COPY NO. ____

OLD NORWICH ROAD, EVERGREEN AVENUE & BLUE HILLS PUMP STATIONS HVAC IMPROVEMENTS
RE-BID # 19-111

WATERFORD UTILITY COMMISSION
WATERFORD, CONNECTICUT

BIDDING AND CONTRACT REQUIREMENTS AND SPECIFICATIONS

September 2019

14064A

WRIGHT-PIERCE
Engineering a Better Environment

WATERFORD UTILITY COMMISSION
WATERFORD, CT

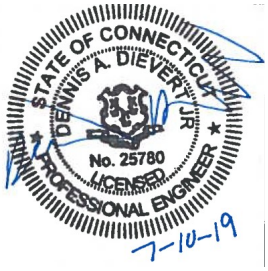
BIDDING AND CONTRACT REQUIREMENTS AND SPECIFICATIONS

FOR

OLD NORWICH ROAD, EVERGREEN AVENUE & BLUE HILLS PUMP STATIONS HVAC IMPOROVEMENTS

Re-BID # 19-111

JULY 2019



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END OF SECTION

FIFTEEN ROPE FERRY ROAD WATERFORD, CT

Town of Waterford
Board of Selectmen
Invitation to Bid
Old Norwich Road, Evergreen Avenue and Blue Hills
Pump Stations HVAC Improvements
Re-Bid # 19-111

The Purchasing Agent will accept sealed bids for the Old Norwich Road, Evergreen Avenue and Blue Hills Pump Stations HVAC Improvements until 10:00 A.M. on October 2nd, 2019. Please see the Town of Waterford website at http://www.waterfordct.org for packets and all information regarding this Bid. Vendors are asked to register on our Web Site through the vendor link.. Any questions regarding this proposal are to be directed to the Purchasing Agent at rdummett@waterfordct.org. Telephone Number 860-444-5842.

A mandatory walk-through of the three pump stations is scheduled for 10:00 A.M on September 18 th, 2019 beginning at the Old Norwich Road Pump Station, 38 Old Norwich Road, Waterford, CT.

The Board of Selectmen reserves the right to reject any or all bids, in whole or in part, and to waive any informality in any bid when such action is deemed in the best interest of the Town; their decision is final.

Rawle Dummett
Purchasing Agent

SCOPE OF WORK

This Contract consists of the removal, replacement and/or rehabilitation of HVAC and electrical systems at the Old Norwich Road, Evergreen Avenue and Blue Hills Sewer Pump Stations in the Town of Waterford. The project involves demolition and modification to existing piping, fans, boilers, ductwork and electrical conduit and wiring as well as the installation of new HVAC and plumbing items and equipment. The project also consists of the installation of a new gas service to the Old Norwich Road Pump Station. This service will be installed by Eversource prior to, or during this project. Coordination will Eversource will be required.

The requirements for bidders under this contract, including all applicable permit and insurance requirements of the Town of Waterford, are explained in the bidding documents. A completed Bid Form must be submitted with the Bid. The Town will enter into a purchase order agreement with the selected bidder.

The work shall be substantially completed within sixty (60) days after the Contract Time commences to run.

TOWN OF WATERFORD
INFORMATION AND GENERAL REQUIREMENTS TO BIDDERS

1. Sealed bids **(one ORIGINAL & TWO copies)** on the attached Bid Forms will be received at the Office of the Purchasing Agent, Town Hall, 15 Rope Ferry Rd Waterford, Connecticut 06385. At the designated time of opening, they will be publicly opened, read, recorded and placed on file. Bids may be mailed or hand-delivered by the specified time. **Packets received after designated time will not be accepted. Time clock in the Finance office is the official time clock.** A mailed Bid shall be addressed to the above address and must arrive in the Purchasing Office and be stamped prior to the date and time of Bid Opening.

2. The envelope enclosing your bid should be clearly marked on its front by bid number, time of bid opening and date.

3. Whenever it is deemed to be in the best interest of the Town, The Town of Waterford reserves the right to reject any or all bids, in whole or in part, and to waive technical defects, irregularities or any informality in any bid when such action is deemed in the best interest of the Town; their decision is final.

4. The contract will be generally awarded to the most qualified, lowest and responsive bidder to meet specifications unless otherwise specified.

5. Bids will be carefully evaluated as to conformance with stated specifications.

6. Specifications must be submitted complete in every detail, and when requested, samples shall be provided. If a bid involves any exception from stated specifications, they must be clearly noted as exceptions, underlined, and attached to the bid.

7. The Bid Documents contain the provisions required for the requested item. Information obtained from an officer, agent, or employee of the Town or any other person shall not affect the risks or obligations assumed by the Bidder or relieve him/her from fulfilling any of the conditions of the Bid.

8. Each bidder is held responsible for the examination and/or to have acquainted themselves with any conditions at the job site which would affect their work before submitting a bid. Failure to meet these criteria shall not relieve the Bidder of the responsibility of completing the Bid without extra cost to the Town of Waterford.

9. Any bid may be withdrawn prior to the above scheduled time for the opening of bids or authorized postponement thereof. Any bid received after the time and date specified shall not be considered. No bidder may withdraw a bid within sixty (60) days after the actual date of the opening thereof. Should there be reasons why a Bid cannot be awarded within the specified period; the time may be extended by mutual agreement between the Town and the bidder.

10. Each bid must be accompanied by a bid bond payable to the Town for five percent (5%) of the total amount of the bid. The bid bond of the successful bidder will be retained until the payment bond and performance bond have been executed and approved, after which it will be returned. A certified check may be used in lieu of a bid bond. The Town of Waterford will not be liable for the accrual of any interest on any certified check submitted.

11. A 100% Performance and Payment bonds are required of the successful bidder. This bond shall cover all aspects of the specification and shall be delivered to the Purchasing Agent prior to the issuance of a purchase order. This submission must be received within fifteen days of contract award. Bonds must meet the following requirements: Corporation - must be signed by an official of the corporation above their official title and the corporate seal must be affixed over the signature; Firm or Partnership - must be signed by all the partners and indicate they are "doing business as"; Individual - must be signed by the owner and indicated as "Owner". The surety company executing the bond or countersigning must be licensed in Connecticut and an official of the surety company must sign the bond with the corporate seal affixed over their signature. Signatures of two witnesses for both the principal and the surety must appear on the bond. Power of attorney for the official signing the bond for the surety company must be submitted with the bond. The Performance and Payment Bonds will be returned upon completion and acceptance of the job.

12. The bidder agrees and warrants that in the submission of this sealed bid, they will uphold the Town of Waterford's commitment to following Connecticut State and Federal law ensuring full compliance with Title VI of the Civil Rights Act of 1964 which affirms that no person or group of persons is excluded from participation, denied benefits, or otherwise subjected to discrimination or permits discrimination under any program or activity or any service rendered to the public, on the grounds of race, color, creed, religion, national origin, sex, age or disability. Unless it is shown by such bidder that such disability prevents performance of that which must be done to successfully fulfill the terms of this sealed bid or in any manner which is prohibited by the laws of the United States or the State of Connecticut. The bidder further agrees to provide the Connecticut Commission on Human Rights and Opportunities with such information requested by the Commission concerning the employment practices and procedures of the bidder. An Affirmative Action Statement will be required by the successful bidder.

13. Bidder agrees to comply with all of the latest Federal, State and OSHA Safety Standards and Regulations and certifies that all work required in this bid will conform to and comply with said standards and regulations. Bidder further agrees to indemnify and hold harmless the Town for all damages assessed against the Town as a result of Bidder's failure to comply with said standards and/or regulations.

14. The Town of Waterford is exempt from Excise, Transportation and Sales taxes imposed by the Federal Government and/or State of Connecticut. Such taxes must not be included in proposal prices. Exemption certificates will be provided upon request.

15. By submitting a proposal, Vendors/Bidders certify that the proposal is made independently and without collusion, agreement, understanding, or planned course of action with any other Vendor/Bidder and that the contents of the proposal shall not be disclosed to anyone other than their employees, agents, or sureties prior to the official opening. Non-Collusion Statement to be filled out.

16. The Bidder, when applicable, agrees to pay its labor force Prevailing Wage Rates and to comply with all Laws, Regulations and Ordinances regarding these wage rates and the recording of them set forth by the Connecticut Department of Labor. Where the total cost of the project, including all current and future change orders and addenda, exceeds $100,000.00 then prevailing wage rates shall apply. All current wage information may be accessed online from the CT Dept of Labor website at www.ctdol.state.ct.us. **IF PREVAILING WAGE SCHEDULES ARE INCLUDED IN BID PACKAGE, THEN REGARDLESS OF SUBMITTED BID AMOUNT PREVAILING WAGES ARE REQUIRED IN BID SUBMISSION.**
The Prevailing wage rates applicable to this project are subject to annual adjustments each July 1st for the duration of the project.
Each contractor shall pay the annual adjusted prevailing wage rate that is in effect each July 1st, as posted by the Department of Labor.
It is the contractor's responsibility to obtain the annual adjusted prevailing wage rate increases directly from the Department of Labor's website.
Contracting Agency (Town of Waterford) is under no obligation pursuant to State labor law to pay any increase due to the annual adjustment provision.

17. **Under all circumstances, contractor shall be responsible for any increases in prevailing wage during the duration of the project, and the town will not agree to any change order request based solely on an increase in prevailing wages by the state during the pendency of the contract between the successful bidder and the town**

18. Vendors shall observe and comply with all Federal, State and local laws, ordinances and regulations. Vendors shall indemnify and save harmless the Town, all of its officers, agents and servants against any claim or liability arising from or based on the violation of any such law, ordinance, regulation or negligence whether by the bidder, his employees, his consultant and/or their employees.

19. Bidders are responsible for checking the Town of Waterford website at http://www.waterfordct.org/depts/finance/purchasing.htm for any addendums and updates to the Bid.

19. All correspondence regarding any purchase made by the Town of Waterford shall reference the Town's purchase order number. Each shipping container shall clearly indicate both Town purchase order number and item number.

20. **Non Resident Contractors (IF APPLICABLE)** Upon award Non Resident Contractors are required to follow all requirements for the State of Connecticut, Department of Revenue Services (DRS) for Non-Resident Contractors, to ensure that Employment Taxes and other applicable taxes are being paid by Contractors. See State of Connecticut **Notice SN 2012 (2).**

21. Bidder shall include on a sheet(s) attached to its proposal a complete disclosure of all past and pending mediation, arbitration and litigation cases that the bidder or its principals (regardless of their place of employment) have been involved in for the most recent five years. Please include a statement of the issues in dispute and their resolution. Acceptability of Bidder based upon this disclosure shall lie solely with the Town.

22. The Town of Waterford is dedicated to waste reduction and the practice of using and promoting the use of recycled and environmentally preferable products. Bidders are encouraged to submit bids responses that are printed double-sided (except for the signed proposal page) on recycled paper, and to use paper dividers to organize the bid for review. All bid pages should be secured with a binder clip, staple or elastic band. We appreciate your efforts towards a greener environment.

23. Catalogue Reference - Unless expressly stated otherwise, any and all reference to commercial types, sales, trade names and catalogues are intended to be descriptive only and not restrictive; the intent is to indicate the kind and quality of the articles that will be acceptable. Bids on other equivalent makes, or with reference to other catalogue items will be considered. The bidder is to clearly state exactly what will be furnished. Where possible and feasible, submit an illustration, descriptive material, and/or product sample.

24. Property Damage - The Contractor shall be responsible for repair of any damage to Town of Waterford and Board of Education's property and restoration of any facility damage beyond normal wear and tear, caused by Contractor's activities. Repair and restoration shall be to the satisfaction of the Town of Waterford and Board of Education. Any repair or restoration of these damages shall be performed at no cost to the Town of Waterford and Board of Education.

25. A statement may be requested of the successful Bidder's financial resources, his experience and his organization and equipment available to complete the work. The Town of Waterford shall have the right to take such steps as deems necessary to determine the ability of the Bidder to perform the work. The Bidder shall furnish all information and data for this purpose as requested. No awarded shall be made to any bidder that is in default of payment to the Town for any reason.

26. The successful Bidder agrees to be bound by its bid, unless specifically excepted. The bid will be incorporated into the contract to be negotiated between the Town of Waterford and the Bidder. A contract will be entered into with contractor. Bids to be considered must be submitted on the Bid Sheets contained in this packet.

27. Bidders should be advised that should budgetary constraints dictate part and/or all of the items listed in this proposal might be rejected. The decision shall be final and not subject to recourse by the Bidder.

28. Bidder or its principals, regardless of their place of employment, shall not have been convicted of, nor entered any plea of guilty, or nolo contendere, or otherwise have been found civilly liable or criminally responsible for any criminal offense or civil action. Bidder shall not be in violation of any State or local ethics standards or other offenses arising out of the submission of bids or proposals, or performance of work on public works projects or contracts.

29. **Vendors are asked to register on our Web Site through the vendor link**

30. All Questions must be submitted in writing to the purchasing agent via email at rdummett@waterfordct.org.

31. **Bid Pricing -** If applicable Unit prices are to be written in both words and figures. In case of discrepancy, the unit price shown in words will govern.

32. If at any time of the scheduled Bid opening, Town Hall or the Office of Procurement is closed due to uncontrolled events such as fire, snow, ice, wind or building evacuation, the Bid opening will be postponed until 2:00 p.m. the next business day. Bidders are reminded to check the web site for updates and information or email the purchasing agent at rdummett@waterfordct.org. Proposals will be accepted until that date and time.

33. **Security and Identification -** The vendor shall take all measures necessary to comply and to ensure the employees of Contractor comply with the security rules and regulations of the Town of Waterford and all Federal, State and local rules, laws and regulations. ***IT IS A REQUIREMENT OF THIS CONTRACT THAT ALL EMPLOYEES OF THE CONTRACTOR BE DULY AUTHORIZED TO WORK IN THE UNITED STATES.***

34. Employees serving hereunder shall not use controlled substances not prescribed for them, or illegal substances on or off the Town of Waterford premises, and shall not use alcohol on the Town of Waterford premises nor preceding their work shift, when to do so would in any way affect the performance of the services. Contractor's employees shall not have any criminal record of misdemeanors or felony, and are not permitted to carry weapons into the Town of Waterford premises. The Contractor shall attest in writing, before a Notary, that a background check, to the full extent allowed by law, of employment history and references has been conducted on each employee within four (4) weeks of

initial employment and prior to commencing work on Town of Waterford premises. Failure to submit said documentation shall result in rejection of bid.

35. The Town of Waterford shall have the right to request any additional investigative background information including, but not limited to, the employment record of any personnel assigned to perform the services. The Contractor shall furnish, in writing, such information to the extent allowed by law within (30) calendar days after receipt of written request from the Town Purchasing Agent. The Town of Waterford reserves the right to conduct its own investigation of any employee of the vendor, who, in the opinion of the Town of Waterford is not performing the services in a proper manner, or who is incompetent, disorderly, abusive, dangerous, or disruptive or does not comply with the rules and regulations of the Town of Waterford. Such removal shall in no way be interpreted to require dismissal or other disciplinary action of the employee by Contractor.

36. The Contractor shall establish, implement and maintain procedures and controls to ensure that each employee of the Contractor complies with all applicable provisions of the contract and all site rules and practices of the Town of Waterford.

37. **Rights Reserved To the Town -** The Town reserves the right to award in part, to reject any and all, in whole or in part, for misrepresentation or if the respondent is in default of any prior Town contract, or if the Respondent limits or modifies any of the terms and conditions and/or specifications of the Request The Town also reserves the right to waive technical defects, irregularities and omissions if, in its judgment, the best interest of the Town will be served.

INSURANCE REQUIREMENTS - Within five days of contract award, the awarded vendor shall provide a Certificate of Insurance in accordance with the following requirements: Contractor/Vendor will agree to maintain in force at all times during which work/services are to be performed, the following minimum limits of insurance coverage. Coverage will include the bidder and all of its agents, employees and sub-contractors and other providers of services and shall name the **Town of Waterford, its employees and agents as an Additional Insured** on a primary and non-contributory basis to all policies, except Workers Compensation. **All policies shall also include a Waiver of Subrogation.** The insurance company(ies) must be licensed with the State of Connecticut and have a Financial Strength Rating of "A-" or higher and a Financial Size Rating of VIII or higher from A.M. Best Company.

		Minimum Limits
General Liability	Each Occurrence General Aggregate Products/Completed Operations Aggregate	$1,000,000 $2,000,000 $2,000,000
Auto Liability	Combined Single Limit Each Accident	$1,000,000
Umbrella (Excess Liability)	Each Occurrence Aggregate	$1,000,000 $1,000,000
Workers' Compensation & Employers' Liability	Work Comp EL Each Accident EL Disease Each Employee EL Disease Policy Limit	Statutory Limits $1,000,000 $1,000,000 $1,000,000

A Certificates of Insurance documenting the coverage listed above must be presented to The Town of Waterford prior to the commencing of any work/service. The Contractor/Vendor also agrees to provide replacement and/or renewal certificates at least 30 days prior to the expiration of each policy.

If any policy is written on a "Claims Made" basis, the policy must be continually renewed for a minimum of two (2) years following the completion date of the work/service. If the claims-made policy is replaced and/or the retroactive date is changed, then the expiring policy must be endorsed to extend the reporting period for claims for two (2) years from the completion date.

FIFTEEN ROPE FERRY ROAD

WATERFORD, CT 06385-2886

TOWN OF WATERFORD
NON-COLLUSION STATEMENT

"The undersigned affirms that they are duly authorized to execute this contract, that this company, corporation, firm, partnership or individual has not prepared this bid in collusion with any other bidder, and that the contents of this bid as to prices, terms or conditions of said bid have not been communicated by the undersigned nor by any employee or agent to any other person engaged in this type of business prior to the official opening of this bid."

We understand that this proposal must be signed by an authorized agent of our company to constitute a valid proposal.

Date: _____

Name of Company: _____

Name and Title of Agent: _____

By (SIGNATURE): _____

Address: _____

_____

Telephone Number: _____

FIFTEEN ROPE FERRY ROAD

WATERFORD, CT 06385-2886

BID FORM
Old Norwich Road, Evergreen Avenue and Blue Hill
Pump Stations HVAC Improvements
Re-BID # 19-111

_____

VENDOR NAME AND ADDRESS

_____

PRINTED NAME AND TITLE OF VENDOR'S AGENT

_____

PHONE AND FACSIMILE NUMBERS, E-MAIL ADDRESS

I _____ (Name), _____ (Position) of the above named firm hereby submit the following bid in accordance with Town of Waterford specifications.

_____

SIGNATURE **DATE**

PROJECT IDENTIFICATION:	Old Norwich Road, Evergreen Avenue and Blue Hills Pump Stations HVAC Improvements
THIS BID IS SUBMITTED TO:	Town of Waterford Connecticut
	15 Rope Ferry Road
	Waterford, Connecticut 06385

1. The undersigned Bidder proposes and agrees, if this Bid is accepted, to enter into a purchase order agreement with the Town of Waterford at the stipulated price indicated in this bid.

2. Bidder accepts all of the terms and conditions of the Advertisement or Invitation to Bid. This Bid will remain subject to acceptance for 90 days after the day of Bid opening.

3. BIDDER has familiarized itself with the nature and extent of the Bid Documents including any Addenda (acknowledge receipt of any and all Addenda by listing the date and Addenda Number where indicated below), Work, locality, and all local conditions and Laws and

Regulations that in any manner may affect cost, progress, performance or furnishing of the Work.

Addenda Date	Addenda Number

4. BIDDER has given ENGINEER written notice of all conflicts, errors or discrepancies that it has discovered in the Bid Documents and the written resolution thereof by ENGINEER is acceptable to BIDDER.

5. BIDDER certifies that the Bid is genuine and not made in the interest of or on behalf of any undisclosed person, firm or corporation and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation; BIDDER has not directly or indirectly induced or solicited any other Bidder to submit a false or sham Bid; BIDDER has not solicited or induced any person, firm or corporation to refrain from bidding; and BIDDER has not sought by collusion to obtain for itself any advantage over any other Bidder or over OWNER.

6. BIDDER understands that the OWNER reserves the right to reject any or all bids.

7. Bidder will complete the Work described in the Contract Documents for the following price(s):

BID SCHEDULE

Item No.	Quantity	Brief Description of Item with Unit Bid Price in Words	Unit Bid In Figures	Amount In Figures
1	1 L.S.	Old Norwich Road Pump Station HVAC/Electrical Improvements all inclusive The Sum of $_____ _____ Per Lump Sum	$_____	$_____
2	1 L.S.	Evergreen Avenue Pump Station HVAC/Electrical Improvements all inclusive The Sum of $_____ _____ Per Lump Sum	$_____	$_____
3	1 L.S.	Blue Hills Pump Station HVAC/Electrical Improvements all inclusive The Sum of $_____ _____ Per Lump Sum	$_____	$_____
4	Allowance	Owners System Integrator Allowance The Sum of $ *five thousand dollars* _____ Amount in Words	$ *5,000*	$ *5,000*
5	Allowance	Utility Service Allowance (Electric/Gas) The Sum of $ *seven thousand dollars* _____ Amount in Words	*$ 7,000*	*$7,000*

TOTAL BID: Total of Items 1 through 5 above.

_____ ($_____)
_____ (use figures)
(use words)

8. Communications concerning this Bid shall be addressed to:
   Rawle Dummett, Purchasing Agent
   Finance Office, 15 Rope Ferry Road
   Waterford, Connecticut 06385
   Phone: (860) 444-5842
   Fax: (860) 440-0579
   rdummett@waterfordct.org

CONTRACTOR INFORMATION SHEETS

(These sheets must be completed and included with Bid)

COMPANY NAME: _____

ADDRESS: _____

ESTABLISHED: _____
(Month) (Year)

TYPE OF ORGANIZATION: *(Circle One)*
A) Individual
B) Partnership
C) Corporation
D) Joint Venture
E) Other _____
(Specify)
(If Applicable)

FORMER FIRM NAME(S) YEARS IN BUSINESS
_____ _____
_____ _____

YEARS OF WORK IN A RELATED FIELD: _____
(Described Any Related Work)
_____
_____
_____

EQUIPMENT AND EMPLOYEES:
Provide a list (attached to this sheet) of equipment and employees anticipated to be utilized for this work.

USE OF SUBCONTRACTORS:
To provide all the services listed in the specifications, would any services be handled by subcontractors? _____ *Yes/*No If "Yes", please explain:
_____
_____

Subcontractor Name(s): _____
_____
_____

PROJECT MANAGER:_____

(This page intentionally left blank)

THIS IS A PUBLIC WORKS PROJECT

Covered by the

PREVAILING WAGE LAW

CT General Statutes Section 31-53

If you have QUESTIONS regarding your wages
CALL (860) 263-6790

Section 31-55 of the CT State Statutes requires every contractor or subcontractor performing work for the state to post in a prominent place the prevailing wages as determined by the Labor Commissioner.

Sec. 31-53b. Construction safety and health course. New miner training program. Proof of completion required for mechanics, laborers and workers on public works projects. Enforcement. Regulations. Exceptions. (a) Each contract for a public works project entered into on or after July 1, 2009, by the state or any of its agents, or by any political subdivision of the state or any of its agents, described in subsection (g) of section 31-53, shall contain a provision requiring that each contractor furnish proof with the weekly certified payroll form for the first week each employee begins work on such project that any person performing the work of a mechanic, laborer or worker pursuant to the classifications of labor under section 31-53 on such public works project, pursuant to such contract, has completed a course of at least ten hours in duration in construction safety and health approved by the federal Occupational Safety and Health Administration or, has completed a new miner training program approved by the Federal Mine Safety and Health Administration in accordance with 30 CFR 48 or, in the case of telecommunications employees, has completed at least ten hours of training in accordance with 29 CFR 1910.268.

(b) Any person required to complete a course or program under subsection (a) of this section who has not completed the course or program shall be subject to removal from the worksite if the person does not provide documentation of having completed such course or program by the fifteenth day after the date the person is found to be in noncompliance. The Labor Commissioner or said commissioner's designee shall enforce this section.

(c) Not later than January 1, 2009, the Labor Commissioner shall adopt regulations, in accordance with the provisions of chapter 54, to implement the provisions of subsections (a) and (b) of this section. Such regulations shall require that the ten-hour construction safety and health courses required under subsection (a) of this section be conducted in accordance with federal Occupational Safety and Health Administration Training Institute standards, or in accordance with Federal Mine Safety and Health Administration Standards or in accordance with 29 CFR 1910.268, as appropriate. The Labor Commissioner shall accept as sufficient proof of compliance with the provisions of subsection (a) or (b) of this section a student course completion card issued by the federal Occupational Safety and Health Administration Training Institute, or such other proof of compliance said commissioner deems appropriate, dated no earlier than five years before the commencement date of such public works project.

(d) This section shall not apply to employees of public service companies, as defined in section 16-1, or drivers of commercial motor vehicles driving the vehicle on the public works project and delivering or picking up cargo from public works projects provided they perform no labor relating to the project other than the loading and unloading of their cargo.

(P.A. 06-175, S. 1; P.A. 08-83, S. 1.)

History: P.A. 08-83 amended Subsec. (a) by making provisions applicable to public works project contracts entered into on or after July 1, 2009, replacing provision re total cost of work with reference to Sec. 31-53(g), requiring proof in certified payroll form that new mechanic, laborer or worker has completed a 10-hour or more construction safety course and adding provision re new miner training program, amended Subsec. (b) by substituting "person" for "employee" and adding "or program", amended Subsec. (c) by adding "or in accordance with Federal Mine
Safety and Health Administration Standards" and setting new deadline of January 1, 2009, deleted former Subsec. (d) re "public building", added new Subsec. (d) re exemptions for public service company employees and delivery drivers who perform no labor other than delivery and made conforming and technical changes, effective January 1, 2009.

Informational Bulletin

THE 10-HOUR OSHA CONSTRUCTION SAFETY AND HEALTH COURSE

(applicable to public building contracts entered into *on or after July 1, 2007,* where the total cost of all work to be performed is at least $100,000)

(1) This requirement was created by Public Act No. 06-175, which is codified in Section 31-53b of the Connecticut General Statutes (pertaining to the prevailing wage statutes);

(2) The course is required for public building construction contracts (projects funded in whole or in part by the state or any political subdivision of the state) entered into on or after July 1, 2007;

(3) It is required of private employees (not state or municipal employees) and apprentices who perform manual labor for a general contractor or subcontractor on a public building project where the total cost of all work to be performed is at least $100,000;

(4) The ten-hour construction course pertains to the ten-hour Outreach Course conducted in accordance with federal OSHA Training Institute standards, and, for telecommunications workers, a ten-hour training course conducted in accordance with federal OSHA standard, 29 CFR 1910.268;

(5) The internet website for the federal OSHA Training Institute is http://www.osha.gov/fso/ote/training/edcenters/fact_sheet.html;

(6) The statutory language leaves it to the contractor and its employees to determine who pays for the cost of the ten-hour Outreach Course;

(7) Within 30 days of receiving a contract award, a general contractor must furnish proof to the Labor Commissioner that all employees and apprentices performing manual labor on the project will have completed such a course;

(8) Proof of completion may be demonstrated through either: (a) the presentation of a *bona fide* student course completion card issued by the federal OSHA Training Institute; *or* (2) the presentation of documentation provided to an employee by a trainer certified by the Institute pending the actual issuance of the completion card;

(9) Any card with an issuance date more than 5 years prior to the commencement date of the construction project shall not constitute proof of compliance;

(10) Each employer shall affix a copy of the construction safety course completion card to the certified payroll submitted to the contracting agency in accordance with Conn. Gen. Stat. § 31-53(f) on which such employee's name first appears;

(11) Any employee found to be in non-compliance shall be subject to removal from the worksite if such employee does not provide satisfactory proof of course completion to the Labor Commissioner by the fifteenth day after the date the employee is determined to be in noncompliance;

(12) Any such employee who is determined to be in noncompliance may continue to work on a public building construction project for a maximum of fourteen consecutive calendar days while bringing his or her status into compliance;

(13) The Labor Commissioner may make complaint to the prosecuting authorities regarding any employer or agent of the employer, or officer or agent of the corporation who files a false certified payroll with respect to the status of an employee who is performing manual labor on a public building construction project;

(14) The statute provides the minimum standards required for the completion of a safety course by manual laborers on public construction contracts; any contractor can exceed these minimum requirements; and

(15) Regulations clarifying the statute are currently in the regulatory process, and shall be posted on the CTDOL website as soon as they are adopted in final form.

(16) Any questions regarding this statute may be directed to the Wage and Workplace Standards Division of the Connecticut Labor Department via the internet website of http://www.ctdol.state.ct.us/wgwkstnd/wgemenu.htm; or by telephone at (860)263-6790.

THE ABOVE INFORMATION IS PROVIDED EXCLUSIVELY AS AN EDUCATIONAL RESOURCE, AND IS NOT INTENDED AS A SUBSTITUTE FOR LEGAL INTERPRETATIONS WHICH MAY ULTMATELY ARISE CONCERNIG THE CONSTRUCTION OF THE STATUTE OR THE REGULATIONS.

November 29, 2006

Notice

To All Mason Contractors and Interested Parties Regarding Construction Pursuant to Section 31-53 of the Connecticut General Statutes (Prevailing Wage)

The Connecticut Labor Department Wage and Workplace Standards Division is empowered to enforce the prevailing wage rates on projects covered by the above referenced statute.

Over the past few years the Division has withheld enforcement of the rate in effect for workers who operate a forklift on a prevailing wage rate project due to a potential jurisdictional dispute.

The rate listed in the schedules and in our Occupational Bulletin (see enclosed) has been as follows:

Forklift Operator:

- **Laborers (Group 4) Mason Tenders** - operates forklift solely to assist a mason to a maximum height of nine feet only.

- **Power Equipment Operator (Group 9)** - operates forklift to assist any trade and to assist a mason to a height over nine feet.

The U.S. Labor Department conducted a survey of rates in Connecticut but it has not been published and the rate in effect remains as outlined in the above Occupational Bulletin.

Since this is a classification matter and not one of jurisdiction, effective January 1, 2007 the Connecticut Labor Department will enforce the rate on each schedule in accordance with our statutory authority.

Your cooperation in filing appropriate and accurate certified payrolls is appreciated.

STATUTE 31-55a

- SPECIAL NOTICE -

To: All State and Political Subdivisions,Their Agents, and Contractors

Connecticut General Statute 31-55a - Annual adjustments to wage rates by contractors doing state work.

Each contractor that is awarded a contract on or after October 1, 2002, for (1) the construction of a state highway or bridge that falls under the provisions of section 31-54 of the general statutes, or (2) the construction, remodeling, refinishing, refurbishing, rehabilitation, alteration or repair of any public works project that falls under the provisions of section 31-53 of the general statutes shall contact the Labor Commissioner on or before July first of each year, for the duration of such contract, to ascertain the prevailing rate of wages on an hourly basis and the amount of payment or contributions paid or payable on behalf of each mechanic, laborer or worker employed upon the work contracted to be done, and shall make any necessary adjustments to such prevailing rate of wages and such payment or contributions paid or payable on behalf of each such employee, effective each July first.

- The prevailing wage rates applicable to any contract or subcontract awarded on or after October 1, 2002 are subject to annual adjustments each July 1st for the duration of any project which was originally advertised for bids on or after October 1, 2002.
- Each contractor affected by the above requirement shall pay the annual adjusted prevailing wage rate that is in effect each July 1st, as posted by the Department of Labor.
- It is the ***contractor's*** responsibility to obtain the annual adjusted prevailing wage rate increases directly from the Department of Labor's Web Site. The annual adjustments will be posted on the Department of Labor Web page: www.ctdol.state.ct.us. For those without internet access, please contact the division listed below.

- The Department of Labor will continue to issue the initial prevailing wage rate schedule to the Contracting Agency for the project. All subsequent annual adjustments will be posted on our Web Site for contractor access.

Any questions should be directed to the Contract Compliance Unit, Wage and Workplace Standards Division, Connecticut Department of Labor, 200 Folly Brook Blvd., Wethersfield, CT 06109 at (860)263-6790.

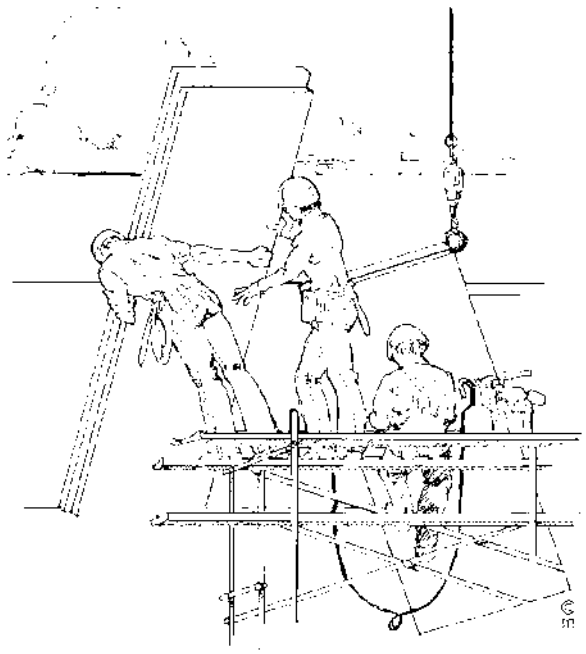
~NOTICE~

TO ALL CONTRACTING AGENCIES

Please be advised that Connecticut General Statutes Section 31-53, requires the contracting agency to certify to the Department of Labor, the total dollar amount of work to be done in connection with such public works project, regardless of whether such project consists of one or more contracts.

Please find the attached "Contracting Agency Certification Form" to be completed and returned to the Department of Labor, Wage and Workplace Standards Division, Public Contract Compliance Unit.

✎ Inquiries can be directed to (860)263-6543.



CONNECTICUT DEPARTMENT OF LABOR
WAGE AND WORKPLACE STANDARDS DIVISION
CONTRACT COMPLIANCE UNIT

CONTRACTING AGENCY CERTIFICATION FORM

I, _____, acting in my official capacity as _____,
authorized representative title

for _____, located at _____,
contracting agency address

do hereby certify that the total dollar amount of work to be done in connection with

_____, located at _____,
project name and number address

shall be $_____, which includes all work, regardless of whether such project

consists of one or more contracts.

CONTRACTOR INFORMATION

Name:_____

Address:_____
Authorized Representative:_____
Approximate Starting Date: _____

Approximate Completion Date:_____

_____ _____
Signature Date

Return To: Connecticut Department of Labor
Wage & Workplace Standards Division
Contract Compliance Unit
200 Folly Brook Blvd.
Wethersfield, CT 06109

Date Issued: _____

CONNECTICUT DEPARTMENT OF LABOR
WAGE AND WORKPLACE STANDARDS DIVISION

CONTRACTORS WAGE CERTIFICATION FORM

Construction Manager at Risk/General Contractor/Prime Contractor

I,_____ of _____
Officer, Owner, Authorized Rep. Company Name

do hereby certify that the _____
Company Name

_____
Street

_____
City

and all of its subcontractors will pay all workers on the

_____
Project Name and Number

_____
Street and City

the wages as listed in the schedule of prevailing rates required for such project (a copy of which is attached hereto).

_____
Signed

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

_____
Notary Public

Return to:

Connecticut Department of Labor
Wage & Workplace Standards Division
200 Folly Brook Blvd.
Wethersfield, CT 06109

Rate Schedule Issued (Date): _____

[New] In accordance with Section 31-53b(a) of the C.G.S. each contractor shall provide a copy of the OSHA 10 Hour Construction Safety and Health Card for each employee, to be attached to the first certified payroll on the project.

In accordance with Connecticut General Statutes, 31-53
Certified Payrolls with a statement of compliance
shall be submitted monthly to the contracting agency.

PAYROLL CERTIFICATION FOR PUBLIC WORKS PROJECTS

WEEKLY PAYROLL

Connecticut Department of Labor
Wage and Workplace Standards Division
200 Folly Brook Blvd.
Wethersfield, CT 06109

CONTRACTOR NAME AND ADDRESS:		SUBCONTRACTOR NAME & ADDRESS	WORKER'S COMPENSATION INSURANCE CARRIER POLICY # EFFECTIVE DATE: EXPIRATION DATE:
PAYROLL NUMBER	Week-Ending Date	PROJECT NAME & ADDRESS	

PERSON/WORKER, ADDRESS and SECTION	APPR RATE %	MALE/ FEMALE AND RACE*	WORK CLASSIFICATION / Trade License Type & Number - OSHA 10 Certification Number	DAY AND DATE / HOURS WORKED EACH DAY: S	M	T	W	TH	F	S	Total ST Hours / Total O/T Hours	BASE HOURLY RATE / TOTAL FRINGE BENEFIT PLAN CASH	TYPE OF FRINGE BENEFITS Per Hour 1 through 6 (see back)	GROSS PAY FOR ALL WORK PERFORMED THIS WEEK	TOTAL DEDUCTIONS: FICA	FEDERAL WITH-HOLDING	STATE WITH-HOLDING	LIST OTHER	GROSS PAY FOR THIS PREVAILING RATE JOB	CHECK # AND NET PAY
												$ Base Rate $ Cash Fringe	1. $ 2. $ 3. $ 4. $ 5. $ 6. $							
												$ Base Rate $ Cash Fringe	1. $ 2. $ 3. $ 4. $ 5. $ 6. $							
												$ Base Rate $ Cash Fringe	1. $ 2. $ 3. $ 4. $ 5. $ 6. $							
												$ Base Rate $ Cash Fringe	1. $ 2. $ 3. $ 4. $ 5. $ 6. $							

12/9/2013 *IF REQUIRED
WWS-CP1 *SEE REVERSE SIDE PAGE NUMBER ______OF

OSHA 10 ~ATTACH CARD TO 1ST CERTIFIED PAYROLL

***FRINGE BENEFITS EXPLANATION (P):**

Bona fide benefits paid to approved plans, funds or programs, except those required by Federal or State Law (unemployment tax, worker's compensation, income taxes, etc.).

Please specify the type of benefits provided:

1) Medical or hospital care _____ 4) Disability_____

2) Pension or retirement _____ 5) Vacation, holiday_____

3) Life Insurance _____ 6) Other (please specify) _____

CERTIFIED STATEMENT OF COMPLIANCE

For the week ending date of _____,

I, _____of _____, (hereafter known as

Employer) in my capacity as _____ (title) do hereby certify and state:

Section A:

1. All persons employed on said project have been paid the full weekly wages earned by them during the week in accordance with Connecticut General Statutes, section 31-53, as amended. Further, I hereby certify and state the following:

a) The records submitted are true and accurate;

b) The rate of wages paid to each mechanic, laborer or workman and the amount of payment or contributions paid or payable on behalf of each such person to any employee welfare fund, as defined in Connecticut General Statutes, section 31-53 (h), are not less than the prevailing rate of wages and the amount of payment or contributions paid or payable on behalf of each such person to any employee welfare fund, as determined by the Labor Commissioner pursuant to subsection Connecticut General Statutes, section 31-53 (d), and said wages and benefits are not less than those which may also be required by contract;

c) The Employer has complied with all of the provisions in Connecticut General Statutes, section 31-53 (and Section 31-54 if applicable for state highway construction);

d) Each such person is covered by a worker's compensation insurance policy for the duration of his employment which proof of coverage has been provided to the contracting agency;

e) The Employer does not receive kickbacks, which means any money, fee, commission, credit, gift, gratuity, thing of value, or compensation of any kind which is provided directly or indirectly, to any prime contractor, prime contractor employee, subcontractor, or subcontractor employee for the purpose of improperly obtaining or rewarding favorable treatment in connection with a prime contract or in connection with a prime contractor in connection with a subcontractor relating to a prime contractor; and

f) The Employer is aware that filing a certified payroll which he knows to be false is a class D felony for which the employer may be fined up to five thousand dollars, imprisoned for up to five years or both.

2. OSHA~The employer shall affix a copy of the construction safety course, program or training completion document to the certified payroll required to be submitted to the contracting agency for this project on which such persons name first appears.

_____	_____	_____
(Signature)	(Title)	Submitted on (Date)

*****THIS IS A PUBLIC DOCUMENT*****
*****DO NOT INCLUDE SOCIAL SECURITY NUMBERS*****

Weekly Payroll Certification For
Public Works Projects (Continued)

PAYROLL CERTIFICATION FOR PUBLIC WORKS PROJECTS

WEEKLY PAYROLL

Week-Ending Date:
Contractor or Subcontractor Business Name:

PERSON/WORKER, ADDRESS and SECTION	APPR RATE %	MALE/ FEMALE AND RACE*	WORK CLASSIFICATION Trade License Type & Number - OSHA 10 Certification Number	DAY AND DATE							Total ST Hours Total O/T Hours	BASE HOURLY RATE TOTAL FRINGE BENEFIT PLAN CASH	TYPE OF FRINGE BENEFITS Per Hour 1 through 6 (see back)	GROSS PAY FOR ALL WORK PERFORMED THIS WEEK	TOTAL DEDUCTIONS				GROSS PAY FOR THIS PREVAILING RATE JOB	CHECK # AND NET PAY
				S	M	T	W	TH	F	S					FICA	FEDERAL WITH-HOLDING	STATE WITH-HOLDING	LIST OTHER		
				HOURS WORKED EACH DAY																
												$ Base Rate	1. $ 2. $ 3. $							
												$ Cash Fringe	4. $ 5. $ 6. $							
												$ Base Rate	1. $ 2. $ 3. $							
												$ Cash Fringe	4. $ 5. $ 6. $							
												$ Base Rate	1. $ 2. $ 3. $							
												$ Cash Fringe	4. $ 5. $ 6. $							
												$ Base Rate	1. $ 2. $ 3. $							
												$ Cash Fringe	4. $ 5. $ 6. $							
												$ Base Rate	1. $ 2. $ 3. $							
												$ Cash Fringe	4. $ 5. $ 6. $							

*IF REQUIRED

12/9/2013
WWS-CP2

NOTICE: THIS PAGE MUST BE ACCOMPANIED BY A COVER PAGE (FORM # WWS-CP1)

[New] In accordance with Section 31-53b(a) of the C.G.S. each contractor shall provide a copy of the OSHA 10 Hour Construction Safety and Health Card for each employee, to be attached to the first certified payroll on the project.

In accordance with Connecticut General Statutes, 31-53
Certified Payrolls with a statement of compliance
shall be submitted monthly to the contracting agency.

PAYROLL CERTIFICATION FOR PUBLIC WORKS PROJECTS

WEEKLY PAYROLL

Connecticut Department of Labor
Wage and Workplace Standards Division
200 Folly Brook Blvd.
Wethersfield, CT 06109

CONTRACTOR NAME AND ADDRESS:
Landon Corporation, 15 Connecticut Avenue, Northford, CT 06472

SUBCONTRACTOR NAME & ADDRESS
XYZ Corporation
2 Main Street
Yantic, CT 06389

WORKER'S COMPENSATION INSURANCE CARRIER
Travelers Insurance Company
POLICY # #BAC8888928
EFFECTIVE DATE: 1/1/09
EXPIRATION DATE: 12/31/09

PAYROLL NUMBER: 1
Week-Ending Date: 9/26/09
PROJECT NAME & ADDRESS: DOT 105-296, Route 82

PERSON/WORKER, ADDRESS and SECTION	APPR RATE %	MALE/ FEMALE AND RACE*	WORK CLASSIFICATION / Trade License Type & Number - OSHA 10 Certification Number	DAY AND DATE: S	M	T	W	TH	F	S	Total ST Hours / Total O/T Hours	BASE HOURLY RATE / TOTAL FRINGE BENEFIT PLAN CASH	TYPE OF FRINGE BENEFITS Per Hour 1 through 6 (see back)	GROSS PAY FOR ALL WORK PERFORMED THIS WEEK	TOTAL DEDUCTIONS: FICA	FEDERAL WITH-HOLDING	STATE WITH-HOLDING	LIST OTHER	GROSS PAY FOR THIS PREVAILING RATE JOB	CHECK # AND NET PAY
				20	21	22	23	24	25	26										
				HOURS WORKED EACH DAY																
Robert Craft 81 Maple Street Willimantic, CT 06226		M/C	Electrical Lineman E-1 1234567 Owner OSHA 123456		8	8	8	8	8		S-TIME 40 O-TIME	$ 30.75 Base Rate $ 8.82 Cash Fringe	1. $ 5.80 2. $ 3. $ 2.01 4. $ 5. $ 6. $	$1,582.80				P-xxxx	$1,582.80	#123 $ xxx.xx
Ronald Jones 212 Elm Street Norwich, CT 06360	65%	M/B	Electrical Apprentice OSHA 234567		8	8	8	8	8		S-TIME 40 O-TIME	$ 19.99 Base Rate $ 16.63 Cash Fringe	1. $ 2. $ 3. $ 4. $ 5. $ 6. $	$1,464.80	xx.xx	xxx.xx	xx.xx	G-xxx	$1,464.80	#124 $xxx.xx
Franklin T. Smith 234 Washington Rd. New London, CT 06320 SECTION B		M/H	Project Manager			8					S-TIME 8 O-TIME	$ Base Rate $ Cash Fringe	1. $ 2. $ 3. $ 4. $ 5. $ 6. $	$1,500.00	xx.xx	xx.xx	xx.xx	M-xx.x		#125 xxx.xx
											S-TIME O-TIME	$ Base Rate $ Cash Fringe	1. $ 2. $ 3. $ 4. $ 5. $ 6. $							

7/13/2009
WWS-CP1

*IF REQUIRED

*SEE REVERSE SIDE

PAGE NUMBER 1 OF 2

OSHA 10 ~ATTACH CARD TO 1ST CERTIFIED PAYROLL

***FRINGE BENEFITS EXPLANATION (P):**

Bona fide benefits paid to approved plans, funds or programs, except those required by Federal or State Law (unemployment tax, worker's compensation, income taxes, etc.).

Please specify the type of benefits provided:

1) Medical or hospital care Blue Cross 4) Disability _____

2) Pension or retirement _____ 5) Vacation, holiday _____

3) Life Insurance Utopia 6) Other (please specify) _____

CERTIFIED STATEMENT OF COMPLIANCE

For the week ending date of 9/26/09,

I, Robert Craft of XYZ Corporation, (hereafter known as

Employer) in my capacity as Owner (title) do hereby certify and state:

Section A:

1. All persons employed on said project have been paid the full weekly wages earned by them during the week in accordance with Connecticut General Statutes, section 31-53, as amended. Further, I hereby certify and state the following:

a) The records submitted are true and accurate;

b) The rate of wages paid to each mechanic, laborer or workman and the amount of payment or contributions paid or payable on behalf of each such employee to any employee welfare fund, as defined in Connecticut General Statutes, section 31-53 (h), are not less than the prevailing rate of wages and the amount of payment or contributions paid or payable on behalf of each such employee to any employee welfare fund, as determined by the Labor Commissioner pursuant to subsection Connecticut General Statutes, section 31-53 (d), and said wages and benefits are not less than those which may also be required by contract;

c) The Employer has complied with all of the provisions in Connecticut General Statutes, section 31-53 (and Section 31-54 if applicable for state highway construction);

d) Each such employee of the Employer is covered by a worker's compensation insurance policy for the duration of his employment which proof of coverage has been provided to the contracting agency;

e) The Employer does not receive kickbacks, which means any money, fee, commission, credit, gift, gratuity, thing of value, or compensation of any kind which is provided directly or indirectly, to any prime contractor, prime contractor employee, subcontractor, or subcontractor employee for the purpose of improperly obtaining or rewarding favorable treatment in connection with a prime contract or in connection with a prime contractor in connection with a subcontractor relating to a prime contractor; and

f) The Employer is aware that filing a certified payroll which he knows to be false is a class D felony for which the employer may be fined up to five thousand dollars, imprisoned for up to five years or both.

2. OSHA~The employer shall affix a copy of the construction safety course, program or training completion document to the certified payroll required to be submitted to the contracting agency for this project on which such employee's name first appears.

Robert Craft (Signature) owner (Title) 10/2/09 Submitted on (Date)

Section B: Applies to CONNDOT Projects ONLY

That pursuant to CONNDOT contract requirements for reporting purposes only, all employees listed under Section B who performed work on this project are not covered under the prevailing wage requirements defined in Connecticut General Statutes Section 31-53.

Robert Craft (Signature) owner (Title) 10/2/09 Submitted on (Date)

Note: CTDOL will assume all hours worked were performed under Section A unless clearly delineated as Section B WWS-CP1 as such. Should an employee perform work under both Section A and Section B, the hours worked and wages paid must be segregated for reporting purposes.

*****THIS IS A PUBLIC DOCUMENT*****

*****DO NOT INCLUDE SOCIAL SECURITY NUMBERS*****

Connecticut Department of Labor
Wage and Workplace Standards Division
FOOTNOTES

⇨ Please Note: If the "Benefits" listed on the schedule for the following occupations includes a letter(s) (+ a or + a+b for instance), refer to the information below.

Benefits to be paid at the appropriate prevailing wage rate for the listed occupation.

If the "Benefits" section for the occupation lists only a dollar amount, disregard the information below.

Bricklayers, Cement Masons, Cement Finishers, Concrete Finishers, Stone Masons
(Building Construction) and
(Residential- Hartford, Middlesex, New Haven, New London and Tolland Counties)

a. Paid Holiday: Employees shall receive 4 hours for Christmas Eve holiday provided the employee works the regularly scheduled day before and after the holiday. Employers may schedule work on Christmas Eve and employees shall receive pay for actual hours worked in addition to holiday pay.

Elevator Constructors: Mechanics

a. Paid Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Veterans' Day, Thanksgiving Day, Christmas Day, plus the Friday after Thanksgiving.

b. Vacation: Employer contributes 8% of basic hourly rate for 5 years or more of service or 6% of basic hourly rate for 6 months to 5 years of service as vacation pay credit.

Glaziers

a. Paid Holidays: Labor Day and Christmas Day.

Power Equipment Operators
(Heavy and Highway Construction & Building Construction)

a. Paid Holidays: New Year's Day, Good Friday, Memorial day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day, provided the employee works 3 days during the week in which the holiday falls, if scheduled, and if scheduled, the working day before and the working day after the holiday. Holidays falling on Saturday may be observed on Saturday, or if the employer so elects, on the preceding Friday.

Ironworkers

a. Paid Holiday: Labor Day provided employee has been on the payroll for the 5 consecutive work days prior to Labor Day.

Laborers (Tunnel Construction)

a. Paid Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day and Christmas Day. No employee shall be eligible for holiday pay when he fails, without cause, to work the regular work day preceding the holiday or the regular work day following the holiday.

Roofers

a. Paid Holidays: July 4th, Labor Day, and Christmas Day provided the employee is employed 15 days prior to the holiday.

Sprinkler Fitters

a. Paid Holidays: Memorial Day, July 4th, Labor Day, Thanksgiving Day and Christmas Day, provided the employee has been in the employment of a contractor 20 working days prior to any such paid holiday.

Truck Drivers

(Heavy and Highway Construction & Building Construction)

a. Paid Holidays: New Year's Day, Memorial Day, Independence Day, Labor Day, Thanksgiving Day, Christmas day, and Good Friday, provided the employee has at least 31 calendar days of service and works the last scheduled day before and the first scheduled day after the holiday, unless excused.

Minimum Rates and Classifications for Building Construction

ID# : B 26300

Connecticut Department of Labor
Wage and Workplace Standards Division

By virtue of the authority vested in the Labor Commissioner under provisions of Section 31-53 of the General Statutes of Connecticut, as amended, the following are declared to be the prevailing rates and welfare payments and will apply only where the contract is advertised for bid within 20 days of the date on which the rates are established. Any contractor or subcontractor not obligated by agreement to pay to the welfare and pension fund shall pay this amount to each employee as part of his/her hourly wages.

