



City of Tacoma, WA

**CITY OF TACOMA - ENVIRONMENTAL SERVICES
DEPARTMENT**

REQUEST FOR BIDS

**SOUTH TACOMA PUMP STATION PHASE 2 VARIABLE
FREQUENCY DRIVE UNIT PROCUREMENT
SPECIFICATION NO. ES23-0161N**



City of Tacoma
Environmental Services Department

REQUEST FOR BIDS ES23-0161N
SOUTH TACOMA PUMP STATION PHASE 2 VARIABLE FREQUENCY DRIVE
UNIT PROCUREMENT

Submittal Deadline: 11:00 a.m., Pacific Time, Wednesday, August 23, 2023

Submittals must be received by the City's Procurement and Payables Division prior to 11:00 a.m. Pacific Time.

For electronic submittals, the City of Tacoma will designate the time of receipt recorded by our email, sendbid@cityoftacoma.org, as the official time of receipt. This clock will be used as the official time of receipt of all parts of electronic bid submittals. Late submittals will be returned unopened and rejected as non-responsive.

Submittal Delivery: Submittals will be received as follows:

By Email:

sendbid@cityoftacoma.org

Maximum file size: 35 MB. Multiple emails may be sent for each submittal.

Bid Opening: Submittals in response to a RFB will be opened at the time listed in the submittal deadline.

Solicitation Documents: An electronic copy of the complete solicitation documents may be viewed and obtained by accessing the City of Tacoma Purchasing website at www.TacomaPurchasing.org.

- [Register for the Bid Holders List](#) to receive notices of addenda, questions and answers and related updates.
- Click here to see a [list of vendors registered for this solicitation](#).

Pre-Proposal Meeting: A pre-proposal meeting will not be held.

Project Scope Material procurement for the South Tacoma Pump Station Phase 2 Variable Frequency Drive Unit Procurement, see Appendix A for Bid Proposal.

Estimate: \$145,000

Paid Sick Leave: The City of Tacoma requires all employers to provide paid sick leave as set forth in Title 18 of the Tacoma Municipal Code and in accordance with State of Washington law.

Americans with Disabilities Act (ADA Information): The City of Tacoma, in accordance with Section 504 of the Rehabilitation Act (Section 504) and the Americans with Disabilities Act (ADA), commits to nondiscrimination on the basis of disability, in all of its programs and activities. Specification materials can be made available in an alternate format by emailing the contact listed below in the *Additional Information* section.

Title VI Information: "The City of Tacoma" in accordance with provisions of Title VI of the Civil Rights Act of 1964, (78 Stat. 252, 42 U.S.C. sections 2000d to 2000d-4) and the Regulations, hereby notifies all bidders that it will affirmatively ensure that in any contract entered into pursuant to this advertisement, disadvantaged business enterprises will be afforded full and fair opportunity to submit bids in response to this invitation and will not be discriminated against on the grounds of race, color, national origin in consideration of award.

Additional Information: Requests for information regarding the specifications may be obtained by contacting Aaron Bratton, Buyer by email to Abratton@cityoftacoma.org.

Protest Policy: City of Tacoma protest policy, located at www.tacomapurchasing.org, specifies procedures for protests submitted prior to and after submittal deadline.



Meeting sites are accessible to persons with disabilities. Reasonable accommodations for persons with disabilities can be arranged with 48 hours advance notice by calling 253-502-8468.


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SUBMITTAL CHECK LIST

This checklist identifies items to be included with your submittal. Any submittal received without these required items may be deemed non-responsive and not be considered for award.

Submittals must be received by the City of Tacoma Purchasing Division by the date and time specified in the Request for Bids page. **See Appendix A for bid forms.**

The following items make up your submittal package:	
One electronic copy of your complete submittal package.	
Price Proposal Form (Appendix A)	
Signature Page (Appendix A)	
After award, the following documents will be executed:	
Purchase Order	

1. BACKGROUND

The City of Tacoma (City) / Environmental Services Departments soliciting bids with qualified vendors to fulfill the City's needs for material procurement to be used on a separate Environmental Services construction project. Contract(s) will be awarded to the lowest responsive and responsible bidder(s) based on price, product quality and availability.

This material will be used by Contractors at the South Tacoma Pump Station located at 3628 S 35th St, Tacoma, WA 98409.

Products that fail to meet City standards or any of the specifications herein may be rejected. Should a contracted vendor fail to meet quality and/or availability requirements contained in these specifications, the City may move to terminate the contract with 10 days written notice.

- 1.1 Material must be delivered to the above address on July 1, 2024.

2. CALENDAR OF EVENTS

This is a tentative schedule only and may be altered at the sole discretion of the City.

The anticipated schedule of events concerning this RFB is as follows:

Bid Posting:	8/8/2023
Question and Substitution Request Deadline:	8/14/2023
City response to Questions:	8/16/2023
Submittal Due Date:	8/23/2023
Anticipated Award Date:	8/23/2023

3. INQUIRIES

- 3.1 Please submit questions in writing to Aaron Bratton, Buyer via email to abratt@cityoftacoma.org

Make subject line read:

ES23-0161N – South Tacoma Pump Station Phase 2 - Variable Frequency Drive Unit
Procurement – VENDOR NAME

- 3.2 The City reserves the discretion to group similar questions to provide a single answer or not to respond when the requested information is confidential.
- 3.3 The answers are not typically considered an addendum.
- 3.4 The City will not be responsible for unsuccessful submittal of questions.
- 3.5 Written answers to questions will be posted in the event approximately one week after the question deadline.

4. PRE-BID MEETING

- 4.1** No pre-proposal meeting will be held; however, questions and request for clarifications of the specifications may be submitted as stated in the **inquires** section.

5. DISCLAIMER

The City is not liable for any costs incurred by the Respondent for the preparation of materials or a proposal submitted in response to this RFB, for conducting any presentations to the City, or any other activities related to responding to this RFB, or to any subsequent requirements of the contract negotiation process.

6. DELIVERY

- 6.1** Vendor shall store purchased material until July 1, 2024 and delivered to the City of Tacoma, 3628 S 35th St, Tacoma, WA 98409. Each vendor will be required to submit a delivery timeline they can commit to. Purchase order delivery dates will reflect this timeline. In the event a purchase order deliver date is not met, the City reserves the right to purchase these products elsewhere if they are in a time constraint. If constant late deliveries occur, the City may terminate the contract.
- 6.2** Hours of operation shall be Monday through Friday, 7:00 a.m. to 3:30 p.m., excluding legal holidays, as referred to in the Standard Terms and Conditions or as otherwise approved by the City.

7. CONTRACT TERM

The City reserves the right to cancel the contract for any reason, by written notice, as stipulated in the contract.

8. RESPONSIVENESS

Bid submittals must provide ten (10) days for acceptance by City from the due date for receipt of submittals. All submittals will be reviewed by the City to determine compliance with the requirements and instructions specified in this RFB. The Respondent is specifically notified that failure to comply with any part of this RFB may result in rejection of the submittal as non-responsive. The City reserves the right, in its sole discretion, to waive irregularities deemed immaterial. The City also reserves the right to not award a contract or to issue subsequent RFB's

9. AWARD

Award will be made to the lowest responsive, responsible bidder. All bidders shall provide unit or lump sum pricing for each line item. Each line item will be added up for a subtotal price. The subtotal price will be compared amongst each bidder, including any payment discount terms offered twenty (20) days or more. The City may also take into consideration all other criteria for determining award, including evaluation factors set forth in Municipal Code Section 1.06.262.

Request for Bids

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Template Revised: 12/08/2021

All other elements or factors, whether or not specifically provided for in this specification, which would affect the final cost to and the benefits to be derived by the City will be considered in determining the award of the contract. The final award decision will be based on the best interests of the City.

