (Remote) Auto: In this mode, all automatic functions associated with a specific control loop are controlled by the PLC automatic logic. Operations staff can only adjust the following functions from the HMI:
   a. Control Mode.
   b. PID Loop Setpoints (Level Setpoints, Timer Values, etc.).
   c. Pump Lead/Lag Settings.
   d. The following list summarizes the safety monitoring and control features active in this mode:
      1) Permissives (Conditions that must be met in order for a machine to begin operation)
         a) H/O/A (L/O/R) Switch must be in AUTO (Remote) position
         b) Computer Mode (soft switch) must be in AUTO.
      2) Interlocks (Conditions that must be met in order for a machine to begin or continue operation)
         a) No active alarms
         b) Additional interlocks are dependent on each individual loop.
      3) Alarms Displayed on graphical user interfaces (HMI, OIT, etc.)
         a) Fail to Operate (Open, Close, Start, Stop, Not at Speed, etc.).
         b) Additional alarms are dependent on each individual loop.

F. Bump-less Transfer of Control:

1. Motor control programming in the PLC shall incorporate bump-less transfer such that switching between Local and Remote, Remote Manual to Remote Automatic or Remote Automatic to Remote Manual, results in a smooth transition without upset to running status or speed. When a piece of equipment is in the HAND or LOCAL position, the PLC shall track its status such that when the switch is placed in the AUTO or REMOTE position, a bump-less transfer will occur when control strategy is in remote manual mode of operation.
2. For AFD pump control, bump-less transfer shall be achieved with the PID control loop tracking the pump speed when the control strategy is placed into Remote Manual mode of control.

G. PLC Code Standardization Requirements.

1. The Control Strategy Submittal shall include items covered under this sub-section.

2. Standard control templates (objects) or User-Defined Function Blocks (UDFBs) will be used as the basic building blocks for comprehensive control strategy development.
3. Standard blocks for all signal conditioning, equipment control such as analog control valve, digital control valve, constant speed pump, variable speed pump, 2 state motors, etc. shall be included.
4. All standard UDFBs developed shall be submitted to the Owner/Engineer for review.
5. Programming structure:
    a. Unit process shall be divided into manageable modules within each program section.
    b. Each section shall be identified with a title that describes the overall function and a revision block.
    c. Within each section, the objective is to convey the operation of a specific rung or function block to be used in the O&M for long term maintenance.
    d. The documentation should be developed such that a person with PLC knowledge may follow the PLC program logic within a reasonable amount of time.
    e. The documentation shall include any user-defined subroutines or function blocks. Each routine shall include a routine name, an abstract on the purpose of the function, a description of the inputs and outputs and data type, and a revision block similar to the main program section.
6. Section names should correspond to the control narratives with word separated by underscore (i.e. Pump_Station_Pressure_Control)
7. Input/output data processing:
    a. Direct access to field I/O is not permitted.
    b. Alarms shall be normalized such that when it is de-energized, it will be in a normal state.
    c. All digital alarms shall be buffered with time delay.
    d. All analog signal shall be provided with data quality check, alarm deadband, live zero filtering, and signal smoothing such as averaging and filtering at the PLC.
8. PLC startup initialization shall be described in detail.
9. Discrete commands shall maintain the request until the desired state is reached.

H. No control strategy development shall be performed prior to completion of any UDFB development, programmed, and tested using the PLC programming software.

3.2 PUMP STATION MONITORING AND CONTROL

A. General

1. A new control panel will be installed to monitor and control the Conn Pump Station. The pump station will be operated from the Operation and Control Center at North Richland Hills.
2. The pump station has three variable speed pumps designated as PMP-1011-1 through PMP-1013-1.
3. All pumps are connected to an existing ground storage tank and discharge into a common 20-inch diameter pipe header to the distribution system.

4. The pumps shall be capable of local manual, remote manual, and remote automatic (computer automatic) operation. In remote automatic operation, the pumps shall be capable of maintaining a flow setpoint via pump speed adjustment.

3.3 PUMP OPERATION

A. Pumps:

1. P&ID Sheet reference: I-05 through I-06
2. The pump station major equipment tag and loop numbers are listed below:

Equipment	Tag number
Station Pump No.1 (2600 GPM Capacity)	PMP-1011-1
Station Pump No.2 (2600 GPM Capacity)	PMP-1012-1
Station Pump No.3 (2600 GPM Capacity)	PMP-1013-1
Storage Tank Level	LIT-1000-1
Distribution Pressure	PIT-1000-1
Meter Vault Flow	FIT-1020-1

3. Control Modes:
   a. Local Manual Control
      1) Each AFD driven pump is provided with a L/O/R switch, Start/Stop/Reset pushbutton, and a speed adjustment selector. When the L/O/R switch is placed in Local, the operator may start, stop, and vary the pump speed from the AFD control panel.
      2) All pumps are equipped with an emergency stop pushbutton located adjacent to the pump. This pushbutton is hard-wired and will stop the pump immediately regardless of the control mode. The E-stop activation shall be monitored and reported to HMI.
      3) The operator may use Reset pushbutton to release the alarm condition interlock and enable the pump operation.
   b. In Remote Manual and Remote Auto mode, operator may select to issue emergency-stop command for a pump from HMI.
   c. Remote Manual Control
      1) When the pump's L/O/R switch is placed in the Remote position and the operator select software switch to Remote Manual at HMI.
         a) The operator may start, stop, and vary the pump speed of the AFD driven pumps from the HMI.
   d. Remote Automatic Control
      1) The pump alternation shall automatically be set based on pump runtime. The pump with the least runtime shall be set as the lead while the pump with the most runtime shall be set as the standby pump. The lead/lag/standby pump rotation shall automatically be set the PLC.
      2) In normal operation, up to two pumps will operate. If the lead or lag is called to start and it is not available for remote control, then the standby pump will be commanded to start and perform process control.
      3) The control of the pumps will be based on the distribution system pressure. The pressure will normally be ranged between 79 to 96 PSI. The operator shall be able to enter a system pressure setpoint (default = 75 PSI) to maintain. When the system pressure drops below system pressure setpoint, the lead pump will be called to start to maintain pressure by varying pump

speed. When the system pressure drops, the lead pump will ramp up the speed to maintain pressure. When the lead pump's speed reaches 100% and the system pressure is still not met, a delay timer shall count down. When the delay timer expires and the system pressure is still below the system pressure setpoint, then the lag pump shall be called to start. Both the lead and lag pump shall drop their speeds to 80% and then modulate in unison based on the system pressure.

4) When the system pressure increases, both pumps will decrease their speeds in unison. When both pumps reach minimum speeds, a delay timer shall count down. When the delay timer expires and both lead and lag pumps are still at minimum speed, the lag1 pump shall be commanded to stop and the lead pump shall continue to operate to maintain system pressure.
5) While maintaining system pressure, if the lead pump reaches minimum speed, a delay timer shall count down. When the delay timer expires and the lead pump is still operating at minimum speed, then the lead pump shall be commanded to stop. At this point, the distribution system pressure is satisfied until the next pump call due to demand in system pressure.
6) Pump automatic rotation shall occur if only a single pump at the pump station is operating and has been running continuously for more than an operator adjustable time period (default = 48 hours). At that time, the PLC shall select the pump with the least runtime to start. Once the lag pump has been confirmed running, then current operating pump shall be commanded to stop.

4. Permissives
   a. The pump will be prohibited from starting when its associated interlock is active.
5. Interlocks for pump shutdown
   a. If any of the pump unit's motor protective equipment including the AFD, or RTD module is tripped or faulted.
   b. If the high pressure switch associated with the pump's discharge header is tripped.
   c. If the low suction pressure switch associated with the pump's discharge header is tripped.
   d. The Ground Storage Tank level below the low level shutoff level (default = 8.0 FT)
6. Calculated Alarms
   a. Low Pump Flow Alarm:
      1) When any pump is operating, if its discharge flow meter does not indicate flow (less than 5% flow reading, operator adjustable) after a time delay, an alarm shall be generated at the HMI.

3.4 MISCELLANEOUS STATION MONITORING AND ALARMS

A. The PLC is wired to report building and vault intrusion, vault flood alarm, sump pump status, SCADA panel, room temperature, and Generator system related alarm and status to HMI at OCC.

3.5 POWER AND PROTECTION RELAY MONITORING

A. Power Monitors and Protection Relays are interfaced to SCADA system network via the PLC.

3.6 REAL TIME CLOCK SYNCHRONIZATION

A. The PLC reads its internal real-time clock on each program cycle and places the time and date information into separate variables.

B. Periodically (default once a day at 3:05 a.m.), the HMI executes a script to set a time synchronization flag to true which commands the clock remote PLC to synchronize with the HMI clock.

3.7 CONTROL PANEL HEALTH MONITORING

A. The alarms described below shall be generated on a separate graphic screen with equipment symbols and display alarm statuses.

B. Each physical input and output card in the PLC will be monitored for fault and alarm generated at the HMI. For example:

1. Expansion_IO1_Fail Alarm will be sent when failure is detected
2. Expansion_IO2_Fail Alarm will be sent when IO failure is detected

C. Incoming AC power will be monitored for failure and alarm will be generated and displayed at the HMI.

D. 24VDC power supply failure will be generated and displayed on the HMI when detected.

E. UPS power status shall be monitored, and alarm generated and displayed on the HMI when detected.

3.8 HMI COMMUNICATION TO PUMP STATION PLC

A. The HMI shall monitor the communication link between the Pump Station PLC. This can be accomplished by monitoring the Time of Day (Seconds) word from the Pump Station PLC. If this value does not change within a pre-defined elapsed time, the HMI shall generate an alarm.

END OF SECTION

SECTION 40 63 00
PROGRAMMABLE LOGIC CONTROLLERS (PLCs)

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section of the Specifications describes the requirements for Programmable Logic Controllers (PLCs) to be furnished under other Sections of the Specifications as listed in the Related Work paragraph of this Section.

B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.

C. Provide equipment, materials, completed application software, calibrations, training, and services required to successfully interface and interconnect the system and associated equipment that are specified or designated in drawings or provisions of these specifications for the purpose of providing a fully integrated and functional control system as specified.

D. Furnish and install cabling and cable accessories, including tools necessary for connecting the system and peripherals, Programmable Logic Controllers (PLCs), Operator Workstations, data highway, and input/output devices.

E. Furnish startup, training, and system check out services.

F. Furnish and install all items obviously necessary for the proper functioning of the equipment even if omitted at no additional cost to the Owner.

G. The Drawings and related Specification sections supplement this Section and provide additional details showing panel elevations, functional requirements of the system, and interaction with other equipment.

H. Coordinate and schedule all testing procedures with the Construction Manager.

I. All software packages provided shall be licensed under the Owner’s name and address. The PCSI shall coordinate with the Owner for correct name and address.

J. For each PLC furnished for the project, provide 20% wired spares for all inputs and outputs from PLC to terminal blocks within the control panel.

1.2 RELATED WORK

A. Section 40 61 00 Instrumentation General Provisions

B. Section 40 67 00 Instrumentation Control Panels

1.3 SUBMITTALS

A. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned un-reviewed.

B. Submit catalog data for all items supplied from this specification Section as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc., sufficient to confirm that the equipment provides every specified requirement. Any options or exceptions shall be clearly indicated.

C. Submit a bill of materials for each PLC clearly identifying all components and quantities.

D. Submit catalog data sheets for all software licenses provided under this Specification Section.

E. Operation and Maintenance Manuals.

1. Operation and Maintenance manuals shall include the following information:
   a. Manufacturer's contact address and telephone number for parts and service.
   b. Instruction books and/or leaflets
   c. Recommended renewal parts list
   d. Record Documents for the information required by the Submittals above.
   e. Copy of the software license data including serial numbers, license key, etc.

1.4 REFERENCE CODES AND STANDARDS

A. Instrumentation equipment, materials and installation shall comply with the National Electrical Code (NEC and with the latest edition of the following codes and standards:

1. National Electrical Safety Code (NESC)
2. NEMA ICS 1-101 Diagrams, Designations and Symbols
3. ANSI/ISA-5.06.01-2007 - Functional Requirements Documentation for Control Software Applications.
4. ISA-TR20.00.01-2001 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005.
5. ISA-5.4-1991 Instrument Loop Diagrams.
6. ISA-5.5-1985 Graphic Symbols for Process Displays.
7. ISA-5.1-1984 (R1992) Instrumentation Symbols and Identification.
8. ISA-5.3-1983 Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
9. ISA-20-1981 Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
10. ISA-5.2-1976 (R1992) Binary Logic Diagrams For Process Operations.
11. National Electrical Manufacturers Association (NEMA)
12. The International Society of Automation (ISA)
13. Underwriters Laboratories (UL)
14. UL 508, the Standard of Safety for Industrial Control Equipment
15. UL 508A, the Standard of Safety for Industrial Control Panels
16. Factory Mutual (FM)
17. NFPA 70 National Electrical Code (NEC)
18. ANSI C37.90.2 Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
19. NEMA ICS 4 Terminal Blocks for Industrial Use.
20. NEMA LS1 Low Voltage Surge Protection Devices.
21. UL 1283 Standard for Safety-Electromagnetic Interference Filters.
22. UL 1449 Third Edition Surge Protective Devices

23. All equipment and installations shall conform to applicable Federal, State, and local codes.

B. All equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.

C. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

1.5 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of five (5) years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. Equipment submitted shall fit within the space or location shown on the Drawings. Equipment which does not fit within the space or location is not acceptable.

C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.6 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for 2 years from date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty, the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Contractor at no expense to the Owner.

1.7 COMMUNICATIONS PROTOCOL REQUIREMENTS

A. The PLC System shall communicate utilizing Modbus TCP Protocol with the following as minimum capabilities:

1. All data shall be available and/or mirrored within the Modbus 4x or "Holding Register" memory area. The other areas can be optionally supported, but all 0x, 1x, and 3x data shall be readable and writable in the 4x memory area. For digital writes, supports of single-bit writes (function 5) to the 0x area are acceptable on a case by case basis. Products that require access to the 1x and 3x area to operate are not acceptable; access to 1x/3x area shall be optional.
2. Register 4x00001 shall exist and be readable to allow simple, predictable "communications tests".
3. Software tools shall function properly with slaves' only supporting Modbus functions 3, 4 and 16. Requiring support of diagnostic function 8 is not acceptable.
4. Software tools shall be configurable to write a single register as either function 6 or 16.
5. Software tools shall allow setting the Modbus/TCP "Unit Id" to be a value other than zero. This is required for Ethernet-to-Serial bridging.

PART 2 - PRODUCTS

2.1 PROGRAMMABLE LOGIC CONTROLLER

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Schneider Electric
   a. Model: SCADAPack 474

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Where an existing PLC is to be modified or expanded as a part of this Contract, as specified in Section 40 67 00, and as shown on the Drawings, the modified PLC shall meet all of the requirements of Paragraph 2.01of this Section.

D. Programming Languages
   1. Each PLC shall support IEC Standard 61131-3 for all of the following programming languages:
      a. Ladder (LD)
      b. Function Block Diagram (FBD)
      c. Structured Text (ST)
   2. PLC shall support user defined functions for customization and user defined tag structures.
   3. PLC shall have application-specific instructions for process, drive, batch, motion and safety applications built into the controller.

E. Central Processor Unit (CPU)
   1. Each processor shall have the following:
      a. SRAM – 4 MB, battery backed static RAM
      b. DDR3 RAM – 256 MB, dynamic RAM
      c. NAND Flash – 256 MB, flash memory
   2. Provide up to five serial communication ports and two Ethernet ports.
   3. Provide hardware employing identical revisions of software and firmware as applicable.
   4. The CPU shall be able to perform time synchronization.

F. Power Supply (PS)
   1. The power supply shall be 120 Volt 60 Hz, and shall be sized for the total quantity of modules including the power requirement of spare I/0 module slots.

G. Communication
   1. Provide up to five serial communication ports and two Ethernet ports.
   2. Serial DNP3 level 4, Modbus RTU server/client.
   3. DNP3 level 4 in TCP, Modbus TCP server, Modbus/TCP client

H. Based Inputs/Outputs
   1. Digital Inputs: 20
   2. Digital Outputs: 12
   3. Analog Inputs: 12
   4. Analog Outputs: 2

I. Additional I/O Expansion Modules
   1. Provide additional I/O board to accommodate all I/Os shown on the I/O list and on Drawings plus 20% pre-wired spares.

2.2 PROGRAMMING

A. The contractor shall perform the PLC programming using Schneider's "SCADAPack x70 Logic Editor within RemoteConnect" software.

B. The programming shall be performed using following language only.
   1. Ladder (LD)
   2. Function Block Diagram (FBD)
   3. Structured Text (ST)

C. The 'Logic Editor' software package shall be a part of deliverable licensed to the Owner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment specified herein shall be factory installed, programmed, field adjusted, tested and cleaned as an integral part of equipment specified elsewhere in these Specifications.

END OF SECTION

SECTION 40 66 00
COMMUNICATIONS INTERFACE EQUIPMENT AND SYSTEM

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section of the Specifications describes the requirements for Communications Interface Equipment and Systems to be furnished under other Sections of the Specifications as listed in the Related Work paragraph of this Section.

B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in the Related Work Section of the Specifications.

C. All work shall adhere to codes and standards within this Section and shall be compliant with other local and national codes.

1.2 RELATED WORK

A. Section 40 61 00 Instrumentation and Controls General Provisions

B. Section 40 67 00 Instrumentation Control Panels

C. Section 40 78 00 Panel Mounted Control Devices

1.3 SUBMITTALS

A. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned un-reviewed.

B. Submit catalog data for all items supplied from this specification Section as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc., sufficient to confirm that the equipment provides every specified requirement. Any options or exceptions shall be clearly indicated.

1.4 REFERENCE CODES AND STANDARDS

A. The Contractor is responsible to conform to the current revision of all codes and standards as may be referred to in these specifications. All such referenced codes are, by such reference, incorporated into this Contract as is set forth herein in full. In the event of conflict between this specification and the codes, standards, and specifications below, the most stringent requirement shall govern.

B. Codes and standards shall be the latest issue and/or amendment thereto published at the date of the issue for bids. Codes and standards are abbreviated as follows:

Codes & Standards	Title
NEC	National Electric Code
ICEA	Insulated Cable Engineers Association
ANSI/IEEE Std. 100	IEEE Standard, Dictionary of General and Electronic Terms
EIA-RS-210-C	Racks, Panels and Associated Equipment

Codes & Standards	Title
EIA/TIA-568	Performance Standards for Data Communication Wiring Systems.
NFPA 780	Standard for the Installation of Lightning Protection Systems

1.5 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. Equipment submitted shall fit within the space or location shown on the Drawings. Equipment which does not fit within the space or location is not acceptable.

C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.6 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for 2 years from date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty, the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Contractor at no expense to the Owner.

PART 2 - PRODUCTS

2.1 INDUSTRIAL ETHERNET SWITCH LAYER 3

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable. All field control panel switches shall be the model indicated below:
   1. Cisco
      a. Model: IE4000 Series

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Environmental
   1. Operating temperature: -40 Deg F to 167 Deg F
   2. Operating humidity: 10 – 95% Non-condensing
   3. Storage temperature: -40 Deg F to 185 Deg F

D. Physical
   1. Enclosure complies with NEMA TS-2.
   2. Equipment complies with UL 508.
   3. Power supply: 24VDC from UPS source.
   4. Din rail mountable capability.

E. Functional Performance

1. Per port status LED indication.
2. Port based Ethernet MAC security individually port configurable.
3. Wire speed switching, 16 Gbps switching fabric.
4. HSRP protocol support.
5. Cisco Express Forwarding Hardware Routing Architecture.
6. SNMPv1, SNMPv2c, and SNMPv3 support
7. 802.1d Spanning Tree Protocol support
8. HTTPS accessible.
9. Common Industrial Protocol (CIP) Management Objects support.
10. Smartports templates for EtherNet/IP
11. PROFINET v2 certification.
12. Alarm Contacts for external fault notification.
13. 100/1000 BaseT ports with RJ-45 connectors for Category 6 cabling.
14. Switch configuration on removable/configurable via Flash Memory module.
15. LC type Fiber Optic Connectors for 100BaseFX, 1000BaseSX for Multimode Fiber and 1000BaseLX for Single Mode Fiber as shown on the drawings
16. Fully managed switch capability.

F. For the long haul single mode fiber connection to the Sister Grove RWRRF, provide SFP module for long haul fiber optic communication. Provide Cisco SFP ruggedized model GLC-BX40-U-I.

G. Options and Accessories Required:
   1. Provide twenty (20) percent spare port capacity for each port type.
   2. SmartNet support for 60 months subscription agreement for each switch.

