DEPARTMENT OF FINANCE AND PURCHASING

345 South Main Street

Harrisonburg, VA 22801

ISSUE DATE: September 20, 2013	**INVITATION TO BID NUMBER:** 2014012-PW-B	**FOR:** Boiler Feed Water Pump Replacement
DEPARTMENT: Public Works RRF	**DATE/TIME OF CLOSING:** October 17, 2013 at 3:00pm local time	**CONTRACT ADMINISTRATOR:** Aaron Rhoney, RRF Maintenance Manager

A Mandatory Pre-Bid meeting will be held Monday, September 30, 2013 at 10:00am local time.

Bids - In accordance with the following and in compliance with all terms and conditions, unless otherwise noted, the undersigned offers and agrees, if the bid is accepted, to furnish items or services for which prices are quoted, delivered or furnished to designated points within the time specified. It is understood and agreed that this entire ITB and any addendums shall constitute a contract.

NAME AND ADDRESS OF FIRM:

Telephone/Fax No.:

Federal Employer Identification # :

State Corporation Commission #:

E-mail:

Prompt Payment Discount: __% for payment within____days/net____ days

By signing this bid, Vendor(s) certifies, acknowledges, understands, and agrees to be bound by the conditions set forth in this ITB.

CHECK ONE: ☐ INDIVIDUAL ☐ PARTNERSHIP ☐ CORPORATION ☐ LLC

Vendor's Legally Authorized Signature

Date

Print Name

Title

Sealed bids, subject to terms and conditions of this Invitation to Bid will be received by the City of Harrisonburg Purchasing Office, 345 South Main Street, Room 201, Harrisonburg, Virginia 22801 until the date/ time specified above for furnishing items or services delivered or furnished to specified destinations within the time specified or stipulated by the vendor(s).

The City does not discriminate against small and minority businesses or faith-based organizations.

**This document must be completed & returned with bid submission.*

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I. Background

The City of Harrisonburg's Resource Recovery Facility (RRF) is a waste-to-energy facility that combusts municipal solid waste in order to create steam to heat and cool the James Madison University (JMU) campus. Refuse from the City, Rockingham County, and surrounding municipalities is brought to the facility. The original RRF was constructed and put into operation in 1982. The RRF is permitted to burn 200 tons of waste per day, creating 57,000 lbs. of steam an hour, which heats and cools the entire College of Integrate Science and Technology (CISAT) side of JMU campus, as well as heats the Convocation Center, University Recreation Center (UREC) and the west side of campus. Trash is considered by the federal government to be a renewable resource, and in the City's case, this means that nonrenewable resources such as natural gas and oil can be saved. The Harrisonburg Resource Recovery Facility operates 24 hours a day, 365 days a year to reduce our refuse.

II. Description of Work

The City of Harrisonburg RRF is seeking a Mechanical Contractor to perform the following as outlined by the bid documents. Contractor shall provide labor and equipment for demolition and removal of selected mechanical and electrical systems. Contractor shall provide labor and material per specifications to install new boiler feed water pumps, piping, valves, etc. and all supplemental electrical controls as outlined by the specifications.

III. Instructions to Bidders

A. Bid Submission

Bidders shall submit their bid on the attached Bid Form (Attachment B). In addition to bid information, bidders will be required to submit a schedule of the bidder's timeframe for completing this project. In addition, bidders must complete and return the State Corporation Commission (SCC) form with bid documents (Attachment J). Any and all addenda issued must be signed and returned with bid documents as well. Bidders shall submit on a separate page, a rate schedule and percentages onto material purchased for additional work, if needed.

Bids must be sealed in an opaque envelope or box and be mailed or hand-delivered to the Purchasing Agent at 345 South Main Street, Room 201, Harrisonburg, Virginia 22801. No faxed or emailed bids will be accepted. It is the sole responsibility of the bidder to see that his bid is received on time. Enclose each bid in a sealed envelope bearing the title of the work and the bid number, "Boiler Feed Water Pump Replacement 2014012-PW-B." Submit only the original signed copy of the bid.

The City of Harrisonburg will receive sealed bids at the Office of the Purchasing Agent at 345 South Main Street, Room 201, Harrisonburg, Virginia 22801 up until **Thursday, October 17, 2013 at 3:00pm local time**. At the above-stated time and place, all bids will be opened and read. No bids received after the time fixed for receiving them will be considered. Late or incomplete bids will be returned to the bidder. The City reserves the

right to reject any and all bids. The City further reserves the right to waive or not waive any informality in any bid.

Bid documents are available on the City's website at www.harrisonburgva.gov/bids-proposals and also on the eVA website at www.eva.virginia.gov.

B. Mandatory Pre-Bid Meeting

The City of Harrisonburg will conduct a mandatory pre-bid meeting on **Monday, September 30 at 10:00am local time**. The meeting will be held at the Resource Recovery Facility (RRF) Administration Building, located at 1630 Driver Drive, Harrisonburg, Virginia 22801. All bidders interested in submitting a bid to this invitation must be present.

A summary of questions and answers from the meeting will be compiled into an addendum and posted on the City's website and also on eVA. A sign-in sheet from the meeting will also be posted as part of this addendum.

The mandatory Pre-Bid meeting will cover:

- Scheduling aspect of the work
- Critical path aspect of the project
- Procurement questions

C. BONDS

A. Bids shall be accompanied by a 5% bid security. Bid bond must be in the form of a certified check, cashiers check or bid bond issued by a surety. The successful bidder's security will not be returned until he has signed the Contract and has furnished the required Certificates of Insurance.

B. The Owner reserves the right to retain the security of all bidders until the successful bidder enters into the Contract. Other bid security will be returned as soon as practicable. If any bidder refuses to enter into a Contract, the Owner may retain his bid security as liquidated damages but not as a penalty.

C. Prior to signing the Contract, the Owner will require the successful bidder to secure and post a Labor and Materials Payment Bond and a Performance Bond, each in the amount of 100% of the Contract Sum, and each on the form provided therefore in the Project Manual. Such Bonds shall be issued by a Surety acceptable to the Owner.

IV. Specifications

Specifications for the Harrisonburg RRF JMU Boiler Feed Pump Replacement Project can be found in Attachment A of this bid document. In addition to the specifications, seven (7) drawings of the boiler feed pump have been made available as part of this bid document (see Attachments C through Attachment I). All attachments should be reviewed by bidder and taken into consideration prior to submitting a bid for this project.

The timeline for this project is critical, as part of the plant will need to be shut down during construction time. In order to minimize the time the plant is shut down, the schedule for construction will need to commence not more than forty-five (45) calendar days after the Notice of Award is issued. The work must be completed prior to the summer of 2014. Public Works staff will work closely with the winning bidder to establish a firm schedule on the construction dates. Bidders will be required to submit a schedule of the bidder's timeframe for completing this project as part of their bid submission.

V. Liquidated Damages

Due to the critical timeline of this project, liquidated damages will be included. Further information on the liquidated damages will be discussed at the **Mandatory Pre-Bid Meeting on Monday, September 30, 2013 at 10:00am local time**.

VI. General Terms & Conditions for the City of Harrisonburg

PURCHASING AND CONTRACTING MANUAL: This solicitation is subject to the provisions of The Purchasing and Contracting Policy Manual for the City of Harrisonburg (City) and any revisions thereto, which are hereby incorporated into this contract in their entirety. A copy of the manual is available for review at www.harrisonburgva.gov/bids-proposals.

APPLICABLE LAWS AND COURTS: This solicitation and any resulting contract shall be governed in all respects by the laws of the Commonwealth of Virginia and any litigation with respect thereto shall be brought in the courts of the Commonwealth. The contractor shall comply with all applicable federal, state and local laws, rules and regulations.

ANTI-DISCRIMINATION: By submitting their (bids/proposals), (bidders/offerors) certify to the City that they will conform to the provisions of the Federal Civil Rights Act of 1964, as amended, as well as the Virginia Fair Employment Contracting Act of 1975, as amended, where applicable, the Virginians With Disabilities Act, the Americans With Disabilities Act and 2.2-4311 of the *Virginia Public Procurement Act*.

In every contract over $10,000 the provisions below apply:

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

    a. The contractor will not discriminate against any employee or applicant for employment because of race, religion, color, sex, national origin, age, disability, or any other basis prohibited by state law relating to discrimination in employment, except where there is a bona fide occupational qualification reasonably necessary to the normal operation of the contractor. The contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices setting forth the provisions of this nondiscrimination clause.

b. The contractor, in all solicitations or advertisements for employees placed by or on behalf of the contractor, will state that such contractor is an equal opportunity employer.

c. Notices, advertisements and solicitations placed in accordance with federal law, rule or regulation shall be deemed sufficient for the purpose of meeting these requirements.

The contractor will include the provisions of 1. above in every subcontract or purchase order over $10,000, so that the provisions will be binding upon each subcontractor or vendor.

2. The City does not discriminate against small and minority businesses or faith based organizations.

ETHICS IN PUBLIC CONTRACTING: By submitting their (bids/proposals), (bidders/offerors) certify that their (bids/proposals) are made without collusion or fraud and that they have not offered or received any kickbacks or inducements from any other (bidder/offeror), supplier, manufacturer or subcontractor in connection with their (bid/proposal), and that they have not conferred on any public employee having official responsibility for this procurement transaction any payment, loan, subscription, advance, deposit of money, services or anything of more than nominal value, present or promised, unless consideration of substantially equal or greater value was exchanged.

IMMIGRATION REFORM AND CONTROL ACT OF 1986: By submitting their (bids/proposals), (bidders/offerors) certify that they do not and will not during the performance of this contract employ illegal alien workers or otherwise violate the provisions of the federal Immigration Reform and Control Act of 1986.

DEBARMENT STATUS: By submitting their (bids/proposals), (bidders/offerors) certify that they are not currently debarred by the Commonwealth of Virginia from submitting bids or proposals on contracts for the type of goods and/or services covered by this solicitation, nor are they an agent of any person or entity that is currently so debarred.

ANTITRUST: By entering into a contract, the contractor conveys, sells, assigns, and transfers to the City all rights, title and interest in and to all causes of action it may now have or hereafter acquire under the antitrust laws of the United States and the Commonwealth of Virginia, relating to the particular goods or services purchased or acquired by the City under said contract.

MANDATORY USE OF CITY FORM AND TERMS AND CONDITIONS FOR IFBs AND RFPs

1. (For Invitation For Bids(ITB):) Failure to submit a bid on the form provided, (if provided) shall be a cause for rejection of the bid. Modification of or additions to any portion of the Invitation for Bids may be cause for rejection of the bid; however, the City reserves the right to decide, on a case by case basis, in its sole discretion, whether to

reject such a bid as nonresponsive. As a precondition to its acceptance, the City may, in its sole discretion, request that the bidder withdraw or modify nonresponsive portions of a bid which do not affect quality, quantity, price, or delivery. No modification of or addition to the provisions of the contract shall be effective unless reduced to writing and signed by the parties.

2. (For Request For Proposals(RFP):) Failure to submit a proposal on the form provided, (if provided) shall be a cause for rejection of the bid. Modification of or additions to the General Terms and Conditions of the solicitation may be cause for rejection of the proposal; however, the City reserves the right to decide, on a case by case basis, in its sole discretion, whether to reject such a proposal.

REVISIONS TO THE OFFICIAL ITB/RFP: No offeror shall modify, revise, edit or make any unauthorized change(s) to the original Official Invitation to Bid (ITB) or Official Request for Proposal (RFP). The Official solicitation document and the Addenda(s) are the documents posted on the City of Harrisonburg's web site and/or authorized by the City of Harrisonburg's Purchasing Agent. Any such violation as stated above may result in rejection of the ITB/RFP response. In addition, violations may result in the debarment of the offeror by the City of Harrisonburg.

CLARIFICATION OF TERMS: If any prospective (bidder/offeror) has questions about the specifications or other solicitation documents, the prospective (bidder/offeror) should contact the person whose name appears on the face of the solicitation no later than five working days before the due date. Any revisions to the solicitation will be made only by addendum issued by the buyer.

PAYMENT:

1. To Prime Contractor:

   a. Invoices for items ordered, delivered and accepted shall be submitted by the contractor directly to the payment address shown on the purchase order/contract. All invoices shall show the purchase order number; social security number (for individual contractors) or the federal employer identification number (for proprietorships, partnerships, and corporations).

   b. Any payment terms requiring payment in less than 30 days will be regarded as requiring payment 30 days after invoice or delivery, whichever occurs last. This shall not affect offers of discounts for payment in less than 30 days, however.

   c. All goods or services provided under this contract or purchase order, that are to be paid for with public funds, shall be billed by the contractor at the contract price.

   d. The following shall be deemed to be the date of payment: the date of postmark in all cases where payment is made by mail, or the date of offset when offset

proceedings have been instituted as authorized under the Virginia Debt Collection Act.

e. Individual contractors shall provide their social security numbers, and proprietors , partnerships, and corporations shall provide the City with a federal employer identification number, prior to receiving any payment from the City.

f. **Unreasonable Charges**. Under certain emergency procurements and for most time and material purchases, final job costs cannot be accurately determined at the time orders are placed. In such cases, contractors should be put on notice that final payment in full is contingent on a determination of reasonableness with respect to all invoiced charges. Charges which appear to be unreasonable will be researched and challenged, and that portion of the invoice held in abeyance until a settlement can be reached. Upon determining that invoiced as to those charges which it considers unreasonable and the basis for the determination. A contractor may not institute legal action unless a settlement cannot be reached within thirty (30) days of notification. The provisions of this section do not relieve the City of its prompt payment obligations with respect to those charges which are not in dispute (*Code of Virginia*, 2.2.4363.