The City reserves the right to let the contract to the lowest responsible bidder whose bid will be the most advantageous to the City, price and any other factors considered. In evaluating the proposals, the City may also consider any or all of the following:

1. Compliance with specification.
2. Proposal prices, listed separately if requested, as well as a lump sum total
3. Time of completion/delivery.
4. Warranty terms.
5. Bidder's responsibility based on, but not limited to:
 - a) Ability, capacity, organization, technical qualifications and skill to perform the contract or provide the services required.
 - b) References, judgment, experience, efficiency and stability.
 - c) Whether the contract can be performed within the time specified.
 - d) Quality of performance of previous contracts or services

10. PRICE ADJUSTMENTS

Bid submittal prices will establish a base against which Contractors may request price adjustments per the following terms:

1. Contractor shall submit proposed price changes in writing to the contract administrator (contract information provided after award) 45 days prior to the effective date
2. The city reserves the right to accept or reject all such price adjustments
3. Price increases will be adjusted only to the amount of cost increase to Contractor. No adjustment will be made for Contractor profit margin
4. Any proposed price increase to Contract line items must be beyond the control of the contractor and supported by written documentation from the manufacturer or wholesale distributor, indicating new higher cost adjustments in effect
5. Increase requests may be evaluated against various market conditions, including but not limited to:
 - a) Consumer Price Index for Seattle - Tacoma - Bremerton, All Items 1982-84+100, for comparable period
 - b) Consumer Price Index for All Urban Consumers (CPI-U) for the U.S. City Average Index for All Items, 1982-84=100, unadjusted for the comparable period
 - c) State/federal regulations affecting production costs of the materials
 - d) Volatile commodity market conditions
 - e) Various producer price or commodity indices
 - f) Minimum wage adjustments

11. STANDARD TERMS AND CONDITIONS

City of Tacoma [Standard Terms and Conditions](#) apply.

12. INSURANCE REQUIREMENTS

Successful proposer will provide proof and maintain the insurance coverage in the amounts and in the manner specified in the City of Tacoma Insurance Requirements document applicable to the services, products, and deliverables provided under the solicitation. The City of Tacoma Insurance Requirements document is fully incorporated into the solicitation by reference, see Appendix C.

13. WARRANTY Material and Equipment: Manufacturer's warranty or minimum one-year warranty whichever is greater.

Contractor shall arrive on-site at the 3628 S 35th St, Tacoma, WA 98409 within 48 hours of notification for all warranty repairs during normal work hours of 8:00 a.m. to 5:00 p.m. Monday through Friday. Repairs shall include free pick-up and delivery. Repairs must be completed and vehicle returned within 48 hours of pick-up.

Contractor agrees to allow City to make minor warranty repairs where that is most cost effective and, if requested, contractor will credit City for cost of parts, but not labor.

Vendor will warrant goods according to the manufacturer's warranty guidelines. The start of the warranty commences once the goods are delivered and accepted by the City.

14. INSPECTION

All goods are subject to final inspection and acceptance by the City. If any inspection fails, the vendor shall be required to make arrangements to exchange the goods at their own expense and replace it in a timely manner acceptable to the City.

Material failing to meet the requirements of this contract will be held at Vendor's risk and may be returned to Vendor. If so returned, the cost of transportation, unpacking, inspection, repackaging, reshipping, or other like expenses are the responsibility of the Vendor.

15. REPORTS

After the conclusion of the contract, upon request from the City to facilitate a new bid process, contractor shall furnish a list that cross references the manufacturer model numbers specified in this bid to the current model numbers.

16. APPROVED ITEM EQUIVALENT

A specific manufacturer for almost all line items has been listed in the Technical Specifications because this is the current manufacturer accepted. For those line items, which do not list a specific manufacturer, bidders shall provide the technical specifications for the manufacturer they are offering. The City may request, after the bid due date, a sample of that product for review and approval by the City. The City reserves all rights to be the sole judge as to whether any other manufacturer can meet or exceed the current specifications they use. Unless an item

is indicated "No Substitute", approved equivalents shall be submitted by the date listed in the Calendar of Events section. Please submit any substitutions for approval using the form attached in Appendix B. Equivalents will be approved by Addendum to the solicitation.

17. COMPLIANCE WITH SPECIFICATIONS

All products shall be new and unused. Any product that does not comply with any part of these technical specifications shall be rejected and the vendor shall, at its own expense, including shipping, replace the item.

18. MATERIALS AND WORKMANSHIP

The successful bidder shall be required to furnish all materials necessary to perform contractual requirements. Materials and workmanship for this contract shall conform to all codes, regulations and requirements for such specifications contained herein and the normal uses for which intended. Material shall be manufactured in accordance with the best commercial practices and standards for this type of goods. All literature and products must be packaged and labeled to sell in the United States.

19. DAMAGED GOODS

The vendor shall replace any orders that are damaged in transit. They will be notified by the City and they must arrange to have damaged orders picked up within 48 hours' notice (excluding weekends and holidays). Vendor will pay all expenses incurred to ship damaged goods back to manufacturer or their own warehouse.

20. UPDATED PRODUCTS

During the contract term, if items on the contract are being replaced and updated by the manufacturer, the supplier may submit the manufacturer information, technical specifications, and pricing to the City for consideration. The supplier shall provide this updated product information to the City as soon as it becomes available by the manufacturer. The City will work with Purchasing Division to review the information submitted and either accept or reject the product. If the replacement product is not approved, the vendor will be notified and the current item on the contract will be removed. Because of fixed pricing, the replacement item must be offered at the same price.

21. PRODUCT DISCONTINUED

During the contract term, if the supplier discontinues carrying any of the contracted items, they must notify the City and the Purchasing office within 30 calendar days. The City reserves the right to seek other suppliers to supply those items or purchase directly from the manufacturer or their designated distributor until the contract term ends.

22. QUANTITIES AND PURCHASE ORDERS

The quantities listed are from the attachments listed in **Appendix A Bid Proposal**. Delivery will be according to purchase order of the contract.

23. ENVIRONMENTALLY PREFERABLE PROCUREMENT

In accordance with the City of Tacoma's [Sustainable Procurement Policy](#), it is the policy of the City of Tacoma to encourage the use of products or services that help to minimize the environmental and human health impacts of City Operations. Respondents are encouraged to incorporate environmentally preferable products or services that have a lesser or reduced effect on human health and the environment when compared with competing products or services that serve the same purpose. This comparison may consider raw materials acquisition, products, manufacturing, packaging, distribution reuse, operation, maintenance or disposal of the product or service.

The City of Tacoma encourages the use of sustainability practices and desires any awarded contractor(s) to assist in efforts to address such factors when feasible for:

- Reduction of pollutant releases
- Toxicity of materials used
- Waste generation
- Greenhouse gas emissions, including transportation of materials and services
- Recycle content
- Comprehensive energy conservation measures
- Waste management reduction plans
- Potential impact on human health and the environment

24. EQUITY IN CONTRACTING

There is no Equity in Contracting goal, however the City of Tacoma is committed to encouraging firms certified through the [Washington State Office of Minority and Women's Business Enterprise](#) to participate in City contracting opportunities. See the **TMC 1.07 Equity in Contracting Policy** at the City's [Equity in Contracting Program website](#).

25. PROPRIETARY OR CONFIDENTIAL INFORMATION

The Washington State Public Disclosure Act ([RCW 42.56 et seq.](#)) requires public agencies in Washington make public records available for inspection and copying unless they fall within the specified exemptions contained in the Act, or are otherwise privileged. Documents submitted under this RFB shall be considered public records and, with limited exceptions, will be made available for inspection and copying by the public.

Information that is confidential or proprietary must be clearly marked. Further, an index must be provided indicating the affected page number(s) and location(s) of all such identified material. Information not included in said index will not be reviewed for confidentiality or as proprietary before release.

26. VARIABLE FREQUENCY DRIVE SPECIFICATIONS

The following details are required in order to meet material specifications and required to have a 100% approved submittal.



**CITY OF TACOMA
TACOMA, WASHINGTON**

SOUTH TACOMA PUMP STATION REHABILITATION PROJECT PHASE 2

TECHNICAL SPECIFICATIONS

VFD PROCUREMENT PACKAGE

MAY 2023

Digitally signed by Monte K. Richard
Contact Info: Carollo Engineers, Inc.
Date: 2023.05.16 21:02:07-06'00'



CITY OF TACOMA
SOUTH TACOMA PUMP STATION REHABILITATION PROJECT PHASE 2
VFD PROCUREMENT PACKAGE
TECHNICAL SPECIFICATIONS
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DIVISION 26 - ELECTRICAL

SECTION NO.	TITLE
26_29_26	REDUCED HARMONIC VARIABLE FREQUENCY DRIVES

APPENDICES

APPENDIX A	VFD PROCUREMENT PACKAGE DRAWINGS
APPENDIX B	SOUTH TACOMA PUMP STATION REHABILITATION PROJECT PHASE 2 PUMP PROCUREMENT PACKAGE

SECTION 26_29_26

REDUCED HARMONIC VARIABLE FREQUENCY DRIVES

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Reduced harmonic active front end variable frequency drives (VFD), for control of standard NEMA Design B squirrel cage induction motors.