2.2 ETHERNET AND COMMUNICATION CABLES

A. Subject to compliance with the contract documents, the following manufacturers are acceptable:
   1. Belden

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Cables for Ethernet: Category 6 Above Grade Cable: Sunlight and Oil Resistant U/UTP 003 Cable, non-plenum.
   1. Conductors: 4 bonded pair 23 AWG Bare Copper
   2. Insulation: Polyolefin
   3. Overall Cabling Separator Material of Foamed Polyolefin Tape
   4. Jacket: PVC with 300 volt rated Color of jacket to match as follows:
      a. Green – Phone / Data
      b. Red – FIRE Alarm
      c. Blue – SCADA
   5. Transmission Standards: Category 6 - TIA 568.C.2
   6. Nominal Velocity of Propagation: 72 %

7. Flame Test Method: UL1666 Vertical Riser
8. Model: Belden 7953A

D. Cables for Ethernet: Category 5e Below Grade Outdoor and Under Grade locations cable: Sunlight and Oil Resistant Category 5e U/UTP 003 Cable, non-plenum.
1. Conductors: 4 pair 24AWG Bare Copper
2. Insulation: Polyolefin
3. Shield: 100 percent aluminum foil polyester tape with drain wire
4. Jacket: LLPE (Linear Low Density Polyethylene) with 300 volt rated and manufacturer's identification
5. Misc.: NEMA WC-63.1, listed for outdoor and wet locations use
6. Model: Belden 7937A

E. Cables for serial: 485 Communication Cable
1. Conductors: 1 pair 24AWG Tinned Copper
2. Insulation: Polyethylene
3. Shield: 100 percent aluminum foil polyester tape with tinned copper drain wire
4. Jacket: PVC with 300 volt rated and manufacturer's identification
5. Misc.: UL2919 listed for indoor and dry locations use
6. Model: Belden 9841

F. Cables for serial: 232 Communication Cable
1. Conductors: 4 pair 28AWG Tinned Copper
2. Insulation: Polypropylene
3. Shield: 100 percent aluminum foil polyester tape with tinned copper drain wire
4. Jacket: PVC with 300 volt rated and manufacturer's identification
5. Model: Belden 9806

2.3 ETHERNET SURGE PROTECTOR

A. Subject to compliance with the contract documents, the following manufacturers are acceptable:
1. Phoenix Contact
2. PolyPhaser
3. Cooper Bussman

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Environmental
1. Operating temperature: -40 degrees F to 176 degrees F
2. Operating humidity: 95% non-condensing for indoor applications
3. Storage Temperature: -40 to 176 degrees F

D. Physical
1. DIN Rail Mountable indoors and pole mountable outdoors applications
2. I/O connectors: RJ-45

3. Power over Ethernet POE+ to IEEE802.3 at up to 57VDC

E. Functional Performance

1. Protection: handles 100 or more lightning strikes at surge levels of 8/20uSec at 6kV/3kA
2. Standard: Compliant to IEC61000-4-5.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment specified herein shall be factory installed in an overall assembly, field adjusted, tested and cleaned as an integral part of equipment specified elsewhere in these Specifications.

END OF SECTION

SECTION 40 67 00
INSTRUMENTATION AND CONTROLS-CONTROL PANELS

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install fully functional control panels to manually and automatically operate control systems as specified in the detailed requirements of the instrumentation sections of Division 40 and supplemented with logic and schematics diagrams as shown on the Electrical and Instrumentation Drawings.

B. It is the intent of these specifications to have all I/O and signal conditioning components included within their respective control panels. The panel sizes shown on the Drawings shall be considered minimum. The Process Control System Integrator (PCSI) shall be responsible for final sizing of enclosures to meet the clearance requirements and clearance requirements of components contained within the panels of NFPA 79, the NEC and as specified herein. Should the PCSI submit a panel size and layout that is, in the opinion of the Owner and or Engineer, insufficient in size to meet these requirements, the submittal will not be approved and will be returned for revision and resubmission. The PCSI shall be required to revise the panel size and layout and resubmit for approval at no additional cost to the Owner.

C. Control panels as specified in the Process Equipment Division, Electrical Equipment Division or Mechanical Equipment Divisions, except as specifically stated herein shall not be submitted under this section.

D. All enclosures and panel components shall be of the same manufacture wherever possible.

E. Installation and configuration of network infrastructure cabling and equipment shall be a cooperative and coordinated effort between Owner, the Contractor, and the PCSI. The PCSI shall furnish all labor necessary for the installation and testing as required to fully meet the applicable specifications of this equipment.

F. Provide, install and commission all field instruments as specified in contract documents.

G. The following panels shall be furnished by the PCSI. All the enclosure shall be supplied with full back and side panel. The Contractor shall be responsible for furnishing any and all control panels shown in the Drawings but not included in the following listing:

Panel Identification	Enclosure Rating	Panel Location	Minimum Enclosure Size
Conn Pump Station PLC Enclosure (PLC-1000-1)	NEMA12, 316 SS steel, front entry only, floor mounted	Electrical Room	72”H X 36”W X 24”D

1.2 RELATED WORK

A. Section 40 61 00 Instrumentation and Controls General Provisions

B. Section 40 61 21 Instrumentation Testing and System Commissioning

C. Section 40 61 26 Instrumentation System Training

D. Section 40 61 90 Field Instrumentation List

E. Section 40 78 00 Panel Mounted Control Devices

F. Section 40 63 00 Programmable Logic Controllers (PLC) Systems

G. Section 40 61 96 Control Loop Descriptions

H. Section 40 61 93 Field Input-Output List

I. Section 40 66 00 Communication Interface and Equipment and Systems

J. Section 40 71 00 Field Instrumentation

1.3 SUBMITTALS

A. Submittal Process:

1. Submittals shall be made in accordance with the requirements of Section 40 61 00 Instrumentation and Controls General Provisions, and as additionally specified herein.
2. Submittals require information on related equipment to be furnished under this Specification and described in the related sections listed in the Related Work paragraph above. Incomplete submittals not containing the required information on the related equipment will be returned un-reviewed.
3. Equipment specified in Process, Mechanical, or Electrical Equipment Divisions, and supplied as an integral part of a process equipment manufacturer's package shall be submitted with the manufacturer's submittals, in those Divisions.

B. Submittal Content:

1. The PCSI shall create equipment shop drawings, including all wiring diagrams, in the PCSI's engineering department. All equipment shop drawings shall bear the PCSI logo, drawing file numbers, and shall be maintained on file in the original equipment manufacturer's archive file system. Photocopies of the Engineer's ladder schematics are unacceptable as shop drawings.

C. Required Submittals:

1. Copies of previously approved related work submittals
2. Documentation confirming that the Panel Assembly Facility is a UL-508 certified panel shop
3. Facsimile of the UL label that is to be applied to each of the completed panels
4. Shop Drawings:
   a. Shop Drawings shall include the following:
      1) Drawings shall be to scale and shall show the location of panel mounted devices, including doors, and sub panels.
      2) Equipment outline drawings that show elevation, plan, interior views, front panel arrangement, dimensions, weight, shipping splits, conduit entrance points, and anchor bolt pattern. Indicate all options, special features, ratings, and deviations from this section's requirements.
      3) The first sheet of each Panel Drawing Packet shall contain a Bill of Materials for that panel. The Bill of Materials shall list all devices mounted within the panel, and shall include the tag number, description, manufacturer, and model number of each item.

4) Following the Bill of Material shall be a listing, uniquely identifying each component of the Panel, and a description of the item used, i.e. devices by their assigned tag numbers, nameplate inscriptions, service legend, and annunciator inscriptions.
5) Include power and control schematics with external connections. Show wire and terminal numbers and color-coding.

b. Interconnecting Wiring Diagrams:
1) Provide interconnecting wiring diagrams showing electrical connections between equipment, consoles, panels, terminal junction boxes, and field mounted components.
2) Diagrams shall show component and panel terminal board identification numbers, and external wire and cable numbers.
3) Circuit names corresponding to the Circuit and Raceway Schedule shall be shown. The diagram shall include intermediate terminations between field elements and panels (e.g., terminal junction boxes, pull boxes, etc.)

5. Factory Tests:
a. Submittals shall be made for factory tests as specified herein. Owner/Engineer approval of required factory tests is required prior to shipment of the equipment.

6. Field Tests:
a. Submittals shall be made for field tests as specified herein.

7. Operation and Maintenance Manuals:
a. Operation and maintenance manuals shall include the following information:
1) Manufacturer’s contact address and telephone number for parts and service.
2) Instruction books and/or leaflets
3) Recommended renewal parts list
4) Record documents for the information required by the Submittals paragraph above.
5) The submittal shall include all final settings component configuration at the time of successful field test and startup.

1.4 REFERENCE CODES AND STANDARDS

A. Instrumentation equipment, materials and installation shall comply with the National Electrical Code (NEC and with the latest edition of the following codes and standards:

1. National Electrical Safety Code (NESC)
2. The International Society of Automation (ISA)
3. Underwriters Laboratories (UL)
4. UL 508, the Standard of Safety for Industrial Control Equipment
5. UL 508A, the Standard of Safety for Industrial Control Panels
6. Factory Mutual (FM)
7. NFPA 70 National Electrical Code (NEC)
8. ANSI C37.90.2 Standard Withstand Capability of Relay Systems to Radiated Electromagnetic Interference From Transceivers.
9. NEMA ICS 4 Terminal Blocks for Industrial Use.
10. NEMA LS1 Low Voltage Surge Protection Devices
11. UL 1449 Third Edition Surge Protective Devices

12. All equipment and installations shall conform to applicable Federal, State, and local codes.

1.5 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar equipment for a minimum period of five years. When requested by the Owner or Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. The control panels shall be assembled in a UL-certified panel shop, experienced in the assembled of control panels for water and wastewater treatment systems. A submittal of the documentation, that certifies the panel fabrication shop is a UL-certified shop, is required.

C. Equipment components and devices shall be UL labeled wherever UL standards exist for such equipment. The completed control panel shall be UL Labeled in accordance with UL 508 and or 508A as applicable. The panel shall be UL labeled for the environment in which it is to be placed. A UL label shall be affixed to the inside of the external door by the panel fabrication assembly shop. Submit a facsimile of the UL label in the submittal information.

D. Equipment submitted shall fit within the space shown on the drawings. Equipment which does not fit within the space is not acceptable.

1.6 DELIVERY STORAGE AND HANDLING

A. Completed control panels and related equipment shall be handled and stored in accordance with manufacturer's instructions. Two copies of these instructions shall be included with the equipment at time of shipment, and shall be made available to the general contractor, the Owner and Engineer.

B. Shipping groups shall be designed to be shipped by truck, rail, or ship. Indoor groups shall be bolted to skids. Accessories shall be packaged and shipped with each panel.

C. Visible shipping damage to any portion of a shipment shall be assumed to have also damaged the surrounding portion. The visibly damaged and the surrounding panels shall be returned to the manufacturer’s UL 508 facility, for examination and damaged equipment replaced, followed by a Witnessed Test of the returned portion, as specified in Section 40 61 21, at no expense to the Owner or Engineer.

D. Control Panels shall be installed in their permanent finished location shown on the drawings within seven calendar days of arriving onsite. If the equipment cannot be installed within seven calendar days, the equipment shall not be delivered to the site, but stored offsite, at the contractor’s expense, until such time that the site is ready for permanent installation of the equipment.

E. Space heaters shall be furnished in control panels and the contractor shall provide temporary electrical power and operate space heaters during storage, and after equipment is installed in permanent location, until equipment is placed in service.

1.7 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for 2 years from date of final acceptance.

PART 2 - PRODUCTS

2.1 MATERIAL MANUFACTURERS

A. Subject to compliance with the contract documents, the following electrical material manufacturers are acceptable for all materials not otherwise specified herein or related specifications:

1. General Electric Co.
2. Eaton / Cutler-Hammer
3. Square D Co.
4. Allen Bradley

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Materials Manufactures listed above are not relieved from meeting the requirements of these Specifications in their entirety.

C. Manufactures of all related devices and components shall be as specified elsewhere in related work specifications

2.2 RATINGS

A. The complete control panel assembly shall be UL certified or carry a UL 508A listing for "Industrial Control Panels".

B. The control panel shall meet all applicable requirements of the National Electrical Code.

C. All devises unless otherwise specified shall be designed for continuous operation at rated current in a 40-degree C ambient temperature

D. For additional ratings and construction notes, refer to the drawings.

E. The service voltage shall be as specified and as shown on the drawings. The overall short circuit withstand and interrupting rating of the equipment and devices shall be equal to or greater than the overall short circuit withstand and interrupting rating of the feeder device immediately upstream of the Control Panel, but not less than 10,000 amperes RMS symmetrical at 120 volts' single phase.

2.3 CONSTRUCTION

A. General:

1. Refer to the drawings for: schematics, actual layout and location of equipment and components; current ratings of devices, bus bars, components; protective relays, voltage ratings of devices, components and assemblies; and other required details.

B. Enclosures:

1. General:
   a. Each enclosure shall incorporate a removable back panel, and side panels, on which control components shall be mounted. Back panel shall be secured to the enclosure with collar studs for wall mounted enclosures, and 316 SS hardware for free standing enclosures.
   b. All free-standing enclosures shall be provided with feet of the same construction as the enclosure.
   c. Back panel shall be tapped to accept all mounting screws. Self-tapping screws shall not be used to mount any components.

d. All enclosure doors shall have bonding studs. The enclosure interior shall have a bonding stud.
e. Each enclosure shall be provided with a documentation pocket on the inner door.
f. Enclosures shall not have holes or knockouts.
g. Provide manufacturer's window kits where shown on the drawings.
h. All panels installed outdoors shall have a factory applied, suitable primer and final coat of weatherproof white paint.
i. All enclosures shall be provided with three-point latch.
j. All enclosures shall be lockable, and keyed alike.
k. Power shall be distributed and coordinated such that the loss of an individual powered component does not result in further loss of other components, power, or capability
l. All PLC enclosures, including RIO enclosures if applicable, network enclosures, shall be powered by separate, redundant power sources. One power source shall be UPS and the other shall be an alternate conditioned 120 VAC source. The non-UPS power source shall be used to power the non-critical load of each enclosure such as enclosure lights, receptacles, cooling fans, air conditioners, heaters, etc.
m. All power subsystems shall be supplied with redundant 125% capacity power supplies, equipped with redundancy diodes, for all DC voltage levels and services. Each set of redundant power supplies shall be wired and equipped to accept two separate power feeds. The Contractor shall size the power supply not to exceed 50% of normal operating capacity.

2. All Panels shall be supplied as follows:
a. NEMA 4X 316 Stainless Steel
b. Type 316 stainless steel, body and door
c. Stainless steel continuous hinge
d. Foam in-place gasket
e. 3-point latch

3. Manufacturers:
a. Pentair
b. Rittal WM Series
c. EMF Company
d. NEMA Enclosures Company
e. Hammond Company

C. Environmental Controls:

1. Enclosure Condensate Heaters:
a. A self-contained enclosure condensation heater with thermostat and fan shall be mounted inside the control panel, if panel is to be installed outdoors or in a non-air-conditioned space:
1) Enclosure heaters shall be energized from 120 volt, single-phase power supply and sized to prevent condensation within the enclosure.
2) Locate enclosure heaters to avoid overheating electronic hardware or producing large temperature fluctuations on the hardware.
3) Enclosure heaters shall have an internal fan for heat distribution and shall be controlled with adjustable thermostats. The thermostat shall have an adjustment range of 40 degrees Fahrenheit to 90 degrees Fahrenheit. Provide a circuit breaker or fused disconnect switch within the enclosure.

4) Enclosure heaters shall be Hoffman type DAH.

2. Corrosion Protection:
   a. Provide corrosion protection in each control panel with a corrosion-Inhibiting vapor capsule as manufactured by Northern Instruments; Model Zerust VC, or Hoffman Engineering; Model A-HCI.

2.4 PANEL EQUIPMENT

A. Equipment Requirements:
   1. The requirements for equipment, controls, meters, converters, etc., for each Control Panel, shall be as shown on the Panel Schedule herein, the drawings, panel schematics, and the functions specified in the control narratives sections of the specifications.
   2. All other equipment, controls, meters, converters that are designed as a part of the control panel, shall be as specified in Section 40 78 00 Panel Mounted Control Devices and the Related Work Sections specified herein.
   3. Furnish installed in each Control Panel, a dedicated Surge Protective Device (SPD) (UL 1449 Type 3), permanently connected, on the load side of the power entrance, as specified in Section 40 78 00 Panel Mounted Control Devices.

B. Panel Control Device Requirements:
   1. Control Devices and Indicators:
      a. All operating control devices, indicators, and instruments shall be securely mounted on the panel door. All controls and indicators shall be 30mm, corrosion resistant, NEMA 4X/13, anodized aluminum or reinforced plastic. Booted control devices are not acceptable. Auxiliary contacts shall be provided for remote run indication and indication of each status and alarm condition. Additional controls shall be provided as specified herein and as required by the detailed mechanical and electrical equipment requirements.
      b. Indicator lamps shall be LED type. For all control applications, indicator lamps shall incorporate a push-to-test feature. Lens colors shall be as follows:
         1) Red for RUNNING, Valve OPENED, and Breaker CLOSED.
         2) Green for OFF, Valve CLOSED, and Breaker OPEN
         3) Amber for FAILED
         4) Blue for READY
         5) White for POWER ON
      c. Mode selector switches (HAND-OFF-AUTO, LOCAL-OFF-REMOTE, etc.) shall be as shown on the drawings. Units shall have the number of positions and contact arrangements, as required. Each switch shall have an extra dry contact for remote monitoring.
      d. Pushbuttons shall be as follows:
         1) Red for STOP, Valve OPEN, Breaker CLOSE, and mushroom Red for EMERGENCY STOP
         2) Green for START, Valve CLOSE, and Breaker OPEN
         3) Black for RESET
      e. Furnish nameplates for each device. All nameplates shall be laminated plastic, black lettering on a white background, attached with stainless steel screws. Device mounted nameplates are not acceptable.

2. A failure alarm with horn and beacon light shall be provided when required or specified. Silence, test and reset buttons shall be furnished. Alarm horn and beacon shall be by Federal Signal or Crouse-Hinds, NEMA 4X for all areas except for NEMA 7 areas, which shall be NEMA 7/4X cast aluminum.
3. Control and Instrument Power Transformers:
   a. Control power transformers shall be provided where shown on the drawings. Transformer shall be sized for the entire load, including space heaters, plus 25% spare capacity, and shall be not less than 100VA.
   b. Control power transformers shall be 120 volt grounded secondary. Primary side of the transformer shall be fused in both legs. One leg of the transformer secondary shall be solidly grounded while the other leg shall be fused.

2.5 EQUIPMENT INSTALLATION

A. Equipment Mounting:
1. The location of the installed equipment shall be as shown on the Panel Layouts on the drawings.
2. Each piece of equipment shall be securely mounted to the back plate or side plate in accordance with the manufacturer's installation instructions. All mounting hardware shall be from the front of the back plate or side plate with threaded screws. Attaching hardware shall not be installed from the rear of the back plate or side plate. Removal of any piece of equipment shall not require the removal or loosening of any other piece of equipment.
3. Operator interface equipment installed on the door shall be arranged as shown on the drawings in accordance with the manufacturer's installation instructions. No penetrations of the door shall be made except for equipment mounting. Provide adequate clearance between pieces of equipment and door latching mechanisms.

B. Nameplates:
1. External:
   a. Nameplates shall be engraved, laminated impact acrylic, matte finish, not less than 1/16-in thick by 3/4-in by 2-1/2-in, Rowmark 322402. Nameplates shall be 316 SS screw mounted to all enclosures except for NEMA 4 and 4X. Nameplates for NEMA 4 and 4X enclosures shall be attached with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X ½". Prior to installing the adhesive nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residues has been removed. Epoxy adhesive or foam tape is not acceptable:
      1) There shall be a master nameplate that indicates supply voltage equipment ratings, short circuit current rating, manufacturer's name, shop order number and general information. Cubicle nameplates shall be mounted on the front face, on the rear panel and inside the assembly, visible when the rear panel is removed.
      2) Provide permanent warning signs as follows:
         a) "Danger- High Voltage- Keep Out" on all doors where any voltage over 125 volts AC is present.
         b) "Warning- Hazard of Electric Shock - Disconnect Power before Opening or Working On This Unit" on main power disconnect or disconnects.
2. Internal:
   a. Provide the panel with a UL 508A label.

b. Control components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., shall be suitably marked for identification, corresponding to appropriate designations on the submitted and reviewed wiring diagrams.

3. Special:
   a. Identification nameplates shall be white with black letters, caution nameplates shall be yellow with black letters, and warning nameplates shall be red with white letters.

C. Wiring Trough and Terminal Block Installation:

1. Space between wiring troughs and equipment shall be such that space for terminal blocks is provided for termination of each conductor or group of conductors before connection to the equipment. Removal of equipment for service shall not leave any exposed conductors hanging unconnected.
2. Install the wiring troughs such that one may be removed without interference from the other. Troughs shall be installed such that trough covers may be removed without cover interference.
3. Install terminal blocks on DIN rail with adequate space for access to the terminal with clear view of the wire identification label. All incoming or outgoing wiring shall enter or leave the panel on terminal blocks. Terminal blocks or wiring troughs shall not be installed on the doors. Provide terminal blocks on side plates and back plates for all door mounted equipment.
4. In no case shall internal and external wiring share a wiring trough.
5. Provide 600 volt rated terminal blocks for any conductor carrying any voltage over 120 volts to ground.
6. Provide 600 volt rated strap screw terminal blocks for any power conductors carrying over 20 amps, at any voltage. Terminals shall be double sided and supplied with removable covers to prevent accidental contact with live circuits.
7. Power conductors carrying over 20 amps, at any voltage shall be terminated to strap-screw type terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated. Do not terminate more than one conductor in any lug, and do not land more than two conductors under any strap-screw terminal point.
8. Terminals shall have permanent, legible identification, clearly visible with the protective cover removed. Each terminal block shall have 20 percent spare terminals, but not less than two spare terminals.
9. Do not land more than two conductors per terminal point. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating common or ground conductors.
10. Twisted shielded pair or triad cables shall have each individual conductor and shield drain wire landed on individual terminal blocks. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating the shield drain wire conductors.
11. Provide an AC ground bar bonded to the panel enclosure, if metal, with 20 percent spare terminals.
12. Provided ground terminal blocks for each twisted-shielded pair drain wire.