2. To Subcontractors:

a. A contractor awarded a contract under this solicitation is hereby obligated:

(1) To pay the subcontractor(s) within seven (7) days of the contractor's receipt of payment from the City for the proportionate share of the payment received for work performed by the subcontractor(s) under the contract; or

(2) To notify the City and the subcontractor(s), in writing, of the contractor's intention to withhold payment and the reason.

b. The contractor is obligated to pay the subcontractor(s) interest at the rate of one percent per month (unless otherwise provided under the terms of the contract) on all amounts owed by the contractor that remain unpaid seven (7) days following receipt of payment from the City, except for amounts withheld as stated in (2) above. The date of mailing of any payment by U. S. Mail is deemed to be payment to the addressee. These provisions apply to each sub-tier contractor performing under the primary contract. A contractor's obligation to pay an interest charge to a subcontractor may not be construed to be an obligation of the City.

PRECEDENCE OF TERMS: General Terms and Conditions shall apply in all instances. In the event there is a conflict between any of the other General Terms and Conditions and any Special Terms and Conditions in this solicitation, the Special Terms and Conditions shall apply.

QUALIFICATIONS OF (BIDDERS/OFFERORS): The City may make such reasonable investigations as deemed proper and necessary to determine the ability of the (bidder/offeror) to

perform the services/furnish the goods and the (bidder/offeror) shall furnish to the City all such information and data for this purpose as may be requested. The City reserves the right to inspect (bidder's/offeror's) physical facilities prior to award to satisfy questions regarding the (bidder's/offeror's) capabilities. The City further reserves the right to reject any (bid/ proposal) if the evidence submitted by, or investigations of, such (bidder/offeror) fails to satisfy the City that such (bidder/offeror) is properly qualified to carry out the obligations of the contract and to provide the services and/or furnish the goods contemplated therein.

TESTING AND INSPECTION: The City reserves the right to conduct any test/inspection it may deem advisable to assure goods and services conform to the specifications.

ASSIGNMENT OF CONTRACT: A contract shall not be assignable by the contractor in whole or in part without the written consent of the City.

CHANGES TO THE CONTRACT: Changes can be made to the contract in any of the following ways:

1. The parties may agree in writing to modify the scope of the contract. An increase or decrease in the price of the contract resulting from such modification shall be agreed to by the parties as a part of their written agreement to modify the scope of the contract.
2. The Purchasing Agent or City delegated agent may order changes within the general scope of the contract at any time by written notice to the contractor. Changes within the scope of the contract include, but are not limited to, things such as services to be performed, the method of packing or shipment, and the place of delivery or installation. The contractor shall comply with the notice upon receipt. The contractor shall be compensated for any additional costs incurred as the result of such order and shall give the City a credit for any savings.

DEFAULT: In case of failure to deliver goods or services in accordance with the contract terms and conditions, the City, after due oral or written notice, may procure them from other sources and hold the contractor responsible for any resulting additional purchase and administrative costs. This remedy shall be in addition to any other remedies, which the City may have.

CANCELLATION OF THE CONTRACT: The City may terminate any agreement resulting from this solicitation at any time, for any reason or for no reason, upon thirty days advance written notice to the Contractor. In the event of such termination the Contractor shall be compensated for services and work performed prior to termination.

TAXES: Sales to the City of Harrisonburg are normally exempt from State sales tax. State sales and use tax certificates of exemption, Form ST-12, will be issued upon request.

(NOT NORMALLY REQUIRED FOR SERVICE CONTRACTS)

USE OF BRAND NAMES: Unless otherwise provided in this solicitation, the name of a certain brand, make or manufacturer does not restrict (bidders/offerors) to the specific brand, make or manufacturer named, but conveys the general style, type, character, and quality of the article desired. Any article which the public body, in its sole discretion, determines to be the equal of that specified, considering quality, workmanship, economy of operation, and suitability for the

purpose intended, shall be accepted. The (bidder/offeror) is responsible to clearly and specifically identify the product being offered and to provide sufficient descriptive literature, catalog cuts and technical detail to enable the City to determine if the product offered meets the requirements of the solicitation. This is required even if offering the exact brand, make or manufacturer specified. Normally in competitive sealed bidding only the information furnished with the bid will be considered in the evaluation. Failure to furnish adequate data for evaluation purposes may result in declaring a bid nonresponsive. Unless the (bidder/offeror) clearly indicates in its (bid/proposal) that the product offered is an "equal" product, such (bid/proposal) will be considered to offer the brand name product referenced in the solicitation.**(NOT NORMALLY REQUIRED FOR SERVICE CONTRACTS)**

TRANSPORTATION AND PACKAGING: By submitting their (bids/proposals), all (bidders/offerors) certify and warrant that the price offered for FOB destination includes only the actual freight rate costs at the lowest and best rate and is based upon the actual weight of the goods to be shipped. Except as otherwise specified herein, standard commercial packaging, packing and shipping containers shall be used. All shipping containers shall be legibly marked or labeled on the outside with purchase order number, commodity description, and quantity.**(NOT NORMALLY REQUIRED FOR SERVICE CONTRACTS)**

INSURANCE: By signing and submitting a bid or proposal under this solicitation, the bidder or offeror certifies that if awarded the contract, it will have insurance coverages per the solicitation document at the time the contract is awarded. For construction contracts, if any subcontractors are involved, the subcontractor will have workers' compensation insurance in accordance with 2.2-4332 and 65.2-800 et seq. of the *Code of Virginia*. The bidder or offeror further certifies that the contractor and any subcontractors will maintain these insurance coverages during the entire term of the contract and that all insurance coverages will be provided by insurance companies authorized to sell insurance in Virginia by the Virginia State Corporation Commission. **(NOT NORMALLY REQUIRED FOR GOODS CONTRACTS. INSURANCE IS REQUIRED WHEN WORK IS TO BE PERFORMED ON CITY OWNED OR LEASED FACILITIES OR PROPERTY.)**

AVAILABILITY OF FUNDS: Agreements are made subject to the appropriation of funds by the Harrisonburg City Council and are null and void in the event of non-appropriation by the City Council. Non-appropriation of funds shall not be deemed a cancellation and shall terminate this agreement without recourse and with no liability on the part of the City.

SELECTION PROCESS/AWARD: Upon the award or the announcement of the decision to award a contract as a result of this solicitation, the department will publicly post such notice for a minimum of ten (10) days, or will notify all responsive bidders/offerors.

BID/PROPOSAL ACCEPTANCE PERIOD: Any bid/proposal resulting from this solicitation shall be valid for (30) days. At the end of the (30) days the bid/proposal may be withdrawn at the written request of the Bidder/Offeror. If the bid or proposal is not withdrawn at that time it remains in effect until an award is made or the solicitation is canceled.

EXCUSABLE DELAY: The City shall not be in default of any failure in performance of this agreement in accordance with its terms if such failure arises out of causes beyond its reasonable control and without the fault of or negligence of the City. Such causes may include, but are not restricted to acts of God or the public enemy, fires, flood, epidemics, quarantine restrictions, strikes, freight embargoes, and usually severe weather, but in every case the failure to perform must be beyond the reasonable control and without the fault or negligence of the City.

DRUG-FREE WORKPLACE: During the performance of this contract, the contractor agrees to (i) provide a drug-free workplace for the contractor's employees; (ii) post in conspicuous places, available to employees and applicants for employment, a statement notifying employees that the unlawful manufacture, sale, distribution, dispensation, possession, or use of a controlled substance or marijuana is prohibited in the contractor's workplace and specifying the actions that will be taken against employees for violations of such prohibition; (iii) state in all solicitations or advertisements for employees placed by or on behalf of the contractor that the contractor maintains a drug-free workplace; and (iv) include the provisions of the foregoing clauses in every subcontract or purchase order of over $10,000, so that the provisions will be binding upon each subcontractor or vendor.

SAFETY and OSHA STANDARDS: All parties performing services for the City shall comply with all Occupational Safety and Health Administration (OSHA), State Occupational Health Standards, and any other applicable rules and regulations. All parties shall be held responsible for the training, supervision, and safety of their employees. Any unsafe acts or hazardous conditions that may cause injury or damage to any persons or property within and around the work site areas under this contract shall be remedied per the regulatory agency's guidelines.

PERMITS AND FEES: All proposals submitted shall have included in price the cost of any business or professional licenses, permits or fees required by the City of Harrisonburg or the Commonwealth of Virginia. The offeror must have all necessary licenses to perform the services in Virginia and, if practicing as a corporation, be authorized to do business in the Commonwealth of VA.

COOPERATIVE PROCUREMENT: This procurement is being conducted on behalf of other public bodies, in accordance with 2.2-4304 (A) of the Code of VA. The successful bidder has the option to provide these same items (services), except architectural and engineering services, at the same prices, awarded as a result of this solicitation to any public body within the Commonwealth of Virginia. If any other Public body decides to use the final contract, the contractor(s) must deal directly with that public body concerning the placement of orders, issuance of the purchase orders, contractual disputes, invoicing and payment. Failure to extend a contract to any public body will have no effect on consideration of your bid.

LIABILITY AND LITIGATION: The City shall not indemnify or hold harmless any Contractor or other third party. The City does not waive any right or release any party from liability, whether on its own behalf or on behalf of any boards, employees or agents. The City does not waive the right to trial by jury for any cause of action arising from the Contract and shall not submit any Contract claim to binding arbitration or mediation. The City shall not be liable to Contractor for any special, punitive or exemplary damages arising from the performance

of the contract, including, but not limited to, incidental damages, and lost profit and lost wages, even if such special damages are reasonably foreseeable. Any provision(s) in the Contract contrary to these statements is/are hereby deleted and rendered void.

STATE CORPORATION COMMISSION IDENTIFICATION NUMBER: Pursuant to Code of VA 2.2-4311.2 subsection B, a bidder or offeror organized or authorized to transact business in the Commonwealth pursuant to Title 13.1 or Title 50 is required to include in its bid or proposal the identification number issued to it by the State Corporation Commission (SCC). Any bidder or offeror that is not required to be authorized to transact business in the Commonwealth as a foreign business entity under Title 13.1 or Title 50 or as otherwise required by law is required to include in its bid or proposal a statement describing why the bidder or offeror is not required to be so authorized. Link to the SCC site is http://www.scc.virginia.gov.

VII. Questions

Vendors may submit questions in writing to Ms. Pat Hilliard, Purchasing Agent for the City of Harrisonburg by email at Purchasing@harrisonburgva.gov. Questions deemed relevant will be responded to and posted on the City's website at www.harrisonburgva.gov/bids-proposals and also on eVA at www.eva.virginia.gov. Questions must be received by **Thursday, October 10, 2013 at noon local time**.

Any and all addenda issued shall be reviewed by bidder. Upon issuance, addenda shall be considered part of the bid documents and must be signed and returned with bid submission.

VIII. Insurance Requirements for the City of Harrisonburg

Independent Contractors/Vendors must have the following insurance coverages before beginning work on City premises:

1. The contractor/vendor will maintain a general liability policy with $1,000,000 combined single limits. Coverage is to be on an occurrence basis with an insurer licensed to conduct business in the Commonwealth of Virginia. Excess Liability coverage in the amount of $1,000,000. The insurer must have an A. M. Best rating of A- or better. The insurer must list the City of Harrisonburg as an additional insured. The endorsement must be issued by the insurance company. A notation on the certificate of insurance is not sufficient.

2. The contractor/vendor will maintain workers' compensation coverage in compliance with the laws of the Commonwealth of Virginia. The coverage must have statutory limits and be with an insurer licensed to conduct business in the Commonwealth of Virginia. The insurer must have an A. M. Best rating of A- or better. As an alternative, it is acceptable for the contractor to be insured by a group self insurance association that is licensed by the Virginia Bureau of Insurance. The contractor will also carry employers liability insurance with a limit of at least $100,000 bodily injury by accident/$500,000 bodily injury by disease policy limit/$100,000 bodily injury by disease each employee.

3. The contractor/vendor will maintain automobile liability insurance with limits of at least $1,000,000. The coverage is to be written with a symbol "1". The insurer must be licensed to conduct business in the Commonwealth of Virginia. The insurer must have an A. M. Best rating of A- or better.