1.02 REFERENCES

- A. Definitions:
 - 1. AFE: Active Front End.
 - 2. IGBT: Insulated Gate Bipolar Transistor.
 - 3. VFD: Variable Frequency Drive.
- B. Standards:
 - 1. National Electrical Manufacturers Association (NEMA):
 - a. 250 - Enclosures for Electrical Equipment (1,000 V Maximum).
 - 2. Underwriters' Laboratories, Inc. (UL):
 - a. 508A - Standard for Safety for Industrial Control Panels.

1.03 SUBMITTALS

- A. Custom prepared by the VFD manufacturer and specific for the equipment furnished.
- B. Product data:
 - 1. Manufacturer of the VFD.
 - 2. Manufacturer of all components of the VFD.
 - 3. Dimensions:
 - a. Height.
 - b. Width.
 - c. Depth.
 - 4. Weight.
 - 5. Nameplate schedule.
 - 6. Bill of material.
 - 7. Ratings:
 - a. Voltage.
 - b. Phase.
 - c. Input current.
 - d. Output current.
 - e. Interrupting rating.
 - f. Momentary current rating.
 - 8. Catalog cutsheets for major components.

9. Surge protection data.
 10. Design data:
 - a. Efficiency and power factor values.
 - b. Certification that the drive is sized for the full nameplate motor hp and current (at rated RPM) of the driven load at the installed altitude.
 - c. Certification that based upon VFD design, cable length to motor, and motor dielectric insulation level that the VFD will not damage motor insulation due to carrier frequency, reflected wave, dv/dt, or other VFD produced characteristics.
 - d. Certification that all electronic circuits and printed circuit boards are conformably coated.
 - e. Certification that the VFD will operate with all power sources including on-site generation.
 11. List of recommended spare parts.
 12. Submit the following for equipment installed in structures designated as seismic design category D:
 - a. Design Criteria of non-structural components and their connections to structures:
 - 1) Component amplification factor, a_p : In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.
 - 2) Component response modification factor, R_p : In accordance with ASCE 7, Tables 13.5-1 and 13.6-1.
 - 3) Component importance factor, $I_p = 1.5$.
 - 4) Design spectral acceleration at short period, SDS: 0.907 g.
 - b. Manufacturer's statement of seismic qualification with substantiating test data.
 - c. Manufacturer's special seismic certification with substantiating test data.
- C. Shop drawings:
1. Complete plan and elevation drawings showing:
 - a. All dimensions.
 - b. Panel, sub-panel and component layout indexed to the bill of material.
 - c. Conduit connections.
 - d. Required clearance around equipment.
 2. List of faults and alarms for the basic control and protection systems. Identify the protection, control, trip and alarm functions, the reference signals, commands, and the auxiliary devices.
 3. Complete schematic, wiring and interconnection diagrams showing connections to both internal and external devices:
 - a. Wiring diagrams shall include terminal number and wire numbers.
 4. Complete 1-line and 3-line diagrams including, but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system:
 - a. Device electrical ratings shall be clearly indicated on the Drawings.
 5. Data map or register map identifying all functions (control, protection, trip, alarm, reference, commands, and auxiliaries) available over digital bus (Ethernet/IP) communication network.

- D. Installation instructions:
 - 1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
 - 2. Provide manufacturer's installation instructions.
- E. Warranty:
 - 1. As specified below.
- F. Commissioning submittals:
 - 1. Manufacturer's representative qualifications.
 - 2. Certificates:
 - a. Provide Manufacturer's Certificate of Source Testing.
 - 1) The form shall be completed by the manufacturer to confirm that the specified source tests have been performed and the results conform to the specified requirements. The form is provided in Attachment A at the end of this Section.
 - b. Provide Manufacturer's Certificate of Installation Verification:
 - 1) The form shall be completed by the manufacturer to confirm that the equipment or system is installed in conformance with the Contract. The form is provided in Attachment B at the end of this Section.
 - c. Provide Manufacturer's Certificate of Functionality Compliance.
 - 1) The form shall be completed by the manufacturer to confirm that testing of the installed equipment or system has been performed and the results conform to the specified performance. The form is provided in Attachment C at the end of this Section.
 - 3. Test Plans:
 - a. Define approach and timing for:
 - 1) Testing and Training Phases.
 - 2) Start-Up Phase.
 - 4. Source Test (Factory Acceptance Test) and Functional Test Plans:
 - a. Based on approved shop drawings.
 - b. Prepared by VFD Manufacturer.
 - 1) Coordinate with installing Contractor to develop Functional (Site) Test Plans.
 - c. Include the following items for each test:
 - 1) Purpose of the test.
 - 2) Identification of each item of equipment/system to be tested, including system designation, location, tag number, control loop identifier, etc.
 - 3) Description of the pass/fail criteria that will be used.
 - 4) Listing of pertinent reference documents (Contract and industry standards or sections applicable to the testing).
 - a) Credentials of test personnel.
 - 5) Test equipment:
 - a) Include Product Data for the test equipment.
 - b) Appropriate calibration records.
 - (1) Drawings or photographs of test stands and/or test apparatus.

- 6) Duration: Determine test durations with Owner's input.
 - 7) Detailed step-by-step test procedures.
 - a) The level of detail shall be sufficient for the witness to follow the steps.
 - d. Define for Functional Testing:
 - 1) Required temporary systems (pumps, piping, etc.).
 - 2) Shutdown requirements for existing systems.
 - e. Furnish labor, power, tools, equipment, instruments, and services required for and incidental to testing activities.
 - 5. Test Reports.
 - a. Minimum requirements:
 - 1) Title.
 - 2) Abstract.
 - 3) Equipment.
 - 4) Procedures.
 - 5) Results.
 - a) Complete disclosure of the calculation methodologies.
 - 6) Conclusions.
 - 7) Signature by an authorized party.
 - 8) Appendices.
 - a) Completed test forms signed by witnesses.
 - 6. Manufacturer's representatives field notes and data.
 - 7. Owner training.
- G. Certifications:
- 1. Certification letter from the VFD manufacturer stating that the VFD(s) are capable of operating with all new and existing sources (utility source and on-site generation).
 - 2. Certification letter from the VFD manufacturer stating that the VFD(s) are capable of operating with all new and existing VFDs in the existing and new distribution system.
- H. Control descriptions and control logic program:
- 1. Provide control descriptions describing the full control functionality to be incorporated into the programming of the drive including the following:
 - a. Functionality in local and remote.
 - b. Software and hardware interlocks.
 - c. Control response upon loss and restoration of power.
 - 2. Provide complete register list of all IO available to the Plant PCS.
 - 3. Submit the completed control logic program for each and every device supplied.
 - 4. Submit a list of all networking address tables.
 - 5. Submit configuration settings in accordance with actual motor and field equipment being supplied.
 - 6. Modify control logic program as required by Owner or installing Contractor/Instrumentation and Controls Subcontractor.
- I. Installation instructions:
- 1. Detail the complete installation of the equipment including rigging, moving, and setting into place.
 - 2. Provide manufacturer's installation instructions.

J. Calculations:

1. Harmonic study:
 - a. A preliminary harmonic analysis shall be performed:
 - 1) A power system short circuit ratio of 20 shall be used.
 - 2) All VFDs shall be assumed to be operating at maximum speed and maximum load.
 - 3) The short circuit current (ISC) utilized for the harmonic analysis calculations is defined as:
 - a) $ISC = 20 * (\text{Sum Total Full Load Amps of all VFDs})$.
 - b. A separate harmonic analysis shall be performed based on the standby generator system. Coordinate with the generator manufacturer and the VFD manufacturer so the actual characteristics for the existing generator for this Project are used in the harmonic analysis.
 - 1) Generator information as indicated on the Appendix A VFD Procurement Package Drawings.
2. Detailed calculations or details of the actual physical testing performed on the VFD to prove the VFD is suitable for the seismic conditions at the Project Site.