D. Internal Panel Wiring:

1. Power and control wiring shall be tinned stranded copper, minimum size No. 14 AWG, with 600 volts, 90 degree C, flame retardant, Type MTW thermoplastic insulation. Line side power wiring shall be sized for the full fault current rating or frame size of the connected device, and as shown on the drawings.
2. Analog signal wires shall be 600 Volt Class, insulated stranded tinned copper, twisted shielded #16 AWG pair.
3. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks. Field wiring shall not be terminated directly on any panel-mounted device.
4. All wiring shall be tagged and coded with an identification number as shown on the drawings. Coding shall be typed on a heat shrinkable tube applied to each end showing origination and destination of each wire. The marking shall be permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE.
5. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover. Plan wire routing such that no twisted shielded pair cable conducting analog 4-20 mA signals or low voltage analog signals are routed in the same wire trough as conductors carrying discrete signals or power.
6. Control panel wire color code shall be as follows:
   a. Black: AC power at line voltage
   b. Red: switched AC power
   c. Orange: May be energized while the main disconnect is in the off position
   d. White: AC neutral
   e. Orange/white stripe or white/orange stripe: separate derived neutral
   f. Red/white stripe or white/red stripe: switched neutral
   g. Green or green w/ yellow tracer: ground/earth ground
   h. Blue: Ungrounded DC power
   i. Blue/white stripe or white/blue stripe: DC grounded common
   j. Brown: 480V AC 3 phase - phase A
   k. Orange: 480V AC 3 phase - phase B
   l. Yellow: 480V AC 3 Phase - phase C
   m. Purple: common for analog signal wiring
   n. Brown: positive leg of an analog signal

E. Field Entrance Internal Wiring:

1. Field entrance internal wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Circuit groups shall be supported so that circuit terminations are not stressed. In addition, low signal wiring (millivolt and milliamp) shall be bundle separately from the rest of the control wiring.
2. All field wiring shall be tagged and coded with an identification number. Coding shall be typed on a heat shrinkable tube applied to each end of the wire. The marking shall be a permanent, non-smearing, solvent-resistant type similar to Raychem TMS-SCE.
3. All conduit entering or leaving equipment shall be coordinated, in advance with the panel installer, so that the conduit entrances to the enclosure are directly below the termination area for immediate termination. Conduits shall not enter the top or side of the panel unless approved in writing by the Owner and Engineer.

F. Fusing of PLC Inputs and Outputs:

1. All PLC analog inputs and outputs shall be individually fused for each channel. All discrete inputs and outputs shall be buffered with relays from the field connections. Discrete points shall be fused for each circuit group with no less than one fuse per PLC I/O card.

G. Buffering PLC Discrete Inputs and Outputs:

1. All PLC Discrete inputs and outputs shall be individually buffered with relays as specified. Where field voltage is AC reed type relays shall not be used.

2.6 FACTORY TESTING - GENERAL

A. The entire control panel shall be completely assembled, wired, and adjusted at the factory and shall be given the manufacturer's routine shop tests and any other additional operational test to insure the workability and reliable operation of the equipment.

B. The operational test shall include the proper connection of supply and control voltage and, as far as practical, a mockup of simulated control signals and control devices shall be fed into the boards to check for proper operation.

C. Factory test equipment and test methods shall conform to the latest applicable requirements of ANSI, IEEE, UL, and NEMA standards, and shall be subject to the Owner and Engineer's approval.

PART 3 - EXECUTION

3.1 INSTALLER'S QUALIFICATIONS

A. Installer shall be specialized in installing this type of equipment with minimum 5 years documented experience. Experience documentation shall be submitted for approval prior to beginning work on this project.

3.2 EXAMINATION

A. Examine installation area to assure there is enough clearance to install the equipment.

B. Housekeeping pads shall be included for the floor mounted panels as detailed on the drawings.

C. Check concrete pads and baseplates for uniformity and level surface.

D. Verify that the equipment is ready to install.

E. Verify field measurements are as instructed by manufacturer.

3.3 INSTALLATION

A. The contractor shall install all equipment per the manufacturer's recommendations and contract drawings.

B. Conduit hubs for use on raceway system pull and junction boxes shall be watertight, threaded aluminum, insulated throat, stainless steel grounding screw, as manufactured by T&B H150GRA Series.

C. Conduits entering a control Panel or box containing electrical equipment shall not enter the enclosure through the top.

D. Install required safety labels.

3.4 RACEWAY SEALING

A. Where raceways enter control panels containing electrical or instrumentation equipment, all entrances shall be sealed with 3M 1000NS Watertight Sealant.

B. This requirement shall be strictly adhered to for all raceways in the conduit system.

3.5 FIELD QUALITY CONTROL

A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.

C. Provide laminated copies of the Control schematics along with the final approved I/O list in each enclosure door pocket.

3.6 FIELD TESTING

A. Perform all electrical field tests recommended by the manufacturer. Disconnect all connections to solid-state equipment prior to testing.

B. Test each key interlock system for proper functioning.

C. Test all control logic before energizing the equipment.

3.7 CLEANING

A. Remove all rubbish and debris from inside and around the panel. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

3.8 EQUIPMENT PROTECTION AND RESTORATION

A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

END OF SECTION

SECTION 40 68 60
APPLICATION SERVICES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. The work described within this Section relates to the software application for Human-Machine Interface (HMI) and Programmable Logic Controller (PLC) programming. This work shall be performed by the Application Services Provider (ASP).

B. The Process Control System Integration (PCSI) shall also be the ASP and shall perform all work as the ASP.

C. The PCSI will perform all work necessary to configure, customize, debug, install, and place into operation all HMI and PLC software specified within this Division and other related divisions.

D. The Contractor shall coordinate with the PCSI all scheduling, installation, and startup services.

E. Program the Conn Pump Station PLC per the requirements stated in Specification Section 40 61 96 – Control Loop Descriptions.

F. Program the Wonderware Intouch at the Operation Control Center (OCC) to monitor and control the Conn Pump Station.

G. Generate new HMI graphic displays, database, and reports for the Conn Pump Station.

1.2 RELATED WORK

A. Section 40 61 00 Instrumentation and Controls General Provisions

B. Section 40 61 96 Control Loop Descriptions

1.3 SUBMITTALS

A. Workshops; Refer to Section 40 61 00 for the workshop requirements. The results of the various workshops shall be documented and submitted. The submittal requirements in this Section are supplemental to the requirements stated under Section 40 61 96 Control Loop Descriptions.

B. Submittal Process

1. Submittals shall be made in accordance with the requirements of, Section 40 61 00 Instrumentation and Controls General Provisions, and as specified herein.
2. All PCSI related submittals shall be submitted in electronic format. PLC Programs shall be submitted in its native format and fully annotated PDF file.

C. Control Strategy and I/O Database Development Submittal Requirements

1. Programming standards to be used for process graphics conventions shall be submitted after the standards workshop.
2. Programmable Logic Controller Programming
   a. Provide field I/O List with tag name, description, alarm priority, alarm enable/disable, engineering unit (EU) ranges, engineering unit, historical data enable/disable, and I/O register assignments Diagrams of the process control functions by each strategy.

b. Listing of inputs to the control function
c. A detail narrative of each control strategy
d. Listing of all Operator inputs and outputs to and from the control function. Any special displays related to the function shall be illustrated. A description of the operation of any display shall be described as it relates to the control function.
e. Cross references of all I/O, showing to which I/O modules or software modules.
f. Failure contingencies shall be described in detail.

D. HMI Graphics Submittal Requirements
1. Provide all static HMI graphic screens for review.
2. Provide HMI I/O List with tag name, description, alarm priority, alarm enable/disable, engineering unit (EU) ranges, engineering unit, historical data enable/disable, and I/O register assignments.
3. Displays for each process area including all pop ups.
4. Listing of data points on each display
5. A short narrative of each control usage
6. Listing of all Operator inputs and outputs to and from the control function. Any special displays related to the function shall be illustrated. A description of the operation of any display shall be described as it relates to the control function.
7. Cross references of all I/O, showing which software module at each point used
8. Failure contingencies shall be described in detail.
9. A complete listing of all historical points
10. Listing of all required configuration files for each SCADA client.

E. Reports and Contents Submittal Requirements
1. The PCSI shall obtain a copy of existing reports to analyze and present recommendations for modification and addition during the workshop.
2. The PCSI shall chair and develop an agenda at least 2 weeks before the workshop.
3. Provide a listing of all reports including any existing reports that require modifications.
4. For each report that requires modification, scan each existing report using PDF format and provide the markups directly on the PDF file.
5. Provide the layout and contents of all new reports.
6. Provide details on how manual data will be entered.
7. Provide a review of the report generation procedure.

F. Submit a proposed Schedule of Work following the PCSI pre-submittal conference.

1.4 REFERENCE CODES AND STANDARDS

A. Instrumentation equipment and HMI programming shall comply with the following codes and standards:
1. NEMA ICS 1-101 Diagrams, Designations and Symbols
2. ANSI/ISA-5.06.01-2007 - Functional Requirements Documentation for Control Software Applications
3. ISA-TR20.00.01-2001 - Specification Forms for Process Measurement and Control Instruments Part 1: General Considerations Updated with 27 New Specification Forms in 2004-2005.

4. ISA-5.4-1991 Instrument Loop Diagrams.
5. ISA-5.5-1985 Graphic Symbols for Process Displays
6. ISA-5.1-1984 (R1992) Instrumentation Symbols and Identification
7. ISA-5.3-1983 Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic, and Computer Systems.
8. ISA-20-1981 Specification Forms for Process Measurement and Control Instruments, Primary Elements, and Control Valves.
9. ISA-5.2-1976 (R1992) Binary Logic Diagrams for Process Operations
10. The International Society of Automation (ISA)
11. All equipment and installations shall conform to applicable Federal, State, and local codes.

B. All work associated with PLC and HMI programming services shall comply with the requirements set forth within the contract documents and as agreed and approved from the standards submittal.

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.5 QUALITY ASSURANCE

A. The PCSI shall provide verifiable documentation supporting the application programming team is qualified to perform the work under this Contract. Resume of each team member shall be provided for Owner/Engineer review.

1.6 SYSTEM DESCRIPTION

A. The PCSI is responsible for providing all applications programming and configuration services to accomplish the control and monitoring functions as described in the contract specifications and drawings. The PCSI shall provide all programming functions including, but not limited to, control strategies, Lift Station PLC, Front End driver, and HMI.

B. The PCSI will obtain from the OWNER a copy of the existing HMI application and PLC programs. The PCSI shall analyze this information to obtain a general understanding of existing station control and provide all applications programming and configuration services necessary to monitor and control various lift station processes as described in the contract specifications and drawings.

C. The PCSI shall develop and provide customized reports as discussed in the reports workshop. The reports shall be designed and function with the Human Machine Interface software application.

1.7 WARRANTY

A. Provide HMI and PLC programming warranty as defined in Section 40 61 00 and Supplementary Conditions.

1.8 SYSTEM FINAL DOCUMENTATION

A. Prior to final acceptance of the system and owner training, operating and maintenance manuals covering instruction and maintenance on each type of equipment shall be furnished in accordance with the Section 40 61 00.

B. The instructions shall be bound in three-ring binders with Drawings reduced or folded for inclusion. As a minimum, the following information shall be provided:

1. A comprehensive index
2. A complete "As Constructed" set of approved shop Drawings.
3. A complete list of all programs furnished in their native format and PDF format.
4. Detailed service, maintenance and operation instructions for each item supplied.
5. Operating instructions which incorporate a functional description of the entire system with references to the systems schematic Drawings and instructions.

C. The final documentation shall be new documentation written specifically for this project but may include standard and modified standard documentation. Modifications to existing hardware or software manuals shall be made on the respective pages or inserted adjacent to the modified pages. All standard documentation furnished shall have all portions that apply clearly indicated. Any portions that do not apply shall be shown strike through the texts.

D. The manuals shall contain all illustrations, detailed displays, and instructions necessary for installing, operating, and maintaining the equipment. The illustrated parts shall be numbered for identification. All information contained therein shall apply specifically to the equipment furnished and shall only include instructions that are applicable. All such illustrations shall be incorporated within the printing of the page to form a durable and permanent reference book.

E. All PCSI related software application work shall become the property of the Owner.

F. The following approved submittals shall be used as the basis for generating the final documentation for HMI and PLC:

1. HMI Graphics
2. Control Strategy and I/O database development
3. Reports and Contents

G. The final documentation requirements in this Section are supplemental to requirements under Section 40 61 00.

H. System Operator’s Manual

1. This manual shall include HMI functions and serves as a complete instruction to the system and equipment and shall describe in detail the Operator interfaces and operator procedures.
2. This manual shall be provided for each specific process area.
3. In addition to the Operator interaction sequences, the following shall be provided, as a minimum:
   a. Summary description of all major functions
   b. Glossary of terms
   c. A listing of all displays
   d. Color screen shots of all graphic screens developed for the project
   e. Presentation of data on displays
   f. Navigation features
   g. Description of Local, Remote Manual, and Remote Auto controls
   h. Description of how the operator interface with equipment monitoring and control and how to set control parameters such as lead/lag sequencing, flow, and level control setpoints, etc.

i. Description of how the system and equipment react to situations such as heavy alarming, loss of communication links, heavy operator interaction, and loss of power and restoration of power.
j. Description of how the systems and equipment react to system failures such as loss of CPU, loss of mass storage, loss of operator/machine display capabilities, and loss of communication.
k. Description of the hardware configuration and device switching capabilities.
l. Description of every message and alarm that the system and equipment are capable of outputting and explanation of what the message indicates and what action the system operator should take.
m. Description on how to generate and print reports.

I. HMI System Administration/Maintenance Manual – Any HMI graphic screens generated for the project shall be included in this Manual. The content of the HMI Maintenance Manual shall include, at a minimum, the topics as outlined below:

1. HMI system architecture
   a. Overall system diagram
2. Network configuration
   a. Overall system diagram
   b. Network switch configuration
3. HMI objects and object libraries
4. Graphic display resolution
5. Multi-monitor configuration
6. Color Usage
   a. Background
   b. Informational text
   c. Alarm text
   d. Analog process values
   e. Process piping
   f. Animation
7. Screen Layout and graphic display convention
   a. Screen display hierarchy
   b. Level 1 – Process area overview displays
   c. Level 2 – Process unit control displays
   d. Level 3 – Process unit detail displays
   e. Level 4 – Process unit support displays
   f. Interlock functionality on level 2 and level 3 displays
   g. Communication performance displays
   h. Computed point displays
   i. Color convention
   j. Analog input popups
   k. Display naming convention
8. Screen Operation:
   a. Menu bars, menu options
   b. Cursor movements
   c. Opening and closing displays
   d. HMI control
      1) Local
      2) Remote manual

3) Remote automatic
4) Popups
5) Equipment control
6) Setpoint control

e. Control action confirmation popups
f. Equipment tagging
1) Information
2) Lockout
g. Status/value override/on scan/off scan
h. Data entry point/operator override function
i. Display printing

9. Alarming
a. Alarm summary display
b. Alarm sub-menu
c. Historical alarms
d. Alarm management
1) Audible alarms
2) Alarm popups
3) Alarm priority
4) Alarm aggregation
5) Alarm shelving
6) Alarm acknowledgement

10. Trending
a. Real-time
b. Historical
c. Ad-hoc
d. PID tuning popups
e. Embedding trends on graphics
f. Usage of sparklines
g. Printing trends

11. HMI system Security
12. Reporting
13. Historical data archival and retrieval
14. HMI input/output list
15. HMI System Startup and shutdown procedures
16. All application specific scripts such as HMI to PLC time synchronization shall be provided.

J. PLC Maintenance Manual – This Manual shall be organized by control strategies generated for the project. The content of the PLC Maintenance Manual shall include, at a minimum, the topics as outlined below:

1. Overall program structure including naming convention
2. Field input and output list
3. Input/Output processing
a. Discrete
b. Analog
c. Analog Signal smoothing
d. Signal quality check

e. Analog deadband alarming
f. Analog scaling
g. Live zero filtering

4. Control functions:
   a. Detailed control narratives
   b. Local operation
   c. Remote manual
   d. Remote automatic
   e. Startup initialization
   f. Data quality check
   g. Bumpless transfer between modes
   h. Command verification
   i. Flow totalization
   j. Equipment runtime and starts
   k. Information tag and tagout commands
   l. PLC health monitoring
   m. Program documentation
5. Memory mapping
6. Database types
7. PLC time synchronization
8. Peer-to-peer communication.
9. PLC program listing. The printable version of the PLC program shall be formatted such that all the control logic is modularized with information properly displayed within 8 ½ x 11 sheets. Ladder diagram with line or individual function block that splits between pages are not permitted.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 APPLICATION DEVELOPMENT COORDINATION MEETINGS

A. The PCSI shall attend all coordination meetings as defined under Section 40 61 00, Instrumentation and Controls General Provisions. The purpose of these meetings is to discuss PCSI's milestone deliverables related to the HMI and PLC software applications. The PCSI shall generate meeting minutes, within three business days, after the completion of each workshop specified herein. The meeting minutes shall document all items discussed, with the appropriate action items, to be reviewed during the next workshop to ensure all action items are addressed.

B. Workshops and Submittal Requirements
   1. HMI graph screens workshop
      a. Schedule one mandatory workshops with the Owner/Engineer to discuss development and modification of existing graphic screens on the existing FactoryTalk HMI Control System.
      b. HMI discussion shall follow guidelines from ANSI/ISA-101.01-2015 (Human Machine Interfaces for Process Automation Systems).
      c. Prior to the workshop, the PCSI shall arrange a meeting with Owner to obtain all existing graphic files that require modification. The Contractor shall use

these existing graphics as the basis for generating new and improved screens using the existing FactoryTalk HMI Application.

d. The purpose of the workshop shall be focused on screen enhancement and shall be as follows:
   1) Review any existing graphic standards.
   2) Review existing HMI guidelines for various display types such as overviews, system overview, trends, popups, alarming, equipment control, navigation, information density, etc.
   3) Review hand-sketched screens for additional process monitoring that are currently not on the existing HMI.
   4) Standard graphic symbol library to be used on the graphics.
   5) Navigation convention, color usage convention such as using low contrast color on display background, text font type, size, etc.
   6) Conventions for displaying trends, multiple coding of alarms, alarm coloring, alarm priority/color, alarm aggregation, device status, process variables, etc.
   7) Alarm acknowledgment, alarm color, foreground/background color, flashing (unacknowledged) vs. steady (acknowledged) usage, etc.
   8) Conventions for naming and identifying devices and depiction of equipment operational states.
   9) General guidelines for layout of graphics (levels 1 through 4) regarding Process Overview, Process Unit Control, Process Unit Detail, Process Unit Support and Diagnostic graphics. Furthermore, typical content and information density of graphics shall be discussed.
   10) Analog and equipment control popups.
   11) Proper depiction and implementation of trends.
   12) Proper usage of dashboards, Key Performance Indicators (KPIs).

e. Submittal Requirements: The items discussed during the first workshop shall be used to generate the Standard HMI Screens submittal.

2. Control Strategy and I/O Database Workshop
   a. Schedule a mandatory workshop with the Owner/Engineer to discuss development and modification to existing databases and control strategies specific to the Conn Pump Station. The existing tag I/O database shall be retained as much as practical.
   b. The PCSI shall schedule a workshop to discuss the field I/O list, monitoring and control aspects of the Conn Pump Station.
   c. The purpose of the workshop is to:
      1) Review Owner's guidelines and/or standards documents.
      2) Review existing tag naming convention.
      3) Discuss any revision to the I/O database.
      4) Discuss naming convention for pseudo I/O points such as equipment start/stop request, runtime, no. of starts, flow totals, alarms, etc.
      5) Ensure PCSI's understands the monitoring and control functions.
      6) Present to the Owner/Engineer sample PLC programs, methodology, program documentation, any User-defined Function Blocks (UDFBs) to be used in conjunction with standard Instructions used in control strategy generation.
      7) Present memory map address ranges for specific input/output functions.
      8) Other related topics

d. Submittal Requirements: The items discussed during the workshop shall be utilized to generate the I/O database and control strategy submittals.

3. Reports and Contents Workshop
   a. Schedule a mandatory workshop with the Owner/Engineer to discuss development of the reports. The purpose of the reports workshop is to:
      1) Discuss all existing reports required in the new SCADA HMI
      2) Discuss all existing reports required modifications and any new reports needed
      3) Discuss layouts for daily, monthly, and yearly reports
      4) Discuss report formatting
      5) General guidelines for format of typical reports, the guidelines will establish the typical content and information of each report
      6) Develop a list of reports to be generated
      7) Discuss methodology on Daylight Savings and leap year to be automatically built into each report
      8) Other topics related to reports generation
   b. It is anticipated there will be three (3) reports to be developed. These reports will be medium complexity. Medium complexity report is defined as up to two standard 8 ½ x 11 pages.

C. Submittal Requirements: The items discussed during the workshop shall be used to generate the Reports and Contents submittal.

3.2 TESTING

A. The PCSI shall coordinate all testing with the Engineer/Owner. Refer to Section 40 61 21 Instrumentation Testing and System Commissioning for all detail testing requirements.

3.3 TRAINING

A. The PCSI shall coordinate all training with the Owner. Refer to Section 40 61 26 Instrumentation System Training for details of all project specific training requirements.

END OF SECTION

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SECTION 40 70 50
INSTRUMENT SUPPORT HARDWARE

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish and install instrumentation mounting and support hardware, as shown on the Drawings and as specified herein.

B. Hardware shall include anchor systems, adhesive anchor systems, metal framing systems, and other instrumentation installation mounting and support systems as specified herein with additional requirements as shown on the Drawings.

1.2 RELATED WORK

A. Section 40_61_00 Instrumentation and Controls-General Provisions

B. Section 40_71_00 Field Instrumentation

C. Section 40_67_00 Instrumentation and Controls-Control Panels

1.3 SUBMITTALS

A. Submit, in accordance with Division 1, the manufacturers' names and product designation or catalog numbers for each of the types of materials specified and shown on the Drawings.

B. The submittal information, for anchor systems, shall contain manufacturer's specifications and technical data that includes:

1. Acceptable base material conditions (i.e., cracked, un-cracked concrete)
2. Acceptable drilling methods
3. Acceptable bore hole conditions (dry, water saturated, water filled, under water)
4. Manufacturer's installation instructions including bore hole cleaning procedures and adhesive injection.
5. Cure and gel time tables
6. Temperature ranges (storage, installation, and in-service).

1.4 REFERENCE CODES AND STANDARDS

A. All products and components shown on the Drawings and listed in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. ASTM E 488-96 (2003); Standard Test Method for Strength of Anchors in Concrete and Masonry Elements, ASTM International
2. ASTM E 1512-93, Standard Test Methods for Testing Bond Performance of Adhesive-Bonded Anchors, ASTM International
3. AC308; Acceptance Criteria for Post-Installed Anchors in Concrete Elements, Latest revision
4. SAE 316 Stainless Steel Grades

B. All equipment components and completed assemblies specified in this Section of the Specifications, having a UL standard, shall bear the appropriate label of Underwriters Laboratories.