4. Indemification: The provider (Indemnitor), in consideration of the City of Harrisonburg, (Indemnitee) do hereby release and forever discharge Indemnitee from any and all claims, demands, actions, or causes of action, of any kind whatsoever which we might have, or could hereafter have on account of or in any way growing out of personal injuries and property damages which may result at any time. In addition, Indemnitor hereby covenants and agrees to, and does hereby, indemnify and save Indemnitee harmless from and against any and all claims for death, injury or property damage which may occur upon the aforesaid property, to any persons whomsoever or entities whatsoever while the property is in the possession of or being used by the Indemnitor.

IX. Modification & Withdrawal of Bids

A bidder may modify or withdraw his bid, either personally or by written request, at any time prior to the scheduled time for opening bids.

Except as provided in 2.2-4330 Code of Virginia, no bidder may withdraw his bid for a period of sixty calendar days after the date set for opening thereof, and bids shall be subject to acceptance by the Owner during this period.

X. Award of Contract

Award will be made to the lowest responsible and responsive bidder, meeting all of the specifications within this document. Award consideration will also include the project timeline offered by the contractor. Upon selection of a vendor, the City will post a "Notice of Award" on the City's website at www.harrisonburgva.gov/bid-proposal-award-notifications and also on eVA at www.eva.virginia.gov. Upon award of contract, bidder shall furnish a copy of the bidder's current W-9 form to the Purchasing Agent.

XI. Payment Terms

Payment terms allow the contractor to request payment for any equipment and/or material purchases made during the project and upon approval by the City. Payment for labor will be made at the end of the project**.**

City of Harrisonburg

Harrisonburg RRF JMU Boiler Feed Pump Replacement Project Code A/E -2011.13.WW

Issued For Construction

Project No. 212272.00

August 14, 2013

City of Harrisonburg

Harrisonburg RRF JMU Boiler Feed Pump
Replacement Project Code
A/E -2011.13.WW

Issued For Construction

Project No. 212272.00

August 14, 2013

Contact:
George G. Doby, PE
Project Manager
434.947.1625 .direct
434.947.1613 .fax
gdoby@wileywilson.com

Division	Section Title	Pages
DIVISION 02 - EXISTING CONDITIONS		
024119.....	SELECTIVE DEMOLITION	3
DIVISION 13 - SPECIAL CONSTRUCTION		
137000.....	BASIC INSTRUMENTATION AND CONTROL SYSTEMS REQUIREMENTS	2
137010.....	DATA SUBMITTALS	2
137020.....	INSTALLATION DRAWINGS	4
137030.....	INSTALLATION AND STARTUP	4
137090.....	SEQUENCE OF OPERATION	3
137420.....	ELECTRONIC PRESSURE INSTRUMENTATION	3
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230529.....	HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT	7
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SECTION 024119 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of mechanical and electrical systems.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
3. Review areas where existing construction is to remain and requires protection.

1.6 INFORMATIONAL SUBMITTALS

A. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted or interruptions are minimized.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Coordination of Owner's continuing occupancy of existing building.

1.7 FIELD CONDITIONS

A. Owner will occupy building. Conduct selective demolition so Owner's operations will not be disrupted.

B. Notify Owner of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

C. Storage or sale of removed items or materials on-site is not permitted.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Disconnect, demolish, and remove mechanical and electrical systems, equipment, and components indicated to be removed.

   a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap remaining piping with same or compatible piping material.
   b. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   c. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

3.2 SELECTIVE DEMOLITION, GENERAL

A. General: Demolish and remove existing mechanical and electrical only to the extent as indicated.

B. Existing Items to Remain: Protect construction to remain against damage during selective demolition.

C. Concrete slabs-on-Grade (Equipment Pad): Break-up and remove.

3.3 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be salvaged or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn demolished materials.

C. Disposal: Transport demolished materials off Owner's property and legally dispose of them.

3.4 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 024119

SECTION 137000 - BASIC INSTRUMENTATION AND CONTROL SYSTEMS REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 DESCRIPTION

A. The 137000 and 138000 series of specification sections provide a guide to the contractor for the purchase of equipment and are not intended to cover all the normal appurtenances. The contractor shall provide working systems complete with all appurtenances to make the systems fully operable.

1.3 REFERENCES

A. UL508A Outline of Investigation for Industrial Control Panels

1.4 RELATED WORK SPECIFIED ELSEWHERE INCLUDES THE FOLLOWING:

A. Section 260533 Raceway and Boxes for Electrical Systems

B. Section 260519 Low-Voltage Electrical Power Conductors and Cables

C. Section 260529 Hangers and Supports for Electrical Systems

D. Section 260523 Control-Voltage Electrical Power Cables

E. Section 260526 Grounding and Bonding for Electrical Systems

1.5 QUALITY ASSURANCE

A. Provide the services of a single controls and instrumentation (C and I) contractor to furnish, install, test, and place the system in operation. The C and I contractor shall have the full in house capabilities and personnel to design, fabricate, program, install, calibrate, start up, and troubleshoot all control and instrumentation equipment without subcontracting or otherwise involving any temporary or non staff personnel. However, the contractor may install conduit, associated pull boxes, and wire excluding wire terminations. Removal of I/O and programming from the existing Allen Bradley PLC 3 shall be performed by:

Valley Automation
11 Campbell Street, Suite 200
Luray, VA 22835
Attn: Patrick Embry, President
540.743.7772

B. New I/O and programming associated with the existing Emerson Process Management DELTA-V Digital Automation System:

Control Dynamics, a Division of RE Mason Company
201 Wylderose Drive
Midlothian, VA 23113
804.858.5800
Attn: Ryan Hedrick

1.6 VERIFICATION

A. Before installation, verify that controls are appropriate for the furnished equipment.

1.7 CHANGES

A. Make changes required due to different equipment, more up to date controls, or safety devices so that the equipment operates as required.

1.8 MODIFICATIONS

A. When equipment is supplied with requirements other than those specified or shown on drawings, associated modifications shall be provided.

1.9 CONTROL VOLTAGE

A. Control voltage shall not exceed 120 volts unless indicated otherwise on the drawings.

1.10 REQUIREMENTS

A. Material, equipment, and installation shall meet requirements of applicable codes and standards. Electrical material and equipment shall bear the UL label except where UL does not label such types of material and equipment. General use control panels in non hazardous areas shall meet the requirements of UL 508A.

1.11 MISCELLANEOUS REQUIREMENTS

A. The C&I contractor shall provide 8 hours of on-site programming time after the completion of station startup for the purpose of modification, refinement, and customization of the station program.

B. All software applications used by the C&I contractor to develop site specific programs and not already owned by Owner shall become the property of the Owner and shall be turned over to them at the end of the project.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION (not used)

END OF SECTION 137000

SECTION 137010 - DATA SUBMITTALS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUBMITTALS

A. Provide the following in a timely manner in accordance with the approved submittals schedule as specified in Division 01 General Requirements.

1. Manufacturer's Data - Within 30 days after award of contract, submit manufacturer's data in one coordinated package for approval by Wiley|Wilson.

    a. Submit data on each device to be installed. Data submitted shall be manufacturer's original catalog sheets. Xerox or similar copies will not be accepted.
    b. Arrange the submittals in the same sequence as these specifications and reference at the upper right hand corner the particular specification section and paragraph number for which each submittal is intended. Place tab sheets between the devices specified in different specification sections. Submittals for each manufactured item shall be manufacturer's descriptive literature (equipment specification), equipment drawings, diagrams, performance and characteristic curves, and catalog cuts and shall include the manufacturer's name, trade name, catalog model or number, nameplate data, size, layout dimensions, capacity, specification reference, and all other information necessary to establish contract compliance. Bind in loose leaf binder.

B. Operation and maintenance manual - 14 days prior to project closeout, submit five copies of the manual bound in loose leaf binders for review by Wiley|Wilson.

1. The manual's identification shall be inscribed on the cover.
2. The manuals shall include the names, addresses, and telephone numbers of each subcontractor installing equipment and systems and of the local representatives for each item of equipment and each system.
3. The manuals shall have a table of contents and be assembled to conform to the project manual table of contents with the tab sheets placed before instructions covering the subject. Additionally, each manual shall contain a comprehensive index of all manuals submitted in accordance with this paragraph.

4. Manuals and specifications shall be furnished which provide full and complete coverage of the following subjects:

   a. Operational Requirement: This document shall describe, in concise terms, all the functional and operational requirements for the system.
   b. Maintenance: Documentation of all user performed maintenance on all system components including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective units. This shall include calibration, maintenance, and repair of all sensors and controls, plus diagnosis and repair or replacement of all system hardware.

1.3 INSTALLATION DRAWINGS

A. Installation drawings shall be in accordance with Section 137020.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (not used)

END OF SECTION 137010

SECTION 137020 - INSTALLATION DRAWINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 REFERENCES

A. Instrument Society of America (ISA) Publications

1. S5.1 Instrumentation Symbols and Identification
2. S5.4 Instrument Loop Diagrams
3. S51.1 Standard Process Instrumentation Terminology

B. National Fire Protection Association (NFPA)

1. NFPA 79 Electrical Standard for Industrial Machinery

1.3 DESIGN CRITERIA

A. The contract documents include P&I diagrams but not detailed installation drawings of the system. Items such as ladder diagrams, cabinet layout, and tubing runs have been left for design by contractor.

B. Provide installation drawings to completely document the controls and instrumentation installation.

1.4 SUBMITTALS

A. Provide submittals in a timely manner in accordance with the approved submittals schedule as specified in Division 01 – General Requirements.

1. Review Drawings

1.5 DRAWING REQUIREMENTS

A. Drawings shall consist of the following:

1. Floor plans, elevations, and sections of equipment and control spaces identifying and indicating proposed location, layout and arrangement of items of equipment, control panels, accessories, piping, permanent nameplate identification, wiring, conduit and any other items that must be shown to assure a coordinated installation. Drawings shall indicate required clearance for operation, maintenance, and replacement of operating equipment devices.
2. Integrated pneumatic, electric, and electronic control diagrams similar to the P&I diagrams in the contract documents except detailed to show all variations required due to the actual equipment being supplied. Diagrams shall conform to ISA Standard S5.1. Identify each run of pneumatic control tubing with a unique number.
3. Electrical control wiring diagrams of the ladder type similar to those in the contract documents annotated to conform to NFPA 79, Annex D. The installation drawings shall contain ladder diagrams for each motor and the like showing equipment exactly as it shall be installed. Diagrams shall clearly indicate location of each device. Field wiring shall be shown dotted, panel wiring solid. Each wire shall have a unique identification number. If the systems house does not have an established system resulting in uniquely numbered wires, the following system shall be used. Each wire number shall consist of five digits. The first two digits shall be the last two digits of the drawing number on which the wire is shown or originates. The second two digits shall be the ladder rung number where the wire is shown or originates. The fifth digit shall be the number of the wire on a given rung numbered in a left to right sequence. Number each device terminal with manufacturer's terminal number.
4. Instrumentation loop diagrams showing interconnecting wiring and tubing between primary elements, transmitters, controllers, recorders, indicators, computational devices, decision devices, valves, and the like. Diagrams shall conform to ISA Standard S5.4. Installation drawings shall contain a loop diagram for each loop showing equipment exactly as it shall be installed. Field wiring shall be shown dotted, panel wiring solid. Number each device terminal with manufacturer's terminal number. Number wires using a system similar to that used for ladder diagrams.
5. Panel interior and exterior elevations and sections, conforming to NFPA 79, Annex D.
6. Programmable controller logic diagrams of the ladder type conforming to NFPA 79, Annex D. Further annotate logic diagrams by identifying input contacts with their P&ID tag numbers as well as their programmable controller input address number. Also identify outputs by the P&ID tag number of the final element controlled as well as their programmable controller output address number. In addition, provide a narrative of the logic in English language text format.

B. Preparation of Drawings

1. Drawings shall be prepared on a CAD (computer aided drafting) system. System disks shall become the property of the Owner at project closeout. A copy of the disks may be retained by the systems house.
2. All available information which will define the scope of the work shall be included on the drawings. A complete legend of abbreviations and symbols and equipment schedules shall also be included on the drawings. Drawings shall be final and complete, with all elements thoroughly checked and coordinated with each other and with the specifications.
3. Equipment tag numbers shall be the same as those indicated on the contract drawings.
4. Drawing Format: The drawing format, style, and lettering shall be the same as the contract drawings. Every effort shall be made to avoid unnecessary detail, poor spacing, careless lettering, weak lines, and crowded drawings.
5. Sizes of Drawings: The drawings shall be 30 by 42 inches. Loop diagrams and programmable controller logic diagrams shall be 8-1/2 by 11 inches or 11 by 17 inches as required.
6. Scales: Located directly under the title of each plan, elevation, section, detail, etc., shall be an indication of the scale of the object drawn. Include a graphic scale on drawings which may be subject to half-size reproduction.
7. Arrangement of Drawings: Drawings shall be arranged in the following order:

    a. Index
    b. Floor plans
    c. P&I diagrams
    d. Ladder diagrams
    e. Programmable, controller logic diagrams
    f. Loop diagrams
    g. Panel interior and exterior elevations and sections

8. Loop diagrams and programmable controller logic diagrams shall be separately bound in loose leaf binders. If a significant portion of the diagrams are 11 by 17 inches, use binders sized for 11 by 17 inch drawings.
9. Lettering: The minimum size lettering, which includes all alphanumeric symbols used on all project Drawings shall be not less than 0.10 inch.