Project Number: Project Town: Waterford
State# FAP#:

Project: Evergreen, Blue Hill And Old Norwich Road Pump Station HVAC Upgrades

CLASSIFICATION	Hourly Rate	Benefits
1a) Asbestos Worker/Insulator (Includes application of insulating materials, protective coverings, coatings, & finishes to all types of mechanical systems; application of firestopping material for wall openings & penetrations in walls, floors, ceilings	38.25	27.96
1b) Asbestos/Toxic Waste Removal Laborers: Asbestos removal and encapsulation (except its removal from mechanical systems which are not to be scrapped), toxic waste removers, blasters.**See Laborers Group 7**		
1c) Asbestos Worker/Heat and Frost Insulator	40.21	29.30

As of: **Friday, June 28, 2019**

2) Boilermaker	38.34	26.01
3a) Bricklayer, Cement Mason, Concrete Finisher (including caulking), Stone Masons	34.72	32.55 + a
3b) Tile Setter	34.90	25.87
3c) Terrazzo Mechanics and Marble Setters	31.69	22.35
3d) Tile, Marble & Terrazzo Finishers	26.70	21.75
3e) Plasterer	33.48	32.06

As of: **Friday, June 28, 2019**

Project: Evergreen, Blue Hill And Old Norwich Road Pump Station HVAC Upgrades

------LABORERS------

4) Group 1: Laborers (common or general), acetylene burners, concrete specialists, wrecking laborers, fire watchers.	30.75	20.84
4a) Group 2: Mortar mixers, plaster tender, power buggy operators, powdermen, fireproofer/mixer/nozzleman (Person running mixer and spraying fireproof only).	31.00	20.84
4b) Group 3: Jackhammer operators/pavement breaker, mason tender (brick), mason tender (cement/concrete), forklift operators and forklift operators (masonry).	31.25	20.84
4c) **Group 4: Pipelayers (Installation of water, storm drainage or sewage lines outside of the building line with P6, P7 license) (the pipelayer rate shall apply only to one or two employees of the total crew who primary task is to actually perform the mating of pipe sections) P6 and P7 rate is $26.80.	31.75	20.84
4d) Group 5: Air track operator, sand blaster and hydraulic drills.	31.50	20.84

As of: **Friday, June 28, 2019**

4e) Group 6: Blasters, nuclear and toxic waste removal.	33.75	20.84
4f) Group 7: Asbestos/lead removal and encapsulation (except it's removal from mechanical systems which are not to be scrapped).	31.75	20.84
4g) Group 8: Bottom men on open air caisson, cylindrical work and boring crew.	29.03	20.84
4h) Group 9: Top men on open air caisson, cylindrical work and boring crew.	28.49	20.84
4i) Group 10: Traffic Control Signalman	18.00	20.84
5) Carpenter, Acoustical Ceiling Installation, Soft Floor/Vinyl Floor/Carpet Laying, Metal Stud Installation, Form Work and Scaffold Building, Drywall Hanging, Modular-Furniture Systems Installers, Lathers, Piledrivers, Resilient Floor Layers.	33.53	25.66

As of: **Friday, June 28, 2019**

5a) Millwrights	34.04	26.09
6) Electrical Worker (including low voltage wiring) (Trade License required: E1,2 L-5,6 C-5,6 T-1,2 L-1,2 V-1,2,7,8,9)	38.50	28.61+3% of gross wage
7a) Elevator Mechanic (Trade License required: R-1,2,5,6)	53.37	33.705+a+b
-----LINE CONSTRUCTION----		
Groundman	26.50	6.5% + 9.00
Linemen/Cable Splicer	48.19	6.5% + 22.00

As of: **Friday, June 28, 2019**

8) Glazier (Trade License required: FG-1,2)	37.18	21.05 + a
9) Ironworker, Ornamental, Reinforcing, Structural, and Precast Concrete Erection	36.67	35.77
----OPERATORS----		
Group 1: Crane handling or erecting structural steel or stone, hoisting engineer 2 drums or over, front end loader (7 cubic yards or over), work boat 26 ft. and over and Tunnel Boring Machines. (Trade License Required)	40.97	24.80 + a
Group 2: Cranes (100 ton rate capacity and over); Excavator over 2 cubic yards; Piledriver ($3.00 premium when operator controls hammer); Bauer Drill/Caisson. (Trade License Required)	40.64	24.80 + a
Group 3: Excavator; Backhoe/Excavator under 2 cubic yards; Cranes (under 100 ton rated capacity), Grader/Blade; Master Mechanic; Hoisting Engineer (all types of equipment where a drum and cable are used to hoist or drag material regardless of motive power of operation), Rubber Tire Excavator (Drott-1085 or similar);Grader Operator; Bulldozer Fine Grade. (slopes, shaping, laser or GPS, etc.). (Trade License Required)	39.88	24.80 + a

As of: **Friday, June 28, 2019**

Group 4: Trenching Machines; Lighter Derrick; Concrete Finishing Machine; CMI Machine or Similar; Koehring Loader (Skooper).	39.48	24.80 + a
Group 5: Specialty Railroad Equipment; Asphalt Paver; Asphalt Reclaiming Machine; Line Grinder; Concrete Pumps; Drills with Self Contained Power Units; Boring Machine; Post Hole Digger; Auger; Pounder; Well Digger; Milling Machine (over 24" Mandrell)	38.87	24.80 + a
Group 5 continued: Side Boom; Combination Hoe and Loader; Directional Driller; Pile Testing Machine.	38.87	24.80 + a
Group 6: Front End Loader (3 up to 7 cubic yards); Bulldozer (rough grade dozer).	38.55	24.80 + a
Group 7: Asphalt roller, concrete saws and cutters (ride on types), vermeer concrete cutter, Stump Grinder; Scraper; Snooper; Skidder; Milling Machine (24" and under Mandrell).	38.20	24.80 + a
Group 8: Mechanic, grease truck operator, hydroblaster; barrier mover; power stone spreader; welding; work boat under 26 ft.; transfer machine.	37.79	24.80 + a

As of: **Friday, June 28, 2019**

Group 9: Front end loader (under 3 cubic yards), skid steer loader regardless of attachments, (Bobcat or Similar): forklift, power chipper; landscape equipment (including Hydroseeder).	37.34	24.80 + a
Group 10: Vibratory hammer; ice machine; diesel and air, hammer, etc.	35.24	24.80 + a
Group 11: Conveyor, earth roller, power pavement breaker (whiphammer), robot demolition equipment.	35.24	24.80 + a
Group 12: Wellpoint operator.	35.18	24.80 + a
Group 13: Compressor battery operator.	34.58	24.80 + a
Group 14: Elevator operator; tow motor operator (solid tire no rough terrain).	33.41	24.80 + a

As of: **Friday, June 28, 2019**

Group 15: Generator Operator; Compressor Operator; Pump Operator; Welding Machine Operator; Heater Operator.	32.99	24.80 + a
Group 16: Maintenance Engineer/Oiler.	32.32	24.80 + a
Group 17: Portable asphalt plant operator; portable crusher plant operator; portable concrete plant operator.	36.76	24.80 + a
Group 18: Power safety boat; vacuum truck; zim mixer; sweeper; (Minimum for any job requiring a CDL license).	34.26	24.80 + a
------PAINTERS (Including Drywall Finishing)------		
10a) Brush and Roller	33.62	21.05

As of: **Friday, June 28, 2019**

10b) Taping Only/Drywall Finishing	34.37	21.05
10c) Paperhanger and Red Label	34.12	21.05
10e) Blast and Spray	36.62	21.05
11) Plumber (excluding HVAC pipe installation) (Trade License required: P-1,2,6,7,8,9 J-1,2,3,4 SP-1,2)	43.62	32.06
12) Well Digger, Pile Testing Machine	37.26	24.05 + a
13) Roofer (composition)	36.70	19.85

As of: **Friday, June 28, 2019**

14) Roofer (slate & tile)	37.20	19.85	
15) Sheetmetal Worker (Trade License required for HVAC and Ductwork: SM-1,SM-2,SM-3,SM-4,SM-5,SM-6)	37.98	38.31	
16) Pipefitter (Including HVAC work) (Trade License required: S-1,2,3,4,5,6,7,8 B-1,2,3,4 D-1,2,3,4, G-1, G-2, G-8 & G-9)	43.62	32.06	
------TRUCK DRIVERS------			
17a) 2 Axle	29.51	24.52 + a	
17b) 3 Axle, 2 Axle Ready Mix	29.62	24.52 + a	

As of: **Friday, June 28, 2019**

17c) 3 Axle Ready Mix	29.67	24.52 + a
17d) 4 Axle, Heavy Duty Trailer up to 40 tons	29.72	24.52 + a
17e) 4 Axle Ready Mix	29.77	24.52 + a
17f) Heavy Duty Trailer (40 Tons and Over)	29.98	24.52 + a
17g) Specialized Earth Moving Equipment (Other Than Conventional Type on-the-Road Trucks and Semi-Trailers, Including Euclids)	29.77	24.52 + a
18) Sprinkler Fitter (Trade License required: F-1,2,3,4)	43.92	15.84 + a

As of: **Friday, June 28, 2019**

19) Theatrical Stage Journeyman	25.76	7.34

Welders: Rate for craft to which welding is incidental.

**Note: Hazardous waste removal work receives additional $1.25 per hour for truck drivers.*

***Note: Hazardous waste premium $3.00 per hour over classified rate*

ALL Cranes: When crane operator is operating equipment that requires a fully licensed crane operator to operate he receives an extra $4.00 premium in addition to the hourly wage rate and benefit contributions:

1) Crane handling or erecting structural steel or stone; hoisting engineer (2 drums or over)

2) Cranes (100 ton rate capacity and over) Bauer Drill/Caisson

3) Cranes (under 100 ton rated capacity)

Crane with 150 ft. boom (including jib) - $1.50 extra
Crane with 200 ft. boom (including jib) - $2.50 extra
Crane with 250 ft. boom (including jib) - $5.00 extra
Crane with 300 ft. boom (including jib) - $7.00 extra
Crane with 400 ft. boom (including jib) - $10.00 extra

All classifications that indicate a percentage of the fringe benefits must be calculated at the percentage rate times the "base hourly rate".

Apprentices duly registered under the Commissioner of Labor's regulations on "Work Training Standards for Apprenticeship and Training Programs" Section 31-51-d-1 to 12, are allowed to be paid the appropriate percentage of the prevailing journeymen hourly base and the full fringe benefit rate, providing the work site ratio shall not be less than one full-time journeyperson instructing and supervising the work of each apprentice in a specific trade.

The Prevailing wage rates applicable to this project are subject to annual adjustments each July 1st for the duration of the project.

Each contractor shall pay the annual adjusted prevailing wage rate that is in effect each July 1st, as posted by the Department of Labor.

It is the contractor's responsibility to obtain the annual adjusted prevailing wage rate increases directly from the Department of Labor's website.

The annual adjustments will be posted on the Department of Labor's Web page: www.ct.gov/dol. For those without internet access, please contact the division listed below.

The Department of Labor will continue to issue the initial prevailing wage rate schedule to the Contracting Agency for the project.

All subsequent annual adjustments will be posted on our Web Site for contractor access.

Contracting Agencies are under no obligation pursuant to State labor law to pay any increase due to the annual adjustment provision.

As of: **Friday, June 28, 2019**

Project: Evergreen, Blue Hill And Old Norwich Road Pump Station HVAC Upgrades

Effective October 1, 2005 - Public Act 05-50: any person performing the work of any mechanic, laborer, or worker shall be paid prevailing wage

All Person who perform work ON SITE must be paid prevailing wage for the appropriate mechanic, laborer, or worker classification.

All certified payrolls must list the hours worked and wages paid to All Persons who perform work ON SITE regardless of their ownership i.e.: (Owners, Corporate Officers, LLC Members, Independent Contractors, et. al)

Reporting and payment of wages is required regardless of any contractual relationship alleged to exist between the contractor and such person.

~~Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clause (29 CFR 5.5 (a) (1) (ii)).

Please direct any questions which you may have pertaining to classification of work and payment of prevailing wages to the Wage and Workplace Standards Division, telephone (860)263-6790.

As of: **Friday, June 28, 2019**

SECTION 00839

WAIVER OF LIEN - MATERIALS AND LABOR

STATE OF _____

COUNTY OF _____

TO WHOM IT MAY CONCERN:

WHEREAS, _____ the undersigned _____ have been employed by _____ _____ to furnish labor and materials for the project known as _____.

NOW THEREFORE, KNOW YE, THAT WE, the undersigned, for good and valuable considerations do hereby waive and release any and all lien or right of lien on said above project and premises under the Law, in relation to Mechanics' Liens Law, on account of labor and materials, or both, furnished by the undersigned to or on account of the said contract for the said project and premises only so far as that portion of work which has been included in our requisition dated _____ and all prior requisitions.

THIS WAIVER AND RELEASE is being made to the undersigned in the amount of $_____ which sum the undersigned certifies to be the balance due the undersigned for all labor, materials or both, furnished by the undersigned to or on account of the said contract as included on his requisition dated _____.

GIVEN UNDER _____ hand and seal, the _____ day of _____, 20 __.

By: _____

_____

END OF SECTION

EJCDC
ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

SECTION 00840
WORK CHANGE DIRECTIVE

Work Change Directive No.

Date of Issuance:		Effective Date:	
Owner:	Waterford Utility Commission	Owner's Contract No.:	
Contractor:		Contractor's Project No.:	
Engineer:	Wright-Pierce	Engineer's Project No.:	
Project:	Pump Station HVAC Improvements	Contract Name:	

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

Description:

Attachments: [List documents supporting change]

Purpose for Work Change Directive:

Directive to proceed promptly with the Work described herein, prior to agreeing to changes on Contract Price and Contract Time, is issued due to: [check one or both of the following]

☐ Non-agreement on pricing of proposed change.

☐ Necessity to proceed for schedule or other Project reasons.

Estimated Change in Contract Price and Contract Times (non-binding, preliminary):

Contract Price $ [increase] [decrease].

Contract Time days [increase] [decrease].

Basis of estimated change in Contract Price:

☐ Lump Sum ☐ Unit Price

☐ Cost of the Work ☐ Other

RECOMMENDED:	AUTHORIZED BY:	RECEIVED:
By:	By:	By:
Engineer (Authorized Signature)	Owner (Authorized Signature)	Contractor (Authorized Signature)
Title:	Title:	Title:
Date:	Date:	Date:

Approved by Funding Agency (if applicable)

By: Date:

Title:

EJCDC
ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

SECTION 00842
CHANGE ORDER

Change Order No. _____

Date of Issuance:	Effective Date:
Owner: Waterford Utility Commission	Owner's Contract No.:
Contractor:	Contractor's Project No.:
Engineer: Wright-Pierce	Engineer's Project No.:
Project: Sewer Pump Station HVAC Improvements	Contract Name:

The Contract is modified as follows upon execution of this Change Order:

Description:

Attachments: [List documents supporting change]

CHANGE IN CONTRACT PRICE	CHANGE IN CONTRACT TIMES [note changes in Milestones if applicable]
Original Contract Price: $_____	Original Contract Times: Substantial Completion: _____ Ready for Final Payment: _____ days or dates
[Increase] [Decrease] from previously approved Change Orders No. __ to No. __: $_____	[Increase] [Decrease] from previously approved Change Orders No. __ to No. __: Substantial Completion: _____ Ready for Final Payment: _____ days
Contract Price prior to this Change Order: $_____	Contract Times prior to this Change Order: Substantial Completion: _____ Ready for Final Payment: _____ days or dates
[Increase] [Decrease] of this Change Order: $_____	[Increase] [Decrease] of this Change Order: Substantial Completion: _____ Ready for Final Payment: _____ days or dates
Contract Price incorporating this Change Order: $_____	Contract Times with all approved Change Orders: Substantial Completion: _____ Ready for Final Payment: _____ days or dates

RECOMMENDED:	ACCEPTED:	ACCEPTED:
By: _____	By: _____	By: _____
Engineer (if required)	Owner (Authorized Signature)	Contractor (Authorized Signature)
Title: _____	Title _____	Title _____
Date: _____	Date _____	Date _____

Approved by Funding Agency (if applicable)

By: _____ Date:

Title: _____

EJCDC
ENGINEERS JOINT CONTRACT DOCUMENTS COMMITTEE

Contractor's Application for Payment No.

	Application Period:	Application Date:
To (Owner):	From (Contractor):	Via (Engineer):
Project:	Contract:	
Owner's Contract No.:	Contractor's Project No.:	Engineer's Project No.:

Application For Payment

Change Order Summary

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

1. ORIGINAL CONTRACT PRICE	**$**
2. Net change by Change Orders	**$**
3. Current Contract Price (Line 1 ± 2)	**$**
4. TOTAL COMPLETED AND STORED TO DATE (Column F total on Progress Estimates)	**$**
5. RETAINAGE:	
a. X _____ Work Completed	**$**
b. X _____ Stored Material	**$**
c. Total Retainage (Line 5.a + Line 5.b)	**$**
6. AMOUNT ELIGIBLE TO DATE (Line 4 - Line 5.c)	**$**
7. LESS PREVIOUS PAYMENTS (Line 6 from prior Application)	**$**
8. AMOUNT DUE THIS APPLICATION	**$**
9. BALANCE TO FINISH, PLUS RETAINAGE (Column G total on Progress Estimates + Line 5.c above)	**$**

Contractor's Certification

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

Contractor Signature

By:	Date:

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

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

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

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

Approved by: _____ _____
Funding or Financing Entity (if applicable) (Date)

Progress Estimate - Lump Sum Work

Contractor's Application

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

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

Progress Estimate - Unit Price Work

Contractor's Application

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

Stored Material Summary

Contractor's Application

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

SECTION 01045

CUTTING, CORING AND PATCHING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included - This section establishes general requirements pertaining to cutting, excavating, coring, fitting, and patching of the Work required to:
   1. Make alterations to existing structures.
   2. Make the parts fit properly.
   3. Replace work not conforming to requirements of the Contract Documents.
   4. Contractor is responsible for all cutting, coring, and rough and finish patching. Contractor shall coordinate the work of any and all subcontracting trades performing the work.
   5. Contractor is responsible for reviewing with the Owner and Engineer and receiving permission to proceed prior to cutting and coring and patching.

B. Quality Assurance:
   1. Perform all cutting, coring and patching in strict accordance with pertinent requirements of these Specifications, and in the event no such requirements are determined, in conformance with the Engineer's written direction.

C. Submittals:
   1. Provide a shop drawing submittal to include the following information:
      a. Identification of coring and cutting subcontractor including: Company name, business address contact information, or if by Contractor indicated as such.
      b. List of type of coring and cutting equipment proposed to be used with equipment cuts of the equipment.
      c. Schedule indicating the: location of the core or cut, size and any potential obstructions or embedded conduits and wiring.
      d. Key plan indicating the location of anticipated cores and cuts.
   2. Request for the Engineer's consent:
      a. Prior to cutting which affects structural safety, submit written request to the Engineer for permission to proceed with cutting.
      b. Should conditions of the work, or schedule, indicate a required change of materials or methods for cutting and patching, so notify the Engineer and secure his written permission prior to proceeding.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials for replacement of work shall be equal to those of adjacent construction and shall comply with the pertinent sections of these Specifications.

B. Concrete and grout for rough patching shall be as specified in Division 3.

PART 3 - EXECUTION

3.1 CONDITIONS

A. Inspection:
   1. Inspect existing conditions, including elements subject to movement or damage during cutting, excavating, coring, backfilling, and patching.
   2. After uncovering the work, inspect conditions affecting installation of new work.

B. Discrepancies:
   1. If uncovered conditions are not as anticipated, immediately notify the Engineer and secure needed directions.
   2. Do not proceed in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 PREPARATION PRIOR TO CUTTING AND CORING

A. Provide all required protection including, but not necessarily limited to, shoring, bracing and support to maintain structural integrity of the work.

B. All cutting and coring shall be performed in such a manner as to limit the extent of patching.

C. All holes cut through concrete and masonry walls or slabs shall be core drilled unless otherwise approved. No structural members shall be cut without approval of the Engineer and all such cutting shall be done in a manner directed by him. No holes may be drilled in beams or other structural members without obtaining prior approval. All work shall be performed by mechanics skilled in this type of work.

D. If holes are cored through floor slabs they shall be drilled from below.

E. The Contractor shall determine from Owner's information, logical deduction and field testing if there are embedded electrical conduits, wiring or piping in the coring locations and shall readjust locations if possible to avoid coring through them. If concealed embedded conduit and piping are damaged, or severed, the coring contractor shall immediately notify the Contractor, Owner and RPR to determine impact of the damage and develop and implement a plan to repair the damage and reactive the lines.

F. If embedded concealed conduit, wiring or pipe is damaged or severed and all reasonable steps were taken by the Contractor to identify embedded items, and alternate routing was investigated, the repair work will be compensated by the Owner through a Change Order. If it was reasonable to expect an embedded item could have been present at the location, the Contractor shall repair at no additional cost to the Owner.

3.3 CORING

A. Coring shall be performed with an approved non-impact rotary tool with diamond core drills. Size of holes shall be suitable for pipe, conduit, sleeves, equipment or mechanical seals to be installed.

B. All equipment shall conform to OSHA standards and specifications pertaining to plugs, noise and fume pollution, wiring and maintenance.

C. Provide protection for existing equipment, utilities and critical areas against water or other damage caused by drilling operation.

D. Slurry or tailings resulting from coring operations shall be vacuumed or otherwise removed from the area following drilling. Slurry or tailings shall not be allowed to enter floor drains.
E. Work area (e.g., adjacent walls, floors, ceilings, pipes, conduits, etc.) shall be cleaned to remove splash residues from coring operation.

3.4 CUTTING

A. Cutting shall be performed with a concrete wall saw and diamond saw blades of proper size.
B. Provide for control of slurry generated by sawing operation on both sides of wall.
C. When cutting a reinforced concrete wall, the cutting shall be done so as not to damage bond between the concrete and reinforcing steel left in structure. Cut shall be made so that steel neither protrudes nor is recessed from face of the cut.
D. Adequate bracing of area to be cut shall be installed prior to start of cutting. Check area during sawing operations for partial cracking and provide additional bracing as required to prevent a partial release of cut area during sawing operations.
E. Provide equipment of adequate size to remove cut panel.
F. Slurry or tailings resulting from cutting operations shall be vacuumed or otherwise removed from the area following drilling. Slurry or tailings shall not be allowed to enter floor drains.
G. Work area (e.g., adjacent walls, floors, ceilings, pipes, conduits, etc.) shall be cleaned to remove splash residues from cutting operation.

3.5 PERFORMANCE

A. Perform all required excavating and backfilling as required under pertinent sections of these specifications. Perform cutting, coring and demolition by methods which will prevent damage to other portions of the work and will provide proper surfaces to receive installation of repair and/or new work. Perform fitting and adjustment of products to provide finished installation complying with the specified tolerances and finishes.
B. Coring or cutting which exposes cut surfaces of reinforcing steel or structural steel shall be coated. Coating shall be 10 mil (dry film thickness) applied in two 5 mil (dry film thickness) coats of a single component moisture cured coal tar urethane or two part coal tar epoxy corrosion barrier. Alternately the exposed steel can be cut back two inches from the surface and a non-shrink grout applied over the steel flush to the concrete core or cut surface.
C. Rough patching shall be such as to bring the cut or cored area flush with existing construction unless otherwise shown.
D. Finish patching shall match existing surfaces as approved.

END OF SECTION

SECTION 01050

COORDINATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Contractor is required to work in close proximity to Owner's existing facilities. The Contractor, under this Contract, will be responsible for coordinating construction activities with Owner to ensure that services, facilities, and safe working conditions are maintained.

B. Any damage to existing structures, equipment and property, accepted equipment or structures, and property; as a result of the Contractor's or his subcontractor's operations shall be made good by the Contractor at no additional cost to the Owner.

1.2 COORDINATION WITH OTHERS

A. Town of Waterford:

1. Contractor shall coordinate all work on Town property with Waterford Utility Commission personnel.
2. Contractor shall coordinate all activities that will interrupt wastewater flows with the Waterford Utility Commission.
3. The Contractor shall be responsible for coordinating and maintaining public services to all public and private properties.
4. Contractor shall coordinate access, egress, detours and traffic control, if required, at the site with the Waterford Police Department. The Contractor shall notify Waterford Police, Fire Department and Rescue Squad at least 24 hours in advance of any street closings or detours.

B. Eversource (Gas and Electric):

1. The Contractor shall be responsible for coordinating all work around Eversource facilities with Eversource and shall bear all costs of inspection requirements, temporary facilities relocation and other requirements.

C. Veolia Water:

1. The Contractor shall be responsible for coordinating the installation of all water service piping with the City of New London and Veolia Water.

D. Call Before You Dig (CBYD):

1. The Contractor shall be responsible for coordinating and contacting Call Before You Dig prior to the commencement of work.

E. The Contractor shall provide the Engineer and Owner a construction schedule indicating the times to perform the work required. The Contractor shall update the schedule when required and give the facility one week notice before the start of any work. The Contractor shall provide the facility personnel enough time to obtain materials and perform the work required of them. The Contractor shall communicate with the Engineer and Owner concerning updating the schedule, job progress, delay or early starts that affect the work, facility staffing, etc.

END OF SECTION

SECTION 01150

MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.1 DESCRIPTION

A. For lump sum items, payment shall be made to the Contractor in accordance with an accepted Progress Schedule and Schedule of Values on the basis of actual work completed.

1.2 SCOPE OF PAYMENT

A. Payments to the Contractor will be made for the actual quantities of the Contract items performed and accepted in accordance with the Contract Documents. Upon completion of the construction, if these actual quantities show either an increase or decrease from the quantities given in the Bid Form, the Contract unit prices will still prevail.

B. The Contractor shall accept in compensation, as herein provided, in full payment for furnishing all materials, labor, tools, equipment, and incidentals necessary to the completed work and for performing all work contemplated and embraced by the Contract; also for all loss or damage arising from the nature of the Work, or from the action of the elements, or from any unforeseen difficulties which may be encountered during the prosecution of the Work and until its final acceptance by the Engineer, and for all risks of every description connected with the prosecution of the work, except as provided herein, also for all expenses incurred in consequence of the suspension of the work as herein authorized.

C. The payment of any partial estimate or of any retained percentage except by and under the approved final invoice, in no way shall affect the obligation of the Contractor to repair or renew any defective parts of the construction or to be responsible for all damage due to such defects.

1.3 PAYMENT FOR INCREASED OR DECREASED QUANTITIES

A. When alterations in the quantities of work not requiring supplemental agreements, as hereinbefore provided for, are ordered and performed, the Contractor shall accept payment in full at the Contract price for the actual quantities of work done. No allowance will be made for anticipated profits. Increased or decreased work involving supplemental agreements will be paid for as stipulated in such agreements.

l.4 OMITTED ITEMS

A. Should any items contained in the bid form be found unnecessary for the proper completion of the work contracted, the Engineer may eliminate such items from the Contract, and such action shall in no way invalidate the Contract, and no allowance will be made for items so eliminated in making final payment to the Contractor.

l.5 PARTIAL PAYMENTS

A. Partial payments shall be made monthly as the work progresses. Partial payment shall be made subject to the provisions of the Agreement.

l.6 PAYMENT FOR MATERIAL DELIVERED

A. When requested by the Contractor and at the discretion of the Owner, payment may be made for all or part of the value of acceptable, non-perishable materials and equipment which are to be incorporated into bid items, have not been used, and have been delivered to the construction site or placed in storage places acceptable to the Owner.

B. No payment shall be made upon fuels, supplies, lumber, false work, or other materials, or on temporary structures or other work of any kind which are not a permanent part of the Contract.

1.7 FINAL PAYMENT

A. The Engineer will make, as soon as practicable after the entire completion of the project, a final quantity invoice of the amount of the Work performed and the value of such Work. Owner shall make final payments of the sum found due less retainages subject to the provisions of the Agreement.

l.8 INCIDENTAL WORK

A. Incidental work items for which separate payment is not made include (but are not limited to) the following items:
   1. Clearing, grubbing and stripping
   2. Dust control
   3. Dewatering
   4. Clean-up
   5. Erosion and sedimentation control
   6. Loam, seeding, grading, liming, fertilization, mulching, and watering.
   7. Restoration of property, and replacement of fences, curbs, structures and other minor items disturbed by the construction activities.
   8. Coordination with the Owner, Utilities and others, including related inspection cost (refer to Section 01050)
   9. Utility crossings and relocations, unless payment is otherwise made
   10. Trench boxes, steel and/or wood sheeting as required, including that left in place
   11. Project record documents
   12. Materials testing
   13. Construction schedules, bonds, insurance, shop drawings, warranties, guarantees, certifications, and other submittals required by the Contract Documents
   14. Temporary utilities for construction and to maintain existing service during construction

15. Quality assurance testing
16. Temporary construction and other facilities not to be permanently incorporated into the Work necessary for construction sequencing and maintenance of operations
17. Weather protection
18. Permits not otherwise paid for or provided by the Owner
19. Visits to the Project site or elsewhere by personnel or agents of the Contractor, including manufacturer's representatives, as may be required.
20. On-site and other facilities acceptable to Engineer for the storage of materials, supplies and equipment to be incorporated into the Work
21. Mobilization/demobilization.
22. Test pits to determine existing utility locations, soils conditions, and as required to complete the project.
23. Pavement Markings
24. Removal of Existing Pavement
25. Temporary Pavement
26. Earthwork (except ledge)
27. Maintenance of all existing sewer flows, repair of existing sewer pipes, and bypass pumping.
28. Pre-Construction photographs.
29. Traffic Control and Project Signage
30. Minor Items--such as relocation of sign posts, guard rails, rock wall, mail boxes, curbs, traffic loop detectors, pavement markings, etc., damaged as a result of construction activities.
31. Removal and disposal of existing sanitary sewer structures and pipe as and where indicated on the drawings.
32. Final cleaning.
33. Miscellaneous demolition required by the construction.

1.9 DESCRIPTION OF PAY ITEMS

A. The following sections describe the measurement of and payment for the work to be done under the respective items listed in the Bid Form.

B. Each unit or lump-sum price stated in the Bid Form shall constitute full compensation, as herein specified, for each item of the work completed.

(1) Old Norwich Road Pump Station HVAC/Electrical Improvements Complete

A. Method of Measurement: Lump Sum.

B. Basis of Payment:

1. Said lump sum price shall constitute full compensation for furnishing all labor, materials, tools, and equipment necessary for the HVAC and Electrical Improvements at the Old Norwich Road Sewer Pump Station, complete as shown on the drawings.

(2) Evergreen Avenue Pump Station HVAC/Electrical Improvements Complete

A. Method of Measurement: Lump Sum.

B. Basis of Payment:

2. Said lump sum price shall constitute full compensation for furnishing all labor, materials, tools, and equipment necessary for the HVAC and Electrical Improvements at the Evergreen Avenue Sewer Pump Station, complete as shown on the drawings.

(3) Blue Hills Pump Station HVAC/Electrical Improvements Complete

A. Method of Measurement: Lump Sum.

B. Basis of Payment:

3. Said lump sum price shall constitute full compensation for furnishing all labor, materials, tools, and equipment necessary for the HVAC and Electrical Improvements at the Blue Hills Sewer Pump Station, complete as shown on the drawings.

(4) Owners System Integrator Allowance

A. Method of Measurement:

1. Cash Allowance for SCADA integration services. Integrator shall be selected by the Owner.
2. System Integrator shall provide all required programming to tie the new equipment into the existing control/SCADA system as determined necessary. All costs associated with field conduit and wiring, field testing shall be included in Item 1 and as shown on the drawings.

B. Basis of Payment:

1. Payment shall be in accordance with the Schedule of Values and progress of the work.
2. Adjustment to the final cost for this Item, if necessary, will be made based on invoices for the work provided with no mark-up. Owner will assist Contractor in establishing any adjustments to this item.

(5) Utility Service Allowance (Electric/Gas)

A. Method of Measurement:

1. Cash Allowance for electrical and gas utility services.

B. Basis of Payment:

1. Payment shall be made based on utility invoices and the Schedule of Values.
2. Adjustment to the final cost for this Item, if necessary, will be made based on invoices for the work provided with no mark-up. Owner will assist Contractor in establishing any adjustments to this item.

END OF SECTION

SECTION 01200

PROJECT MEETINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: To enable orderly review during progress of the work, and to provide for systematic discussion of problems, the Engineer will conduct project meetings throughout the construction period.

B. Related work described elsewhere: The Contractor's relations with his subcontractors and materials suppliers and discussions relative thereto, are the Contractor's responsibility and are not part of project meetings content.

1.2 QUALITY ASSURANCE

A. Persons designated by the Contractor to attend and participate in the project meetings shall have all required authority to commit the Contractor to solutions agreed upon in the project meetings.

1.3 SUBMITTALS

A. Agenda items: To the maximum extent practicable, advise the Engineer at least 24 hours in advance of project meetings regarding all items to be added to the agenda.

B. Minutes: The Engineer will compile minutes of each project meeting and will furnish a copy to the Contractor. The Contractor may make and distribute such other copies as he wishes.

PART 2 - PRODUCTS

(No products are required in this Section.)

PART 3 - EXECUTION

3.1 MEETING SCHEDULE

A. Except as noted below for Preconstruction Meeting, project meetings will be held monthly. Coordinate as necessary to establish mutually acceptable schedule for meetings.

3.2 MEETING LOCATION

A. To the maximum extent practicable, meetings will be held at the job site or at the Office of the Waterford Utility Commission.

3.3 PRECONSTRUCTION MEETING

A. Preconstruction meeting will be scheduled within twenty days after the Effective Date of the Agreement, but before the Contractor starts work at the site. Provide attendance by authorized representatives of the Contractor and all major subcontractors. The Engineer will advise other interested parties and request their attendance.

B. Minimum agenda: Distribute data on, and discuss:
   1. Identification of key project personnel for Owner, Engineer, Contractor, funding/regulatory Agencies.
   2. Responsibilities of Owner, Engineer, Resident Project Representative, Contractor.
   3. Channels and procedures for communications.
   4. Construction schedule, including sequence of critical work.
   5. Easements, permits.
   6. Contract Documents, including distribution of required copies of original documents and revisions.
   7. Processing of Shop Drawings and other data submitted to the Engineer for review.
   8. Processing of field decisions and Change Orders.
   9. Rules and regulations governing performance of the Work, including funding/regulatory Agency requirements.
   10. Procedures for safety and first aid, security, quality control, housekeeping, and other related matters.

3.4 PROJECT MEETINGS

A. Attendance: To the maximum extent practicable, assign the same person or persons to represent the Contractor at project meetings throughout progress of the Work. The Superintendent shall attend. Subcontractors, materials suppliers, and others may be invited to attend those project meetings in which their aspects of the Work are involved.

B. Minimum agenda:
   1. Review, revise as necessary, and approved minutes of previous meeting.
   2. Review progress of the Work since last meeting, including status of submittals for approval.
   3. Review schedule of work to be accomplished prior to next meeting.
   4. Discuss monthly partial payment request.
   5. Review status of change order requests and Work Directive Changes.
   6. Identify problems which impede planned progress.
   7. Develop corrective measures and procedures to regain planned schedule.
   8. Complete other current business.

END OF SECTION

SECTION 01310

CONSTRUCTION SCHEDULES – SHORT FORM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Within ten (10) days after the effective date of the Agreement between Owner and Contractor submit to the Engineer an estimated progress schedule as specified herein.

B. Form of Schedules:
   1. Narrative: Completely describe the construction methods to be employed.
   2. Network Analysis System:
      a. Provide a separate horizontal schedule line for each trade or operation and show concurrent and preceding activities.
      b. Present in chronological order the beginning of each trade or operation showing duration and float time.
      c. Scale: Identify key dates and allow space for updating and revision.
   3. Mathematical Analysis:
      a. A mathematical analysis shall accompany the network diagram. A computer printout will be acceptable.
      b. Information shall be included on activity numbers, duration, early start, late start, etc. and float times.

C. Content of Schedules:
   1. Provide complete sequence of construction by activity:
      a. Shop Drawings, Project Data and Samples:
         i. Submittal dates.
         ii. Dates reviewed copies will be required.
      b. Decision dates for:
         i. Products specified by allowances.
         ii. Selection of finishes.
      c. Estimated product procurement and delivery dates.
      d. Dates for beginning and completion of each element of construction.
   2. Identify work of separate phases and logically grouped activities.
   3. Show the projected percentage of completion for each item of work as of the first day of each month.
   4. Provide separate sub-schedules, if requested by the Engineer, showing submittals, review times, procurement schedules, and delivery dates.

D. Updating:
   1. Show all changes occurring since previous submission.
   2. Indicate progress of each activity, show completion dates.
   3. Include:
      a. Major changes in scope.
      b. Activities modified since previous updating.
      c. Revised projections due to changes.
      d. Other identifiable changes.

4. Provide narrative report, including:
    a. Discussion of problem areas, including current and anticipated delay factors.
    b. Corrective action taken, or proposed.
    c. Description of revisions that may affect schedules.

1.2 SUBMITTALS

A. Submit updated schedules with each progress payment request.
B. Submit 4 copies of initial and updated schedules to the Engineer.

END OF SECTION

SECTION 01320

SAFETY AND HEALTH PLAN

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. The Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the work, as outlined herein. Within (10) days after the effective date of the Agreement between Owner and Contractor, submit to the Engineer a Safety and Health Plan as specified herein.
2. Contractor shall comply with all applicable Laws and Regulations related to the safety of persons or property, or for the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection.
3. Contractor shall designate a qualified and experienced safety representative (OSHA defined "Competent Person") at the site whose duties and responsibilities shall be the prevention of accidents and maintaining and supervising of safety precautions and programs, including a "Job Hazards Analysis".

B. Content of Safety and Health Plan:

1. Prepare complete safety and health plan in accordance with the requirements of CFR Title 29 Part 1926 - Safety and Health Regulations for Construction.
   a. Provide documentation that Contractor's hazardous communication program is up to date.
   b. Provide documentation that Contractor's safety training is up to date.
   c. Prepare a project specific Safety and Health Plan addressing construction safety issues, including but not limited to excavations, fall protection and egress, as well as provisions for construction in hazardous environmental conditions at the wastewater treatment facility. The hazardous environmental conditions at the wastewater treatment facility include, but are not limited to, confined space entry, electrically-classified spaces, and chemical storage and handling areas, to name a few.
2. Safety provisions for confined space entry shall follow General Industry Standard CFR Title 29 Part 1910.146 and will be incorporated into the Safety and Health Plan.
   a. The Owner has provided Table 1 at the end of this section listing confined space locations which may be encountered during the execution of this Contract. Spaces listed as Permit Required Confined Space may only be entered with a permit, alternate procedures (1910.146 (c) (5)), or reclassification to non-permit required confined space (1910.146 (c) (7)). The Contractor is required to perform a site evaluation to identify all

hazards and potential hazards in work areas whether included in Table 1 or not, prior to control of site.

b. The Contractor shall be responsible for all aspects of construction site safety including development of appropriate confined space entry procedures. The plan shall include, but not necessarily be limited to, the following:
   - Definitions
   - Confined Space Evaluations
   - Equipment Selection
   - Confined Space Entry Training Documentation
   - Permit Required Confined Space Entry Requirements
   - Testing (Monitoring) and Ventilation
   - Confined Space Entry Permit Form
   - Rescue and Emergency Procedures
   - Emergency Contact Information

c. The Contractor shall inform the Owner and Engineer's representative whenever work will be performed in a confined space and the permit space program that the Contractor will follow.

d. The Contractor shall inform the Owner and Engineer's representative of any hazards confronted or created during entry operations, either through a briefing or during the entry operation.

e. The Contractor will coordinate entry operations with the Owner when both Owner personnel and Contractor personnel will be working in or near permit spaces.

f. The Owner, Engineer, their representatives, independent testing laboratories and government agencies, when inspecting the site, shall be supplied by the Contractor proper safety equipment when entry into a confined space is required.

C. Updating:

1. Contractor shall be responsible for updating the Safety and Health Plan as appropriate throughout the course of the construction period.

1.2 SUBMITTALS

A. **Contractor shall be responsible for all aspects of construction site safety.** Provide 3 copies of the Contractor's site specific Safety and Health Plan to the Engineer. The Safety and Health Plan is provided for information only to inform the Owner, Engineer (and Resident Project Representative) of the project specific safety program requirements. The Contractor will overview the plan with the Owner (and staff), Engineer (and Resident Project Representative) at the beginning of the project, and subsequently when the safety plan is updated.

B. Provide updated Safety and Health Plans as necessary during the course of the project.

C. Contractor's most current Safety and Health Plan shall be available at the construction site throughout the construction project.

1.3 ON-SITE COORDINATION MEETINGS

A. Contractor shall review key aspects of Safety and Health Plan at the Pre-Construction Meeting, and subsequent on-site safety informational meeting.

B. Contractor shall report to Engineer and Owner at each progress meeting concerning compliance with the Safety and Health Plan for the most recent construction period and new considerations and requirements for the upcoming period.

C. Contractor shall hold weekly on-site coordination meetings with Resident Project Representative and Owner to ensure that Owner's staff is aware of key Safety and Health Plan requirements of the current phase of construction.

1.4 SITE-SPECIFIC INFORMATION

A. Refer to Table 1 below.

TABLE 1
CONFINED SPACE LISTING

Confined Space Location	Hazard Description
Example: Sewer Manholes	Possible lack of oxygen or presence of explosive or hazardous gases - Hydrogen Sulfide.

Note: This list has been provided by the Owner based upon their knowledge of the site and may not include all site hazards. Its intent is to aid the Contractor in determining the magnitude of effort needed to fulfill the safety and health requirements of this Contract.

END OF SECTION

SECTION 01340

SUBMITTALS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. Submit to the Engineer, Shop Drawings, Operation and Maintenance Manuals, Manufacturers' Certificates, Project Data, and Samples required by the Specification Sections.

B. Related Work Specified Elsewhere:
   1. Construction Schedules: Section 01310

1.2 SHOP DRAWINGS

A. Shop Drawings are required for each and every element of the work. Each shop drawing shall be assigned a number consisting of the Specification Section number followed by a dash and then a sequential number beginning with 01 (e.g., 16000-01) for purposes of easy identification. Resubmittals shall include an alphabetic suffix after the corresponding sequential number (e.g., 16000-01A).

B. Shop Drawings are generally defined as all fabrication and erection drawings, diagrams, brochures, schedules, bills of material, manufacturers data, spare parts lists, and other data prepared by the Contractor, his subcontractors, suppliers, or manufacturers which illustrate the manufacturer, fabrication, construction, and installation of the work, or a portion thereof.

C. The Contractor shall submit to the Engineer a pre-determined number of hardcopies of Shop Drawings and approved data (for Owner's, Engineer's and Field Representative's files), and one electronic Portable Document Format (PDF) transmitted using e-mail, File Transfer Protocol (FTP), or approved submittal sharing software. The Engineer shall return one hardcopy and electronic PDF to the Contractor for duplication and distribution to subcontractors, suppliers and manufacturers. All shop drawing comments will be summarized on the Submittal Review Form and must be retained with each submittal hardcopy and electronic PDF. Number of copies, mandatory hardcopy submissions for specific submittals, format, and transmission method will be finalized at Pre-Construction Meeting.

D. The Contractor shall provide a completed Contractor Submittal Certification Form (copy provided for Contractor's use at the end of this Specification Section) which shall be attached to every hardcopy and electronic PDF of each shop drawing. Shop Drawings shall show the principal dimensions, weight, structural and operating features, space required, clearances, type and/or brand of finish or shop coat, grease fittings, etc., depending on the subject of the drawing. When it is customary to do so, when the dimensions are of particular importance, or when so specified, the drawings shall be certified by the manufacturer or fabricator as correct for the work.

E. Shop Drawings shall be submitted as a complete package by specification section, unless otherwise reviewed and approved by the Engineer. It is the intent that all information, materials and samples associated with each specification section be included as a single submittal for the Engineer's review. Any deviation from this

requirement, such as submitting miscellaneous metals grouped by structure, shall be requested in writing with an anticipated shop drawing breakdown/schedule prior to any associated submittal.

F. The Contractor shall be responsible for the prompt and timely submittal of all shop and working drawings so that there shall be no delay to the work due to the absence of such drawings.

G. No material or equipment shall be purchased or fabricated especially for the Contract until the required shop and working drawings have been submitted as hereinabove provided and reviewed for conformance to the Contract requirements. All such materials and equipment and the work involved in their installation or incorporation into the Work shall then be as shown in and represented by said drawings.

H. Until the necessary review has been made, the Contractor shall not proceed with any portion of the work (such as the construction of foundations), the design or details of which are dependent upon the design or details of work, materials, equipment or other features for which review is required.

I. All shop and working drawings shall be submitted to the Engineer by and/or through the Contractor, who shall be responsible for obtaining shop and working drawings from his subcontractors and returning reviewed drawings to them. Hard copies of shop drawings shall be of standardized sizes to enable the Owner to maintain a permanent record of the submissions. Approved standard sizes shall be: (a) 24 inches by 36 inches; (b) 11 inches by 17 inches, and (c) 11 inches by 8-1/2 inches. Provision shall be made in preparing the shop drawings to provide a binding margin on the left hand side of the sheet. Shop drawings submitted other than as specified herein may be returned for resubmittal without being reviewed.

J. Only drawings which have been checked and corrected by the fabricator should be submitted to the Contractor by his subcontractors and vendors. Prior to submitting drawings to the Engineer, the Contractor shall check thoroughly all such drawings to satisfy himself that the subject matter thereof conforms to the Drawings and Specifications in all respects. All drawings which are correct shall be marked with the date, checker's name, and indication of the Contractor's approval, and then shall be submitted to the Engineer.

K. If a shop drawing shows any deviation from the Contract requirements, the Contractor shall make specific mention of the deviations in his letter of transmittal. Shop Drawings that contain significant deviations that are not brought to the attention of the Engineer may be subject to rejection.

L. Should the Contractor submit equipment that requires modifications to the structures, piping, electrical conduit, wires and appurtenances, layout, etc., detailed on the Drawings, he shall also submit details of the proposed modifications. If such equipment and modifications are accepted, the Contractor, at no additional cost to the Owner, shall do all work necessary to make such modifications.

M. A maximum of two submissions of each Shop Drawing will be reviewed, checked, and commented upon without charge to the Contractor. Any additional submissions which are ordered by the Engineer to fulfill the stipulations of the Drawings and Specifications, and which are required by virtue of the Contractor's neglect or failure to comply with the requirements of the Drawings and Specifications, or to

make those modifications and/or corrections ordered by the Engineer in the review of the first two submissions of each Shop Drawing, will be reviewed and checked as deemed necessary by the Engineer, and the cost of such review and checking, as determined by the Owner, and based upon Engineer's documentation of time and rates established for additional services in the Owner-Engineer Agreement for this Project, may be deducted from the Contractor to make all modifications and/or corrections as may be required by the Engineer in an accurate, complete, and timely fashion. Resubmittals for the sole purpose of providing written responses to review comments will not be considered a resubmittal counting towards the two submission limit.

1.3 SAMPLES

A. The Contractor shall submit samples when requested by the Engineer to establish conformance with the specifications, and as necessary to define color selections available.

1.4 OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall furnish the Engineer a predetermined number of hardcopies and 1 electronic PDF of a complete instruction manual for installation, operation and maintenance of each item specified (unless otherwise specified) transmitted using e-mail, File Transfer Protocol (FTP), Compact Disc (CD) or approved submittal sharing software. At least 3 months prior to the expected substantial completion date, the Contractor shall submit to the Engineer all manuals in accordance with the requirements specified herein.

B. Each manual shall be provided in a stand-alone binder or shall be suitable for insertion into a 3-ring binder. Include the General Contractor's and Manufacturer's representative's contact information on the front cover. O&M manuals must be appropriate for the project and customized for the project. If a Manufacturer's standard O&M manual is included in the submittal, all non-applicable content must be removed or crossed out.

C. Manuals shall include operating and maintenance information on all systems and pieces of equipment. The manual shall contain sufficient data to install, operate, maintain, repair and rebuild all components of the equipment, design data specific to the project. Descriptions of operation should include procedures for both normal and emergency operation. All information required by the Operations and Maintenance Manual Certification Form described herein and any additional information deemed necessary by the Owner and Engineer for proper installation, operation and maintenance. Also include model numbers and serial numbers, as well as rated capacities and motor data, where applicable.

D. Attached to every hardcopy and electronic PDF of each Operations and Maintenance Manual submitted, the Contractor shall provide a copy of the complete Operations and Maintenance Manual Certification Form (copy provided for the Contractor's use at the end of this Specification Section) signed by both the Contractor and the Manufacturer.

1.5 MANUFACTURER'S CERTIFICATES

A. Prior to accepting the installation, the Contractor shall submit manufacturer's certificates for each item specified.

B. Such manufacturer's certificates shall state that the equipment has been installed under either the continuous or periodic supervision of the manufacturer's authorized representative, that it has been adjusted and initially operated in the presence of the manufacturer's authorized representative, and that it is operating in accordance with the specified requirements, to the manufacturer's satisfaction. All costs for meeting this requirement shall be included in the Contractor's bid price.

1.6 SUBMISSION REQUIREMENTS

A. Accompany submittals with transmittal letter, containing:
   1. Date.
   2. Project title and number.
   3. Contractor's name and address.
   4. The sequential shop drawing number for each shop drawing, project data and sample submitted shall be:
      i. Specification Section number followed by a dash and then a sequential number beginning with 01 (e.g., 16000-01).
      ii. Under limited situations when additional different pieces of equipment are submitted under the same specification section, those submittals shall be numbered sequentially (e.g. 05500-01, 05500-02, 05500-03, etc.).
      iii. Resubmittals shall include decimal point and an alphabetic suffix after the corresponding sequential number (e.g., 16000-01A).
      iv. O&M submittals shall be numbered with the Specification Section number followed by a dash, the letters “OM”, another dash, and then a sequential number beginning with 01 (e.g. 16000-OM-01). Resubmittals of O&Ms shall include an alphabetic suffix after the corresponding sequential number (e.g., 16000-OM-01A).
   5. Notification of deviations from Contract Documents.
   6. Other pertinent data.

B. A completed Contractor Submittal Certification Form shall be attached to each hardcopy and electronic PDF of each shop drawing and must include:
   1. Project name
   2. Specification Section and sequential number with alphabet suffix for resubmittal
   3. Description
   4. Identification of deviations from Contract Documents.
   5. Contractor's stamp, initialed or signed, certifying review of the submittal, verification of field measurements and compliance with Contract Documents.
   6. Where specified or when requested by the Engineer, manufacturer's certification that equipment, accessories and shop painting meet or exceed the Specification requirements.
   7. Where specified, manufacturer's guarantee.

C. Requirements for Electronic Submittals:
   1. Each individual shop drawing or O&M submittal shall be contained in one

PDF.

2. The first page of the PDF shall be the Contractor Submittal Certification Form as described above.
3. Subject lines for e-mails transmitting PDF submissions and subsequent correspondence referring to specific submittals shall identify the submittal's Specification Section, sequential number, appropriate alphabet suffix for resubmittals, and a brief description (e.g. 16010-01-Electrical General).
3. The electronic PDF shall be **exactly** as submitted in the hardcopy and shall be transmitted using e-mail, File Transfer Protocol (FTP), or approved submittal sharing software.
4. PDF versions of 24x36 drawings shall be converted to 24 x 36 PDFs so as not to lose the clarity of the original drawing.
5. Electronic PDF submittals that are not submitted in accordance with the requirements stated above will not be reviewed by the Engineer.

1.7 RESUBMISSION REQUIREMENTS

A. Revise initial drawings as required and resubmit as specified for initial submittal.
B. Indicate on drawings any changes which have been made other than those required by Engineer. All renumbering of shop drawings, relabeling of individual pieces or assemblies or relocating of pieces or assemblies to other Drawings within the submittal shall be clearly brought to the attention of the Engineer.

1.8 ENGINEER'S REVIEW

A. The review of shop and working drawings hereunder will be general only, and nothing contained in this specification shall relieve, diminish or alter in any respect the responsibilities of the Contractor under the Contract Documents and in particular, the specific responsibility of the Contractor for details of design and dimensions necessary for proper fitting and construction of the work as required by the Contract and for achieving the result and performance specified thereunder.
B. The Engineer's review comments will be summarized on a Submittal Review Form, which includes an action code. A description of each action code is provided below.
    1. **No Exceptions Taken (Status 0 on shop drawing log)**. The shop drawing complies with the Contract Document requirements. No changes or further information are required. Where appropriate, the submittal review form will be used to alert the Contractor, Owner and Field personnel of remaining items within that specification section that still needs to be submitted.
    2. **Make Corrections Indicated (Status 1 on shop drawing log)**. The shop drawing complies with the Contract Document requirements except for minor changes, as indicated. Resubmittal is not required unless it is specifically called for; however, Engineer requires that all comments will be addressed by the Contractor, unless otherwise notified in writing prior to execution of the relevant work.
    3. **Conditional to Remarks (Status 2 on shop drawing log)**. The shop drawing potentially complies with the Contract Document requirements, contingent upon satisfactory resolution of review comments. Remarks will explicitly list

what information needs to be resubmitted. Resubmittal from the Contractor should include a cover letter or summary which indicates how each review comment has been addressed.

4. **Revise and Resubmit (Status 3 on shop drawing log)**. The shop drawing does not comply with the Contract Document requirement as submitted, but may with changes indicated and/or submission of additional information. The entire package must be resubmitted with the necessary information and a cover letter which indicates how each review comment has been addressed and where to find the information in the resubmittal.
5. **Rejected (Status 4 on shop drawing log)**. The shop drawing does not comply with the Contract Document requirements, for the reasons indicated in the remarks, and is unacceptable.
6. **In Review (Status 5 on shop drawing log)**. The shop drawing is currently under review.
7. **For Information Only (Status 6 on shop drawing log)**. The shop drawing review was informational only. No comments are provided.

CONTRACTOR SUBMITTAL CERTIFICATION FORM

PROJECT: _____ CONTRACTOR'S PROJ. NO: _____

CONTRACTOR: _____ ENGINEER'S PROJ. NO: _____

ENGINEER: _____

SHOP DRAWING NUMBER:	_____ SPECIFICATION SECTION OR DRAWING NO:	- _____ SEQUENTIAL NUMBER (& ALPHA SUFFIX FOR RESUBMITTAL)

DESCRIPTION: _____

MANUFACTURER: _____

The above referenced submittal has been reviewed by the undersigned and I/we certify that the material and/or equipment meets or exceeds the project specification requirements with

☐ NO DEVIATIONS

or

☐ A COMPLETE LIST OF DEVIATIONS AS FOLLOWS[a]:

_____
_____
_____
_____
_____

By: _____ By: _____

Contractor[b]

Manufacturer[c]

Date: _____ Date: _____

[a] Any deviations not brought to the attention of the Engineer for review and concurrence shall be the responsibility of the Contractor to correct, if so directed.

[b] Required on all submittals

[c] When required by specifications

General Contractor's Stamp

OPERATIONS AND MAINTENANCE MANUAL CERTIFICATION FORM

PROJECT: _____ CONTRACTOR'S PROJ. NO: _____

CONTRACTOR: _____ ENGINEER'S PROJ. NO: _____

ENGINEER: _____

O&M NUMBER: _____ - OM- _____

SPECIFICATION SECTION OR DRAWING NO: | SEQUENTIAL NUMBER (& ALPHA SUFFIX FOR RESUBMITTAL)

DESCRIPTION: _____

MANUFACTURER: _____

The above referenced operations and maintenance manual has been reviewed by the undersigned and I/we certify that the manual is customized as needed for this project, is suitable for mounting in a 3-ring binder, and contains the following items:

- ☐ Table of Contents
- ☐ Maintenance Schedule and Summary
- ☐ Lubrication Schedule
- ☐ Troubleshooting Information
- ☐ Warranty Information
- ☐ Rebuild Information for All Components/ Systems
- ☐ Startup, Operation, Shutdown Procedures
- ☐ Safety Procedures
- ☐ Shop Drawings corrected to As-Built Conditions
- ☐ Project-Related Design Data
- ☐ Wiring Diagrams
- ☐ Equipment Layout Drawings & Schematics
- ☐ Equipment Performance Curves
- ☐ Parts and Service Contact Information
- ☐ Manufacturer's Contact Information
- ☐ Emergency Operations Plan
- ☐ List of Part Numbers for all Components
- ☐ List of Spare Parts Supplied and Cost
- ☐ Other System Specific Information

By: _____ By: _____

Contractor[a] Manufacturer[b]

Date: _____ Date: _____

[a] Contact information shall include name, address and telephone number.
[b] Required on all Operation and Maintenance Manuals.
[c] When required by Specifications.