K. Test forms and reports:

1. Submit complete factory acceptance test procedures and all forms used during the test:
 - a. For VFD units less than 250 hp, provide certified test results for the actual VFD being furnished or prototype units.
 - b. Provide the following certified test reports:
 - 1) Efficiency at rated power output and output frequency of 60 hertz.
 - 2) Power factor at 0 percent, 25 percent, 50 percent, 75 percent, and 100 percent speed.
 - 3) Harmonics at the input terminals of the VFD at 100 percent speed and 100 percent load:
 - a) Voltage distortion: Measure individual harmonics up to and including the 50th harmonic and total harmonic distortion.
 - b) Current distortion: Measure individual harmonics up to and including the 50th harmonic and total demand distortion.
2. Submit complete control description checklist and IO checklist organized by VFD for use during the control logic portion of the witnessed field acceptance testing.
 - a. Coordinate with installing Contractor and Instrumentation and Controls Subcontractor to provide.

L. Record documents:

1. Certified record documents of all equipment with information listed above.

M. Manufacturer's field reports:

1. Certification letter from the VFD manufacturer that the VFD(s) has been inspected and installed in accordance with the manufacturer's requirements.
2. Report listing the setting of all VFD adjustable parameters and their values after start-up.
3. Certification letter from the VFD manufacturer stating that the VFDs are programmed to avoid system resonances when connected to the standby generator and will not conflict with generator system voltage regulator.

- N. Operation and maintenance manuals:
1. Spare parts list with supplier names and part numbers.
 2. Start-up and commissioning instructions and data.
 3. Complete bill of material indexed to the drawings, identifying the catalog or part numbers, manufacturer, and quantities of components of the VFD system.
 4. Operating manuals:
 - a. Submit operating instructions and a maintenance manual presenting full details for care and maintenance of each model of VFD provided under this Contract.
 5. Operating instructions:
 - a. The written descriptions shall detail the operational functions of all controls on the front panel including keypad functions and parameters.
 6. Maintenance manual:
 - a. Furnish maintenance manuals with instructions covering all details pertaining to care and maintenance of all equipment as well as identifying all parts.
 - b. Manuals shall include but are not limited to the following:
 - 1) Adjustment and test instructions covering the steps involved in the initial test, adjustment and start-up procedures.
 - 2) Detailed control instructions that outline the purpose and operation of every control device used in normal operation.
 - 3) All schematic wiring and external diagrams:
 - a) Furnish drawings in a fully legible reduced 11-inch by 17-inch format.

1.04 QUALITY ASSURANCE

- A. Qualifications:
1. Any third-party certification, safety or protection requirements shall be applied to the VFD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.
 2. VFDs shall be UL 508C listed and labeled.
 3. VFD systems (packaged VFD panels) shall be UL 508A listed and labeled.
 4. VFDs shall be manufactured by the VFD manufacturer at its own facility, which shall have a quality assurance program that is certified in accordance with ISO 9001.
 - a. Deviations to this requirement are acceptable provided all variances are identified in writing during the submittal review process and approved by the Engineer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Ship VFDs to Owner's designated facility on a dedicated air ride vehicle that will allow the Owner to utilize on site off-loading equipment:
1. VFDs shall be delivered to the site pre-assembled and wired.
 2. Ship each VFD with 2 tamperproof accelerometers that record the maximum shock and vibration experienced by the VFD during shipping and handling.
- B. Furnish temporary equipment heaters within the VFD to prevent condensation from forming.

1.06 ADMINISTRATIVE REQUIREMENTS

- A. Sequencing:
 - 1. Conduct factory acceptance test and submit certified test results for Engineer's review.
 - 2. Ship equipment to Project Site after successful completion of factory acceptance test.
 - 3. Conduct Programming and Data Exchange Coordination Meeting.
 - a. Coordinate with installing Contractor and Instrumentation and Controls Subcontractor to facilitate.
 - 4. Contractor to assemble equipment in the field.
 - 5. Conduct field acceptance tests including harmonic testing and submit results for Engineer's review:
 - a. All utility power sources and on-site generation shall be installed and operable for field test.
 - 6. Submit manufacturer's certification that equipment has been properly installed and is fully functional for Engineer's review.
 - 7. Conduct Owner's training sessions.
 - 8. Commissioning and process start-up as specified.

1.07 WARRANTY

- A. Two (2) years from date of startup (completion of functional testing, and acceptance of associated test report) or thirty (30) months from the date of shipment, whichever occurs sooner.
- B. Submittals:
 - 1. For each item of material or equipment furnished under the Contract:
 - a. Submit manufacturer's warranty prior to fabrication and shipment of the item from the manufacturer's facility.
 - 1) Include each required warranty in proper form, with full information, certified by manufacturer as required, and properly executed by Installing Contractor, or supplier.
 - 2) Provide name, address, phone number, and point of contact of manufacturer, supplier, as applicable.
- C. Relationship to Warranty and Correction Period:
 - 1. Warranties specified for materials and equipment shall be in addition to, and run concurrent with, both the warranty and the correction period requirements.
- D. Manufacturer's Warranty Minimum Requirements:
 - 1. Written warranty issued by item's manufacturer.
 - 2. Project-specific information, properly executed by product manufacturer, and expressly states that its provisions are for the benefit of the Installing Contractor.
 - 3. Covers all costs associated with the correction of the defect, including but not limited to removal of defective parts, new parts, labor, and shipping.
 - 4. Provides a timely response to correct the defect.

5. Warranty to commence upon on the date of successful completion of functional testing, and acceptance of associated test report.
 - a. For items of Work for which acceptance is delayed beyond completion of functional testing and acceptance of associated reporting, submit warranty within 10 calendar days after acceptance, listing date of acceptance as beginning of warranty period.
- E. Warranty Work:
 1. Replacement cost:
 - a. Upon determination that work covered by warranty has failed, replace or rebuild the work to an acceptable condition complying with requirement of this Section.
 - 1) Manufacturer is responsible for the cost of replacing or rebuilding defective work regardless of whether Owner has benefited from the use of the work through a portion of its anticipated useful service life.
 2. Owner's recourse:
 - a. Written warranties are in addition to implied warranties, and shall not limit the duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitation on time in which Owner can enforce such other duties, obligations, rights, or remedies.
 3. Reinstatement of warranty:
 - a. When work covered by a warranty has failed and has been corrected by replacement or rebuilding, reinstate the warranty by written endorsement.
 - 1) The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

1.08 SYSTEM START-UP

- A. The VFD manufacturer shall be responsible for start-up of the VFDs in the presence of the pump equipment suppliers, Contractor, Engineer, and Owner.

1.09 MAINTENANCE

- A. Maintenance service: Manufacturer shall describe the field service system available to support the proposed VFD system. As a minimum describe:
 1. Type of technical support available (e.g., system engineering and technician).
 2. Location of field service personnel.
 3. Field service daily rates in dollars per hour and dollars per day.
 4. Guaranteed response times to service requests.
- B. Spare parts:
 1. The following spare parts shall be furnished:
 - a. 1 complete VFD of each size furnished.
 - b. 1 set of all power and control fuses for each VFD.
 - c. 1 spare fan for each VFD unit.
 - d. 2 sets of ventilation filters for each VFD unit (if applicable in VFD cabinet louvers).
 - e. Any special dedicated tools for emergency service and troubleshooting.
 - f. All hardware and software required for configuration, maintenance, troubleshooting and inquiry of all drive parameters.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