C. Submittal Requirements:

1. Approval Review Submittal: Submit one set of original size drawings for review by Wiley|Wilson. Drawings shall be complete. Review does not constitute approval or acceptance of any variations from the contract documents unless such variations have been specifically pointed out in writing by the contractor and specifically approved in writing by Wiley|Wilson.
2. Certified for Construction Submittal: After the changes required as a result of the approval review have been made to the original drawings, submit to Wiley|Wilson one original size set of drawings marked "certified for construction."
3. As Built Submittal: Prior to project closeout, update drawings to reflect "as built" conditions. Mark drawings "as built." Submit to Wiley|Wilson. All drawings shall become the property of the Owner.

D. Work shall not be started until the "Certified for Construction" drawings have been issued by the contractor.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION (not used)

END OF SECTION 137020

SECTION 137030 - INSTALLATION AND STARTUP

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 GENERAL

A. Calibration instrumentation shall have been certified within 6 months of the date of use to have an accuracy of 50 percent greater than the device being calibrated. Certification sheets shall be available upon request.

PART 2 - PRODUCTS

2.1 BRASS TAGS SHALL HAVE THE FOLLOWING FEATURES

A. Minimum Gauge: 16

B. Minimum Dimensions: 0.75 inch by 1.5 inches

C. Stamped to form permanent letters minimum 0.10 inch high.

D. Hole to receive cable tie.

2.2 CABLE TIES SHALL HAVE THE FOLLOWING FEATURES

A. Steel strapping coated with nylon.

B. One way detent head.

C. Acceptable Manufacturer and Type: Thomas & Betts, Ty Wraps.

PART 3 - EXECUTION

3.1 INSTALLATION

A. All installation shall be made in accordance with the manufacturer's recommendations and with the control industry's standard accepted practices.

B. Coordination for Installation of Instrumentation and Controls:

1. Coordinate instrumentation and controls work with the mechanical equipment suppliers regarding recommendations for proper installation of devices in piping. Size and select all sensors and primary signaling devices, pressure sensors, and the like. Provide instructions for the proper installation of equipment. Size and select all final control elements such as valves, actuators and the like.
2. Where instrumentation or controls or both are called for on one drawing, but are not shown on another, they shall be provided. Where a device is specified but not shown on a drawing, it shall be provided.

C. Electrical and Electronic

1. Field devices, wiring, and conduit have not been shown in the contract documents in plan view. Device location shall be determined from the P&I diagrams and the mechanical and electrical drawings.
2. Field wiring requirements shall be determined from the installation drawings. Provide all required field wiring.
3. Shielded Cables: Identify each cable at each splice and termination using the wire numbers assigned on the installation drawings.

    a. The shield shall be grounded at a single location. That location shall be within the control cabinet unless the manufacturer recommends otherwise.
    b. The shield shall be made electrically continuous over the entire run of shielded cable.
    c. Unless otherwise noted on the drawings, splices shall be allowed only at termination points on equipment in the loop and at terminal strips inside control panels. Length of splice points and terminations where the shield is not physically around the conductors shall be kept as short as possible.
    d. At the cable ends where the shield is not connected, trim back the shield and cover with heat shrink insulation to prevent accidental grounding.
    e. The use of non-shielded conductors to carry an analog signal is not allowed.
    f. Analog shielded cable shall not be installed in conduit with power cable.

4. Nonshielded Wires: Identify each wire at each termination using the wire numbers assigned on the installation drawings. Wiring from each terminal at each field mounted device shall be run from the device back to its associated panel and all interconnecting splicing shall be done in the panel.

5. Unless otherwise noted:

   a. All control voltages shall be 120 V ac maximum.
   b. All control voltages for motor control circuits shall be 120 V ac maximum, derived from the motor power circuit using a control voltage transformer as necessary.

6. The use of control devices with non-isolated electrical connections (power or signal) shall be allowed only when all non-isolated connections are compatible and derived from the same power source. Devices include, but are not limited to analog and discrete PLC I/O cards, signal conditioning modules, computational modules (such as adder/subtractor), loop isolators, transmitters, controllers, and recorders.

D. Pneumatic

1. Field devices and control tubing have not been shown in the contract documents in plan view. Device location shall be determined from the P&I diagrams and the mechanical and electrical drawings.
2. Control tubing requirements shall be determined from the installation drawings. Install all required control tubing.
3. Control Tubing: identify control tubing at each termination using the numbers assigned on the installation drawings.

E. Support field devices which are not inherently self supporting using floor stands, pipe brackets, wall brackets, or other suitable devices of stainless steel, aluminum, or both. Do not support devices from vibrating equipment or equipment operating at temperatures outside the limits of the device.

F. All devices shall be readily accessible.

G. Painting: Touch up or repaint completely equipment on which factory paint has been damaged.

3.2 CALIBRATION

A. Calibration forms shall be used for each instrument to document calibration of the instrument.

B. Unless otherwise specified, all display indicators of analog signals shall be in engineering units.

C. Pressure Instruments

1. Calibrate pressure transmitters at 25, 50, 75, and 100 percent span.

D. Calibrate all other analog instruments including analytical instruments using the manufacturers' recommended procedures.

E. Control Valves

1. Inspect control valves to ascertain that they conform to the valve nameplate. Verify the following points prior to installation:

   a. Valve body and trim materials of construction
   b. Body size and type; trim size and type
   c. Valve connection size and type
   d. Valve action
   e. Travel direction indicator installed correctly

2. Stroke the valve its entire length. Adjust the actuator spring compression as required. Check valve to insure that it shuts off tight when the appropriate signal is applied to the actuator.

3.3 TESTS

A. Furnish calibrated testing equipment and competent, experienced testing engineers who shall conduct operating and performance tests for each system specified.

B. Test instruments shall be calibrated prior to tests.

C. Coordinate tests with requirements of other sections of the specifications.

D. Prior to conducting formal tests, operate systems and equipment for at least 7 days.

E. Conduct formal tests in presence of Owner's representative to demonstrate that all contract requirements are met. These tests shall include performance tests for all equipment and operating tests for systems.

1. Malfunction in any tested system or piece of equipment or component part thereof that occurs before, during, or as a result of tests shall be corrected, repaired, and/or replaced at no additional cost and the tests repeated in the presence of Owner's representative.
2. Further malfunctions shall be similarly repaired and test shall be repeated in the presence of Owner's representative.

3.4 BRASS TAGS

A. Install a brass tag on each field mounted device.

B. Stamping shall be device name on top line(s) followed by P&ID tag number on last line.

C. Attach brass tags to associated devices using cable ties.

END OF SECTION 137030

SECTION 137090 - SEQUENCE OF OPERATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 REFERENCES

A. Instrument Society of America (ISA) Publications

1. S5.1 Instrumentation Symbols and Identification
2. S51.1 Standard Process Instrumentation Terminology

1.3 SEQUENCES OF OPERATION

A. The following sequences of operation are provided to assist the contractor to familiarize himself. The P&I diagrams and sequence of operation shall be considered complementary. Items shown or described in one document but not in the others shall be provided. The sequences are not intended to be all inclusive. Some of the simpler, repetitive logic has not been included in the sequences.

1.4 CONTROL PLAN

A. Automatic control functions shall be accomplished by the feedwater pump variable frequency drive programmable logic controller (PLC), existing Emerson Process Management Delta-V Digital Automation System serving existing Boilers B-3 and B-4, and various discrete devices as specified elsewhere in the 137000 series of specifications.

B. Operator interface with the control system shall be accomplished by the existing Delta-V operators workstation located in the CISAT Chiller Building and RRF Control Room.

1.5 CONTROL TECHNIQUES

A. Upon power failure, control logic shall fail in a safe mode. Unless otherwise noted the control system shall not allow automatic restart of equipment after a power failure. Where automatic restart is allowed, logic shall be such that proper startup sequences are followed and all safeties are automatically checked.

B. Control logic, equipment, and interlocks shall be designed to fail safely, preserving both life and property. Life safety shall take precedence. All interlocks, safeties, and alarms shall be designed

such that failure of the sensor, wiring, relays, etc. Shall have the same effect as the alarm condition.

C. All interlocking shall be done by control wiring as indicated on the drawings and specifications.

D. Arrange circuitry involving hand/off/automatic (HOA) switches such that all safeties shall be functional when the switch is in the hand or automatic position.

E. Upon power failure and upon restoration of power, no erroneous alarms shall be initiated.

F. During equipment startup, during shutdown, and after equipment shutdown, no erroneous alarms shall be initiated.

G. Where condition of a final control element is required by the control system logic, it shall be supplied by actual hardware and not implied by output to the element. (the fact that a start signal has been sent to a motor starter does not mean the motor starts.)

H. Equipment shall be monitored for control availability. The control system shall not attempt to start equipment which is off or has faulted.

I. Unless otherwise noted, alarm function shall be as follows:

1. Alarms shall be annunciated at the existing operators workstation.
2. The control system shall store alarm occurrence, alarm acknowledgement, and alarm condition clear events in an alarm history file. The events shall be time and date stamped.
3. All alarm events stored in the alarm history file shall also be printed on the alarm printer. Print the events as they occur, with the time and date stamp.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION

3.1 BOILER FEEDWATER PUMPS AND FEEDWATER RECIRCULATING SYSTEM SEQUENCE OF OPERATION

A. General: The boiler feedwater recirculating system shall be controlled by the existing Delta-V Distributed Control System (DCS). The boiler feedwater pumps shall be monitored by the existing Delta-V Distributed Control System (DCS). Provide modifications to the existing boiler feedwater system programming and operators workstation as indicated below. Provide programming and screen graphics as listed below.

The boiler feedwater pump speed shall be controlled by the variable frequency drive (VFD) PLC.

All setpoints and alarm parameters shall be adjustable. All I/O shall be displayed at the existing operators workstation.

B. Feedwater Pump Controls: The feedwater pumps shall be manually started by the Boiler Plant Operator. Once the pump is started and ramped up locally at the VFD to the desired set point, the VFD will be placed in the Automatic Mode.

Once in the Automatic Mode, the VFD PLC shall modulate the feedwater pump VFD speed between minimum and maximum flowrate to maintain 275 psig header pressure. Coordinate minimum and maximum speed setting and flowrate with the testing and balancing contractor. Coordinate header pressure with Boiler Plant Operator.

C. The following conditions shall be monitored at the existing operators workstation when sequenced on:

1. Pump status (P-21 and P-22).

2. VFD status (P-21 and P-22).

Program VFD P-21 and P-22 to shut down the associated pump whenever no-flow (dry pump condition) is detected.

Feedwater pump(s) shall be denergized whenever the existing deaerator TK-2 level drops below its low level set point.

Pump P-21 and P-22 Additional Controls: The Delta-V DCS shall monitor the operating pump status via VFD status and current sensor. Should the operating pump fail, the Delta-V DCS shall send an alarm system to the operators work station.

D. Feedwater Recirculating Control:

The Delta-V DCS shall control feedwater recirculating flow control valve FCV-6 to maintain minimum pump flowrate as scheduled or recommended by the pump manufacturer.

Whenever the existing gas boilers B-3 or B-4 are sequenced on, the Delta-V DCS shall open FCV-6.

The Delta-V DCS shall modulate the FCV-6 closed based upon combined steam production of boilers B-3 and B-4. Provide linear control; 100 percent open to closed from 0-35,000 lbs/hr of combined steam flow production of boilers B-3 and B-4. Coordinate feedwater recirculating flow rates with the testing and balancing contractor.

END OF SECTION 137090

SECTION 137420 - ELECTRONIC PRESSURE INSTRUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 REFERENCES

A. Instrument Society of America (ISA) Publications

1. S5.1 Instrumentation Symbols and Identification
2. S5.4 Instrument Loop Diagrams
3. S51.1 Standard Process Instrumentation Terminology

B. National Electrical Manufacturers Association (NEMA) Publications

1. ICS 1 General Standards for Industrial Controls and Systems
2. ICS 2 Standards for Industrial Control Devices, Controllers, and Assemblies
3. ICS 6 Enclosures for Industrial Controls and Systems

1.3 PRESSURE INSTRUMENTATION LOOP

A. Pressure instrumentation loop shall be 4 20 mA. Loop loads shall be within the current source load capacity.

1.4 ENCLOSURES

A. Enclosures shall be as follows:

1. Nonhazardous Areas: Cast, NEMA 4X, corrosion resistant

1.5 SUBMITTALS

A. Provide submittals in a timely manner in accordance with the approved submittals schedule as specified in Division 1 – General Requirements.