Page ___ of ___

General Contractor's Stamp

PROCESS EQUIPMENT MANUFACTURER SUBMITTAL CERTIFICATION
(Divisions 15)

Owner:_____ Date: _____

_____

Project:

_____

_____

Contractor: _____

_____

Equipment Manufacturer: _____

_____

_____

Equipment: _____

As an authorized representative of the equipment manufacturer, the undersigned certifies that the equipment listed above conforms to the requirements of Section 15. The undersigned authorized representative of the manufacturer further certifies that the equipment manufacturer or supplier has: reviewed the Construction Documents, the intended installation by the Contractor, and the intended functional and operational conditions; determined all conditions to be acceptable; and found no conditions which would cause the warranty to be void; or the equipment to function improperly, or not meet the performance requirements.

_____ _____
(Authorized Representative of the Manufacturer) (Date)

END OF SECTION

SECTION 01370

SCHEDULE OF VALUES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Extent of Work:

1. Provide a detailed breakdown of the agreed Contract Sum showing values allocated to each of the various parts of the Work, as specified herein and in other provisions of the Contract Documents. The breakdown shall divide the projects into its appropriate component parts together with a quantity and a unit price for each part such that the sum of the products of quantities and unit prices will equal the contract price for the item(s). Coordinate with the Engineer regarding the level of detail warranted for the project.

B. Related Work Specified Elsewhere:

1. Documents affecting work of this Section include, but are not necessarily limited to, General Conditions, and Sections of these Specifications.
2. Schedule of values is required under the General Conditions.
3. Schedule of values is required to be compatible with applications for progress payment.

1.2 QUALITY ASSURANCE

A. Use required means to assure arithmetical accuracy of the sums described.

B. When so required by the Engineer, provide copies of the subcontracts or other data acceptable to the Engineer substantiating the sums described.

1.3 SUBMITTALS

A. Prior to first application for payment, submit a proposed schedule of values to the Engineer.

1. Secure the Engineer's approval of the schedule of values prior to submitting first application for payment.

END OF SECTION

SECTION 01380

CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. Pre-Construction Record: Contractor shall utilize digital photographs and video to obtain a visual record of the project area; copies of same shall be given to the Engineer and Owner.
2. Notify Engineer at least three (3) working days prior to photographing or videoing the project area so Engineer may, at his option, observe.

1.2 QUALITY

A. Pre-Construction Record: Quality shall be such that the condition of existing pavement, curbing, driveway entrances, sidewalks, etc. can be readily determined.

1.3 SUBMITTAL OF PRINTS

A. Pre-Construction Record: Submit hard copy prints and electronic files on CD ROM, and video electronic files on DVD to the Engineer and Owner prior to any construction work.

B. The quality of the photos and video are subject to approval by the Engineer prior to the start of construction work in the areas shown by the photos.

END OF SECTION

SECTION 01400

QUALITY CONTROL

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

A. General Quality Control.
B. Workmanship.
C. Manufacturer's Instructions.
D. Manufacturer's Certificates.
E. Manufacturer's Field Services.

1.2 RELATED REQUIREMENTS

A. Section 01340 - Submittals: Submittal of Manufacturer's Instructions.

1.3 QUALITY CONTROL

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

1.4 WORKMANSHIP

A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.
B. Perform work by persons qualified to produce workmanship of specified quality.
C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking.

1.5 MANUFACTURERS' INSTRUCTIONS

A. Comply with instructions in full detail, including each step in sequence. Should instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

1.6 MANUFACTURERS' CERTIFICATES

A. When required by individual Specifications Section, submit manufacturer's certificate that products meet or exceed specified requirements.

1.7 MANUFACTURERS' FIELD SERVICES

A. When specified in respective Specification Sections, require supplier and/or manufacturer to provide qualified personnel to observe field conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment as applicable, and to make appropriate recommendations.
B. Representative shall submit written report to Engineer listing observations and recommendations.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 01710

PROJECT CLEANING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. Maintain premises and public properties free from accumulations of waste, debris, and rubbish, caused by operations.
2. At completion of work, remove waste materials, tools, equipment, machinery and surplus materials, and clean all sight-exposed surfaces. Leave project clean and ready for use.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Conduct cleaning and disposal operations in accordance with all applicable local and state laws, ordinances, and code requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.

B. Use cleaning materials only on surfaces recommended by cleaning material manufacturers.

PART 3 - EXECUTION

3.1 PERFORMANCE

A. Cleaning During Construction:

1. Execute cleaning operations to ensure that buildings, grounds, and public properties are maintained free from accumulations of waste materials and rubbish.
2. Entirely remove and dispose of material or debris during the progress of the work that has washed into or has been placed in watercourses, ditches, gutters, drains, catch basins, or elsewhere as a result of the Contractor's operations.
3. Wet down dry materials and rubbish to lay dust and prevent blowing dust.
4. At reasonable intervals during the progress of work, clean the site and dispose of waste materials, debris, and rubbish.
5. Clean interiors of buildings, when applicable, prior to finish painting, and continue to clean on an as-needed basis until buildings are ready for occupancy.
6. Handle materials in a controlled manner with as few handlings as possible. Do not drop or throw material from heights.
7. When applicable, schedule cleaning operations so that dust and other contaminants resulting from the cleaning process will not fall on wet, newly painted surfaces.

B. Control of Hazards:
   1. Store volatile wastes in covered metal containers, and remove from premises daily.
   2. Prevent accumulation of wastes which may create hazardous conditions.
   3. Provide adequate ventilation during use of volatile or noxious substances.

C. Disposal:
   1. Do not burn or bury rubbish and waste materials on project site.
   2. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner, in storm or sanitary drains.
   3. Do not dispose of wastes into streams or waterways.

D. Final Cleaning:
   1. Employ experienced workmen, or professional cleaners, for final cleaning.
   2. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials, from all sight-exposed interior and exterior finished surfaces.
   3. Repair, patch and touch up marred surfaces to specified finishes.
   4. Broom clean paved surfaces.
   5. Rake clean non-paved surfaces of the project site.
   6. Restore to their original condition those portions of the site not designated for alterations by the Contract Documents.

END OF SECTION

SECTION 01720

PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:
   1. Keep accurate record documents for all additions, demolition, changes of material or equipment (from that shown on the Drawings), variations in work, and any other additions or revisions to the Contract (via Change Order, Work Change Directive, Field Order or Clarification).

B. Related Work Specified Elsewhere:
   1. Shop Drawings, Project Data, and Samples are specified in "General Conditions" and Section 01340, Submittals.
   2. Electrical System Record Drawing requirements are outlined in Section 16010.

1.2 MAINTENANCE OF DOCUMENTS

A. Maintain at job site, one copy of:
   1. Contract Drawings
   2. Specifications
   3. Addenda
   4. Reviewed Shop Drawings
   5. Change Orders
   6. Any other modifications to the Contract
   7. Field Test Reports

B. Store documents in files and racks specifically identified for Record Drawing use, that are apart from documents used for construction.

C. File documents in a logical manner indexed for easy reference.

D. Maintain documents in clean, dry, legible condition.

E. Do not use record documents for construction purposes.

F. Make documents available at all times for inspection by the Engineer and Owner, and by the end of the project, transmit these documents to the Engineer.

G. Failure to maintain current records, as specified herein, shall be grounds for withholding additional retainage from monthly partial payment requests.

1.3 RECORDING

A. Label each document "PROJECT RECORD" in large high printed letters.

B. Keep record documents current and do not permanently conceal any work until required information has been recorded.

C. General Field Recording Issues:
   1. All swing ties shall be taken from existing, permanent features such as utility poles, corners of buildings and hydrants. Porches, sheds or other house additions shall be avoided as they could be torn down. A minimum of two swing ties shall be taken. Survey grade GPS coordinates are also acceptable.
   2. Stations shall be recorded to the nearest foot.

3. Inverts shall be recorded to the nearest hundredth of a foot.
4. Elevations shall be recorded to the nearest hundredth of a foot.
5. Building dimensions shall be recorded to the nearest 1/4".
6. Equipment and Piping shall be recorded to the nearest tenth of a foot, and the overall dimensions and layout of the equipment shall be adjusted to reflect the equipment provided.

D. Project Record Drawings - Legibly mark Contract Drawings to record existing utilities and actual construction of all work, including but not limited to the following (where applicable):
   1. Existing Utilities
      a. Water mains and services, water main gate valves, sewer mains and services, storm drains, culverts, steam lines, gas lines, tanks and other existing utilities encountered during construction must be accurately located and shown on the Drawings. In congested areas supplemental drawings or enlargements may be required.
      b. Show any existing utilities encountered in plan and profile and properly labeled showing size, material and type of utility. Ties shall be shown on plan. Utility shall be drawn to scale in section (horizontally and vertically) and an elevation shall be called out to the nearest hundredth of a foot.
      c. When existing utility lines are broken and repaired, ties shall be taken to these locations.
      d. If existing water lines are replaced or relocated, document the area involved and pipe materials, size, etc. in a note, and with ties.
   2. Manholes, Catch Basins, Valve Pits and other structures.
      a. Renumber structure stationing to reflect changes.
      b. Show ties to center of structure covers or hatches.
      c. In general, show inverts at center of structures. However, for manholes with drop structures, or steep channels (greater than 0.2' change on slope), show inverts at face of manhole.
      d. Show inverts for other structures at the face of the structure.
      e. Draw any new structures that are added on plan and profile.
      f. Show any field or office redesigns.
      g. Redraw plan if the structure's location is moved more than 5 feet in any direction. Note: It is important to show existing utilities, as outlined in Paragraph 1 above, especially if they were one reason for relocating the sewer, manholes and other structures.
      h. Redraw profile if inverts changed by more than 6 inches.
   3. Gravity Sewer Line
      a. Change sewer line slopes indicated on Drawings if inverts are changed.
      b. Draw any new gravity lines that are added on plan and profile.
      c. Show any field or office redesigns.
      d. Redraw the sewer line profile if manhole inverts are redrawn.
      e. Redraw the sewer line on plan corresponding to relocated manholes.
   4. Water Mains and Force Mains
      a. Show ties to the location of all valves, bends (horizontal and vertical), tees and other fittings. The use of thrust blocks shall be recorded.

b. Revise elevations indicated on the Drawings to reflect actual construction.

5. Ledge
   a. Ledge profiles shall be shown. Note whether the plotted ledge profile reflects undisturbed or expanded conditions.
6. Yard Piping and Buried Electrical Conduit
   a. Site piping and utilities shall be drawn to reflect the installed locations, with ties and elevation of all bends (horizontal and vertical).
   b. Show routing for electrical conduits and pull boxes, especially in close proximity to buildings and when the conduits change direction or cross process piping.
7. Roads
   a. Show centerline road profile and level spot elevations.
   b. Show pavement widths.
   c. On road cross sections, show the pavement cross slope.
   d. Show any deviations from the design plans.
8. Utilities
   a. When encountered, additional utilities (e.g., gas, cable, telephone, fiber optic, etc.) shall be indicated on the Record Drawings.
9. Equipment Systems and Piping
   a. Show any changes to equipment systems, whether interior or exterior, for process, HVAC, plumbing, instrumentation or electrical. If any dimensional changes were made in the field, the numerical change shall be made on the Drawing and be properly labeled. Update dimensions and elevations on Drawings. Record Drawings must reflect any equipment configuration and layout changes differing from that shown on the Drawings.
   b. Show any changes to piping systems, whether interior or exterior, for process, HVAC, plumbing and instrumentation. If any dimensional changes were made in the field, the numerical change shall be made on the Drawing and be properly labeled. Update dimensions and elevations on Drawings.

E. Specifications and Addenda - Legibly mark up each section to record:
   1. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
   2. Changes made by Change Order, Field Order, or other method.

1.4 SUBMITTALS

A. At the completion of the project, and prior to the release of retainage, deliver record documents to the Engineer.
   1. Record drawings shall be provided as a bound, red-line paper set.
   2. Record drawings shall be provided as a bound, red-line paper set and an electronic file (pdf format) consisting of a full scan of the bound paper set.
   3. Record drawings shall be provided as a bound paper set of computer generated drawings, an electronic file (pdf format) of the bound paper set, and electronic files in AutoCAD format. Ownership of the drawings and files shall pass to the Owner at the time of submittal.

4. Record drawings shall be provided as electronic files in ESRI GIS format. Ownership of the drawings and files shall pass to the Owner at the time of submittal.
5. If the Contractor provides alternate or substitute equipment that requires revised arrangements from the Bidding Documents, the Contractor shall provide supplemental record drawings of these items in AutoCAD format.

B. Accompany submittal with transmittal letter, in duplicate, containing:
1. Date, project title and number.
2. Contractor's name and address.
3. Title and number of each record document with certification that each document is completed and accurate.
4. Signature of Contractor, or his authorized representative.

C. Failure to supply all information on the Project Record Drawings as specified in Part 1.3 may result in withholding final completion and in non-approval of final payments of the Contract. If Contract Time has elapsed, this shall be grounds for imposing liquidated damages.

1.5 QUALITY ASSURANCE

A. All horizontal and vertical dimensions, swing-ties, and elevations shall be accurate to within one-tenth of a foot, unless greater accuracy is specified elsewhere in the Specifications (e.g., concrete elevations, weir elevations, etc.).

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 MAINTAINING AND PROVIDING RECORDS

A. Records shall be kept current as the work progresses.

B. Records shall be made available for review by the Owner, Engineer, Resident Project Representative and/or Funding Agency(s) upon request.

C. Records shall be kept current as the work progresses. Failure to maintain current records, as specified herein, shall be grounds for withholding additional retainage from monthly partial payment requests. Failure to provide records shall also be grounds for withholding of final payment and, if beyond contract time, shall be grounds for imposing liquidated damages.

3.2 AS-BUILT SURVEY PERFORMANCE

A. From established survey control, and construction baseline as shown on the drawings, conduct surveys of the project area during construction as needed to obtain information of buried and above ground items. Surveys shall include information outlined in Section 1.3.

B. Actual road alignments; walls; fence and guardrail; existing, new and relocated utility poles; traffic and warning sign locations; crosswalks, parking space and stop bar locations; retaining walls and foundations drains; all underground and overhead utility poles and lines within the project limits, including those installed on private property; all other new features and appurtenances and those existing features and appurtenances changed as a result of this project shall be included in the survey.

3.3 FORMAT FOR ELECTRONIC DELIVERABLES

A. AutoCAD digital survey data for the as-built survey shall include:

1. Copy of field notes and sketches of the survey.
2. Paper copy of description of layers.
3. Paper copy of base map.
4. Provide digital information on compact disk with paper copy printout; information shall be provided in .DWG format (AutoCAD 2011 or earlier). Data shall be provided in 3D format (northing, easting, elevation, or Y, X, Z).
5. Drawing scale: Minimum one inch = twenty feet.
6. Layering:
    a. Repetitive symbols made into blocks and defined on layer 0.
    b. All entities shall be drawn “by layer” as opposed to individual properties.
    c. Use one linetype and one color per layer as opposed to numerous colors/linetypes on a single layer.
    d. Preface each layer with the initials of the Survey company or Contractor (example, Survey Company: SC “layername”).
    e. Database text annotation will be coordinated so the text will be right-reading.
    f. Place text on separate layers.

END OF SECTION

SECTION 01800

EQUIPMENT STARTUP, CERTIFICATION AND OPERATOR TRAINING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. General: The work included in this Section includes startup of equipment, Certified Equipment Testing and Manufacturer provided Operator Training of the facility personnel in the proper operations and maintenance of the furnished equipment. This shall include all equipment provided for the project, regardless of specification Division, unless specifically noted otherwise. Clean, test and adjust each piece of equipment and/or system to the complete satisfaction of the Engineer.
2. One Year Service Call: In addition to the Manufacturer's installation and startup/testing services, the Contractor shall arrange for the Manufacturer to provide one additional service call of one 8 hour working day on site upon demand of the Owner for each type of equipment within the first year of operation (commencing upon date of Substantial Completion) at no additional cost to the Owner.
   a. Equipment Systems requiring one year of service call are as follows:

Specification Section	Equipment System
	None

General Definitions:

1. Equipment Startup shall be generally defined as the initial placing into operation of the equipment by representatives of the Contractor, any subcontractors directly responsible for the equipment provided, and the equipment Manufacturer.
2. Certified Equipment Testing shall generally be defined as the formal and scheduled demonstration of operations in accordance with the requirements of the Contract Documents. This formal demonstration shall be performed in the presence of the Engineer by representatives of the General Contractor, any Subcontractors directly responsible for the equipment provided, and the equipment Manufacturer.
3. Operator Training shall generally be defined as the formal and scheduled instruction of plant personnel and other Owner designated representatives in the proper operations of provided equipment, and in the techniques, methods, schedules, etc. associated with maintenance. This formal training shall be performed in the presence of the Engineer, by representatives of the Contractor, any subcontractors directly responsible for the equipment provided, and the equipment Manufacturer. Operator Training shall also include assistance to plant personnel by Manufacturer representatives during the initial operations of the equipment.

C. Related Work Specified Elsewhere:
   1. Plumbing and HVAC Systems are specified in Division 15.
   2. Electrical systems are specified in Division 16.

D. Submittals:
   1. A minimum of ten days prior to the Pre-Startup Meeting, Contractor shall provide a preliminary equipment start-up schedule and plan for the Certified Equipment Testing and the Operator Training for each piece of equipment to the Engineer for review. This preliminary plan will include a written outline description of the means and methods to be employed during the certified equipment test of each piece of equipment. The schedule and means and methods of testing will be discussed with the Engineer at the pre-startup meeting for acceptance.
   2. Submit the name(s) and resume(s) of the duly authorized representatives of the Manufacturer proposed for the project at least 30 days prior to the need for such services. The qualifications of duly authorized representatives of the Manufacturer are identified in Paragraph 1.2 below.

E. Schedules:
   1. Contractor shall provide Engineer with at least 72-hours' notice of his desire to perform Certified Equipment Testing and/or training to allow necessary coordination with Owner representatives. Contractor shall be responsible for any and all coordination necessary with the daily operations of the facility to accommodate his testing schedule. Actual date and time for testing and/or training will be the first mutually acceptable date and time available to all parties subsequent to receipt of the request.
   2. Operator Training may be conducted concurrently with the Certified Equipment Testing with prior approval of the Engineer. However, under no circumstances will conditions of the testing interfere with the ability of Owner's representatives to observe necessary features, to hear and understand instructions, or to ask questions. Under such conditions, and as deemed necessary by the Engineer, Operator Training will be conducted separately from, and subsequent to, the Certified Equipment Testing.

1.2 QUALITY ASSURANCE

A. Duly authorized representative of the Manufacturer shall meet the following criteria:
   1. A direct employee of the Manufacturer;
   2. Fluent in the English language;
   3. Has a minimum of 5 years of experience in the proper installation, adjustment, operation, testing, and startup of the specified model, including, but not limited to, equipment calibration, and other mechanical or electrical components of the equipment.
   4. Sales personnel, marketing personnel or local representatives will not be accepted as a duly authorized representative of the Manufacturer unless the Manufacturer has certified them accordingly.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.1 EQUIPMENT STARTUP

A. Equipment startup shall be performed by the authorized representative(s) of the Manufacturer as identified in the Submittals. Refer to Paragraph 1.1.D above.

B. The Equipment Startup shall be performed prior to Certified Equipment Testing and prior to Operator Training.

C. No form of energy shall be applied to any part of the system prior to receipt by the Engineer of a certified statement of approval of the installation from the Contractor. This certification shall contain a statement by an authorized representative of the equipment Manufacturer that the equipment is ready for testing, as outlined below.

D. As part of the equipment startup, the Contractor shall:

1. Verify that the equipment is installed properly and in accordance with Manufacturer's requirements and instructions, and as such, it is appropriate to apply power to the units in question.
2. Verify that all manual, automatic and safety control features of the equipment functions properly, including all alarm, activation and deactivation sequences.
3. Verify that the equipment can operate without excessive noise, vibration, overheating, overloading, jamming, etc. during normal operating conditions.
4. Check amperage draws on all power feeds with equipment running under normal operating conditions.

E. Each piece of equipment shall be tested sufficiently to ensure that all features required to be demonstrated and/or verified during the equipment certification testing are within acceptable limits. The startup shall not be considered complete until the unit is fully capable of passing the equipment certification testing.

F. Where multiple units are provided, each unit shall undergo startup procedures.

G. The duly authorized representative of the Manufacturer shall provide all specialty tools, specialty testing equipment and labor necessary for the start-up of the equipment.

H. The Contractor shall provide all power, chemical, tools, equipment, labor, water and fuel as required for startup.

1. The Contractor shall be responsible for all contacts and arrangements as necessary with the proper municipal departments and/or public utility companies to arrange for temporary and/or separate billing so that bills associated with testing and startup procedures can be easily identified.
2. Contacts and arrangements with the local power company shall include, but not be limited to, all arrangements as necessary so that peak power demands incurred during testing and startup procedures will not become a part of the permanent record for determining future power demand charges for the Owner.
3. All waste materials shall be disposed of by the Contractor in an environmentally acceptable manner at no additional cost to the Owner.

I. In the event of an unsuccessful equipment start-up, Manufacturer and Contractor shall make necessary alternations, adjustments, repairs and replacements and the equipment start-up shall be repeated.

J. The Manufacturer Representative’s shall fill out the Equipment Start-Up Certification form included at the end of this Section. Startup will not be considered complete until this form has been provided to the Engineer along with the Manufacturer

Representative's field report.

3.2 CERTIFIED EQUIPMENT TESTING

A. Certified Equipment Testing shall be performed after the equipment startup testing is completed and it has been verified that equipment functions in accordance with the requirements of the Contract Documents in all aspects. Certified Equipment Testing shall be performed by the authorized representative(s) of the Manufacturer as identified in the Submittals. Refer to Paragraph 1.1.D above.

B. Certified Equipment Testing shall not be scheduled concurrently with the equipment startup without the prior approval of the Engineer. In all cases, if the Engineer has arrived on-site for the scheduled Certified Equipment Testing and the equipment is not capable of demonstrating complete compliance with the Contract Documents, or if the Manufacturer's representative is not present, the Contractor shall be responsible for all costs to the Engineer associated with failed testing, including travel expenses. The importance of prior and proper equipment startup demonstrations to verify the requirements of the Certified Equipment Testing is stressed.

C. At a minimum during the Certified Equipment Testing, the Contractor shall demonstrate to the complete satisfaction of the Engineer the following:
    1. That the equipment is installed properly and in accordance with Manufacturer's requirements and instructions, and as such, it is appropriate to apply power to the units in question.
    2. That all manual, automatic and safety control features of the equipment functions properly, including all alarm, activation and deactivation sequences.
    3. That the equipment can operate without excessive noise, vibration, overheating, overloading, jamming, etc. during normal operating conditions.
    4. Amperage draws on all power feeds with equipment running under normal operating conditions.
    5. The noise level of equipment, drives and motors, unless otherwise noted, shall not exceed 90 dBA, as measured 3 feet from the unit under free field conditions.
        i. Each unit shall be monitored for compliance independently with other area equipment deactivated.
        ii. For monitoring, the equipment will be run under normal operation conditions.
        iii. Contractor shall provide certified proof of calibration for instrument utilized to measure noise level.
    1. Other specific requirements as outlined within the individual specifications sections.

D. Each piece of equipment shall be tested sufficiently to ensure that all features required to be demonstrated and/or verified are within acceptable limits.

E. Where multiple units are provided, each unit shall undergo equipment certification testing procedures individually and then with multiple units on-line to verify the total systems output capacity and performance.

F. The duly authorized representative of the Manufacturer shall provide all specialty tools, specialty testing equipment and labor necessary for the start-up and testing of the equipment.

G. The Contractor shall provide all power, chemical, equipment, labor, water and fuel as required for startup and testing.

H. All equipment provided on the project shall be demonstrated to function properly. Demonstration as a component of an overall system shall not relieve the Contractor of his responsibilities to demonstrate proper operation or verify specific requirements for each individual component.

I. Minimum Certified Equipment Testing Requirements for Blowers/Fans:
   1. During tests, observe and record pressure, unit rpm's and motor input. If multiple operational points are specified, compliance with all points must be sufficiently demonstrated.
   2. Fully demonstrate ability to operate at specified conditions without motor overload.
   3. Refer to Section Section 15600 and 15907, as applicable, for additional details.

J. Minimum Certified Equipment Testing Requirements for Instrumentation/Control Systems:
   1. All instruments shall be calibrated in the presence of the Engineer.
   2. All transmitters or direct-operated receivers shall be calibrated to impose input values representing zero percent, ten percent, and eighty percent of full scale.
   3. The inputs and outputs of devices, as appropriate, shall be connected to manometers for differential pressure devices, or compared to measured levels, rates or quantities, during calibration. The receiving devices shall be adjusted to read the calibrated output of the initial calibration.
   4. After placing each measuring system in service, an actual comparison of the measured variable versus readout shall be made. For each differential pressure based measuring system, a manometer shall be connected to the connections provided in the piping, tank, or other appropriate device. Each system shall meet the manufacturer's standard accuracy.
   5. Secondary functions, such as sequencing, timing features, alarm actuation and pacing shall be adjusted during initial calibration and demonstrated after the system is placed in service.
   6. Linkage or range adjustments shall be sealed by colored lacquer in the presence of the Engineer immediately following calibration.
   7. Process calibration, such as volumetric drawdown tests on flows and level measurements, shall be conducted on all measuring systems as requested by the Engineer. Once established as being within acceptable accuracy limits, future tests which require use of the measuring device to demonstrate system operations can utilize generation of mA signals to simulate level, flow or similar variable variations.

K. Minimum Certified Equipment Testing Requirements for Electrical Systems.
   1. Refer to Section 16620 and 16950.

L. In the event of an unsuccessful Certified Equipment Test, Manufacturer and Contractor shall make necessary alternations, adjustments, repairs and replacements and the equipment testing shall be repeated.

M. The Manufacturer Representative’s shall fill out the Equipment/System Testing Certification form included at the end of this Section. Certification Testing will not be considered complete until this form has been provided to the Engineer along with the Manufacturer representative field report.

3.3 OPERATOR TRAINING

A. Operator Training shall be performed by the authorized representative(s) of the Manufacturer as identified in the Submittals. Refer to Paragraph 1.1.D above.

B. Unless otherwise noted within the specific specification sections, provide minimum of one day (8-hour days, not including travel time) of combined training and operational assistance for plant operators for each piece of equipment in the proper operations of provided equipment, and in the techniques, methods, schedules, etc. associated with maintenance.

C. The level of the training and operational assistance provided shall be as required to ensure proper understanding of the equipment's operations, maintenance and warranty conditions. Should manufacturer require time in addition to the minimums indicated herein, or within the individual specification sections, to sufficiently detail the proper operations and maintenance of the equipment, it will be provided at no additional cost to Owner. Under absolutely no circumstances shall warrantees become void due to Owner's failure to follow operational and maintenance procedures which were not fully detailed and described to Owner's representatives during these sessions.

D. Refer to individual equipment specification sections for further requirements.

E. The manufacturer representative shall fill out the Equipment Training Certification form included within this Section. Training will not be considered complete until this form has been provided to the Engineer.

EQUIPMENT START-UP CERTIFICATION

Owner:_____ Date: _____

_____

Project:

_____

_____

Contractor: _____

Equipment Manufacturer: _____

_____

Equipment: _____

Specification Number: _____

As an authorized representative of the equipment manufacturer, the undersigned certifies that the equipment listed above conforms to the requirements of the Contract Documents. The undersigned authorized representative of the manufacturer further certifies that the equipment has been installed in accordance with the manufacturer's written instructions, that it is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.

_____ _____

(Authorized Representative of the Manufacturer) (Date)

_____ _____

(Contractor) (Date)

_____ _____

(Engineer) (Date)

** Attach Manufacturer Representative's Field Report **

EQUIPMENT TRAINING CERTIFICATION

Owner: _____ Date: _____

_____

Project:

_____

_____

Contractor: _____

Equipment Manufacturer: _____

_____

Equipment: _____

Specification Number: _____

1. I have trained the Owner's personnel in the proper operation and maintenance of the above equipment.

_____ _____
(Authorized Representative of the Manufacturer) (Date)

2. The personnel listed below attended the training session.

_____

_____

_____

_____ _____
(Owner's Representative) (Date)

3. Witnessed by: _____ _____
(Engineer) (Date)

CERTIFIED EQUIPMENT/SYSTEM TESTING FORM

Owner:_____ Date: _____

_____

Project:

_____

_____

Contractor: _____

Equipment Manufacturer: _____

_____

Equipment: _____

Specification Number: _____

This certifies that the entire equipment/system has met the requirements of Section 01800, 16950 and all other applicable requirements of the contract documents.

_____ _____
(Authorized Representative of the Manufacturer) (Date)

_____ _____
(Contractor) (Date)

_____ _____
(Engineer) (Date)

** Attach Manufacturer Representative's Field Report **

END OF SECTION

SECTION 02050

DEMOLITION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. The Contractor shall furnish all labor, materials, tools, equipment and apparatus necessary and shall do all work required to complete the demolition, removal, and alterations of existing facilities as indicated on the Drawings, as herein specified, and/or as directed by the Engineer.
2. Demolition and alteration work within occupied areas shall be accomplished with minimum interference to the occupants and to the plant which shall be in continuous operation during construction.
3. All equipment, piping, and other materials that are not to be relocated or to be returned to the Owner shall become the property of the Contractor and shall be disposed of by him, away from the site of the work and at his own expense.
4. All demolition or removal of existing structures, utilities, equipment, and appurtenances shall be accomplished without damaging the integrity of existing structures, equipment, and appurtenances to remain, to be salvaged for relocation or stored for future use.
5. Such items that are damaged shall be either repaired or replaced at the Contractor's expense to a condition at least equal to that which existed prior to the start of his work.
6. Unless otherwise indicated, all items labeled to be "removed", "demolished" or "remove/demolish" shall be removed and disposed of off site in accordance with all Local, State and Federal Regulations.

B. Related Work Specified Elsewhere: (When Applicable)

1. See Summary of Work, Section 01010.

1.2 JOB CONDITIONS

A. Condition of Structures:

1. The Owner assumes no responsibility for the actual condition of structures to be demolished.
2. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner as far as practicable. However, variations within the structures may occur due to Owner's removal and salvage operations prior to the start of demolition work (where applicable).

1.3 UTILITIES

A. Utility Locations:

1. Utility locations shown on the plans are approximate only, based on information supplied by the utility companies.

B. Coordination with Utilities:

1. The Contractor shall make all necessary arrangements and perform any necessary work to the satisfaction of affected utility companies and governmental divisions involved with the discontinuance or interruption of affected public utilities and services.

1.4 SUBMITTALS

A. Schedule - Demolition:
   1. Submit two (2) copies of proposed methods and operations of demolition to the Engineer for review prior to the start of work. Include in the schedule the coordination for shut-off, capping and continuation of utility services as required.
   2. Provide a detailed sequence of demolition and removal work to ensure the uninterrupted progress of the Owner's operations.

1.5 PROTECTIONS

A. Ensure the safe passage of persons around the area of demolition. Conduct operations to prevent injury to adjacent buildings, structures, other facilities and persons. Erect temporary, covered passageways as required by authorities having jurisdiction.
B. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement or collapse of structures to be demolished and adjacent facilities to remain.

1.6 DAMAGES

A. The Contractor shall promptly repair damages caused by demolition operations to adjacent facilities at no cost to the Owner.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 PERFORMANCE

A. Remove and dispose of non-salvageable material in accordance with all applicable local and state laws, ordinances and code requirements.
B. Dispose of material daily as it accumulates.
C. Carefully remove, store and protect from damage all materials to be salvaged.
E. Maintaining Traffic:
   1. Ensure minimum interference with roads, streets, driveways, sidewalks and adjacent facilities.
   2. Do not close or obstruct streets, sidewalks, alleys or passageways without permission from authorities having jurisdiction.
F. Architectural, structural, mechanical, process and electrical demolition, removal and alteration are indicated in the corresponding sections.
G. Mechanical/Process Demolition:

1. Mechanical/Process demolition in general shall consist of the dismantling and removal of existing piping, tanks, pumps, motors, equipment and other appurtenances as specified, and indicated on the Drawings.
2. It shall also include, where necessary, the cutting of existing piping for the purpose of making connections thereto.
3. Piping not indicated to be removed but which may interfere with construction shall be removed to the nearest solid support, capped and left in place. Where piping that is to be removed passes through the wall of existing structures, it shall be cut off and properly capped on each side of the wall.
4. When piping is to be altered or removed underground, the remaining piping shall be properly capped or plugged.
5. Abandoned underground piping shall be left in place unless it interferes with new structures or unless otherwise noted on the Drawings.

H. Salvage:
1. Salvaged items shall be stored on site for the Owner in an acceptable location and manner.

I. Demolition Sequence:
1. The demolition sequence is to conform the reviewed and approved project schedule, and restrictions outlined in Section 01310, Construction Schedules.

J. Pest Control:
1. Provide pest control when needed or when directed by the Engineer.
2. Exterminate and prevent migration of rodents to adjoining buildings in accordance with the requirements of the state or local health department.

END OF SECTION

SECTION 09900

PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes surface preparation and field painting of the following surfaces of new items unless specified elsewhere to be prefinished. This includes pre-primed surfaces.
   1. Painting of all exposed interior surfaces.
   2. Painting of all exposed exterior surfaces.

B. Painting of existing items:
   1. Existing floors, walls and ceilings exposed during the improvements shall be prepared and touched up to match existing finishes.
   2. Any other existing items on the drawings or in this specification indicated to be painted will receive surface preparation and field painting.

C. This Section also includes:
   1. Piping runs above finished ceilings shall be considered exposed and shall be painted.
   2. Back prime, with specified interior first coat, all surfaces of wood finish and trim which will be concealed after installation.
   3. All surfaces of ferrous metal fabrications built into concrete and masonry shall be shop primed or receive a primer coat in accordance with this section. All surfaces exposed to view shall receive intermediate and finish coats.
   4. Paint all items modified or relocated in the existing facility.

D. Definitions:
   1. Exposed interior surfaces shall be non-submerged surfaces exposed to view that are enclosed and/or protected in such a manner that they cannot be exposed to UV light or weather conditions.

1.2 RELATED SECTIONS

A. Section 01340 - Submittals
B. Division 15 - Mechanical
C. Division 16 - Electrical

1.3 REFERENCES

A. ASTM D2247 - Practice for Testing Water Resistance of Coatings in 100 Percent Relative Humidity.
B. ASTM D 2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
C. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
D. D ASTM D6386 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Products for Painting
E. Federal Test Method No. 141 - Method 6141, Stain Removal.
F. ANSI A13.1 - Scheme for the Identification of Piping Systems.

G. SSPC - Steel Structures Painting Council.
H. SSPC-PA1, “Standard for Shop, Field, and Maintenance Painting.”
I. SSPC-PA2, “Measurement of Dry Paint Thickness with Magnetic Gauges.”
J. SSPC-SP1, “Solvent Cleaning.”
K. SSPC-SP2, “Hand Tool Cleaning.”
L. SSPC-SP3, “Power Tool Cleaning.”
M. SSPC-SP6, “Commercial Blast Cleaning.”
N. SSPC-SP7, "Brush Off Blast."
O. SSPC-SP10, “Near-White Blast Cleaning.”
P. SSPC-SP16, "Brush Blast Cleaning of Non Ferrous Metals"
Q. SSPC-PA Guide 3, Standard “A Guide to Safety in Paint Application,” latest revision.
R. VOC Standards - All coatings shall be in accordance with all applicable State and Federal VOC Standards.
    1. OSHA 29 CFR 1925.55 Gases, Vapors, Fumes, Dusts and Mists.
    2. Ozone Transportation Commission (OTC) 2005 VOC Regulation.
    3. 38 MRSA: Section 584A; Air Protection and Improvement Law.
S. OSHA 29 CFR 1926.62 Lead.
T. SSPC - Guide 61 (COH) Guide for Containing Debris Generated during Paint Removal Operations.
U. SSPC - Guide 71 (DIS) Guide for Disposal of Lead-Contaminated Surface Preparation Debris.
V. SSPC Publication 91-18 Industrial Lead Paint Removal Handbook.
W. USEPA 40 CFR Part 261 Identification and Listing of Hazardous Waste.
X. USEPA 40 CFR Part 262 Standards Applicable to Generators of Hazardous Waste.
Y. USEPA 40 CFR Part 263 Standards Applicable to Transporters of Hazardous Waste.
Z. USEPA 40 CFR Part 268 Land Disposal Restrictions.
AA. USDOT 49 CFR Parts 173, 178 and 179.

1.4 SUBMITTALS

A. Submit product data under provisions of Section 01340 including tested performance characteristics.
B. Submit manufacturer’s color chips showing the full range of colors available for each type of finish coat material specified.
C. Submit schedule on manufactures letter head with list of items to be coated, type and manufacturer of shop coating and type of field coating, including primers, details on surface preparation methods, application procedures and dry mil thickness.
D. Submit a letter from the manufacturer certifying that the products submitted are applicable for the applications indicated.
E. Submit coating manufacturer’s certification that the proposed coatings meet all state and federal VOC regulations.

1.5 QUALITY ASSURANCE

A. The Contractor shall obtain the services of a painting contractor with 5 years experience on similar projects.

B. All materials used on work shall be exactly as specified in brand and quality. No claim by the Contractor as to unsuitability or unavailability of any material specified, or his unwillingness to use same, or his inability to produce first class work with same, will be entertained unless such claims are made in writing and submitted to the Engineer at least seven (7) days prior to the date established for receipt of General Bids.
C. Before purchasing materials for the work, the Contractor shall submit to the Engineer a list of the products he proposes to use, and the list shall be reviewed by the Engineer and no exceptions taken and reviewed by him before commitment for materials is made.
D. Materials selected for coating systems for each type of surface shall be the products of a single manufacturer.
E. Include on label of all containers:
    1. Manufacturer's name
    2. Type of paint
    3. Manufacturer's stock number
    4. Color
    5. Instructions for reducing, where applicable
    6. Label analysis
    7. Shelf life dates
F. Paints submitted shall meet all Federal and State regulations pertaining to Volatile Organic Compounds (VOC) compliance, and be in accordance with OTC 2005 Standards.
G. All coating systems used for potable water applications shall be previously approved by the National Sanitation Foundation (NSF) in accordance with Standard 61. Evidence of compliance shall be an approval letter from NSF listing the submitted material.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver coating materials in sealed containers with labels legible and intact.
B. Store only acceptable project materials on the project site.
C. All painting materials shall be stored and mixed in a single location coordinated with the Engineer. The Contractor shall not use any plumbing fixture or pipe for mixing or for disposal of any refuse. The Contractor shall carry all necessary water to the mixing room, and shall dispose of all waste outside of the building in a suitable receptacle.
D. Restrict storage location to paint materials and related equipment and supplies.
E. Keep storage location neat and clean.
F. Remove all soiled and used rags, waste and trash from the storage location and building at the end of each work day.
G. Repair all damage to the storage location, caused by painting materials and equipment at no additional cost to the Owner.
H. Comply with all applicable health and fire codes and regulations including safety precautions recommended by the manufacturer. Storage space shall be provided with a suitable fire extinguisher fully charged at all times.

I. Heat shall be provided in the storage area if paints are to be stored during winter months. The temperature shall be maintained above 40 degrees F at all times.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Comply with manufacturer's recommendations as to environmental conditions under which coatings and coating systems shall be applied.
B. Do not apply coatings in areas where dust is being generated.
C. Do not apply coatings when the air or material surface temperature is below 50 degrees Fahrenheit and unless the temperature is at least 5 degrees Fahrenheit above the dew point.
D. Do not apply exterior coatings in frosty, damp or rainy weather or while surfaces are exposed to hot sunlight.

1.8 EXTRA MATERIALS

A. For all materials with a shelf life of greater than 12 months, provide one gallon of each type and each color of touch-up paint shall be provided to the Owner by the Contractor in unopened containers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS (PAINT)

A. Tnemec Company, Inc.
B. Sherwin Williams
C. PPG

2.2 MATERIALS

A. Refer to the paint schedule for specific products and application.

2.3 MIXING AND TINTING

A. Deliver paints and enamels ready-mixed to project site.
B. Accomplish job mixing and job tinting only when required.
C. Mix only in mixing pails placed in suitably sized nonferrous or oxide resistant metal pans.
D. Use only tinting colors recommended by the manufacturer for the specific type of finish.
E. Fungicidal agents, when applicable, shall be incorporated into the paints and stains by the manufacturer.
F. Mix and prepare paints in strict accordance with Manufacturers recommendations.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine surfaces scheduled to receive paint and finishes for conditions that will adversely affect execution, permanence or quality of work and which cannot be put

into an acceptable condition through preparatory work as included in Part 3.2, Surface Preparation.

B. Immediately notify the Engineer in writing when a surface to be finished cannot be put into an acceptable condition.

C. Do not proceed with surface preparation or coating application until conditions are suitable.

D. The Contractor shall be responsible for and shall rectify, at no additional cost to the Owner any unsatisfactory finish resulting from the application of coatings on surfaces not in acceptable condition.

3.2 SURFACE PREPARATION

A. Concrete and Masonry:
   1. Clean all dust, dirt, oil and efflorescence from surfaces.
   2. Fill cracks and irregularities with Portland cement grout to provide uniform surface texture.
   3. Etch dense and smooth concrete, or concrete that has had a hardener applied, with a five percent solution (by weight) of muriatic acid.
   4. Fill concrete masonry unit surfaces with block filler in sufficient thickness to produce a final result which shall fill all voids and pin holes.
   5. Allow surfaces to thoroughly dry prior to application of first coat.

B. Ferrous Metal Surfaces (Items not shop primed):
   1. All submerged ferrous metals shall be sandblast cleaned in accordance to SSPC-SP10 immediately prior to priming.
   2. All other ferrous metals shall be sandblast cleaned in accordance to SSPC-SP6 immediately prior to priming.
   3. Remove dirt, oil and grease by washing surfaces with mineral spirits.
   4. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming.
   5. Feather edges of sound existing paint by grinding, if necessary.
   6. Clean and touch up weathered, worn or damaged shop coats of paint with the specified primer.
   7. Restore shop coats of paint with identical materials if removed for welding and fabrication.

C. Galvanized metals indicated to be painted (nonferrous metals):
   1. Solvent clean in accordance with ASTM D6386.
   2. Surfaces shall receive SSPC-SP-16 and shall be surfaced prepared in accordance with ASTM D6386.
   3. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming.
   4. Restore shop coats of paint with identical materials if removed for welding and fabrication.

D. Previously Coated Surfaces (including existing items and new items that are shop primed):
   1. The areas of the coated surface that are blistered, eroded, brittle or otherwise failed shall be completely removed before beginning the specified surface preparation.

2. The areas where the existing coating is intact shall be sanded to dull the finish.
3. Before applying the new coating over an existing coating, a test section must be done to ensure compatibility of the new and old coatings.
4. All other existing coatings shall be prepared as recommended by the manufacturer and as specified in this section.
5. Ferrous metals arriving at the job site with shop primers other than the polyamide epoxy or rust inhibitive primers specified shall be provided with an intermediate coat as necessary for compatibility with specified topcoats.
6. Special attention shall be paid to the potential for epoxy shop and intermediate coats to chalk upon exposure to sunlight. The Contractor shall follow the manufacturer's required surface protection/covering and surface preparation recommendations before any intermediate or top coats can be applied over chalked surface. Epoxy primers and intermediate coats shall be top coated no later than 45 days after the application of the epoxy coating. If topcoats are to be applied later than 45 days, the following surface preparation shall be provided:
   a. The existing finish shall be etched by sanding with 80 grit paper or cloth.
   b. Surfaces shall be pressure washed with 3000 to 5000 pounds of pressure.
   c. The Engineer, at his discretion, can require the Contractor to conduct adhesion tests of the topcoats.
7. The following shall be the minimum surface preparatory for existing surfaces that are to be painted, unless indicated otherwise:
   a. Non-submerged ferrous metals.
      - Clean
      - Sandblast in accordance with SSPC-SP6.
   b. Existing concrete floors and all surfaces to receive secondary contaminant coatings.
      - Clean
      - Sand or shot blast to remove existing coatings and to provide an anchor profile for the new coating.
   c. Existing Concrete and Masonry Walls
      - Clean
      - Scrape existing paint to a sound surface.
      - Sand with 80 grit paper or cloth.
      - Pressure wash all existing epoxy coated surfaces.

3.3 APPLICATION

A. Workmanship:
   1. Employ skilled workmen to insure workmanship of the highest quality.
   2. Materials shall be applied only by craftsmen experienced in the use of the specific products involved.
B. General Requirements:
   1. Apply all coatings under adequate illumination.
   2. Perform no work in the rain, dew, or fog, when the temperature is below 50 degrees Fahrenheit and at least 5 degrees Fahrenheit above the dew point, or before the other coats have thoroughly dried.

3. Do not apply coatings until the material surfaces are thoroughly dry.
4. Apply paints and varnishes with suitable brushes, rollers or spraying equipment.
    a. The rate of application shall not exceed that as recommended by the paint manufacturer for the surface involved.
    b. Keep brushes, rollers and spraying equipment clean, dry and free from contaminates and suitable for the finish required.
    c. Apply stain by brush. Cover surfaces with a uniform coat and wipe off if required.
    d. Make each coat a different tint from that of the preceding coat, with final coat tinted to the exact shade selected by the Engineer. Lightly sand surfaces between each coat of gloss and semi-gloss finishes, and wipe clean.
5. Comply with the recommendation of the product manufacturer for drying time between succeeding coats. Contractor shall follow the manufacturer's specific curing requirements for rust inhibitive primer shop coats prior to allowing topcoating.
6. Sand and dust between each coat to remove defects visible from a distance of five feet.
7. Finish coats shall be smooth, free of brush marks, streaks, laps or pile up of paints and skipped or missed areas.
8. Inspection:
    a. Do not apply additional coats until the completed coat has been inspected by the Engineer.
    b. Only inspected and reviewed coats will be considered in determining the number of coats applied.
9. Leave all parts of moldings and ornaments clean and true to details with no undue amount of paint in corners and depressions.
10. Make edges of paint adjoining other materials or colors clean and sharp with no overlapping.
11. Apply primer on all work before glazing.
12. Refinish entire wall where portion of finish has been damaged or is not acceptable.
13. Apply one coat of metal primer, of the types specified hereunder, and one coat of flat black metal enamel, to the surfaces of all ductwork behind grilles, for a distance of 18 inches.
14. Back prime all exterior and interior wood finish and trim.
15. Runs on face are not permitted.
16. Back prime all wood siding with specified first coat.
17. Adjust natural finishes as necessary to obtain identical appearance on veneers and solid stock.

3.4 PROTECTION

A. Furnish and lay drop cloths in all rooms and areas where painting and finishing is being done to adequately protect flooring and other work from damage during the prosecution of the painting work.

B. Remove all canopies of lighting fixtures, all electric switch plates, and similar equipment, set them carefully away, and cover adequately, protect the fixtures, etc.; replace the canopies, plate, etc. in as good condition as when found.
C. Do not paint over any code-required labels, such as Underwriter's Laboratories and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.
D. Correct and refinish all interior and exterior surfaces in the existing facility affected by the new work. Materials and their application shall be as required to most closely match the existing finishes and as specified in this Section.

3.5 CLEANING

A. At the completion of the work of this Section, remove all paint spots and oil or grease stains, caused by this work from floors, walls, fixtures, hardware and equipment, leaving their finishes in a satisfactory condition. Remove all materials and debris and leave the site of the work in a clean condition so far as this work is concerned.

3.6 FINAL INSPECTION

A. Protect all painted and finished surfaces against damage until the date of final acceptance of the work. The Engineer will conduct a final inspection of all painters' work. As part of the final inspection the Contractor shall demonstrate compliance with the specified film thickness with appropriate paint gauges. The Contractor shall be required to repaint, refinish, or retouch any areas found which do not comply with the requirements of this Section.

3.7 PAINT SCHEDULE

A. The following product model and coatings system numbers are listed below to establish the standard of quality. Equivalent products from other manufactures will be accepted provided they meet or exceed the performance of the listed products.
B. The primer coat is not required on shop primed items. Installer to verify that proposed field coatings are compatible with shop coatings.

SURFACE/ITEM	SURFACE PREPARATION	PRIMER	INTERMEDIATE	FINISH
PLASTER & DRYWALL				
Drywall Surfaces to Receive Epoxy	Clean & Dry	Tnemec Series 51 PVA Sealer **OR** SW PrepRite 200 Latex Primer at 1.0 to 2.5 mils	Tnemec Series N69 Tneme-Epoxoline at 3 to 5 mils **OR** SW Pro Industrial High Performance Epoxy at 4 to 6 mils	Tnemec Series N69 Tneme-Epoxoline at 3 to 5 mils **OR** SW Pro Industrial High Performance Epoxy at 4 to 6 mils
MASONRY & CONCRETE				

SURFACE/ITEM	SURFACE PREPARATION	PRIMER	INTERMEDIATE	FINISH
Masonry Surfaces to Receive Epoxy	Clean & Dry	Tnemec Series 1254 EpoxoBlock; at 80-100 SF/Gallon **OR** SW Cement-Plex 875 at 100 SF/Gallon	Tnemec Series N69 Tneme-Epoxoline at 3 to 5 mils **OR** SW Pro Industrial High Performance Epoxy at 4 to 6 mils	Tnemec Series N69 Tneme-Epoxoline at 3 to 5 mils **OR** SW Pro Industrial High Performance Epoxy at 4 to 6 mils
Other Masonry Surfaces	Clean & Dry	Tnemec Series 1254 EpoxoBlock; at 80-100 SF/Gallon **OR** SW Heavy Duty Block Filler	Tnemec Series 1028/1029 Enduratone at 2 to 3 mils **OR** SW DTM Acrylic Coating at 3 to 4 mils	Tnemec Series 1028/1029 Enduratone at 2 to 3 mils **OR** SW DTM Acrylic Coating at 3 to 4 mils
Non-Submerged Concrete Vertical and Ceiling Surfaces to Receive Epoxy	Brush-off Blast to achieve uniform anchor profile	Tnemec Series N69 Tneme-Epoxoline at 3 to 5 mils **OR** SW Pro Industrial High Performance Epoxy at 4 to 6 mils	N/A	Tnemec Series N69 Tneme-Epoxoline at 3 to 5 mils **OR** SW Pro Industrial High Performance Epoxy at 4 to 6 mils
Other Non-Submerged Concrete Vertical and Ceiling Surfaces	Clean, Dry and Surface Grind	Tnemec 151-1051 Elasto Grip FC at 2 to 3 mils mils **OR** SW DTM Acrylic Coating at 3 to 4 mils	N/A	Tnemec Series 1028/1029 Enduratone at 2 to 3 mils **OR** SW DTM Acrylic Coating at 3 to 4 mils
METALS				
Ferrous Metals concealed within wood or metal stud framing and not exposed to view	SSPC-SP3	Tnemec Series 1 Omnithane Gray at 2.5 to 3 mils **OR** SW-Kem-Bond HS Universal Primer at 3 mils	N/A	N/A
Galvanized metal fabrications built into concrete and masonry including lintels.	ASTM D6386 Solvent Cleaning Followed by SSPC-SP16	Tnemec Series 1 Omnithane Gray at 2.5 to 3 mils 3 mils **OR** SW Recoatable Epoxy Primer at 4 to 6 mils	Top coats as noted herein for the surfaces exposed to view	Top coats as noted herein for the surfaces exposed to view

SURFACE/ITEM	SURFACE PREPARATION	PRIMER	INTERMEDIATE	FINISH
Exposed electrical conduit, conduit fittings and outlet boxes mounted on painted or finished surfaces or exposed in painted rooms		Same color and finish as background surface and/or equipment	Same color and finish as background surface and/or equipment	Same color and finish as background surface and/or equipment
PIPING (other than ferrous metal)				
Insulated Pipe	Clean & Dry	Tnemec 151-1051 Elasto Grip FC at 2 to 3 mils **OR** SW Premium Wall and Wood Primer at 1.8 mils	Tnemec Series 1028/1029 Enduratone at 2 to 3 mils **OR** SW DTM Acrylic Coating at 3 to 4 mils	Tnemec Series 1028/1029 Enduratone at 2 to 3 mils **OR** SW DTM Acrylic Coating at 3 to 4 mils

NOTES:

1. Surface preparation shall be as specified within this section and as noted in the table above.
2. All dry film thickness indicated are the minimum required.
3. All ferrous metals, piping and equipment delivered to the site with shop primers other than the specified primer shall receive an intermediate coat as necessary for compatibility with the indicated top coats.
4. Painting of the piping system shall include all ferrous valves, levers, valve handles, fittings, stands, supports, hangers, pumps and appurtenances.
5. Epoxy primers and intermediate coats that have been in place for more than 45 days shall be prepared as indicated under the "Surface Preparation" Section of this Specification.
6. Verify the products provided are compatible with the existing coatings in the existing facility.
7. Conduit Painting Schedule:
   Electrical Rooms - Not painted
   All other Rooms - Painted
   Above Finish Ceiling - Not painted

3.8 PIPING IDENTIFICATION SCHEDULE

A. Pipe Coating

1. All pipes, whether concealed or exposed to view shall be painted a separate color as scheduled in the PIPE IDENTIFICATION SCHEDULE below or as otherwise directed by the Engineer. For insulated pipes, only the insulation shall be painted.
2. Pipe supports consisting of pipe rings, clamps, clevises, U bolts, pipe rollers, saddles, etc., shall be painted with the same color as that of the pipe.
3. Wall supported pipe hangers consisting of brackets, standoffs, etc., shall be painted with the same color as that of the wall.
4. Ceiling/roof supported pipe hangers consisting of thread rods, beam clamps, etc., shall be painted with the same color as that of the ceiling.
5. Floor supported pipes consisting of stanchions shall be painted with same color as that of the pipe.