- A. Provide equipment and components that are fully rated for the site elevation and operating environment where the equipment will be installed.
- B. Non-conditioned spaces:
 - 1. For equipment located in non-conditioned spaces, provide additional temperature conditioning equipment to maintain the equipment temperature within a band of 10 degrees Fahrenheit above the minimum operating temperature and 10 degrees Fahrenheit below maximum operating temperature.
- C. Design requirements:
 - 1. Each VFD system shall consist of all components required to meet the performance, protection, safety, testing and certification criteria of this Section.
 - 2. The VFD system:
 - a. Is a fully integrated package.
 - b. Includes all material necessary to interconnect VFD system elements, even if shipped separately.
 - 3. Any modifications to a standard product necessary to meet this Section shall be made only by the VFD manufacturer.
 - 4. Each VFD shall be completely factory pre-wired, assembled and then tested as a complete package by the VFD manufacturer to ensure a properly coordinated, fully integrated drive system.
 - 5. The VFD shall be capable of operating standard NEMA Design B motors. It is the responsibility of the VFD manufacturer to ensure that the drive will not damage motor insulation due to high carrier frequency, reflected wave, dv/dt or other drive electrical characteristics:
 - a. The VFD manufacturer shall furnish equipment necessary to mitigate potential damage to motor insulation.
 - b. Coordinate bearing protection methods with the supplier of the driven equipment.
 - c. Motors as specified in Appendix B South Tacoma Pump Station Rehabilitation Project Phase 2 Pump Procurement Package September 2022.
- D. Performance:
 - 1. Operating envelope:
 - a. Speed and torque requirements:
 - 1) Provide a variable torque or constant torque VFD as required by the driven load.
 - 2) The VFD shall be capable of producing a variable alternating voltage/frequency output to provide continuous operation over the 40 to 110 percent (25 to 66 hertz) speed range.
 - b. Current requirements:
 - 1) Provide 100 percent of rated output current on a continuous basis.

- 2) Variable torque VFD :
 - a) Minimum 110 percent current overload for 1 minute.
- 3) Constant torque VFD :
 - a) Minimum 150 percent current overload for 1 minute.
2. Harmonics:
 - a. The VFD shall meet the following distortion limits at 2 percent line voltage unbalance measured at the input terminals of the VFD:
 - 1) Voltage harmonics: The maximum allowable total harmonic distortion, THD, for each VFD shall not exceed 5 percent.
 - 2) Current harmonics: The maximum allowable total harmonic current distortion limit, TDD, for each VFD shall not exceed 5 percent as measured at the input terminals of the VFD system.
3. Efficiency:
 - a. VFD system minimum efficiency shall be 93 percent at rated kilowatt output of the VFD. VFD system efficiency shall be calculated as follows:

$$\text{Efficiency (\%)} = \frac{\text{Power (Load)}}{\text{Power (Supply)}} \times 100$$
 - b. Power:
 - 1) Load power is the total 3-phase power measured at the output terminals of the drive system, including the output filter.
 - 2) Supply power is the total power measured at the input terminals of the VFD including phase shifting transformer or active front end components and auxiliary equipment (e.g., controls, fans) for complete system operation.
4. Total power factor:
 - a. Minimum of 0.96 lagging across the entire speed range.
 - b. Under no operating conditions shall the VFD have a leading power factor.
5. Frequency accuracy:
 - a. Minimum of within 0.01 percent.
6. Speed regulation:
 - a. Minimum of within 0.5 percent across the entire speed range.
7. Capable of working with all available power sources (utility and on-site generation) and with all new and existing VFDs.

2.02 MANUFACTURERS

- A. Yaskawa U1000.

2.03 EQUIPMENT

- A. General:
 1. Sinusoidal pulse width modulated, (PWM), voltage source type drive shall consist of the following:
 - a. Rectifier section.
 - b. Direct current link with capacitors.
 - c. Insulated gate bipolar transistor (IGBT), inverter section.
 - d. Microprocessor based controls.
 - e. Output filter.

2. Rectifier section:
 - a. Provide VFDs with an active front end:
 - b. Active front end rectifier:
 - 1) IGBT based converter module:
 - a) Six IGBTs minimum.
 - 2) Inductor/capacitor/inductor, LCL, harmonic filter:
 - a) Low pass filter.
 - b) The filter shall be disconnected from the line when the VFD is not running or powered off.
 - c) Installed within same enclosure as VFD.
- B. Ratings:
 1. Voltage:
 - a. Input voltage: 480 Volts plus or minus 10 percent, 3-phase, 3-wire, 60 hertz.
 - b. Solidly grounded.
 2. Short-circuit rating:
 - a. 65 kA RMS symmetrical.
- C. Operational features:
 1. Protective features:
 - a. Annunciated at the keypad and available via network connection.
 - b. Include the following protective features:
 - 1) Motor overload protection.
 - 2) Instantaneous overcurrent.
 - 3) Instantaneous overvoltage.
 - 4) Undervoltage.
 - 5) Power unit overtemperature.
 - 6) Phase loss.
 - 7) VFD output short circuit.
 - 8) VFD output ground fault.
 - 9) Blown fuse with blown fuse indication.
 - 10) IGBT protection.
 - 11) Cooling fan failure.
 - 12) Component failure.
 2. Control mode:
 - a. The VFD shall operate in either a constant volts/hertz or sensorless vector mode. Selectable using the programming keypad.
 3. Frequency control:
 - a. Minimum of 3 selectable skip frequencies with adjustable bandwidths.
 - b. Programmable minimum frequency.
 - c. Programmable maximum frequency.
 4. Acceleration/Deceleration:
 - a. Separately adjustable acceleration and deceleration rates.
 - b. Each rate shall be adjustable from 0.01 to 1,800 seconds.
 5. Spinning load:
 - a. Capable of determining the speed and direction of a spinning load, "catch" the load and accelerate or decelerate it without damage to the load.
 6. Programmable loss of signal:
 - a. Upon loss of reference speed signal the VFD shall be programmable to either stop, maintain current speed, or default to preselected speed.

7. Power interrupt ride through:
 - a. Capable of continuous operation in the event of a power loss of 5 cycles or less.
8. Hardwired inputs and outputs:
 - a. Manufacturer's standard number the following:
 - 1) Analog inputs:
 - a) Configurable as either 0 to 10 volts or 4 to 20 milliamperes.
 - 2) Analog outputs:
 - a) Programmable 4 to 20 milliamperes isolated.
 - 3) Discrete inputs:
 - a) Programmable.
 - 4) Discrete outputs:
 - a) Programmable.
 - b) Form C relay contacts.
 - 5) Potentiometer 3-wire input.
 - b. Provide additional inputs and outputs as required to meet the control functions indicated on the Appendix A VFD Procurement Package Drawings.
9. Communications:
 - a. Provide each VFD with a dual port EtherNet/IP communications interface module.
 - b. The use of gateways is not acceptable.
 - c. All protocols shall be certified by the governing authority.
10. Automatic control:
 - a. PID capability utilizing an internal or external setpoint.
 - 1) Selectable setpoint source.
11. Real-time clock:
 - a. Capable of providing time-stamped events.
 - b. Set locally or via a remote controller.
 - c. Programmable for day, month, year, local time zones in hours, minutes and seconds.
12. Diagnostics:
 - a. Minimum of 4 fault conditions in memory on a first in - first out basis.
 - b. Time stamped.
 - c. Operating frequency, drive status and power mode shall also be stored at the time of the fault.
 - d. Fault memory shall be maintained in the event of a power outage.
 - e. The fault memory shall be accessible via RS-232, RS-422 or RS-485.
13. Automatic restart:
 - a. User selectable, automatic restart feature allowing the VFD to restart following a momentary power failure or other VFD fault:
 - 1) Programmable for up to 9 automatic restart attempts with an adjustable time delay between restart attempts.

2.04 COMPONENTS

- A. Enclosure:
 1. NEMA Type 3R.
 2. Provide cooling devices required to maintain the VFD within the manufacturer's specified temperature limits for the Project conditions:
 - a. Provide cooling device alarm.