1. Pressure Transmitter Data
2. Hart Interface Unit Data
3. Instrument and Gauge Valve Data

PART 2 - PRODUCTS

2.1 PRESSURE TRANSMITTERS

A. Pressure transmitters shall have the following features:

1. Gauge pressure transmitters shall be microprocessor based, 24 VDC 2-wire, digital devices:

   a. Accuracy: Plus or minus 0.1 percent of span at a turndown of up to 10 to 1 (includes linearity, hysteresis, and repeatability).
   b. Ambient Temperature Range: Minus 20 to 180 degrees F.
   c. Line Voltage Effect: Maximum output change of less than 0.005 percent of span per volt dc.
   d. Stability: 0.2 percent of upper range limit per 12 months.
   e. Elevated Zero and Suppressed Zero: Only limitation is the maximum span and the upper and lower range limits cannot be exceeded.
   f. Working Pressure: 200 percent of system pressure rating, minimum.
   g. Overrange Pressure: 1,000 percent of system pressure rating.
   h. Turndown: 10 to 1.
   i. Minimum Temperature Effect: Maximum change of plus or minus 1 percent of span per 100 degree F temperature change.
   j. All adjustments including zero and span shall be internal to the enclosure.
   k. Signal output: a hart based protocol digital signal and a 4-20 mA analog signal shall be output. It shall be possible to calibrate the transmitter using a handheld universal hart ambient interface unit either locally or remotely. Additionally it shall be possible to calibrate the transmitter using 4-20 mA analog calibration techniques.
   l. Output signal indicator shall be a four-digit liquid crystal display.
   m. Wetted Parts: 316 stainless steel.
   n. Sensor Fill Fluid: Silicone oil where applicable.
   o. Electronics Housing: NEMA 4X low copper cast aluminum with epoxy coating.
   p. Manifold: 2-valve, inline, 316 stainless steel.
   q. Manufacturer and Type

      1) ABB
      2) Endress & Hauser
      3) The Foxboro Company
      4) Rosemount

2.2 INSTRUMENT TUBING AND FITTINGS

A. Instrument tubing and fittings shall be rated for the pressure and temperature and have the features listed below:

1. Tubing shall be ASTM A269, seamless, Type 316 stainless steel and 0.049 inch minimum wall thickness.
2. Fittings shall be live-loaded, two-ferrule design, 316 stainless steel compression type manufactured by Swagelok.

PART 3 - EXECUTION

3.1 TRANSMITTERS INSTALLATION

A. Install instrument and gauge valves on all pressure transmitter sensing legs so that transmitter can be removed for servicing without shutting down or draining the system.

B. All pressure transmitters shall have the range selected so the operating span does not require an excessive turndown which would affect the accuracy of the transmitter.

C. The provided pressure transmitters, valves, and manifolds shall be suitable for the specific application including process fluid and ambient conditions.

END OF SECTION 137420

SECTION 137450 - ELECTRONIC MISCELLANEOUS DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 REFERENCES

A. Instrument Society of America (ISA) Publications

1. S5.1 Instrumentation Symbols and Identification
2. S5.4 Instrument Loop Diagrams
3. S51.1 Standard Process Instrumentation Terminology

B. National Electrical Manufacturers Association (NEMA) Publications

1. ICS 1 General Standards for Industrial Controls and Systems
2. ICS 2 Standards for Industrial Control Devices, Controllers, and Assemblies
3. ICS 6 Enclosures for Industrial Controls and Systems

1.3 ENCLOSURES

A. Enclosures shall be as follows:

1. Inside of Panels: NEMA 1, rack, nest, or modular individual mounting.

PART 2 - PRODUCTS

2.1 STATUS SENSORS

A. Status inputs for electric motors: UL Listed, current-sensing fixed-core transformers with self-powered transmitter, 600 VAC RMS Insulation Class, adjustable trip point, and suitable for 175 percent of rated motor current. Status open led and status close led. Veris Hawkeye HX08 series.

2.2 SPLITTER SIGNAL CONDITIONER

A. UL 508 Passive isolator splitter designed for (1) 4-20 mA Input and providing (2) 4-20 mA outputs, electrical isolation, input and output current loop fuel and no calibration necessary. 0.2 percent of measuring range final value accuracy, less than 20 ms step response time, and 300 v rated insulation voltage. Rockwell Automation Standard Signal Conditioner.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install status sensors inside existing motor control center.

B. Install splitter signal conditioners inside NEMA 12, UL 508A Listed Single door wall-mount enclosure with gasketed hinged door, quarter-turn slotted latch(es), 16 gauge door, minimum 18 gauge body and textured light-gray polyester powder paint inside and out.

END OF SECTION 137450

SECTION 137730 - PNEUMATICALLY OPERATED VALVES, INDUSTRIAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 REFERENCES

A. American National Standards Institute (ANSI)/Fluid Controls Institute (FCI) Publications

1. ANSI/FCI 70-2 Control Valve Seat Leakage

B. Instrument Society of America (ISA) Publications

1. S5.1 Instrumentation Symbols and Identification
2. S5.4 Instrument Loop Diagrams
3. S51.1 Standard Process Instrumentation Terminology

C. National Electrical Manufacturers Association (NEMA) Publications

1. ICS 6 Enclosures for Industrial Controls and Systems

1.3 SUBMITTALS

A. Provide the following in a timely manner in accordance with the approved submittals schedule as specified in Division 1 - General Requirements.

1. Control Valve Data
2. Valve Actuator Data
3. Positioner Data

B. ASME Compliance:

1. ASME B16.11 and ASME B16.34 for ferrous control valve dimensions and design criteria.

1.4 DELIVERY, STORAGE AND HANDLING

A. Prepare control valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store control valves indoors and maintain at higher than ambient dew point temperature.

PART 2 - PRODUCTS

2.1 CONTROL VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cashco, Inc.
2. Jamesbury; Metso Automation, Inc.
3. Fisher.

B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

C. Hydronic System, Two-way globe-style control Valves shall have the following characteristics:

1. Performance Characteristics:

a. Process Temperature Range: Minus 20 to plus 300 degrees F.
b. Shut off class: ANSI/FCI 70-2 Class IV.
c. Ports: 1.
d. Flow Characteristics: Equal percentage.
e. Flow Direction: Up through the seat ring.

2. Body:

a. Type: Globe sliding stem.
b. Material: WCC Steel.
c. Connections: Threaded.
d. ANSI Class: 600.

3. Disc:

a. Type: Plug.
b. Materials: S41600 416 Stainless steel hardened.

4. Shaft:

    a. Type: One piece, splined on outboard end.
    b. Materials: S31600 316 stainless steel.

5. Bushings: S17400 17-4 PH stainless steel.
6. Seat Ring: S41600 hardened.
7. Seat Ring Retainer: CB7 CU1 17-4 PH stainless steel.
8. Packing: Teflon/Kevlar or Teflon with no asbestos.
9. Other Metallic Wetted Parts: 302, 303, 316, or 17 4 stainless steel in accordance with manufacture's standard.
10. Actuator:

    a. Type: Spring diaphragm, floating stem pneumatic actuator.
    b. ActionL Increasing air extends stem.
    c. Fail Safe ActionL Field reversible.
    d. Bracket: Cast iron.

2.2 POSITIONERS

A. Positioners shall have the following features:

1. Type: HART communicating instrument that converts a two-wire 4-20 MA control signal into a pneumatic output to an actuator.

2. Operation shall directly compare the valve stem position with controller dc output signal to provide improved dynamic response and positioning accuracy by offsetting inaccuracies introduced by spring forces and forces due to flow through the valve body. Provide linkage-less non-contact position feedback and valve diagnostics.

3. Construction:

    a. Housing: Die cast aluminum, NEMA 4X rating.
    b. Finish: Anodized or chromated surface with baked enamel overcoat.

4. Performance:

    a. Open Loop Gain: Approximately 100.
    b. Load Sensitivity: Output pressure change of 1.2 psi per 0.1 percent of full stroke offset.
    c. Supply Pressure Influence: Plus or minus 1 percent of full stroke for a plus or minus 5 percent change from 20 psi.
    d. Maximum Supply Pressure: 145 psi.
    e. Ambient Temperature Range: Minus 40 to plus 180 degrees F.
    f. Conformity: Plus or minus 2 percent of span.

5. Accessories:

   a. Supply and output pressure gauges.
   b. Integral mounted instrument air filter and regulator.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine control valve for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials.

B. Operate control valves in positions from fully open to fully closed.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Do not attempt to repair defective control valves; replace with new control valves.

3.2 VALVE INSTALLATION

A. Install control valves with unions or flanges to allow service, maintenance, and removal without system shutdown.

B. Locate control valves for easy access and provide separate support where necessary.

END OF SECTION 137730

SECTION 137800 – INSTRUMENT AIR PIPING AND FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 REFERENCES

A. American National Standards Institute (ANSI) Publication

1. ANSI B16.22 Wrought Copper and Bronze Solder Joint Pressure Fittings

B. American Society for Testing and Materials (ASTM) Publications

1. B 88 Seamless Copper Water Tube

C. Instrument Society of America (ISA) Publications

1. S5.1 Instrumentation Symbols and Identification
2. S5.4 Instrument Loop Diagrams
3. S51.1 Standard Process Instrumentation Terminology

PART 2 - PRODUCTS

2.1 TUBING

A. Tubing shall be one of the following type:

1. Copper tube Type L meeting requirements of ASTM B 88

B. Tubing fittings shall be one of the following type:

1. Copper tubing fittings shall be copper solder joint fittings meeting the requirements of ANSI B16.22, except at connections to apparatus, where brass compression type fittings shall be used.

C. Tubing support system shall have the following features:

1. Channel and Angle Material: Aluminum, natural finish.
2. Channel and Angle Material: T 304 stainless steel.
3. Nuts and Bolts: Stainless, 18 8.
4. Yoke Clamps, Spacers, Bundle Clamps: Stainless steel or plastic.
5. Manufacturer and Type: James C. White Company, Tube Track.

2.2 SHUTOFF VALVES

A. Shutoff valves shall have the following features:

1. Three-piece, ball type, full part, female pipe thread end connections, 600 psi CWP.
2. Body: Brass or bronze.
3. Ball: 316 stainless steel.
4. Seats: Reinforced PTFE.
5. Stem packing: Reinforced PTFE.
6. Manufacturer and Type:

   a. Apollo 82-140 series or equal.

PART 3 - EXECUTION

3.1 TUBING INSTALLATION

A. Field tubing tie-in has been shown in the contract documents in plan view. Field tubing requirements shall be determined from the P&I diagrams. Install all required field tubing.

B. Run tubing parallel to or at right angles to the building structure.

C. Run tubing exposed.

3.2 TUBING FORMING AND CONNECTING

A. Copper Tubing:

1. Bending: Make changes in direction in copper tubing using tool made field bends or factory fabricated elbows.
2. Soldering: Make joints by soldering using factory solder fittings with proper clearances between surfaces. Immediately before soldering, thoroughly clean and burnish the joints with a crocus cloth or fitting brush especially made for this purpose. Apply a suitable flux over the cleaned surface and apply heat with an air acetylene or oxy acetylene torch. For copper piping, use 95 percent tin, 5 percent antimony solder. Acid core solder or acid flux shall not be used. Remove residue from flux. Disassemble joints that leak; clean, and make again.

3.3 INSTALLATION

A. Install shutoff valves at connection point to existing instrument air piping and on all pneumatic actuators to allow servicing and/or removal of the actuator without shutting down the process.

END OF SECTION 137800

SECTION 230519 - GAUGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Dial-type pressure gauges.
2. Gauge attachments

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of gauge, from manufacturer.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

A. Panel-Mounted, Hinged Ring, Dial-Type Pressure Gauges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Ashcroft Inc.
   b. Trerice, H. O. Co.
   c. Weiss Instruments, Inc.
   d. WIKA.

2. Standard: ASME B40.100.
3. Case: Black-painted aluminum or high impact polypropylene with 3 threaded mounting bolts, solid-front, blowout back safety case, 304 stainless steel blow out proof back plate; 6-inch nominal diameter.
4. Hinged Ring: Black-painted steel with knurled clamping screw.
5. Pressure-Element Assembly: All-welded Type 316 stainless steel tube.

6. Pressure Connection: Type 316 stainless steel, with NPS 1/4, ASME B1.20.1 pipe threads and lower back-outlet type.
7. Movement: Mechanical, with stainless steel link to pressure element and connection to pointer.
8. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
9. Pointer: Dark-colored metal.
10. Window: Shatterproof glass.
11. Accuracy: Grade 2A, plus or minus 0.5 percent of middle half of scale range.
12. Pressure Range: 1.5 times operating pressure.

2.2 GAUGE ATTACHMENTS

A. Snubbers: Adjustable type with an adjustable needle valve that enables the operator to restrict. 1/4 NPT stainless steel body, FPM Viton O-ring and stainless steel needle. 5,000 psi pressure and 248 degree F temperature rating.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panel-mounted pressure gauges in remote panel. Coordinate mounting height with owner.