B. Pipe Markers

1. Markers shall be corrosion resistant laminated plastic bound to the pipes with nylon fasteners or shall be "coil-fit." Stickers are not acceptable. Markers and flow direction indicators shall be manufactured by Seton, Brimar Industries, or equivalent.
2. Pipes with diameters less than 1-1/4 inch shall have marker hung from pipe with nylon fasteners.
3. Lettering size shall be in accordance with the following:

SIZE OF LEGEND LETTERS

Outside Diameter of Pipe or Covering	Minimum Length of Marker	Size of Letters
In	In	In
Up to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/2 to 6	12	1-1/4
8 to 10	24	2-1/2
Over 10	32	3-1/2

4. Adjacent to each marker there shall be an arrow indicating flow direction.
5. Marker location shall be in accordance with the American National Standard Institute Scheme for Identification of Piping Systems (ANSI A13.1). Markers shall be placed adjacent to all valves and/or flanges; adjacent to all changes in direction on all pipe branches; and where all pipes pass through walls or floors on each side of wall/floor. On straight runs of piping, markers shall be placed at no less than 10 foot intervals. Where pipes are located above or below the normal line of vision, the lettering shall be placed below or above (as appropriate) the horizontal centerline of the pipe.

C. Refer to Specification Sections 15100, 15400 and 15600 for Equipment and Valve Identification requirements.

PIPE IDENTIFICATION SCHEDULE

SYSTEM NAME/ MARKING	TAG	PIPE COLOR	PIPE MARKERS
Water			
Cold Potable Water	CW	Lt. Blue	White on Green
Hot Potable Water	HW	Lt. Blue	White on Green
Heating Water Supply	HWS	Safety Blue w/ Red Bands	White on Green
Heating Water Return	HWR	Safety Blue w/ Red Bands	White on Green
Gases			
Natural Gas	NG	Safety Orange w/ Black Bands	White on Brown

END OF SECTION

SECTION 15061

STEEL PIPE & FITTINGS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish and install steel pipe and fittings of the type(s) and size(s) and in the location(s) shown on the Drawings and as specified herein.

B. Related Work Specified Elsewhere (When Applicable): "Pipe and Pipe Fittings - General" is specified in this Division.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Standard Steel Pipe:
   1. Classes and maximum working pressures shall be as specified in ANSI B31.1 and as shown on the Drawings.
   2. ASTM A-53 carbon steel, welded or seamless.
   3. Black steel.
   4. End connections: As shown on the Drawings.

B. Fittings:
   1. General Service Screwed: Standard pattern malleable iron with full length clean cut threads, ANSI Bl6.3.
   2. Unions: 250 pound series malleable iron with brass to iron seats.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Threaded Joints:
   1. Ream the ends of threaded pipe to remove all burrs.
   2. Cut threads clean with long tapers.
   3. Remove all dirt and chips from the inside of the pipe and fittings and from the threads.
   4. Make up joints with an approved pipe joint compound or tape applied to the male threads only.
   5. When connecting pipes to recessed drainage fittings, seat them against the shoulder of the fittings.
   6. When required to back off joints, entirely disjoint, wipe the threads of both the pipe and fittings clean, apply new joint compound, and reassemble the connection.

B. Support: Support all pipes in accordance with the International Mechanical Code & International Plumbing Code

C. Cutting: Cut pipe from measurements taken at the site; not from the Drawings.

D. To permit convenient disassembly for alterations and repairs, install unions or flanges where shown on the Drawings and:
   1. In long runs of piping

2. In bypasses around equipment
3. In connections to traps, tanks, pumps, and other equipment
4. Between shutoff valves
5. In other locations as directed by the Engineer, and as indicated on the Drawings.

END OF SECTION

SECTION 15063

COPPER PIPE & FITTINGS (INTERIOR APPLICATIONS)

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish and install copper pipe and fittings of the type(s) and size(s) and in the location(s) shown on the Drawings and as specified herein.

B. Related Work Specified Elsewhere:
   1. Pipe & Pipe Fittings - General is specified in this Division.
   2. Copper Service Pipe & Fittings for Buried Applications is specified in Section 02626.

1.2 QUALITY ASSURANCE

A. Pipe: Seamless copper water tube, ASTM B88 (pressure) and ASTM B-306 atmospheric.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pipe Use (When Applicable):
   1. Hot Water Heating (interior).
      a. Type L, hard temper.

B. Fittings:
   1. Wrought copper and bronze solder joint pressure fittings: ANSI Bl6.22.
   2. Cast bronze solder joint pressure fittings: ANSI Bl6.l8.
   3. Cast bronze solder joint drainage fittings: ANSI Bl6.23.
   4. Cast bronze fittings for flared copper tubes: ANSI Bl6.26.

C. Solder and Flux:
   1. Solid string or wire solder, 95 percent tin, 5% antimony on all pressure piping and potable water.
   2. Silver solder, 45% brazing silver alloy (where indicated).
   3. Flux: Non-corrosive paste type as required for type of solder.
   4. Acid core, paste type, or solder/flux combinations are not permitted.
   5. Solder or flux containing lead in any form will not be permitted on any potable water system.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Jointing:
   1. Solder Joints:
   2. Ream or file pipe to remove burrs.
   3. Clean and polish contact surfaces of all joints.
   4. Apply flux to both male and female ends.

5. Insert ends of tubes into fittings, the full depth of the sockets.
6. Bring the joints to soldering temperature in as short a time as possible.
7. Form continuous solder beads around the entire circumferences of the joints.

B. Bending Pipe:
   1. Bend pipe by the method and to the radius to comply with the manufacturer's recommendation.
   2. Bends shall be free of any cracks or buckles.

C. Support: Support all pipes in accordance with the International Mechanical Code & International Plumbing Code

D. To permit convenient disassembly for alterations and repairs, install unions where shown on the Drawings and:
   1. In long runs of piping,
   2. In bypasses around equipment,
   3. In connections to traps, tanks, pumps, and other equipment,
   4. Between shutoff valves, and
   5. In other locations as directed by the Engineer.

E. Remove all valve internals when soldering into pipelines.

END OF SECTION

SECTION 15092

PIPE SLEEVES & SEALS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish and install wall sleeves and seals of the type(s) and sizes(s) and in the location(s) shown on the Drawings and specified herein.

B. Related Work Specified Elsewhere:
   1. Firestopping is specified in Section 07270.
   2. Sealants are specified in Section 07900.
   3. Plumbing - General is specified in Section 15400.
   4. HVAC - General is specified in Section 15600.

1.2 QUALITY ASSURANCE

A. Provide and install all sleeves of the types specified herein, as shown on the Drawings and as directed by the Engineer.

B. Provide sleeves that are airtight, gastight or watertight as required.

C. Penetrations through fire rated walls, floors and ceiling shall have proper fire stopping, as specified in Section 07270.

PART 2 - PRODUCTS

2.1 TYPES AND LOCATIONS

A. Penetrations Through Existing Construction:
   1. Interior masonry, drywall, or wood partition - Air to Air:
      a. Cleanly cut brick or block as required. Grout sleeve into place using non-shrink grout.
      b. Cleanly cut wood frames partitions as required. Set sleeve into position and secure.
      c. Sleeves to be as required for New Construction - Interior masonry, drywall, or wood partition - Air to Air.
      d. Holes bored with equipment leaving a smooth hole in masonry walls less than l/2 inch larger than the pipe will not require a sleeve, unless otherwise specified.
      e. Minimum 1/4 inch annular space between cored opening or sleeve and pipe or insulation.
      f. Firmly pack with oakum and seal both ends with polyurethane sealant, per Section 07900 for standard penetrations.
      g. Install split cover plates in all finished areas. Both sides of wall if required. Plates shall be chrome finished, suitably sized to fit pipe in question and cover opening.
   2. Interior Concrete Partitions - Air to Air:
      a. Core smooth-walled opening with coring machine. Grout sleeve into place using non-shrink grout.

b. Schedule 40 galvanized steel pipe with 1 inch x 1/8 inch thick welded sealing and anchoring collar in middle, hot-dip galvanize after fabrication. Pipe sleeve thicknesses for sizes larger than 24-inch diameter shall be the standard 0.375-inch thickness.
c. Holes cored with equipment leaving a smooth hole, less than l/2 inch larger than the pipe will not require a sleeve, unless otherwise specified.
d. Minimum 1/4 inch annular space between cored opening or sleeve and pipe or insulation.
e. Firmly pack with oakum and seal both ends with polyurethane sealant, per Section 07900 for standard penetrations.

3. Interior Concrete Partitions - Air to Air:
   a. Core smooth-walled opening with coring machine. Grout smooth any irregularities in opening.
   b. Size of cored opening as required by seal manufacturer.
   c. Seal with rubber link compression seal.
4. Interior Concrete Partitions - Air to Air (Unclassified to Classified):
   a. Core smooth-walled opening with coring machine. Grout smooth any irregularities in opening.
   b. Size of cored opening as required by seal manufacturer.
   c. Seal with two, back to back rubber link compression seals.
5. Exterior Masonry Walls
   a. Core drill a smooth hole through all layers of the existing masonry. Hole shall be sized to facilitate standard rubber link compression seal installation.
   b. Install rubber link compression seal at each layer of masonry.
   c. Seal each face with polyurethane sealant.
   d. If a clean, smooth hole cannot be achieved, remove the masonry as required to install Schedule 40 galvanized wall sleeve. Pipe sleeve thicknesses for sizes larger than 24-inch diameter shall be the standard 0.375-inch thickness. Grout sleeve in place. Install rubber link compression seal and sealant as noted above.
6. Exterior Wood Walls
   a. Remove existing siding and other materials, as required to install the new item.
   b. Restore the wall and siding to provide a weather-tight seal acceptable to the Engineer.
7. Concrete Floor Penetrations - Air to Air:
   a. Same as “Interior Concrete Partitions - Air to Air”, except that sleeve will not be required.
   b. Stainless steel pipe riser clamp with stainless steel threaded rod embedded into concrete floor to be installed on topside of penetration to support the pipe vertically.
   c. Install rubber link compression seal, as shown, covered by self-leveling sealant (SikaFlex or equivalent).
   d. Refer to details on Process Drawings.
8. Concrete Exterior Walls - Air to Ground:

a. Core smooth-walled opening with coring machine. Grout smooth any irregularities in opening.
b. Size of cored opening as required by seal manufacturer.
c. Seal with rubber link compression seal.

9. Other conditions shall be installed as reviewed and accepted by the Engineer.

B. Pipe openings in and penetrations through precast concrete structures shall be as specified in Division 2 and 3.

C. Rubber Link Compression Seals:

1. Acceptable Manufacturers:
   a. Link Seal by Thunderline Company
   b. Innerlynx by Advance Products and Systems
   c. Or equivalent.
2. Multi-rubber link type with pressure plates, bolts, nuts and sealing element providing a leak proof seal. Model numbers provided below are based on Link Seal by Thunderline Company are to establish type and level of quality.
3. General Service (Model C):
   a. Glass Reinforced Nylon Pressure Plate.
   b. Carbon steel zinc-phosphated nut and bolt.
   c. Sealing element: EPDM rubber.
   d. Temperature Rating: -40°F to 250°F.
4. Corrosive Service: (Model S-316):
   a. Use in the following locations: Sludge tanks, scum tanks, digesters, wetwells, manholes, dewatering rooms, headworks rooms, exterior tanks, chemical rooms, as shown on the Drawings.
   b. Glass Reinforced Nylon Pressure Plate.
   c. Bolt and nut, l8-8 stainless steel.
   d. Sealing element: EPDM rubber.
   e. Temperature Rating: -40ºF to 250ºF.
5. Potable/Clean Water Service (Model S61)
   a. Blue reinforced Nylon polymer pressure plates.
   b. 316 stainless steel nuts and bolts.
   c. Sealing element: Black EPDM NSF 61 certified.
   d. Temperature Rating: -40º to 250º F.
   e. Certified to NSF/ANSI standard 61.
6. High Temperature Service (Model T)
   a. Steel zinc dichromate pressure plates.
   b. Carbon steel with zinc dichromate finish nuts and bolts.
   c. Sealing element: Silicone.
   d. Temperature Rating: -67º to 400º F.
7. Refer to details on Process Drawings.

D. Wall Plates: Provide split type cast iron or brass wall plates on pipes penetrating walls in finished spaces such as labs and offices. Refer to details on Process Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Existing Construction:
   1. The location will be reviewed and accepted by the Engineer prior to coring or cutting hole.
   2. For concrete, holes shall be located to avoid the reinforcing steel when possible.
   3. Patch all damaged work as required to maintain a neat and clean appearance.

B. Rubber Link Compression Seals: Install as required and in strict accordance with the manufacturer's instructions and recommendations.

END OF SECTION

SECTION 15180

PIPE AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Provide and apply insulation to all non-buried interior piping in accordance with Table 1, heating system pipeline components, boiler breaching and emergency generator exhaust pipe and muffler.

B. Related Work Specified Elsewhere: "Plumbing - General", "HVAC General", and "Emergency Generator Exhaust Piping" are specified in this Division.

1.2 QUALITY ASSURANCE

A. Standards:
   1. Fiberglass pipe insulation shall conform to ASTM C547.
   2. All-service vapor retarder jacket shall conform to ASTM C1136.

B. Have all insulation work performed by skilled insulation workmen regularly employed in the trade.

C. Fire Hazard Rating: Except for materials listed below, all insulation materials, adhesives, coatings and other accessories shall have a UL fire hazard rating not to exceed 25 for flame spread and 50 for fuel contributed and smoke developed. Exceptions are:
   1. Factory pre-molded one-piece PVC fitting and valve covers and pipe jacketing.
   2. Asphaltic mastic.

D. Acceptable Manufacturers:
   1. Fiberglass:
      a. Owens-Corning
      b. Certainteed
      c. Knauf
      d. or equal

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fiberglass Pipe Insulation:
   1. Mineral fiber thermal insulation.
   2. All service vapor retarder jacket.
   3. Required for use on all pipes as listed in Table 1.
   4. Thickness of insulation shall conform to Table 2.

B. Fittings and Valves:
   1. Pre-molded PVC covers with fiberglass fill on fiberglass insulation systems.
   2. Mineral fiber insert insulation with an aluminum pre-molded fitting cover.
   3. Do not insulate unions and flanges.

C. PVC Jacketing

1. For use on straight runs of fiberglass insulated piping in designated wet areas as follows:
   a. Old Norwich Pump Station: Fan Room, Comminutor Room

D. Staples: Outward clinching type, type 304 or 3l6 stainless steel.

E. Adhesives:
1. Fiberglass: Non-flammable vapor barrier adhesive as manufactured by Benjamin Foster or Childers or equal.

2.2 APPLICATION THICKNESS TABLES

TABLE 1 – PIPING WHICH REQUIRES INSULATION

PIPE SYSTEM	FLUID TEMPERATURE RANGE (°F)
Domestic Water Systems – Cold Water	40 – 100
Heating Systems – Hot Water Supply/ Return	120-180

TABLE 2 - MINIMUM PIPE INSULATION THICKNESS (IECC)

FLUID OPERATING TEMPERATURE RANGE (°F)	INSULATION CONDUCTIVITY		NOMINAL PIPE SIZE (INCHES)				
	Conductivity (BTU-in/hr-ft^2-°F)	Mean Temperature Range (°F)	<1	1 to 1 ½	1 ½ to <4	4 to <8	8+
141-200	0.25-0.29	125	1.5	1.5	2.0	2.0	2.0
105-140	0.21-0.28	100	1.0	1.0	1.5	1.5	1.5
40-60	0.21-0.27	75	0.5	0.5	1.0	1.0	1.0

PART 3 - EXECUTION

3.1 INSTALLATION

A. Apply insulation only after all pipes have been tested and approved.

B. Clean and dry all surfaces to which insulation is to be applied.

C. Neatly finish the ends of insulation on exposed piping at valves, flanges, etc., with cover strips.

D. Insulation at sleeves:
1. Insulation shall be continuous through all sleeves except where gas-tight seal is indicated.
2. Provide aluminum cover on insulation where caulking is required.
3. Delete insulation at walls requiring a gas-tight seal.

E. Insulation at Hangers:
1. Insulation shall be continuous at hangers.
2. Provide protection saddles at pipe hangers where required to prevent compression or distortion of insulation in accordance with insulation manufacturer's requirements.

F. Fiberglass factory applied insulation jacket:
1. Seal all laps, joint strips, exposed staples, exposed ends with vapor barrier adhesive.
2. Install only when temperature is between 40 degrees and l20 degrees F.

3. Secure with staples where required for additional strength and to prevent fishmouths.

3.2 CLEANING

A. Clean all insulation of accumulated paint, concrete, mortar, etc.

B. Do not damage insulation during cleaning.

END OF SECTION

SECTION 15400

PLUMBING – GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Description: Perform the following items of work required to complete the work of this Section, as shown on the DRAWINGS and specified herein:
   1. All labor, materials, equipment and transportation shall be provided as required to completely install the plumbing and water systems, with all connections as shown on the DRAWINGS and described in these specifications or as required by the International Plumbing Code as amended by the State of Connecticut. The accompanying DRAWINGS do not show every detail of pipe, valves, fittings, hangers, equipment and fixtures which are necessary for the complete installation but are provided to show the general arrangement and extent of work to be performed.

B. Work Included: The plumbing work shall include, but not be limited to the following (when applicable):
   1. Fuel gas supply system.
   2. Sump pump, piping and installation.
   3. All other plumbing items indicated on the DRAWINGS, specified herein, or needed for a complete and proper plumbing installation.

C. Related Work Specified Elsewhere (When Applicable)
   1. Project cleaning is specified in Division l.
   2. Excavation and backfill is specified in Division 2.
   3. Concrete is specified in Division 3.
   4. Caulking and flashing are specified in Division 7.
   5. Painting is specified in Division 9.
   6. Pipe Sleeves and Seals are specified in Section 15092.
   7. Piping, pipe fittings, valves, insulation, fixtures, equipment, and accessories are specified in the appropriate Sections of this Division.
   8. Electrical is specified in Division l6.
   9. Pipe identification is specified in Division 9.
   10. Signage is specified in Section 10010.

D. Drawings and Measurements:
   1. The Drawings show the general arrangement, direction, and sizes of pipes. They are not intended to show every offset, valve, and fitting, and every structural difficulty that may be encountered.
   2. All measurements shall be verified at the job site.

1.2 QUALITY ASSURANCE

A. Materials and Workmanship: All materials and workmanship shall be suitable for the respective work and the type of service encountered.

B. Equipment: All equipment shall be constructed to operate safely without water hammer and undue wear.

C. Local Codes: Perform all work in accordance with applicable state and local plumbing codes, except where requirements of this Contract are more stringent.
D. Permits: Arrange for all permits, inspections, and tests required by codes at no additional cost to the Owner.
E. Standards: When standards are referred to, the latest issue shall apply.

1.3 SUBMITTALS

A. Prior to ordering fixtures, equipment and appurtenances, submit shop drawings in accordance with the General Conditions of the Construction Contract.
B. Submit to the Engineer: Copies of manufacturer's installation, maintenance and operating instructions including parts lists for all equipment furnished as specified in the General Conditions of the Construction Contract.
C. Submit a list of local supply houses for replacement parts for all equipment furnished.

1.4 DELIVERY, STORAGE & HANDLING

A. Exercise care during loading, transporting, unloading and handling to prevent damage of any nature to interior and exterior surfaces of equipment, fixtures, pipe and fittings.
B. Do not drop equipment and fixtures.
C. Store materials on the project site in enclosures or under protective coverings.
D. Assure that all materials are kept clean and dry.
E. Do not store materials directly on the ground.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide materials that are new, suitable for intended use, and of type, style, and quality specified and as shown on the Drawings.
B. Provide pipe, fittings, and devices that meet requirements of local plumbing codes and be in accordance with applicable ASTM, ANSI, and Commercial Standard (CS) standards.

2.2 BOLTS, ANCHOR BOLTS AND NUTS

A. Furnish all necessary bolts, anchor bolts, nuts, washers, lock washers or locking nuts, plates and bolt sleeves in accordance herewith. Anchor bolts shall have suitable washers, lock washers and, where so required, their nuts shall be hexagonal.
B. All bolts, anchor bolts, nuts, washers, lock washers, plates, and bolt sleeves shall be galvanized unless otherwise indicated below or specified elsewhere.
    1. Galvanized steel in accordance with Division 5 unless otherwise indicated below or specified elsewhere.
    2. Stainless steel hardware (minimum of Type 304, unless otherwise indicated) is required in all corrosive atmospheres, exterior areas, and/or areas with NEMA 4X or NEMA 7 rating.
    3. Stainless steel hardware (minimum of Type 316, unless otherwise indicated) is required in all submerged applications, including but not limited to the headworks, dewatering rooms, chemical rooms, clarifiers, aeration basins, splitter structures, equalization or storage tanks, etc. For additional description and definition of submerged surfaces refer to Specification Section 09900.

2.3 EQUIPMENT AND VALVE TAGS

A. All new plumbing and HVAC (Mechanical Systems) equipment shall be identified by a color coded equipment/valve tag, provided and installed by the Contractor. Contractor shall submit a complete list of proposed Identification Tag information and it shall be reviewed by the Engineer and Owner and revised as indicated. In general, tag information shall match the information provided on the Drawings.

B. Tags shall conform to the following specifications:

1. The tags shall be 2.5-inch diameter, 1/16" thick, rigid, multi-layered sandwich laminate with contrasting inner and outer colored acrylic plastic layers. Top hole size is 5/32" for hanging tags.
2. Tags shall be available in 7 different outside colors. Owner and Engineer shall select up to 4 different colors for the project.
3. Tags shall have up to three lines engraved on a side and eight characters per line of identification information. Tags shall be engraved one side.
4. Tags shall be secured to valves with nylon cable ties or adjustable stainless steel bead chain. Securing method shall be selected by the Owner and Engineer.
5. Tags secured to equipment shall be fastened to a flat visible surface by a minimum of two SS screws or SS pop rivets.
6. Tags shall have a service temperature of -40°F to 175°F
7. Manufactured by Seton Name Plate Corporation, New Haven, CT, Brimar Industries, Garfield, NJ, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all plumbing and piping systems in a neat workmanlike manner.

B. Lines and Grades:

1. Unless otherwise shown on the Drawings, install all piping parallel to the building walls wherever possible.
2. Install all piping to accurate lines and grades.

C. Supports: Provide pipe hangers and supports as required by the International Plumbing Code.

D. Expansion: Provide suitable provisions for expansion of pipelines wherever necessary.

E. Do not provide nor install close nipples.

F. Do not install piping through, directly over, or in front of electrical switchgears and power panels.

G. Caulk the spaces between the pipe and walls, ceilings, and floors gas-tight where shown on the Drawings.

H. Fittings for Dismantling Piping: Provide a sufficient number of unions to allow the dismantling of all piping.

I. Pitch:

1. Pitch sanitary and drainage piping l/4 inch per foot, and never less than l/8 inch per foot for piping 4" or larger with prior approval by the administrative authority.
2. Pitch all other piping toward low points and install valved drains at the low points.

3.2 TESTING

A. When the installation is complete, test all pipelines in the presence of the Engineer and the Plumbing or Building Inspector in accordance with the requirements of the local and state plumbing codes, at no additional cost to the Owner. Provide all necessary equipment and utilities.
B. Test underground piping prior to backfilling.
C. Test piping prior to application of paint and insulation.
D. Separately test portions of piping which will be concealed before completion.
E. Procedure:
    1. Piping Which Carries Water or Liquid Under Pressure: Fill pipes with water and subject them to l00 psig. or l-l/2 times the normal working pressure, whichever is greater, for two (2) hours with no loss in test pressure.
    2. Fuel Gas Piping: Test with compressed air at l5 psi for 30 minutes with no loss in pressure at test gauge. Bubble test all fittings and joints with a soap/water solution.
    3. Isolate any equipment that cannot withstand test pressures prior to any testing.
F. Repairs:
    1. Should leaks be found, repair as required even to the extent of disassembling and remaking the joints, or replacing sections of pipe.
    2. Caulking of threads or the use of chemical compounds to correct leaks will not be permitted.
    3. Replace defective pipe and fittings and repeat tests until the testing results are approved by the Engineer.

3.3 PAINTING AND IDENTIFICATION

A. All plumbing piping, valves, pumps and equipment shall be painted and labeled in accordance with Specification Section 09900.
B. Signage is specified in Section 10010.

END OF SECTION

SECTION 15401

PLUMBING, PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish and install a complete piping system including all required specialties and appurtenances as indicated on the Drawings and as herein specified.

B. Related Work Specified Elsewhere:
   1. "Polyethylene Pipe" is specified in Section 15076.
   2. "Plumbing General" is specified in Section 15400.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pipe and Fittings:
   1. Natural Gas Lines:
      a. 1/2 inch and larger: Schedule 40 black steel with malleable iron fittings.
   2. L.P. Gas system (all materials must meet NFPA 58 standard and the National Fuel Gas Code as it applies to L.P. Gas):
      a. 1/2 inch and larger: Schedule 40, ASTM A-53, Grade B steel pipe with malleable iron fittings.
   3. Sump Pump Discharge Piping:
      a. Schedule 80 polyvinyl chloride pipe and solvent cement socket type fittings.

PART 3 - PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide offsets in all piping to place in proper position and avoid work of other trades.

B. Where plastic piping joins metal piping, threaded adapters shall be installed only with plastic male into metal female.

END OF SECTION

SECTION 15444

NATURAL GAS SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish and install a natural gas system within the building to a point outside the building in the location of the gas meter, including final connection to the meter.

B. Related Work Specified Elsewhere: "Plumbing - General" is specified in Section 15400, "Steel Pipe & Fittings" is specified in Section 15061.

1.2 QUALITY ASSURANCE

A. The entire installation shall conform to NFPA 54 as adopted by the State of Connecticut.

B. Installation, testing, and replacement of gas piping, appliances, or accessories, and repair and servicing of equipment, shall be performed only be a qualified agency.

1.3 SUBMITTALS TO THE ENGINEER

A. General: Submittals shall be in accordance with specification Section 01340.

B. When state or local codes require licensed gas fitters or licensed plumbers to perform the work being done on the natural gas system, submit notarized copies of licenses of all mechanics to be used on the installation.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Deliver gas system materials to job site as work progress requires.

B. Protect all materials in a suitable weathertight enclosure to prevent damage of any nature.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials shall be in accordance with NFPA54 and all state and local codes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Clean pipe before installation.
2. Remove internal scale.
3. Ream pipe ends after cutting.
4. For screwed joints, apply noncorrosive, non-hardening Teflon pipe thread compound or Teflon tape to male threads only.
5. Install gas piping and accessories according to NFPA No. 54.

6. Install gas piping parallel with building walls or structure. The lower end of all vertical supply piping near equipment shall terminate with a tee, nipple and cap to serve as a sediment trap.
7. Install a gas cock and union in the pipe adjacent to each appliance, in such a manner that the appliance may be removed without disturbing the gas piping.

B. Gas Service: Tie into local gas company gas meter at the building.

C. Gas pipe sizes are based on the terminal equipment designed around. The Contractor shall confirm line sized based on NFPA54 sizing criteria for the terminal equipment provided on the job prior to the start of the installation.

D. Leak testing shall be in accordance with NFPA54 requirements. Test pressure shall be 1 ½ times working pressure. Test duration shall be not less than ½ hour for each 500 ft^3 of pipe volume. Piping system shall withstand the test pressure without showing any evidence of leakage.

E. Purging: After piping has been tested, the Contractor shall fully purge the gas piping in accordance with NFPA54.

END OF SECTION

SECTION 15492A

EXPLOSION PROOF SUBMERSIBLE SUMP PUMP

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish and install automatic, submersible, Group 1, Division 1, Class D explosion proof sewage and dewatering pump of type, capacity, and in the location as shown on the Drawings and as specified herein.

B. Related Work Specified Elsewhere: "Plumbing - General" is specified in this Division. "Electrical-General" is specified in Section 16010.

1.2 QUALITY ASSURANCE

A. Acceptable Manufacturers:
   1. Zoeller Pump Company
   2. Liberty Pumps
   3. Or approved equal.

PART 2 - MATERIALS

2.1 SUMP PUMPS

A. Simplex systems:
   1. Pump:
      a. Non-clogging cast iron vortex impeller design.
      b. Stainless steel rotor shaft.
      c. Cast iron constructed cover, motor adapter and pump housing.
      d. Stainless steel bolts, handle, guard and float rod guide, switch arm and actuator assembly.
      e. 1 ½" NPT threaded conduit connection.
      f. Upper and lower ball bearing running in bath of oil.
      g. Neoprene square ring seals throughout.
      h. Capable of passing 2" spherical solids.
      i. 2" NPT female flanged vertical discharge.
      j. Corrosion resistant powder coated epoxy finish.
   2. Motor:
      a. FM listed motor for Class I, Div. 1, Group C&D environment.
      b. Sensor and power leads in one cord.
      c. Oil-filled, hermetically sealed motor.
      d. Automatic reset thermal overload protected.
      e. ½ HP, 115 volt, single phase.
   3. Control:
      a. Brass float and float rod.
      b. On point: 19 ¾".
      c. Off point: 10:"
   4. Capacity: 20 GPM at 22 foot discharge head.

5. Equal to Zoeller model MX282.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install where shown on Drawings.
B. Provide a gate valve and a check valve in discharge pipe above sump pump, where shown on the Drawings.
C. Provide a union on the pump side of the gate valve to permit removal of pump unit.
D. Extend discharge as shown on the Drawings. Discharge piping shall be PVC unless otherwise noted.

3.2 TESTS

A. Test operation of pump and controls under actual working conditions in presence of the Engineer.

END OF SECTION

SECTION 15600

HVAC - GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work included:

1. Furnish all labor, materials, equipment and transportation as required to completely install the heating and ventilation system as shown on the Drawings and as specified herein.
2. The heating and ventilating work shall include, but not be limited to the following:
   a. Heating system piping, valves, supports, and specialties.
   b. Heat generation and transfer equipment.
   c. Ductwork and devices.
   d. Air moving and air handling equipment.
   e. Automatic temperature control systems.
   f. Pipe and equipment insulation.
   g. Balancing air and water systems.
   h. Installation of components and devices furnished by other trades that are located in Heating and Ventilating piping, ducts, or equipment.

B. Related Work Specified Elsewhere (When Applicable) :

1. Excavation and backfill is specified in Division 2.
2. Concrete is specified in Division 3.
3. Structural steel is specified in Division 5.
4. Painting is specified in Division 9.
5. All equipment shall comply with Specification Section 11000, Equipment General.
6. Pipe Sleeves and Seals are specified in Section 15092.
7. Pipe, insulation, ductwork, dampers, fans, etc., are specified in the appropriate Sections in this Division.
8. Electrical Work:
   a. The H&V work shall include the installation of all motors, temperature controls, limit switches, etc., as herein specified. All 480-volt, 208-volt, and 120-volt wiring and connections, and all motor starters, not specified in this Section, will be provided under Division 16 - Electrical.
   b. All 24 volt wiring and auxiliary devices required for the specified systems, equipment and operations indicated in this Section shall be provided under this Section, unless specifically indicated on the Drawings related to Division 16 - Electrical. This shall include, but is not necessarily limited to, all wiring for automatic temperature and damper modulation control.
   c. The materials and methods for all electrical work provided under this Section shall comply with the requirements specified under Division 16 - Electrical. Coordinate equipment ratings, starter sizes, protective device

sizes, wire and conduit sizes, holding coil voltages and control voltages with Division 16.

C. Design Criteria: The Drawings do not show every detail of pipe, valves, fittings, hangers and equipment which are necessary for the complete installation, but are provided to show the general arrangement and extent of work to be performed.

1.2 SUBMITTALS TO THE ENGINEER

A. Submit shop drawings as specified in the General Conditions of the Construction Contract and as stated in each Section.

B. Submit manufacturer's installation, operation, and maintenance information for all mechanical equipment as specified in the General Conditions. Information shall consist of, but not be limited to, the following:

1. Manufacturer's operation & maintenance manuals.
2. Parts List.
3. Address of local suppliers for parts.
4. Address of local factory approved service organizations.

1.3 DELIVERY, STORAGE, AND HANDLING

A. The Contractor shall be responsible for the care and protection of all materials and mechanical work until the project is accepted by the Owner.

B. Immediately remove from the construction site all materials damaged and/or destroyed and replace with new materials to the complete satisfaction of the Engineer without additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide and install only new materials and equipment and of the latest design of the respective manufacturers.

B. All materials and equipment of the same classification shall be the product of the same manufacturer unless otherwise specified.

C. Provide all electrical specialties and accessories as specified with the equipment in accordance with requirements of Division l6. All specialties and accessories shall meet the NEMA Electrical Classification of the space in which they are installed. See Drawing Sheet E-1 for the NEMA Schedule.

D. Furnish to the proper trades, all manufacturer's wiring diagrams for installation of mechanical equipment.

E. Provide tee fittings, elbows, reducers, sheet metal safing, and other required components to install equipment and control devices furnished by other trades.

F. Furnish and install all necessary supports and bases for all items furnished under HVAC as required for the specific item/equipment to provide alignment to adjacent inlet and outlet interconnecting piping and/or ductwork. In the absence of specific details within the Contract Documents for the supports and bases, submit proposal outlining supports/bases for the specific item/equipment being provided including materials of construction, size, components and other necessary details for review and acceptance by the Engineer. Materials of construction shall be suitable for the intended operating environment. Standard 4-inch concrete housekeeping pads are

not included within this specification and are furnished by others.

2.2 BOLTS, ANCHOR BOLTS AND NUTS

A. Furnish all necessary bolts, anchor bolts, nuts, washers, lock washers or locking nuts, plates and bolt sleeves in accordance herewith. Anchor bolts shall have suitable washers, lock washers and, where so required, their nuts shall be hexagonal.

B. All bolts, anchor bolts, nuts, washers, lock washers, plates, and bolt sleeves shall be galvanized unless otherwise indicated below or specified elsewhere.

1. Galvanized steel in accordance with Division 5 unless otherwise indicated below or specified elsewhere.
2. Stainless steel hardware (minimum of Type 304, unless otherwise indicated) is required in all corrosive atmospheres, exterior areas, and/or areas with NEMA 4X or NEMA 7 rating.
3. Stainless steel hardware (minimum of Type 316, unless otherwise indicated) is required in all submerged applications, including but not limited to the headworks, dewatering rooms, chemical rooms, clarifiers, aeration basins, splitter structures, equalization or storage tanks, etc. For additional description and definition of submerged surfaces refer to Specification Section 09900.

2.3 EQUIPMENT AND VALVE TAGS

A. All new plumbing and HVAC (Mechanical Systems) equipment shall be identified by a color coded equipment/valve tag, provided and installed by the Contractor. Contractor shall submit a complete list of proposed Identification Tag information and it shall be reviewed by the Engineer and Owner and revised as indicated. In general, tag information shall match the information provided on the Drawings.

B. Tags shall conform to the following specifications:

1. The tags shall be 2.5-inch diameter, 1/16" thick, rigid, multi-layered sandwich laminate with contrasting inner and outer colored acrylic plastic layers. Top hole size is 5/32" for hanging tags.
2. Tags shall be available in 7 different outside colors. Owner and Engineer shall select up to 4 different colors for the project.
3. Tags shall have up to three lines engraved on a side and eight characters per line of identification information. Tags shall be engraved one side.
4. Tags shall be secured to valves with nylon cable ties or adjustable stainless steel bead chain. Securing method shall be selected by the Owner and Engineer.
5. Tags secured to equipment shall be fastened to a flat visible surface by a minimum of two SS screws or SS pop rivets.
6. Tags shall have a service temperature of -40°F to 175°F
7. Manufactured by Seton Name Plate Corporation, New Haven, CT, Brimar Industries, Garfield, NJ, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all work with a neat and orderly appearance, as specified and as shown on the Drawings.

B. Make all installations structurally sound throughout.
C. Locate all installations to avoid interference with cranes and materials handling equipment, storage areas, work of other trades, and traffic areas.
D. Perform all work incidental to the installation of the apparatus and materials including, but not limited to, cutting, patching, trenching, excavating, backfilling, trench covering, plastering and the constructing of chases, slots, furring, foundations, piers and pads, when applicable. All work shall be performed in accordance with the applicable Divisions of this Specification by qualified workmen regularly employed in the applicable trades.

3.2 CLEANING

A. Do not allow refuse and surplus materials to accumulate and obstruct the construction site.
B. Upon completion of the installation, remove refuse and surplus materials from the construction site and leave the building neat and clean.

3.3 BALANCING

A. Balancing of air and water system flows shall be in accordance with Section 15907.

3.4 IDENTIFICATION

A. All HVAC piping, valves, pumps and equipment shall be painted and labeled in accordance with Specification Section 09900 or as specified herein.
B. Signage is specified in Section 10140.

END OF SECTION

SECTION 15601

HYDRONIC HEATING SYSTEMS
PIPING AND SPECIALTIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Provide and install a complete hot water heating system including all the required specialties and appurtenances as shown on the Drawings and as specified herein.

B. Related Work Specified Elsewhere:
   1. "HVAC - General" is specified in this Division.
   2. “Steel Pipe & Fittings” is specified in Section 15061.
   3. “Copper Pipe & Fittings” is specified in Section 15063.

1.2 QUALITY ASSURANCE

A. Acceptable Manufacturers:
   1. Valves:
      a. Stockham.
      b. Crane.
      c. Nibco.
      d. Walworth.
      e. Or Approved Equal.
   2. Specialties:
      a. Bell & Gossett.
      b. Taco.
      c. Or Approved Equal.
   3. Instruments:
      a. Trerice.
      b. U.S. Gauge.
      c. Taylor.
      d. Or approved equal.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Manufacturers' names given below are intended to identify type and style. Products of other manufacturers may be acceptable upon the approval of the Engineer.

B. Pipe: Schedule 40 black steel or Type L copper.

C. Valves (general):
   1. Gate Valves:
      a. Up to and including 2-1/2 inch - screwed or solder end, bronze body, rising stem, solid bronze disc, 125 psi steam pressure. Equal to Nibco T-111 or S-111.
   2. Globe Valves:

a. Up to and including 2-1/2 inch - screwed or solder end, bronze body, TFE disc, 125 psi steam pressure. Equal to Nibco T-211 or S-211.

3. Check Valves:
   a. Up to and including 2-1/2 inch - screwed or solder end, bronze body, Buna-N disc, 200 psi WOG cold pressure. Equal to Nibco T-413-W or S-413-W.
4. Ball Valve: Acceptable in lieu of gate and globe valves for 2 inch and smaller, full port bronze ball screwed or solder ends, 3-part bronze body, TFE or equal resilient seat, lever handle, 400lb. WOG. Equal to NIBCO S-595-W.

D. Strainer:
1. "Y" Pattern: Bronze or cast iron body, screw or flange ends, 250 psi body, stainless steel screen of 40 mesh.
2. Basket Type: Bronze or cast iron body, clamped cover, l25 psi working pressure, perforated brass basket, equal to Mueller #l25.

E. Air Separation (as indicated):
1. In Line: In-line cast iron or fabricated steel, removable strainer, l25lb ASME Construction, Bell & Gossett, Rolairtrol or Equal.

F. Pressurized Diaphragm Expansion Tank:
1. Size and capacity as indicated on the Drawings.
2. Steel shell designed and constructed per ASME Section VIII.
3. Heavy duty Butyl rubber diaphragm removable for inspection.
4. Working pressure - 125 psig.
5. Operating temperature - 240°F.
6. Vertical floor mounted style.
7. Equal to Taco CAX.

G. Make-up Water Pressure Reducing Valve: Brass body with anti-siphon check valve, integral strainer, field adjustable spring, l2 PSI setting, equal to Bell & Gossett FB38.

H. Make-up water reduced pressure zone backflow preventer; Assembly shall consist of an internal pressure differential relief valve located in a zone between two positive seating check modules with captured springs and silicone seat discs. Service of all internal components shall be through a single access bronze cover secured with stainless steel bolts. The assembly shall also include two resilient seated isolation valves, four test cocks and an air gap drain fitting. Equal to Watts series 009.

I. Self-Contained Thermostatic Valve:
1. Equal to Danfoss RA-6.
2. Capillary tubing and bulb thermostatic element with guard when exposed.
3. Combination thermostat dial and control valve.
4. Bronze body valve with composition disc.

J. Triple Duty Valves
1. Equal to Bell & Gossett Model 3D or 3DS.
2. Cast iron body construction.
3. Designed to permit repacking under full line pressure.
4. Non-slam check valve with a spring loaded weighted disc and a calibrated adjustment feature permitting regulation of pump discharge flow and shut off.
5. Acceptable in lieu of gate, check and balancing valve on discharge of each pump.

K. Vents:
   1. Provide vents at all piping high points and where indicated.
   2. Automatic vents shall be ½-inch connection, l25 PSI working pressure, brass body with built-in air chamber. Provide gate valve between piping system and vent.
   3. Manual vents shall consist of a minimum 3/4-inch air chamber with 3/8-inch piping and gate valve off top.

L. Thermometers:
   1. Furnish brass immersion thermowells where indicated on the Drawings.
   2. Furnish two additional immersion thermometers suitable for all thermowells for use in balancing and by operating personnel.
   3. Furnish and install where indicated on the drawings 9-inch separable socket mercury thermometer with a range of 30 to 240°F. Provide adjustable angle type where required for proper visibility. Equal to Trerice industrial thermometers.

M. Pressure Gauges:
   1. Furnish pressure gauge connections where indicated consisting of ¼-inch take-off and globe valve.
   2. Furnish 0-l00 PSI, 3-l/2-inch pressure gauge where indicated. Equal to Trerice Model 600.

N. Expansion Compensator: Brass body with stainless steel or brass bellows capable of l-inch minimum change in length.

O. Balancing/Flow Measuring Valve:
   1. Meter connections with built-in check valve.
   2. Integral pointer register in degree of valve opening.
   3. Bubble tight shut-off.
   4. l25-pound working pressure.
   5. Equal to Bell & Gossett circuit setter.

P. Pressure Relief Valve:
   1. Diaphragm operated, ASME rated in BTU/hr.
   2. Capacity shall exceed the maximum heating capacity of the protected device by 110% minimum. Set point shall be equal to or less than the normal working pressure of the protected device.
   3. Fluid shall not discharge into valve chamber.
   4. Low blow-down differential.
   5. Equal to Bell & Gossett.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide offsets in all pipe to place in proper position and avoid work of other trades.

B. Erect all piping to provide for easy and noiseless circulation of hot water under all working conditions.

C. Use inverted eccentric fittings to reduce the size of the water mains.

D. Make proper allowances for the expansion and contraction of all piping. Anchor piping where necessary to control expansion.

E. Install a sufficient number of unions for disassembling pipe around equipment.
F. Weld all steel piping 3 inches and larger in size. Weld or install screwed fittings in pipe 2-l/2 inches and under in size.
G. Install piping level or slightly pitched upward in the direction of flow so that no air pockets are formed in the piping.
H. Install pipe hangers to properly support all equipment and piping in accordance with Specification Section 15094.
I. Sleeves and Plates:
    1. Provide and install sleeves sized to provide 1/4 inch minimum annular space around pipes passing through masonry walls and floors. Allow all insulation to pass through sleeves except where gas-tight calking is required.
    2. Where exposed pipes pass through finished walls, floors, ceilings, etc. provide and set split cover plates.
J. Drains:
    1. Provide drain valves where shown on the Drawings, at all low points, and at all equipment.
    2. Drains shall be l/2 inch hose valve style.
K. Provide and install dielectric unions at junction of pipes of dissimilar metals.
L. Provide and install control measurement and valves in piping systems that are supplied by other trades.
M. Provide and install unions to allow removal of all control valves.

3.2 TESTING AND BALANCING

A. Perform a hydrostatic pressure test on all piping and equipment.
B. Test pressure shall be l00 psi or l-l/2 times the working pressure, whichever is greater.
C. Repair, replace and rework, as required, to repair any defects and retest for approval.
D. Perform all testing prior to installation of insulation. Test systems in sections as required to prevent delay of project.
E. Balance the entire hydronic heating system in accordance with applicable sections of Division 1 and Section 15907 of this Division.
F. Operational Test: Upon completion of installation of all equipment and acceptance of tests and balancing, perform a 24-hour continuous operational test in the presence of the Engineers and Owner's representative to demonstrate proper operation of all functions of the equipment and system.

3.3 PAINTING AND IDENTIFICATION

A. All heating system piping, valves, pumps and equipment shall be painted and labeled in accordance with Specification Section 09900.

END OF SECTION

SECTION 15604

AUTOMATIC TEMPERATURE CONTROL (ELECTRIC)

PART 1 - GENERAL

1.1 DESCRIPTION

A. Furnish, install and test an Automatic Temperature Control (ATC) system of the type and function required on the Drawings and as herein specified.
   1. Type of System: Electric.

B. Related Work Specified Elsewhere: "HVAC - General" is specified in this Division. "Cabinets and Enclosures" is specified in Section 16160.

C. Other Trades: The automatic temperature control trades shall coordinate and supervise other trades whose work affects the control systems.

D. Work Performed by Other Trades: The following incidental work shall be furnished by the designated trade under the supervision of the automatic temperature control (ATC) trade:
   1. The heating/cooling trades shall:
      a. Install automatic valves and separable wells that are specified to be supplied as a portion of the control systems.
      b. Furnish and install all necessary: valved pressure taps, water, drain and overflow connections and piping.
   2. The sheet metal trades shall:
      a. Furnish and install all automatic dampers.
      b. Provide necessary blank-off plates required to install dampers that are smaller than duct size.
      c. Assemble multiple section dampers with required interconnecting linkages and extend required number of shafts through duct for external mounting of damper motors.
      d. Provide necessary sheet metal baffle plates to eliminate stratification and provide air volumes specified. Locate baffles by experimentation and affix and seal permanently in place only after stratification problem has been eliminated.
      e. Provide access doors or other approved means of access through ducts for service to control equipment.

1.2 QUALITY ASSURANCE

A. The system shall be installed, tested, and balanced by competent mechanics regularly employed by the temperature control manufacturer.

B. Acceptable Manufacturers:
   1. Honeywell.
   2. Johnson Service Co.
   3. MCC Powers
   4. Barber-Coleman
   5. Robertshaw
   6. or equal

1.3 SUBMITTALS TO THE ENGINEER

A. Shop drawings shall be submitted for approval as required by the General Conditions. Shop drawings shall consist of, but not be limited to, the following:
   1. Manufacturer's literature for all equipment including maintenance and operating instructions and parts lists.
   2. Description of operation for all systems.
   3. Electric wiring diagrams showing all wiring, and equipment including all inter-connections on a terminal to terminal basis. Refer to ladder wiring diagrams shown on the Drawings. Note any discrepancies due to actual system submitted.
   4. Panel layouts for all local and central panels, and panel sizes.
   5. Valve and damper operator schedule showing size, configuration, capacity and location of all equipment.
   6. A detailed explanation of any control system that is different, or will function differently than that specified.

1.4 JOB CONDITIONS

A. Scheduling of Work: Schedule all work so as not to delay the work of other trades.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:
   1. The control system shall consist of all thermostats, temperature transmitters, controllers, automatic valves and dampers, damper operators, control panels, and other accessory equipment to fill the intent of the specification and provide for a complete and operable system.
   2. All 24 volt control wiring shall be provided by the automatic temperature control contractor as shown or required to provide a complete system.
   3. Refer to Drawings for electrical wiring and interlocks.
   4. All panels and devices shall meet the NEMA electrical classification of the space in which they are installed. See Drawing Sheet E-1 for NEMA schedule.

B. Electric Line-Voltage Industrial Thermostat:
   1. Furnish and install industrial/heavy commercial grade, Line-Voltage type thermostats in NEMA 12, 3R, 4/4X process and production areas capable of directly activating heating or cooling equipment.
   2. Thermostat shall be wall mounted in a heavy duty metal enclosure. The enclosure shall meet the NEMA requirements of the are in which they are installed. Minimum rating shall be dust tight, NEMA 12.
   3. Switching shall be SPST with a minimum rating of 16 Full Load Amps (FLA) and 80 Locked Rotor Amps (LRA) at 120 VAC or the full load rating of the device(s) to be activated, whichever is greater.
   4. Differential shall be fixed 3-5 deg. F.
   5. Bulbs shall be corrosion resistant, shielded and either locally or remote mounted as required.

6. Covers shall have temperature set point adjustment knob except when concealed or removable key adjustment is noted. Scale range shall be 40 to 100 °F unless described otherwise in the control description under paragraph 3.1.
7. In areas of a building that comply with the Americans with disabilities act, thermostats shall be mounted at a height of 48" above a finished floor.

C. Industrial Temperature Controller:
1. Furnish and install industrial/heavy commercial grade, Temperature Controllers in NEMA 12, 3R, 4/4X process and production areas capable of controlling heating and cooling equipment through motor starters, variable speed drives, industrial relays or other equipment control devices.
2. The temperature controller shall be programmable for staged on-off heating and cooling control with front mounted program pushbuttons with LCD backlit display to show current temperature, setpoint and programming modes.
3. Temperature controller shall be wall mounted in a metal enclosure. The enclosure shall meet the NEMA requirements of the area in which they are installed. Minimum rating shall be dust tight, NEMA 12.
4. Power shall be 120 VAC with battery backup or programmed parameter stored in non-volatile memory.
5. The controller will include a minimum of four (4) form C contacts rated a minimum of 5 amps at 120 VAC.
6. Differential shall be programmable from 1-5 °F.
7. Temperature sensor shall be a shielded and water tight platinum RTD temperature sensor mounted external to the control enclosure or remotely mounted as required.
8. In areas of a building that comply with the Americans with disabilities act, thermostats shall be mounted at a height of 48" above a finished floor.
9. Honeywell Model T775, Johnson Controls, or equal.

D. Commercial Room Thermostat:
1. Furnish and install commercial grade thermostats in office and administrative areas capable of controlling heating, cooling and ventilation. Provide cover guards in publicly accessible areas.
2. Low voltage temperature controllers shall be programmable for multistage 7-day heating and cooling control with front mounted program pushbuttons and LCD backlit display to show current temperature, setpoint and programming modes.
3. Temperature controller shall be wall mounted.
4. Power shall be 24/120 VAC with real time clock and battery backup or programmed parameter stored in non-volatile memory.
5. Temperature sensor shall be a thermistor or RTD sensor internal to the unit.
6. In areas of a building that comply with the Americans with disabilities act, thermostats shall be mounted at a height of 48" above a finished floor.

E. Duct and Immersion Thermostats:
1. Duct and immersion thermostats of the single input type shall have integral setpoint adjustments and throttling ranges adequate for the application. Duct thermostats shall have sensing elements of sufficient length and accuracy to measure average duct temperature in each location.

2. Controllers shall be designed and constructed for equipment room use and shall not be affected by ambient temperature and humidity.
3. Duct mounted or immersion type shall have spans of one hundred degrees or two hundred degrees Fahrenheit as required. Averaging element sensors shall have a minimum nine-foot capillary element. Temperature sensors shall be of rigid stem using bimetallic sensing elements except where averaging is required.
4. Sensors shall be of corrosion resistant construction, tamper proof, suitable for mounting on a vibrating surface. If capillary, shall be temperature compensated and armored or installed in protective tubing.
5. All sensing elements for water pipe mounting shall be furnished complete with separable protecting wells filled with heat conductive compound. Sensors shall be factory calibrated and tamper proof. If easily adjustable sensors are provided, they shall be located inside metal enclosures with cylinder lock and key to prevent unauthorized setting.

F. Low Temperature Safety Thermostat (Freezestat):
1. Electric: Low temperature safety thermostats shall be capillary type, with 20 ft. low point sensitive elements (not averaging type) installed in serpentine arrangement across discharge face of coil. These thermostats shall be two position, double-pole manual reset type. Devices used on integral coil face and bypass units shall have remote thermostat, and have bulb in accordance with manufacturer's requirements.

G. High Temperature Safety Thermostat:
1. Electric: High temperature safety thermostat shall be duct mounted manual reset type with adjustable setpoint. (75-165 degrees F).

H. Smoke Detectors:
1. Duct smoke detectors shall be furnished under Division 16 and installed under Division 15. Power and alarm indication wiring to the Fire Alarm Control Panel to be provided under Division 16.

I. Thermometers:
1. A thermometer shall be located adjacent to each rigid stem thermostat. A dual thermometer with liquid-filled remote system shall be mounted adjacent to each remote bulb thermostat. Averaging bulb thermometers shall be used where averaging bulb thermostats are required.
2. Provide duct-type thermometers in all fresh air intake, mixed air, return air, and all supply fan discharges and elsewhere where noted or shown. Thermometers shall have the proper range scales for the locations where installed.
3. Panel-mounted indicating thermometers shall be minimum two inches' diameter.

J. Duct-mounted Airflow Switch:
1. SPDT paddle-type or thermal dispersion proof- of- airflow switch, for mounting in ductwork of ventilation equipment serving Class 1/Division 2 rated areas and Unclassified rated areas in accordance with NFPA 820.
    a. Paddle type: Stainless steel paddle, range adjustment screw, 120 Volt, 16 FLS AC rated. Unit shall have NEMA 4X or NEMA 7 enclosure in areas requiring same. Furnish switch, for mounting in ductwork by mechanical

contractor; provide wiring to ATC panel. Dwyer V4, Johnson Controls, or equal.

b. Thermal dispersion: 316 Stainless steel sensor head, NEMA 4X and Class 1 Division 1&2 rated powder coated housing, 120VAC, 4W. Ameritrol FX, Johnson Controls, or equal.

K. Differential Pressure Controllers:
1. Static pressure regulators shall be direct or reverse acting as required with adjustable setpoint and throttling range with field calibration capability.

L. Control Valves: Three-way, two-way, mixing, or diverting service as required. Operator shall be electric. Valve pressure drop shall not exceed 7 feet water column (w.c.). Control valves shall be sized by the ATC contractor.

M. Dampers:
1. All control dampers shall be furnished as part of Section 15862.
2. All dampers shall be installed by sheet metal trades.