1.5 QUALITY ASSURANCE

A. The manufacturer of these materials shall have produced similar electrical materials and equipment for a minimum period of five (5) years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.6 JOBSITE DELIVERY, STORAGE AND HANDLING

A. Prior to jobsite delivery, the Contractor shall have successfully completed all submittal requirements, and present to the Owner and Engineer upon delivery of the equipment, an approved copy of all such submittals. Delivery of incomplete constructed equipment, onsite factory work, or failed factory tests will not be permitted.

B. Materials shall be handled and stored in accordance with manufacturer's instructions.

C. Adhesive Anchor Systems

1. Deliver materials undamaged in Manufacturer's clearly labeled, unopened containers, identified with brand, type, and ICC-ES Evaluation Report number.
2. Coordinate delivery of materials with scheduled installation date, minimizing storage time at job-site.
3. Store materials under cover and protect from weather and damage in compliance with Manufacturer's requirements, including temperature restrictions.
4. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
5. Do not use damaged or expired materials.
6. Storage restrictions (temperature range) and expiration date must be supplied with product

D. Metal Framing Systems

1. Material shall be new and unused, with no signs of damage from handling.

1.7 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for 1 year from date of final acceptance of the equipment. Within such period of warranty, the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition.

PART 2 - PRODUCTS

2.1 ANCHORING SYSTEMS

A. Acceptable Manufacturers

1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   a. HILTI Kwik Bolt 3
   b. Approved Equal

2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. Product Description

1. Torque controlled expansion anchor consisting of anchor body, expansion element (wedges), washer and nut. Anchor shall be used for anchor sizes less than 3/8 inch.
2. All parts and materials shall be manufactured of 316 stainless steel and conform to SAE 316 standards.
3. UL 203 Rated.

2.2 ADHESIVE ANCHORING SYSTEMS

A. Acceptable Manufacturers

1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   a. HILTI HIT-RTZ with HIT-HY 150 MAX
   b. Approved Equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. Product Description

1. Anchor body with helical cone shaped thread on the embedded end and standard threads on the exposed end, with washer and nut, inserted into Injection adhesive. Anchor shall be used for anchor sizes 3/8 inch and larger.
2. All parts and material shall be manufactured of 316 Stainless Steel and shall conform to SAE 316 standards.

2.3 STRUT SUPPORT SYSTEMS

A. Acceptable Manufacturers

1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   a. Tyco Unistrut
   b. Cooper B-Line
   c. Approved Equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. Product Description

1. Metal framing system for use in the mounting or support of electrical systems, panels and enclosures, and including lighting fixture supports, trapeze hangers and conduit supports.
2. Components shall consist of telescoping channels, slotted back-to-back channels, end clamps all threads and conduit clamps.
3. Minimum sizes shall be 13/16” through 3-1/4”

4. Components shall be assembled by means of flat plate fittings, 90 degree angle fittings, braces, clevis fittings, U-fittings, Z-fittings, Wing-fittings, Post Bases, channel nuts, washers, etc.
5. Field welding of components will not be permitted.
6. Unless otherwise specified or shown on the Drawings, all parts shall be manufactured of 316 stainless steel and conform to SAE 316 standards.
7. Framing systems for chlorine and ammonia rooms shall be manufactured of structural fiberglass.

2.4 INSTRUMENT PIPE STANDS

A. Acceptable Manufacturers

1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   a. O'Brien Saddlepak
   b. Approved Equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. Product Description

1. Floor mount pipe stand for use in the mounting or support of Instrumentation Transmitters.
2. Stand shall consist of a 10 by 10 inch base plate of 1/4 inch steel with a minimum 40 inch long 2 inch steel tube center welded with a minimum of two 8 inch long gussets fully welded for maximum strength. The base plate shall have slotted mounting holes near all four corners.
3. The stand shall be fully zinc metallized or hot dip galvanize coated.
4. Field welding of components will not be permitted.

2.5 INSTRUMENT SUNSHIELD

A. Acceptable Manufacturers

1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   a. O'Brien VIPAK
   b. Anderson Greenwood
   c. Approved Equal
2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. Product Description

1. Pipe stand or structure mounted sunshield for use in the protection of instrumentation from direct sunlight.

2. Sunshield shall consist of a minimum 10 inch overhang with a clear view of the instrument display and working space for service of the instrumentation without removal. The sunshield shall be made of fiberglass reinforced plastic with UV inhibitors unless shown otherwise on the drawings. All mounting hardware shall be manufactured of 316 or 316L Stainless steel.
3. All aluminum or stainless steel Sunshields shall have all edges ground smooth without burs or sharp edges.

2.6 INSTRUMENT TUBING AND FITTINGS

A. Acceptable Manufacturers
   1. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
      a. Tubing
         1) Swagelok
         2) Parker
         3) Approved Equal
      b. Fittings
         1) Swagelok
         2) Parker
         3) Approved Equal
      c. Valves
         1) Whitney
         2) Parker
         3) Approved Equal
   2. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

B. Product Description
   1. All instrument air header and branch connections shall be 316 stainless steel.
   2. All instrument shut-off valves and associated fittings shall be supplied in accordance with the piping specifications and all instrument installation details. Fittings shall be 316 stainless steel. Valves shall be 316 stainless steel.
   3. All instrument tubing shall be fully annealed ASTM A269 Seamless 316 grade free of O.D. scratches and having the following dimensional characteristics as required to fit the specific installation:
      a. 1/4-in to 1/2-in O.D. x 0.035 wall thickness
      b. 5/8-in to 1-in O.D. x 0.049 wall thickness
      c. 1-in O.D. x 0.065 wall thickness
      d. 1-1/4-in O.D. x 0.065 wall thickness
      e. 1-1/2-in O.D. x 0.083 wall thickness
      f. 2-in O.D. x 0.095 wall thickness
   4. All process connections to instruments shall be annealed 1/2-in O.D. stainless steel tubing, Type 316.
   5. All mounting hardware shall be provided of 316 Stainless steel
   6. All tubing shall be supported by stainless steel and installed as per manufacturer's installation instructions.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall install all equipment strictly in accordance with the manufacturer's instructions and the Contract Drawings.

B. The location of all devices is shown, in general, on the Drawings and may be varied within reasonable limits so as to avoid any piping or other obstruction without extra cost, subject to the approval of the Owner. Coordinate the installation of the devices for piping and equipment clearance.

C. No instrumentation or electrical equipment shall be attached to or supported from, sheet metal walls.

D. Install required safety labels.

3.2 FIELD QUALITY CONTROL

A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible electrical connections. Minimum acceptable values are specified in manufacturer's instructions.

3.3 POST INSTALLED ANCHOR SYSTEMS

A. Prior to installation of the anchor systems, the hole shall be clean and dry in accordance with the manufacturer’s instructions.

3.4 CLEANING

A. Remove all rubbish and debris from inside and around the installation. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

END OF SECTION

SECTION 40 71 00
FIELD INSTRUMENTATION

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. Furnish, install and test all measurement instrument, level control devices and appurtenances, as shown on the Drawings, specified in the Related Work Sections and Divisions, and as specified herein.

B. Equipment, specified in other Divisions, shall be manufactured in accordance with this Section, and submitted as a part of the equipment specified in other Divisions.

1.2 RELATED WORK

A. Section 40 61 00 Instrumentation and Control General Provisions

B. Section 40 61 21 Instrumentation Testing and System Commissioning

C. Section 40 61 90 Field Instrumentation List

1.3 SUBMITTALS

A. Submit catalog data for all items supplied from this specification Section as applicable. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc., sufficient to confirm that the meter or relay provides every specified requirement. Any options or exceptions shall be clearly indicated.

B. Submittals for equipment specified herein, for other Sections or Divisions, shall be made as a part of equipment submittals furnished under other Sections or Divisions.

C. Installation experience documentation shall be submitted for approval with the Section Equipment Submittal

D. Operation and Maintenance Manuals.

1. Operation and Maintenance manuals shall be constructed in accordance with Division 1 and shall include the following information:
   a. Manufacturer’s contact address and telephone number for parts and service.
   b. Instruction books and/or leaflets
   c. Recommended renewal parts list
   d. Record Documents for the information required by the Submittals above.

1.4 REFERENCE CODES AND STANDARDS

A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. National Electrical Manufacturers Association (NEMA)
2. Instrumentation Society of Automation (ISA)
3. Underwriters Laboratories (UL)
4. UL 508, the Standard of Safety for Industrial Control Equipment
5. UL 508A, the Standard of Safety for Industrial Control Panels
6. Factory Mutual (FM)

7. All equipment and installations shall satisfy applicable Federal, State, and local codes.

1.5 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar instrumentation equipment for a minimum period of five (5) years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. Equipment submitted shall fit within the space or location shown on the Drawings. Equipment which does not fit within the space or location is not acceptable.

C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.6 WARRANTY

A. The Manufacturer shall warrant the equipment to be free from defects in material and workmanship for two (2) years from date of acceptance of the equipment containing the items specified in this Section. Within such period of warranty, the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Contractor at no expense to the Owner.

PART 2 - PRODUCTS

2.1 FLOAT TYPE LEVEL SWITCHES

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Contegra FS-90.
   2. Flygt Model ENM-10.
   3. Endress+Hauser FTS20.
   4. Approved Equal.

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. General:
   1. Provide sufficient lengths of Manufacturer's specialty cables for installation of power and signal conductors as provided with each instrument.

D. Type:
   1. The switch assembly shall be weighted and suspended on its own cable.

E. Function/Performance:
   1. Temperature Rating: 0-50 degrees C.
   2. Contact Rating: Up to 150V AC/DC and 1 amps AC, 1 amps DC.
   3. Contact Arrangement: Form C contact which is field selectable normally open or closed.

F. Physical:
1. Contact: Sealed mercury free switch housed in a chemical-resistant polypropylene or stainless steel casing.
2. Switch shall have a rating for the area in which it is installed.
3. Flexible Support Cable: Synthetic four wire cable, minimum 19 AWG wire.
4. Specific Gravity: Match to fluid being measured.

G. Power Requirements:
1. None.

H. Required Options/Accessories:
1. Provide flexible support cable of sufficient length to ensure no splice or connection is required in the wet well.
2. Provide junction box rated for the area in which it is installed.
3. Provide stainless steel supports/mounting accessories as required.

I. Installation:
1. Provide All Hardware from the manufacturer for the installation as described and shown on the plans.
2. Provide stainless steel wire ties for all cables within the wet well area or exposed to outdoor environments.

2.2 ELECTROMAGNETIC FLOW METER

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
1. Siemens
1. Endress & Hauser
2. Toshiba

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. General
1. Provide sufficient lengths of Manufacturer's specialty cables for installation of power and signal conductors as provided with each instrument.
2. Provide a hand-held programmer, for each transmitter, where full setup is not available for the instrument directly.

D. Type
1. Microprocessor based intelligent type.

E. Function/Performance:
1. Output: 4-20 mA DC. Output shall be linear for pressure applications.
2. Accuracy: 0.5 percent of span (linear output).
3. Stability: Combined temperature effects shall be less than 0.2 percent of maximum span per 50 degrees F temperature change. Effect on accuracy, due to static pressure changes, shall be negligible.
4. RFI Protection: 0.1 percent error between 27 and 500 MHZ at 30 v/m field intensity.
5. Drift: 0.10 percent per six months for 4-20 mA output.
6. Temperature rating: Suitable for process liquid temperature up to 70 degrees C and an ambient of 65 degrees C.

7. Pressure rating: 240 PSI if 150 lb flanges are used; 700 PSI if 300 lb flanges are used.
8. Meter shall be capable of running empty indefinitely without damage to any component.

F. Physical:

1. Metering Tube
Carbon steel with 304 Stainless interior unless otherwise indicated.
Electrical Classification: Rating shall be FM approved for the location shown on the Drawings
Tube Flanges: Match piping AWWA rating of the pipe. Minimum AWWA 150# Flange.
Tube Liner: Polyurethane or EDPM unless noted otherwise.
Tube Electrodes: ANSI 316 stainless steel or Hastelloy C, bullet nosed or elliptical self-cleaning type unless otherwise noted.
Tube Housing:
Sensor shall be suitable for continuous submergence (10 mH2O). Sensor shall be NEMA 6P/IP68.
The sensor cable shall be attached and potted to IP68 with cable lengths as required to reach the separately mounted transmitter in location shown on drawings.
Painting: All external surfaces shall be painted with a chemical and corrosion resistant epoxy finish.
2. Transmitter
Transmitter Enclosure: NEMA 4X.
Electrical Classification: Rating shall be FM approved for the location shown on the Drawings

G. Power Requirements

1. As shown on the Drawings.

H. Options/ Accessories

Factory calibration: Each meter shall be factory calibrated, with a copy of the Report delivered with the device and in the O&M manual.
1. Grounding: Meter shall be grounded with rings. Provide 316 Stainless Steel ground rings, ground wires, and gaskets, etc. All materials shall be suitable for the liquid being measured.
2. Provide a hand-held programmer for each transmitter, where full setup is not available from the instrument transmitter display directly.

2.3 PRESSURE INDICATING TRANSMITTER

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable

1. Endress and Hauser
Type: Cerabar series
2. Siemens
Type: Sitrans P series

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. General

1. Provide sufficient lengths of Manufacturer's specialty cables for installation of power and signal conductors as provided with each instrument.

D. Type:

1. Microprocessor based intelligent type.
2. Diaphragm actuated.

E. Function/Performance:

1. Output: 4 20 mA DC. Output shall be linear for pressure applications.
2. Accuracy: 0.1 percent of span (linear output).
3. Stability: Combined temperature effects shall be less than 0.2 percent of maximum span per 50 degrees F temperature change. Effect on accuracy due to static pressure changes shall be negligible.
4. RFI Protection: 0.1 percent error between 27 and 500 MHZ at 30 v/m field intensity.
5. Drift: 0.10 percent per six months for 4 20 mA output.
6. Sensor Technology: Digital.
7. Over Range Protection: Provide positive over range protection.

F. Physical:

1. Electrical Classification: Intrinsically safe for Class I and Class II, Division 1 locations.
2. Enclosure: NEMA 4X.
3. Sensor Diaphragm Material: Cobalt Nickel Chrome alloy or Hastelloy C.
4. Gaskets: Teflon.
5. Sensor Fill Fluid: Shall be suitable for process fluid being measured. When used for chemical metering service, sensor fill fluid shall be rated specifically for the chemical being measured.

G. Power Requirements:

1. Loop powered, two wire type.

H. Options/Accessories:

1. Provide span and zero adjustment at each transmitter.
2. Provide local indication at each transmitter, either analog gauge or LCD readout. Scale shall be in engineering units.
3. For each transmitter provide a manifold as specified herein, with the following Modes:
   Normal Mode
   Zeroing Mode
   Isolation Mode
   Calibration Mode
   Blowdown Mode
4. Provide hand held programmer(s) where full setup is not available for the instrument directly.
5. Provide a factory installed and calibrated capillary tube to the annular seal.

2.4 RADAR LEVEL TRANSMITTERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Siemens LR-560

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. General

1. Principle: To pulse K Band signals form the transducer toward the liquid and receive the echo measuring the time between sending and receiving the pulse signal and proportioning that to the measured liquid depth.

D. Type:

1. 316 SS Antenna sensor
2. Wetted parts 316L
3. Horn Antenna

E. Function Performance

1. Function: To sense variable liquid level.
2. Input Power: From transmitter signal wire 4 – 20 mA 24 VDC.
3. Range Capability: 1 feet to 99 feet
4. Beam Angle: 4 degrees
5. Shall have integral temperature compensation unit.
6. Accuracy. Current output 1 percent of selected full-scale range.
7. Repeatability. 0.25 percent full scale.

F. Physical

1. Mounting: flange mounted. Flange shall be as shown on plans", 150 lb. RF. All flanges for chemical tanks shall be coated to match the antennae and flange coatings.
2. Antenna shall be shaped to optimize reading accuracy and desired location.

G. Options/Accessories

1. Provide stainless steel hardware

2.5 PRESSURE SWITCHES

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

2. Static-O-Ring (SOR)
3. United Electric
4. Ashcroft
5. Approved equal

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. General

3. Ratings shall be equal to or exceed the piping.

D. Type:

2. Diaphragm actuated.

E. Function/Performance:

3. Repeatability: Greater than 1.0 percent of pressure.
4. Setpoint: Field adjustable and set between 30 and 70 percent of the adjustable range.
5. Dead Band: Adjustable
6. Reset: Unit shall be of the automatic reset type unless noted otherwise on the Instrument Device Schedules.
7. Over Range Protection: Over range protection to maximum process line pressure.

8. Switch Rating: 250V AC at 10 amps; and 30V DC at 5 amps.

F. Physical:

8. Housing: NEMA 4X.
9. Switching Arrangement: Single pole double throw (SPDT) unless double pole double throw (DPDT) switches are shown on the instrument device schedule.
10. Wetted Parts: 316 Stainless Steel Alloy, Hastelloy C or Monel diaphragm, viton seals, stainless steel connection port as confirmed compatible with the process fluid by the manufacture.
11. Connection Size: ½-in NPT.

G. Power Requirements

6. None

H. Required Options/Accessories

2. 1. Shutoff Valve: Provide process shutoff valve which can be used as an adjustable pressure snubber.

2.6 PRESSURE GAUGES

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable

4. Ashcroft Model 1279
5. Ametek/U.S. Gauge Division
6. Wika

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. General

1. Ratings shall be equal to or exceed the piping.

D. Type:

1. Bourdon tube actuated pressure gauge.

E. Function/Performance:

1. Accuracy: Plus or minus 1.0 percent of span or better.

F. Physical:

1. Case: Phenolic shock resistant or 316 stainless steel for surface/stem mounting with a pressure relieving back. The case shall be vented for temperature/atmospheric compensation. Gauge shall be capable of being liquid filled in the field or at the factory.
2. Window: Clear acrylic or shatter proof glass.
3. Bourdon Tube: 316 stainless steel.
4. Connection: ½-in NPT.
5. Gauge size: Minimum 4.5 inches viewable.
6. Pointer travel: Not less than 200 degrees nor more than 270-degree arc.
7. Range: As indicated in the instrument device schedule.

G. Power Requirements
   1. None

H. Required Options/Accessories
   1. Shutoff valve: Each gauge shall have a process shutoff valve which can also be used as an adjustable pressure snubber.
   2. Special scales: The Engineer reserves the right to require special scales and/or calibration if the manufacturer's standard is not suitable for the application.
   3. Gauges listed as liquid filled in the Instrument Device Schedule shall be liquid filled at the Manufacturer's Factory.

2.7 DOOR SWITCHES

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   4. Schlage
   5. Honeywell

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Type:
   1. Surface Mount Magnetic Switches for single and double doors

D. Function/Performance:
   2. Contact: Normally Close on door close.
   3. Switching Voltage: 24 VDC
   4. Current: 0.25 Amps at 30 Vdc
   5. The door position switch shall detect the open or closed status of an opening and then send this status to PLC panel.

2.8 TEMPERATURE TRANSMITTER – RTD TYPE

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   6. Rosemount
   7. Foxboro

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. General
   8. Provide sufficient lengths of Manufacturer's specialty cables for installation of power and signal conductors as provided with each instrument.

D. Type:
   9. Input: 3-wire, 100 Ohm platinum RTD.
   10. Output: 2-wire, 4-20 mA DC into 750 Ohm
   11. Element mounted

E. Function/Performance:
   12. Receive input signal from resistance temperature device (RTD) indicated in process units and transmit a 4-20mA DC signal linear proportional to the measured temperature.
   13. Calibrated Accuracy - + 0.25 percent of calibrated span, or, + 0.1 percent, whichever is greater.
   14. Independent Linearity - + 0.05 percent of calibrated span
   15. Speed of Response - 0.5 seconds for 90 percent of step change
   16. Stability - + 0.02 percent (1-degree F.) zero and span

F. Physical:
   17. Case Material: Cast aluminum
   18. Cast Type: NEMA 4X
   19. Mounting: Threaded connection
   20. Indicator: 2-in ARC type

G. Power Requirements
   21. Loop powered

H. Options/Accessories
   22. Provide span and zero adjustment at each transmitter.
   23. Provide local indication at each transmitter, either analog gauge or LCD readout. Scale shall be in engineering units.
   24. Provide hand held programmer(s) where full setup is not available for the instrument directly.

PART 3 - EXECUTION

3.1 INSTALLER'S QUALIFICATIONS

A. Installer shall be specialized in installing this type of equipment with minimum 5 years documented experience

3.2 EXAMINATION

A. Examine installation area to assure there is enough clearance to install the equipment.

B. Verify that the equipment is ready to install.

C. Verify field measurements are as instructed by the manufacturer.

3.3 INSTALLATION

A. The Contractor shall install all equipment per the manufacturer's recommendations and Contract Drawings.

B. All process connections shall be 316 stainless steel tubing, 3/8" minimum, unless otherwise shown on the Drawings. Fittings shall be of the compression type, 316 stainless steel.

C. All conduit entries into the instruments shall use hubs of watertight, threaded aluminum, insulated throat, stainless steel grounding screw, as manufactured by T&B H150GRA Series, or equal.

D. Install stainless steel instrument labels with instrument ID, secured with safety wire.

3.4 RACEWAY SEALING

A. Where raceways enter terminal boxes, junction boxes, or instrumentation equipment, all entrances shall be sealed with 3M 1000NS Watertight Sealant, or approved equal.

3.5 FIELD QUALITY CONTROL

A. Inspect installed equipment for anchoring, alignment, grounding and physical damage.

B. Check tightness of all accessible electrical connections. Minimum acceptable values shall be specified in the manufacturer's instructions.

3.6 FIELD ADJUSTING

A. Adjust all equipment for proper range and field conditions, as described in the manufacturer's instructions.

B. Any field adjustments, required for proper system operation, shall be included in the Final O&M.

3.7 FIELD TESTING

A. Perform all electrical field tests recommended by the manufacturer.

B. Test each interlock system for proper functioning.

C. Test all control logic for proper operation.

3.8 CLEANING

A. Remove all rubbish and debris from inside and around the equipment. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint free rags. Do not use compressed air.

3.9 EQUIPMENT PROTECTION AND RESTORATION

A. Touch-up and restore damaged surfaces to factory finish, as approved by the manufacturer. If the damaged surface cannot be returned to factory specification, the surface shall be replaced.