B. Install gabe valve, snubbers, and bleed needle valve for each pressure gauge for fluids.

C. Install pressure gauges in the following locations:

1. Suction and discharge of each pump.

3.2 CONNECTIONS

A. Install gauges adjacent to equipment to allow service and maintenance of gauges.

END OF SECTION 230519

SECTION 230523 - GENERAL-DUTY VALVES (MANUAL)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Forged steel swing check valves.
2. Forged steel globe valves.
3. Forged steel gate valves.
4. Cast steel gate valves.
5. Pump discharge check valves.

1.3 DEFINITIONS

A. OS&Y: Outside screw and yoke.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads and flange faces.

3. Set gate and globe valves closed to prevent rattling.
4. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Handwheel: For valves other than quarter-turn types.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1.
2. Threaded: With threads according to ASME B1.20.1.

2.2 FORGED STEEL SWING CHECK VALVES

A. Class 800, Forged Steel Swing Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :

a. Powell Valves
b. Velan
c. Vogt

2. Description:

a. Body Design: Horizontal flow with bolted cap and spiral wound stainless steel and graphite gasket.
b. Body Material: ASTM A105, WCB Carbon steel.
c. Ends: Threaded.
d. Disc and Seat Surface: WCB stellite 6 and 13 CR (410) stem.
e. Size Range: NPS 2-inch and smaller.
f. Basis of Design: Velan Fig. S__-2114B-02TS.

2.3 FORGED STEEL GLOBE VALVES

A. Class 800, Forged Steel Globe Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Powell Valves.
b. Vogt.
c. Velan.

2. Description:

a. Body Design: Horizontal flow with bolted bonnet and spiral wound stainless steel and graphite gasket.
b. Body Material: ASTM A105, WCB Carbon steel.
c. Ends: Threaded.
d. Stem: Grade 410 Stainless Steel.
e. Disc and Seat Surface: Stellite 6 faced A105 tapered disc and WCB stellite 6 hard faced seat.
f. Pocking: Graphite
g. Handwheel: Malleable Inn
h. Size Range: 2 inch and smaller.
i. Basis of Design: Velan Fig. S__-2074B-02TS.

2.4 FORGED STEEL GATE VALVES

A. Class 800, OS&Y Forged Steel Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Powell Valves.
b. Vogt.
c. Velan.

2. Description:

a. Port: Full.
b. Body Material: ASTM A105, WCB Carbon steel with bolted bonnet and spiral wound stainless steel and graphite gasket.
c. Ends: Threaded.
d. Stem: Grade 410 stainless steel.
e. Disc and Seat Surface: Solid wedge; WCB stellite 6, hard faced seat and fully guided wedge.
f. Packing: Graphite.
g. Handwheel: Malleable iron.
h. Size Range: NPS 2 inch and smaller.
i. Basis of Design: Velan Fig. S__-2064B-02TS.

2.5 CAST STEEL GATE VALVES

A. Class 150 and 300, OS&Y, Cast Steel Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :

a. Crane Co.; Crane Valve Group; Crane Valves.
b. Powell Valves.
c. Velan.

2. Description:

a. Port: Full.
b. Body Material: ASTM A 216, WCB Carbon steel with bolted bonnet and spiral wound stainless steel and graphite gasket.
c. Ends: Flanged.
d. Stem: Grade 410 stainless steel.
e. Seat Surface: WCB Stellite 6.
f. Disc: Flexible wedge, WCB stellite 6, hard faced seat.
g. Packing: Graphite.
h. Handwheel: Malleable iron or steel.
i. Size Range: 2 1/2 inch through 36 inch.
j. Basis of Design: Velan Fig. F__-_064C-02TS.

2.6 PUMP DISCHARGE CHECK VALVES

A. Class 300, Steel, Globe, Center-Guided Check Valves with Metal Seat:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. DFT Inc.
b. Keckley Company.
c. Mueller Steam Specialty; a division of SPX Corporation.

2. Description:

a. NPS 2-1/2 to NPS 12, Class 300.
b. Body Material: ASTM A216 Gr. WCB Carbon Steel.
c. Style: Globe, spring loaded, center-guided, dual-guide stan.
d. Ends: RF Flanged.
e. Disc and Trim: ASTM A351, CF8M Stainless Steel.
f. Spring: ASTM A313, 316 Stainless Steel.
g. Gasket: CFG corrugated flexible graphite.
h. Seal Leakage: MSS-SP61.
i. Basis of Design: DFT Inc. GLC Silent Check Valve.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

B. Locate valves for easy access and provide separate support where necessary.

C. Install valves in horizontal piping with stem at or above center of pipe.

D. Install valves in position to allow full stem movement.

E. Install check valves for proper direction of flow and as follows:

1. Lift Check Valves: Vertical with stem upright and plumb.

2. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:

1. Shutoff Service: Gate valves.
2. Pump-Discharge: Check valves.

a. NPS 2-1/2 and larger: Center-guided, metal-seat check valves.

B. If valves with specified classes are not available, the same types of valves with higher pressure classes ratings may be substituted.

C. Select valves with the following end connections:

1. For Steel Piping, NPS 2 and Smaller: Threaded ends.
2. For Steel Piping, NPS 2 1/2 and Larger: Flanged ends.

3.5 BOILER FEEDWATER SUCTION (BFS) VALVE SCHEDULE **CLASS 125 OR 250 CAST IRON OR BRONZE VALVES ARE NOT PERMITTED.**

A. Pipe NPS 2 and Smaller:

1. Forged Steel Gate Valves: Class 800, OS&Y.

B. Pipe Sizes NPS 2-1/2 and Larger:

1. Cast Steel Gate Valves: Class 150, OS&Y.

3.6 BOILER FEEDWATER DISCHARGE (BFD) VALVE SCHEDULE **CLASS 125 OR 250 CAST IRON OR BRONZE VALVES ARE NOT PERMITTED.**

A. Pipe NPS 2 and Smaller:

1. Forge Steel Swing Check Valves: Class 800.
2. Forged Steel Gate Valves: Class 800, OS&Y.
3. Forged Steel Globe Valves: Class 800, OS&Y.

B. Pipe NPS 2-1/2 and Larger:

1. Center Guided Check Valves: Class 300.
2. Cast Steel Gate Valves: Class 300, OS&Y.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports.
2. Metal framing systems.
3. Thermal-hanger shield inserts.
4. Fastener systems.
5. Equipment supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated-steel.

2.2 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Metallic Coating: Hot-dipped galvanized-Post Fabrication.

2.3 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
2. National Pipe Hanger Corporation.

3. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
4. Rilco Manufacturing Co., Inc.

B. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig minimum compressive strength.

C. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

D. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type, stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

C. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete according to manufacturer's written instructions.

D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

E. Equipment Support Installation: Fabricate from welded-structural-steel shapes or metal framing systems.

F. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion loops, expansion bends, and similar units.

G. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping.

H. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.1 power piping code and ASME B31.9 for building services piping.

J. Insulated Piping:

1. Attach clamps and spacers to piping.

   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Do not exceed pipe stress limits allowed by ASME B31.1 power piping code and ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.

   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3. Shield Dimensions for Pipe: Not less than the following:

   a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.

4. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for pipe and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.3 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.5 HANGER AND SUPPORT SCHEDULE

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports and attachments for general service applications.

F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 degrees F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
6. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
7. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
8. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

J. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 degrees F piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 degrees F piping installations.

K. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
2. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
3. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
4. C-Clamps (MSS Type 23): For structural shapes.
5. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
6. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
7. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
8. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
9. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

10. Side-Beam Brackets (MSS Type 34): For sides of steel beams.
11. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

L. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

M. Comply with MFMA-103 for metal framing system selections and applications.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION 230529

SECTION 230553 - IDENTIFICATION FOR PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.

1.3 COORDINATION

A. Coordinate installation of identifying devices with completion of insulation of surfaces where devices are to be applied.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch minimum thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 degrees F.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number.

2.2 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches high.

2.3 VALVE TAGS

A. Valve Tags: Engraved with 1/2-inch numbers.

1. Tag Material: Multilayer, multicolor, plastic tags for mechanical engraving, 1/8 inch minimum thickness, and having predrilled hole for attachment hardware.
2. Fasteners: Brass wire-link or beaded chain; or S-hook.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection.
3. Near major equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 25 feet.

B. Pipe Label Color Schedule:

1. Boiler Feedwater:

a. Background Color: Yellow.
b. Letter Color: Black.

3.4 VALVE-TAG INSTALLATION

A. Install tags on new controls valves and control devices in piping systems as indicated on the Piping & Instrumentation (P&ID) diagrams.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape: Minimum 2 inches round or square.

2. Valve-Tag Color: Black.

3. Letter Color: White.

END OF SECTION 230553

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Balancing Hydronic Piping Systems:

a. Variable-flow hydronic systems.

2. Verifying feedwater recirculating bypass flow rate versus steam flow rate to in order to maintain pump flow rate.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Certified TAB reports.

C. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.

B. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

C. TAB Report Forms: Use standard TAB contractor's forms.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

E. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on steam condensate distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine the approved submittals for HVAC systems and equipment.

C. Examine equipment performance data including pump curves.

D. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

E. Examine test reports specified in individual system and equipment Sections.

F. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

G. Examine system pumps to ensure absence of entrained air in the suction piping.

H. Examine operating safety interlocks and controls on equipment.

I. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:

1. Permanent electrical-power wiring is complete.
2. Hydronic systems are filled, clean, and free of air.
3. Automatic temperature-control systems are operational.
4. Isolating valves are open and control valves are operational.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" or SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

B. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

A. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

1. Open all manual valves for maximum flow.
2. Check pump-motor load. If motor is overloaded, adjust variable frequency drives so motor nameplate rating is not exceeded.
3. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.5 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures:

1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

    a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Owner and comply with requirements in Division 23 Section "Hydronic Pumps."

2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump variable frequency drive until indicated water flow is achieved.

    a. Monitor motor performance during procedures and do not operate motors in overload conditions.

3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
4. Report flow rates that are not within plus or minus 10 percent of design.

3.6 PROCEDURES FOR VERIFYING MINIMUM PUMP FLOW AND FEEDWATER RECIRCULATING BYPASS FLOW RATE

A. Coordinate minimum pump flow and feedwater recirculating bypass flow rate verification with controls contractor and owner. Use the following procedures:

1. Provide portable clamp-on ultrasonic flow meter with an accuracy of plus or minus 0.5 percent on the feedwater recirculating pipe.

   a. With the feedwater bypass flow control valve 100 percent open and Boilers 3 and 4 level control valves closed, adjust each feedwater pump variable-frequency controller minimum setting to the minimum pump flow rate as specified or recommended by pump manufacturer.

   b. With one feedwater pump and at least one boiler operating, verify feedwater recirculating bypass flow versus steam flow per the sequence of operation. Adjust flow control valve output signal if required to maintain minimum pump flow rate.

B. Submit report of flow rates and test procedures.

3.7 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Variable-frequency controllers thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.8 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:

1. Pump curves.
2. Field test reports prepared by system and equipment installers.
3. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:

1. Title page.
2. Name and address of the TAB contractor.
3. Project name.
4. Project location.
5. Engineer's name and address.
6. Contractor's name and address.
7. Report date.
8. Signature of TAB supervisor who certifies the report.
9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
10. Summary of contents including the following:

    a. Indicated versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

11. Nomenclature sheets for each item of equipment.
12. Notes to explain why certain final data in the body of reports vary from indicated values.
13. Test conditions for pump performance forms.

D. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

    a. Unit identification.
    b. Location.
    c. Service.
    d. Make and size.
    e. Model number and serial number.
    f. Water flow rate in GPM.
    g. Water pressure differential in feet of head or psig.
    h. Required net positive suction head in feet of head or psig.
    i. Pump rpm.
    j. Impeller diameter in inches.
    k. Motor make and frame size.
    l. Motor horsepower and rpm.
    m. Voltage at each connection.
    n. Amperage for each phase.
    o. Full-load amperage and service factor.
    p. Seal type.

2. Test Data (Indicated and Actual Values):

   a. Static head in feet of head or psig.
   b. Pump shutoff pressure in feet of head or psig.
   c. Actual impeller size in inches.
   d. Full-open flow rate in GPM.
   e. Full-open pressure in feet of head or psig.
   f. Final discharge pressure in feet of head or psig.
   g. Final total pressure in feet of head or psig.
   h. Final water flow rate in GPM.
   i. Voltage at each connection.
   j. Amperage for each phase.

E. Instrument Calibration Reports:

1. Report Data:

   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

END OF SECTION 230593

SECTION 230719 - PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following piping systems:

1. Boiler Feedwater piping, indoors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," and “Outdoor Piping Insulation Schedule” article for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Johns Manville; Micro-Lok.
   b. Knauf Insulation; 1000-Degree Pipe Insulation.
   c. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 degrees F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
3. Type II, 1200 degrees F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

E. Removable Insulation Blankets:

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Advance Thermal Corp.
   b. Coverflex.
   c. Insultech.
   d. Thermaxx.