N. Damper Operators and Linkages:
1. Damper operators shall be electric open-close or fully proportioning as indicated or required.
2. Linkages shall be suitable to connect operator to damper leaves and transmit full torque of motor. All necessary hardware shall be included with the linkages.
3. Damper motors shall be quiet in operation and shall have ample power to overcome friction of damper linkage and air pressure acting on louvers to position dampers accurately and smoothly. The damper operator mounting arrangement shall be outside the airstream wherever possible.
4. The operators shall be capable of operating at varying rates of speed to correspond to the dictates of the controllers and variable load requirements. The operators shall be capable of operating in sequence when required by the sequence of the operation. The operators shall have external adjustable stops to limit the stroke in either direction. The operator linkage arrangement shall be such as to permit normally open or normally closed positions of the dampers as required.
5. Electric Operators:
a. On-off, reversing, or proportional as required.
b. Spring return to closed or open position as required.
6. Dampers associated with emergency generator cooling shall fail open on loss of electrical power.

O. Electric Humidistats:
1. Humidistats shall be line or low voltage with an adjustable setpoint range as indicated or required. Contacts shall be rated to handle the current load for the application.

P. Miscellaneous Devices:
1. Provide all the necessary relays, positioners, clocks, transformers, etc. to make a complete and operable system.
2. Locate these devices on local panel unless specified otherwise.

Q. Miscellaneous Hand Switches and Indicator Lights:
1. Size: 30 mm

2. All indicator lights shall be 120V AC, LED with push to test option.
3. Reference Section 16900 for additional specifications.
4. Number of positions and nameplate legends shall be as indicated in Paragraph 3.1 of this specification.

R. Relays:
1. Pilot duty relays shall be Form C, UL listed, two (2) to four (4) pole relay with DIN rail mounted base rated a minimum of 5 amps at 120 VAC. Relay shall have indicator and mechanical test pushbutton.
2. Industrial relays or contactors shall be used to directly drive 120 VAC single phase equipment.
3. Refer to Section 16900 for additional requirements.

S. Panels:
1. Panels shall be provided to enclose all relays, switches, and controllers as required.
2. Required indicating and control devices shall be installed in the cover.
3. Terminal strips shall be provided for all electrical connections.
4. Panels shall be central and/or local as indicated or required.
5. Control Panels shall be provided in accordance with Section 16160 and NEMA schedule on drawing sheet E-1.

T. Gas Detectors:
1. All gas detectors shall be provided under Division 13. Power and alarm indication wiring to the Main Control Panel to be provided under Division 13.
2. Each detector shall be furnished with one extra set of SPDT dry contacts for use by the ATC contactor only.

U. Gauges: Thermometers and pressure indicating gauges shall be provided as shown on the Drawings and other points throughout the system where the visual indication of temperature or pressure is required or will prove beneficial to operating personnel in the operation of the control system. Gauges will not be required on room type thermostats.

V. Timer/Controller: Repeat Reset Cycle Timers shall be rated 120 volts. The cycle shall automatically reset to origin upon loss of power. The "ON" timing circuit shall be continuously adjustable up to a period of 60 minutes. The "OFF" timing circuit shall be continuously adjustable up to a period of 10 hours. Both circuits shall have a minimum setting of 3% of range. Setting accuracy shall be 10% of range maximum. Timer life shall have a warrantee through 10,000,000 operations (no load). An LED cycle progress annunciator shall be provided with each timing circuit. Contacts shall be NO and/or NC as detailed on the Drawings, and shall be rated 7 amperes at 125 volts. Repeat, Reset cycle Timers shall be suitable for recessed panel mounting, and shall be Automatic Timing Controls 342 series, Omron Electronics, or equal.

W. Combination Horn/Strobe Unit: 24V, polycarbonate weatherproof, surface mounted combination horn/strobe unit (unmarked). The unit shall be powered and controlled by the associated ATC panel. The horn and strobe circuits shall be capable of independent operation. Edwards Signaling 868 STR series, Eaton, or equal.

PART 3 - EXECUTION

3.1 DESCRIPTION OF OPERATION

A. General – Typical operation shall be as follows unless noted otherwise:
   1. Hydronic Unit Heater (UH):
      a. Wall mounted thermostat provided with unit shall energize the fan as necessary to maintain the space temperature setpoint.
      b. Space temperature setpoint – 55°F (adj.)
   2. Dehumidifier (DH)
      a. Provide wall mounted humidistat.
      b. When the relative humidity at the humidistat rises above the setpoint (50% adj.), the unit shall be energized. The reverse shall occur when the setpoint has been satisfied.
   3. Boiler (B)
      a. Boilers shall operate using unitary controls to maintain hot water system temperature setpoint.
      b. When the outside air temperature falls below 50°F, the boiler shall be enabled.
      c. Boiler pump (BP) and circulating pump (CP) shall be controlled by the boiler unitary controls. The circulating pump shall run continuously when the boiler is enabled.
   4. Duct-Mounted Flow Switch: If the proof-of-flow switch indicates a lack of air flow the associated horns and/or strobes shall be activated. Refer to the Ventilation Monitoring Horn / Strobe Activation Schedule this Section.
      a. Maintenance Switch: Provide two position selector switch on door of ATC panel. Label switch “Ventilation Monitoring Alarm” and the positions “Maintenance” and “Active”. The switch shall disengage the operation of the horns and strobes when in the “Maintenance” position.

B. Old Norwich PS Drywell Ventilation:
   1. Controlled by the following associated with the ATC panel:
      a. Hand/Auto switch
      b. Light status relays (provided by Division 16). Provide wiring to dry contacts; coordinate locations with electrical contractor and electrical plans; refer to ATC riser diagrams for additional information.
      c. Existing combustible gas detector (provide wiring to detector alarm panel dry contacts; coordinate connection as require to send signal to SCADA system to alert operator to alarm condition)
   2. When the lights in the space served are energized, the space shall be considered occupied; when the lights are de-energized, the space shall be considered unoccupied.
   3. If the space is occupied, the switch is in “Hand” position, or the combustible gas detector is in alarm condition;
      a. EF-ON1
         i. The motorized backdraft damper (D-ON1) shall open.
         ii. The motorized intake air damper (*D-ON-E1*) shall open.
         iii. The fan shall be energized.
         iv. The ECM motor shall modulate the fan speed to operate at the

design airflow.

b. SF-ON1:

i. The fan shall be energized and operate continuously.

4. If the space is unoccupied and the switch is in "Auto" position;

a. EF-ON1

i. The motorized backdraft damper (D-ON1) shall open.

ii. The motorized intake air damper (*D-ON-E1*) shall open.

iii. The fan shall be energized.

iv. The ECM motor shall modulate the fan speed to operate at 25% of the design airflow.

b. SF-ON1:

i. The fan shall be energized and operate continuously.

5. Safeties:

a. Duct-Mounted Flow Switch: Refer to typical (§ 3.1.A.4).

C. Old Norwich PS Wetwell Ventilation:

1. Controlled by the following associated with the ATC panel:

a. Hand/Off/Auto switch

b. Run cycle timer

c. Outside air temperature sensor

d. Light status relays (provided by Division 16). Provide wiring to dry contacts; coordinate locations with electrical contractor and electrical plans; refer to ATC riser diagrams for additional information.

e. Existing combustible gas detector (provide wiring to detector alarm panel dry contacts; coordinate connection as require to send signal to SCADA system to alert operator to alarm condition)

2. When the lights in the space served are energized, the space shall be considered occupied; when the lights are de-energized, the space shall be considered unoccupied.

3. If the outside air temperature is greater than 50°F, the space is occupied, the combustible gas detector is in alarm condition, or the switch is in "Hand" position;

a. EF-ON2

i. The motorized intake damper (D-ON2) shall open.

ii. The fan shall be energized.

4. If the switch is in the "Off" position;

a. EF-ON2

i. The motorized intake damper (D-ON2) shall close.

ii. The fan shall be de-energized.

5. If the outside air temperature is less than 50°F, the space is unoccupied, and the switch is in "Auto" position;

a. EF-ON2 - shall be controlled by the run cycle timer on repeating schedule:

i. Active:

(1) The motorized intake damper (D-ON2) shall open.

(2) The fan shall be energized.

ii. Inactive:

(1) The motorized intake damper (D-ON2) shall close.

(2) The fan shall be de-energized.

iii. Active – 10 minutes; Inactive – 20 minutes (adj.)

D. Evergreen PS Drywell Ventilation:

1. Controlled by the following associated with the ATC panel:
   a. Hand/Auto switch
   b. Light status relays (provided by Division 16). Provide wiring to dry contacts; coordinate locations with electrical contractor and electrical plans; refer to ATC riser diagrams for additional information.
   c. Existing combustible gas detector (provide wiring to detector alarm panel dry contacts; coordinate connection as required to send signal to SCADA system to alert operator to alarm condition)
2. When the lights in the space served are energized, the space shall be considered occupied; when the lights are de-energized, the space shall be considered unoccupied.
3. If the space is occupied, the switch is in "Hand" position, or the combustible gas detector is in alarm condition;
   a. AHU-EG1
      i. The motorized return air damper shall be closed fully.
      ii. The motorized outside air damper shall be open fully.
      iii. The fan shall be energized and operate continuously at the design airflow.
   b. EF-EG2
      i. The motorized backdraft damper (existing) shall open.
      ii. The fan shall be energized.
      iii. The ECM motor shall modulate the fan speed to operate at the design airflow.
4. If the space is unoccupied and the switch is in the "Auto" position:
   a. AHU-EG1
      i. The motorized return air damper shall be open to allow 75% of the design airflow to be recirculated to the unit.
      ii. The motorized outside air damper shall be open to allow 25% of the design airflow to be introduced from the outside.
      iii. The fan shall be energized and operate continuously at the design airflow.
   b. EF-EG2
      i. The motorized backdraft damper (existing) shall open.
      ii. The fan shall be energized.
      iii. The ECM motor shall modulate the fan speed to operate at 25% of the design airflow.
5. Safeties:
   a. Duct-Mounted Flow Switch: Refer to typical (§ 3.1.A.4).

E. Evergreen PS Drywell Heating & Cooling:

1. AHU-EG1
   a. The packaged unitary controls and manufacturer provided remote controller/sensor shall modulate the unit (compressors, hot gas reheat, gas furnace, etc.) as necessary to maintain the setpoints.

i. Cooling:
(1) Space temperature - 85°F
ii. Heating:
(1) Space temperature - 55°F
(2) Discharge air temperature - 55°F
iii. Dehumidification:
(1) Space relative humidity - 50%
(2) Discharge air temperature - 70°F (when space cooling not required and unit in dehumidification mode)

F. Evergreen PS Wetwell Ventilation:
1. Controlled by the following associated with the ATC panel:
a. Hand/Off/Auto switch
b. Run cycle timer
c. Outside air temperature sensor
d. Light status relays (provided by Division 16). Provide wiring to dry contacts; coordinate locations with electrical contractor and electrical plans; refer to ATC riser diagrams for additional information.
e. Existing combustible gas detector (provide wiring to detector alarm panel dry contacts; coordinate connection as require to send signal to SCADA system to alert operator to alarm condition)
2. When the lights in the space served are energized, the space shall be considered occupied; when the lights are de-energized, the space shall be considered unoccupied.
3. If the outside air temperature is greater than 50°F, the space is occupied, the combustible gas detector is in alarm condition, or the switch is in “Hand” position;
a. MUA-EG1
i. The motorized outside air damper shall open fully.
ii. Damper D-EG1 shall open fully.
iii. Damper D-EG2 shall close fully.
iv. The fan shall be energized.
b. EF-EG1
i. The fan shall be energized.
4. If the switch is in the “Off” position;
a. MUA-EG1
i. The motorized outside air damper shall close fully.
ii. Damper D-EG1 shall close fully.
iii. Damper D-EG2 shall open fully.
iv. The fan shall be de-energized.
b. EF-EG1
i. The fan shall be de-energized.
5. If the outside air temperature is less than 50°F, the space is unoccupied, and the switch is in “Auto” position;
a. Equipment shall be controlled by the run cycle timer on repeating schedule:
i. Active:

(1) MUA-EG1
(a) The motorized outside air damper shall open fully.
(b) Damper D-EG1 shall open fully.
(c) Damper D-EG2 shall close fully.
(d) The fan shall be energized.
(2) EF-EG1
(a) The fan shall be energized.

ii. Inactive:
(1) MUA-EG1
(a) The motorized outside air damper shall close fully.
(b) Damper D-EG1 shall close fully.
(c) Damper D-EG2 shall open fully.
(d) The fan shall be de-energized.
(2) EF-EG1
(a) The fan shall be de-energized.

iii. Active – 10 minutes; Inactive – 20 minutes (adj.)

G. Blue Hills PS Drywell Modified Ventilation Controls:
1. Controlled by the following associated with panel ATC-1:
a. Hand/Off/Auto switch (existing)
b. Outside air temperature sensor (existing)
c. Light status relays (provided by Division 16). Provide wiring to dry contacts; coordinate locations with electrical contractor and electrical plans; refer to ATC riser diagrams for additional information. (existing)
d. Combustible gas detector (existing)
2. When the lights in the space served are energized, the space shall be considered occupied; when the lights are de-energized, the space shall be considered unoccupied.
3. If the outside air temperature is greater than 50°F, the space is occupied, the combustible gas detector is in alarm condition, or the switch is in "Hand" position;
a. If the existing condensing unit CU-1 is not operating to provide dehumidification:
i. HV-1 (existing)
(1) D-BH1 shall be to maximum position.
(2) The fan shall be operating at high speed to provide 100% of the design airflow.
ii. EF-BH1
(1) The fan shall be energized.
(2) The integral VFD shall modulate the fan speed to operate at the design airflow.
b. If the existing condensing unit CU-1 is operating to provide dehumidification:
i. HV-1 (existing)
(1) D-BH1 shall be closed as needed to allow 50% of the design airflow to pass through the dehumidification coil (DC-1).
(2) The fan shall be operating at high speed to provide 100% of

the design airflow.

ii. EF-BH1
(1) The fan shall be energized.
(2) The integral VFD shall modulate the fan speed to operate at the design airflow.

4. If the outside air temperature is less than 50°F, the space is unoccupied, and the switch is in "Auto" position;
a. If the existing condensing unit CU-1 is not operating to provide dehumidification:
i. HV-1 (existing)
(1) D-BH1 shall be open to maximum position.
(2) The fan shall be operating at low speed to provide 50% of the design airflow.
ii. EF-BH1
(1) The fan shall be energized.
(2) The integral VFD shall modulate the fan speed to operate at 50% of the design airflow.
b. If the existing condensing unit CU-1 is operating to provide dehumidification:
i. HV-1 (existing)
(1) D-BH1 shall be closed fully.
(2) The fan shall be operating at low speed to provide 50% of the design airflow.
ii. EF-BH1
(1) The fan shall be energized.
(2) The ECM motor shall modulate the fan speed to operate at 50% of the design airflow.

H. Blue Hills PS Wetwell Modified Ventilation Controls:
1. Controlled by the following associated with panel ATC-2:
a. Hand/Off/Auto switch (existing)
b. Outside air temperature sensor (existing)
c. Space thermostat (existing)
d. Light status relays (existing)
e. Combustible gas detector (existing)
2. *Existing sequences of operation: Heat Pump Unit HP-2:*
a. *Heat pump unit, HP-2, shall operate using unitary controls located in control panel, ATC-2, to provide ventilation and heating to the wet well.*
b. *Unit shall be interlocked to operate with existing exhaust fan EF-2.*
c. *HP-2 shall operate continuously at a rate of twelve (12) ACH, 2,400 CFM, while the space is occupied.*
d. *While the space is unoccupied, HP-2 shall operate at a rate equivalent to twelve (12) ACH for fifteen (15) minute periods at thirty (30) minute intervals.*
e. *The unit shall provide heat as needed to maintain the space at a minimum temperature of 55°F.*

f. *When additional heat is needed to maintain the space temperature, the auxiliary electric heater will operate to supplement the heat from the heat pump.*

g. *In the event that the heating and ventilation unit fails to operate, or the combustible gas detector in the wet well detects a hazardous concentration of gas, an alarm light interlocked with the unit shall generate an alarm signal at the control panel.*

3. Additional sequences of operation:

a. When the combustible gas detector is in alarm condition;

i. EF-2 and HP-2 shall be energized and operate continuously at a rate of twelve (12) ACH, 2,400 CFM.

I. Ventilation Monitoring Horn / Strobe Activation Schedule:

Panel	Flow Switch	Horn	Strobe	SCADA notification
ATC-ON1	FSL-ON1 FSL-ON2	H/S-ON2 H/S-ON3 H/S-ON4	H/S-ON1 H/S-ON2 H/S-ON3 H/S-ON4	No
ATC-EG1	FSL-EG1 FSL-EG2	H/S-EG1 H/S-EG2 H/S-EG3	H/S-EG1 H/S-EG2 H/S-EG3	No

3.2 INSTALLATION

A. The automatic temperature control mechanics shall provide supervision and direction for all trades that are installing equipment supplied by the temperature control manufacturer.

B. All controllers, wiring, equipment, etc., shall be installed by mechanics regularly employed by the temperature control manufacturer.

C. Control wiring shall be neatly installed, parallel to building lines, and in locations not subject to damage.

3.3 TESTING AND COMPLETION

A. Demonstrate the function of each system in the presence of the Engineer.

B. Upon completion of the project, the control system provider shall:

1. Completely adjust, ready for use, all thermostats, controllers, valves, damper operators, relays, etc., provided under this Section.

2. Furnish three (3) instruction manuals covering the function and operation of the control systems on the project for the use of the Owner's operating personnel. A representative of the ATC systems provider shall be available on site for 8 hours of start-up and shall conduct an operational test of the system in the presence and satisfaction of the Engineer's designated representative and the Owner's representative. During this 8-hour period, the technician shall instruct the Owner's Representatives in the proper use and routine maintenance of all ATC equipment.

3.4 OPERATOR TRAINING

A. Operator Training shall be performed by a duly authorized representative of the ATC system provider, who is fully trained in the installation, startup and operation of the equipment.

B. Provide combined training and operational assistance for plant operators in the proper operations of the ATC system equipment, and in the techniques, methods, schedules, etc. associated with maintenance.

C. The level of the training and operational assistance provided shall be as required to ensure proper understanding of the equipment's operations, maintenance and warranty conditions. Should the representative require time in addition to the minimums indicated herein to sufficiently detail the proper operations and maintenance of the equipment, it will be provided at no additional cost to Owner. Under absolutely no circumstances shall warrantees become void due to Owner's failure to follow operational and maintenance procedures which were not fully detailed and described in Owner's representatives during these sessions.

D. At the Owner's discretion, the training sessions may be video recorded for Owner's future use.

E. The system provider representative shall fill out the Equipment Training Certification form included within this Section. Training will not be considered complete until this form has been provided to the Engineer.

3.5 IDENTIFICATION

A. Provide all control equipment, panels and manual controls with black lamacoid nameplates engraved with white letters indicating the function, tag number, service or apparatus being served.

B. Properly number all wires and terminals where applicable.

3.6 GUARANTEE

A. The control system designated on Drawings and plans and herein specified, shall be guaranteed to be free from original defects in both material and workmanship for a period of one (1) year of normal use and service, excepting damages from other causes. This guarantee shall become effective starting the date the Owner begins to receive beneficial use of the system.

3.7 PROGRAMMED MAINTENANCE

A. Upon completion of the installation, the control contractor shall submit to the Owner for consideration, an agreement, to provide the necessary programmed maintenance to keep the various control systems in proper working condition.

B. This proposed programmed maintenance agreement shall fully describe the maintenance work to be performed and shall advise the cost of this work during the 1-year guarantee period provided as part of this Contract by the ATC Contractor as well as for subsequent years thereafter.

ATC SYSTEM TRAINING CERTIFICATION

Owner: _____ Date: _____
_____

Project:
_____

_____

Contractor: _____
_____

ATC System Provider _____
Representative: _____
_____

Equipment: _____

1. I have trained the Owner's personnel in the proper operation and maintenance of the above equipment.

_____ _____
(Authorized Representative of the ATC System Provider) (Date)

2. The personnel listed below attended the training session.

_____
_____
_____

_____ _____
(Owner's Representative) (Date)

3. Witnessed by _____ _____
Wright-Pierce (Date)

END OF SECTION

SECTION 15621

SEALED COMBUSTION HOT WATER BOILER

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Provide and install, where shown on the Drawings, packaged, modulating, sealed combustion, power-vented, high efficiency gas-fired boilers.

B. Related Work Specified Elsewhere (When Applicable):
   1. Cast-in-place concrete is specified in Division 3.
   2. Piping, valves, insulation, etc. is specified in the appropriate Sections of this Division.
   3. Electrical is specified in Division l6.

C. Function of Equipment: The System shall be a forced circulation hot water system with boiler and burner, heating and ventilating unit, unit heaters, circulating pumps, temperature controls, and the customary specialties, valves, piping, ducts, grilles, etc., as specified or required to make a complete installation.

1.2 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies: Obtain, at no additional cost to the Owner, all licenses or permits, pay all fees, and comply with all local and state rules and regulations, as well as those of The National Fire Protection Association Section 54 (National Fuel Gas Code) latest edition.

B. Verification of Unit Output: Have the boiler and burner manufacturer's representatives supervise start-up including boiler safety relief valve test, combustion efficiency test over full operating range, and carbon dioxide test. Within ten days thereof furnish a written report to the Engineer, providing all test results and confirming that safety and operating controls and burners have been properly installed, calibrated and adjusted.

C. Acceptable Manufacturers; Boiler:
   1. Lochinvar
   2. HTP
   3. Smith
   4. Weil McLain
   5. Burnham
   6. Or equal.

1.3 SUBMITTALS

A. Shop Drawings: Submit shop drawings as stated in the General Conditions of the Construction Contract.

B. Submit complete manufacturer's installation instructions.

C. Submit all certified reports of verification of unit output test.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver equipment in manufacturer's original unopened protective packaging or skids as job progress requires.

B. Storage: Store equipment in original protective packaging in a clean and dry environment to keep it clean and free of damage of any nature.

C. Handle to prevent damage of any nature to the equipment during installation and storage.

1.5 JOB CONDITIONS

A. Power Characteristics: Provide 120 volt, 1 phase, 60 cycle power wiring to the boiler control panel. Provide wiring to all control and safety devices in accordance with Division l6.

B. Protection:

1. The Contractor shall be completely responsible for the care and protection of all materials and mechanical work until the project is accepted by the Owner.
2. Remove all damaged or destroyed materials and equipment from the site and replace in full compliance of the specification at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Boiler size and capacity shall be as shown on the Drawings.

B. Boiler output shall be minimum net IBR rating.

C. Boiler: Provide:

1. Minimum 18 gauge steel jacket assembly, primed and pre-painted on both sides.
2. 316L stainless steel combustion chamber, sealed and completely enclosed, independent of the outer jacket assembly.
3. Burner/flame observation port.
4. Burner shall be a premix design and constructed of high temperature stainless steel with a woven metal fiber outer covering to provide modulating firing rates.
5. Gas valve designed with negative pressure regulation and be equipped with a variable speed blower system.
6. Leveling legs.
7. Modulating the firing rate down to 20%
8. Integrated 24 VAC digital control system and components.
    a. Capable of controlling a variable speed boiler pump to keep a constant ΔT at all modulation rates.
    b. Capable of accepting a 0-10 VDC input connection for BMS control of modulation or setpoint.
    c. Electronic display for boiler set-up, status, and diagnostics.
    d. Temperature/pressure gauge
    e. High limit temperature control
    f. ASME certified pressure relief valve
    g. Outlet water temperature sensor
    h. Return water temperature sensor
    i. UL 353 certified flue temperature sensor

j. Outdoor air sensor
k. Low water flow protection
l. Built-in adjustable freeze protection.

D. Low voltage connection board with 42 data points for safety and operating controls:
1. Auxiliary Relay
2. Auxiliary Proving Switch
3. Alarm Contacts
4. Runtime Contacts
5. Manual Reset Low Water Cutoff
6. Flow Switch
7. High and Low Gas Pressure Switches
8. Tank Thermostat
9. Three Wall Thermostat/Zone Controls
10. System Supply Sensor
11. Outdoor Sensor
12. Building Management System Signal

E. High voltage terminal strip shall be provided for supply voltage. The high voltage terminal strip plus integral relays provided for independent pump control of the system pump, the boiler pump, and domestic hot water pump.

F. Boiler shall be suitable for use with propylene glycol, up to 50% concentration without contingencies.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide all piping, electrical, etc., in the boiler room to facilitate the installation of the boiler.

3.2 PREPARATION

A. Install boiler and burner in strict accordance with manufacturer's installation instructions, as directed by the Engineer and as shown on the Drawings.
B. Install the boiler on a 3½-inch high concrete pad.
C. Provide and install necessary gas train and pressure regulator(s).
D. Provide and install necessary gas safety shut-offs.
E. Provide and install CPVC combustion air intake and vent.

3.3 INSTALLATION

A. After the installation is complete, flush and clean the system in accordance with the boiler manufacturer’s recommendations. Test the system under normal operating conditions in the presence of the Engineer.

3.4 CLEANING

A. Upon completion of the installation, remove all of the refuse and surplus materials from the site and leave the building neat and clean.

END OF SECTION

SECTION 15626

HVAC SYSTEM PUMPS (IN-LINE CIRCULATORS)

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Provide and install horizontal inline centrifugal single stage pumps with the capacities and characteristics as shown on the equipment schedules.

B. Related Work Specified Elsewhere: "HVAC - General" is specified in this Division.

1.2 QUALITY ASSURANCE

A. Verification of Unit Output: Equipment shall be supplied with manufacturer's certificate and pump curve for rated performance, horsepower, etc.

B. Acceptable Manufacturers:

1. Grundfos
2. Taco
3. Aurora
4. Bell and Gossett Company
5. or Equal

PART 2 - PRODUCTS

2.1 MATERIALS

A. All pump casings shall be centerline discharge of cast iron designed for line mounting. All pumps are to be provided with companion flanges. Units shall have a maximum operating pressure of 175psig at a maximum operating temperature of 300º F.

B. Pumps shall have a cast bronze impeller and shall be dynamically balanced. Suction and discharge flanges shall be provided with drilled and tapped gauge ports.

C. Pump shall be canned-rotor type, the pump and motor form an integral unit without shaft seal and with only two gaskets for sealing. The bearings are lubricated by the pumped liquid.

D. Controller shall be integrated in the control box.

E. Pump shall contain built-in differential-pressure and temperature sensor.

F. Rotor can shall be made of carbon-fiber-reinforced composite.

G. Stainless-steel bearing plate and rotor cladding.

H. Aluminum alloy stator housing.

I. Air-cooled power electronics.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install using manufacturer's recommendations and as shown on the Drawings.

B. Install so no vibration is transmitted to piping system. Provide independent support and flexible connections as required to eliminate pipeline vibration.

C. Fully lubricate pump in accordance with manufacturer's recommendations prior to start-up.

3.2 ADJUSTING

A. Test and run complete heating system under actual working conditions and adjust the unit to the satisfaction of the Engineer.

END OF SECTION

SECTION 15760

HOT WATER UNIT HEATERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Provide and install unit heaters of the types and sizes shown on the Drawings.

B. Related Work Specified Elsewhere: "HVAC - General" is specified in this Division. "Electrical-General" is specified in Section 16010.

1.2 QUALITY ASSURANCE

A. Verification of Capacities: Supply manufacturer's certificate of output for the unit heaters.

B. Acceptable Manufacturers:

1. Trane Company.
2. McQuay, Inc.
3. Sterling Radiator, Co.
4. Or equal.

1.3 SUBMITTALS

A. General: Submittals shall be in accordance with specification Section 01340.

B. Submittals shall show physical dimensions, electrical data and performance output.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Unit capacity and type shall be as shown in the equipment schedule on the Drawings.

B. Casing: Heavy gauge steel with electrostatically applied finish with manufacturers standard color unless otherwise noted.

C. Coil: Copper tubing mechanically bonded to aluminum fins.

D. Fan and Motor:

1. Unit shall have a direct-mounted aluminum propeller fan.
2. Electrical characteristics as indicated.
3. Motors shall be Totally Enclosed Non-Ventilated (TENV) type with integral thermal overload protection unless unit heater is located in a Class I, Division II, Group D space which will require an explosion proof motor, including wiring devices.
4. Operated by a zone thermostat (fan cycling).
5. Shall have vibration proof mountings and be permanently lubricated with provisions for field lubrication.

E. Provide individually adjustable horizontal louvers on horizontal discharge units.

F. Provide casings with special corrosion resistant coatings unless otherwise shown on the Drawings. Coatings shall give superior resistance to corrosion due to high moisture levels and shall be equal to air dried epoxy phenolic or baked phenolic finishes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in strict accordance with the manufacturer's instructions and recommendations and as shown on the Drawings.

B. Install with shut off valves, balancing valves, drain, and air vent as required for unit operation and balancing.

C. Performance testing and balancing shall be in accordance with specification Section 15907-Testing and Balancing Heating and Ventilating Systems.

D. Unit heater hangers shall be fabricated and installed so as to prevent unit vibration and/or movement during normal operation cycle. Hot water supply and return piping shall not be supported by the unit heater.

END OF SECTION

SECTION 15763

AIR HANDLING UNITS
HEATING AND VENTILATING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish and install where shown on the Drawings, complete heating/ventilating and cooling units.

B. Related Work Specified Elsewhere: "HVAC - General" is specified in this Division.

1.2 QUALITY ASSURANCE

A. Verification of Unit Output: Heating, cooling and air flow capacities shall be ARI certified.

B. Acceptable Manufacturers:
   1. Reznor.
   2. Greenheck Fan Corp.
   3. Trane Company.
   4. American Air Filter
   5. McQuay, Inc.
   6. Or approved equal.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Gas-Fired Makeup Air Units of the size and type as shown on the Drawings.
   1. General:
      a. Packaged, outdoor heating and makeup air, power vented unit. The unit shall be minimum 81% efficient, designed for slab or roof curb mounting. The gas furnace is to be arranged for ducted flue gas exhaust.
      b. The packaged heating and makeup air system shall be design-certified to ANSI Z83.8 and CSA 2.6 Standards. The energy usage shall be designed to meet ASHRAE Standard 90.1.
   2. Cabinet Construction
      a. Cabinet shall have through-the-base utility knockouts. Control, burner, and blower service compartment doors shall be hinged. Blower door hardware shall be heavy duty stainless. Control and burner door hardware shall have heavy duty external hardware.
      b. Unit cabinet to be supplied with double wall steel construction with factory installed 1 1/2 Lb. density insulation. R value of said insulation shall be 3.8 or greater. Insulation with foil backing is not acceptable.
      c. The packaged system shall have a pre-coat RAL 1001 white paint finish. Finish shall be a minimum 80 gloss on G90 galvanized steel.
      d. All painted metal shall pass 1,000 hour salt spray test per ASTM B-117.

e. Unit shall be designed with heavy 16 gauge prepainted steel rail perimeter base. Said base shall feature provisions for corner lifting, with lifting strap holes to facilitate handling and installation.

3. Combustion Air and Venting
   a. The unit shall have a factory-installed power venter device with a centrifugal wheel and direct drive motor to draw combustion air through an inlet in the cabinet.
4. Electrical Specifications & Control Systems
   a. All units shall be equipped with 24-volt control transformer; protective air proving switch; resiliently isolated venter motor; and a high temperature limit control. Operation shall be controlled through an integrated circuit board. The circuit board shall monitor heater operation and have LED diagnostic indicator lights to identify abnormalities in control functions.
   b. Unit Shall be supplied with a Motor starter, IEC open, for single-speed motors.
   c. The unit shall be supplied with factory installed disconnect. The line voltage connections to the unit shall be made through a flush-mounted, NEMA 4X switch with lock-out feature. The disconnect shall be rated for the unit MCA/MOP as shown on the schedule. The unit shall carry a rating plate showing necessary data and all approvals.
   d. Unit shall be supplied with factory-installed GFI Convenience outlet on unit.
   e. The unit shall have a factory installed dirty filter switch installed. The switch shall have an adjustable differential pressure range between 0.25 - 1.5 inch w.c. The switch shall be connected to the unit's controller and display and alarm when the switch makes indicating an alarm.
   f. The unit shall operate to maintain the discharge air temperature setpoint: 70F DAT (Range 50 - 100F)
   g. The unit shall operate based upon contact closure. In the occupied mode the unit supply fan shall run continuously.
   h. The intake dampers shall operate based upon one of the following: 100% outside air 2-position. In the unoccupied period the outside air damper shall be 100% closed.
   i. The control system shall incorporate all the necessary safeties.
5. Supply Blower
   a. The unit blower shall include an adjustable belt-driven centrifugal fan.
   b. The blower assembly shall be factory set to specified CFM at the given static pressure.
   c. The blower assembly shall have adjustable sheave for airflow adjustment.
   d. The blower assembly shall be shipped with spare belts.
6. Air Intake: Unit to be furnished with factory supplied 100% outside air screened inlet hood with moisture eliminator louvers.
7. Supply Motor: Unit shall be supplied from factory with EPACT compliant TEFC blower motor.
8. Filtering: Blower cabinet shall have Filter Section with an integral filter rack and 4" Pleated Filters.

9. Fuel & Burner Type
    a. Unit to be supplied for operation with natural gas as fuel source.
    b. Units to be supplied from factory adjusted for installation at altitudes from elevations sea level-2000 Feet.
    c. Burner shall be of a single body design with Stainless Steel face insert. Said burner shall require one orifice supplying multiple heat exchanger tubes.
    d. The units shall incorporate a single, one-piece burner assembly with a single orifice per staging. The burner shall have a continuous wound close pressed stainless-steel ribbon separating the flame from the burner interior.
    e. All units shall have a single venturi tube and orifice supplying fuel to a one-piece burner housing per staging.
    f. Each heat exchanger cell shall use balanced draft induction to maintain optimum flame control.
10. Gas Train, Controls & Ignition
    a. Gas controls for furnace shall be designed for makeup air heating application.
    b. The unit shall have electronic modulation offering at least full modulation to 28% of full fire (capacity) input rate (Note: 50% modulating gas valves will not be accepted).
    c. Modulating gas control shall be certified by CSA for use in the United States and Canada.
    d. The furnace shall maintain an average thermal efficiency over the range of modulation that is equal to or exceeds the full input rate thermal efficiency.
    e. The furnace shall ignite at any fire rate within its modulation range, not just high fire on start.
    f. Furnace shall be provided with an electronic modulating gas regulator which provides for firing rates between 25% and 100%, or 4 to 1 turndown ratio, while maintaining part-load thermal efficiency to comply with and exceed the current 75% minimum requirement of ASHRAE 90.1.
    g. A main redundant safety shut-off valve shall include a servo regulator which maintains constant gas pressure to the modulating regulator under wide variations in gas supply pressure. Said valve shall also include the safety pilot valve, and the manual shutoff valve. On/off control of the unit shall be by external control system.
11. Heat Exchanger
    a. Heat exchanger shall be manufactured from die-formed halves of 316 Stainless Steel.
    b. Manufacturer shall provide said unit with a 10-year extended (Parts only) warranty on the heat exchanger. (Non-Prorated)
    c. Note: Manufacturer's Limited Warranty for heat exchangers applies. Refer to written limited warranty for terms.
    d. The heater shall be equipped with a multicell, 4 pass serpentine style steel heat exchanger. Heat exchanger tubes shall be press fabricated.

e. All heat exchangers shall be fabricated with no welding or brazing, only tool pressed mechanical joints. All heat exchanger cells shall be designed with an aerodynamic cross section to provide maximum airflow.
f. Furnace Section shall have a factory-installed Heat Exchanger Condensate Drain.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coil piping connections shall be made with unions or flanges, and in such a manner that piping can be easily removed to allow for coil removal.
B. Install unit so as to provide access to all moving parts, grease fittings, and access doors or panels.
C. Install unit to allow for coil removal.
D. Install second set of filters in unit after final clean-up, and prior to final acceptance of the building. Provide the third set of filters to the Owner.
E. Do not operate unit without filters in place.

END OF SECTION

SECTION 15764

AIR HANDLING UNITS
HEATING/VENTILATING & COOLING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Furnish and install where shown on the Drawings, complete heating/ventilating and cooling units.

B. Related Work Specified Elsewhere: "HVAC - General" is specified in this Division.

1.2 QUALITY ASSURANCE

A. Verification of Unit Output: Heating, cooling and air flow capacities shall be ARI certified.

B. Acceptable Manufacturers:

1. Reznor.
2. Greenheck Fan Corp.
3. Trane Company.
4. American Air Filter
5. McQuay, Inc.
6. Or approved equal.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Packaged Air Handling Units of the size and type as shown on the Drawings.

1. A. DX Cooling

a. Furnish and install packaged air handling unit for treatment of up to 100% constant outside air per plans and specifications. Unit shall be completely factory assembled, tested, internally wired, fully charged with Refrigerant R410A, and shipped as one piece. Unit shall consist of foam insulated weather-tight casing with optional field installed outdoor intake hood, compressors, air-cooled condenser coils, condenser fans, evaporator coils, supply fan, motors and drives, and unit controls. Packaged Cooling and Heating Units shall carry an ETL listing.

b. DX systems shall be designed to provide 10% to 100% incremental capacity control for treatment of up to 100% outside air with up to 80 degree F dewpoint entering the unit. Unit shall have hermetic compressors with a scroll design with internal pressure relief and motor temperature winding protection. Compressor shall be equipped with reversal rotation protection. Refrigeration protection shall include low and high pressure switches, refrigerant circuit frost protection, liquid line filters/dryers and service gage ports. The unit shall have a factory installed refrigerant charges to provide unit performance as shown in the schedule. Low pressure switch shall operate at 35 psi or lower pressure. The auto reset

low pressure switch shall not reset until the pressure rises about 50 psi. The manual reset high pressure switch shall operate above 600 psi with 15 psi. The unit will not reset without a user manually pushing the reset button and the refrigerant line pressure is below 400 psi. Refrigeration control shall include thermal expansion valves, external equalizers and distributors for each compressor circuit.

c. The refrigerant system shall have a non-user adjustable 5 minute minimum ON and minimum OFF timer circuit protection. The refrigerant circuit shall have an anti-cycle timer in addition to the minimum ON/OFF timer that prevents the compressor(s) from cycle on the minimum timer circuit.

d. The refrigerant system shall include evaporator coil. The copper tube-aluminum plate fin evaporator coil shall be 4 rows with 14 fins per inch to meet leaving air performance as shown on the unit schedule. The multi-circuit evaporator coils shall be interlaced configuration. The entire coil face area shall be active with a single circuit or multiple circuit activation such that the entire coil face shall provide air cooling and dehumidification in part load operation. Split coil face design not acceptable because it does not allow full active face area for dehumidification in the part load operation. The evaporator coils shall be protected from frosting by a low temperature cutout. The factory installed froststat on each circuit shall interrupt power to the associated compressor when the temperature drops below 35 F. The frost stat shall not deactivate until the circuit temperature rises to 50 F. The coils shall be leak tested at the factory to ensure pressure integrity. The unit shall include air cooled condenser coils sized to provide the unit performance as shown in the mechanical schedule. The condenser coil shall be light weight 5/16 copper tubing with aluminum fins. The condenser shall be compact 2 row coil design with low refrigerant volume.

e. The condensate drain pan shall be rust proof or high corrosion resistant 316 stainless steel. The drain outlet shall be attached to a double sloped drain pan with a minimum 1/8 inch per foot slope. The drain pain shall collect potential condensate from all evaporator/condenser coils and distributor area in the air stream to prevent blow-off condensate reaching unprotected bottom unit surfaces. The unit shall have field supplied and installed P trap, in accordance with all local and area codes and Best Practices.

f. The unit shall be supplied with standard efficiency condenser fan motor(s) rated for the necessary condenser coil airflows. The condenser fans shall be accessible for servicing. The condenser fan system shall be dynamically balanced at the factory and installed with vibration dampening to reduce ambient noise.

g. Factory installed hot gas bypass options shall be available on all fixed capacity refrigerant stages in addition to multiple steps of capacity modulation to supplement discharge air control. The hot gas bypass valve shall have a range of 95 -115 psi with a factory setting of 105. (SST 33.7F) The valve shall be rated to handle 30% of the associated compressor

capacity. The HGBP circuit shall be equipped to prevent reverse flow through the valve.

h. The unit shall have a factory installed removable condenser coil hail guard providing protection from large debris and hail that can cause significant damage to the condenser coils. The hail guard shall not obstruct condenser airflow or add significant condenser fan static pressure. The hail guard shall prevent half-inch diameter debri from hitting the condenser coil.

i. The condenser coils shall be copper tube and aluminum fin design. The coils shall be light weight and low refrigerant volume with the use of 5/16 copper tubing.

j. The evaporator coil(s) shall be copper tube and aluminum fin design. The evaporator coils shall be interlaced, 4 row design maximizing latent performance as shown on the unit's mechanical schedule.

k. Unit shall include DX based reheat. The method of reheat shall comply with ASHRAE 90.1 requirements. Unit shall include a dedicated compressor and refrigeration circuit using full condenser reheat or total heat of rejection to the supply airstream. The reheat coil position shall include a minimum separation of 10 inches from the cooling coil to eliminate re-evaporation of cooling coil condensate. The circuit shall be capable of delivering a nominal 13°F to 17°F temperature rise from the main evaporator temperature without the need for modulating the capacity for all entering outside air conditions. The reheat system shall modulate to maintain the user adjustable unit leaving air temperature setpoint while also maintaining a constant evaporator temperature setpoint. The reheat coil shall operate down to 50 F ambient temperature without the need of low ambient kit. The reheat coil shall provide greater than 7 COP efficiency at 65°F db / 64°F wb entering air temperature. Manufacturer shall show unit performance at above condition. The refrigerant circuits shall include thermal expansion valves with external equalizers. Service gage ports and refrigerant line filter dryers are factory installed as standard. Pre-cooling coils shall be two row depth with 6 fin per inch to minimize air pressure drop.

2. Gas Heating

a. The system shall be provided with gas heat with the capacity shown the schedule. Gas heating system shall be factory install consisting of heat exchanger, venter fan, spark ignition system, control valves and all necessary safeties to provide a fully operational heating system ready for operation from the factory. The heat exchanger shall be constructed of 409 stainless steel for make-up air applications. The heat exchanger shall properly drain condensate or other water during the heating and cooling season. The system shall modulate both the gas and combustion air to maintain temperature setpoint(s) and thermal efficiency. The heat exchanger shall be capable of 100°F temperature rise for 100% outside air treatment. The heating system shall be certified to ANSI Standard Z83.8/CSA 2.6. The heat exchanger shall be 4 pass serpentine, non-

welded, constructed of 316 stainless steel. Safety Features shall consist but not limited to:

i. Automatic discharge air limit control.
ii. Air proving pressure switch.
iii. Color coded wiring and matching terminal blocks.
iv. Circuit breaker protected transformers

b. The gas heating shall utilize natural gas.

c. Heating system shall have a minimum thermal efficiency of 81%. The thermal efficiency shall not fall below 80% through the modulated operational range. The Heat exchanger shall have condensate drain to remove and/or prevent water build up in the unit. The condensate shall be piped to the appropriate building system for removal.

d. Provide 5:1 power vented modulation. The single gas heat section shall have a single modulating gas valve with spark ignition controls. The modulating valve shall allow capacity control from 20 to 100%. (5:1). The gas control shall consist of ignition board, 2-speed venter, flame sensor, igniter, gas valve and associated safeties. The spark ignition board shall have LED status & diagnostic. The unit shall lock out heating system for the following failures: venter pressure switch failure, ignition lockout, excessive limit switch losses and excessive flame sense losses. The gas control system shall be designed to maintain constant gas efficiency throughout is modulated range. The control system shall allow 50% capacity ignition for 1-2 minutes than it shall allow the valve to modulate to maintain the active discharge air or space temperature setpoints.

3. Cabinet

a. Unit shall have foam panel construction for all exterior surfaces and base. The foam insulation shall meet ASTM E-84 with a flame spread of 20 and smoke density of 300. No foam panel acceptable if unit construction exceeds R12 value, no exposed installation air stream and exceed flame safety characteristic of foam paneling. Outer casing shall be fabricated from G90 galvanized steel substrate with 60 gloss painted finish coat. Finish shall be rated for > 1000 salt spray hours. The cabinet design shall prevent condensation forming on the outside of the unit casing in operation via a dedicated thermal break from all internal components to the external surface. Fully gasketed, hinged doors of foam construction shall provide access to filters, dampers, evaporator coils section, supply fan section. Provide hinged single wall construction doors for the heater section and control section. On hinged doors frequently used for service (i.e. filter and coil access) The unit control panel section shall be laid out to provide separation of high and low voltage components per UL standards. High voltage contactors & distribution shall be touch safe. The control panels shall be hinged for easy access to the unit controls. For ease of service, all electrical components will be clearly identified with 1/2 inch diameter self-adhesive labels to match the unit specific wiring diagram. The low voltage and unit controller access electrical panel shall be physically isolated from the high voltage section. The open door to the control section

reveals the wiring diagrams, DDC programming instructions and all manuals and literature protected and permanently attached to the cover. Control transformers will incorporate integral, resettable circuit breaker protection.

4. Supply Fan
   a. The unit's supply fan shall be direct drive with an ABB variable frequency drive allowing peak fan efficiency and system RPM. The fan system shall be made of galvanized steel. The impeller shall have RAL 5002 coating, directional arrows marketing. The fan sled shall allow up to 176°F for the impeller and the motor shall allow ambient temperatures -4°F to 104°F. The impeller and motor shall be designed for continuous operation. The 7 blade, welded construction impeller shall be dynamically balanced at the factory with hub; admissible vibration level less than 0.11 in/s in conformity with ANSI/AMCA 204.
   b. The supply fan sled shall have slide out design for easy inspection and replacement.
   c. The fan sled shall also allow inspection of the gas or electric heat exchangers.
   d. The fan sled shall have rubber dampers to isolate and minimize vibration.
   e. The fan sled shall include inlet cone with measuring device for airflow measurement. The packaged unit shall allow fan inlet differential pressure readings inside the control panel to measure supply fan CFM with an accuracy of +/-5%. The unit controller shall allow fan speed settings for occupied and unoccupied modes. The unit controller shall also allow fan speed settings for heating and cooling modes. The unit shall meet the schedule performance. The unit control system shall have test and balance function to allow permanent setting of the airflow(s) as shown in the mechanical schedule.
   f. The ABB frequency drive shall be factory installed with line reactor, ECM Filter and all necessary wiring per UL standard. The drive shall have built in menu drive display with test, start-up, maintenance and diagnostic assistant. The drive shall be factory programmed for 30 second soft start. The drive shall have the following protection and alarms: single phase, overvoltage trip limit, under voltage trip limit, over temperature, microprocessor fault, motor stall protection, motor over temperature.
   g. Supply fan shall be controlled constant volume
5. Intake & Section
   a. Unit shall include outdoor air hood design for 100% airflow to allow uniform coil velocity and filter loading. The motorized damper shall be spring return for closure during unit shutdown or power interruption. Outdoor air inlet hood shall include 1-inch permanent filters and screen. Hood filter and screen shall meet MERV 4 rating. Hood airflow shall not exceed 300 fpm intake velocity to prevent snow and rain entrainment. Units designed for 100% outside air intake only shall include an integrated transition section (without return air opening) designed specifically for 100% outside air introduction

b. Units shall be available with fully integrated factory installed 100% motorized outdoor damper and return damper.
c. The damper(s) shall have 4 position damper control: Sensors/Signal: Quantity 2, user supplied, dry contact closures. (4 wires) Sequence: Whenever the supply fan is ON in the occupied mode, the dampers will open to a user defined % of outside air based upon 2 dry contact closure inputs. When the supply fan is on in the unoccupied mode the dampers will open to a second user defined % of outside air based on 2 dry contact closure points. When the supply fan is OFF, the dampers will be closed to outside air.
d. Damper Construction: The control damper shall be low leak with blade and jamb seals. The damper leakage shall not exceed 10 cfm per square foot at 4" sp. The damper shall be constructed of 16 gage galvanized steel with reinforcement to insure structural integrity. Blade edge seals shall be PVC coated polyester fabric suitable for -25°F to +180°F mechanically locked into the blade edge. Jamb seals shall be flexible stainless-steel metal, compression type to prevent leakage between end of the blade and the damper frame. Bearings shall be corrosion resistant, molded synthetic sleeve type turning in an extruded hole in the damper frame. Linkage shall be concealed out of airstream, within the damper frame to reduce pressure drop and noise and lessen the need for maintenance.
e. The unit shall have factory installed 4" MERV 8 filters before the evaporator coils. The filters shall be accessible through a hinged door. None hinge door access is not acceptable. The filters shall be pleated V configuration with an average arrestance of 95%; MERV Rating 8 per ASHRAE 52.2-99. The filters shall be manufactured from recycled synthetic material with moisture & microbial growth resistant properties. The filter shall have less than 0.36" w.c. pressure drop at 500 fpm air velocity. The filter area shall be sized to handle the rated airflow as shown on the mechanical schedule.

6. Full Perimeter Curbs:
   a. Manufacturer shall furnish a 36" Tall Curb, with Horizontal Discharge, capable of up to 10,000 cfm. Shall be a full perimeter curb with integral horizontal supply air and return air ductwork and duct connections. The horizontal airflow curb shall be designed for slab installation.
7. Make-up Air Control System.
   a. The unit shall operates to maintain one of the following discharge air temperature setpoints during all weather conditions.
      i. Space Cooling Required: 55F DAT (Range 50 - 100F)
      ii. Space Heating Required: 90F DAT (Range 50 - 100F)
      iii. Space cooling required during winter operation. 55F DAT (Range 50 - 100F)
      iv. Neutral Air - Dehumidified: 70F DAT @ 52-55 Dewpoint (Range 50 - 100F)
      v. Neutral Air - Heating: 70F DAT (Range 50 - 100F)

b. The unit shall operate based upon a contact closure or a BMS command to operate in either occupied or unoccupied mode.
c. The mechanical heating and cooling shall operate to maintain the discharge air temperature setpoint.
d. The control system shall incorporate all the necessary safeties.
e. The alarm functionality shall include low temperature, compressor failure, sensor failure, smoke alarm, power failure, heating failure and supply fan failure. The failures shall protect the unit and displays a code at the unit's display and the optional wall mounted display. The unit will have test and diagnostics routines for services and start-up.
f. The control system shall be able to provide neutral air and space temperature control per the sequences of operation.
g. The unit shall be supplied with a wall mounted DDC temperature monitor and setpoint adjustment interface device. The wall mounted unit communicating thermostat shall provide space temperature and space humidity values back to the unit controller. The room module shall allow the user to set the space temperature setpoint and read current values. The room module shall allow the user to read alarm codes from the control system. The room interface module shall allow occupancy time schedules and direct unit mode commands.
h. The unit shall be supplied with factory installed disconnect. The line voltage connections to the unit shall be made through a flush-mounted, NEMA 4X switches with lock-out feature. The disconnect shall be rated for the unit MCA/MOP as shown on the schedule. The unit shall carry a rating plate showing necessary data and all approval.

8. Options:
   a. A weatherproof convenience outlet shall be provided. The outlet shall be field powered utilizing an independent circuit form the main unit power. The circuit shall be 20-amp circuit with breaker and installed per local and state building codes.
   b. The unit shall have a factory installed dirty filter switch installed for both the unit DX filters and the energy recovery filters. The switch shall have an adjustable differential pressure range between 0.25 - 1.5-inch w.c. The switch shall be connected to the unit's controller and display and alarm when the switch makes indicating an alarm.
   c. Unit shall have factory installed phase lost protection
   d. Unit shall have a factory provided 5-year compressor warranty
   e. Unit shall have a factory provided 10-year gas heat exchanger warranty

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coil piping connections shall be made with unions or flanges, and in such a manner that piping can be easily removed to allow for coil removal.
B. Install unit so as to provide access to all moving parts, grease fittings, and access doors or panels.

C. Install unit to allow for coil removal.
D. Install second set of filters in unit after final clean-up, and prior to final acceptance of the building. Provide the third set of filters to the Owner.

END OF SECTION

SECTION 15820

VENTILATION FANS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Provide and install ventilation fans of the types and arrangement as shown on the Drawings and as specified herein.

B. Related Work Specified Elsewhere "HVAC - General" is specified in this Division. "Electrical-General" is specified in Section 16010.

1.2 QUALITY ASSURANCE

A. Standards

1. Air Movement and Control Association
   AMCA 210-85 Laboratory Methods of Testing Fans for Rating
   AMCA 300-85 Test Code for Sound Rating
2. National Fire Protection Association
   NFPA 70-90 National Electrical Code
   NFPA 90A Installation of Air Conditioning and Ventilating Systems

B. Each fan shall be licensed by AMCA to bear the Certified Rating Seal. When this standard is not applicable, the manufacturer shall submit data to verify the fan capacity at the specified operating condition.

1.3 SUBMITTALS

A. General: Submittals shall be in accordance with specification Section 01340.

B. Submittals shall show physical dimensions, shaft sizes, drives, drive arrangement, motor data, electrical data and performance curves. Where there is a requirement for explosion proof motor the shop drawing will verify that the motor and associated wiring devices meet Class I, Group D, Division I requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Refer to the Drawings for the following information (when applicable):

1. Specific type and size of fan.
2. Electrical characteristics - voltage and phase.
3. Direct or belt drive.
4. Requirement for explosion proof motors including wiring devices (Class I, Group D, Division 1).
5. Requirements of explosion proof fan construction shall comply with AMCA Standards handbook Publication 99-86, construction type "B".
6. Special corrosion resistant coatings.
7. Additional accessories and specialties.

B. Motors:

1. Totally enclosed fan cooled (TEFC) unless noted otherwise.

2. Integral thermal overload protection on single phase fractional horsepower motors
3. ECM motors shall be DC electronic commutation type motor (ECM) specifically designed for fan applications. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.

C. Belt Drive Units:
1. Shaft seals (axial & vane axial).
2. Belt guard (full belt enclosure).
3. Motor cover (weatherproof for exterior mounted fans and fans in wet areas).
4. Variable pitch sheave on motor.
5. Idler wheel when required for belt adjustment.
6. Adjustable motor base when required for belt adjustment.

D. Roof Curbs:
1. Required for all roof mounted fans unless an integral part of roof structure and so shown on the Architectural Drawings.
2. 18 inches high.
3. Supplied with fan.
4. Prefabricated all welded aluminum construction structurally reinforced to support fan.
5. 1½ inch thick rigid fiberglass insulation.
6. Wood blocking when required for fan installation.