- B. Power disconnect:
 - 1. Flange mounted thermal magnetic circuit breaker:
 - a. Lockable in the OFF position.
- C. Output filter:
 - 1. 3 percent load reactor.
- D. Keypad:
 - 1. Furnished with a keypad for programming and control.
 - 2. Password security to protect drive parameters.
 - 3. Mounted on the door of the VFD.
 - 4. Back-lit LCD with a minimum of 2 lines of a minimum of 16 characters each.
 - 5. Programming and display features language: English.
 - 6. Capable of displaying the following parameters:
 - a. Speed (percent).
 - b. Input current (amperes).
 - c. Output current (amperes).
 - d. Output frequency (hertz).
 - e. Input voltage.
 - f. Output voltage.
 - g. Total 3-phase kilowatt.
 - h. Kilowatt hour meter.
 - i. Elapsed run time meter.
 - j. Revolutions per minute.
 - k. Direct current bus voltage.
 - 7. In addition to all keys required for programming, the keypad shall have the following:
 - a. Automatic/Manual selector.
 - b. Start pushbutton.
 - c. Stop pushbutton.
 - d. Jog pushbutton.
 - e. Speed increment.
 - f. Speed decrement.
 - g. Forward/Reverse selector.
 - h. RUN indicator.
 - i. PROGRAM indicator.
 - j. FAULT indicator.
 - k. DRIVE READY indicator.
 - l. Diagnostics.
 - 8. Provide the VFD with the hardwired controls indicated on Appendix A VFD Procurement Package Drawings.
- E. Control power transformer:
 - 1. Furnish a control power transformer mounted and wired inside the drive enclosure:
 - a. Primary and secondary fusing.
 - 2. Size the transformer to supply power to all VFD controls and options as well as any external devices indicated on the Appendix A VFD Procurement Package Drawings including the motor winding heater.

- F. Line side tuning for AFE VFDs:
 - 1. Provide 2 sets of line side tuning parameters: One for the normal utility supply, another for the standby generator supply.
 - 2. Line side tuning parameters shall be selectable via the communications network or a digital input from a contact enclosure at the Pump Station Process Control System/PLC-17511.
- G. Low voltage molded case circuit breaker:
 - 1. General:
 - a. In accordance with UL 489.
 - b. Operating mechanism:
 - 1) Quick-make, quick-break, non-welding silver alloy contacts.
 - 2) Common Trip, Open and Close for multi-pole breakers such that all poles open and close simultaneously.
 - 3) Mechanically trip free from the handle.
 - 4) Trip indicating handle - automatically assumes a position midway between the manual ON and OFF positions to clearly indicate the circuit breaker has tripped.
 - 5) Lockable in the "OFF" position.
 - c. Arc extinction:
 - 1) In arc chutes.
 - d. Voltage and current ratings:
 - 1) Minimum ratings as indicated on the Drawings.
 - 2) Minimum frame size 100A.
 - e. Interrupting ratings:
 - 1) Minimum ratings as indicated on the Drawings.
 - 2. Terminals:
 - a. Line and load terminals suitable for the conductor type, size, and number of conductors in accordance with UL 489.
 - 3. Case:
 - a. Molded polyester glass reinforced.
 - b. Ratings clearly marked.
 - 4. Trip units:
 - a. Provide thermal magnetic trip units .
 - b. Thermal magnetic:
 - 1) Instantaneous short circuit protection.
 - 2) Inverse time delay overload.
 - 3) Ambient or enclosure compensated by means of a bimetallic element.
 - 5. One of the following or equal:
 - a. ABB.
 - b. Eaton.
 - c. Schneider Electric.

2.05 ACCESSORIES

- A. Surge protection:
 - 1. Metal oxide varistors:
 - a. Provide protection for the VFD against:
 - 1) Line transients: 5,000-volt peak minimum.
 - 2) Line to ground transients: 7,000-volt peak minimum.

- B. Conformal coating:
 - 1. Provide conformal coating material applied to electronic circuitry and printed circuit boards to act as protection against moisture, dust, temperature extremes, and chemicals such as H₂S and chlorine.
- C. Air filters:
 - 1. Mounted on the outside of the VFD enclosure:
 - a. Replaceable without requiring that the VFD be turned off or the door opened.
 - 2. Located on the front, side, or top of the VFD enclosure:
 - a. Rear mounted air filters are not acceptable.
- D. Conductor identification:
 - 1. Identify each conductor and cable with unique wire numbers.
 - 2. Readily identified without twisting the conductor.
- E. Pilot devices:
 - 1. General:
 - a. Provide operator pushbuttons, switches, and pilot lights, from a single manufacturer.
 - b. Size:
 - 1) 30.5 millimeters.
 - c. Heavy duty.
 - d. Pushbuttons:
 - 1) Contacts rated:
 - a) NEMA Type A600.
 - 2) Furnish 1 spare normally open contact and normally closed contact with each switch.
 - e. Selector switches:
 - 1) Contacts rated:
 - a) NEMA Type A600.
 - b) Knob type.
 - 2) Furnish 1 spare normally open contact and normally closed contact with each switch.
 - f. Pilot lights:
 - 1) Type:
 - a) LED for interior installations.
 - 2) Push to test.
 - 3) Lamp color:
 - a) On/Running/Start: Green.
 - b) Off/Stop: Red.
 - c) Power: White.
 - d) Alarm: Amber.
 - e) Status or normal condition: White.
 - f) Opened: Green.
 - g) Closed: Red.
 - h) Failure: Amber.

- F. Potentiometer and slidewire transmitters:
1. Provide a DC output in proportion to a potentiometer input.
 2. Potentiometer input:
 - a. 100 ohms to 100 K ohms.
 - b. Impedance greater or equal to 1 M ohms.
 - c. Zero turn-up: 80 percent of full-scale input.
 - d. Span turn-down: 80 percent of full-scale input.
 3. Field-configurable output:
 - a. Voltage and current: Conventional current loops and voltage control signals.
 4. Accuracy including linearity and hysteresis within 0.1 percent maximum at 77 degrees Fahrenheit.
 5. Operating temperature: 32 degrees to 131 degrees Fahrenheit.
 6. Supply power: 9 to 30 VDC.
 7. Manufacturers: The following or equal:
 - a. Phoenix Contact, Mini Analog Pro.
 - b. Allen Bradley Type 800T-U29.
- G. Relays:
1. General:
 - a. For all types of 120-VAC relays, provide surge protection across the coil of each relay.
 - b. For all types of 24-VDC relays, provide a free-wheeling diode across the coil of each relay.
 - c. For plug in type relays, provide a relay base from the same manufacturer as the relay manufacturer.
 2. Control:
 - a. Magnetic style.
 - b. For use as standard control relay for motor and starter relay logic.
 - c. NEMA ratings:
 - 1) 300 volts.
 - 2) 10 amps thermal continuous test current.
 - 3) 60 amps make.
 - 4) 6 amps break.
 - d. Plug-in type.
 - e. LED indication for energization status.
 - f. Coil voltages: As required for the application.
 - g. Minimum poles: DPDT.
 - h. Touch-safe design: Connection terminals to be protected against accidental touch.
 - i. Enclose each relay in a clear plastic heat and shock-resistant dust cover.
 - j. Quantity and type of contact shall be as indicated on the Drawings or as needed for system compatibility.
 - k. Relays with screw-type socket terminals.
 - l. Provide additional relays when the following occurs:
 - 1) Number or type of contacts shown exceeds the contact capacity of the specified relays.
 - 2) Higher contact rating is required in order to interface with starter circuits or other equipment.
 - m. DIN rail mounting on 35-millimeter rail.

- n. Ice-cube-type relays with retainer clips to secure relay in socket.
- o. Integrated label holder for device labeling.
- p. Manufacturers: One of the following or equal:
 - 1) Potter and Brumfield: Type KRP or KUP.
 - 2) IDEC: R* Series (* = H, J, R, S, U).
 - 3) Allen-Bradley: Type 700 HC.
 - 4) Square D: Type K.

2.06 FINISHES

- A. Enclosure finish shall be manufacturer's standard gray.

PART 3 EXECUTION

3.01 COMMISSIONING

- A. As specified in this Section.
- B. Source Testing:
 - 1. VFDs:
 - a. Not witnessed.
 - b. All VFDs furnished under this Section shall be tested and inspected as specified below.
 - c. The testing procedures specified are the minimum acceptable requirements. The manufacturer may perform additional tests at its discretion.
 - d. Failure of any component during testing requires replacement of the faulted component and a complete retest.
 - e. Component tests:
 - 1) Preliminary inspection:
 - a) Verify that all components are correct.
 - b) Verify that all connections are properly torqued.
 - 2) Printed circuit boards:
 - a) Test each printed circuit board per the manufacturer's standard testing procedure.
 - 3) Wiring:
 - a) Control and power wiring continuity verified point-to-point.
 - b) Hi-pot power and control wiring at manufacturer's recommended levels.
 - c) Verify ground bond resistance.
 - 4) Load testing:
 - a) No load testing in accordance with the manufacturer's standard factory test procedure.
 - b) Full load testing:
 - (1) Test each VFD and all control logic with a representative motor or dynamometer load to simulate field operation conditions at 25 percent, 50 percent, and 100 percent full load current.