2. Blanket construction shall be a double sewn lock stitch with a minimum of 7 stitches per inch. All raw jacket edges shall have a tri-fold silicone cloth binding. No raw cut jacket edge shall be exposed. Stitching shall be done with teflon coated fiberglass thread. The inner and outer jacket shall be 17.0 oz/sq yd silicone impregnated fiberglass cloth. The insulation shall be fiberglass needled mat fiber, 2-inch thickness, 11 lb/ft^3 density and suitable for 450 degrees F continuous operation temperature.
3. Blanket shall overlap mating flanges as well as insulation with a minimum of 2-inch overlap. Where blanket cannot overlap oversized insulation, blanket shall butt up to insulation with a friction closing seam. Open gaps are not acceptable. Blanket diameters which are 2 inches larger than insulation must be capped to eliminate open air void.
4. To accommodate a leak and detect its origin, blanks shall have a low point stainless steel drain grommet or the design shall incorporate a mating seam at the low point.
5. To enhance blanket quality and to maintain uniform thickness, stainless steel tufts or pins shall be placed at random locations no greater than 18 inches apart. This shall prevent shifting of the insulation. Stainless steel speed washers shall secure the quilting pin stem in place.
6. Blanket design shall conform to the equipment with minimized air void. All covers shall be a two-piece design.
7. A 20-gauge stainless steel wire shall be doubled up and twisted in a spiral fashion with a minimum of 5 twists per inch. Wire twist length shall be 16 inches or longer. The wire twist shall be secured to the lacing pin at the pin stem. Lacing pin stems shall be 14 gauge. Wire twists shall be spaced 6 inches o.c. along closing seams with matching lacing pins to secure to.
8. For easy identification and location, a stainless steel or aluminum name plate tag shall be riveted to each blanket piece. The lettering shall show location, description, and size.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 G/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
   b. Eagle Bridges - Marathon Industries; 550.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
   d. Mon-Eco Industries, Inc.; 55-50.
   e. Vimasco Corporation; WC-1/WC-5.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 degrees F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
   b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
   c. Vimasco Corporation; 713 and 714.

2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
3. Service Temperature Range: 0 to plus 180 degrees F.
4. Color: White.

2.6

Sealants are categorized into "joint sealants" and "flashing sealants." Joint sealants are primarily used for vapor sealing longitudinal seams and butt joints of insulation materials. Flashing sealants are primarily used for sealing jacket and mastic materials. Materials in first paragraph below are for sealing metal jacket seams and joints.

B. ASJ Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following :

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 degrees F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

1. Products: Subject to compliance with requirements, provide the following :

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas Number 10.

2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide the following:

   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.9 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide the following:

   a. ITW Insulation Systems; Gerrard Strapping and Seals.
   b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.

B. Install insulation materials, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above-ambient services, do not install insulation to the following:

1. Testing agency labels and stamps.
2. Nameplates and data plates.

3.4 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Control Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, strainers, and other specialties with continuous thermal integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate control valves, valves, flanges and unions using removable insulation blankets.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement.
6. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

C. Install removable insulation blankets at control valves, valves, flanges and unions. Installation shall conform to the following:

1. Extend removable blanket insulation at least 2 inches over adjacent pipe insulation on each side of control valve, valve, flange and union.

3.5 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.

B. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with aluminum bands 12 inches o.c. and at end joints.

3.6 FINISHES

A. Pipe Insulation with ASJ Jacket Material: Paint jacket with paint system identified.

1. Flat Acrylic Finish: Two finish coat over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Color: Match existing as indicated below:

1. Boiler Feedwater Piping in Chiller Building: Light Blue

3.7 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

3.8 INDOOR PIPING INSULATION SCHEDULE

A. Boiler Feedwater Recirculating, 250 degrees F:

1. NPS 2 and Smaller: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.

B. Boiler Feedwater Suction and Discharge, 250 degrees F:

1. NPS 1-1/2 and Smaller: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I or II: 1-1/2 inches thick.

2. NPS 2 and Larger: Insulation shall be the following:

a. Mineral-Fiber, Preformed Pipe, Type I or II: 2 inches thick.

END OF SECTION 230719

SECTION 232123 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Separately coupled, base-mounted, split-case, multi-storage centrifugal pumps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.

B. Shop Drawings: For each pump.

1. Show pump layout and connections.
2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 DELIVERY, STORAGE AND HANDLING

A. Manufacturer’s Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat wit anticorrosion compound after assembly and testing. Protect flanges, pipe openings and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearing and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

A. Coordinate size and locations of concrete bases. Cast anchor-bolt inserts into bases.

PART 2 - PRODUCTS

2.1 SEPARATELY COUPLED, BASE-MOUNTED, SPLIT-CASE, MULTI-STAGE CENTRIFUGAL PUMPS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aurora Pump; Division of Pentair Pump Group.
2. Flowserve Corporation.
3. Goulds Pumps.

B. Description: Factory-assembled and -tested, centrifugal, impeller-between-bearings, separately coupled, horizontal or diagonal split case, two stage centrifugal pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 450-psig minimum working pressure and a continuous water temperature of 300 degrees F.

C. Pump Construction:

1. Casing: Horizontally or diagonal split, ASTM A48 cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and ASME B16.1, Class 250 flanges. Casing supports shall allow removal and replacement of impeller without disconnecting piping.

a. Casing shall be subject to a hydrostatic pressure test at 150 percent of the specified duty point. Bearing housing supports, suction and discharge flanges shall be integrally cast with the lower half of the casing. The upper casing shall be dowel aligned to the lower casing. Both halves of the casing shall be self-venting to prevent vapor lock. Drain openings shall be provided in the bearing arms for removal of lubricating liquid.

2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, and keyed to shaft and screw locked shaft sleeves. Enclosed, opposed suction type. Stainless steel impeller key.

3. Pump Shaft: AISI C1045 steel protected from wear by bronze shaft sleeves. The sleeve shall be key-locked and threaded so that the sleeves tighten with rotation of the shaft. EPR O-rings shall be provided between the impeller hub and the shift sleeves to prevent pumped liquid from corroding the shaft.
4. Case Wearing Rings: Easily renewable bronze designed that hydraulic pressure will seat them against a shoulder in the pump case around the full periphery of the wearing ring. The wear rings shall be locked in place by doweling to percent rotation. The rotating element shall be mounted in heavy-duty grease lubricated ball bearings and equipped with bronze water slingers for packed pumps on side next to pump glands.
5. Seal: Packing seal consisting of stuffing box placed on both sides of the pump centerline to seal the pump shaft. Provide a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland. Provide flush arrangement with piping and needle valves to ensure packing lubrication and heat dissipation.
6. Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings with average life of 250,000 hours and shall be mounted in machined, moisture and dust proof housings. Bearing housings shall be designed to flush lubricant through and provide continuous cleaning of bearing surfaces and maximum protections against overheating. The housings shall have register fits and then be bolted to the pump casing to ensure permanent alignment. Provide duplex back to back ball bearings.

D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. EPDM coupling sleeve for variable-speed applications.

E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.

F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.

G. Motor: Single speed, inventer duty suitable for variable frequency drive, secured to mounting frame, with adjustable alignment.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements.

    a. Enclosure: Totally enclosed, fan cooled.
    b. Enclosure Materials: Cast iron.
    c. Motor Bearings: Grease lubricated ball bearings.
    d. Efficiency: Premium efficient, as defined in NEMA MGI Part 31.
    e. Description: NEMA MG1, Design B, medium induction motor.
    f. Service Factor: 1.15 at 40 degrees C.
    g. Insulations: Class H with Class F temperature rise.
    h. Thermal protections: Comply with NEMA MG1 requirements for thermally protected motors.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

C. Examine foundations bases for suitable conditions where pumps are to be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Equipment Mounting:

1. Install base-mounted pumps on existing concrete equipment bases.

3.3 ALIGNMENT

A. Engage a factory-authorized service representative to perform alignment service.

B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.

C. Comply with pump and coupling manufacturers' written instructions.

D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 232113 “Hydronic Piping.” Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to pump, allow space for service and maintenance.

C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

E. Install check valve and shut off valve on discharge side of pumps.

F. Install Y-type strainer and shutoff valve on suction side of pumps.

G. Install pressure gages on pump suction and discharge.

H. Install bearing flush and pump warm-up tubing and needle valves.

I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Perform the following startup checks for each pump before starting:

    a. Verify bearing lubrication.
    b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

SECTION 232213 – HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following for boiler feedwater piping:

1. Pipe and fittings.
2. Strainers.

1.3 DEFINITIONS

A. HP Systems: High-pressure piping operating at more than 15 psig as required by ASME B31.1.

B. LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9.

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:

1. HP Boiler Feedwater Discharge (BFD) Piping: 300 psig at 250 degree F.
2. LP Boiler Feedwater Suction (BFS) Piping: 15 psig at 250 degree F.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following:

1. Strainers.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Field quality-control test reports.

1.7 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For safety valves, pressure-reducing valves and steam traps to include in emergency, operation, and maintenance manuals.

1.8 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."

B. Pipe Welding: Qualify processes and operators according to the following:

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. ASME Compliance: Comply with ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping" for materials, products, and installation.

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 106/A106M, seamless, Grade B, black steel, plain ends, Schedule as indicated in Part 3 piping applications articles.

B. Forged Steel Socket Welded Unions: ASME B16.11 and ASTM A105 3,000 pound.

C. Forged Steel Socket Welded Fittings: ASME B16.11 and ASTM A105 3,000 pound.

D. Wrought-Steel Fittings: ASME B16.9 and ASTM A 234/A 234M, seamless, Grade B, wall thickness to match adjoining pipe.

E. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.
2. End Connections: Butt welding.
3. Facings: Raised face.
4. Type: Welding Neck.

F. Steel Pipe Nipples: ASTM A 733, made of ASTM A 106/A106M, black steel of same Type, Grade, and Schedule as pipe in which installed, except that nipples having an unthreaded section of 1 inch or less shall be Schedule 80. The use of running thread nipples will not be allowed.

2.2 STAINLESS STEEL TUBING, FITTINGS AND NEEDLE VALVES

A. Stainless Steel Tubing: ASTM A213 and A269, seamless, 316 stainless steel, 0.049-inch wall thickness and plain ends. Acceptable manufacturer: Swagelok.

B. Stainless Steel Fittings: ASTM A276 and A182 with threaded end type connections per ASTM B1.20.1. Live-loaded two-ferrule mechanical grip design and 316 stainless steel construction. 2,000 psig/200 degrees F minimum pressure/temperature rating. Acceptable Manufacturer: Swagelok.

C. Needle Valves: Union-bonnet, live-loaded packing system, 316 stainless steel construction, PTFE packing rated for 450 degrees F, regulating stem, anodized block aluminum bar handle and tube fitting ends. Acceptable Manufacturer: Swagelok N series.

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. Spiral wound, carbon steel guide ring material, 304 stainless steel metallic windings, flexible graphite filler material rated for 950 degrees F. Provide materials, pipe size, and pressure class identification on gasket.

B. Flange Bolts and Nuts: ASTM A193/A193M, Grade B7 bolts with ASTM A 194/A194M, Grade 2H nuts. **ZINC PLATED OR GALVANIZED STEEL BOLTS AND NUTS ARE NOT PERMITTED.**

C. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

2.4 VALVES

A. Gate, Globe and Check Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves (Manual)."

2.5 STRAINERS

A. Y Pattern Strainers:

1. Body: ASTM A 216 Gr. WCB Carbon Steel, with threaded plug and spiral wound graphite filled gasket NPS 2 and smaller and bolted cover and 316SS graphite gasket NPS 2-1/2 and larger and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 and smaller; Class 150 flanged ends for strainers NPS 2-1/2 and larger serving boiler feedwater suction piping.

B. Strainers:

1. Strainer Screen: ASTM A240 304 Stainless-steel, 20 mesh strainer.
2. Tapped blowoff with gate valve, same size as tapping.

PART 3 - EXECUTION

3.1 LP BOILER FEEDWATER SUCTION (BFS) PIPING APPLICATIONS

A. Boiler Feedwater Suction (BFS) piping, NPS 2 and smaller, shall be the following:

1. Schedule 40, Type S, Grade B, steel pipe; 3,000 lb forged steel socket welded fittings.

B. Boiler Feedwater Suction (BFS) piping, NPS 2-1/2 and larger, shall be the following:

1. Schedule 40, Type S, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

3.2 HP BOILER FEEDWATER DISCHARGE (BFD) PIPING APPLICATIONS

A. Boiler Feedwater Discharge (BFD) Piping, NPS 2 and Smaller:

1 Schedule 40, Type S, Grade B, steel pipe; 3,000 lb forged steel socket welded fittings.

B. Boiler Feedwater Discharge (BFD) Piping, NPS 2-1/2 and larger:

1. Schedule 40, Type S, Grade B, steel pipe; Class 300 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

C. Feedwater Pump Bearing Flushing & Warm-up Piping Applications

1. Type 316 seamless stainless steel tubing, fittings and needle valves.

3.3 VALVE APPLICATIONS

A. Install shutoff duty valves at branch connections to mains, at connections to equipment, and at control valves.

3.4 PIPING INSTALLATION

A. Drawing plans and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved.

B. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

C. Install piping to permit valve servicing.

D. Install piping free of sags and bends.

E. Install fittings for changes in direction and branch connections.

F. Install piping to allow application of insulation.

G. Select system components with pressure rating equal to or greater than system operating pressure.

H. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

I. Install drains, consisting of a tee fitting, NPS 3/4 gate valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

J. Install piping at a minimum uniform grade of 0.2 percent downward in direction of flow.

K. Install valves according to Division 23 Section "General-Duty Valves (Manual)."

L. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

M. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

N. Install strainers on supply side of pumps, controls valves, and elsewhere as indicated. Install NPS 3/4 nipple and gate valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

O. Identify piping as specified in Division 23 Section "Identification for Piping and Equipment."

3.10 HANGERS AND SUPPORTS

A. Install hangers and supports according to Division 23 Section "Hangers and Supports for Piping and Equipment." Comply with requirements below for maximum spacing.