3.10 MANUFACTURER’S CERTIFICATION

A. A qualified factory-trained and certified representative shall certify in writing that the equipment has been installed, adjusted, including all settings as defined in the Contract Documents.

B. The Contractor shall provide three (3) copies of the representative’s certification.

3.11 TRAINING

A. Provide the representatives, services for training of Owner’s personnel in operation and maintenance of the equipment furnished under this Section.

B. The cost of training program to be conducted with Owner's personnel shall be included in the Contract Price. The training and instruction, insofar as practicable, shall be directly related to the system being supplied.

C. Provide detailed O&M manuals to supplement the training course. The manuals shall include specific details of equipment supplied and operations specific to the project.

D. The training session shall be conducted by a manufacturer's qualified representative. Training program shall include instructions on the assembly, motor starters, protective devices, metering, and other major components.

E. The Owner reserves the right to videotape the training sessions for the Owner’s use.

END OF SECTION

SECTION 40 78 00
PANEL MOUNTED CONTROL DEVICES

PART 1 - GENERAL

1.1 SCOPE OF WORK

A. This Section of the Specifications describes the requirements for panel mounted equipment to be furnished under other Sections of the Specifications as listed in the Related Work paragraph of this Section.

B. All equipment described herein shall be submitted and furnished as an integral part of equipment specified elsewhere in these Specifications.

1.2 RELATED WORK

A. Section 40 67 00 Instrumentation Control Panels

1.3 SUBMITTALS

A. Submittals for equipment specified herein shall be made as a part of equipment furnished under other Sections. Individual submittals for equipment specified herein will not be accepted and will be returned un-reviewed.

B. Submit catalog data for all items supplied from this specification section as applicable with the control panel submittal as referenced in the related work paragraph. Submittal shall include catalog data, functions, ratings, inputs, outputs, displays, etc., sufficient to confirm that the devices provide every specified requirement. Any options or exceptions shall be clearly indicated.

1.4 REFERENCE CODES AND STANDARDS

A. The equipment in this specification shall be designed and manufactured according to latest revision of the following standards (unless otherwise noted):

1. NEMA/ISCI 109 Transient Over-voltage Withstand Test
2. IEEE Std. 472/ANSI C37.90.2 Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
3. IEC 255.4 Surge Withstand Capability Tests
4. NEMA/ICS 1 General Standard for Industrial Control Systems.
5. NEMA/ICS 4 Terminal Blocks for Industrial Use.
6. NEMA/ICS 6 Enclosures for Industrial Control Systems.
7. NEMA LS 1 Low Voltage Surge Protective Devices.
8. UL 1449 Third Edition – Surge Protective Devices

B. All equipment shall comply with the requirements of the National Electric Code and Underwriters Laboratories (UL) where applicable.

C. Each specified device shall also conform to the standards and codes listed in the individual device paragraphs.

1.5 QUALITY ASSURANCE

A. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five years. When requested by the Owner/Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

B. Equipment submitted shall fit within the space or location shown on the Drawings. Equipment which does not fit within the space or location is not acceptable.

C. For the equipment specified herein, the manufacturer shall be ISO 9001 2000 certified.

1.6 WARRANTY

A. The Manufacturer shall warrant the specified equipment to be free from defects in material and workmanship for two year from date of acceptance of the assembly containing the items specified in this Section. Within such period of warranty, the Manufacturer shall promptly furnish all material and labor necessary to return the equipment to new operating condition. Any warranty work requiring shipping or transporting of the equipment shall be performed by the Contractor at no expense to the Owner.

PART 2 - PRODUCTS

2.1 MODE SELECTOR SWITCHES, PUSHBUTTONS AND INDICATING LAMPS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Allen Bradley
   2. Cutler Hammer
   3. GE
   4. Square D

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Construction
   1. 30mm Diameter
   2. Corrosion resistant
   3. NEMA 4/4X/13 without booted covers
   4. “Finger safe” contact blocks, 10A rating
   5. Function indicating colors per NFPA 79 unless otherwise shown on the Drawings.
   6. Engraved corrosion resistant nameplates
   7. LED lamps
   8. Mode selector switches shall have 1 spare set auxiliary contacts.
   9. Indicator lights to be Push-to-Test
   10. Potentiometer ratings to match I/O devices connected

2.2 TERMINAL BLOCKS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Phoenix Contact
   2. Entrelec
   3. Weidmuller
   4. Allen Bradley

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Terminal Blocks
   1. Terminal blocks shall be DIN-rail-mounted one-piece molded plastic blocks with tubular-clamp-screw type, with end barriers, dual side terminal block numbers and terminal group identifiers. Terminal blocks shall be rated for 600 volts except for control and instrumentation circuits, or 4-20 mA analog signal conductors.
   2. Provide 600 volt rated terminal blocks for any conductor carrying any voltage over 120 volts to ground.
   3. Provide 600 volt rated strap screw terminal blocks for any power conductors carrying over 20 amps, at any voltage. Terminals shall be double sided and supplied with removable covers to prevent accidental contact with live circuits.
   4. Power conductors carrying over 20 amps, at any voltage shall be terminated to strap-screw type terminal blocks with crimp type, pre-insulated, ring-tongue lugs. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated. Do not terminate more than one conductor in any lug, and do not land more than two conductors under any strap-screw terminal point.
   5. Terminals shall have permanent, legible identification, clearly visible with the protective cover removed. Each terminal block shall have 20 percent spare terminals, but not less than two spare terminals.
   6. Do not land more than two conductors per terminal point. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating common or ground conductors.
   7. Twisted shielded pair or triad cables shall have each individual conductor and shield drain wire landed on individual terminal blocks. Use the manufacturer's provided bridge connectors to interconnect terminal blocks terminating the shield drain wire conductors.
   8. Control circuits, 120 volts and below, and 4-20 mA analog signal conductors shall be terminated with manufacturer's recommended ferrules. Ferrules shall be provided with plastic sleeves.
   9. Provide an AC ground bar bonded to the panel enclosure, if metal, with 20 percent spare terminals.
   10. Provided ground terminal blocks for each twisted-shielded pair drain wire.

D. Terminal Blocks (Analog Input/output)
   1. Fused modular terminal blocks shall be provided for all analog inputs and outputs.

2. Technical:
    a. Connection: Screw
    b. No. of levels: 3
    c. No. of connections: 5
    d. Nominal cross section: 4 mm^2
    e. Insulating material: PA
    f. Fuse: G/5 x 20
    g. Fuse type: Glass
    h. Rate surge voltage: 6 KV
    i. Overvoltage category: III
    j. LED voltage range: 12V AC/DC …30V AC/DC
    k. LED current range: 0.31 mA…0.95 mA
    l. Maximum load current: 36 A
    m. Connection standard: IEC 60947-7-2/IEC 60947-7-3

2.3 WIRE TROUGHS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
    1. Panduit
        a. Model: PanelMax

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. All wiring shall be enclosed in PVC wire trough with slotted side openings and removable cover. Plan wire routing such that no low voltage twisted shielded pair cable conducting analog 4-20 mA signals or communications low voltage analog signals are routed in the same wire trough as conductors carrying discrete signals or power

D. The following trough colors shall be used:
    1. Black: All 480 volt AC
    2. Grey: All 24 volt DC
    3. White: All 120 volt AC
    4. Blue: Intrinsic Safe Circuits

2.4 DIN RAILS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
    1. Phoenix Contact
    2. Entrelec
    3. Weidmuller
    4. Allen Bradley

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Standard 35 mm rails shall be made of steel zinc-plated and chromated. Rails shall be 7.5 mm tall and meet standard EN 60715: 2001.

D. Unless noted otherwise, all reference to DIN Rail mounting shall be of type standoff (raised) DIN Rail mounted.

2.5 SIGNAL ISOLATORS, BOOSTERS, CONVERTERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Moore Industries
   2. Phoenix Contact

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.
   1. Type:
      a. Externally powered solid state electronic type. Loop powered devices are not acceptable.
      b. Minimum of 2 isolated loops.
   2. Functional/Performance:
      a. Accuracy - 0.15 percent.
      b. Inputs - Current, voltage, frequency, temperature, or resistance as required.
      c. Outputs - Current or voltage as required.
      d. Isolation - There shall be complete isolation between input circuitry, output circuitry, and the power supply.
      e. Adjustments - Zero and span adjustment shall be provided.
      f. Protection - Provide RFI protection.
      g. 24 Volt DC power input.
   3. Physical:
      a. Mounting - Suitable for DIN Rail mounting in an enclosure or instrument rack.
   4. Options/Accessories Required:
      a. Mounting rack or general purpose enclosure as required.

2.6 POTENTIOMETER / RTD TRANSMITTERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Phoenix Contact
   2. Moore Industries

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Design and fabrication:
   1. Solid state electronics.
   2. Transmit analog signal directly proportional to measured impedance input.
   3. Power source: 24 Vdc.
   4. Input: 0-1000 ohms.
   5. Output signal: 4-20 mA DC.
   6. Accuracy (maximum error): ±o.25 percent.
   7. Ambient temperature range: 0-140 Deg F.

2.7 PANEL DISPLAYS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Siemens
      a. Model: RD 200

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Displays shall be as shown on the Drawings or where otherwise specified.

D. Design and fabrication:
   1. 4-20 mA, ± 10 V, TC & RTD Inputs
   2. Rating: NEMA 4X, IP65 without the use of a separate cover.
   3. Shallow Depth Case 3.6" Behind Panel
   4. Power Supply: 85-265 VAC
   5. Optional features to be supplied: two relays providing form A contacts, software settable at independent values.
   6. Output: analog 4-20 mA
   7. Display: minimum digit height of 2.5 inches; sunlight readable

2.8 RELAYS AND TIMERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Phoenix Contact
   2. Square D
   3. IDEC
   4. Potter-Broomfield.
   5. Allen-Bradley

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features, and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Type:
   1. Relays shall be double pole, double throw (form C) except PLC I/O buffer relays which shall be single pole, double throw (form C), spade plug in type with a transparent dust cover. The relay shall be equipped with an indicating light to indicate when its coil is energized.
   2. Units shall be of the general purpose plug-in type.

D. Functional/Performance:
   1. Coil voltage shall match supply voltage.
   2. Contact arrangement/function shall be as required to meet the specified control function.
   3. Mechanical life expectancy shall be in excess of 10,000,000 cycles.
   4. Duty cycle shall be rated for continuous operation.

5. Units shall be provided with integral indicating light to indicate if relay is energized.
6. Solid state time delays shall be provided with polarity protection (DC units) and transient protection.
7. Time delay units shall be adjustable and available in ranges from .1 second to 4.5 hours.
8. Plug-in general purpose relay.
9. Blade connector type.
10. Contact material: Silver cadmium oxide.
11. Relay sockets are DIN rail mounted.
12. Internal neon or LED indicator is lit when coil is energized.
13. Clear polycarbonate dust cover with clip fastener.
14. Operating temperature: -20 to +150 Deg F.
15. UL listed or recognized.

E. Ratings:
1. For 120VAC service provide contacts rated 10 amps at 120VAC, for 24VDC service provide contacts rated 5 amps at 28VDC, for electronic (milliamp/ millivolt) switching applicator provide gold plated contacts rated for electronic service.
2. Relays shall be provided with dust and moisture resistant covers.

F. Physical
1. DIN Rail mounting base
2. Screw Terminals

G. Options/Accessories Required:
1. Provide mounting sockets with pressure type terminal blocks rated 300 volts and 10 amps.
2. Provide mounting rails/holders as required.

2.9 INTRINSICALLY SAFE BARRIERS

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
1. Rockwell Automation
2. Phoenix Contact
3. Square D

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Type:
1. Intrinsically safe barriers are used to transfer digital signals from a hazardous area to a safe area. The device type is a switch amplifier with a relay output.

D. Functional/Performance:
1. I/O Signal: Discrete Input
2. 2-channel isolated barrier

3. Power: 24V DC supply
4. Input: Dry contact or NAMUR inputs
5. Output: Relay contact output
6. Line fault detection (LFD)
7. Housing width 12.5 mm

E. Ratings:
1. Up to SIL2 acc. to IEC 61508
2. UL listed or recognized.

F. Physical
1. DIN Rail mounting base
2. Screw Terminals

2.10 ANALOG SIGNAL SURGE PROTECTORS (SPDS)

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
1. AGM Electronics
2. Acromag Inc.
3. Moore Industries
4. Phoenix Contact

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Type:
1. DIN Rail mounting for control and termination panels.
2. For loop powered transmitters provided pipe nipple style mounting at the transmitter.

D. Minimum Ratings:
1. Peak Surge Current 10 kA
2. Response Time <5 Nanoseconds
3. Voltage Clamp >26 Volts

2.11 24 VDC POWER SUPPLIES

A. All 24 Vdc subsystems shall be supplied with redundant 125% capacity power supplies, equipped with redundancy diodes, for all DC voltage levels and services. Each power supply shall have sufficient power to continuously supply the total system for each voltage required. Auctioneering, load sharing or switching circuits shall be provided such that failure of a power supply shall transfer, without bump, to the backup supply. Each set of redundant power supplies shall be wired and equipped to accept two separate power feeds. The Contractor shall size the power supply not to exceed 50% of normal operating capacity.

B. A “power on” switch and indicating light shall be provided for each power supply. Each power supply shall be provided with voltage monitors for the output of each bus voltage level. An alarm shall provide the operator with adequate warning before power failure equipment malfunction.

C. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Phoenix Contact

D. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

E. Design and fabrication

1. Converts 120 Vac input to DC power at required voltage.
2. Sized as required by the load. Minimum 2.5 Amp output
3. AC input: 120 Vac +10 percent -13 percent; 47 to 63 HZ.
4. Provision for output failure alarm contact.
5. DIN rail mounting.
6. All Power Supplies shall be redundant pairs.

2.12 ACTIVE REDUNDACY MODULE

A. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Phoenix Contact

B. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

C. Type:

1. Active redundancy module with active current balancing
2. Din-rail mountable

D. Functional/Performance:

1. Input: 24Vdc
2. Output: 24Vdc, 2 x 10A minimum (10A redundancy minimum)

2.13 NAMEPLATES

A. Furnish nameplates for each device as indicated in Drawings. Nameplates shall be engraved, laminated impact acrylic, matte finish, black lettering on a white background, not less than 1/16-in thick by 1/2-in by 1-1/2-in, Rowmark NoMark Plus or equal, Nameplates shall be attached to the backplate with double faced adhesive strips, TESA TUFF TAPE 4970, .009 X ½”, no equal. Prior to installing the nameplates, the metal surface shall be thoroughly cleaned with 70% alcohol until all residues has been removed. Epoxy adhesive or foam tape is not acceptable.

2.14 SINGLE PHASE UPS – CONTROL PANELS

A. Control panels shown on the Drawings shall be provided with a UPS to provide conditioned back up power to the panel(s) it serves.

B. All UPS provided shall be true on-line Double-Conversion power conditioning type UPS that provide for constant, pure sine wave AC output.

C. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:

1. Eaton 9PXxxxx series with a minimum of 1,500 VA.

D. The listing of specific manufacturers above does not imply acceptance of their products that do not meet the specified ratings, features and functions. Manufacturers listed above are not relieved from meeting these specifications in their entirety.

E. For control panel application, provide external UPS maintenance bypass switch with an auxiliary contact for the UPS supplied. The switch shall transfer power without interrupting the load utilizing make before break contacts.

1. Maintenance bypass switch shall be Liebert MicroPOD or approved equal.

F. Design and fabrication

1. Rating: 120VAC, 60 hertz, 1,500 VA minimum shall provide uninterrupted conditioned power fully loaded conditions for at least thirty (30) minutes.
2. Submit load calculation for review to ensure the UPS is properly sized for the connected load and for thirty minutes of runtime power under full load condition is maintained.
3. Lightning and Surge Protection: Inherent 2000: 1 spike attenuation.
4. Regulation: 1-3 percent load regulation with less than 2pF effective coupling capacitance for line to load.
5. Output Waveform: Computer grade sinewave with 3% maximum single harmonic and 5% maximum total harmonic distortion.
6. Output Frequency: 60 hertz +/- 0.5 hertz.
7. Operating Temperature: 0 degrees to +40 degrees Centigrade.
8. Relative Humidity: 5% – 90% without condensation.
9. Input Protection: Independent battery charger fuse and DC fuses.
10. Output Protection: Current limited.
11. Battery Charger: Two step charger, 8 amps and 2 amps.
12. AC Input: 120V, 60Hz, single phase, +15%, -20%.
13. Provide Simple Network Monitoring Protocol (SNMP) Ethernet interface or output card to interface with PLC as required and shown on the Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All equipment specified herein shall be installed, field adjusted, tested and cleaned as an integral part of equipment specified elsewhere in these Specifications.

END OF SECTION

SECTION 43 23 13
HORIZONTAL SPLIT CASE PUMP

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Furnish all labor, materials, equipment, and incidentals required to completely install, put in operation, and field test horizontal centrifugal pumping units as specified herein and shown on the drawings
2. Each pump unit shall consist of a horizontal single-volute or double-volute centrifugal pump, horizontal drive shaft and couplings, horizontal squirrel cage induction motor, and all necessary appurtenances to provide a complete pumping system. Provide the complete pumping unit assemblies specified, not including the variable frequency drives (VFD's), supplied by a single manufacturer. VFD's may be supplied by separate manufacturer.

B. Related Specification Sections include but are not limited to:

1. Division 0 – Bidding Requirements, Contract Forms and Conditions of the Contract
2. Division 1 – General Requirements

1.2 PRICE AND PAYMENT PROCEDURES

A. The work performed and the materials furnished in accordance with this Item are subsidiary to the structure or Items being placed and no other compensation will be allowed.

1.3 REFERENCES

A. This section references the following documents. They are part of this section as specified and modified. In case of conflict between the requirements of this section and those of the listed documents, the requirements of this section shall prevail.

1. NEMA-NG1-1253a: Test Standards for Determining Motor Efficiency.
2. ANSI/Hydraulic Institute Standards

1.4 ADMINISTRATIVE REQUIREMENTS

A. Unit Responsibility and Coordination

1. The Contractor shall cause all equipment (pumping unit) specified under this section to be furnished by a single pump manufacturer who shall be responsible for the adequacy and compatibility of all pumping unit components including but not limited to the pump and motor.
2. Any component of each complete pumping unit not provided by the pump manufacturer shall be designed, fabricated, tested, and installed by factory-authorized representatives experienced in the design and manufacture of pumping equipment. This requirement, however, shall not be construed as relieving the Contractor of the overall responsibility for this portion of the work.

1.5 SUBMITTALS

A. Submittals shall be in accordance with Section 01 33 00.

B. All submittals shall be approved by the City prior to construction.

C. Submittals required prior to fabrication:

1. Certification of full compliance with specifications.
2. Performance curves (head-capacity, BHP (brake horsepower), NPSH, pump efficiency) covering full operating range from shutoff to run out.
3. Complete materials specifications for each part of unit to be furnished.
4. Dry and wet weight of pump, weight of motor and assembled weight on baseplate.
5. Construction drawings showing anchor bolt locations, piping connection location and other pertinent information including installation procedures.
6. Technical bulletins and brochures on pumping unit.
7. Drawing of pumping unit showing parts and their materials of construction.
8. Drawings showing pump setting plan including the pump, motor and base.
9. Statement of equipment warranty.
10. Statement of guarantee of pump efficiency, speed (rpm), capacity, head, BHP, and motor horsepower at design point.
11. Guarantees of motor efficiency and power factor at one-half, three-fourths, and full load at 1,800 rpm for the motors to be furnished.
12. Nearest location of factory maintenance and service facilities that will be available to service the equipment offered. Resumes shall be provided for qualified pump and motor service personnel who will perform start-up operations at the site.
13. Provide a schedule that includes manufacturing of the pump and motor, performance testing of pump, performance testing of motor, delivery date for the equipment (which shall be stated as number of calendar days after release date to Manufacturer). Once the order has been placed, the Manufacturer shall notify the Engineer in writing that the pump and motor order has been placed. Notification shall include test date.
14. Base Plate installation procedure and tolerances, including anchor bolt sizing and installation procedure.
15. Motor and pump alignment procedures and tolerances. Pump supplier shall perform laser alignment of pump and motor prior to start up.
16. Lubrication specifications for bearings and for gear coupling.
17. Two (2) year guarantee from the date of substantial completion which shall cover both replacement parts and service of the units in the event of failure of the equipment caused by workmanship and materials. Also included shall be the terms and conditions of the warranty.
    a. Failure to submit the above data as set forth for the pumping equipment shall be cause for rejection of the quotation at the City's sole option.
18. Shipping instructions in accordance with Section 1.10.
19. Pump and motor name plate layout.
20. Name, address and phone number for bearing manufacturer representative.
21. Name, address and phone number for mechanical seal manufacturer representative.

D. Submittals required prior to tests
   1. Test book for witnessed test containing the following information in bound form minus the actual test data:
      a. Description of factory test to be conducted.
      b. Description of factory test procedures.
      c. Copy of Test Standards.
      d. Calibration certifications of test equipment.
      e. Dimensional layout of test assembly and reservoir.
      f. Example of presentation of test data.

E. Submittals required prior to shipping
   1. Certified copies of all witnessed tests on the pumps.
   2. Manufacturer's certification that pump and motor conform to the specifications.
   3. Operation and maintenance manual.
   4. Shipping information, including shipping company, type of transport and shipping schedule.
   5. Site Storage Plan
   6. Lifting instructions.

1.6 ACTION SUBMITTALS/INFORMATIONAL SUBMITTALS [NOT USED]

1.7 CLOSEOUT SUBMITTALS [NOT USED]

1.8 MAINTENANCE MATERIAL SUBMITTALS [NOT USED]

1.9 QUALITY ASSURANCE [NOT USED]

1.10 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements
   1. No shipment shall be shipped until approved by the Engineer in writing.
   2. Pump and motor shall be shipped as one unit. Separate shipments are not allowed.
   3. Manufacturer shall provide lifting instructions.