- (2) Tests shall be conducted in a manner in which the inverter (IGBT) section supplies all the output power (kw) of the VFD system. Control strategies using a contactor or other means of bypassing the VFD when operating at the line frequency shall not be permitted.
 - (3) Tests shall be conducted using a minimum output frequency of 60 hertz, and a minimum switching frequency of 2.5 kHz.
 - f. Furnish test reports and Manufacturer's Certificate of Source Testing.
- 2. Low voltage molded case circuit breaker:
 - a. Test breakers in accordance with:
 - 1) UL 489.
 - 2) Manufacturer's standard testing procedures.
- C. Installation Verification:
 - 1. Furnish Manufacturer's Certificate of Installation Verification.
- D. Owner Training:
 - 1. Perform Owner training as specified in this Section.
 - 2. Number of sessions:
 - a. Operations: 2.
 - b. Maintenance: 2.
 - c. Minimum 2 Hours scheduled on 2 different days to accommodate Owner's staff.

3.02 FIELD QUALITY CONTROL

- A. Provide the services of a VFD manufacturer representative for start-up assistance and training:
 - 1. Inspection and field adjustment:
 - a. Supervise the equipment installation and confirm controls have been properly installed, aligned, adjusted, and readied for operation.
 - b. Configure AFE drives for all new and existing sources (utility source and on-site generation in possible operating configurations).
 - 2. Start-up field testing:
 - a. Provide technical direction for testing, checkout, and startup of the VFD equipment in the field.
 - b. Under no circumstances are any portions of the drive system to be energized without authorization from the manufacturer's representative.
 - c. Compliance with the following specified parameters shall be verified by the VFD manufacturer:
 - 1) Motor terminal voltage:
 - a) Make field measurements at the motor connection box.
 - b) Make measurements of the full speed range of the VFD.
 - c) Make measurements with a recording type oscilloscope.
 - 2) Harmonics:
 - a) Make field measurements at the input terminals of the VFD with and without the VFD in operation.

- b) Harmonic testing shall include utility power as well as generator standby power.
- c) Make measurements with a recording type harmonic analyzer displaying individual and total harmonic currents and voltages:
 - (1) Record currents and voltages for a minimum of 10 minutes.
 - (2) Analyzers using snapshots are not acceptable.
- d. All utility sources and on-site generation shall be operational for start-up field testing.

3.03 ADJUSTING

- A. Make all adjustments as necessary and recommended by the manufacturer, Engineer, or Contractor's designated electrical field acceptance testing firm.
- B. Provide the services of a VFD manufacturer factory technician to make all drive parameter and protective device settings:
 - 1. Protective device settings provided by the VFD manufacturer in accordance with the manufacturer of the driven equipment requirements.
 - 2. Provide documentation of VFD settings included but not limited to:
 - a. Minimum speed.
 - b. Maximum speed.
 - c. Skip speeds.
 - d. Current limit.
 - e. Acceleration time.
 - f. Deceleration time.
 - g. Carrier frequency.
- C. Programming:
 - 1. Manufacturer/supplier may contract with the Contractor's project Programmer for portions of the tasks below.
 - 2. Provide network communication card between the drive to the Owner's control system as required.
 - 3. Provide all control logic as indicated in the control descriptions.
 - 4. Configure all network communications with applicable security settings, IP addresses and any other addressing tables required to provide a fully functioning system.
 - 5. Coordinate all IP addresses with the Contractor and Owner.
 - 6. Coordinate data exchange approach for efficient communications to the Owner's Process Control System. This effort will include a coordination meeting with Contractor and Owner to discuss the data exchange approach including formatting and mapping.

END OF SECTION

ATTACHMENT A - MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

Comments: _____

I hereby certify Source Testing has been performed on the above-referenced equipment/system as defined in the Contract, and results conform to the Contract Document requirements. Testing data is attached.

Date of Execution: _____, 20____

Manufacturer: _____

Manufacturer's Authorized Representative Name (*print*): _____

(Authorized Signature)

If applicable, Witness Name (*print*): _____

(Witness Signature)

ATTACHMENT B - MANUFACTURER'S CERTIFICATE OF INSTALLATION VERIFICATION

MANUFACTURER'S CERTIFICATE OF INSTALLATION VERIFICATION

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

I hereby certify the installation of the above-referenced equipment/system as defined in the Contract Documents.

NOTES:

Attach written certification report prepared by and signed by the electrical and/or instrumentation subcontractor.

Comments: _____

I, the undersigned manufacturer's representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate this equipment/system, and (iii) authorized to make recommendations required to ensure that the equipment/system furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Manufacturer: _____

Manufacturer's Authorized Representative Name (*print*): _____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

ATTACHMENT C - MANUFACTURER'S CERTIFICATE OF FUNCTIONAL COMPLIANCE

MANUFACTURER'S CERTIFICATE OF FUNCTIONAL COMPLIANCE

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

I hereby certify the Functional Testing of the above-referenced equipment/system as defined in the Contract Documents.

NOTES:

Attach test results with collected data and test report.

Attach written certification report prepared by and signed by the electrical and/or instrumentation subcontractor.

Comments: _____

I, the undersigned manufacturer's representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate this equipment/system, and (iii) authorized to make recommendations required to ensure that the equipment/system furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Manufacturer: _____

Manufacturer's Authorized Representative Name (*print*): _____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

WITNESSES

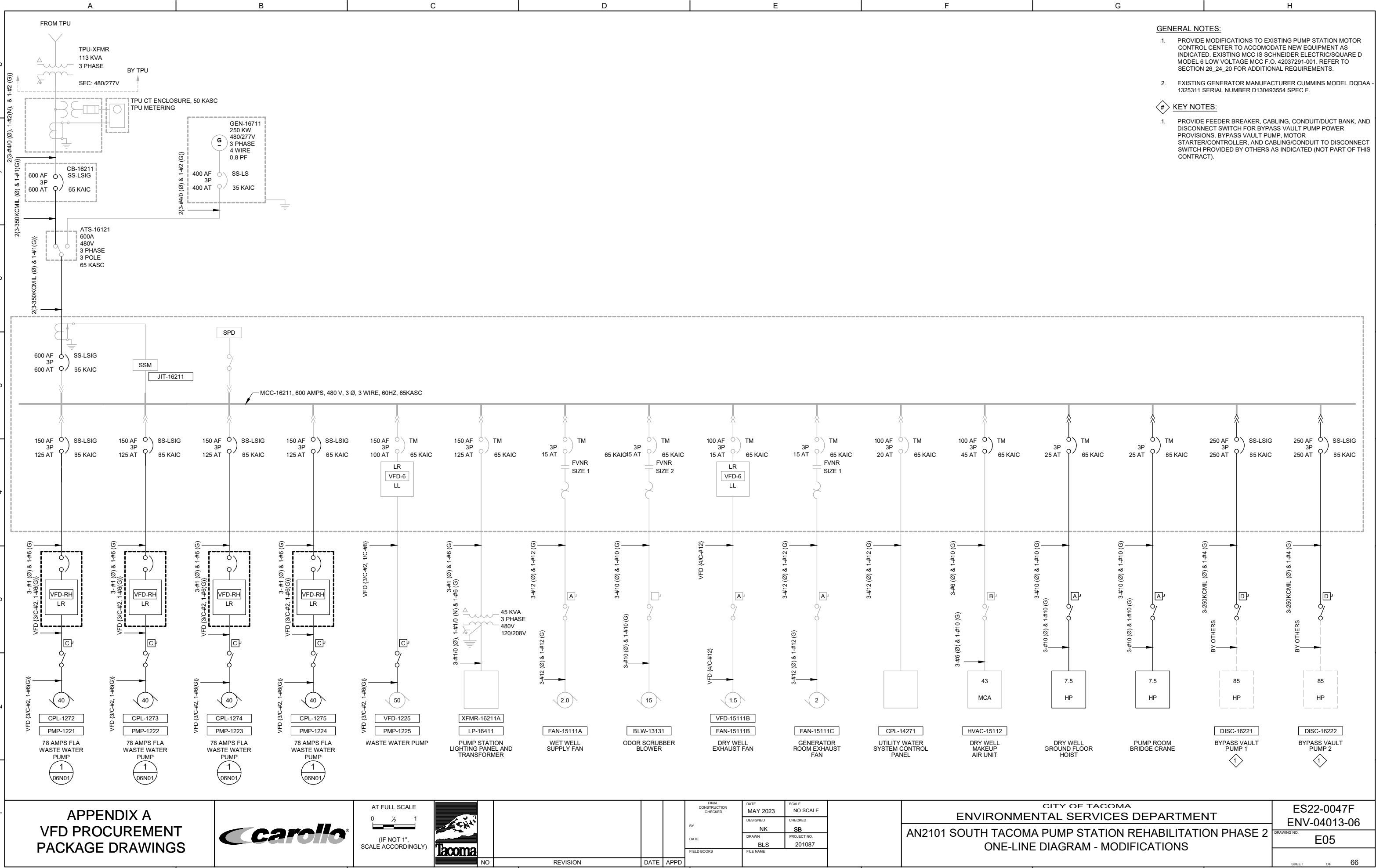
By Owner's Authorized Representative: _____
(Authorized Signature)