B. Install the following pipe attachments:

1. Adjustable roller hangers for individual horizontal piping 20 feet or longer.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.

3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.

D. Support vertical runs at each floor.

3.11 PIPE JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

1. Apply Loctite 5770 or appropriate thread compound to external pipe threads. Thread compound shall be suitable for design temperature and pressure.
2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use Chesterton 785 anti-seizing compound on bolt threads.

3.12 CLEANING OF PIPING SYSTEMS

A. The interior surfaces of piping shall be smooth and entirely free from obstructions to flow. Clean and flush the systems before connecting to equipment or other systems. Verify that all foreign material has been removed before placing in service.

B. Fill systems with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and blow out steam piping completely dry.

3.13 FIELD QUALITY CONTROL

A. Prepare boiler feedwater piping according to ASME B31.1, "Power Piping" and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Flush system with clean water. Clean strainers.

3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
4. Provide temporary air vents at high points in the system to purge air pockets while the piping system is filling. Venting during the filling may be provided by loosening of the flanges.

B. Perform the following tests on feedwater piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure or 100 psig, whichever is higher. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
3. After hydrostatic test pressure has been applied for at least 4 hours, examine piping, joints, and connections for leakage. Subject joints to a hammer test while under pressure. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
4. Liquid Penetrant (PT) examination can be performed for welds onto existing piping which cannot be hydrostatic tested. Indications with major dimensions greater than 1/16 of an inch will be rejected. The following indications are unacceptable and will be rejected:

    a. Any cracks or linear indications.
    b. Rounded indications with dimensions greater than 3/16 inch.
    c. Four or more rounded indications in a line separated by 1/16 inch or less edge-to-edge.

C. Prepare written report of testing.

END OF SECTION 232213

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Belden Cable Company
2. American Insulated Wire Corp.; a Leviton Company.
3. General Cable Corporation.
4. Senator Wire & Cable Company.
5. Southwire Company.

B.

C. Copper Conductors: Comply with NEMA WC 70.

D. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN f.

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.
3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

B. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

C. Class 1 Control Circuits: Type THHN-THWN, in raceway.

D. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

B. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 260519

SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Low-voltage control cabling.
2. Control-circuit conductors.
3. Identification products.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.

B. IDC: Insulation displacement connector.

C. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

D. Open Cabling: Passing telecommunications cabling through open space (e.g., between the studs of a wall cavity).

E. RCDD: Registered Communications Distribution Designer.

F. UTP: Unshielded twisted pair.

1.4 QUALITY ASSURANCE

A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Support of Open Cabling: NRTL labeled for support of Category 5e cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

B. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 LOW-VOLTAGE CONTROL CABLE

A. Paired Cable: NFPA 70, Type CMG.

1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with UL 1581.

2.3 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN , in raceway, complying with UL 83.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway, complying with UL 83.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or Type TF, complying with UL 83.

2.4 IDENTIFICATION PRODUCTS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Brady Corporation.
2. Belden Cable Company

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.5 SOURCE QUALITY CONTROL

A. Cable will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
3. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
5. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
6. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

E. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.2 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits, No 12 AWG.

3.3 GROUNDING

A. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.4 IDENTIFICATION

A. Identify system components, wiring, and cabling according to TIA/EIA-606-A.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 260523

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: Grounding systems and equipment.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

2.2 CONNECTORS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.

B. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

3.2 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Three-phase motor and appliance branch circuits.
3. Flexible raceway runs.

C. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

1. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.

3.4 LABELING

A. Comply with requirements for instruction signs. The label or its text shall be green.

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

B. Grounding system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.

1.3 DEFINITIONS

A. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

B. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.

a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1) Hilti Inc.
2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
3) MKT Fastening, LLC.
4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

   1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

A. GRC: Galvanized rigid steel conduit.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. AFC Cable Systems, Inc.
2. Allied Tube & Conduit; a Tyco International Ltd. Co.
3. Anamet Electrical, Inc.
4. Electri-Flex Company.
5. O-Z/Gedney; a brand of EGS Electrical Group.
6. Picoma Industries, a subsidiary of Mueller Water Products, Inc.
7. Republic Conduit.
8. Robroy Industries.
9. Southwire Company.
10. Thomas & Betts Corporation.
11. Western Tube and Conduit Corporation.
12. Wheatland Tube Company; a division of John Maneely Company.

B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. GRC: Comply with ANSI C80.1 and UL 6.

D. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

E. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

F. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Adalet.
2. Cooper Technologies Company; Cooper Crouse-Hinds.
3. EGS/Appleton Electric.
4. Erickson Electrical Equipment Company.
5. FSR Inc.
6. Hoffman; a Pentair company.
7. Hubbell Incorporated; Killark Division.
8. Kraloy.
9. Milbank Manufacturing Co.
10. Mono-Systems, Inc.
11. O-Z/Gedney; a brand of EGS Electrical Group.
12. RACO; a Hubbell Company.
13. Robroy Industries.
14. Spring City Electrical Manufacturing Company.
15. Stahlin Non-Metallic Enclosures; a division of Robroy Industries.
16. Thomas & Betts Corporation.
17. Wiremold / Legrand.

B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

G. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 4 with continuous-hinge cover with flush latch unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Indoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:

a. Loading dock.
b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
c. Mechanical rooms.
d. Gymnasiums.

2. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
3. Damp or Wet Locations: GRC.
4. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.

B. Minimum Raceway Size: 1/2-inch trade size.

C. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical Systems" for hangers and supports.

E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

F. A. Support conduit within 12 inches of enclosures to which attached.

G. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

H. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

I. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

J. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

K. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

L. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

M. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

N. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

O. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

P. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 260533

SECTION 262923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CE: Conformite Europeene (European Compliance).

C. CPT: Control power transformer.

D. EMI: Electromagnetic interference.

E. IGBT: Insulated-gate bipolar transistor.

F. LAN: Local area network.

G. LED: Light-emitting diode.

H. MCP: Motor-circuit protector.

I. NC: Normally closed.

J. NO: Normally open.

K. OCPD: Overcurrent protective device.

L. PCC: Point of common coupling.

M. PID: Control action, proportional plus integral plus derivative.

N. PWM: Pulse-width modulated.

O. RFI: Radio-frequency interference.

P. TDD: Total demand (harmonic current) distortion.

Q. THD (V): Total harmonic voltage demand.

R. VFC: Variable-frequency motor controller.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.

B. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings. Include the following:

   a. Each installed unit's type and details.
   b. Factory-installed devices.
   c. Enclosure types and details.
   d. Nameplate legends.
   e. Short-circuit current (withstand) rating of enclosed unit.
   f. Features, characteristics, ratings, and factory settings of each VFC and installed devices.
   g. Specified modifications.

2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each VFC, from manufacturer.

B. Field quality-control reports.

C. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate, full-load currents.

D. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor-running overload protection suit actual motors to be protected.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For VFCs to include in emergency, operation, and maintenance manuals. Include the following:

1. Manufacturer's written instructions for testing and adjusting thermal-magnetic circuit breaker and MCP trip settings.
2. Manufacturer's written instructions for setting field-adjustable overload relays.
3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.
4. Manufacturer's written instructions for setting controls and status and alarm points.

1.7 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than 32 degrees F and not exceeding 104 degrees F.
2. Ambient Storage Temperature: Not less than minus 4 degrees F and not exceeding 140 degrees F.
3. Humidity: Less than 95 percent (noncondensing).
4. Altitude: Not exceeding 3300 feet.

B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical systems.
2. Do not proceed with interruption of electrical systems without Owner's written permission.
3. Comply with NFPA 70E.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, including clearances between VFCs, and adjacent surfaces and other items.

1.10 COORDINATION

A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:

1. Torque, speed, and horsepower requirements of the load.
2. Ratings and characteristics of supply circuit and required control sequence.
3. Ambient and environmental conditions of installation location.

B. Variable frequency controllers shall be of the same manufacturer and type for all driven equipment on the project.

1.11 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Danfoss Inc.; Danfoss Drives Div. - VLT HVAC Drive.

B. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.

C. Application: Variable torque.

D. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."

3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

E. Design and Rating: Match load type, such as pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

F. Output Rating: Three-phase; 10 to 120 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

G. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding 3 percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 97 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 98 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: 100 kA.
7. Ambient Temperature Rating: Not less than 32 degrees F and not exceeding 104 degrees F.
8. Ambient Storage Temperature Rating: Not less than minus 4 degrees F and not exceeding 140 degrees F.
9. Humidity Rating: Less than 95 percent (noncondensing).
10. Altitude Rating: Not exceeding 3300 feet.
11. Vibration Withstand: Comply with IEC 60068-2-6.
12. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
14. Speed Regulation: Plus or minus 5 percent.
15. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

H. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

I. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical.

J. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

K. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor overtemperature fault.

L. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

M. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

N. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

O. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

P. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

Q. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
2. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.

R. When used with a pumping system, the VFC shall be able to detect no-flow situations, dry pump conditions, and operation off the end of the pump curve. It shall be programmable to take appropriate protective action when one of the above situations is detected.

2.2 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

    a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

   a. A minimum of two programmable analog inputs: 4- to 20-mA dc.
   b. A minimum of four multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the control systems:

   a. 0- to 10-V dc.
   b. 4- to 20-mA dc.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.

3. Output Signal Interface: A minimum of one programmable analog output signal 4- to 20-mA dc, which can be configured for any of the following:

   a. Output frequency (Hz).
   b. Output current (load).
   c. DC-link voltage (V dc).
   d. Motor torque (percent).
   e. Motor speed (rpm).
   f. Set point frequency (Hz).

4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

   a. Motor running.
   b. Set point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

F. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor and display VFC status and alarms. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.

1. Network Communications Ports: Ethernet or EIA-485.

2.3 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Provide input filtering, as required, to limit TDD and THD(V) at the defined PCC per IEEE 519.

B. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

2.4 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.5 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, type.

a. Push Buttons: Unguarded types; momentary.
b. Pilot Lights: LED.
c. Selector Switches: Rotary type.
d. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

B. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

C. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

D. Cooling Fan and Exhaust System: For NEMA 250, Type 12; UL 508 component recognized: Supply fan, with composite intake and exhaust grills and filters; 120-V ac; obtained from integral CPT.

2.6 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.

1. Test each VFC while connected to its specified motor.
2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

B. VFCs will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFCs for compliance with requirements for installation tolerances, and other conditions affecting performance.

B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Free standing-Mounting Controllers: Install VFCs on metal framing systems with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to metal framing system. Provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

C. Install fuses in each fusible-switch VFC.

D. Install fuses in control circuits if not factory installed.

E. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

G. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify VFCs, components, and control wiring.

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect selector switches and other automatic control devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

D. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Owner before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. VFCs will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies the VFC. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 262923

ATTACHMENT B: BID FORM

Bid Number: 2014012-PW-B
Project: Boiler Feed Water Pump Replacement

Bid for Harrisonburg Resource Recovery Facility (RRF) Boiler Feed Pump Replacement Project for the City of Harrisonburg (Owner).

Bidder attests that all bid documents, including bid specifications packet, drawings, and addenda were read thoroughly and taken into account in the submission of this bid.

Bidder understands that time is of the essence for this project, and has therefore submitted an estimated timeline for the schedule of events to occur, in addition to this bid form. Bidder further agrees that the project shall begin no later than forty-five (45) calendar days after the Notice of Award is issued by the Owner. Upon award of contract, the City of Harrisonburg Public Works Department shall work with the winning bidder to establish a firm time schedule and bidder understands that not adhering to this time schedule may lead to liquidated damages being sought by the Owner.

Bidder agrees to all of the terms and conditions, as well as all specifications, provided within this bid document.

Bidder agrees to provide all material and work at the total price below:

BID PRICE: $_____

BID PRICE, IN WRITTEN FORMAT: _____

_____ *SIGNATURE*	_____ *VENDOR NAME*
_____ *TITLE*	_____ *ADDRESS*
_____ *PHONE NUMBER*	_____ *DATE*

**This document must be completed & returned with bid submission.*
*Please submit estimated timeline on separate page.**