B. Storage and Handling Requirements
   1. All parts shall be properly protected so that no damage or deterioration will occur during a prolonged delay from the time of shipment until installation is completed and the units and equipment are ready for operation. Units shall be shipped per the manufacturer's recommendation. Prior to shipping the manufacturer shall provide written shipping instructions to the Engineer.
   2. All equipment and parts must be stored to properly to protect against any weather or damage during a prolonged period at the site.
   3. The finished surfaces of all exposed flanges shall be protected by wooden blank flanges, strongly built and securely bolted.
   4. Finished iron steel surfaces not painted shall be properly protected to prevent rust and corrosion.

1.11 FIELD CONDITIONS [NOT USED]

1.12 WARRANTY

A. Manufacturer Warranty
   1. Manufacturer's Warranty shall be in accordance with Division 0 and Division 1.

PART 2 - PRODUCTS

2.1 CITY-FURNISHED OR CITY-SUPPLIED PRODUCTS [NOT USED]

2.2 EQUIPMENT, PRODUCT TYPES, AND MATERIALS

A. General
   1. The pumping unit required under this section shall be complete including pump, baseplate assembly, and motor. The pump manufacturer shall be responsible for the furnishing and performance of this equipment.
   2. Pump and motor shall be so matched and/or individually balanced as necessary so as to limit the amplitude of vibration of the entire installed pumping assembly in any place to Hydraulic Institute standards when operating at full load speed.
      a. Vibrations at other than design speeds shall not exceed 1.30 times the Hydraulic Institute's allowed vibration at design speeds.
      b. The factory representative during the field shall take vibration measurements. Pumping units failing to meet vibration criteria during field test shall be subject to rejection.
   3. Resonant vibration of the pumping unit shall be checked by the manufacturer. If the natural frequency is found to be close to the operating range of the pump, the manufacturer shall alter the pumping unit accordingly to prevent operation near the natural frequency. Vibrations shall be evaluated at 70% 75%, 80%, 85%, 90%, 95%, and full speed. Damage due to resonant vibration shall be repaired at no additional expense to the City.
   4. An embossed stainless steel nameplate shall be attached to the pump. As a minimum the nameplate shall give the following:
      a. Name and Manufacturer
      b. Pump Model
      c. Year Manufactured
      d. Speed
      e. Impeller Diameter
      f. Shaft Diameter
      g. Serial Number
      h. Bearing Manufacturer and Type
      i. Seal Manufacturer and Model
      j. Impeller Material

B. System Description
   1. Pumps to be supplied:
      a. Pumps shall be 2,600 gpm horizontal split case pumps, each provided with a 200 hp motor and mounting base.
   2. The arrangement shown on the drawings is based upon the best information available to the Engineer at the time of design and is not intended to show exact dimensions to any specific equipment unless otherwise shown or specified. Therefore, it may be anticipated that the structural supports, foundations, connected piping and valves shown, in part or in whole, may have to be changed in order to

accommodate the pumping equipment furnished. No additional payment will be made for such changes. All necessary calculations and drawings for any related redesign shall be submitted to the Engineer for approval prior to fabrication.

3. The pumping unit shall be designed to operate without cavitation or damaging vibration over the entire specified range of flow and head conditions. The pumping unit shall not produce undue noise or vibrations in the specified operating capacity range.
4. All components shall be designed to safely withstand forces resulting from flow reversals, up to 125 percent of maximum speed, within the pump during shutdowns caused by power failure. The Contractor shall be responsible for this coordination and shall ensure that the component parts do not interact on each other to produce unacceptable vibrations, stresses, or undesirable conditions.
5. The pump base shall be designed for anchor bolting to a concrete foundation.
6. The complete pumping unit shall be designed to operate without overload on any component at any point along the pump's entire full-speed operating curve.
7. The pumping unit shall achieve the rated points in Section 9 below. The speed of the pumps shall not exceed 1,800 rpm.
8. The pumps shall operate satisfactorily over the complete operating range shown in Section 9. Knees or saddles within the operating range shall be cause for rejection. The equipment to be provided under this section shall be suitable for installation and operation at elevations for about 2,970 feet above sea level inside weather-protected structures. Outside ambient temperatures range between 10 and 110 degrees F, and reported water temperatures vary between 50 and 105 degrees F. Relative humidity is expected to range between 5 and 100 percent.
9. Each pumping unit shall be capable of operating on a continuous basis to meet the following operating conditions outlined below:

Pump Description	**Pump Requirements**
Rated Capacity and Total Head of Operating Point	
Capacity (gpm)	2,600
Minimum Total Head (ft.)	210
Minimum Pump Efficiency	79 – 85%
Maximum NPSH required (ft.)	14 – 14.4
Rated Capacity and Total Head of Secondary Point	
Capacity (gpm)	2,400
Minimum Total Head (ft.)	220
Minimum Pump Efficiency	77 – 83.4%
Maximum NPSH required (ft.)	12 – 13.3
Rated Capacity and Total Head of Tertiary Point	
Capacity (gpm)	3,100
Minimum Total Head (ft.)	180
Minimum Pump Efficiency	80.5 – 82%

Maximum NPSH required (ft.)	18 – 18.6
Minimum Capacity and Total	
Head Expected at Run out	
Capacity (gpm)	3,600
Minimum Total Head (ft.)	136
Minimum Pump Efficiency	71.9 – 75.5%
Maximum NPSH required (ft.)	24.4 – 28
Minimum Shut-Off Head (ft.)	249 – 275
Minimum Continuous Flow (gpm)	750
Pump Rotation as Viewed From Driver End	See Plans
Power	480 volt - 3 phase - 60 Hz
Max Operating Speed (RPM)	1,800
Maximum full Load (Hp)	200
Minimum Discharge Size (in)	8
Minimum Suction Size (in)	10

C. Manufacturers

1. The pump shall be the product of a pump manufacturer regularly engaged in the manufacture of pumps having similar service and size within a radius of 100 miles and in service for a minimum period of five years. The manufacturer shall also have a service shop in the area in which the manufacturer has been regularly engaged. The pumps covered by the specifications are intended to be standard pumping equipment of that has proven ability. The following manufacturers and models are acceptable. No other manufacturers will be allowed.
   a. Pumps
      1) Flowserve – 8LR-20A, A-24366R1 – 16.30”
      2) Pentair – 8” 1824B-14-8x10x17B-1775 – 15.00”
      3) Patterson – 10x8x17 SSC-G – 15.1875”
2. The motors shall be the product of a single motor manufacturer regularly engaged in the manufacture of motors having similar service and of equal size for a minimum period of five years. Only the following motor manufacturers are acceptable:
   a. Baldor
   b. Marathon
   c. WEG
   d. TECO-Westinghouse
   e. GE
3. The listing above does not imply that the pump or the motor manufacturer's standard product is acceptable. The successful manufacturer will be required to conform to all specifications.

D. Rotation

1. Rotation shall be as shown on the construction plans for the project.

E. Pump Casing

1. Each pump casing shall be horizontal-split case single-volute or double-volute-type of fine grained gray cast iron construction conforming to ASTM A48, Class 25, Class 30, or Class 40, with proper cross sections, design, and thickness to withstand all stresses to which it may be subjected during erection and operation. It shall be designed to produce a smooth flow and gradual change in water velocity when pump is operating at full speed. Casing shall have a minimum 30,000 psi tensile strength, and withstand a hydrostatic test at 150% of shutoff head.
2. The casing shall be split on the horizontal centerline, and the suction and discharge nozzles and rigid foot supports shall be cast integral with its lower half. The casing shall be designed so that the upper half can be removed without disturbing the pipe connections or alignment of the pump. The pump casing and its fasteners shall be designed to transmit to the base plate all static and dynamic forces which the pump shall exert, without regard to any support offered by the piping. The fasteners used should leave the pump capable of subsequent readjustment.
3. Casing shall consist of upper and lower half casings containing the volute and suction passages, and removable bearing housings that are doweled and securely bolted to the lower half casing, inboard and outboard bearing housings shall be replaceable without the need for field alignment.
4. Suction and discharge connections shall be sized to reduce hydraulic friction losses and to reduce turbulence and pipe noise. All suction and discharge flanges shall be designed for straight through nut and bolt flange connections with Class 125 ANSI drilling. Upper half casing shall have a drilled and tapped connection with 1/2" ball valve at the highest point on the casing for the purpose of pump priming or air release. Lower half casing shall be drilled and tapped to allow for drainage piping.
5. Suction and discharge taps shall be provided for pressure gauges.
6. The nominal casing thickness shall be 3/4” or 5/8”.

F. Pump Impeller

1. Impeller shall be 316 stainless steel, enclosed type, double-suction, Francis vane design, to minimize inlet losses and accommodate high suction lifts. Impeller shall be statically and dynamically balanced to grade ISO1940, G6.3 to reduce vibrations and improve bearing life.
2. Impellers shall be cast in one piece with smooth flow contours to promote maximum efficiency. Impeller shall be fixed axially along the shaft by shaft sleeves and nuts and secured to the shaft through a precession fit and full length key. An interference, or shrink fit, is not acceptable.
3. Impeller skirt or hub shall have sufficient metal thickness to allow machining for installation of impeller rings.

G. Shaft

1. Shaft shall be stainless steel and of sufficient diameter to allow no greater than 0.003" maximum deflection measured at the sealing box for all normal performance conditions on the curve. Shaft shall be manufactured to meet stiff shaft construction with a critical speed at least 25% in excess of operation speed, in order to prevent vibration and fatigue. The shaft shall be accurately machined along its entire length. A keyway shall be machined at the coupling end. No threads shall be machined adjacent to the impeller.

2. The shaft shall be reversible to provide for field change to opposite rotation if required. Renewable Stainless-steel shaft sleeve shall be provided to protect the shaft from wear and from contact with the pumped liquid. The sleeves shall also serve to accurately position the impeller on the shaft.
3. Minimum shaft diameter shall be as follows
   a. Pumps
      1) At impeller: 2.1875" – 2.375"
      2) At sleeve: 2.0" – 2.375"
      3) At coupling: 1.75"
      4) At inboard bearing: 1.77"
      5) At outboard bearing: 1.77"

H. Pump Bearings
1. Bearings shall be double row angular contact thrust ball type bearings and single row deep groove radial ball type bearings. Bearing shall be selected to carry radial and thrust loads. Bearing life shall be designed to give a minimum of 100,000 hours minimum at design in continuous operations. Provide thrust bearing rated at 1.5 times the maximum thrust loads involved.
2. Interchangeable inboard and outboard bearing shall be press fit and positioned onto ground journals on both ends of an accurately machined shaft. Bearing housing shall be doweled and accurately positioned onto ground journals on both ends of an accurately machined shaft. Bearing housings shall be doweled and accurately positioned onto the bearing shoulders located on the lower half casing to ensure accurate alignment. Bearings shall be grease lubricated and shall be re-greasable with a grease reservoir above the bearing. Bearing housing shall be sealed with a labyrinth type seal.
3. Any bearings furnished shall be removable in the field without any damage to bearing or shaft. Application of heat to bearings for removal shall not be acceptable. Pump manufacturers shall furnish data showing detailed procedure for removal of the bearings and furnish one complete set of special tools required for bearing removal from pump.

I. Wearing Rings
1. Casing and impeller wear rings shall be provided.
2. Casing wear rings shall be stainless steel of an annular type, designed to minimize leakage across the ring fit.
3. Impeller wear rings shall be stainless steel with appropriate hardness differential to work in conjunction with case wear ring and impeller material, and will be designed to minimize re-circulation of the pump fluid through the casing and to prevent any damage to the wear rings.
4. The wearing rings shall be of tolerances such that they may be replaced with minimum difficulty. They shall be designed to prevent leakage through the joint without resorting to excessively small clearances.
5. Follow the manufacturer's recommendations for ring clearance and tolerances.

J. Sealing Box
1. The sealing box shall be machined into the casing. Sealing box shall contain a Chesterton split seal, Type Model 442 or approved equal.

2. External piping complete with snubber valves shall be installed from the casing to each sealing box to circulate sealing water. External piping shall be stainless steel with stainless steel fittings and valves.
3. All seal components shall be off the shelf items and shall be locally available.
4. All metal parts shall be 316 stainless steel.
5. Seal faces shall be carbon/silicon carbide.
6. Seal shall be rated for a pressure of 200 psig and 28" Hg vacuum.
7. A manufacturer's representative shall be provided prior to pump startup to inspect seal installation. Manufacturer's representatives shall also be present during the full duration of startup.

K. Base Plate

1. A structural steel base for pump and driver is to be supplied. The base shall be designed to resist torsional movement and support the combined weight of both pump and driver. After leveling and alignment, the base shall be grouted and completely filled with a non-shrinking grout, as recommended by the Manufacturer.
2. Coat base plate in accordance with Section 09 91 00 – Equipment and Pipe Painting.
3. The base plate shall include a drip tray which is drained to the floor drain by means of a minimum 1/2" copper tubing. Coordinate required drain connection with pump manufacturer.
4. Base and drip tray shall be of sufficient size that no part of pump or the motor except for conduit boxes extends beyond the base and drip tray. Drip tray shall collect any oil leaking from bearing housings.
5. Base plate shall be drilled or cast for anchor bolts. Anchor bolts shall not protrude within any of the drain lips. Contractor shall field finish by painting anchor bolts and nuts.
6. Pump and motor shall be mounted and pre-aligned on the base plate at the factory. Dowel pins for securing the motor in position on the base after the unit is installed and realigned shall be provided by the manufacturer.
7. Mounting surfaces shall be flat and parallel within 0.005-inches/foot. Corners shall be rounded smooth and welds shall be ground.
8. Each base plate shall be grouted by the Contractor using non-shrink epoxy-based grout as recommended by the manufacturer.

L. Coupling and Guard

1. The pump shall be direct connected to its driver by means of a Falk grid coupling and an enclosed type-coupling guard. The coupling shall be of adequate size to transmit the torque without undue stress when operating at peak loads and starts. The lubrication type and application instructions shall be provided.

M. Motors

1. Electric motors for driving pumping units shall be Open Drip Proof (ODP) and rated for 480V, 3-phase, 60 Hz, full across the line starting to be operated on a 480 volt variable frequency drive (VFD) unit.

2. Horsepower rating of motors shall be equal to or greater than the total horsepower requirement of the pump when operating at any point on the curve. The horsepower of the pump should not exceed 100% of the horsepower rating of the motor at any point on the pump curve.
    a. Motors for proposed pumps shall be 200 Hp.
3. Motors shall comply with NEMA and associated ANSI and IEEE standards unless otherwise amended.
4. Motors shall be premium efficiency rated motors per NEMA MG-1.
5. Motor windings shall be random wound. Insulation shall be Class F or higher.
6. Each motor shall be electrically and mechanically suited for the pump to which it will be applied. The manufacturer of the motor shall coordinate closely with the manufacturer of the pump, so that all physical and operational characteristics of the motor are compatible with the requirements of the pump. The motor shall operate efficiently, without overloading, overheating, or abnormal vibration, throughout the entire range of speed and load. There shall be no point on the pump curves at which the motor nameplate rating is overloaded, even momentarily. The motor shall have a service factor rating of 1.15.
7. Motor terminal box shall be oversized, one size over NEMA standard, and shall have a ground lug and threaded conduit openings and sized for connecting as shown on the plans. Terminal box shall be a minimum size of 14-inches tall by 15-inches wide by 10.5-inches deep. Terminal box shall be fully gasketed for connection to the motor. Terminal box shall have two 4-inch threaded openings for conduit or cable terminator entrance.
8. All openings shall be screened to prevent entrance of insects and rodents.
9. Motors shall have winding thermostats. The winding thermostat shall be embedded one per phase. Winding thermostat leads shall be terminated at a terminal block mounted in an auxiliary terminal box. Drawings shall clearly identify terminals with respect to winding thermostat location.
10. Bearings shall have an AFSMA rated life of 10 years minimum when the motor is operated continuously at rated speed, considering weight of rotor plug combined dead weight and load thrust.
11. Motor balance shall be within an amplitude, peak to peak, of 0.06 in/sec in any direction measured at the bearing housing in accordance with NEMA MG1-7.1
12. Torque
    a. Each motor shall be readily capable of starting the pump under all conditions to which it could be subjected.
    b. Starting and pull-up torque shall not be less than 75% of full load torque. Minimum breakdown torque shall not be less than 200% of full load torque. The foregoing torque is minimums and the starting, pull-up and breakdown torque shall satisfy the requirements of the pump.
13. Insulation
    a. Insulation shall be Class F non-hydroscopic insulation with a maximum Class B temperature rise. Temperature rise shall not exceed at any operational speed at or less than 1,800 rpm.
    b. Motor shall operate continually at rated load (1.0 service factor), voltage, and frequency with a temperature rise not exceeding 80 degrees C (Class B insulation rise) over 40 degrees C ambient. Rise shall be measured by change in resistance and winding thermostats.

14. The critical speed of the shaft and rotor shall exceed the operating speed by a minimum of 25%.
15. The noise shall not exceed 85 dB with a tolerance of 3 on the "A" scale at 5 feet in any direction from the motor, when measured per IEEE 85.
16. Lubrication
    a. Bearing shall be grease lubricated and shall be re-greasable with a grease reservoir above the bearing
17. Starting Duty
    a. The radius of gyration of both motor and pump shall be considered when designing the required starting duty.
    b. The motor will be suitable for two starts per hour on the average with the subsequent start being immediately after coasting to a stop after being fully loaded just prior to the stop.
    c. The starting National Electric Code kVA Code letter shall not be higher than Code G. The motors will normally be started with a VFD or a solid state soft starter, but the motor shall be suitable for starting across the line via the bypass contactor.
18. Lifting Eyes
    a. Lifting eyes or other means capable of sustaining the weight of the motor, less the pumping unit, and shall be provided and loaded so the motor will be balanced in the vertical position when lifted.
19. Rotor bars and end rings shall be aluminum.
20. The motors shall have cast iron or heavy fabricated steel frames, end bells, conduit boxes, and fan cover guards.
21. Downtime space heaters shall be provided and sized adequately for protection against moisture when motor is not in operation. They shall be rated to operate at 120 volts, single phase, 60 hertz.
22. An auxiliary terminal box separate from the motor power and motor winding thermostat terminal boxes shall be provided for space heater leads.
23. The following minimum information shall be given on the motor nameplate:
    a. Manufacturer's type designation, frame number, serial number
    b. Horsepower output
    c. Temperature rise by detector
    d. RPM at full load
    e. Frequency
    f. Number of phases
    g. Voltage
    h. Rated full load amperes
    i. Service factor
    j. Motor terminal identification diagram
    k. Direction of rotation
    l. Bearing ID numbers
    m. Bearing temperature rise
    n. Number of allowable starts within a time period and the minimum time interval between starts
    o. Full load power factors and efficiencies
    p. Locked rotor current
    q. NEC Code kVA/Hp letter designator

r. Space heater voltage and watts
s. Insulation class

2.3 ACCESSORIES [NOT USED]

2.4 SOURCE QUALITY CONTROL [NOT USED]

PART 3 - EXECUTION

3.1 INSTALLERS [NOT USED]

3.2 EXAMINATION

A. Preinstallation Testing
1. The City shall have the right to inspect all materials and equipment to be furnished under these specifications, prior to their shipment from the point of manufacture.
2. Pump Tests
a. All pumps shall be factory tested using a factory calibrated motor operating at full speed. Certified copies of test data and test curve shall be furnished to the Engineer. The efficiency, capacity, and horsepower requirements shall be determined for not less than five points throughout the specified head range from shut-off to maximum capacity. All pumps NPSH required shall be tested. Test procedures, interpretation and conversion of data, shall conform to the latest requirements of the Test Code of Hydraulic Institute. Pump test Acceptance Grade shall be 1U. Following completion of shop tests, the Vendor shall furnish to the Engineer for review and approval.
3. Motor Tests
a. Each motor shall have a non-witnessed factory test conducted at the motor manufacture's facility prior to shipment. The actual values of the complete test shall be measured and run in accordance to the applicable provisions for Standard Routine Motor Test Code MG20.46 and the American Test Code. All tests shall be made at the full design voltage unless specified otherwise. All tests will be made in accordance with IEEE #112B and reported on Form G of that manual. Complete test shall include, but not be limited to, the following for each motor rating.
1) No load running current.
2) High potential test.
3) Winding resistance test.
4) Full load heat run.
5) Percent slip.
6) Current balance check.
7) Pull out, starting and breakdown torque.
8) LR current.
9) Efficiency at full, 3/4 and 1/2 load.
10) Power factor at full, 3/4 and 1/2 load.
11) Bearing inspection and temperature recordings.
12) Vibration test.

3.3 PREPARATION [NOT USED]

3.4 INSTALLATION

A. General

1. All pumps shall be installed in accordance with the instructions of the manufacturer and as shown on the drawings.
2. Field test shall not be conducted until such time that the entire installation is complete and ready for testing.
3. A certificate from each equipment manufacturer stating that the installation of his equipment is satisfactory, that the equipment is ready for operation, and that the operating personnel have been suitably instructed in the operation, lubrication and care of each unit shall be submitted.

3.5 REPAIR RESTORATION [NOT USED]

3.6 RE-INSTALLATION [NOT USED]

3.7 FIELD QUALITY CONTROL [NOT USED]

3.8 SYSTEM STARTUP

A. Refer to Section 01 75 00.

3.9 ADJUSTING [NOT USED]

3.10 CLEANING [NOT USED]

3.11 CLOSEOUT ACTIVITIES

A. Operating Instructions

1. A factory representative of all major component manufacturers, who has complete knowledge of proper operation and maintenance, shall be provided for one day to instruct representatives of the City on proper operation and maintenance. If there are difficulties in operation of the equipment during instruction sessions, additional sessions shall be provided at no cost to the City.
2. Prior to scheduling instructions, submit outline of instructions to Engineer for approval.
3. Operating and maintenance manual shall be explained during these instructions.

B. Spare Parts and Tools

1. Furnish one set of special tools required for the proper servicing of all equipment supplied under these Specifications, packed in a suitable steel tool chest with a lock.
2. Furnish all required lubricants in sufficient quantities for startup and testing and for the warranty period.