E. Inline Centrifugal Fans:
1. Acceptable Manufacturers
   a. Greenheck Fan Corp.
   b. Loren Cook, Co.
   c. PennBarry
   d. Or equal.
2. Duct mounted, belt or direct driven as scheduled.
3. Fan wheels, aluminum backward inclined.
4. Housing, all aluminum construction.
5. Mounting brackets and vibration isolations required for wall mounting or hanging from ceiling as shown.
6. AMCA certified for both air and sound performance.
7. Completely wired internally with leads brought to an external junction box.
8. Belt drive fans shall have variable pitch sheaves selected with scheduled operating point midrange of the selected sheave.

F. Power Roof Ventilators; Upblast Type:
1. Acceptable Manufacturers:
   a. Greenheck Fan Corp.
   b. Loren Cook, Co.
   c. PennBarry
   d. Or equal.

2. Ventilator housings: Spun aluminum construction completely weatherproofed and securely seated on and fastened to the roof curb.
3. Hood shall be designed with necessary wind bands, and venturi inlet to provide a vertical upward discharge pattern.
4. Fan Wheels: Aluminum Centrifugal, backward inclined, non-overloading, quiet-operating, statically and dynamically balanced.
5. Unit shall include motor and drive assembly cooling tube, and drainage area with drain plug.
6. Gravity backdraft damper unless motorized damper is required and shown on the Drawings.
7. Aluminum bird screen.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as required in strict accordance with the manufacturer's instructions and recommendations and as shown on the Drawings.
B. Provide flexible duct connections on inlet and outlet of fan when fans are ducted.
C. Install fans on roof or exterior wall with flashing to prevent water and weather from entering building.
D. Performance testing and balancing shall be in accordance with specification Section 15907-Testing and Balancing Heating and Ventilating Systems.

END OF SECTION

SECTION 15862

DAMPERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Provide and install dampers and accessories where shown on the Drawings.

B. Related Work Specified Elsewhere:
   1. "HVAC General" is specified in this Division.
   2. Electrical is specified in Division 16.
   3. Combination louvers and dampers are specified in Section 15869.

1.2 QUALITY ASSURANCE

A. Acceptable Manufacturers:
   1. Greenheck
   2. Air Balance, Inc.
   3. Airstream
   4. Louvers & Dampers, Inc.
   5. Ruskin.
   6. Or equal.

1.3 SUBMITTALS TO THE ENGINEER

A. Submit shop drawings in accordance with the General Conditions of the Construction Contract.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver as Work progress requires.

B. Protect in a suitable weathertight enclosure to prevent damage of any nature.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Motor Operated Air Control Dampers:
   1. Material to match ductwork material in space installed.
   2. Control Dampers - Galvanized:
      a. Equal to Greenheck VCD-23 control damper.
      b. Frame:
         i. 16 ga. galvanized steel formed into a 5" x 1" structural hat channel
         ii. Top and bottom frame members on dampers less than 17" high shall be low profile design to maximize free area.
         iii. 4-piece construction with minimum 1-½" integral overlapping gusset reinforcements in each corner to assure square corners and resist racking.
      c. Blades:
         i. Parallel or opposed blade as indicated.

ii. 16 ga. galvanized steel strengthened by three longitudinal 1" deep V grooves running the entire length of each blade.
iii. Provide symmetrical blades of varying size as required to completely fill the damper opening.
iv. Blade orientation shall be horizontal.

d. Fully gasketed with a maximum allowable leakage of 8 cfm per square foot of face area at 4 inches W.C. differential pressure.
e. Bearings and blade shafts shall be non-corrosive.

3. Control Dampers – Aluminum:
   a. Equal to Greenheck VCD-43 control damper.
   b. Frame:
      i. Aluminum frame formed into a 5" x 1" structural hat channel
      ii. Top and bottom frame members on dampers less than 17" high shall be low profile design to maximize free area.
      iii. 4-piece construction with minimum 1-½" integral overlapping gusset reinforcements in each corner to assure square corners and resist racking.
   c. Blades:
      i. Parallel or opposed blade as indicated.
      ii. Extruded airfoil shaped, aluminum construction with metal blade to metal blade overlap.
      iii. Provide symmetrical blades of varying size as required to completely fill the damper opening. Blade orientation is horizontal.
   d. Fully gasketed with a maximum allowable leakage of 8 cfm per square foot of face area at 4 inches W.C. differential pressure.
   e. Bearings and blade shafts shall be non-corrosive.

B. Damper Operators:
   1. Manual operators: Chrome plated locking quadrant supplied by damper or louver manufacturer. Provide with standoff brackets as necessary.
   2. Motor operators and linkage to connect motor to damper linkage will be furnished and installed by the Automatic Temperature Control (ATC) Contractor.
   3. Normal closed or open as noted, spring return, electric motor operated. Modulating type as indicated in Section 15604.

C. Miscellaneous Connecting Sheet Metal:
   1. Galvanized steel or aluminum to match adjacent duct.
   2. Thickness: Per SMACNA
   3. Joints, seams, connections, cross bracing, flanges and supports as required for installation and recommended by SMACNA.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install dampers, operators and linkage in strict accordance with the manufacturer's instructions and recommendations.
B. Insure all blades open, close, and seal properly.
C. Adjust weights on backdraft dampers.

END OF SECTION

SECTION 15869

LOUVERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Provide and install louvers and accessories where shown on the Drawings.

B. Related Work Specified Elsewhere (When Applicable):

1. Caulking and flashing are specified in Division 7.
2. Sheet metal ductwork, air devices, automatic temperature control, etc., are specified in the appropriate Sections in this Division.
3. Electrical is specified in Division 16.

1.2 QUALITY ASSURANCE

A. All louvers shall be certified by AMCA for air pressure drop, free area, and water penetration.

B. Acceptable Manufacturers:

1. Greenheck
2. Ruskin Mfr. Co.
3. Air Balance, Inc.
4. Louvers & Dampers, Inc.
5. American Warming and Ventilating, Inc.
6. Airstream Inc.
7. Or equal.

1.3 SUBMITTALS TO THE ENGINEER

A. Submit shop drawings, manufacturer's literature, maintenance data and operating instructions as stated in the General Conditions of the Construction Contract.

B. Submit free area, pressure drop, and water penetration data for each louver for approval.

C. Submit AMCA certification for louver style.

D. Submit sample louver section with proposed finish for review and no exceptions taken by the Engineer.

E. Submit scale drawings of each louver showing sizes, construction details, and mullion locations.

1.4 DELIVERY, STORAGE AND HANDLING

A. Deliver in manufacturer's unopened containers as job progress requires.

B. Store in unopened containers in weathertight building.

C. Exercise care in handling to avoid bending blades or frames, damaging finish and other damage of any nature.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Exterior Stationary Louvers:
   1. Equal to Greenheck model EDJ-601.
   2. Storm proof, .08l extruded aluminum 6063-T5 blades.
   3. Architectural style.
   4. 6063-T5 extruded structural aluminum frame, 0.100" wall thickness, mitered corners and caulking slots.
   5. Rigid hidden architectural style mullions as required for span, but not greater than 48" on center. Provide mullions at each section of louver requiring duct or fan connection.
   6. Blade stiffeners.
   7. l/2 inch mesh replaceable aluminum bird screen on interior, insect screen where shown on the Drawings.
   8. Kynar 500 finish - manufacturer's standard color selected by Engineer.
   9. 6 inch depth.
   10. Provide extended sill.
   11. Caulk slots and flange when installed in masonry construction. Provide nailing flange when installed in wood frame construction.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as required using manufacturer's instructions and recommendations and as shown on the Drawings.
B. Caulk all openings as required in Division 7 and as shown on the Drawings.
C. Isolate metal to metal contact between aluminum louver frames and steel damper frames or ductwork with suitable paint.

3.2 CLEANING AND ADJUSTING

A. Clean all louvers and dampers of grease, tar and dirt to the satisfaction of the Engineer.
B. Adjust all louvers to the satisfaction of the Engineer.

END OF SECTION

SECTION 15891

DUCT INSULATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Provide and install all duct insulation as shown on the Drawings and specified herein.

B. Related Work Specified Elsewhere: "HVAC - General" is specified in this Division.

1.2 QUALITY ASSURANCE

A. Fire Hazard Rating: When tested by ASTM E84 method flame spread rating shall not exceed 25.

B. Acceptable Manufacturers:

1. Closed cellular flexible plastic:
   a. Armacell "AP/ARMAFLEX".
   b. Rubetex.
   c. Or approved equal
2. Fiberglass:
   a. Owens-Corning.
   b. Knauf.
   c. Certainteed.
   d. Or approved equal.

1.3 SUBMITTALS TO THE ENGINEER

A. Submit samples of each insulation type.

B. Submit 2'-0" piece of sealing tape.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Duct insulation for non-wet area locations.

1. Ductwork:
   a. 1½ inch thick fiberglass ductwrap
   b. Factory applied reinforced aluminum or vinyl vapor barrier facing.
   c. Thermal conductivity @ 75°F: 0.26/BTU-in/hr-ft^2-ºF maximum
   d. Equal to Owens-Corning series ED-100 FRK-25

B. Exterior Duct Insulation

1. Closed cellular flexible plastic
   a. 2” thick
   b. Thermal conductivity at @ 75°F: 0.25/BTU-in/hr-ft^2-ºF maximum
   c. U.L. flame spread: 25 or less
   d. Finish: Armaflex WB finish with 10X10 Leno Weave glass mesh

PART 3 - EXECUTION

3.1 APPLICATION

A. Duct Insulation:
   1. Required on all supply and return ductwork at Evergreen PS Wetwell Entry, Drywell Entry, and exterior.
   2. Required on all outside air intakes from exterior wall or roof to duct termination including fan casing.
   3. Required on all heated or cooled supply air ductwork from air handling unit to duct termination including air handler if not factory insulated.
   4. Required on exhaust ductwork from outside closure damper to exterior wall or roof.
   5. Insulate entire ducts and seal to prevent condensation on cold surfaces, including standing seams, support straps, and other metal attached to the ductwork.
   6. Insulate access doors and gaskets to prevent metal to metal contact.

B. Apply insulation to clean, dry ductwork.

C. Remove damaged insulation and replace to the satisfaction of the Engineer at no additional cost to the Owner.

D. Use sealing tapes 3 inches wide, reinforced, pressure sensitive type, SMACNA approved. Tapes that do not adhere to insulation shall be cause for rejection of all insulation work. Only apply tape when ambient temperature is between 40°F and 100°F.

E. Closed cellular plastic:
   1. Obtain adhesive from the insulation manufacturer and apply to entire duct surface, and all joints.
   2. Apply in strict accordance with manufacturer’s instructions and recommendations.

F. Fiberglass Ductwrap:
   1. Apply insulation adhesive in 4" wide strips, 8" on center, circumferentially around duct.
   2. Tightly wrap insulation around duct with all joints butted and longitudinal joint overlapped 2 inches.
   3. On the bottom of ductwork over 24 inches wide, provide and install mechanical fasteners at not more than 18" on center.
   4. Tape all joints with 3" wide tape.
   5. Tape over protruding stick pins.

END OF SECTION

SECTION 15907

TESTING AND BALANCING HEATING AND VENTILATING SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: The testing and balancing Work includes the measurement and setting of air and water flow devices in accordance with the Contract Documents for the systems, recording data, making tests, and preparing reports, all as hereinafter specified. Perform the Work specified in this Section on, and after the completion of, Work on the HVAC systems.

B. Related Work Specified Elsewhere:
   1. "HVAC - General" is specified in this Division.

C. Qualifications: Obtain the services of a qualified testing organization, approved by the Engineer, to perform the testing and balancing work as herein specified.

D. Procedures: Accomplish the Work in accordance with the Agenda specified herein. Follow procedures described herein and, in general, if not specifically described herein, the Work shall be in accordance with the Associated Air Balance Council's "National Standards for Field Measurements and Instrumentation Total System Balance", Volume Two, No. 12173, and standards of NEBB.

E. Cooperate with the selected test and balance agency in the following manner:
   1. Provide sufficient time before final completion date so that tests and balancing can be accomplished.
   2. Provide immediate labor and tools to make corrections when required without undue delay. Install balancing dampers as required by test and balance agency.
   3. Put all heating, ventilating and air conditioning systems and equipment into full operation and continue the operation of same during each working day of testing and balancing.
   4. Keep the testing and balancing agency informed of any major changes made to the system during construction, and provide with a complete set of as-built drawings.
   5. Include the costs of dampers, pulley and belt changes and the costs of obtaining the test and balancing agency in the Contract price.

F. Installation shall not be considered complete until final reports by the testing agency have been submitted to the Engineer and approved.

1.2 SUBMITTALS TO THE ENGINEER

A. Submit the name of the proposed testing organization to the Engineer for approval within 90 days after Contract award.

B. Provide all results of all required tests for the Engineer's approval.

1.3 AGENDA

A. Preliminary Report: Review Drawings and Specifications prior to the installation of any of the affected systems and submit a written report to the Engineer indicating

any deficiencies in the system that would preclude the proper adjusting, balancing, and testing of the systems.

B. Submit an agenda for approval by the Engineer prior to start of testing and balancing work. The agenda shall include the following:
   1. A complete listing of all air and water flow and air terminal measurements to be performed.
   2. Specific test procedures and parameters for determining specified quantities, e.g., flow, drafts, etc., from the actual field measurements to establish compliance with the Contract Documents.
   3. Samples of forms showing applications of procedures and calculations to typical systems.

C. Advise the Engineer in advance when the testing will begin so that the testing procedure and techniques can be evaluated and approved or modified.

D. Procedure Reporting: Specific test procedures for measuring air quantities at terminals shall specify type of instrument to be used, method of instrument application (by sketch), and factors used.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Not applicable in this Section.

PART 3 - EXECUTION

3.1 PROCEDURES AND INSTRUMENTS - GENERAL

A. Requirements: Adjust all systems and components to perform as required by the Drawings and Specifications.

B. Test Duration: Perform operating tests of heating coils, fans and other equipment no less than a four-hour duration after stabilized operating conditions have been established. Base capacities on temperatures and air and water quantities measured during such tests.

C. Instrumentation: Use methods of application of instrumentation in accordance with the approved agenda.

D. Use only instruments used for measurements that are accurate, and calibrated within 6 months of the testing with calibration histories for each instrument available for examination. Have each test instrument calibrated by a laboratory approved by the Engineer or by the manufacturer. The Engineer has the right to request instrument recalibration, or the use of other instruments and test methodology, where accuracy of readings is questionable.

E. Apply all instruments in accordance with manufacturer's instructions and recommendations.

F. Provide all labor, instruments and appliances required. Do not install instruments that are permanent installations used for the tests, e.g., gages, thermometers, etc., until just prior to the tests to avoid damage and changes in calibration.

G. Accuracy of all thermometers shall be plus or minus l graduation at the temperatures to be measured. Graduations shall conform to the following schedule.

Medium	Design Temperature Differential (°F)	Maximum Graduation (°F)
Air	10 or less	l/2
Air	over 10	l
Water	10 or less	1/10
Water	10-20	l/2
Water	over 20	l

3.2 AIR SYSTEM PROCEDURES

A. Adjustments: Adjust all air handling systems to provide the required design air quantity to, or through, each component. Conduct adjustment and balancing of all systems during the period of the year approximating maximum seasonal operation, unless otherwise directed or approved by the Engineer.

B. Equalizers: Adjust equalizing devices to provide uniform velocity across the inlets (duct side for supply) of terminals prior to measuring flow rates.

C. Balance: Use flow adjusting (volume control) devices to balance air quantities only, i.e., proportion flow between various terminals comprising system, and only to the extent that their adjustments do not create objectionable air motion or sound, i.e., in excess of normal limits.

D. Accomplish balancing between runs (submains, branch mains and branches) generally by flow regulating devices at, or in, the divided flow fitting.

E. Restriction imposed by flow regulating devices in or at terminals shall be minimal. Make final measurements of air quantity after the air terminal has been adjusted to provide the optimum air patterns of diffusion.

F. Fan Adjustment: Generally vary the total air system quantities, by adjusting fan speeds, or axial-flow fan wheel blade pitch. Use damper restriction of a system's total flow only for systems with direct connected fans (without adjustable pitch blades), provided system pressure is less than l/2 inch w.g.

G. Except as specified herein, make pitot tube traverses of each duct to measure air flow therein. Pitot tubes, associated instruments, traverses, and techniques shall conform to the ASHRAE Handbook of Fundamentals.

H. Omit pitot tubes traverse when the duct serves only a single room of space and its design volume is less than 200 cfm. In lieu of Pitot tube traverse, determine air flow in the duct by totaling volume of individual terminals served, measured as specified herein.

I. Where duct's design velocity and air quantity are both less than 1000 (fpm/cfm), determine air quantity by measurements at terminals served.

J. Test Holes: Provide test holes, in straight ducts, as far as possible downstream from elbows, bends, take-offs, and other turbulence generating devices, to optimize reliability of flow measurements.

K. Air Terminal Balancing.

L. Air Motion: Air motion and distribution shall be as specified and as shown on Drawings. In addition to air motion measurements, make smoke tests wherever requested by the Engineer, to demonstrate the air distribution from air terminals, at no additional cost to the Owner.

M. Changes in the specified agenda due to field conditions, will be considered for

approval by the Engineer.

3.3 WATER SYSTEM PROCEDURES

A. Adjustment: Adjust all heating, bypass, and transfer systems to provide the required quantity to, or through each component.
B. Metering: Measure water quantities and pressures with calibrated meters.
C. Use venturi tubes, orifices, or other metering fittings installed in system and pressure gages to measure water flow rates and balance the systems.
D. Adjust the systems to provide the approved pressure drops through the heat transfer equipment (coils, converters, etc.) prior to the capacity testing.
E. Where flow metering fittings are not installed, determine flow balance by measuring temperature differential across the heater transfer equipment.
F. Perform measurement of temperature differential with the air system, adjusted as described herein, in operation.
G. Automatic Controls: Position automatic control valves for full flow through the heat transfer equipment of the system during tests.
H. Flow: Adjust the flow through bypass circuits at three-way valves to balance that through the supply circuit.
I. Distribution: Adjust distribution by balancing devices (cocks, valves, and fittings) and automatic flow control valves as provided. Do not use service valves.
J. Only record pressure differential where automatic flow control valves are utilized in lieu of venturi tubes, provided the pressure is at least the minimum applicable to the tag rating.
K. Special Procedures: Where available pump capacity (as designed) is less than total flow requirements of individual heat transfer units of system served, full flow may be simulated by the temporary restriction of flow to portions of the system; specific procedures shall be delineated in the agenda.

3.4 TEST RECORDS

A. Submittal: Submit three (3) copies of the reports described herein, covering air and water system performance, and air motion (fpm), to the Engineer prior to final tests and inspection.
B. Instrument Records: Include types, serial numbers, and dates of calibration of all instruments.
C. Reports: Identify conspicuous items not conforming to Contract requirements in the reports.

3.5 AIR SYSTEM DATA

A. Report: Include in the certified report, for each air-handling system, the following data (as applicable):
    1. Equipment (fan or factory fabricated station unit):
        a. Installation Data:
            i. Manufacturer and Model.
            ii. Size.
            iii. Arrangement, Discharge, and Class.
            iv. Motor H.P., Voltage, Phase, Cycles and Full Load Amps.
            v. Location and Local Identification Data.

b. Design Data: Data listed in schedules on the Drawings and in the Specifications.
c. Fan Recorded (Test) Data:
i. C.F.M.: Discharge CFM and % of OA under minimum conditions.
ii. Static Pressure: S.P. total, S.P. suction and S.P. discharge.
iii. R.P.M.: Fan and motor.
iv. Motor Operating Amps.
v. Motor Operating B.H.P.
vi. Motor Sheave Size and Make.
vii. Fan Sheave Size and Make.
viii. Number of Belts Size and Make.

2. Duct Systems:
a. Duct Air Quantities (Maximum and Minimum) - Main, Submains, Branches, Outdoor (Outside) Air, Total-Air, and Exhaust:
i. Duct size(s)
ii. Number of Pitot tube (Pressure) Measurements.
iii. Sum of Velocity Measurements (Note: Do not add pressure measurements).
iv. Average Velocity.
v. Recorded (Test) C.F.M.
vi. Design C.F.M.
b. Individual Air Terminals:
i. Terminal Identification (Supply or Exhaust, Location and Number designation).
ii. Type, Size, Manufacturer and Catalog Identification.
iii. Applicable Factor for Application, Velocity, Area, etc., and Designated Area.
iv. Design and Recorded Velocities - F.P.M. (State "core", "inlet", etc., as applicable). Record data for three readings and average.
v. Design and Recorded Quantities - C.F.M. Record data for three readings and average.
vi. Deflector Vane or Diffusion Cone Settings.

3.6 WATER SYSTEM DATA

A. Report: Include in the certified report, for each water system, the following data:
1. Pumps:
a. Installation Data:
i. Manufacturer and Model.
ii. Size.
iii. Type Drive.
iv. Motor H.P., Voltage, Phase, and Full Load Amps.
b. Design Data:
i. G.P.M.
ii. Head.
iii. R.P.M.
iv. B.H.P and Amps.
c. Recorded Data:

i. Discharge Pressure (Full-Flow and No-Flow).
ii. Suction Pressures (Full-Flow and No-Flow).
iii. Operating Head.
iv. Operating G.P.M. (From pump curves if metering is not provided).
v. No-Load Amps. (where possible).
vi. Full-Flow Amps.
vii. No-Flow Amps.

2. Converters and Heat Exchangers:
   a. Installation Data:
      i. Manufacturer, Model and Type.
      ii. G.P.M.
      iii. Inlet (entering) and Outlet (leaving) Temperatures.
      iv. Water pressure drop.
   b. Recorded Data:
      i. G.P.M. (if metered).
      ii. Entering and Leaving Water Temperatures - System.
      iii. Water Pressure drop.
      iv. Heating (or Cooling) Media - Entering and Leaving Water Temperature.
      v. Heating (or Cooling) Media - Flow (G.P.M. or lbs per hour).
3. Air Heating Equipment:
   a. Design Data:
      i. Load in BTUH or MBH.
      ii. Entering and Leaving Water Temperature.
      iii. C.F.M.
      iv. Water Pressure Drop.
   b. Recorded Data:
      i. Type of Equipment and Identification (location or number designation).
      ii. Entering and Leaving Air Conditions (D.B. and W.B).
      iii. Entering and Leaving Water Temperatures.
      iv. G.P.M. (if metered).
      v. Temperature Rise or Drop.

3.7 FINAL TESTS, INSPECTION AND ACCEPTANCE

A. General: Make tests to demonstrate that the capacities and general performance of air and water systems comply with the Contract Documents.
B. At the time of final inspection, recheck, in the presence of the Engineer, random selections of data (water and air quantities and air motion) recorded in the Certified Report.
C. Points and areas for recheck will be selected by the Engineer.
D. Measurement and test procedures shall be the same as approved by the Engineer for the Work forming basis of report.
E. Selections for recheck (specific plus random), in general, will not exceed 15 percent of the total number tabulated in the report.
F. Retests: If random tests elicit a measured flow deviation of ten percent or more from that recorded in the Balance Report listings, at ten percent or more of the

rechecked selections, the report shall be automatically rejected. In the event the report is rejected, readjust all systems and re-test. Submit new data recorded, new Balance Reports and make new inspection tests, all at no additional cost to the Owner.

G. Marking of Settings: Following final acceptance of Balance Reports by the Engineer, permanently mark the settings of all valves, splitters, dampers, and other adjustment devices so that adjustment can be restored if disturbed at any time. Do not mark devices until after final acceptance.

END OF SECTION

SECTION 16010

ELECTRICAL - GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide all labor, materials, equipment, operations, methods and procedures as indicated in the Contract Documents, together with all items necessary for or incidental to the completion of the work.

B. All systems or additions to existing systems indicated in the Contract Documents shall mean all necessary supervision, labor, equipment and materials required to provide complete, properly functioning systems.

C. All systems shall be adjusted, tested, inspected and turned over to the Owner in perfect working order.

D. The words "provide", "supply", "supply and install", "install", "furnish" or "furnish and install", as used in DIVISION 16 or as indicated on the Drawings related to DIVISION 16 shall mean a complete and properly functioning Electrical installation performed by the Contractor.

E. References:

1. Refer to Architectural, Structural, Heating and Ventilating, Plumbing, Process Piping and Instrumentation Drawings to coordinate material and equipment locations and electrical requirements.
2. Applicable portions of DIVISION 0 - BIDDING AND CONTRACT REQUIREMENTS together with DIVISION 1 - "GENERAL REQUIREMENTS", are part of DIVISION 16.
3. Refer to SECTION 00100 - INSTRUCTIONS TO BIDDERS; SECTION 00700 - GENERAL CONDITIONS: SECTION 00800 - SUPPLEMENTARY CONDITIONS; and as specified herein regarding substitutions of materials and equipment.

F. Division 16 Contract Requirements and Responsibilities:

1. The requirements of Division 16 - Electrical is based on the information provided in the Contract Documents. This information has been outlined in either the specifications or the drawings or both. The contractor's responsibility of Division - 16 Electrical is to review all information in both the specifications and the drawings in order to determine the complete work required. Whether the work is specified in the Specifications or shown on the Drawings it is required as part of the work. No additional compensation or interpretations stating that it was not shown in both locations will be acceptable or allowed.

G. Work Specified Herein:

1. Visit and examine the project site and become familiar with all existing conditions pertinent to the work to be performed thereon. No additional compensation will be allowed for failure to be so informed. This contractor is responsible to be familiarized with the conditions of the project during the bidding period in order to bring any clarifications or issues to the attention of the Engineer prior to submission of his/her final bid price.

2. The following scope of work is a brief generalization of the type and extent of the work specified under DIVISION 16. Detailed requirements are indicated on the Drawings and in related sections of the Specifications. The work specified under DIVISION 16 includes, but is not limited to the following:
   a. Provide Electrical Service and Distribution Systems as indicated on the "Single-Line Diagrams", related drawings and schedules, and as specified herein. There is a significant amount of electrical demolition and reconnection of equipment to remain for the work required for this project and therefore a thorough understanding of the existing conditions is critical. It is to be understood that the drawings do not intend to show or provide details for all of the existing conditions or equipment to be demolished. In addition, not all existing condition information may reflect exact conditions due to the accuracy of existing data and information. As an example, there are a significant number of existing branch circuit panelboards which have been listed and shown for this project. The existing panelboard schedules have been shown and noted as could be determined or as noted on existing information. The Contractor's responsibility is to field investigate and determine all existing conditions. Any and all existing equipment which is found to remain shall be reconnected to new panelboards with new conduit and wiring of equal sizing and conditions which presently exists in order to provide a complete system reconnection. No exception will be allowed for any extra compensation to perform this work. This contractor is responsible to be familiarized with the conditions of the project during the bidding period in order to bring any clarifications or issues to the attention of the Engineer prior to submission of his/her final bid price.
   b. Provide all required 480 Volt, 208 Volt, 240V, and 120 Volt Power and Control wiring, Signal wiring, grounding, and connections for equipment specified under DIVISION 15 except as indicated on the Drawings and specified herein.
   c. Provide all required and supplemental motor starters, protective device sizes, wire and conduit sizes, holding coil voltages and control voltages specified under DIVISION15. All rating and sizing shall match the requirements of equipment specified. No additional compensation will be allowed for modifications required due to equipment and devices which differ from those of specified equipment.
   d. Provide complete branch circuit wiring systems including all raceways, conductors, cables, outlet and junction boxes, wiring devices and device connections as shown on the Drawings and as specified herein.

H. Work Specified Elsewhere:
   1. The materials and methods used for all Electrical Work indicated in the Contract Documents shall meet the requirements specified in Division 16.
   2. The following Electrical Work and Work relating to the Electrical Work will be performed under other Divisions of the Contract Documents. This Contractor is to review all of the Contract Documents and Drawings and shall

work closely with the other related areas which will affect his/her work under this Contract in order to avoid any and all conflicts:

a. Substitutions, product options, cleaning up and project record documents are specified in DIVISION 1.
b. Mechanical equipment is specified in DIVISION 15.

I. Removals and Relocations and Rearrangements:

1. Examine the existing site, structure(s) and installation(s) for the work of all trades which will influence the cost of the work under DIVISION 16. This work shall include removals, relocations, rewiring and rearrangements relating to the work of all trades which may interfere with, disturb or complicate the performance of the work under DIVISION 16; and relating to the work involving systems, equipment and related service lines which shall continue to be utilized as part of the finished project.
2. When the Contract Documents indicate elimination of, or structural changes in walls, floors, ceilings, enclosures, pipe chases, etc., remove, relocate, rearrange and reconnect as required, all existing Electrical Work such that systems to remain shall continue to function properly.
3. Provide in the Base Bid all associated labor, material and costs to include all removals, relocations, rewiring, rearrangements and reconnections herein specified, necessary or required to provide approved operation and coordination of the combined new and existing systems and equipment.
4. Demolition:
   a. Disconnect and remove existing equipment, devices, boxes, conduit, and associated electrical equipment as shown on the contract drawings.
   b. Any demolition, relocation or rearrangement work performed which results in unused openings in control panels, instrument panels, control stations, pull or junction boxes, etc., which are to remain shall be plugged by appropriate means such that it maintains the integrity of the NEMA classification of the area, as defined on Drawing E-1.
   c. Any demolition, relocation or rearrangements which results in unused openings in walls, ceilings, floors, etc. shall be sealed using approved methods to maintain the fire rating and NEMA classification of the existing structure.
   d. Review all Contract Documents and coordinate with all disciplines for a complete understanding of this demolition work. Provide all new work required to modify these changes along with all requirements for installation of the new work, as shown on the Contract Drawings.
   e. There are areas where the demolition shall require that existing pullboxes, conduit, wiring and associated devices be disconnected, removed, relocated and in some cases, be replaced in order for the new equipment, walls, structures, etc. to be constructed and installed. In most cases, the detail of these existing conditions has not been shown. This Contractor will be responsible to perform all work necessary to demolish all required conduit, wiring, boxes and associated equipment for the noted and intended demolition. At no time shall this Contractor imply that he/she does not understand the responsibility of associated demolition as the

Contractor shall visit the site locations and shall become familiar with the areas where this work is to be performed. If there are any concerns or issues regarding this work they need to be addressed and submitted to the Engineer for clarification prior to submission of the final bid price for the work of this Contract. All costs associated with this work is the responsibility of this Contractor and shall be included as part of the overall costs for the electrical work of this project. No additional costs shall be allowed by this Contractor for any demolition work required under the work of this contract.

f. Disconnect and remove all abandoned conduits, wiring, boxes, equipment, controls, hangers, etc. shown or not shown, which is located within the area of construction under this contract.

J. Codes and Fees:
   1. Comply with the following codes, standards, regulations and specifications:
      a. National Electrical Code (N.F.P.A. No. 70 - most recent edition)
      b. Life Safety Code (N.F.P.A. No. 101 - most recent edition)
      c. Occupational Safety and Health Act (O.S.H.A.) - regarding construction practices.
      d. Utility company standards, specifications and requirements.
      e. Telephone company standards, specifications and requirements.
      f. Cable company standards, specification and requirements.
      g. State and local electrical codes, building codes, and fire codes for the locale where the work is to be performed.
      h. N.F.P.A. 820 Standards for Fire Protection in Wastewater Treatment and Collection Facilities.
   2. Compliance with the above codes, standards, etc., does not relieve the Contractor from the requirements of the Contract Documents which may exceed these codes, standards, etc. but which are not contrary to them.
   3. If it is observed that the Contract Documents are at variance with any of the above codes, standards, etc., promptly notify the Engineer in writing, and necessary changes shall be adjusted by appropriate modification. If any work is performed which is contrary to such codes, standards, etc., the Contractor shall assume full responsibility therefore and shall bear all costs in correcting such work in order to comply with such codes, standards, etc.
   4. Secure and pay for all permits, fees and licenses necessary for the proper execution of the work under DIVISION 16.

K. Tests and Procedures Prior To Start-up:
   1. Refer to Section 16950 - Testing Electrical Systems and start-up for testing and scheduling requirements.

L. Demonstration of Complete Electrical Systems:
   1. The Owner will assume no liability or responsibility for any portions of the installation under this Contract until they are demonstrated and accepted in writing. Final demonstrations shall be made only after the Engineer is satisfied that the work has been completed in accordance with the intent of the Contract Documents.
   2. Refer to Section 16950 for additional requirements.

M. Identification:

1. All distribution equipment (switchboards, motor control centers, distribution panelboards, transformers, transfer switches, disconnects, starters, control panels, control stations, etc.) shall have an engraved lamacoid tag, permanently mounted adjacent to the manufacturer's nameplate, indicating the equipment's designation (as called out on the Drawings) and identification number per the Contract Documents.
2. All switchboard and distribution panel overcurrent devices, motor control center devices, individually mounted motor controllers, disconnect switches, control devices, etc., shall be provided with permanently attached engraved lamacoid tags indicating the equipment which they serve or control per the equipment designation and identification number indicated in the Contract Documents, and in accordance with OSHA requirements.
3. All branch circuit panelboards shall have, on the inner side of the door, a permanently attached, engraved lamacoid tag with the identification number of that panelboard. Provide and mount under plastic, in the directory frame of each panelboard, a neatly typewritten directory identifying the branch circuit overcurrent devices and the circuits, devices and areas which they serve.
4. All individually mounted panelboards, disconnects, motor controllers, control stations, etc. shall have a second engraved lamacoid tag below the first one which identifies from where the equipment is receiving power. This second label shall be smaller in height.
5. Nomenclature on these nametags shall be project specific and wherever possible shall be full and complete. Excess abbreviations will not be allowed.
6. Power conductors shall be continuously polarized and color coded throughout using the following scheme:
   a. White or gray - All neutral conductors, 208/120V systems
   b. White w/tracer of any color but Green - All neutral conductors, 480/277 volt systems
   c. Green - All ground conductors
   d. Phase Conductors

208/120V Systems	**240/120V Systems**	**480/277V Systems**
Phase A - Black	Phase A - Black/(Red)	Phase A - Yellow
Phase B - Red	Phase B - Red/(Blue)	Phase B - Brown
Phase C - Blue		Phase C - Orange

   e. For Conductors No. 6 and smaller, color coding shall correspond to the color of the conductor insulation. For color coding of wire larger than No. 6, use self-adhesive, wrap¬-around type markers. These markers shall be used at all panelboards, junction boxes, disconnect switches, circuit breakers, etc.
7. All individual conductors shall be identified using unique numerical tags corresponding to conductor designations indicated on approved shop drawings of schematic diagrams for all terminations. This includes all process- and non-

process-related wiring done as part of the work, such as fire alarm panels. Conductors shall be clearly identified at each terminal block, equipment connection and junction. Markings shall utilize the equipment designation and terminal block number in the device higher upstream in the system hierarchy. Markings shall follow the format “Device Tag-Equipment Served Tag-Device Terminal Block No.” Refer to Division 13 for communication and manufacturer instrument cable labeling requirements.

a. System hierarchy shall be defined as follows:
    i. Master Terminal Unit
    ii. Remote Terminal Unit
    iii. Motor Control Center
    iv. Transmitters, Local Control Stations
    v. Elements
b. Examples:
    i. From MCC-DB-2 TB No. 53 to SLSC-1: “MCCDB2-SLSC1-53”
    ii. From DBCP TB No. 17 to SLSC-1: “DBCP-SLSC1-17”
    iii. From PBCP TB No. 8 to FIT-411: “PBCP-FIT411-8”

8. All feeder cables shall be marked indicating load for each feeder for all junction boxes, handholes, and manholes.
9. Conduits shall be marked at both ends with designations corresponding to the conduit schedule on approved drawings. Such marking shall include the designation of the conduit, the destination of the conduit, and the type of conductors in the conduit, being power (P), control (C), or signal (S). The format for the marking shall be “Conduit Designation-Equipment Designation.”
    a. For example, conduit P79 provides a power connection from Control Panel CP-CF to LIT-172. The marking at CP-CF shall therefore read “P79-LIT712.” The corresponding marking at LIT-712 shall read “P79-CPCF.”
    b. Conduit C90 provides a control connection from Motor Control Center MCC-1 to Control Panel CP-M. The marking at MCC-1 shall therefore read “C90-CPM.” The corresponding marking at CP-M shall read “C90-MCC1.”
    c. Conduit S37 provides a signal connection from Control Panel CP-CF to CFP-800. The marking at CP_CF shall therefore read “S37-CFP800.” The corresponding marking at CFP-800 shall read “S37-CPCF.”
10. Labels and tags shall be typewritten and pre-manufactured for the intended purpose. Labels and tags with “tails” will not be accepted. All labels and tags must be installed prior to site acceptance.
11. Lamacoid tags shall be nominal 1" x 4" with 3/8" white lettering on black background.
12. The following safety signage shall be provided for the following equipment. Signage shall be lamacoid plastic (Large Letters) yellow background with red engraved letters:
    a. All switchboards, motor control centers, VFD equipment, automatic transfer switches, solid-state, reduced-voltage starters, enclosed circuit breakers, etc., shall be provided with signage to read "DANGER - HIGH

VOLTAGE". Each section (vertical component of multi-section enclosure) shall be furnished with an individual signage. Final requirements shall be determined at the discretion of the Engineer.

b. All motor control center motors starters, individual motor starters and/or control panels shall be provided with signage to read "CAUTION - This Enclosure Contains Voltage Sources from Outside of This Enclosure".

c. All switchboards, motor control centers, panel boards, transformers control panels, etc., shall have large letter lamacoid nameplates which reflect the full tag names and designations noted on the Contract Drawings.

d. All switchboards, motor control centers, panel boards, transformers control panels, etc., shall have Arc Flash labels as provided and determined by the Arc Flash Study.

13. Label and identify with branch circuit and lighting panel for all light switches, manual motor starters, and receptacles.

N. All electrical equipment shall be suitable for the areas where mounted in accordance with Area Classifications indicated on Electrical Drawings. In specific, refer to Drawing E-1 NEMA classification for Electrical Equipment and Enclosures for specific requirements and these specifications. In addition, there are several areas which have been indicated to meet NEC National Electrical Code requirements based on the final location of the equipment. Coordinate and provide these NEMA ratings whether or not specifically stated on the Drawings. Contractor shall assure that the proper type, enclosure, mounting and catalog numbers are provided during the Submittal phase.

1.2 QUALITY ASSURANCE

A. Supply all new materials, devices and equipment in conformance with:
1. Underwriter's Laboratory, Inc.
2. National Electrical Manufacturers Association.
3. American National Standards Institute.
4. National Electrical Code (NEC).
5. Local Power Company.
6. Local Telephone Company
7. Local Internet Provider
8. OSHA

B. All materials provided under this Contract shall be equal in quality, appearance and performance to that specified herein and shall be subject to no exceptions taken by the Engineer. Verify the availability of all materials proposed to be used in the execution of the work prior to submitting same for the Engineer's review. The discontinuance of production of any material or product after the Engineer's review has been made shall not relieve the Contractor from furnishing an alternate of equal quality and design without additional cost.

C. Materials and equipment furnished under this Contract shall be standard products of manufacturers regularly engaged in manufacture of such products and shall be manufacturer's latest standard design that complies with Specification requirements. Products shall essentially duplicate material and equipment that have been in satisfactory local use at least three years.

D. The Contractor shall have supplied comparable systems to those specified herein and shall maintain engineering and service departments capable of designing and maintaining these systems. For a period of twelve (12) months from the date of acceptance of the work, provide all necessary supervision, labor, materials, and equipment, in order to correct any defects in any system due to faulty materials, equipment, installation methods, or workmanship and consequent damage resulting from such defects. This work shall be scheduled during normal working hours and at the convenience of the Owner.

E. All switchboards, motor control centers, panelboards, motor starters, transformers, and distribution equipment shall be by the same manufacturer based on providing the Owner with equipment of the same type. This will allow for replacement and spare parts of the same type and also allow efficient maintenance of this equipment.

F. All electrical equipment shall be suitable for the areas where mounted in accordance with Area Classifications indicated on Electrical Drawing E-1. Contractor shall assure all equipment is installed in strict accordance with the latest version of the National Electrical Code.

G. All equipment to be submitted such as low voltage switchboards, motor control centers, panelboards, dry-type transformers, motor starters, disconnect switches, etc. shall be furnished by the same single manufacturer unless otherwise noted. Substitutions of multiple manufacturers for this equipment shall be rejected.

1.3 SUBSTITUTIONS

A. General

1. Where new equipment is specified to be provided as part of an extension to an existing system, the manufacturer of the new equipment shall match that of the original. Substitutions will not be considered as equal unless specifically noted so.
2. Certain new equipment and systems have been specified with one or more make(s) followed by the phrase "or equal". In such cases, the Contractor may submit a proposed substitution for review by the Engineer. The decision of equality of a proposed substitution rests fully with the Engineer.
3. Certain new equipment and systems have been specified with one or more make(s) WITHOUT the phrase "or equal". In such cases, only one of the manufactured products listed will be allowed. No other manufacturer is allowed.
4. Where substitutions are allowed as "equal" it shall be the Contractor's responsibility to make any and all necessary modifications required to accommodate the installation of the substituted item(s) at no additional cost to the Owner.
5. The Drawings have been designed and shown with a basis of design being of a specific vendor. This Contractor shall understand that if the submission is by another vendor to be considered as an equal then it shall be his/her responsibility to provide a system which will be thoroughly coordinated to meet the intended design. Any additional equipment, conduit, wiring, controls, etc., required to make the final installation "as equal" will be the responsibility of the Contractor and shall be included at no cost to the Owner.

6. Systems submitted which require extensive work in order to review will be rejected or the Contractor shall be accessed additional costs for additional resubmissions required for obtaining no exceptions by the engineer for the equipment to be considered as an acceptable equal submission.

1.4 SUBMITTALS TO THE ENGINEER

A. Submit Shop Drawings, O&M documentation, and manufacturer certificates per Section 01340.

B. Provide all certificates of inspection and approval from all regulatory agencies having jurisdiction over the Work under Division 16.

C. Maintain properly documented and witnessed test and checkout reports and submit these to the Engineer prior to energizing the Electrical system.

D. Submit complete documentation for coordination, short circuit, and arc flash study and report immediately upon approval of equipment and prior to start-up and testing of any equipment. Selection of equipment in order to make any necessary changes based on the study's findings before the equipment is approved. No start-up will be allowed without this study and report and without the final recommended system settings being implemented and tested in the field. If equipment needs to be ordered prior to receiving the study, all necessary changes will be the responsibility of the contractor at no additional costs.

E. Furnish the Engineer with a written statement from the Owner indicating that he is satisfied with the operating instructions given.

F. These requirements for Shop Drawings are in addition to the standards in Section 01340.

1. Shop Drawings Shall Consist of:
   a. Project name and location.
   b. Contractor's name.
   c. Index Sheet - Listing the equipment being submitted utilizing equipment designations, or symbols, indicated on the Contract Documents together with the proposed manufacturer, style/ type and catalog number.
   d. Manufacturer's scale or dimensioned drawings along with standard catalog "cut" sheets. These cut sheets shall be marked up to indicate equipment, sizes, types, etc., of equipment and all options being provided.
   e. Equipment ratings, service clearances and configuration.
   f. Listing of accessories to be furnished.
   g. Single-line and schematic diagrams where applicable. All text and symbols shall be easily legible and submitted on a 11"x17" sized drawing(s) as necessary.
   h. Refer to related sections of the specifications for special shop drawing requirements for individual equipment types.
2. All Cut Sheets shall be marked up to indicate specific equipment, specific sizes, specific types, etc., for all equipment and materials with all options provided for this project. Catalog cut sheets that are not properly marked up or are difficult to read and understand as to what equipment or application that it is used for will be returned un-reviewed for re-submittal.
3. The contract drawings have provided detailed customized schematic wiring diagrams for all motor control center equipment as well as individual wall

mounted starters, control panels, etc. These are very detailed and a lot of effort has been expended to compile these diagrams. The equipment manufacturer/supplier of this equipment as specified shall be responsible to provide the following detailed and customized schematic wiring diagrams.

a. A separate customized and detailed schematic for each piece of equipment (i.e. RAS pumps No. 1, No. 2 and No. 3). Even though the schematic appears to be same for this equipment a separate schematic for each will be provided with the referenced title (i.e. RAS Pump No. 1, etc.) noted on the respective schematic.
b. Each schematic shall indicate and show the specific devices (hand-off-auto, run light, ETM, etc.) and a reference to where this is located.
c. All contacts and interlocks shall be identified as to their location.
d. All metering and interface devices such as digital metering, TVSS, lightning protection, etc., shall be shown, identified, and dimensional heights from bottom of equipment shall be noted.
e. Failure to provide the proper customized schematic wiring diagrams shall be grounds for automatic rejection. Any delays, scheduling issues and additional contract time and cost associated with these delays due to equipment not being approved or being rejected for these reasons shall be the responsibility of the Contractor.

G. The following example is provided as a suggested formatting guideline. In addition to expediting the review process, this formatting will help ensure that the vendor has included all items applicable to the submittal, reduce the number of re-submittals and ensure a quality project.

1. Submittal Formatting:
    a. Project information as required by the contract specifications.
    b. Contact page.
    c. Index sheet - this sheet shall list each tab with a description of its contents, i.e., Tab 1 - MCC 12.
    d. Each tab shall be set up as follows:
        i. Pertinent project specific information and modifications associated with this MCC, with references to the general information tab number.
        ii. A parts list of all items/devices and accessories associated with this MCC including starters, relays, controls, fuses, etc.
        iii. A project specific nameplate data sheet for the MCC - this shall include, but not limited to, full project specific title descriptions, starter/feeder information and submitted wiring diagram number.
        iv. Dimensioned MCC layout plans and elevations pertaining only to this MCC.
        v. Project specific MCC one line diagram.
        vi. A complete set of project specific wiring diagrams for all loads associated with this MCC. Wiring diagrams shall include the following general information: The full project specific title of the load served and the submitted applicable compartment number. If more than one motor of a specific load within the applicable MCC

is indicated then separate and identified wiring diagrams shall be submitted for each load description and compartment number. All wiring diagram information and notation shall be clearly defined and referenced. Common wiring diagrams will not be acceptable.

2. As shown, this format is set up for a motor control center submittal, however, the same format shall be used for all switchboards, control panels, lighting panels etc.
3. Each submittal shall be neatly bound with typewritten index sheets.
4. Each control panel, system or equipment package shall be submitted in its entirety with all associated controls, devices, panels, layouts, wiring diagrams etc., included.
5. If the contractor relies on the equipment provider to submit this information, it shall be the Contractor's responsibility to ensure the format is as noted above. Submittals which do not clearly indicate, in an organized manner, what is being provided will be rejected, without being reviewed, for the submittal.
6. Equipment submitted which will be used throughout the facility, such as Local Control Stations, junction boxes, conduit, panels etc., shall clearly indicate which areas these will be located or used for, either on the submittal or a cross referenced list i.e., PVC conduit - Chemical Room, or screw type covered stainless steel enclosure - pullbox in NEMA 4X environments, etc.

1.5 RECORD DRAWINGS

A. At the completion of the installation, provide reproducible Record Drawings indicating the final configuration of all Electrical Systems as they were installed. Symbols, equipment designations, etc. shall be consistent with the Contract Documents. Provide exact locations of all work which has been concealed in concrete, masonry or underground.

B. Contractor shall provide detailed instrumentation loop diagrams, control panel diagrams, and motor schematics indicating exact point to point wiring. The electrical contractor and instrumentation vendor shall prepare the diagrams jointly to allow full coordination.

The requirements above are in addition to the standards for Record Drawings in Section 01720.

1.6 DELIVERY, STORAGE AND HANDLING

A. Coordinate material and equipment delivery with the project schedule. Notify the Engineer immediately, in writing, if material or equipment delivery will adversely affect the project schedule, include documentation from equipment suppliers indicating the revised delivery dates and the reason for the delay.

B. Exercise care during loading, transporting, unloading and handling of materials to prevent damage.

C. Check for defective or damaged materials, and for incomplete equipment shipments within seven (7) days after equipment delivery to the project site.

D. Store materials and equipment on the construction site in enclosures or under protective covering and off the ground in order to keep materials and equipment undamaged, clean, and dry.

E. Replace or repair, to the satisfaction of the Engineer, all materials and equipment that

are defective or that have been damaged during installation, at no additional cost to the Owner.

1.7 GUARANTEE/WARRANTY

A. Guarantee all equipment, materials and workmanship in accordance with the General Conditions and Supplemental Conditions of the Construction Contract and Section 11000.

B. Warrant all material furnished and work executed is in accordance with all applicable laws and regulations.

1.8 SUBCONTRACTOR COORDINATION AND RESPONSIBILITY

A. Coordination with Division 15

1. Electrical subcontractor is responsible to review the HVAC Drawings and Specifications to determine the power conduit and wiring requirements. Electrical subcontractor is responsible to implement conduit and wiring needs to match the functional descriptions in DIV. 15 except that specifically identified as being provided by the HVAC subcontractor. HVAC subcontractor shall be responsible for all control, low voltage 24VDC / 24VAC, conduit and wiring. This shall include, but is not necessarily limited to, wiring for automatic temperature control, and control wiring for plumbing systems. The HVAC subcontractor shall provide all miscellaneous 120VAC control from HVAC control panels to final control devices, as required, unless specifically included in Electrical work per the Drawings and Specifications.

B. Coordination with Miscellaneous Divisions

1. The electrical contractor shall coordinate all coring, cutting and patching of openings in existing structures and locations with the General Contractor in a timely manner not to delay scheduling of the project.

C. Schedules:

1. The electrical subcontractor shall maintain close contact and coordination at all times with the work of these related Divisions in order to provide a complete electrical system or delay the scheduling of the project.
2. Perform all coordination and scheduling of all cutting, temporary power usage with all other trades. patching, trenching, painting, trench covers, plastering, chases, slots, furring, grounds, masonry foundations, piers, excavating, pole bases, backfilling, pads, duct banks and other work incidental to installation of apparatus as required for electrical work.

1.9 CONDUIT LAYOUT PLANS AND DETAILS FOR CONCEALED AND EXPOSED WORK

A. The Contract documents require that conduit be concealed in walls, floors, ceilings or below floor slab in slab on grade areas due to the configuration and layout of the proposed building construction.

B. In areas of exposed conduits, conduits shall be installed via vertical drops down to equipment in order to maintain a clean and consistent look of conduit for this installation. Horizontal runs shall be limited to ceiling racked installation and shall drop down to equipment. In areas of hung ceilings and accessible space above ceilings conduits shall be installed concealed within these areas with vertical drop

down to the equipment to be fed.

C. A detailed conduit layout plan and routing path for the new addition shall be submitted for review and with no exceptions taken by the engineer prior to performing any work. The plan shall clearly indicate the equipment locations and path of runs along with overall sizes of conduits to be installed for a complete layout plan.

D. The contract drawings specifically note areas with blockout structural openings for the installation of conduits into and within the proposed building. A coordination review of equipment locations and layouts will be required such that the conduit layout plan has been pre-planned and approved prior to the commencing of the work. There is a significant amount of conduit to be installed under this project and this plan will provide an overview of the intended work to be preformed.

E. The contractor shall be allowed to reduce the number of conduit runs by combining conduit runs and increasing overall conduit sizes based on the National Electrical Code (NEC) allowable sizing and derating requirements. The contract documents will limit this however based on the allowable sizing of conduits within the slab and also this will be limited to smaller branch circuit feeders. Individual motor feeders to equipment such as pumps, process equipment runs, electrical distribution feeders and HVAC larger loads will not be allowed to be combined as further stated within the contract documents.

F. The Conduit and Wire Schedule has provided a summary of individual conduit runs throughout the project in order to clearly indicate where conduit and wiring is to be installed. The contractor shall utilize the schedule along with the electrical plans to develop the overall Conduit Layout Plan as required under this section. The submitted plans shall be formatted on 2' x 3' full size plans and submitted as part of the shop drawings requirements for this project prior to commencing any and all work.

G. The electrical contract drawings are diagrammatic and may not specifically show exact locations of the equipment. The contractor shall coordinate all conduit layout, and dimensions with the final equipment locations for the entire project for both concealed and exposed conduit runs.

1.10 MEASUREMENT AND PAYMENT

A. Measurement and payment for the work described in this section will be made in accordance with the provisions of DIVISION 1 MEASUREMENT AND PAYMENT.

1.11 REQUEST FOR INFORMATION

A. When there is a conflict or coordination issue, or if additional information is necessary for the contractor to proceed with the intended work, a Request of Information (RFI) form shall be submitted through the General Contractor to the Engineer. The specific issue shall be described in the RFI and shall be sent to the engineer for review and a response provided in an appropriate time period. RFI form shall be available via the General Contractor through the Engineer as required for this contract. This process shall be used as part of the work of this contract.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall be as specified in the appropriate Sections of DIVISION 16.

B. No exceptions to the Engineer of materials shall be as indicated in these Sections.

PART 3 - INSTALLATION

3.1 INSTALLATION

A. Installation shall be as specified in the appropriate Sections of DIVISION 16.

3.2 TESTS

A. Refer to all related requirements as set forth within SECTION 16950 and additional testing as indicated in the appropriate Sections of DIVISION 16.

3.3 CLEANING

A. Do not allow refuse and surplus materials to accumulate on the project site during the course of the work. Areas shall be cleaned and picked up on a daily basis.

B. Upon completion of the work, remove all refuse and surplus materials and leave the premises neat and clean on a daily basis.

C. Clean all equipment surfaces and touch up all damaged surfaces to the satisfaction of the Engineer.

D. Clean all lighting fixture reflector assemblies, lenses, louvers and lamps upon completion of the installation.

END OF SECTION

SECTION 16050

BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The Drawings are diagrammatic, unless detailed dimensioned Drawings are included, and show approximate locations of distribution equipment, fixtures, control panels and wiring devices. Equipment layouts shall be submitted prior to work in these areas with sufficient time for a detailed review. All equipment and locations shall be closely reviewed and coordinated. Coordinate all work and equipment locations with the Engineer prior to performing final installations.

B. While the general run of electrical feeders, branch circuits and conduits are indicated on the Drawings, it is not intended that exact routing be determined there from. Conductors can be combined in conduits for ease of construction as permitted by these specifications and the latest edition of the N.E.C.

C. Circuit designations can be found on the contract drawings in the combination of any of the following formats:

Single Line Diagrams	"Home Runs"
Electrical Schematics	Wiring Diagrams
Control and Instrumentation Diagrams	Panelboard Schedules
	Conduit and Wire Schedule

The Contractor shall be responsible for reviewing all drawings and may modify these designations subject to field conditions and review of the Engineer.

D. Measurements shall be made and coordinated with all approved equipment at the site and in the buildings during construction and all systems installed as the work progresses in such a manner that the equipment, piping, vents, ducts, conduit, etc., will fit in the space provided, maintain head room and if in unfinished areas, be as neatly installed, as obscure and "out-of-the- way" as physically possible.

E. Prior to submission for review any item of equipment, determine whether or not it will fit in the space provided and that no design changes in conduits, wiring or controls will be required. Any changes in the size, location or interconnections of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Engineer and no exceptions must be taken before such alterations are made.

F. All equipment and accessories and its interconnecting piping, ductwork, conduits, etc., shall be installed in such a manner that ample maintenance passage and Code-required space/access will be provided.

G. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general ductwork shall be given preference (except where grading of piping becomes a problem) followed by piping then electrical

wiring. If, after installation of any equipment, piping, ducts, conduit, etc., it is determined that ample maintenance and passage space has not been provided, the work shall be rearranged and/or furnished with other equipment as required to provide this space at no additional cost to the Engineer. The Contractor shall review the drawings for all other trades to determine any potential interferences and identify and coordinate with those with other trades.

H. When there is a conflict or coordination issue, or if additional information is necessary for the contractor to proceed with the intended work, a Request for Information (RFI) form shall be submitted through the General Contractor to the Engineer. The specific issue shall be described in the RFI and shall be sent to the Engineer for review and a response shall be provided in an appropriate time period. RFI form shall be available via the General Contractor through the Engineer as required for this contract. This process shall be used as part of the work of this contract.

1.2 QUALITY ASSURANCE

A. In General, the workmanship of the electrical installation shall be as described in the N.E.C.A. Electrical Design Guidelines. All methods of construction, details of workmanship, etc. that are not specifically described therein or indicated in the Contract Documents, shall be subject to the control and approval of the Engineer.

B. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the Specifications.

C. Work determined by the Engineer to be unsatisfactory according to industry standards shall be redone at the Contractor's expense, with no additional compensation.

D. All efforts shall be made in the location and installations of all raceways and equipment for a neat, logical, and safe installation as it pertains to personnel and operations.

E. An electrical conduit and associated electrical devices, etc., shall be installed concealed wherever possible in order to provide for a clean and limited amount of exposed conduit runs. Coordinate all work with the Engineer prior to performing this work.

1.3 SUBMITTALS TO THE ENGINEER

A. Submittals shall be provided in accordance with Sections 01340, 16010 and as specified in this section.

B. The contractor shall be responsible to submit a complete list of conduit type to be used for all locations of the project. A Conduit Layout Plan shall be submitted as a shop drawing with the following:

1. Shall include a column for exposed and concealed conduit heading. Mark up each location with the type of conduit to be used for the respective space in the appropriate heading of exposed and concealed installation.
2. Provide detailed drawings indicating intended routing and combination of conductors. Refer to section 16010 for additional requirements.

C. Submit a shop drawing for the following equipment, materials, products, etc.:

1. Conduit, Raceway and Tubing.
2. Conductors and Cable

3. Outlet Boxes
4. Pull and Junction Boxes and Terminal Cabinets
5. Wiring Devices
6. Control Devices and Equipment
7. Motor Starters
8. Safety Disconnect Switches
9. Enclosed Circuit Breakers
10. Fuses
11. Ground Rods
12. Metal Framing Channel
13. Distribution Equipment (medium and low voltage)
14. Motor Control Centers
15. Control Panels
16. Miscellaneous Electrical Distribution Equipment
17. Conduit and wall and floor link seal fittings
18. Conduit cable sealing fittings
19. Test results on all feeder conductors and heat trace cables as specified in Section 16950.
20. Variable Frequency Drive equipment
21. All other equipment and requirements shown and noted on the drawings

PART 2 - PRODUCTS

2.1 MATERIALS

A. Conduit, Raceway and Tubing

1. Rigid Heavy Wall Steel Conduit (RSC or RGS) shall be constructed of hot dipped galvanized or electro-galvanized steel. Acceptable Manufacturers: Allied - a division of Atkore, Wheatland, Republic Conduit, or equal.
2. Electrical Metallic Tubing (EMT) shall be constructed of electro-galvanized steel. EMT fittings shall be interlocking compression type of cadmium-plated malleable iron or zinc coated steel, or stainless steel. No die cast, set screw and indenter type fittings shall be used. Acceptable manufactures are Allied - a division of Atkore, Wheatland, Republic Conduit, or equal.
3. Aluminum conduit shall be rigid, heavy wall aluminum. Acceptable manufacturers: Anaconda, Kaiser, VAW, or equal.
4. Flexible Metal Conduit
    a. Flexible Metal Conduit shall be constructed of one continuous length of U. L. Approved electro-galvanized, spirally wound steel strip with interlocking convolutions and interior surfaces free from burrs and sharp edges.
    b. Flexible metal conduit shall be "liquid-tight" with PVC jacket. Acceptable Manufacturers: Alflex - a division of Southwire, Electri-Flex, Thomas & Betts - a division of ABB, or equal.
    c. Flexible metal conduit installed in hazardous, NEMA 7, Class I Div. 1 areas shall be UL Listed, and shall have a bronze or stainless steel braid covering over a flexible brass inner core. Packing shall be woven cotton braid impregnated with asphalt. Acceptable manufacturer: Crouse-Hinds

- a division of Eaton, Killark, Thomas & Betts - a division of ABB -XP Series, or equal.

5. Non-Metallic (P.V.C.) Conduit shall be Schedule 80, extra heavy wall or Schedule 40, heavy wall and UL Listed for the use intended. Acceptable Manufacturers: Carlon, Harrison, JM Eagle, or equal.
6. P.V.C. Coated Rigid Galvanized Steel Conduit
   a. The PVC Coated Rigid Galvanized Steel conduit, shall fully comply with the following industry listings and manufacturer's standards without exception prior to PVC coated application, shall conform to Federal Specifications WW-C-581E, ANSI Standard C80.1, ANSI Standard C80.5 UL Standard #6 and NEMA RN1-2005.
   b. The PVC coated rigid galvanized steel (RGS) conduit shall comply with the below listed specifications without exceptions allowed. PVC coated rigid galvanized steel (RGS) conduit shall be hot dipped galvanized both internally & externally. The PVC coated rigid galvanized (RGS) conduit shall have hot dipped galvanized threads. The external PVC coating shall be a nominal 40 mils of external PVC coating and 2 mils of blue interior urethane coating. The PVC coating shall be applied by the same manufacturer of the hot dipped galvanized rigid steel (RGS) conduit.
   c. Conduit bodies and fittings for PVC coated rigid galvanized steel (RGS) conduit shall be from the same manufacturer as the PVC coated rigid galvanized steel (RGS) conduit. Conduit bodies shall be coated on the entire body both internally and externally with 2 mil of blue urethane and exterior coated with 40mil of PVC coating.
   d. All conduit, conduit bodies, connectors, support systems and accessories in the corrosive areas, above grade or below grade, shall be coated as specified.
   e. The thickness of the coating is to be a nominal 40 mils except where the configuration or application of the unit dictates otherwise.
   f. PVC coated conduit shall be UL or ETL Listed.
   g. During the manufacturing of the PVC coated rigid galvanized steel (RGS) conduit, the factory applied hot dipped galvanized coating of both the internal and external (RGS) conduit shall not be disturbed in any fashion prior to the application of PVC coating being applied as per UL 6. The PVC coated rigid galvanized steel (RGS) conduit shall comply with all UL listings providing the hot dipped galvanized coating as the primary means of protection of corrosion protection for the conduit, and the PVC coating shall be listed as a secondary means of corrosion protection as required by UL 6 and NEMA RN-1-2005.
   h. Every female opening shall have a plastic sleeve extending one pipe diameter or 2", whichever is less, beyond the opening. The inside diameter of the sleeve shall be the same as the outside diameter of the pipe used with it. The wall thickness of the sleeve shall be the same as the plastic coating.
   i. Fittings and Accessories:
      i. Right angle beam clamps and U-bolts will be provided with PVC

encapsulated nuts that cover all exposed parts of the threads.

ii. U-bolts will be sized to snugly fit the nominal 40 mil coated conduit.

iii. The screw heads on Form 8 condulets shall be stainless steel encapsulated by the same manufacturer. All conduit bodies used in wash down, wet or outdoor applications shall be NEMA 4X rated.

iv. Couplings shall have longitudinal ribs 40 mils in thickness to protect them from wrenches or channel-locks.

v. All coated conduit and fittings must be installed wherever possible by a certified trained installer using a tool available from the manufacturer for the use intended in order to protect the PVC coating.

j. The interior coating shall be applied in such a manner so as to allow field bending without cracking or flaking of the interior coating.

k. <u>All fittings shall be of the same material as the respective raceway system.</u>

7. Acceptable manufacturers shall be: Plasti-Bond, Thomas & Betts-a Division of ABB/Ocal, Perma-COTE, or equal.

B. Wire Markers:

1. For locations where the integrity of the marker is a concern (such as in manholes or outdoor locations) wire markers shall be one piece, nylon locking marker ties equal to “OMNI GRIP” as manufactured by the W. H. Brady company, Panduit PLM series, or equal.

2. For other locations where the integrity of the marker will not be compromised (such as a control panel in a dry, indoor location) plastic-coated sticker-type labels may be used.

C. Conductors and Cable

1. All power wiring conductors (P-X on drawings) shall be insulated for 600 volts, Type XHHW insulation, unless otherwise noted. Conductors shall be standard AWG and KCMIL sizes. Conductors shall be 98 percent copper, stranded, heat and moisture resistant with cross-linked synthetic polymer insulation for all sizes No. 12 AWG and larger. Smaller sizes shall not be used except for communications and special systems. For lighting and receptacle circuits, solid wire may be used in lieu of stranded wire, for No. 12 and No. 10 AWG only. Conductors shall be labeled with U.L. approval and be marked with the manufacturer's name, wire size and insulation type. All underground power cables shall be UL Listed and Labeled for underground use in wet locations. Acceptable Manufacturers: Okonite, Southwire, Pirelli, or equal.

2. Variable frequency drive (VFD) motor supply shall be four (4) conductor tinned stranded copper, with cross-linked polyethylene insulation, overall foil (100% coverage) / tinned copper braid (85% coverage) shields, No. 12 AWG tinned copper drain wire, and outer PVC jacket. Cables shall conform to UL specification for 1000 Volt flexible motor supply cable. All underground power cables shall be U.L. Listed and Labeled for underground use in wet locations. Acceptable Manufacturers: Belden, Olflex, Houston Wire & Cable, or equal.

3. Control Wiring:

a. All control wiring (120 or 24 volt, AC or DC) conductors within buildings or above grade shall be insulated for 600 volts, unless otherwise noted,

and shall be No. 14 AWG minimum size, or larger if so indicated on the Drawings. Conductors shall be 98 percent copper, stranded, heat and moisture resistant, and thermal plastic insulated and shall be type THWN/THHN.

b. All conductors for control wiring located below grade shall be 600V, 98 percent copper, stranded, heat and moisture resistant, with cross-linked synthetic polymer insulation type XHHW. All underground control cables shall be U.L. Listed and Labeled for underground use in wet locations. Acceptable Manufacturers: Okonite, Southwire, Pirelli, or equal.

4. All instrumentation control cables (4-20 mA signal) referred to on the Drawings as "twisted shielded pairs", shall be rated 600V, 80 deg. C, individually shielded twisted pairs, No. 16 AWG, stranded conductors of tinned copper with polyethylene insulation and aluminum-polyester shielding with #18 awg stranded copper drain wire surrounded by a chrome PVC jacket. Control cable shall be UL listed with 100% shield coverage. All underground instrumentation cables shall be U.L. Listed and Labeled for underground use in wet locations. Acceptable Manufacturers: Belden, Alpha Wire & Cable or equal. Provide instrumentation control cables equivalent to Belden type 8719 or equivalent unless specified otherwise by the instrument manufacturer.
5. Three conductor shielded cable for use with remote potentiometers for varying motor speeds etc. Cable shall be stranded, tinned copper, polyethylene insulated, drain wires with aluminum-polyester shielding with #18 awg stranded copper drain wire surrounded by a chrome PVC jacket. Control cable shall be rated 600 volt and shall be UL listed with 100% shield coverage. Acceptable Manufacturers: Belden, Alpha Wire & Cable or equal. Provide three conductor shielded cables equivalent to Belden type 8618 or equivalent unless specified otherwise by the instrument manufacturer.
6. RTD wiring shall be rated 600V, 60 degree, triads 3C#16TWS, with stranded, tinned copper, polyethylene insulated, drain wires with aluminum-polyester shielding with #18 awg stranded copper drain wire surrounded by a chrome PVC jacket. Control cable shall be UL listed with 100% shield coverage. Acceptable Manufacturers: Belden, Alpha Wire & Cable, or equal. Provide RTD wiring equivalent to Belden type 8618 or equivalent unless specified otherwise by the instrument manufacturer
7. Thermocouple wire shall be 600V, No. 16 AWG, solid duplex, tinned copper, polyethylene insulated of materials to match the characteristics of the thermocouple. Thermocouple lead wire shall have PVC insulation with PVC jacket.
8. Intercommunication Wiring:
   a. Conductors for intercommunication wiring in indoor applications shall be 150V, 80 deg C, tinned copper, PVC insulated twisted pair, 24 AWG solid conductor with chrome PVC jacket, two-pair minimum. Acceptable Manufacturers: Belden type 9562, Alpha Wire & Cable, or equal.
   b. Conductors for underground intercommunication wiring shall 24 AWG solid bare copper, low smoke PVC insulated (ls PVC), twisted pairs (unshielded) conductor surrounded by a white category 3 ls PVC outer

jacket, four-pair minimum, U.L. Listed and Labeled for underground wet locations. Acceptable Manufacturers: Belden type 1245A2, Alpha Wire & Cable, or equal.

9. Data Wiring:
   a. Cables for data wiring shall be Category 6, 4-pair, 24 AWG solid bare copper conductor, unshielded, FEP insulation, plenum rated. Acceptable Manufacturers: Belden Type 7813LC, Alpha Wire & Cable, or equal.

D. Outlet Boxes
1. Standard, recessed outlet boxes and covers shall be galvanized steel not less than 1-1/2 inches deep, 4 inches square or octagonal, with knockouts. Recessed boxes shall only be used for recessed work. Acceptable Manufacturers: Thomas & Betts, Steel City, OZ Gedney, Raco or equal.
2. Outlet boxes exposed to moisture or used for exposed work shall be cadmium cast alloy complete with hubs and gasketed screw fastened covers.
3. Outlet boxes used in hazardous, Class I, Div 1, Group C & D locations shall be UL Listed Feraloy iron alloy body with electrogalvanized and aluminum acrylic paint or epoxy powder coat complete with hubs as required for the installation. Provide covers to fit the application. Covers to be utilized for pendant mounted light fixtures shall incorporate flexible cushion or ball type fixture hangers rated for the area in which it is to be installed. Acceptable manufacturers: Crouse Hinds, Appleton, or equal.
4. Outlet boxes used in corrosive, NEMA 4X areas, shall have a plastic P.V.C. coating as previously described in the conduit, raceway and tubing section. Acceptable manufacturer shall be Rob-Roy "Plasti-Bond", Thomas & Betts, Ocal, or equal.
5. In no case shall boxes be sized smaller than as indicated in Article 314 of the National Electrical Code for the conductor sizes installed.
6. Acceptable Manufacturers: Thomas & Betts, Steel City, OZ Gedney, Crouse-Hinds, Raco or equal.

E. Pull and Junction Boxes
1. Boxes shall be with trim for flush or surface mounting in accordance with the location to be installed. Provide screw-on type flush covers. Boxes with hinges and side clips are not acceptable. Boxes installed in damp locations shall be of watertight construction with gasketed cover and conduit hubs. Refer to the Electrical Drawing E-1 for NEMA rated areas for this project and pullbox type and use required.
2. Boxes installed in Class I, Div 1, Group C & D locations shall be constructed of copper free aluminum (body and cover), extruded aluminum hinges with stainless steel cover bolts and neoprene gasket. The box shall be UL Listed for the location and sized as required for the application. Provide NEMA 4/7 pullboxes when installed in these areas.
3. Boxes used in corrosive, NEMA 4X areas, shall have a plastic P.V.C. coating as previously described in the conduit, raceway and tubing section. Acceptable manufacturer shall be Rob-Roy "Plasti-Bond", Thomas & Betts – a division of ABB/ Ocal, Perma-COTE, or equal.

4. In no case shall boxes be sized smaller than as indicated in Article 317 of the National Electrical Code for Conduit and Conductor sizes installed.

F. Expansion Fittings

1. Expansion fittings for exposed conduit runs shall be watertight expansion type designed to compensate for up to 8" of movement (4" in either direction). Fittings shall be U.L. listed, shall be malleable iron or ductile iron with exterior and interior zinc plating for corrosion protection. With U.L. listed internal bonding jumper constructed of a tinned copper braid, sized to meet UL fault current test requirements and comply with bonding requirements –NEC 250-.98. Acceptable Manufacturer: Thomas Betts – a division of ABB Type XJG-TB O.Z./Gedney - a division of Emerson- Type EX, Crouse Hinds, or equal.
2. Expansion/deflection fittings for concealed conduit runs shall compensate for up to 3/4" of movement in any direction. Fittings shall be U.L. listed and be water, rain and concrete tight. Fittings shall be constructed of bronze end couplings, neoprene sleeve with stainless steel bands and an internal braided tinned copper bonding jumper and Ericson type conduit union. Acceptable manufacturer: O.Z. Gedney type a division of Emerson -DX, Thomas Betts – a division of ABB - type XD, or equal.

G. Wiring Devices

1. Wiring devices shall be specification grade as described herein. Switch handles, receptacles, etc. shall be installed in a single color. New wiring devices installed in existing facilities shall match previous installed devices. Provide device cover plates of satin finish stainless steel in finished areas and cadmium finished sheet steel in unfinished areas. Acceptable manufacturers are: Hubbell Inc., Cooper-Arrow-Hart – a division Eaton, Pass & Semour – a Division of Legrand, Thomas & Betts – a Division of ABB, or equal. Provide devices as indicated by Contract Documents.
2. Toggle Switches
   a. 20 Ampere, 1-pole, 277 Volt: Hubbell 1221
   b. 20 Ampere, 2-pole, 277 Volt: Hubbell 1222
   c. 20 Ampere, 3-way, 277 Volt: Hubbell 1223
   d. 20 Ampere, 4-way, 277 Volt: Hubbell 1224
   e. 20 Ampere, 1-pole, 277 Volt w/Neon Pilot Light: Hubbell 1221-PL
   f. 20 Ampere, 2-pole, 277 Volt w/Neon Pilot Light: Hubbell 1222-PL
   g. 20 Ampere, 3-way, 277 Volt w/Neon Pilot Light: Hubbell 1223-PL
3. Receptacles
   a. 20 Ampere, 125 Volt, Single Receptacle: Hubbell 5361
   b. 20 Ampere, 125 Volt, Duplex Receptacle: Hubbell 5362
   c. 20 Ampere, 125 Volt, Duplex G.F.I. Receptacle: Hubbell GF-5362
   d. 30 Ampere, 125/250 Volt, Dryer Receptacle: Hubbell 9430A
   e. 50 Ampere 125/250 Volt, Range Receptacle: Hubbell 9450A
   f. 20 Ampere, 125 Volt, Duplex, Weatherproof: Crouse Hinds WLGF-FS with GFI receptacle
   g. 20 Ampere, 125 Volt, Duplex, Explosion proof:
      i. Crouse Hinds ENR12201 W/(2) ENP5201 Plugs (Dead End Type)
      ii. Crouse Hinds ENRC22201 W/(2) ENP5201 Plugs (Feed Thru Type)

h. 30 Ampere, 600 Volt, 2-wire, 3-Pole Welding Receptacle:
   i. Crouse Hinds ARE3322 W/APJ3575 Plug (Surface Mount)
   ii. Crouse Hinds AR332 W/APJ3575 Plug (Flush Mount)
i. 30 Ampere, 600 Volt, 3-Wire, 4-Pole Welding Receptacle:
   i. Crouse Hinds ARE 3422 W/APJ3485 Plug (Surface Mount)
   ii. Crouse Hinds AR342 W/APJ3485 Plug (Flush Mount)
j. 60 Ampere, 600 Volt, 2-Wire, 3-Pole Welding Receptacle:
   i. Crouse Hinds ARE6323 W/APJ6385 Plug (Surface Mount)
   ii. Crouse Hinds AR632 W/APJ6385 Plug (Flush Mount)
k. 60 Ampere, 600 Volt, 3-Wire, 4-Pole, Welding Receptacle:
   i. Crouse Hinds ARE6424 W/APJ6485 Plug (Surface Mount)
   ii. Crouse Hinds AR642 W/APJ6485 Plug (Flush Mount)
l. Special duty style and type receptacles greater than 20 ampere shall be submitted for specific applications indicated on the drawings specific for each area and load to be connected.
m. Isolated ground type orange coded receptacles rated 20 ampere, 125 volt duplex shall be submitted for all computer power equipment shown on the drawings.
n. Metallic and Non-Metallic Pin and Sleeve type devices and Interlocked receptacles shall comply with NEMA 250, UL94, 746C, 840, 1010,1682 and UL1686 and ASTMD570, IEC 309-1 as indicated on detail drawings. Acceptable manufacturers shall be Crouse Hinds – a division of Eaton, Hubbell, Thomas & Betts – a division of ABB, Russell Stoll Max Guard, or equal.

H. Control Devices and Equipment:
1. Photoelectric Control:
   a. 120 Volt, SPST, 2000 Watt: Tork Model 2101
   b. 120 Volt, DPST, 6000 Watt: Tork Model 5403
2. Lighting and Control Contactors:
   a. Contactors shall be electrically operated, electrically held and shall switch a load at 277 volts, 60 hertz and shall have the number of N.O. contacts and N.C. contacts shown on the Drawings. Minimum number of contacts shall be 5 N.O. and 1 N.C. contact.
   b. The contactor shall be continuously rated 20 amperes per pole for all types of ballast and tungsten lighting and resistance loads, and shall not be de-rated for use on high-inrush loads. The coil should be continuously rated and encapsulated.
   c. The contactor shall have double-break, silver-cadmium-oxide power contacts. Auxiliary arcing contacts are not acceptable. All power contacts shall be convertible from N.O. to N.C. or vice-versa. All contacts shall have clearly visible N.O. and N.C. contact-status indicators.
   d. The contactor shall be approved per UL 508 and CSA.
   e. The contactor shall be designed in accordance with NEMA ICS2-211B. They shall be industrial-duty rated for applications to 600 volts maximum.
   f. The contactor shall have a NEMA Type 1 enclosure unless noted otherwise on the Drawings.

g. Refer to Drawings for location, wiring schematics and details.
h. Acceptable manufacturers: Square D, Cutler-Hammer, or equal.
i. Provide complete system lighting and control panel layout and wiring diagrams for review and approval.

I. Motor Starters
1. For Single Phase Motors: Fractional Horsepower Manual Motor Starter with Thermal Overload(s) and a red running indicating light unless noted otherwise:
a. 120 Volt Single-Pole, Surface Mounted: Square-D FG-1P
b. 120 Volt Single-Pole, Flush Mounted: Square-D FS-1P
c. 120 Volt, Single-Pole, Surface Mounted, Explosion Proof: Square-D FR-1H
d. 120 Volt, Single-Pole, H-O-A Selector, Surface Mounted: Square-D FG-71P
e. 120 Volt, Single-Pole Two-Speed, Surface Mounted: Square-D FG-11P
f. 240 Volt, Two-Pole, Surface Mounted, Explosion Proof: Square-D FR-2H
g. 240 Volt, Two-Pole, Surface Mounted: Square-D FG-2P
h. 240 Volt, Two-Pole, Two-Speed, Surface Mounted: Square-D FG-22P
i. 240 Volt, Two-Pole, H-O-A Selector, Surface Mounted: Square-D FG-72P
2. For Three Phase Motors: Shall be combination starter/disconnect type, employing magnetic starter (NEMA Size 1 minimum), rated to match the equipment served, with thermal overload protection for each phase and with an M.C.P. type circuit breaker/disconnect sized per the circuit breaker manufacturer's recommendations for coordination with the thermal overload protection, lights, relays and auxiliary devices. Combination starters shall be provided with a 480, 240 or 208-120 volt control power transformer with primary and secondary fusing. Provide 2 N.O. and 2 N.C. auxiliary contacts.
3. Refer to control wiring diagrams on the drawings for specific requirements and devices.
4. Acceptable Manufacturers: Square-D, Cutler-Hammer, Allen-Bradley, or equal.

J. Safety Switches
1. All safety switches shall be NEMA Type HD and Underwriters Laboratories Listed.
2. The handle position shall indicate whether the switch is "ON" or "OFF".
3. All current carrying parts shall be plated to resist corrosion and promote cool operation. Switches shall have removable arc suppressers where necessary to permit easy access to line side lugs. Lugs shall be front removable and UL listed for 60°C or 75°C, aluminum or copper wires.
4. Provisions for padlocking the switch in the "OFF" position with at least three locks shall be provided.
5. Switches shall have a dual cover interlock to prevent unauthorized opening of the switch door when the handle is in the "ON" position, and to prevent closing of the switch mechanism with the door open.

6. Disconnect switches, indicated on the drawing to be used for motors controlled by variable frequency drives shall be as indicated above, except shall be 4 pole type switches. The fourth pole shall be wired directly to the disable input, in series with the safety e-stop, in order to lock-out and immediately shutdown the drive. The auxiliary 4th pole shall open prior to any of the other three power poles and shall be designed for proper use with VFD type load circuits.
7. Enclosures
   a. Safety switch enclosures for non-hazardous locations painted galvanized steel for NEMA 12 area and stainless steel for NEMA 4X areas.
   b. Switches specified as NEMA 7 Class 1, Division 1 shall be furnished in cast aluminum enclosures with conduit provisions as specified. Enclosures shall be provided with a bolted cover and with sealing means for hazardous location protection. "ON" and "OFF" position identification shall be cast into the cover, not painted on or applied with an adhesive.
   c. Switches specified as NEMA 7 (Class 1, Division 2) shall be furnished in non metallic enclosures, NEMA 4X/IP66/Class 1, Division 2 rated with conduit provisions as specified. Enclosures shall be provided with "ON" and "OFF" position identification and lockable in the “OFF” position.
8. Acceptable Manufacturers: Square-D, Cutler-Hammer, General Electric, Siemens, or equal.

K. Fusible Disconnect Switches
1. Switches shall be horsepower rated for AC and/or DC as indicated by the plans. All fusible switches rated 100 thru 600 amperes at 240 volts and 30 thru 600 amperes at 600 volts shall have a UL approved method of field conversion from standard Class H fuse spacing to Class J fuse spacing. The switch also must accept Class R fuses and have provisions for field installation of a UL listed rejection feature to reject all fuses except Class R. The UL listed short circuit rating of the switches shall be 200,000 rms symmetrical amperes when Class R or Class J fuses are used with the appropriate rejection scheme. The UL listed short circuit rating of the switch, when equipped with Class H fuses, shall be 10,000 rms symmetrical amperes. The cost of any conversion kit and labor associated with conversion to accommodate the required fuses shall be included in the base bid. In general, U.L. Class H fuses are not to be used. Refer to the paragraph on fuses, this section on further requirements for fuses.
2. Enclosures
   a. Safety switch enclosures for non-hazardous locations painted galvanized steel for NEMA 12 area and stainless steel for NEMA 4X areas. Refer to Drawing E-1 for NEMA classifications.
   b. Switches specified as NEMA 7 & 9 shall be furnished in cast aluminum enclosures with conduit provisions as specified. Enclosures shall be provided with a bolted cover and with sealing means for hazardous location protection. "ON" and "OFF" position identification shall be cast into the cover, not painted on or applied with an adhesive.
3. Acceptable Manufacturers: Square-D, Cutler-Hammer, General Electric, Siemens, or equal.

L. Enclosed Circuit Breakers

1. Circuit breakers shall be molded case, thermal-magnetic type, ratings as noted, with overcenter, trip-free, toggle-type operating mechanism, quick-make, quick-break action and positive handle indication unless otherwise noted. Multiple pole breakers shall be common trip type. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole. Breakers shall be calibrated for operation, an ambient temperature of 40*C and shall be suitable for mounting and operating in any position. Breakers shall have removable lugs, U. L. listed for copper and aluminum conductors. Breakers shall be installed in enclosures as specified in Section 16160, with NEMA ratings as indicated on the Drawings. Breakers shall be provided with manufacturer installed neutral and ground kits and shall be U.L. listed and labeled for service entrance duty as noted on the drawings and where required by the N.E.C. Short circuit ratings of equipment shall be as noted on the drawings or shall be rated equal to the equipment or motor control center which they feed. The minimum rating shall be 42,000 A RMS symmetrical unless otherwise noted or determined by the Engineer.
2. Acceptable Manufacturers: Square-D, Cutler-Hammer, General Electric, Siemens, or equal.

M. Power Distribution Fuses

1. All fuses rated 600 volts and below shall be rejection type dual-element, time-delay type. Acceptable Manufacturers are Bussman, Littlefuse and Shawmut or equal.
2. Fuses shall be U.L. Class and rating as shown on the drawings or as required by the manufacturer of the equipment they are protecting. In general, fuses shall be:
   a. U.L. Class RK1 for service entrances and feeders supplying combination motor loads.
   b. U.L. Class RK5 for motor branch circuits.
3. Provide two (2) complete sets of fuses for all fusible disconnect switches.

N. Ground Rods, Ground Cable, Ground Fittings

1. Ground Rods shall be copper-clad steel at least 3/4-inch in diameter and 10 feet long. The rods shall have a hard, clean, smooth, continuous, surface throughout the length of the rod.
2. Ground System Cable and taps shall be copper stranded, sized as indicated on Drawings and/or in Section 16450. Exothermic welding connections shall be required for underground connections; mechanical fittings are acceptable for above ground connections only. Acceptable manufactures are Erico-Cadweld, Thomas & Betts-Blackburn, Galvan, or equal.
3. Irreversible compression connectors must be factory filled with an oxide inhibitor and installed with the same manufacturers die so that the die index matches the listed index on the connectors. Connector must be fully crimped with a 14 ton or larger hydraulic tool so that the index number is indented on the connector. Connectors must comply with IEEE837, UL467 and CSA22.2. As manufactured by: Thomas & Betts-Blackburn, Hubbell-Burndy, Erico, or equal.

O. Metal Framing Channel
   1. Channel for all locations shall be roll formed from stainless steel AISI Type 316. Channel shall be 1-5/8” and comply with the following industry standards: NFPA70, Fed Spec: W-C-582, WW-H-171, MFMA-4, and ASTM B633
   2. Use stainless steel fittings and hardware of the same material as channel. Fittings shall be by same manufacturer.
   3. All metal framing channel ends shall be furnished and installed with insert type plastic caps for the entire installation of this project at all ends of framing. End caps which install around the outside of the channel will not be allowed.
   4. Provide a complete 4" "C" angle channel mounting channel and hardware system as shown on the drawings and for all vertical supports. Refer to the electrical detail drawings for structural sizing and rigidity of "C" channel. Uni-Strut channel shall only be allowed for horizontal support and cannot be used in a vertical support installation.
   5. Metal framing shall be B-Line Systems, Inc., Thomas & Betts-Super Strut, Unistrut, or equal.

P. Link Seal
   1. Conduit wall and floor seals for cored holes and sleeved openings shall be Link Seal, Innerlynx, Crouse Hinds, or equal. Refer to the contract drawings for additional requirements.

Q. Cable Seals
   1. Conduit sealing bushings shall be OZ Gedney Co., Type CSB Series, Crouse Hinds, Killark, or equal.

R. Conduit Seals-Offs
   1. Provide Class I, Div. 1, Group D and Class 1, Div. 2 seals as required by the N.E.C. Material shall match the conduit in which being installed. Acceptable manufacturers are Appleton, Crouse-Hinds, Killark, or equal.

S. Terminal Cabinet
   1. The enclosure shall meet NEMA rating listed on Drawing E-1 which shall include a fully hinged door with a key lockable handle with no side clips around the edge. In no case shall enclosure be sized smaller than as indicated in the National Electrical Code for Conduit and Conductor sizes installed.
   2. Provide a lamacoid Name Plate at the top center of the cabinet.
   3. All terminal strips shall be numbered on both sides and numbering shall not be repeated within the same enclosure. Provide tags to indicate destination of cable on either side of terminal connections.
   4. Provide an internal backboard for all enclosures
   5. Provide separate terminal strips for power, control, and signal wiring. Also provide separation between all terminal strips. In addition, separation and separate terminal strips shall be provided for 120V and 24V control wiring.
   6. Enclosure shall be free standing with the minimal dimensions as follows:
      a. 90 inches high, 36 inches wide, and 24 inches deep. This will allow for future equipment to be installed.
      b. Three point lockable handle.
      c. Large nameplate at top center of panel.
      d. 60 spare terminals.

e. Create terminal strips to allow for additional equipment to be mounted on back panel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Unless otherwise noted, wiring for all systems indicated in the Contract Documents shall consist of insulated conductors installed in raceways in accordance with the manufacturer's instructions.
   1. Raceways shall be continuous from outlet box to outlet box and from outlet box to cabinet, junction or pull box. Secure and bond raceways to all boxes and cabinets such that each system of raceways will be electrically continuous throughout.
   2. Contract drawing E-1 NEMA CLASSIFICATIONS FOR ELECTRICAL EQUIPMENT AND ENCLOSURES indicates the NEMA ratings of each location at the facility.

B. Unless otherwise indicated on the Drawings and Conduit Installation Schedule on E-1**,** install all wiring in the following applicable raceway system.
   1. Use of Miscellaneous Conduit Types
      a. Flexible "liquid tight" metal conduit shall be used for final connection to the following:
         * all motors * rotating or vibrating equipment
         * dry type transformers * recessed lighting fixtures
         Lengths of liquid tight flexible metal conduit shall be kept to a minimum (12 to 18 inches) and maximum length of 2'-6" except when dictated otherwise by a particular installation approved by the Engineer and as allowed by NEC.
      b. PVC Schedule 80 non metallic conduit shall be used as shown on drawings.
   2. All signal wiring shall be installed in rigid galvanized steel or PVC coated rigid galvanized steel conduit.

C. General Raceways Installation Requirements:
   1. Sized as indicated on the Drawings. Where sizes are not indicated, raceways shall be sized per the National Electrical Code in accordance with the quantity, size, type and insulation of conductors to be installed. However, raceways shall be minimum three quarter (3/4") trade size for all installation unless otherwise noted.
   2. Provide adequate grounding between all outlets and the established electrical system ground. Bond conduit systems per NEC.
   3. Cut square, free of burrs due to field cutting or manufacture, and bushed where necessary. Spray all ends of threaded conduit with cold galvanizing spray compound.
   4. Installed with exterior surfaces not less than six inches (6") from any surface with a temperature of 200°F or higher.
   5. Plugged at the ends of each roughed-in raceway with an approved cap or disc to prevent the entrance of foreign materials during construction.
   6. Concealed throughout except where exposure is permitted by the Engineer.

7. Installed parallel or perpendicular to floors, walls and ceilings.
8. Installed with a minimum of bends and offsets. All bends shall be made without kinking or destroying the cross section contour of the raceway. Factory made bends shall be used for raceways one-inch (1") trade size and larger.
9. Installed with U. L. Listed raintight and concrete-tight couplings and connectors.
10. Firmly fastened within three feet of each outlet box, junction box, cabinet or fitting. Raceways shall not be attached to or supported by wooden plug anchors or supported from Mechanical Work such as ductwork, piping, etc.
11. Arranged in a neat manner for access and allow for access to work installed by other trades.
12. If it is necessary to burn holes through webs of beams or girders, call such points to the attention of the Engineer and receive written approval both as to location and size of hole before proceeding with work. All holes shall be burned no larger than absolutely necessary.
13. Where raceways puncture roof, install pitch pockets as required in order that the roof warranty is maintained.
14. Where raceways penetrate fire-rated walls, floors, or ceilings, install firestops equal to the rating of the wall, floor, or ceiling, per specification section 07270, "Fireproofing".
15. For Raceways installed outdoors:
    a. Conduit entry shall not extend from above and turn down to the equipment causing a path of moisture or liquid to follow down to the equipment.
    b. Install drip loops in liquid tight conduit connections and extend up to equipment to avoid moisture or liquid travel to the equipment.
    c. Seal all conduits with duct seal or cable seals that extend from heated to non-heated locations at both ends of all conduits.

D. Wiring Methods
1. Feeder conductors shall be continuous from point of origin to load termination without splice. If this is not practical, contact the Engineer and receive written approval for splicing prior to installation of feeder(s). Refer to Splicing Methods listed below.
2. Do not pull conductors into raceways until raceway system, including all outlets, cabinets, bushings and fittings, is completed. Verify that all work of other trades which may cause conductor damage is completed. Use only U.L. approved cable lubricants when necessary. Do not use mechanical means to pull conductors No. 8 or smaller.
3. In general, conductors shall be the same size from the last protective device to the load.
4. All wiring systems shall be properly grounded and continuously polarized throughout, following the color coding specified. Connect branch circuit wiring at panelboards, as required, in order to provide a "balanced" three-phase load on feeders.
5. All feeder connections shall be made to bus and other equipment using solderless, pressure type terminal lugs, as manufactured by Burndy, National, O.Z., T. & B., or equal.

E. Conduit Support

1. Support adequately by malleable iron pipe clamps or other approved methods. **In exterior or wet locations and along outside wall supports shall allow not less than 1/4 inch air space between raceway and wall.** Firmly fasten raceway within 3 feet of each outlet box, junction box, cabinet or fitting. The following table lists maximum spacing between supports. Additional supports may be required due to field conditions, strength of supporting members, etc. Furnish and install such supports at no additional cost to Owner.

Conduit Trade Size	Type of Run	Horizontal Spacing in Feet	Vertical Spacing in Feet
¾"	Concealed	7	10
1", 1-1/4"	Concealed	8	10
1-1/2" & lgr.	Concealed	10	10
¾"	Exposed	5	7
1", 1-1/4"	Exposed	7	8
1-1/2" & lgr.	Exposed	10	10

F. Installation of Concrete Envelope

1. Wherever a cluster of four or more raceways rise out of floor exposed, provide neatly formed 6" high concrete envelope with chamfered edges around raceways.

G. Installation of Spare Conduits

1. At each flush mounted panel-board, terminal cabinet, control cabinet, etc., provide four (4) spare three-quarter inch (3/4) raceways from panel-board, etc. to an area above the nearest accessible ceiling space and floor space in the specific room location. Make 90 degree turn above the ceiling or below the floor and cap all conduits.
2. Where drawings indicate a "Spare" conduit, install a #14 AWG fish wire in all runs to facilitate future installation of conductors.

H. Installation of Bushings and Grounding Bushings

1. Provide grounding type insulated bushings on all power conduits regardless of size.
2. Provide grounding type insulated bushings on all control conduit sizes and signal conduit sizes one and one-quarter inch (l-l/4") trade size and larger.
3. Provide standard bushings for conduits one inch (l") and smaller unless otherwise stated.
4. Install cable seal bushings in conduits for all outdoor locations and NEMA 4X locations to prevent moisture from entering enclosures and equipment.
5. Install cable seals in all conduits where there is a change in temperature such as transitioning from a room to the attic.
6. Provide a bushing at each conduit termination unless fitting at box where conduit terminates has hubs designed in such a manner to afford equivalent protection to conductors.
7. Any installations not provided with these requirements shall be removed and reinstalled at no additional cost to the Owner.

I. Myers Hubs
   1. Myers hubs shall be installed on junction boxes and enclosures which do not have cast hubs in non classified areas.

J. Expansion Fittings
   1. All conduit installations where conduits extend up out of the ground at buildings, structures or equipment shall be provided with expansion fittings.
   2. Expansion/deflection type fittings shall be provided at all horizontal or vertical expansion joints, located in new or existing buildings and structures.

K. Conduit Seals
   1. Conduit seals shall be installed in all explosion proof areas Class 1 Division 1, and Class 1, Division 2 areas. The conduit seal shall be installed per the National Electric Code Article 501.15 as well as what is shown on the drawings.
   2. Upon installation of sealant, the contractor shall mark the conduit seal with glyptal or permanent marker to indicate that the conduit seal is filled properly.

L. Link Seals
   1. All penetrations through existing and new concrete floors, and walls shall be core drilled and sleeved, and installed with a link seal.
   2. Refer to all details shown on the Contract Drawings for conduit sealing fittings and weatherproof conduit seals. All conduit penetrations are required to be provided with seals as noted on the Contract Drawings and as specified. Any installations not provided with these requirements shall be removed and reinstalled at no additional cost to the Owner.

M. Splicing Methods
   1. Feeder conductors shall be continuous from point of origin to load termination without splice. If this is not practical, contact the Engineer and receive written approval for splicing prior to installation of feeder(s).
   2. For splices and taps, No. 10 AWG and smaller, use solderless "Thread-On" connectors having spiral steel spring and insulated with a vinyl cap and skirt, as manufactured by 3M Co. (pre- insulated "Scotch-Lock") or Ideal ("Wing-Nuts").
   3. For splices and taps, No. 8 and larger, use solderless "Split Bolt" type connector as manufactured by Anderson, Burndy, Kearney, Thomas & Betts, or equal.
   4. Use cast connections, Cadweld or Thermoweld, for ground conductors.
   5. Make all splices and connections in accessible boxes and cabinets only.
   6. Cover uninsulated splices, joints and free ends of conductor with rubber and friction tape or PVC electrical tape. Plastic insulating caps may serve as insulation.
   7. Where feeder conductors pass through junction and pull boxes, bind and lace conductors of each feeder together. For parallel sets of conductors, match lengths of conductors as near equal as possible.
   8. Branch circuit conductors installed in panelboards, and control conductors installed in control cabinets and panels shall be neatly bound together using "Ty-Raps" or equal.

N. Installation of Ceiling Hung Devices
   1. Lighting fixtures, detectors, etc., in Mechanical Equipment, Boiler and Pump Rooms shall be installed with exposed conduit after equipment, ductwork, piping, etc., are in place.

O. Grouping of Conductors
   1. Contractor may group certain wiring with the approval of the Engineer, as follows.
      a. Power 120V may be grouped with power 120V
      b. Control 120V may be grouped with control 120V
      c. Control 24V may be grouped with control 24V
      d. Instrumentation may be grouped with instrumentation
      e. Specialty wiring may be grouped with like systems
      f. Power wiring at 480V shall not be grouped
      g. Fire alarm system wiring shall not be grouped with other systems

      The installation shall be installed in accordance with all requirements of the NEC (including wire ampacity derating factors), manufacturer's requirements, and the Engineer. Excessive grouping which interferes with functionality and reliability will not be allowed. The wiring configuration as shown on the drawings is the baseline requirement for the work.

P. Light Switches
   1. All light switches shall be installed in close proximity of the door opening where indicated on drawings. Where lights are shown adjacent to strike side of door, locate edge of switch box approximately 6 inches from door frame.
   2. Install cover plates for all single and multi-gang switch boxes for all light switches.

Q. Outlet Boxes
   1. On termination at branch circuit outlets, leave a minimum of eight inches (8") free conductor for installation of devices and fixtures.
   2. Consider location of outlets shown on Drawings as approximate only. Study Architectural, Mechanical, Plumbing, Process, and Structural Drawings and note surrounding areas in which each outlet is to be located. Locate outlet so that when fixtures, motors, cabinets, equipment, etc., are placed in position, outlet will serve its desired purpose. Where conflicts are noted between Drawings, contact Engineer for decision prior to installation. Comply with Article 314 of National Electrical Code relative to position of outlet boxes in finished ceilings and walls.
   3. Prior to installation, relocate any outlet location a distance of five feet in any direction from location indicated on Drawings if so directed by the Engineer. Prior to completion of wall construction, adjust vertical height of any outlet from height indicated if so directed by Engineer. The above modifications shall be made at no additional cost to the Owner.
   4. Where outlets at different mounting heights are indicated on Drawings adjacent to each other (due to lack of physical space to show symbol on Drawings), install outlets on a common vertical line.

5. Where switch outlets are shown adjacent to strike side of door, locate edge of outlet box approximately 3 inches from door frame.
6. Outlet boxes in separate rooms shall not be installed "back-to- back" without the approval of the Engineer.
7. Outlet boxes installed in plaster, gypsum board or wood paneled walls shall be installed with raised plaster covers or raised tile covers.
8. Outlet boxes installed in tile, brick or concrete block walls shall be installed with extra-deep type raised tile covers or shall be 3-l/2 inches deep boxes with square corners and dimensions to accommodate conductors installed.
9. Surface ceiling mounted outlet boxes shall be minimum 4 inches square, l-l/2 inches deep, galvanized sheet metal.
10. Surface wall mounted outlet boxes shall be cast type boxes having threaded or compression type threadless hubs. Exterior boxes shall be cast type with threaded hubs and gasketed cover plates secured by non-ferrous screws.
11. Install a device cover plate over each and every outlet indicated on Drawings. Do not install plates until painting, cleaning and finishing of surfaces surrounding the outlet are complete. Cover plates shall completely cover all edges of openings in the wall around the outlet box for a neat/finished installation.

R. Junction and Pull Boxes

1. Install junction and pull boxes in readily accessible locations. Access to boxes shall not be blocked by equipment, piping, ducts and the like. Provide all necessary junction or pull boxes required due to field conditions and as required by the National Electrical Code, Article 314.

S. Equipment Mounting Heights

1. Unless otherwise noted, mount devices and equipment at heights measured from finished floor to device/equipment base as follows: (Device base to be set at CMU joint unless otherwise noted. The Contractor shall verify all dimensions noted with the Engineer for final approval prior to performing or installing any of this work.)

a.	Toggle switches (up position "on")	48"
b.	Receptacle outlets (long dimension vertical,	
c.	ground pole nearest floor)	16"
d.	Receptacle outlets, above baseboard heaters	30" min.
e.	Receptacle outlets, hazardous areas	48"
f.	Receptacle outlets, at countertops	48"
g.	Receptacle outlets, weatherproof, above grade	24" min.
h.	Terminal cabinets, control cabinets, annunciator	
i.	panels, to top of backbox	72"
j.	Disconnect switches, motor starters, enclosed	
k.	circuit breakers, to top of box	60"

2. Where structural or other interferences prevent compliance with mounting heights listed above, consult Engineer for review to change location before installation.

T. Hangers and Supports
   1. Provide steel angles, channels and other materials necessary for the proper support and erection of motor starters, distribution panelboards, large disconnect switches, pendant-mounted lighting fixtures, etc.
   2. Panelboards, cabinets, large pull boxes, cable support boxes and starters shall be secured to ceiling and floor slab and not supported from conduits. Small panelboards, etc., as approved by Engineer, may be supported on walls. Racks for support of conduit and heavy electrical equipment shall be secured to building construction by substantial structural supports with PVC end caps as noted above.
   3. All vertical supports for stanchion mount structures and control stations shall be 4" angle channel.
   4. Provide PVC end caps for all protruding angles, channels, struts, etc. for personal safety for the entire project installation.

U. Identification of Conduit Systems
   1. Provide lamacoid nameplates to mark intrinsically safe conduit systems for all applicable conduit systems for project.
   2. Refer to Section 16010 for conduit labeling requirements.

V. Grounding Connections
   1. Exothermic welding connections shall be provided for underground connections.
   2. Mechanical fittings and irreversible compression fittings shall be provided for above ground connections.
   3. Make connections to equipment with mechanical connections shall be made by means of approved bronze clamps. Exposed connections between different metals shall be sealed with No-Oxide Paint Grade A, or equal.

3.2 TESTS

A. For testing requirements, refer to Section 16950.
B. For grounding requirements, refer to Section 16450.

END OF SECTION

SECTION 16160

CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. The purpose of this Specification is to provide details of cabinets and enclosures for non-hazardous indoor and outdoor locations which will protect internal equipment from environmental conditions. This section is also to intend to provide consistency between enclosures supplied under different Divisions of this Contract. An exception is control panels provided by Division 11 and Division 13 which are specified within their specifications.

1.2 QUALITY ASSURANCE

A. Supply cabinets and enclosures in accordance with the following:
   1. Underwriter's Laboratory, Inc. listed.
   2. National Electrical Manufacturers Association Standard 250-1991.
   3. American National Standards Institute.
   4. National Electrical Code.

B. Cabinets and enclosures supplied under this Section shall conform to the requirements of Specification Section 16010, "Quality Assurance".

C. Stock cabinets and enclosures shall be manufactured by Hoffman Engineering Company, Saginaw Control and Engineering or approved equal. Custom fabricated enclosures shall be equal in quality, appearance and performance to stock enclosures. All enclosures shall be subject to the review of the Engineer.

1.3 RELATED WORK

A. Additional details for panels and enclosures associated with process equipment are provided in the individual specification sections in Division 11.

B. Additional details for panels and enclosures associated with HVAC equipment are provided in the individual specification sections in Division 15.

C. Miscellaneous panel and enclosure auxiliary equipment, such as lights, switches, receptacles, fuses, etc. are contained in Section 16050, 16900, and as noted on the Contract Drawings.

1.4 REFERENCES

A. ASTM C177 - Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.

B. ASTM D149 - Test Methods for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.

C. ASTM D256 - Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.

D. ASTM D495 - Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation.

E. ASTM D570 - Test Method for Water Absorption of Plastics.

F. ASTM D638 - Test Method for Tensile Properties of Plastic.
G. ASTM D648 - Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
H. ASTM D790 - Test Method of Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
I. ASTM D792 - Test Method for Density and Specific Gravity (Relative Density) of Plastic by Displacement.
J. UL94 - Test for Flammability of Plastic Materials for Parts in Devices and Appliances.
K. UL508A - Industrial Control Panels.
L. The enclosures shall meet all requirements for UL508A - Industrial Control Panels as follows:
    1. All components within the enclosures shall be UL Listed and Labeled.
    2. The enclosure and all components as an entire "assembly as a system" shall be UL Listed and Labeled as UL508A compliant.

1.5 SUBMITTALS TO THE ENGINEER

A. Shop drawings for this section are not required. The items listed below shall be included with the specific control being submitted to show compliance with this section in order to perform a complete review for equipment being submitted.
    1. Provide documentation, as applicable, from a UL certified fabricator that the control panel has been tested, fabricated, and labeled as a complete functioning system and is in compliance with all UL listings and standards.
    2. Scaled and dimensioned enclosure layout drawings (internal and external) along with catalog cut sheets shall be provided.
    3. Enclosure NEMA ratings, project specific identification, where located, etc., shall be clearly and properly identified on each panels cut sheet.
    4. Listing of all accessories to be furnished with each panel and properly identified.
    5. Provide a complete wiring diagram for all items located within the enclosure such as panel lights, duplex receptacles, panel heaters, cooling fans, relays, control devices, protective devices, etc., where applicable.
    6. Provide heating requirement calculations for all exterior panels and panels located in unheated spaces, and cooling requirement calculations for heat dissipation from panels containing VFD's and other heat generating equipment as necessary.
    7. Submit all control panel faceplate arrangements for review and acceptance.

1.6 DELIVERY, STORAGE AND HANDLING

A. Delivery, storage and handling of electrical/instrumentation cabinets, enclosures and equipment contained within shall be in accordance with the general conditions Specification 11000 and specification 16010.
B. Replace or repair, to the satisfaction of the Engineer, any cabinets and enclosures which are defective or have been damaged during storage or installation, at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General for all Enclosures:

1. NEMA classifications for panels and enclosures shall be as noted on Drawing E-1, unless otherwise specifically called out within the Drawings or Specifications.
2. Panels and enclosures shall be furnished factory-wired and tested with all equipment and appurtenances mounted thereon.
3. Control panels and enclosures shall be U.L. listed and labeled as a complete and functioning system.
4. Panels larger than 36-inches in any dimension shall not be wall mounted.
5. Provide two doors if panel is larger than 36-inches wide.
6. Refer to the drawings and pertinent specifications for minimum control panel faceplate requirements. In the absence of specific details, faceplates shall be arranged in such a manner as to provide a neat, workable and operator friendly panel.
7. Doors shall have side mounted, stainless steel, continuous length, piano-type hinges and pins.
8. Latches shall be T-handle or quick-release type only. Latches which require use of tools or coins for access, utilize wing-nuts, clips around the outside of enclosure etc., will not be acceptable.
9. Panels/enclosures shall be equipped with map pockets located on the inside of the door.
10. Enclosures shall be equipped with provisions for locking the access doors.
11. Enclosures shall be sized as required to contain the necessary apparatus for the particular installation except as noted on the drawings. Final panel/enclosure dimensions shall provide for easy access and workability to all internal components with ease of maintenance and future modifications considered. Conflicts with panel sizing and available spacing shall immediately be brought to the attention of the Engineer prior to proceeding.
12. Provide door and body stiffeners where necessary for a rigid enclosure. Large enclosures shall be provided with lifting eyes and, where floor-mounted, with 12-inch floor stands. No floor stands are to be provided for free-standing models.
13. Enclosures larger than 16 inch in any dimension shall utilize a three point latching system.
14. Enclosures 16 inch wide and larger shall be equipped with heavy duty, zinc plated stop arm kits to lock the external door in the open position.
15. Panel front-mounted pilot lights, selector switches, push button control stations and appurtenances shall be provided in accordance with Section 16900.
16. Where required, enclosures shall be provided with an interior panel, painted white, for mounting of internal components.

B. General NEMA Class and Requirements for Indoor Installations:

1. NEMA Type 1 Enclosures
    a. Enclosures shall be sheet steel, 16 gauge for box widths up to and including 18", 14 gauge for box widths of 24", and 12 gauge for box

widths of 30" and greater. Enclosures shall have continuously welded seams ground smooth; supplied with or without knockouts and shall have door and body stiffeners where necessary for a rigid enclosure.

b. Panels/enclosures shall be factory coated inside and out with ANSI 61 gray polyester powder coating over phosphatized surfaces.