3.12 PROTECTION [NOT USED]

3.13 MAINTENANCE [NOT USED]

3.14 ATTACHMENTS

PUMP AND MOTOR UNIT:

INSTRUCTIONS: Complete the following questionnaire for each size of pumping unit.

A. MANUFACTURER_____

B. PUMP AND MOTOR UNIT

1. Model_____

2. Operating Conditions at Normal System Curve (Rated Point)

a. Capacity (gpm_____

b. Head (feet_____

c. Pump Efficiency (percent_____

d. NPSH required at runout (feet_____

e. Minimum Continuous Flow (gpm_____

3. Shutoff Head (feet _____

4. Run out Conditions

a. Capacity (gpm_____

b. Head (feet_____

C. PUMP

1. Manufacturer _____

2. Model Number _____

3. Total (Pump Only) Wet Weight (pounds _____

4. Total (Pump Only) Dry Weight (pounds _____

5. Total Wet Weight (Pump, Motor and Base) (pounds_____

D. CASING

1. Material _____

2. Pressure Rating _____

3. Nominal Casing Thickness _____

E. IMPELLER

1. Material _____

2. Diameter/Weight at full trim (inches _____(pounds _____

3. Diameter/Weight at design trim (inches_____(pounds _____

F. SHAFT

1. Material _____

2. Diameter at:

Impeller (inches_____

Sleeve (inches_____

Coupling (inches_____

Ratio at Center of Impeller to Center of Bearing_____

G. PUMP BEARING

1. Material _____

2. Manufacturer_____

3. Life (hours _____

4. Lubrication _____

5. Normal Operating Temperature _____

6. Maximum Operating Temperature _____

H. WEAR RINGS

1. Casing Wear Ring Material _____

2. Impeller Wear Ring Material _____

A. SEAL

1. Mechanical Seal Type and Model Number _____
2. Seal Face Materials_____

J. MOTOR

1. Manufacturer _____

2. Model Number _____

3. Rated Horsepower _____

4. Speed (rpm _____

5. Enclosure _____

6. Frame Size _____

7. Total Weight (pounds _____

8. Service Factor _____

9. Guaranteed Horsepower and Efficiency @ 1,200 rpm

    a. At 1/2 Load _____

    b. At 3/4 Load _____

    c. At Full Load _____

10. Power Factor @ 1,200 rpm

    a. At 1/2 Load _____

    b. At 3/4 Load _____

    c. At Full Load _____

11. Starting Current (% Full Load _____

12. Full Load Current (Amps _____

13. Locked Rotor Current (Amps _____

14. Noise Level (A Scale _____

15. Resonant Frequency _____

16. Bearings

    a. Manufacturer and Model _____

    b. Lubrication _____

E. DEVIATIONS FROM SPECIFICATIONS (If none, state "NONE")

_____

END OF SECTION

SECTION V

SPECIAL PROVISIONS

SPECIAL PROVISIONS

INDEX

SPECIAL PROVISIONS

SP-1: GENERAL

For this contract, the General Provisions (Division 100) of the "Public Works Construction Standards - North Central Texas" adopted by the North Central Texas Council of Governments (NCTCOG), November 2017 Edition, with all amendments thereto, shall govern and shall constitute as the Special Provisions except as herein amended, modified or supplemented. Omission of any section from this Project's Contract Documents does not mean that such section is not applicable to this Project. The NCTCOG General Provisions will be referred to as the General Provisions (GP) and will not be physically bound with the other contract documents. Copies may be obtained from the North Central Texas Council of Governments.

The following Special Provisions shall take precedence over all other contract conditions, specifications and agreements.

SP-2: PROJECT DESCRIPTION

The work associated with this Project includes, but is not limited to, the following tasks:

1. Construction staking
2. Erosion control
3. General site preparation, grading
4. Trench safety
5. Yard Piping and Pump Station Improvements
6. Cleanup and removal of erosion control

SP-3: DEFINITIONS

Modify GP Item 101.1 Definitions as follows:

The word "City" or "OWNER" in these documents shall be understood as referring to:

The City of North Richland Hills, Texas
4301 City Point Drive
North Richland Hills, Texas 76180

The word "Engineer" in these documents shall be understood as referring to a professional engineer employed by the City of North Richland Hills.

The word "Inspector" in these documents shall be understood as referring to the technical construction inspector within the OWNER's Public Works Department.

The word "OWNER's Representative" in these documents shall be understood as referring to the OWNER's Director of Public Works, Public Works Technical Construction Inspector(s), Engineer of the OWNER, or such other Engineer or Supervisor as may be authorized by the OWNER to act in any particular position.

Any reference to "Special Conditions" or "Supplemental Special Conditions" shall be understood as referring to these Special Provisions.

SP-4: INFORMATION CONCERNING CONDITIONS

Add the following to GP Item 102.3. Examination of Plans, Specifications and Site of the Work:

Prospective bidders shall make a careful examination of the entire site of the project and shall make such explorations as may be necessary to determine the subsoil and water conditions to be encountered; improvements and obstructions which may be encountered, especially those to be protected; methods of providing ingress and egress to private as well as public property; methods of handling traffic during construction and maintenance of the entire project as well as any section thereof; protection of all existing structures both above and below ground; and how the plans fit the proposed project and especially if any discrepancies exist.

The accuracy of the information furnished by the Engineer or the plans and specifications as to underground structures and surface structures, foundation

conditions, character of soil, position and quality of ground and subsoil water, etc., are not guaranteed by the OWNER.

Subsurface exploration, to ascertain the nature of the soils at the project site, including the amount of rock, if any, is to be the responsibility of any and all prospective bidders. Whether prospective bidders perform this subsurface exploration jointly or independently, it shall be left to the discretion of such prospective bidders. Subsurface exploration shall not be attempted without the approval of the Engineer.

SP-5: ADDENDA

Bidders wanting further information, interpretation or clarification of the Contract Documents must make their request in writing to the Engineer **at least five (5) days prior to the Bid Opening.** Answers to all such requests will be made a part of the Contract Documents. No other explanation or interpretation will be considered official or binding.

Should a bidder find discrepancies in, or omission from the Contract Documents, or should he/she be in doubt as to their meaning, he/she should at once notify the Engineer in order that a written addendum may be sent to all bidders. Any addenda issued will be mailed or be delivered to each prospective bidder who has requested and received a bid packet. The bid proposal as submitted by the bidder must be so constructed as to include any addenda issued by the Engineer prior to 24 hours of the bid opening, with the appropriate recognition of addenda so noted in the bid proposal.

SP-6: PROPOSED GUARANTY

Modify GP Item 102.5. Proposal Guaranty to include:

The five percent (5%) proposal guaranty shall be five percent (5%) of the largest possible total for the bid submitted.

SP-7: FILING OF PROPOSAL

Add the following to GP Item 102.6. Filing of Proposals:

Bids, affidavits and proposed construction schedules must be submitted electronically via: www.publicpurchase.com at which time and place the bids will be publicly opened, read aloud and retained by the Public Works Department for tabulation, checking and evaluation. The “as read” bid results will be posted on www.publicpurchase.com

SP-8: REJECTION OF PROPOSALS

Add the following reasons to GP Item 102.11. Rejection of Proposals:

(7) Proposals that are incomplete insofar as the required signatures, proposal guaranty, or containing any material irregularities.

SP-9: DISQUALIFICATION OF BIDDERS

Add the following reason to GP Item 102.12. Disqualification of Bidders:

(9) where more than one proposal for an individual firm, partnership, or corporation is filed under the same or different names and where such proposals are not identical in every respect.

SP-10: QUALIFICATION TO PERFORM

The OWNER may make such investigations as he/she deems necessary to determine the bidder's ability to perform the work, and 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 the evidence submitted fails to satisfy the OWNER that such bidder can properly carry out the obligations of the contract and to complete the work contemplated therein.

SP-11: AWARD OF CONTRACT

Add the following to GP Item 103.2. Award of Contract and Commencement of Work:

The award, if made, shall be on the basis of the lowest acceptable bid submitted by a qualified responsible bidder, as determined by the OWNER, within 60 days after the opening of proposals. In determining the lowest acceptable bid, the OWNER will consider all relative factors such as: efficiency of a single contractor in the project area, increase in public safety due to a single contractor's operations, length of construction, coordination of construction activities, previous experience the OWNER may have had with the bidder, effects on area traffic due to construction detours and efficient use of City funds. The right is reserved, as the interest of the OWNER may require, to reject any and all bids and to waive any formality in bids received. It is the intention of the OWNER to award a single contract for this work.

SP-12: BONDS - AMOUNT AND TERMS

In addition to GP Item 103.3. Surety Bonds, add the following:

With the execution and delivery of the contract, the CONTRACTOR shall furnish and file with the City in the amount herein required, the following surety bonds:

(1) A good and sufficient Performance Bond in an amount equal to one hundred percent (100%) of the total awarded contract price, guaranteeing the full and faithful execution of the work and performance of the contract and for the protection of the City against any improper execution of the work or the use of inferior materials.

(2) A good and sufficient Payment Bond in an amount equal to one hundred percent (100%) of the total awarded contract price, guaranteeing payment for all labor, materials and equipment used in the construction of the project.

(3) A good and sufficient Maintenance Bond in an amount equal to twenty percent (20%) of the final contract price, guaranteeing the maintenance in good condition of such project for a period of two (2) years from and after the time of its completion and acceptance by the City.

General conditions for bonds are as follows:

1. The surety on each bond must be a responsible surety company which is licensed and qualified to do business in the State of Texas (surplus lines carriers are not acceptable) and satisfactory to the City. No surety will be accepted who is in default or delinquent on any bond or who is interested in any litigation against the City. Should any surety on the contract be determined unsatisfactory at any time by the City, notice will be given to the CONTRACTOR to the effect, and the CONTRACTOR shall forthwith substitute a new Surety or Sureties satisfactory to the City. (Texas Lloyd's Plan carriers are not acceptable.) No payment will be made under the contract until the new Surety or Sureties, as required, have qualified and have been accepted by the City. The contract shall not be operative nor shall any payments be due until approval of the bonds has been made by the City.

2. The surety company should be listed in the current circular of the "Federal Register - Department of the Treasury - Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsurance Companies".

3. The surety shall/must have an underwriting limitation (as shown in the Federal Register) to cover 110% of the project cost. Exceptions to a requirement may be made in unusual circumstances, subject to approval by the Office of Risk Management and the City Attorney's Office.

4. All bonds shall be made on forms furnished by the City and shall conform to the requirements as set forth herein.

5. Each Bond shall be executed by the CONTRACTOR and the Surety. The name and residence of each individual party to the bond shall be inserted in the body thereof, and each such party shall sign the bond with his/her usual signature on the line opposite the scroll seal, and if signed in the States of Main, Massachusetts, or New Hampshire, an adhesive seal shall be fixed opposite the signature.

6. If the principals are partners, their individual names will appear in the body of the bond or on proceeding pages to be included with said bond with the recital that they are partners composing a firm, naming it, and all the members of the firm shall execute the bond as individuals.

7. The signature of a witness shall appear in the appropriate place, attesting the signature of each individual party to the bond.

8. The principal or surety shall be a corporate surety; the name of the state in which incorporated shall be inserted in the appropriate place in the body of the bond or on proceeding pages to be included with said bond, and said instrument shall be executed and attested under the corporate seal, the fact shall be stated, in which case a scroll or adhesive seal shall appear following the corporate name.

9. The official character and authority of the person or persons executing the bond for the principal, if a corporation, shall be certified by the secretary or assistant secretary according to the form attached hereto. In lieu of such certificate, records of the corporation as will show the official character and authority of the officer signing, duly certified by the secretary or assistant secretary, under the corporate seal, to be true copies.

10. The date of any bond must not be prior to the date of the contract in connection with which it is given.

SP-13: INSURANCE REQUIREMENTS

In addition to the provisions of GP Item 1.03.4. Insurance, add the following:

Workmen's Compensation Insurance: Statutory requirements as specified by the Workmen's Compensation Law of the State of Texas and adopted by the Texas Workers' Compensation Commission per Title 28, TAC §110.110. Workers' Compensation Insurance Coverage:

A. Definitions:

(1) Certificate of coverage ("certificate") - A copy of a certificate of insurance, a certificate of authority to self-insure issued by the commission or a coverage agreement (TWCC-81, TWCC-82, TWCC-83, or TWCC-84), showing statutory workers' compensation insurance coverage for the person's or entity's employees (including those subject to a coverage agreement) providing services on a project for the duration of the project.

(2) Building or construction - Has the meaning defined in the Texas Labor Code, §406.096(e)(1).

(3) Contractor - A Person bidding for or awarded a building or construction project by a governmental entity.

(4) Coverage - Workers' compensation insurance meeting the statutory requirements of the Texas Labor Code, §401.011(44).

(5) Coverage Agreement - A written agreement on form TWCC-81, form TWCC-82, form TWCC-83, or form TWCC-84, filed with the Texas Workers' Compensation Commission which establishes a relationship between the parties for purposes of the Workers' Compensation Act, pursuant to the Texas Labor Code, Chapter 406, Subchapters F and G, as one of employer/employee and establishes who will be responsible for providing workers' compensation coverage for persons providing services on the project.

(6) Duration of the project - Includes the time from the beginning of the work on the project until the work on the project has been completed and accepted by the governmental entity.

(7) Persons providing services on the project ("subcontractor" in §406.096) - Includes all persons or entities performing all or part of the services the contractor has undertaken to perform on the

project, regardless of whether that person contracted directly with the CONTRACTOR and regardless of whether that person has employees. This includes, without limitation, independent contractors, subcontractors leasing companies, motor carriers, owner-operators, employees of any such entity, or employees of any entity which furnishes persons to provide services on the project. "Services" include, without limitation, providing, hauling, or delivering equipment or materials, or providing labor, transportation, or other service related to a project. "Services" does not include activities unrelated to the project such as food/beverage vendors, office supply deliveries, and delivery of portable toilets.

(8) Project - Includes the provision of all services related to a building or construction contract for a governmental entity.

B. The CONTRACTOR shall provide coverage, based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code, Section 401.011(44) for all employees of the CONTRACTOR providing services on the project for the duration of the project.

C. The CONTRACTOR must provide a certificate of coverage to the governmental entity prior to being awarded the contract.

D. If the coverage period shown on the CONTRACTOR's current certificate of coverage ends during the duration of the project the CONTRACTOR must prior to the end of the coverage period, file a new certificate of coverage with the governmental entity showing that coverage has been extended.

E. The CONTRACTOR shall obtain from each person providing services on the project and provide to the governmental entity:

(1) a certificate of coverage, prior to that person beginning work on the project, so the governmental entity will have on file certificates of coverage showing coverage for all persons providing services on the project; and

(2) no later than seven days after receipt by the CONTRACTOR, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project.

F. The CONTRACTOR shall retain all required certificates of coverage for the duration of the project and for one year thereafter.

G. The CONTRACTOR shall notify the governmental entity in writing by certified mail or personal delivery, within ten (10) days after the CONTRACTOR knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the project.

H. The CONTRACTOR shall post on each project site a notice, in the text, form and manner prescribed by the Texas Workers' Compensation Commission, informing all persons providing services on the project that they are required to be covered, and stating how a person may verify coverage and report lack of coverage.

I. The CONTRACTOR shall contractually require each person with whom it contracts to provide services on a project, to:

(1) provide coverage, based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements, which meets the statutory requirements of Texas Labor Code, Section 401.011(44) for all of its employees providing services on the project, for the duration of the project;

(2) provide to the CONTRACTOR, prior to that person beginning work on the project, a certificate of coverage showing that coverage is being provided for all employees of the person providing services on the project, for the duration of the project;

(3) provide the CONTRACTOR, prior to the end of the coverage period, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project;

(4) obtain from each other person with whom it contracts, and provide to the CONTRACTOR:

(a) a certificate of coverage, prior to the other person beginning work on the project; and

(b) a new certificate of coverage showing extension of coverage, prior to the end of the coverage period, if the coverage period shown on the current certificate of coverage ends during the duration of the project;

(5) retain all required certificates of coverage on file for the duration of the project and for one year thereafter;

(6) notify the governmental entity in writing by certified mail or personal delivery, within ten (10) days after the person knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the project; and

(7) contractually require each person with whom it contracts, to perform as required by paragraphs (1) - (7), with the certificates of coverage to be provided to the person for whom they are providing services.

J. By signing this contract or providing or causing to be provided a certificate of coverage, the CONTRACTOR is representing to the governmental entity that all employees of the CONTRACTOR who will provide services on the project will be covered by workers' compensation coverage for the duration of the project, that the coverage will be based on proper reporting of classification codes and payroll amounts, and that all coverage agreements will be filed with the appropriate insurance carrier or, in the case of a self-insured, with the commission's Division of Self-Insurance Regulation. Providing false or misleading information may subject the CONTRACTOR to administrative penalties, criminal penalties, civil penalties, or other civil actions.

K. The CONTRACTOR's failure to comply with any of these provisions is a breach of contract by the CONTRACTOR which entitles the governmental entity to declare the contract void if the CONTRACTOR does not remedy the breach within ten (10) days after receipt of notice of breach from the governmental entity.

In accordance with statutory requirements, the CONTRACTOR shall:

(1) provide coverage for its employees providing services on the project, for the duration of the project based on proper reporting of classification codes and payroll amounts and filing of any coverage agreements;

(2) provide a certificate of coverage showing workers' compensation coverage to the governmental entity prior to beginning work on the project;

(3) provide the governmental entity, prior to the end of the coverage period, a new certificate of coverage showing extension of coverage, if the coverage period shown on the CONTRACTOR's current certificate of coverage ends during the duration of the project;

(4) obtain from each person providing services on the project, and provide to the governmental entity:

(A) a certificate of coverage, prior to that person beginning work on the project, so the governmental entity will have on file certificates of coverage showing coverage for all persons providing services on the project; and

(B) no later than seven (7) days after receipt by the contract, a new certificate of coverage showing extension of coverage, if the coverage period shown on the current certificate of coverage ends during the duration of the project;

(5) retain all required certificates of coverage on file for the duration of the project and for one year thereafter;

(6) notify the governmental entity in writing by certified mail or personal delivery, within ten (10) days after contractor knew or should have known, of any change that materially affects the provision of coverage of any person providing services on the project;

(7) post a notice on each project site informing all persons providing services on the project that they are required to be covered, and stating how a person may verify current coverage and report failure to provide coverage. This notice does not satisfy other posting requirements imposed by the Act or other commission rules. This notice must be printed with a title in at least 30 point bold type and text in at least 19 point normal type, and shall be in both English and Spanish and any other language common to the worker population. The text for the notices shall be the following text in Figure 1 provided by the commission on the sample notice, without any additional words or changes:

Figure 1:

REQUIRED WORKERS' COMPENSATION COVERAGE

"The law requires that each person working on this site or providing services related to this construction project must be covered by workers' compensation insurance. This includes persons providing, hauling, or delivering equipment or materials, or providing labor or transportation or other service related to the project, regardless of the identity of their employer or status as an employee"

"Call the Texas Workers' Compensation Commission at (512) 440-3789 to receive information on the legal requirement for coverage, to verify whether your employer has provided the required coverage, or to report an employer's failure to provide coverage."

In GP Item 103.4.1.2. Commercial General Liability, change the respective limits as follows:

Contractor's General Liability and Property Damage Insurance:

Bodily Injury (or Death)	$ 600,000 each occurrence
Property Damage	$ 600,000 each occurrence

SP-14: POLICY ENDORSEMENTS AND SPECIAL CONDITIONS

In addition to the provisions of GP Item 103.4.5. Policy Endorsements and Special Conditions, add the following:

(a) CONTRACTOR will not be issued a Work Order to commence work on this Contract until he/she has obtained all the insurance required under this section and such insurance has been approved by the OWNER or his representative.

(b) CONTRACTOR shall procure and shall maintain during the life of this Contract, insurance coverage as herein specified, and in case of any work sublet, shall require any subcontractor in like manner to secure and maintain such minimum limits of insurance coverage, also.

(c) The CONTRACTOR shall furnish the OWNER with certificates showing the type, amount, class of operations covered, effective dates, and dates of expiration of policies. Such certificates shall contain substantially the following statement: "The insurance covered by this certificate will not be canceled or materially altered except after thirty (30) days written notice has been received by the OWNER."

SP-15: ORDER OF WORK

Add the following to GP Item 103.6. Notice to Proceed and Commencement of Work:

The CONTRACTOR shall be fully responsible for proper coordination for the relocation of utilities (i.e. power poles, electrical lines, gas lines, telephone lines, television (TV) cable lines, buried cables, etc.) public and private unless otherwise noted on the plans/drawings.

SP-16: PRIORITY OF CONTRACT DOCUMENTS

Delete GP Item 105.1.1. Priority of Contract Documents and substitute the following:

In case of conflict between contract documents, priority of interpretation shall be in the following order:

(1) This Agreement
(2) Addendum(s)
(3) “Notice to Bidders” advertisement
(4) Bidder’s Proposal
(5) Special Instruction to Bidders
(6) Performance, Payment and Maintenance Bonds
(7) Certification of Insurance
(8) Notice to Proceed
(9) Technical Specifications
(10) City of North Richland Hills’ Public Works Design Manual
(11) Special Provisions
(12) General Provisions
(13) Special Specifications
(14) Project Construction Plans/Drawings
(15) Special Material and/or Equipment Specifications
(16) Special Material and/or Equipment Drawings
(17) “Public Works Construction Standards - North Central Texas” adopted by the North Central Texas Council of Governments (NCTCOG), November 2017 Edition
(18) North Central Texas Council of Government references

SP-17: WARRANTY

In GP Item 105.2.2. Special Warranty, change all references from one year to two (2) years and add the following:

Notwithstanding any certificate which may have been given by the Engineer, if any materials, equipment or any workmanship which does not comply with the requirements of this contract shall be discovered within two (2) years after completion of construction of the project, and acceptance by the OWNER, the CONTRACTOR shall replace such defective materials or equipment, or remedy any such defective workmanship within ten (10) days after notice in writing of the existence thereof shall have been given by the OWNER or City Engineer. In the event of failure of the CONTRACTOR to replace any such defective materials or equipment or to remedy defective workmanship as herein provided, the OWNER may replace such defective materials or equipment or remedy such workmanship as the case may be and in such event the CONTRACTOR shall pay to the OWNER the cost and expense thereof.