2. NEMA Type 12 Enclosures:
   a. Enclosures shall be sheet steel, 16 gauge for box sizes up to and including 24" by 24", 14 gauge for box sizes larger than 24" by 24" up to 60" by 36", and 12 gauge for box sizes greater than 60" by 36". Free-standing enclosures shall be 12 gauge minimum. Enclosures shall have continuously welded seams, ground smooth, supplied with no holes or knockouts and a rolled lip around door and enclosure opening. Enclosures to be installed in areas with the potential for dripping liquids shall be provided with drip shields.
   b. Provide oil-resistant door gaskets.
   c. Enclosures shall be coated inside and out with ANSI 61 gray over phosphatized surfaces.
3. NEMA Type 3R Enclosures:
   a. Type 3R enclosures shall not be used to house controls or electronics that require heating. See the specific “Special Requirements” for outdoor panels below.
   b. Enclosures shall be steel, 16 gauge for box widths up to and including 12", 14 gauge for box widths between 15" and 24", and 12 gauge for box widths of 30" and greater. Free-standing enclosures shall be 12 gauge minimum. Enclosures shall have drip shield top; seam free sides, front, and back; and furnished with knockouts or factory installed cut outs in bottom only.
   c. Panels/enclosures shall be factory coated inside and out with prime and finish coats. Finish coat color to be ANSI 61 gray. Two prime coats shall be applied. Prime coat shall be rust inhibitive primer equal to Koppers Inertol Rust inhibitive Primer 621. Finish coat shall be compatible with prime coat and shall be an alkyd applied in two coats with a minimum dry film thickness of 1.5 mils per coat. Alkyd coating shall be equal to Koppers Glamortex 501 Enamel. Surface preparations shall be in accordance with manufacturer's requirements.
4. NEMA Type 4 Enclosures:
   a. Enclosures shall be sheet steel, 16 gauge for box sizes up to and including 24" by 24", 14 gauge for box sizes larger than 24" by 24" up to 60" by 36", and 12 gauge for box sizes greater than 60" by 36". Free-standing enclosures shall be 12 gauge minimum. Enclosures shall have continuously welded seams ground smooth; supplied with no holes or knockouts. Provide with door and body stiffeners as required for a rigid installation and with rolled lip around door and enclosure opening. Enclosures to be installed outdoors shall be provided with drip shields.
   b. Provide oil-resistant, water tight door gaskets.
   c. Enclosures shall be factory coated inside and out with prime and finish coats. Finish coat color to be ANSI 61 gray. Two prime coats shall be

applied. Primer shall be rust inhibitive primer equal to Koppers Inertol Rust inhibitive Primer 621. Finish coat shall be compatible with prime coat and shall be an alkyd applied in two coats with a minimum dry film thickness of 1.5 mils per coat. Alkyd coating shall be equal to Koppers Glamortex 501 Enamel. Surface preparations shall be in accordance with manufacturer's requirements.

5. NEMA Type 4X Enclosures:
   a. Type 4X enclosures shall be stainless steel or aluminum. No other metals will be allowed.
      i. Type 304 stainless steel enclosures shall be 16 gauge for box sizes up to and including 24" by 24", 14 gauge for box sizes larger than 24" by 24" up to 36" width, and 12 gauge for box widths greater than 36 inches. Free-standing enclosures shall be 12 gauge minimum.
      ii. Aluminum enclosures shall be type 5052 H-32 aluminum, minimum 0.080-inch thick.
   b. Metal enclosures shall have continuously welded seams, ground smoothed.
   c. Enclosures shall be supplied with no holes or knockouts; shall have door and body stiffeners where necessary for a rigid installation and a rolled lip ground door and enclosure opening.
   d. Enclosures to be installed outdoors shall be provided with drip shields.
   e. Provide oil-resistant door gaskets all around door openings. All enclosure hinges, clamps, etc. shall be stainless steel.
   f. Enclosures shall be provided unpainted, with metal enclosures having a smooth brushed finish.

C. Special Requirements
   1. Enclosures located in unheated spaces or general outdoors
      a. When components requiring a minimum temperature in which to operate, such as solid state devices, are to be installed inside the enclosure, the enclosure shall be NEMA 4X or NEMA 4 minimum when not available.
      b. The enclosures shall be insulated. Insulate the inside of all exterior surfaces with 1 inch thick rigid fiberglass insulation board having a maximum thermal conductivity ("k" value) of 0.35 BTU-in/hr-ft²-°F. The insulation shall be finished with manufacturer's standard all service jacket. Coverings containing foil will not be acceptable.
      c. Enclosures shall be equipped with a factory installed built-in heater and adjustable thermostat. Field installations after the fact will not be acceptable. The heater shall be sized to maintain the temperature inside the panel at 40°F (or higher if required) with an outside ambient temperature of -30°F and a 15 MPH wind. The heater shall include a fan to circulate the air within the enclosure to prevent hot spots. Thermostat shall measure air temperature, not surface temperature. Heater shall be similar to Hoffman Engineering Co. series D-AH, Genesis automation, or approved equal.
      d. Provide strip heater with thermostat for condensation control.

e. Provide heating requirement calculations for review and acceptance to be included as part of the shop drawing review for this equipment.
f. Enclosures shall have a lockable outer door with a separate hinged NEMA 1 dead front inner door.
g. The panels inner door latches shall be T-handle or quick release type only.
h. All control devices and the main circuit breaker operating handle shall be mounted through the interior panel door. The main circuit breaker handle shall have a lock arrangement to prevent the inner door from being opened when in the "on" position.
i. Enclosures 16 inch wide and larger shall be equipped with heavy duty, zinc plated stop arm kits to lock the external door in the open position.

2. Instrument and Control Panels
   a. All instrument and control enclosures shall have the proper NEMA rating for the areas in which they will be installed or as specified in Division 11.
   b. All front-mounted instruments and devices shall be installed in such a way as to maintain the NEMA rating of the enclosure.
   c. Panels which are to be installed outdoors shall meet the special requirements of "Outdoor Control Panels and Panels located in Unheated Spaces".
   d. Panels shall be supplied with a GFI type duplex convenience receptacle and a panel light with an easily accessible on-off switch. The receptacle and panel light shall be provided with a separate overcurrent protective device and connected in such a manner so as to not disconnect control, instrumentation, or PLC power in the event that the GFI outlet should trip.
   e. Panel lights for panels located in outdoor or unheated spaces shall a 32W fluorescent lamp with a low temperature starting ballast.
   f. Panel lights for panels located in heated spaces shall be a 32 watt fluorescent lamp with protective lens. The length of the lamp shall be a minimum of 75% of the width of the enclosure.
   g. Provide a separate, dedicated, single pole receptacle for connection of the UPS System as required. This receptacle shall be labeled - "For UPS System Only".
3. Special Cooling Requirements
   a. Enclosures which contain Variable Frequency Drives or other heat-producing equipment shall be provided with modifications and/or accessories designed to dissipate excess heat and allow for proper equipment cooling, while maintaining the enclosures NEMA rating. Following are several accessories which may be used, depending upon the ambient temperature and NEMA rating of the area installed.
      i. Cooling fans with dust filters, for NEMA 1 enclosures.
      ii. Heat exchangers with circulating fans and filters, for NEMA 12 enclosures.
      iii. Air conditioners, for NEMA 12 enclosures in areas with high ambient temperatures.
      iv. Air Conditioners, for NEMA 4X enclosures in both 4X areas and 4X-corrosive areas shall be cooled with the use of a side mounted

air conditioner. The air conditioner shall be controlled by an internal thermostat in parallel with the run contact.

v. Air conditioners shall have a drain tubing installed in order to drain to the nearest floor drain. Tubing shall be plastic PVC flex tube or PVC schedule 40.

b. Cooling fans shall be wired such that they only operate when the VFD or heat producing equipment is running.

c. Air conditioners where used in enclosures shall operate off of an internal thermostat.

d. Provide heat dissipation calculations and cooling method proposal for review and acceptance to be included as part of the shop drawing review for this equipment. Design ambient air temperature shall be 95°F.

D. Nameplate/Identification:

1. All panels/enclosures, and all contained equipment/instrumentation shall be provided with a nameplate providing project specific identification of the unit or device. Identification wording shall be as noted on the drawings. In the absence of specific identification of name tag wording, provide general descriptive information of unit function.
2. Provide nametags as specified in 16010.
3. Name tags shall be permanently mounted below panel mounted items (interior and exterior as appropriate), or in as appropriate location as to clearly identify its function.

E. Control Panel Wiring:

1. All wiring shall conform to the latest requirements of NEC, all state and local code requirements, and as described on the Drawings and in the Contract specifications.
2. All control wires internal to panels shall be minimum No. 14 AWG. Wires carrying line voltage shall be minimum No. 12 AWG. All conductors shall be copper. Wiring in close proximity to heating devices shall be Type AVA U.L. approved. All wiring shall be run in PVC wiring channels and bundled with nylon cable ties. Line voltage wiring must be run separately from control, signal and intrinsically safe wiring. PVC wiring channels shall be properly sized for the capacity of wires being installed based on the overall project needs and shall not be over filled.
3. Bundles of wires must be secured to the panel structure every 8 inches minimum. All interior wiring will be point to point with no splices.
4. Shielded wire shall be separated from other wires and equipment with suitable barriers and with terminal blocks for continuous shield grounding to the connecting cables.
5. Intrinsically safe wiring shall be separated by barriers from all other wiring and shall be identified as required by the N.E.C. and installed with proper separation per U.L. 508A requirements.
6. Wires to the front of panel devices shall be looped, extra flexible, bundled and located in a manner to prevent damage due to opening and closing the door.

7. All wires shall be marked at both ends with numbers by self-sticking wire markers or with slip-on style plastic markers. Color coding shall include the following:
   a. Red wires - Interior control circuits
   b. Orange wires - Interlocks powered from external sources
   c. Blue wires - DC voltages
   d. See Section 16010 for additional color coding.
8. Terminals shall be arranged in alphabetic and numeric order in columns on removable subplates. A maximum of two connections shall be made to each side of a terminal, including jumpers. Provide an additional 20 percent spare terminals with the following minimum requirements:
   a. Power terminals - 2 spares
   b. Control terminals - 10 spares
   c. Signal terminals - 12 spares
9. Provide ground terminal for each panel.
10. All control panels shall be provided with spare mountings for additional relays. Number of spare mountings will correspond to 5% of the total number of relays within each panel, with a minimum of one (1) spare mounting.
11. All control panels shall be provided with an appropriately sized surge arrester to protect panel internals. Surge arrester shall be equal to Square D Model SDSA1175 or Model SDSA3650 (as applicable) in quality and appropriately sized for function.
12. All control panels will be suitable for use with 120V, 1 phase power, unless noted otherwise on the Drawings. The panels shall be equipped with an internal power supply fuse or circuit breaker and a thru-the-door, lockable, disconnect switch. Fuse blocks will be provided as required to allow a separate fuse for each piece of equipment within the panel requiring power.
13. Provide complete "As Built" wiring diagrams to be provided with the O&M manuals and in the enclosures for all control panels.
14. All wiring entering and leaving control panels shall be terminated on field terminal blocks and labeled.
15. Provide large letter lamacoid plastic name plate as specified in 16010 at the top center of each control panel with properly identified nametag which corresponds to the contract designation name. Verify final name designation with the Engineer prior to installation.

F. Spare Parts/Materials:
   1. Provide 1 gallon of paint for each enclosure/panel topcoat color utilized.
   2. Provide the following spare parts for each panel/enclosure provided. Spare parts shall be contained in the panel/enclosure in such a manner as to permit accessibility and prevent accidental damage without interfering with internally mounted equipment.
      a. Provide 10 of each lamp type used.
      b. Provide one of each type relay used.
      c. Provide one control switch, indicating light and/or push-button of each type used.
      d. Provide 1 set of each fuse type and size used.

e. Provide 1 of each color and type light lens used.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All interconnecting wiring between panels, unless specifically detailed otherwise on the drawings, shall be installed by the electrical contractor regardless of source of the panel itself. All conduit, wiring and installation requirements for each enclosure shall be completely and thoroughly coordinated with all applicable trades prior to equipment installation.

B. Install enclosures in locations as shown on the Drawings.
   1. All floor mounted enclosures either free standing or on floor stands shall be mounted on a 4" high, concrete, maintenance pad.
   2. Securely fasten each floor mounted enclosure to the maintenance pad.
   3. Small enclosures may be supported on walls using stainless steel metal framing channels or similar hardware to provide a minimum 1/4 inch air space between enclosure and wall.

C. Equipment Mounting
   1. All framing channels and mounting hardware shall be stainless steel - no exception.
   2. Use stainless steel fittings and hardware of the same material as the channel. All fittings supplied shall be by same manufacturer as the channel.
   3. Provide cross bracing as required using unistrut securely fastened to the mounting structure or building structure to provide for a rigid mounting assembly.
   4. The ends of all framing channels/strut shall be provided with PVC end caps for protection of personnel.
   5. Backboards used for mounting of equipment shall be constructed of ¾ inch thick fiberglass, unless otherwise specified on the drawings.
   6. All channels or unistrut installed in such a manner that parts are located below grade shall be coated with a black bitumastic waterproofing material for the below grade portion and extending a minimum of 6 inches above grade. The exposed portion of the channel shall be taped off prior to coating for a neat, even, finished appearance.
   7. NEMA 4X installations require a 1/4" spacer between the enclosure and mounting support to prevent moisture from collecting.

D. Equipment mounting heights shall be as shown on the contract drawings or the tops placed a maximum of 72 inches above finished floor or platform when the elevation is not shown.

E. Provide special protection for all devices and terminal blocks when cutting, drilling, and/or installing any device in the control panel.

F. All conduits entering exterior enclosures or in NEMA 4X environments shall be suitable gasketed on the outside and conduits shall be sealed (inside) using a pliable duct seal to prevent the entrance of water.

G. All lifting eyes, hooks, brackets, devices etc., used to install, lift, transport, etc., the control panel shall be removed after installation and all resultant holes shall be plugged with threaded bolts for a finished, permanent installation. All methods of

plugging the holes shall maintain the NEMA rating of the enclosure.

3.2 TESTS

A. Testing of the enclosures themselves is not required, however, all equipment and controls which are mounted in or on the enclosures shall be tested as a complete assembly as specified in the applicable sections of DIVISIONS 11, 14, 15 and 16.
B. Each enclosure shall be fully tested by the manufacturer.

3.3 CLEANING

A. Do not allow excess debris, water or other fluids to accumulate inside the enclosures during the course of construction.
B. Upon completion of the work, remove all debris and surplus materials from inside the enclosures and leave them clean.
C. Clean all enclosure surfaces and touch up any scratched or damaged areas to the satisfaction of the Engineer.
D. Clean or replace all filters located in enclosures which contain ventilation fans.

END OF SECTION

SECTION 16445

MODIFICATIONS TO EXISTING MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The work of this section includes the furnishing, installing, and testing of modifications to existing motor control centers as specified herein and as shown on the contract drawings as indicated on the "Single Line Diagrams".

B. Modifications to existing motor control centers are not required to be of the same manufacturer as the motor control centers provided for the project as applicable. These devices take exception to the Quality Assurance Statement of Section 1.2.E of Specification 16010.

1.2 QUALITY ASSURANCE

A. The equipment specified herein is based upon the first manufacturer named after the phrase "Acceptable Manufacturers". Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by that manufacturer. Equipment of other acceptable manufacturers shall be equivalent in every way to that of the equipment specified.

B. Suppliers deemed equivalent shall be responsible to support and supply equivalent equipment which shall meet the intended design. Any extensive modifications or rework of the design drawings in order to facilitate acceptability shall be the responsibility of this Contractor at no additional cost to the Owner.

C. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

D. Motor Control Center(s) shall have been tested in a high power laboratory to prove adequate mechanical and electrical capabilities. All major components shall have been individually design tested and guaranteed by the manufacturer.

1.3 SUBMITTALS TO THE ENGINEER

A. Shop Drawings are required for all items provided under this section. Submittals shall be provided in accordance with Sections 01340, 16010 and as specified in this section.

1.4 REFERENCE TO OTHER SECTIONS

A. Refer to Section 16010 for identification nameplates requirements.

B. Refer to Section 16010 for coordination, short circuit, and arc flash study requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Modifications to Existing Motor Control Centers:

1. The modifications to the existing motor control centers and the manufacturer are shown on the contract drawings.

2. This Contractor shall visit the site to become thoroughly familiar with the work required and specified herein. All modifications shall be performed without jeopardizing the integrity of the existing equipment. All work to be performed shall be complete and shall meet with all standards and guidelines for installation to this equipment.
3. The contract drawings indicate that specific compartment section(s) are to be modified. The modifications shall include new equipment and/or modifications to existing equipment installed. Each compartment is to be replaced and/or existing equipment modified in order to retrofit the compartment sections as required by the contract documents.
4. The short-circuit ratings of all new and modified devices shall be equal to or greater than that of the existing equipment. This is to be verified by this Contractor and the information furnished and included in the shop drawing submittals for this equipment.
5. The Contractor shall be allowed to replace the sections as required in their entirety. This shall be verified with the Contractor and brought to the attention of the Engineer prior to final cost submittal.
6. Provide screwed on nameplates for all revised sections as required for all front compartment devices and as noted on contract drawings.
7. The requirements noted have been outlined for this section. If any information on existing equipment cannot be verified then this shall be brought to the attention of the Engineer and verified prior to submitting bid for this project.
8. Refer to Section 16900 for control device and equipment requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractors shall install all equipment per the manufacturer’s instructions, contract drawings and National Electrical Code.
B. Ground all motor control centers in accordance with the National Electric Code and as specified in section 16450.
C. Motor control centers shall be mounted on 4" high concrete pads which shall extend 2" on exposed sides. Securely bolt each unit to its pad for proper horizontal and vertical alignment. Use shims where necessary.
D. Install Safety Labels in compliance with NEMA 260.

3.2 TESTS

A. Refer to Section 16950 for testing requirements.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included: Provide and install all grounding and appurtenances as shown on the Drawings, manufacturer's installation manuals and guidelines, and as specified herein.

B. The Contractor is responsible to provide a complete interconnected grounding system which provides for a common potential grounding system. All components shall be bonded to the same potential via the grounding system for the entire facility. Review all connections and drawings along with requirements of the latest edition of the National Electrical Code (NEC) for final grounding requirements. A complete and integrated grounding system shall be the responsibility of the Contractor to furnish, install, and integrate into the sequence of construction for this the facility. All work shall be in compliance with NEC requirements and as indicated on the drawings.

1.2 PRODUCT HANDLING

A. All materials shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Refer to Section 16050 - Basic Materials for material to be used under this section.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Grounding electrode conductors shall be run in rigid steel conduits. All metal conduit used for the installation of the grounding electrode conductor shall be bonded with the use of a bonding bushing at both ends.

B. Grounding conductors shall be run with feeders where shown on the drawings or hereinafter specified.

C. Conduits stubbed-up below a motor control center shall be fitted with insulated grounding bushings and connected to the motor control center ground bus. Boxes mounted below motor control centers shall be bonded to the motor control center ground bus. The grounding wire shall be sized in accordance with article 250 of the National Electric Code.

D. Liquid tight flexible metal conduit in sizes 1 inch and larger shall have bonding jumpers. Bonding jumpers shall be external, run parallel (not spiraled) and fastened with plastic tie wraps. Tie wraps shall be installed 12 inches apart and not more than 6 inches from ends.

E. Connect the following equipment by separate wire or cable directly to the grounding system:

1. Frame of each transformer
2. Neutral of each transformer for a separately derived system as defined by NEC article 250.
3. Service entrance line compartment
4. Low voltage switchgear
5. Cable tray system
6. Boiler stacks and the like

F. Connect the following equipment by separate wire or cable to the ground bus in the distribution equipment servicing the equipment:
1. Motor Control Centers and Switchboards
2. Panelboards
3. 480 Volt motors
4. Control panels
5. Bus Duct
6. All feeders and branch circuit installed in non-metallic raceways
7. Receptacle circuits

G. The following equipment shall be grounded through the metallic raceway systems with permanent and effective ground connections:
1. All metal cases and support frames
2. Lighting system
3. All motors
4. Radio Antennas

H. Bond the following N.E.C. approved electrodes together to form a ground system:
1. Metallic water main
2. Building steel frame
3. Steel reinforcing rods
4. Grounding rods and plates
5. Buried bare copper conductors

I. Grounding electrodes shall be driven where shown on the drawings. Spacing between electrodes shall be equal to or greater than the length of the electrodes. Exposed grounding connections shall be made by means of approved bronze clamps. Exposed connections between different metals shall be sealed with No. Oxide Paint Grade A, or equal.

M. All buried conductors shall be laid slack in trenches. The earth surrounding the cables shall be void of sharp objects which may injure the cables. Backfill material shall be natural earth. Where cables are exposed to mechanical injury they shall be protected by pipes or other substantial guards. If guards are iron pipe or other magnetic material, conductors shall be electrically connected to both ends of the guard. Connections shall be made as hereinbefore specified.

N. Do not allow water main connection to be painted. If the connections are painted, they shall be disassembled and remade with new fittings.

O. Bond and ground all conduit systems. Ground conduit system and neutral conductor of wiring system with a connection at the main electrical service switchboard.

P. Furnish and install all main service grounding systems, building grounding systems and supplemental grounding systems as required by NEC and as shown on the drawings for a complete grounded system for the entire facility.

Q. Equip and install all exposed "pigtails" or grounding electrode conductors with an armored sheath.
R. Group and bond ground wires to panel boxes, light fixtures, receptacles, etc., not to system neutral.
S. Ground shield of a twisted-pair cable at one end only, at the power source for the device or instrument.
T. Ground all lightning arresters and exterior conduit risers.

3.2 TESTING

A. Tests shall be performed before loaming and seeding or paving work has been performed. Refer to Section 16950 for testing requirements.

END OF SECTION

SECTION 16469

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide all variable frequency drives (VFD) as indicated on the "Single Line Diagram". Contractor shall coordinate variable frequency drive manufacturer selection with all equipment manufacturers.

B. Contractor shall coordinate variable frequency drive manufacturer selection with all equipment manufacturers, and shall be solely responsible for ensuring that the individual variable frequency drives furnished are completely compatible with all requirements and intended functions of the driven equipment. The basis for design for this project is based on Allen-Bradley.

C. Variable frequency drives which are shown to be located in a stand alone enclosure are required to be of the same manufacturer.

D. Acceptable manufacturers are Square D, Cutler Hammer, Toshiba, or equal.

1.2 QUALITY ASSURANCE

A. The equipment specified herein is based upon the first manufacturer named after the phrase "Acceptable Manufacturer's". Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by that manufacturer. Equipment of other acceptable manufacturers shall be equivalent in every way to that of the equipment specified.

B. Suppliers deemed equivalent shall be responsible to support and supply equivalent equipment which shall meet the intended design. Any extensive modifications or rework of the design drawings in order to facilitate acceptability shall be the responsibility of this Contractor at no additional cost to the Owner.

C. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

D. Refer to equipment manufacturer requirements under 16010, Section 1.2.

1.3 REFERENCES

A. Institute of Electrical and Electronic Engineers (IEEE)
   1. Standard 519-1992 2014, IEEE Guide for Harmonic Content and Control

B. Underwriters Laboratories
   1. UL508C

C. National Electrical Manufacturer’s Association (NEMA)
   1. ICS 7.0, AC Adjustable Speed Drives

1.4 SUBMITTALS TO THE ENGINEER

A. Shop Drawings are required for all items provided under this section. Submittals shall be provided in accordance with Sections 01340, 16010 and as specified in this section.

1.5 REFERENCES TO OTHER SECTIONS

A. Refer to Section 16010 for identification nameplates requirements.
B. Refer to Section 16900 for control device requirements.
C. Refer to Section 16160 for Cabinet and Enclosures.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Variable Frequency Drives (VFD's)
1. The drive shall be capable of varying the speed of a standard or inverter duty rated NEMA Design B induction motor from a virtual standstill to the standard speed of the motor. The unit shall transform input power into a variable voltage, adjustable frequency three phase output of suitable capacity and waveform.
2. Input voltage shall be as indicated on the Drawings and/or as specified in the equipment specification sections. Frequency shall be 60 Hz.
3. Output shall be three (3) phase voltage as indicated on the Drawings and/or as specified in the equipment specification sections.
4. The drive shall be a PWM (Pulse Width Modulated) transistorized invertor.
5. The drive manufacturer shall have not less than five years of experience in the manufacture of drives in the United States.
6. The drives shall be rated for constant or variable torque applications (460V - 1 HP to 150 HP), depending on the individual driven load requirements. For constant torque applications, the output transistors shall be low-gain, fully rated. Derated high-gain transistors are not acceptable.
7. Power Line Considerations
   a. Each VFD or multiple sets of VFD's shall be designed and installed such that: the total harmonic distortion reflected back to the power source is a maximum of 5%, the notch depth reflected back to the power source is a maximum of 20%, and the notch area reflected back to the power source is a maximum of 22,800 volt-microseconds. The total harmonic distortion, notch depth and notch area shall be as defined by IEEE-519-2014.
   b. Line reactors and other required devices shall be provided for individual VFD's where indicated on the Drawings and/or in the VFD schedule.
8. Enclosures
   a. Unless otherwise noted in drive schedule, all variable frequency drives and all associated equipment and control devices shall be located within or contain within their respective enclosure as shown on the Drawings. Separately submitted and mounted devices will not be accepted.
   b. Refer to schematic diagrams and VFD schedule for further information.
9. Filtering
   a. RFI/EMI filters shall be provided by supplier and shall be rated for, and compatible with, each VFD. They shall function as a complete system. Additional line reactors beyond those shown on drawings may be required in order to comply with the above parameters.
   b. 5% line reactors shall be mounted inside the respective VFD enclosure reactors and shall be TCI Harmonic Guard or equivalent.

c. Harmonic matrix filters and switching capacitor shall be provided where shown on drawings. Refer to single line diagrams and schematics for additional information.

10. System Analysis
    a. The VFD supplier shall perform a computer simulated power system study to verify compliance with the parameters as stated herein. The results of this study shall be submitted to the engineer. At a minimum the submitted results of this study shall include:
        i. A brief summary of the equations and calculation procedures used in the study.
        ii. A results summary sheet which briefly describes the power system configuration analyzed and which states the calculated values of total harmonic distortion, notch depth and notch area.
        iii. Computer generated graphs which illustrate the voltage and current waveforms of the power system with the VFD's operating. These waveform graphs shall directly illustrate the results of the power system computer model study.
        iv. Detailed list of the amplitude of harmonic currents and voltages to the 50th harmonic.
    b. The contractor shall supply the VFD supplier with all power system data required to perform the above described study. These data may include but are not limited to:
        i. A complete one line diagram of the subject electrical distribution system. The diagram must show the lengths of all bus and cable runs, impedance values of all types of bus and cable used, and number of conductors per phase.
        ii. Complete electrical data on all equipment shown on the one line diagram is required. At a minimum this data shall consist of: Transformers - kVA, Primary voltage, Secondary voltage, Short circuit capacity or impedance. Motors - Stator resistance, No load RMS current, No load kVA, No load kW, Locked rotor RMS current, Locked rotor kVA, Locked rotor kW, Horsepower, Base speed, Number of poles, Efficiency at relevant speeds, Power factor at relevant speeds, Full load RMS current. Generators - Short circuit capacity or Subtransient reactances (Xd), Power factor, kW, X/R Ratio.
        iii. If the distribution system can function in more than one configuration, the configuration(s) to be analyzed shall be clearly defined. Any other information which may affect the behavior of the distribution system shall also be provided.

11. Ambient Conditions
    a. Environment - Indoors, NEMA rating to match areas as depicted on the NEMA CLASSIFICATION SCHEDULE on Drawing E-1 or as specified herein..
    b. Ambient Temperature - 10 degrees C to 40 degrees C
    c. Altitude - Less than 3,300 feet

d. Relative humidity - 90% maximum
e. Vibration - less than .5G

12. Control System
    a. Input power:
        i. Main circuit: 460V/60Hz or as shown on drawings
        ii. Control circuit: no external power for input shall be required.
    b. Tolerance: Voltage + 10%. Frequency + 2 Hz.
    c. Control method: Sinusoidal PWM control
    d. Output Voltage: 3PH 460 Volt.
    e. Output Frequency: 0.01 Hz to 60 Hz
    f. Frequency resolution: 0.01 Hz Operating panel input; 0.03 Hz Analog input; 0.01 Hz Computer interface input
    g. Frequency accuracy: + 0.5% of max frequency at 25 deg. C + 10 deg.C
    h. Volts/Hz characteristics:
        i. Either constant V/f or variable V/f (user selectable)
        ii. Base frequency adjustable from 25 Hz to 60 Hz
        iii. Voltage boost adjustable from 0% to 30%
        iv. Starting frequency adjustable from 0 Hz to 10 Hz
    i. Overload current: 150% for 1 minute (constant torque applications).
    j. Frequency command signal: 3k Potentiometer 0-10 VDC; 0-5 VDC; 4-20 mA
    k. Frequency jump - 3-point settings: Setting jump frequency (0 to Max frequency), and width (0 to max frequency).
    l. Upper/lower limit frequencies: Upper limit 0 to Max frequency. Lower limit 0 to upper limit.
    m. PWM carrier frequency: Adjustable from 400Hz to 2000Hz.
13. The drive shall provide a minimum displacement power factor of 0.95 throughout the speed range.
14. Minimum lead length to motors for VFD drive without requiring an additional output filter shall be 250 feet.
15. The efficiency of the drive at full speed shall be a minimum of 98 percent.
16. The drive shall be provided with an MCP type circuit breaker to serve as a disconnect, and coordinated with the drive protective features for the motor to form a complete combination type starter/controller. If necessary, the drive shall also be provided with current limiting fuses on the input side of the drive, sized and rated as required by the drive manufacturer, so that the drive is rated for the available fault current.
17. The drive shall contain relays, push buttons, timers, and all other appurtenances necessary for the specific application as specified in the equipment specification sections, and as shown on the Electrical Drawings.
18. Operational Functions:
    a. Acceleration/deceleration times: 0.1 to 600 seconds, 2 separate acceleration and deceleration times.
    b. Forward or reverse run can be chosen.
    c. Jogging
        i. Running - 0 to 20 Hz

ii. Braking - Deceleration, DC injection, or coasting

d. Multispeed run: up to 7 preset speeds can be chosen.
e. VFD shall be capable of accepting a 4-20 mA input signal and adjusting speed accordingly.
f. Automatic Restart: Recovers a normal run of a coast-stopping motor.
g. Soft Stall: Sustains a run in overload mode. (90% - 150% adjustable)
h. Overload: Adjustable from 60 - 100%
i. Complete adjustment of parameters gives thousands of volt/frequency patterns.

19. Protective Features:
    a. Functions individually identified by 18 fault codes:
       Overcurrent during acceleration (OC1)
       Overcurrent during deceleration (OC2)
       Overcurrent during run (OC3)
       Overcurrent detected at start-up (OCA)
       Short circuit at load (OCL)
       Overcurrent in regenerative discharge resistor (OCr)
       Overvoltage during deceleration (OP2)
       Overvoltage (OP)
       Overload (OL)
       Overload of regenerative discharge resistor (OLr)
       Overhead (OH)
       Ground Fault (EF)
       Emergency Stop (E)
       Frequency Setting Signal Abnormality (Err.1)
       EE Prom abnormality (EEP, EEP2, EEP3)
       Computer link abnormality (Err.t)
    b. Drive shall have an external fault trip input terminal.
    c. Drive shall reset when a designated contact is closed on the terminal strip.
20. Monitor Functions
    a. The drive shall have display scaler of monitoring frequency. (Range 0.10 to 200)
    b. The drive shall be able to monitor different parameters.
    c. The drive shall have an LED on the front panel showing that the main DC circuit capacitor is charged.
21. Controller
    a. All parameters should be adjustable from the keypad.
    b. One key shall toggle between panel control and terminal control.
    c. The drive shall have a reset to factory settings.
    d. The keypad shall match enclosure NEMA rating.
    e. The keypad shall allow for parameters to be changed while drive is running.
    f. Most common used parameters should be labeled on the keypad.
    g. All front panel mounted lights shall be push to test, LED, 120 volt.
    h. All front mounted device and top center panel shall have lamacoid nameplates throughout.

22. Variable Frequency Drive Shutdown
    a. The drive shall be able to accept a 4th pole auxiliary contact (from a local disconnect) to be wire directly to an input of the drive. Upon opening of the auxiliary contact, the drive shall be programmed to function such that the drive stops the motor immediately rather than coasting to a stop.
23. All models shall be UL listed.
24. The drive shall be provided with thermal overload function.
25. The drive shall be provided with auxiliary run contact to indicate running status.
26. Variable frequency drive vendor must be a local distributor which has factory-trained personnel and warranty authorization; capable of testing unit(s) with motor loads.
27. Variable Frequency Drive Schedule:

Equipment Name	Motor HP	Constant or Variable Torque	Harmonic Traps/Line Reactors/ RFI/EMI/ dv/dt long lead filters	Supplier MCC Manufacturer /Electrical Contractor	Notes
Drywell Exhaust Fan EF-EG2	3	CT	ERI/EMI/Line Reactor	Electrical Contractor	See Note 1

Notes:

1. The motor rating is 2 HP however the VFD equipment supplier shall provide an oversized VFD as noted and shown on the Schedule.

28. Provide a complete VFD system and a customized and modified control panel for each pump motor installation. Refer to schematic diagram on the Contract Drawings for additional requirements.
29. Provide each of the VFD control panels with the following:
    a. Single VFD NEMA 12 vented and rated as depicted on drawings. This shall be single, wall mounted type enclosure control panel for the installation. No separately mounted devices and equipment outside of this enclosure.
    b. Line reactor 5%, and RFI/EMI filter, as specified and as shown.
    c. Through the door disconnect operator lockable in the off position.
    d. Front panel mounted keypad, run light, speed potentiometer and all specified items and as shown on the drawings.
    e. Provide two (2), 8 hour days of start-up and training for commissioning and final acceptance of this VFD equipment. All equipment must be pre-started, testing and certified ready for testing prior to any of these days being used. Provide a two week written schedule ahead of time to the Engineer and Owner to schedule final start-up and testing as well as training. Training will not be held the same day as start-up and shall be scheduled only upon start-up completion and acceptance. Pre-testing and check out shall not be used as any of the two (2) start-up and training time requirements.

f. VFD shall be calibrated to the input signal based upon minimum and maximum flow settings.
g. Provide VFD Parameter Setup and Verification. See Part 3 of this specification.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The Contractors shall install all equipment per the manufacturer's instructions, contract drawings and National Electrical Code
B. Ground all motor control centers in accordance with the National Electric Code and as specified in section 16450.
C. Ground all motor frames (operating on Variable Frequency Drives) and VFD shielded cable per the recommendations of the manufacturer of the Variable Frequency Drive.
D. Install Safety Labels in compliance with NEMA 260.
E. Inspect all bus bolts prior to energization to check for looseness developed during shipment or handling.
F. Refer to Section 16050 for equipment mounting heights.

3.2 TESTS

A. Refer to Section 16950 for testing requirements.
B. VFD Start-Up, Testing and Parameter Setup and Verification
   1. Responsibility and Coordination: The VFD supplier/electrical subcontractor is responsible for adjusting all of the VFD parameters for a fully functional system integrated with the instrumentation and control systems for this project. The VFD supplier/electrical subcontractor is responsible for coordinating with the instrumentation subcontractor and the instrumentation programmer so the control systems function as intended as described in the instrumentation control descriptions.
   2. VFD Parameter Setup: Complete the VFD Parameter Setup Checklist and Verification below in the presence of the specifying engineer.
   3. The electrical subcontractor shall be responsible to coordinate an onsite meeting with the VFD supplier and the specifying engineer. This meeting shall take place prior to the initial startup of the equipment.

VFD PARAMETER SETUP CHECKLIST

[ENTER NAME OF FACILITY]

- ☐ ☐ 1. Ramp up speed _____
- ☐ ☐ 2. Ramp down speed _____
- ☐ ☐ 3. Min speed (Hz) _____
- ☐ ☐ 4. Max speed (Hz) _____
- ☐ ☐ 5. 4-20mA setting at min speed (mA) _____
- ☐ ☐ 6. 4-20mA setting at max speed (mA) _____
- ☐ ☐ 7. Output scale calibration _____
- ☐ ☐ 8. Auto restart after power failure (yes/no) _____
- ☐ ☐ 9. Auto restart after overcurrent fault (yes/no) _____
- ☐ ☐ 10. Speed reference (internal/external) _____
- ☐ ☐ 11. If external - signal source _____
- ☐ ☐ 12. If external - signal type _____
- ☐ ☐ 13. Restart after E-Stop (yes/no) _____
- ☐ ☐ 14. Discrete outputs - Run (yes/no) _____
- ☐ ☐ 15. Discrete outputs - Fault (yes/no) _____
- ☐ ☐ 16. Analog outputs - Amps (absolute units) _____
- ☐ ☐ 17. Analog outputs - KW (absolute units) _____
- ☐ ☐ 18. Analog outputs - Speed (Hz) _____
- ☐ ☐ 19. Analog outputs - Speed (RPM) _____
- ☐ ☐ 20. Analog inputs - 4mA set to 0Hz (yes/no) _____
- ☐ ☐ 21. Analog inputs - 20mA set to 60Hz (yes/no) _____
- ☐ ☐ 22. Analog inputs - min speed limit set (yes/no) _____
- ☐ ☐ 23. Analog inputs - max speed limit set (yes/no) _____
- ☐ ☐ 24. Voltage boost (%) _____
- ☐ ☐ 25. Starting frequency (Hz) _____
- ☐ ☐ 26. PMW carrier frequency (Hz) _____
- ☐ ☐ 27. Acceleration time (sec) _____
- ☐ ☐ 28. Deceleration time (sec) _____
- ☐ ☐ 29. Forward run (yes/no) _____
- ☐ ☐ 30. Reverse run (yes/no) _____
- ☐ ☐ 31. Overload (60%-100%)

VFD PARAMETER SETUP VERIFICATION

[ENTER NAME OF FACILITY]

Date: _____

General Contractor: _____

Electrical Subcontractor: _____

VFD Supplier: _____

This certifies that the VFD parameters have been coordinated per the specifications and the requirements of Section 16469.

(Authorized Representative of the General Contractor)	Date
(Authorized Representative of the Electrical Subcontractor)	Date
(Authorized Representative of the VFD Supplier)	Date

END OF SECTION

SECTION 16900

CONTROLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide and install all panel and enclosure components and appurtenances as shown on the Drawings as Local Control Stations as specified herein. All components shall meet NEMA ratings as indicated on drawing E-1 for the specific area where they are to be installed.

1.2 SUBMITTALS TO THE ENGINEER

A. Shop drawings are required for all items provided under this Section. Submittals shall be in accordance with Sections 01340 and 16010.

PART 2 - PRODUCT

2.1 MATERIALS

A. Control Station Enclosures:
   1. General:
      a. Control stations shall be heavy duty oil-tight/watertight type stainless steel enclosure and shall consist of operators with contact blocks and indicator lights as indicated on the contract drawings. Enclosures shall have sufficient depth to accommodate mounting four Class 9001 KA-1 contact blocks side-by-side and in tandem behind a single operator for a maximum of eight circuits, four normally open and four normally closed.
      b. Enclosures shall have the required number of holes for the number of operators pre-manufactured as shown on the contract drawings.
   2. NEMA 12 and NEMA 4X
      a. Enclosures shall be 16 gauge Type 304 stainless steel gasketed enclosures.
      b. Acceptable manufacturers are Allen Bradley, General Electric, Square D, or equivalent.
   3. Class I, Division I and Class 1, Division 2 Enclosures
      a. Enclosures and covers shall be shall be iron or aluminum and gasketed with pre manufactured devices installed by manufacturer.
      b. Acceptable manufactures are Cooper Cooper Crouse-Hinds Flex Station Control Stations, Allen-Bradley, Square D, or equivalent.

B. Operators:
   1. General:
      a. All operators used in control stations shall be Square D type K and shall be suitable for cover mounting in a 1-7/32 inch diameter notch type cover hole and shall be held in place by the locking thrust washer. All operators shall be heavy duty oil/water tight, be 30mm in size, and maintain the NEMA rating of the enclosure.

b. Push buttons shall have removable inserts in eight different colors for function color coding. Push-button inserts shall be removable from the front of the control station without disturbing the wiring or mounting of the control units.
c. Selector switches shall have removable knobs in eight different colors for function color coding. Selector switch knobs shall be removable from the front of the control station without disturbing the wiring or mounting of the control units. Operators for selector switches shall be bat wing type.
d. Emergency stop pushbutton operators shall be large operator head type, red mushroom-head, maintained type switch with push to open and pull to re-engage control circuit. Provide multiple output contact type as shown on the drawings.
e. Indicator lights shall be heavy duty, oiltight and have the following requirements:
i. Designed to operate at 120 volts, 60 Hz AC.
ii. Provided with a chrome-plated metal or anodized-aluminum mounting rings, engraved as indicated on the Drawings.
iii. Lens color shall be as indicated on drawings.
iv. Shall be 30 mm LED lamp type, with "Push to Test" requirements.
f. Provide legend plates which describe function of each device on control station.

2. Contact blocks used in heavy duty oil-tight control stations shall be of Square D Type K single-pole, single-throw (SPST), single-pole, double-throw (SPDT). Contact blocks shall be suitable for mounting side by side and/or in tandem to the base of the operator with these following requirements:
a. mounting screws shall be captive with a drilled and tapped head to permit easy tandem mounting of contact blocks.
b. Terminals shall be pressure wire type with a self-lifting pressure clamp that will compensate for wire of different size ranging from #12-#18 solid or stranded.
c. Contacts shall be double break, and silver plated.
3. Class 1 Division 2 operators shall meet all requirements of section 2.1.B.1 with the addition of devices being hermetically sealed by the factory.

C. Control Circuit Fuses
1. Fuses shall be 3AB ceramic body fuses rated for at least 125 volts at the current ratings shown on the Drawings. Fuse size shall be ¼" x 1¼".
2. Blow time shall be:
a. 110%, 4 hours minimum;
b. 135%, 1 hour maximum;
c. 200%, 15 seconds maximum for 1/8-12 amp fuses
d. 200%, 60 seconds maximum for 15-30 amp fuses.
3. Fuses shall be Littlefuse, Bussmann, or approved equal.

D. Relays
1. Industrial Control Relays - Industrial control relays shall be utilized where specifically called for on the Drawings or within the Specifications. Industrial control relays with 10 ampere contact rating shall be Square D, Class 8501 Type

X, Allen-Bradley or approved equal. Relays with 30 ampere contact rating shall be Square D, Class 8501, Type C or equal.

2. Pilot Duty Relays - Unless specifically noted otherwise, relays shall be general purpose relays. General purpose relays shall be IDEC RH Series, 10A contact rating, 4 Form "C" contacts, Allen-Bradley or approved equal, provided with internal indicating light. Pilot duty control isolating relays for PLC inputs and outputs shall be suitable for the application, and shall be submitted for approval by Engineer.
3. Relays shall be electrically held, electrically operated with 120 volt coils except as noted otherwise on the Drawings. Contacts shall be rated 600 volt, 10 ampere and shall be convertible from Normally Open to Normally Closed. Where relays are used to control single-phase, fractional horsepower motors, contacts shall be rated in accordance with the N.E.C. for the motor to be controlled. Where relays are not installed within system control panels, provide a suitable enclosure as specified in Section 16160, with NEMA ratings as indicated on the Drawings.
4. Dry contacts used for instrumentation and SCADA inputs or other low current inputs, shall be bifurcated cross bar gold overlay silver and rated dry circuit. These contacts will be provided through dedicated interposing relays as shown on the schematic diagrams of the Drawings or as specified herein. Relays shall be provided with plug-in type sockets with screw terminal wiring connections to facilitate relay change out and wiring. Relays shall be Potter and Brumfield type KHAU-17A16 - 120 or 12V, IDEC, or approved equal as shown on Drawing.

E. Fuse Blocks
1. Fuse blocks shall be rated for at least 30 amps and 300 volts. The clips shall be high tensile spring brass, electro-tin plated. The base shall be polyester, glass reinforced with a UL-94VO flammability rating.
2. At least four spare sets of clips shall be provided on each fuse block and shall be labeled "SPARE".
3. Fuse block switches shall be din rail mounted.
4. Fuse blocks shall be Littlefuse Omni-block, Bussmann, or considered equal.

F. Terminal Strips
1. Terminal strips with box type connectors shall be supplied to make all power and control connections. All terminals shall be clearly marked for easy identification. A ground terminal strip shall also be provided. At least 20 percent of terminals supplied shall be spare. All wiring shall be terminated on field terminal blocks.

G. Control Power Transformers
1. Supply all control power transformers necessary to make panel functional. All transformers shall have both primary legs and all "hot" secondary legs fused. One secondary leg shall be grounded. Fuse sizing shall be as recommended by the equipment manufacturer for the particular installation.
2. Final sizing of the control power transformer shall be based on the application and control equipment to be operated on this equipment. The supplier/contractor shall review all system schematics and provide the

appropriate size CPT for each application. Oversized CPT will be required where necessary for the installation.

H. Emergency Stop Pushbuttons (E-Stops)

1. Pushbutton control station shall be red, large mushroom-head maintained switch with pull-on and push-off type. Provide multiple output contact type as shown on the drawings. Device shall maintain the NEMA rating for area in which it is being installed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All items incorporated into the work shall be installed in accordance with the Drawings and Specifications. Where detailed drawings or technical specifications are not provided, the items shall be installed in accordance with the manufacturer's preferred recommendations and confirming to the best practice of the trade involved.

B. All installations shall be in accordance with the applicable sections of Division 13, 15 and 16 (where applicable).

3.2 TESTS

A. All items shall be factory tested.

B. Refer to section 16950 for additional testing requirements.

END OF SECTION

SECTION 16950

START-UP AND TESTING OF ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Test and demonstrate, to the satisfaction of the Engineer, all electrical devices in accordance with the following requirements. All testing and checkout of equipment specified under this Section shall be performed by an independent testing agency. The testing agency shall be an independent and qualified field services company regularly engaged in the testing of electrical equipment and apparatus. The following company has been listed:

Electrical Engineering & Service Co., Inc.
289 Center Street
Holbrook, MA 02343
Tel: 781-767-9988
Contact: Mr. Joseph Cipolla

The testing agency noted is a qualified entity. Additional or equally qualified companies shall be considered as or equal.

B. During the checkout and startup period, the electrical contractor shall provide sufficient personnel to aid with the start-up of all electrical equipment, to remove any faults, and to make the necessary adjustments for the proper operation of electrical equipment and installation.

C. A 1000 volt "megger" insulation test shall be available at all times during the testing of power feeders and motor wiring and 2500 volt "megger" test for heat trace cable.

D. All electrical equipment, wiring, switches and insulators found to be defective or to have failed due to poor workmanship shall be replaced promptly at no additional cost to the Owner.

E. The testing agency shall be responsible for setting and adjusting all required setting to all electrical equipment based upon the final coordination, short circuit and arc flash study for the entire facility and associated building structures for the electrical distribution system. Signoff and certification sheets shall be submitted and documented for final acceptance.

F. The contractor will not be allowed to perform any testing, set any equipment parameters or perform any megohm cable testing as this is the responsibility of a third party testing agency as specified herein.

1.2 SUBMITTALS TO THE ENGINEER

A. Shop Drawings are required for all items provided under this section. Submittals shall be provided in accordance with Sections 01340, 16010 and as specified in this section.

B. It should be the Contractors responsibility to provide all required forms/direction as to submittal procedures for this contract and to verify compliance prior to submitting

to the Engineer for review.

C. A record of all insulation values shall be properly recorded as listed in worksheet attached to the back of the section. All time intervals shown shall be recorded for each conductor being tested.

D. Ground testing results shall be properly recorded, witnessed, and reported to the Engineer.

E. All circuit breaker settings and testing shall be provided in order to check for proper cable connections, impedance testing and infra-red testing of all connections of all electrical equipment, cables, devices and distribution system equipment for the entire project at all locations.

1.3 TESTING REQUIREMENTS

A. Prior to the start of check out and testing, insure that all equipment is properly and permanently identified according to Section 16010.

B. Before energizing any electrical equipment or apparatus, thoroughly check all equipment for the following:

1. All equipment and materials shall be clean, dry and free of foreign materials.
2. Vacuum clean to make free from filings, foreign matter or other materials left inside equipment or enclosures. Particular attention shall be given to bus conductors, conductors, terminal blocks, and windings.
3. Check for tools inside equipment or enclosures. All screw, bolt, and terminal connections shall be checked for tightness as specified by the equipment manufacturer.
4. Check the bearings of all rotating electrical apparatus and, if required, have supplier fill with the grease or oil as recommended by the manufacturers.
5. All motors, contacts, relays, bus, insulators and other electrical apparatus shall be cleaned and dried out if required and/or needed. Drying out methods will be such that the insulation temperature of the apparatus does not exceed 90°C.

C. Prior to applying voltage to any apparatus or circuit, make insulation resistance tests and, if necessary, dry the apparatus until resistance values conform to the standards of IEEE.

D. In case of a low resistance circuit insulation, eliminate the problem before the circuit is energized.

E. Provide 1000 volt "Megger" insulation testing on all 600 volt feeder conductors and motor power conductors. This shall include any and all of the existing electrical feeder cables at the facility which shall remain and shall be reconnected. Motors shall be meggered from the starters.

F. Provide 2500 volt "Megger" insulation testing for all heat trace cabling to be installed at all locations as shown on the Drawings.

G. "Megger" test all required service feeder cables and circuit wiring at the existing facility in their entirety and submit a complete test report. Test voltage shall be applied until readings reach a constant value, and until three (3) equal readings, each one (1) minute apart, are obtained. Minimum megger reading shall be 45 megohms for feeder conductors.

H. Panelboard line currents shall be balance to within 10% of each other.

I. Three phase motors shall be checked for rotation and, if necessary, reverse the connections at the starter. Single phase and DC motors at motor connection box.

J. All main plant building loops and major equipment grounds shall be tested to remote earth or directly referenced to an extremely low resistance (approximately 1 ohm) reference ground bench mark. Tests shall be made with ground testing ohm meter or "megger" approved by the Engineer for the purpose.

K. The ground resistance of the individual networks shall be measured at two points with the cables at all the test points disconnected.

L. Test the grounding system to assure continuity and to assure that resistance to ground does not exceed specified limits or form any ground loops.

M. The entire grounding network resistance shall be meggered. Resistance shall not exceed 25 ohms. Drive additional ground rods if necessary.

N. The Contractor shall provide load readings for all equipment, switchgear, motor control centers and panelboards.

O. Set all coordination, short circuit and arc fault settings to study provided for this facility for final set up of the electrical system.

P. Test and set all motor circuit protectors, motor overload heaters to the nameplate horsepower of the equipment; and all circuit breaker settings in all electrical equipment shall be tested and verified operational.

Q. Adjust all settings on protective equipment and verify, check and establish with the power company that the secondary voltage is within 2% of rated voltage.

R. Provide and check all overload relays settings and sizing for all motors and submit this data to the Engineer for final approval. This shall include settings and adjustments to MCP devices for each motor starter.

S. The contractor shall maintain a complete marked up drawing set and all written documentation of all changes at the job site. These documents shall be made available to the Engineer at all times.

1.4 DEMONSTRATION AND START UP

A. All equipment shall be properly identified as indicated in SECTION 16010.

B. When directed by the Engineer, demonstrate the total system operation and make final adjustments to the system. If any system or piece of equipment within a system fails to function properly, rectify such defects or inadequacies and make a final demonstration as directed by the Engineer.

C. Provide the services of authorized manufacturers' representatives to instruct the Owner's representatives in the proper operation of each partial or complete system installed under this Contract.

D. Pay all charges or fees, including the cost of any special test equipment, factory engineers, etc. necessary for the proper performance of the specified tests, demonstrations, and instructions.

E. All demonstrations and instructions shall be scheduled at the convenience of the Engineer and the Owner and shall be scheduled with at least seventy-two (72) hours written notice.

F. Set all circuit breaker and overcurrent devices based on overall system coordination and short circuit study. Final acceptance will not be allowed until all settings and protective devices are set, checked, tested, and verified in the field in the presence of the Engineer.

G. All control circuits shall be functionally checked to see that their operation and sequence are correct. Any adjustable switches such as float switches, limit switches

and timers shall be adjusted for proper operation.

H. Just prior to acceptance of the lighting facilities, clean all lighting fixtures and re-lamp where required at no additional cost to the Owner.

I. All local control stations and control panels for equipment specified in DIVISIONS 13, 15 and 16 shall be demonstrated to function properly of all items under simulated operating conditions unless otherwise specified elsewhere.

MEGGER TEST RESULTS

Project: _____ **Temperature:** _____
Date: _____ **Weather:** _____
Location: _____ **Test Equipment:** _____

Equipment/feeder Under Test: _____ **Start Time:** _____ **End Time:** _____
Test Equipment: Make: _____ **Serial No.:** _____ **Test Voltage:** _____

	0.5 min	1 min	2 min	3 min	4 min	5 min	6 min	7 min	8 min	9 min	10 min	P.I.
Phase A-Gnd.												
Phase B-Gnd.												
Phase C-Gnd.												
Phase A-PhaseB												
Phase A-PhaseC												
Phase B-PhaseC												

Equipment/feeder Under Test: _____ **Start Time:** _____ **End Time:** _____

	0.5 min	1 min	2 min	3 min	4 min	5 min	6 min	7 min	8 min	9 min	10 min	P.I.
Phase A-Gnd.												
Phase B-Gnd.												
Phase C-Gnd.												
Phase A-PhaseB												
Phase A-PhaseC												
Phase B-PhaseC												

Notes: Megger test only should record 5 minutes value…
Polarization Index (P.I.) is 10 min reading divided by 1 min reading
Note: If a neutral is provided, this will also need to be tested

END OF SECTION

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Engineering a Better Environment