SP-18: LINES AND GRADES

Add the following to GP Item 105.4. Construction Stakes:

The CONTRACTOR is responsible to provide all construction staking under this contract.

All work under this contract shall be constructed in accordance with the lines and grades shown on the plans/drawings. The full responsibility for the holding to alignment and grade shall rest upon the CONTRACTOR.

The CONTRACTOR shall protect all property corner markers, and when any such markers or monuments are in danger of being disturbed, they shall be properly referenced and if disturbed shall be reset at the expense of the CONTRACTOR.

SP-19: INSPECTION AND TESTING

Add the following to GP Item 106.5. Samples and Tests of Materials:

The CONTRACTOR shall be responsible for paying for all testing and testing related items (acquiring specimens, proper specimen control, etc.) on this Project.

During the progress of the work, all materials, equipment and workmanship shall be subjected to such inspections and tests as will assure conformance with the contract requirements.

The CONTRACTOR shall furnish at his/her expense all necessary specimens and samples for testing.

Sampling and testing of all materials or construction methods shall be performed by a commercial laboratory, approved by the City Engineer, and permitted with the City of North Richland Hills' Public Works Department.

When the CONTRACTOR's materials, construction items or products incorporated in the project fail to satisfy the minimum requirements of the initial test and he/she has to bear the cost of any retesting, he/she shall be responsible for any and all cost associated with such retesting. If in this situation, the CONTRACTOR utilizes the same testing laboratory as the OWNER, the CONTRACTOR shall pay said testing laboratory in full or the testing laboratory shall be able to gain recourse through the CONTRACTOR's Payment Bond.

In the event a conflict arises concerning the interpretation of A.S.T.M., A.C.I., A.W.W.A., etc., specifications/standards, the City Engineer shall make his/her determination of the interpretation and his/her determination shall be final.

SP-20: INDEMNIFICATION

The CONTRACTOR shall familiarize himself/herself with GP Item 107.2. Indemnification and GP Item 107.19.3.2. Indemnification. Additionally, the following shall be added to both Indemnification items:

This agreement, however, does not waive any governmental immunity available to the OWNER under Texas law and nor any defenses of the parties under Texas law. The provisions of this paragraph are solely for the benefit of the parties hereto and not intended to create or grant any rights, contractual or otherwise, to any other person or entity.

SP-21: SALES TAX

Add the following to GP Item 107.14. State and Local Sales and Use Taxes:

The OWNER qualifies for exemption from state and local sales and use taxes, pursuant to the provisions of Section 151.309 of the Texas Limited Sales, Excise and Use Tax Act, as amended. Therefore, the OWNER shall not be liable for, or pay the CONTRACTOR's cost of such sales and use taxes which would otherwise be payable in connection with the performance of this contract.

SP-22: TRAFFIC CONTROL

Add the following to GP Item 107.19.2. Protection of Persons and Property:

The CONTRACTOR shall not remove any regulatory sign, instructional sign, street name sign, or other sign which has been erected by the City. If it is determined that a sign must be removed to permit required construction, the CONTRACTOR shall contact the City to remove the sign. In the case of regulatory signs, the CONTRACTOR must replace the permanent sign with a temporary sign meeting the requirements of the above referenced manual and such temporary sign must be installed prior to the removal of the permanent sign. If the temporary sign is not installed correctly or if it does not meet the required specifications, the permanent sign shall be left in place until the temporary sign requirements are met. When construction work is completed to the extent that the permanent sign can be reinstalled, the CONTRACTOR shall again contact the City to reinstall the permanent sign and shall leave his temporary sign in place until such installation is completed.

The CONTRACTOR shall prosecute his traffic control work in such a manner as to create a minimum of interruption to traffic and pedestrian facilities and to the flow of vehicular and pedestrian traffic within the project area.

Access to adjacent property shall be maintained at all times unless otherwise approved by the OWNER.

SP-23: TRENCH SAFETY

Add the following paragraph to GP Item 107.19.3. Trench Safety:

Per Chapter 756, Texas Health & Safety Code, it shall be the responsibility of the CONTRACTOR to provide and maintain a viable trench safety system at all times during construction activities. The CONTRACTOR is directed to become knowledgeable and familiar with the standards as set forth by the Occupational Safety and Heath Administration for trench safety that will be in effect during the period of construction of the project and the CONTRACTOR is responsible for conforming to such regulations as prescribed by Occupational Safety and Health Administration standards.

SP-24: WORK-SITE AREA AND CLEAN-UP

Add the following to GP Item 107.21. Working Area:

During construction the CONTRACTOR shall at all times keep the job site free from waste, debris and rubbish, and shall maintain a daily routine of clean-up.

The working operations of the CONTRACTOR shall at all times be conducted so as to create a minimum of inconvenience to the OWNER or to the public. Stringing of pipe, stockpiling of materials, etc., will be allowed only where no inconvenience is caused and only in amounts that can be readily used by the CONTRACTOR.

All trees, stumps, slashings, brush or other debris to be removed from the site, shall be disposed of in a manner consistent with Local Ordinances and all State Regulations. Burning of trash, etc., will only be permitted where allowed by Local Ordinances and State Pollution Regulations.

All excavated earth in excess of that required for project embankments and/or backfilling shall be removed from the job site and disposed of in a satisfactory manner. Disposal of excess material into area creeks and drainageways will not be allowed.

Any trees or other landscape features scarred or damaged by the CONTRACTOR's operations shall be restored or replaced at the CONTRACTOR's expense. Trimming or pruning to facilitate the work will be permitted only by experienced workmen in an approved manner. Pruned limbs of one inch (1") diameter or larger, shall be thoroughly treated as soon as possible with a tree wound dressing.

The CONTRACTOR shall take all precautions required to prevent soil erosion during construction. If, in the opinion of the City Engineer, excessive erosion occurs, the CONTRACTOR shall take immediate measure to prevent further erosion and restore the disturbed surface with topsoil at completion of the work.

All property along and adjacent to the CONTRACTOR's operations including lawns, yards, shrubs, trees, etc., shall be preserved or restored after completion of the work, to a condition equal to or better than existed prior to start of work.

Upon completion of the work as a whole and prior to final acceptance, the CONTRACTOR shall clean and remove from the site all surplus and discarded materials, temporary structures and all debris. He/She shall leave the site in a neat and orderly condition with an appearance satisfactory to the City Engineer and OWNER. Method and location of disposal or surplus and waste materials shall be satisfactory to the City Engineer.

The CONTRACTOR shall then thoroughly clean all equipment and materials installed by him/her and shall present for final inspection materials and equipment in a clean, bright and new condition.

No extra payment will be made for any of this type of work required on the project.

SP-25: EXISTING STRUCTURES, FACILITIES AND IMPROVEMENTS

Add the following to GP Item 107.23. Existing Structures, Facilities and Appurtenances:

The CONTRACTOR's attention is directed to the necessity of taking adequate measures to protect all existing structures, facilities, improvements and utilities, including sprinkler systems, encountered.

The plans show the locations of most known surface and subsurface structures. However, the OWNER assumes no responsibility for failure to show any or all of these structures on the plans or in their exact location. It is mutually agreed that such failure shall not be considered sufficient basis for claims for additional compensation for extra work, or for increasing the pay quantities in any manner, unless the obstruction encountered is such as to necessitate substantial changes in the lines or grades, or requires the building of special works not provided for in the Contract Documents.

Any non-City utilities (cable, electric, gas, telephone, etc.) damaged by the CONTRACTOR shall be the responsibility of the CONTRACTOR for relocation and/or repair as well as the costs associated with the relocation and/or repair of utilities. Any City utilities (sanitary sewer main and water distribution main) damaged by the non-negligent acts of the CONTRACTOR will not be the responsibility of the CONTRACTOR for repair. Any delays associated with the relocation and/or repair of utilities shall not be basis for a claim for extra pay.

In the progress of the work, the CONTRACTOR may have to relocate certain existing utility service lines. All relocation, repairs and replacement work shall be done at the expense of the CONTRACTOR to the satisfaction of the OWNER, except those for which specific pay items appear in the Bid Proposal.

Any utilities damaged during construction work shall be immediately repaired at the CONTRACTOR's expense.

The CONTRACTOR shall at all times maintain streets and drives in a condition which will provide easy ingress and egress and upon completion of the work, repair all damages to roads and streets used during construction, to a condition at least as good as existed prior to the start of work.

SP-26: PROSECUTION OF CONSTRUCTION

Add the following to GP Item 108.2. Prosecution of the Work:

The CONTRACTOR will, unless otherwise approved by the City Engineer, prosecute the construction of this project during normal working hours as defined below:

(a) Normal Work Day shall mean the normal eight (8) hour working day between the hours of 8:00am and 5:00pm

(b) Normal Work Week shall mean the forty (40) hour work week encompassing the five (5) eight-hour days, Monday through Friday.

(c) Holidays to be observed and to be included into the normal work week will be:

New Years Day	January 1st
Martin Luther King Day	Third Monday in January
Good Friday	April 2nd, 2021
Memorial Day	Last Monday in May
Independence Day	July 4th
Labor Day	First Monday in September
Thanksgiving Holiday	Fourth Thursday in November and the following Friday
Christmas Holiday	December 24th & December 25th

Any of the above dates falling on a Sunday shall be observed on the following Monday.

(d) All work contemplated to be done which will not be in accordance with the normal hours will require prior approval from the City Engineer. The CONTRACTOR shall request permission by the City Engineer 72 hours in advance of the time he/she intends to work.

Work which is of necessity performed at times other than normal working hours will not require prior approval unless construction scheduling can be arranged to prevent such conflict of time requirements.

All work performed other than the normal working hours, whether scheduled or required, will in no way increase the cost to the OWNER for the performance of such work. The CONTRACTOR shall pay the OWNER for inspection services, city administrative fees, etc. when work has been approved to be performed on Weekends, Holidays and outside

any normal working hours. These services shall be charged at the rate of $75.00 per hour and shall include a four (4) hour minimum charge.

(e) Calendar Days is defined as any day of the week or month; no days being excepted, such as, Saturdays, Sundays, holidays and inclement weather days. Counting of contract time will only be stopped when the Owner issues a written notice stating this fact, or when the project is noted as substantially complete by written notice from the Owner. The Owner shall determine when such action is necessary.

Extensions of time due to weather delays shall be determined in accordance with the following formula:

E = R – P where P is greater than or equal to R, and

E = Extra Precipitation Days
P = Average Precipitation Days
R = Total Precipitation Days

Average Precipitation Days (P) is defined as a day of rain, sleet, hail, snow or any combination thereof, and shall be based upon the average precipitation for each month of the year as defined in the Local Climatological Data summaries issued by the National Climatic Data Center in Asheville, North Carolina, and for this contract shall be as follows:

Month	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. of Days	6	6	7	7	8	6	4	4	6	6	6	6

Average Precipitation

Partial months shall be prorated uniformly for the entire month and the sum of all the months used will be rounded to the nearest whole number. This number shall be P.

Total Precipitation Days (R) is defined as a day of rain, sleet, hail, snow or any combination thereof, if determined by the Owner's Project Representative that the Contractor's construction cannot progress substantially due to precipitation and thus be put in the Daily Inspection Logs as a precipitation day. The sum of all precipitation says shall be R.

The total number of Extra Precipitation Days (E) shall be granted to the Contractor as extension of time due to weather delays, and no additional time due to drying time for saturated soil will be allowed.

SP-27: LIQUIDATED DAMAGES FOR FAILURE TO COMPLETE ON TIME

The contract time for the entire project is based start from Notice to Proceed issuance date and spans 365 consecutive calendar days.

Liquidated damages are based on the completion of all contract items and assessed at the rate of $2,160 per calendar day for any unfinished work.

This rate shall continue until such time that the Project is complete and accepted by the OWNER.

SP-28: OCCUPATIONAL SAFETY AND HEALTH ACT

All work performed under this contract shall meet the requirements of the Occupational Safety and Health Act. It is the responsibility of the CONTRACTOR to familiarize himself/herself with the latest provisions of regulations published by the Occupational Safety and Health Administration in the Federal Register and to perform all of his/her responsibilities thereunder.

The CONTRACTOR shall comply with the provisions of the Occupational Safety and Health Act and the standards and regulations issued thereunder and warrant that all work, materials and products furnished under this contract will conform to and comply with said standards and regulations which are in existence on the date of this contract. The CONTRACTOR further agrees to indemnify, defend, and hold harmless the OWNER for all damages suffered by the OWNER as a result of the

CONTRACTOR's failure to comply with the Act and the Standards issued thereunder and for the failure of any material and/or equipment furnished under this contract to so comply.

The CONTRACTOR shall also comply with all pertinent provisions of the "Manual of Accident Prevention in Construction" issued by the Associated General Contractors of America, Inc., if not in conflict with those of the Occupational Safety and Health Act and shall maintain an accurate record of all cases of death, occupational disease and injury requiring medical attention or causing loss of time from work, arising out of and in the course of employment or work under the contract.

The CONTRACTOR alone shall be responsible for the safety, efficiency and adequacy of his/her equipment and employees and for any damage which may result from their failure or their improper construction, maintenance or operation.

SP-29: EASEMENTS/RIGHTS-OF-WAY

Without cost to the CONTRACTOR, the OWNER will provide the necessary easements or rights-of-way required for the project. However, the CONTRACTOR may desire additional temporary easements for the duration of the work for his/her construction, storage or access. All such temporary easements shall be obtained by the CONTRACTOR at no additional cost to the contract or the OWNER.

Unless specifically provided otherwise, the CONTRACTOR, as part of his/her work, shall clear all easements or rights-of-way of all obstructions to the work. On conclusion of his/her operations, he/she shall replace, repair or restore any improvements which may have been removed or damaged, as directed by the City Engineer.

SP-30: RIGHT OF ENTRY

The OWNER reserves the right to enter the property or location on which the works herein contracted for are to be constructed or installed, by such agent or agents as he/she may elect, for the purpose of inspecting the work, or for the purchase of constructing or installing such collateral work as said OWNER may desire.

SP-31: AUTHORITY AND DUTIES OF INSPECTOR

Inspectors, designated by and acting under the direction of the OWNER, shall have the authority to inspect all work done and all materials furnished. Such inspection may extend to all or any part of the work and to the preparation, fabrication or manufacture of the materials to be used. He/She is authorized to call to the attention of the CONTRACTOR any failure of the work or materials to conform to the plans, specifications and contract documents. He/She shall have the authority

to reject materials or suspend the work until any situation at issue can be referred to and decided by the OWNER.

The Inspector is not authorized to revoke, alter or waive any requirements of the plans and specifications. He/She shall in no case act as foreman or perform other duties for the CONTRACTOR, interfere with the management of the work by the latter. Any advice which the Inspector may give the CONTRACTOR shall otherwise not be construed as binding the City Engineer in any way, or releasing the CONTRACTOR from fulfilling all of the terms of the Contract.

If the CONTRACTOR refuses to suspend operations on verbal order of the Inspector, a written order will be presented to the CONTRACTOR by the Inspector giving the reason for suspension of work. After placing the order in the hand of the "man-in-charge", the Inspector shall immediately leave the job. Work performed during the absence of the Inspector will not be accepted nor paid for, and shall be removed and replaced.

Notwithstanding any other provision of this agreement or any other Contract Documents, the Inspector shall not be in any way responsible or liable for any act, errors, omissions or negligence of the CONTRACTOR, any subcontractor or any of the CONTRACTOR's or subcontractor's agents, servants or employees or any other person, firm or corporation performing or attempting to perform any of the work.

SP-32: OWNER-ENGINEER RELATIONSHIP

The Engineer will be the OWNER's representative during construction. The duties, responsibilities and limitations of authority of the Engineer as the OWNER's Representative during construction are as set forth in the Contract Documents and shall not be extended or limited without written consent of the OWNER and Engineer. The Engineer will advise and consult with the OWNER, and all of OWNER's instructions to the CONTRACTOR shall be issued through the Engineer.

SP-33: PROFESSIONAL INSPECTION BY ENGINEER

The Engineer shall make periodic visits to the Site to familiarize himself/herself generally with the progress of the executed work and to determine if such work generally meets the essential performance and design features and the technical and functional engineering requirements of the Contract Documents; provided and except, however, that the Engineer shall not be responsible for making any detailed, exhaustive, comprehensive or continuous on-site inspection of the quality or quantity of the work or be in any way responsible, directly or indirectly, for the construction means, methods, techniques, sequences, quality, procedures,

programs, safety precautions or lack of same incident thereto or in connection therewith.

Notwithstanding any other provision of this agreement or any other Contract Documents, the Engineer shall not be in any way responsible or liable for any acts, errors, omissions or negligence of the CONTRACTOR, any subcontractor or any of the CONTRACTOR's or subcontractor's agents, servants or employees or any other person, firm or corporation performing or attempting to perform any of the work.

SP-34: COPIES OF PLANS AND SPECIFICATIONS FURNISHED

Four (4) sets of plans and specifications (not including the General Provisions) shall be furnished to the CONTRACTOR at no charge for construction purposes. Additional sets may be obtained from the Engineer at **$ 50.00 per set.**

SP-35: VERIFICATION OF MEASUREMENTS

Before ordering any material or doing any work, the CONTRACTOR shall verify all measurements involved and shall be responsible for the correctness of these measurements. No extra charge or compensation will be allowed because of differences between actual dimensions and the dimensions shown on the drawings; any difference which may be found shall be called to the attention of the Engineer for consideration before proceeding with the work.

SP-36: PAY ITEMS - INCIDENTAL CONSTRUCTION

The CONTRACTOR shall be paid only for those items which are listed in the proposal or which are added to the job through a change order. All construction or removal considerations which are not listed as a separate pay item shall be considered as incidental construction. Cost for these items shall be considered in the most appropriate item listed in the schedule(s) of pay items.

SP-37: OMISSIONS

(a) In the event that the specifications inadvertently omit some of the usual and customary work, auxiliary equipment or material required for the satisfactory installation and operation of all work, equipment or material, the CONTRACTOR shall provide these items as directed by the Engineer at his/her own expense. The CONTRACTOR will be assumed to be an experienced and qualified CONTRACTOR in this type of work, and to have studied the purpose of operation of the equipment and the results to be obtained, and is to furnish equipment suitable for the work to be done.

(b) In the event that the specifications inadvertently fail to contain a specification for work to be done and material to be furnished, then the Standard Current Specification or Requirements of the A.W.W.A., A.S.T.M., A.S.C.E., A.S.E.E., A.S.M.E., N.B.F.U., N.E.C., N.E.M.A., O.S.H.A., NCTCOG "Standard Specifications for Public Works Construction" or TxDOT "Standard Specifications for Construction of Highways, Streets and Bridges" shall apply. Should the above specifications not apply, then the work done, equipment or material furnished shall be as directed by the Engineer.

SP-38: MINIMUM WAGE RATES

For the work required of this project, the CONTRACTOR and all sub-contractors shall pay his/her employees the prevailing wage rates in accordance with the Texas Government Code, Chapter 2258. The prevailing wage rates determined applicable for this project are the current prevailing wage rate schedules of the United States Department of Labor adopted in accordance with the Davis-Bacon Act (40 U.S.C. Section 276a, et. seq.) and its subsequent amendments. These prevailing wage rates can be obtained from the following web page: **www.sam.gov/wage-determination/TX20210026/1** (Tarrant County).

A CONTRACTOR or sub-contractor who does not pay his/her employees in accordance with these prevailing wages shall pay $ 60.00 for each worker employed for each calendar day or part of the day that the worker is paid less than the wage rates stipulated in these prevailing wage rates to the CITY.

SP-39: LOSSES FROM NATURAL CAUSES

Unless otherwise specified, all loss or damage to the CONTRACTOR arising out of the nature of the work to be done, or from the action of the elements, or from any unforeseen circumstance in the prosecution of same, or from unusual obstructions or difficulties which may be encountered in the prosecution of the work, shall be sustained and borne by the CONTRACTOR at his/her own cost and expense.

SP-40: EXPLOSIVES, BLASTING, ETC.

Neither explosives nor blasting shall be allowed or used on this project.

SP-41: WORK WITH OWN FORCES

The CONTRACTOR shall perform with his own forces work of a value of not less than fifty percent (50%) of the contract amount.

SP-42: WATER FOR CONSTRUCTION

The CONTRACTOR shall make the necessary arrangements for securing and transporting all water required in the construction, including water required for mixing of concrete, sprinkling, testing, flushing or jetting.

The CONTRACTOR may remit the City a deposit for a fire hydrant water meter; additionally, the CONTRACTOR will be billed for the water used on the construction of this contract and measured by such fire hydrant meter. Additionally, the cost of any temporary pipe line, metering or other equipment which may be necessary to make use of such fire hydrant water meter and water, shall be considered as incidental to the work and payment therefore shall be included in the various bid items of the proposal. If the CONTRACTOR chooses to use such fire hydrant water meter, he/she shall assume full responsibility for it and return it in the same or similar condition as received otherwise the CONTRACTOR will not be returned his/her deposit.

SP-43: OWNER'S RIGHT TO SUSPEND WORK AND ANNUL CONTRACT

Delete GP Item 108.9.(2) and replace it with the following:

(2) failure of the CONTRACTOR to make the progress set out in the Progress Schedule;

SP-44: OWNERSHIP OF DRAWINGS

All drawings, specifications and copies thereof furnished by the Engineer shall not be reused on other work, and, with the exception of the signed contract sets, are to be returned to him on request, at the completion of the work. All models are the property of the OWNER.

SP-45: ADEQUACY OF DESIGN

It is understood that the OWNER believes it has employed competent engineers and designers. It is, therefore, agreed that the Engineer shall be responsible for the adequacy of the design, sufficiency of the Contract Documents, the safety of the structure and the practicability of the operations of the completed project; provided the CONTRACTOR has complied with the requirements of the Contract Documents, all approved modifications thereof, and additions and alterations thereto approved in writing by the OWNER. The burden of proof of such compliance shall be upon the CONTRACTOR to show that he/she has complied with the requirements of the Contract Documents, approved modifications thereof and all approved additions and alternations thereto.