By Engineer's Authorized Representative: _____
(Authorized Signature)

APPENDIX A

VFD PROCUREMENT PACKAGE DRAWINGS

Model: Layout Pen Table Assignment: Carollo_Std_F_171703.ctb Plot Scale: 1:1
LAST SAVED BY: bstepard



APPENDIX A
VFD PROCUREMENT
PACKAGE DRAWINGS



AT FULL SCALE
0 1/2 1
(IF NOT 1",
SCALE ACCORDINGLY)



NO

REVISION

DATE

APPD

FINAL
CONSTRUCTION
CHECKED
BY
DATE
FIELD BOOKS

DATE
DESIGNED
DRAWN
PROJECT NO.
FILE NAME

SCALE
NO SCALE
CHECKED
SB
201087

CITY OF TACOMA
ENVIRONMENTAL SERVICES DEPARTMENT
AN2101 SOUTH TACOMA PUMP STATION REHABILITATION PHASE 2
ONE-LINE DIAGRAM - MODIFICATIONS

ES22-0047F
ENV-04013-06
DRAWING NO.
E05
SHEET OF 66

APPENDIX B

SOUTH TACOMA PUMP STATION REHABILITATION PROJECT PHASE 2 PUMP PROCUREMENT PACKAGE



**CITY OF TACOMA
TACOMA, WASHINGTON**

SOUTH TACOMA PUMP STATION REHABILITATION PROJECT PHASE 2

TECHNICAL SPECIFICATIONS

PUMP PROCUREMENT PACKAGE

APRIL 2023



CITY OF TACOMA
SOUTH TACOMA PUMP STATION REHABILITATION PROJECT PHASE 2
PUMP PROCUREMENT PACKAGE

Digitally signed by Tyler James Whitehouse
Contact Info: Carollo Engineers, Inc.
Date: 2023.04.05 11:48:20-07'00'



TECHNICAL SPECIFICATIONS
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SECTION 26_05_09

LOW VOLTAGE MOTORS UP TO 500 HORSEPOWER

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes:
 - 1. Low voltage motors up to 500 horsepower (hp).

1.02 REFERENCES

- A. American Bearing Manufacturers Association (ABMA):
 - 1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. American Petroleum Institute (API):
 - 1. 670 - Machinery Protection Systems.
- C. ASTM International (ASTM).
 - 1. B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- D. Institute of Electrical and Electronic Engineers (IEEE):
 - 1. 43 - IEEE Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
 - 2. 112 - IEEE Standard Test Procedure for Polyphase Induction Motors and Generators.
 - 3. 303 - Recommended Practice for Auxiliary Devices for Rotating Electrical Machines in Class I, Division 2 and Zone 2 Locations.
 - 4. 841 - IEEE Standard for Petroleum and Chemical Industry-Premium-Efficiency, Severe Duty, Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 370 kW (500 hp).
 - 5. 1349 - Guide for Application of Electric Motors in Class I, Division 2 and Class I, Zone 2 Hazardous (Classified) Locations.
- E. National Electrical Manufacturers' Association (NEMA):
 - 1. MG-1 - Motors and Generators.
 - 2. MG-2 - Safety Standard for Construction and Guide for Selection, Installation, and Use of Electric Motors and Generators.
- F. Underwriters Laboratories Inc. (UL):
 - 1. 674 - Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.

1.03 DEFINITIONS (NOT USED)

1.04 SYSTEM DESCRIPTION

- A. Furnish electric motors and accessories as specified in this Section and the Sections specifying driven equipment to provide a complete and operable installation.

1.05 SUBMITTALS

- A. Submit completed motor data sheets for each motor supplied:
 - 1. As specified in Attachment A - Motor Data Sheet.
 - 2. Manufacturer's or other data sheets are not acceptable.
- B. Product data:
 - 1. Descriptive bulletins.
 - 2. Machine tag and loop number as indicated on the Drawings and in the specification section number of the driven machine.
 - 3. Complete electrical data.
 - 4. Manufacturer's storage recommendations.
 - 5. Torque, current, and power factor versus speed curves:
 - a. At 100 percent rated voltage for all full voltage started and VFD-driven motors.
 - b. For motors on reduced voltage start at 70, 80, 90, and 100 percent rated voltage.
 - 6. Accessories data:
 - a. Motor winding heaters:
 - 1) Voltage.
 - 2) Watts.
 - b. Winding temperature detectors:
 - 1) Type.
 - 2) Rating.
 - 7. Mechanical data:
 - a. Bearing design and bearing life calculations.
 - b. Resonant frequencies for all VFD-driven motors 50 hp or greater.
- C. Shop drawings:
 - 1. Motor weight.
 - 2. Frame size.
 - 3. Conduit box(es), size(s), and location(s).
 - 4. Outline drawings with dimensions.
 - 5. Installation details for the project seismic criteria.
- D. Test reports:
 - 1. Factory test reports with test reference standard identified.
- E. Certification:
 - 1. When motors are driven by variable speed drive systems, submit certification that selected motor:
 - a. Is capable of satisfactory performance under the intended load.
 - b. Meets the requirements of the latest edition of NEMA MG-1 Part 31.

1.06 QUALITY ASSURANCE

A. General:

1. Furnish equipment listed by and bearing the label of UL or of an independent testing laboratory acceptable to the Engineer and the Authority Having Jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Shipping precautions:

1. After completion of shop assembly and successful factory testing, pack all equipment in protective crates, and enclose in heavy duty polyethylene envelopes or secured sheeting to provide complete protection from damage, dust, and moisture.
2. Place dehumidifiers, when required, inside the polyethylene coverings.
3. Skid-mount the equipment for final transport.
4. Provide lifting rings for moving without removing protective covering.
5. Display boxed weight on shipping tags together with instructions for unloading, transporting, storing, and handling at the job site.

B. Store motors in accordance with the manufacturer's recommendations.

1.08 PROJECT OR SITE CONDITIONS (NOT USED)

1.09 SEQUENCING (NOT USED)

1.10 SCHEDULING (NOT USED)

1.11 WARRANTY

A. As specified in Section 43_23_13.37 - Vertical Chopper Centrifugal Pumps.

1.12 SYSTEM START-UP (NOT USED)

1.13 OWNER'S INSTRUCTION (NOT USED)

1.14 MAINTENANCE (NOT USED)

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. One of the following or equal:

1. US Motors.
2. General Electric.
3. Reliance.
4. Toshiba.
5. Baldor.

2.02 EXISTING PRODUCTS (NOT USED)

2.03 MATERIALS (NOT USED)

2.04 MANUFACTURED UNITS (NOT USED)

2.05 EQUIPMENT

- A. 3-phase induction motors - general:
 - 1. Voltage:
 - a. All motors 1/2 hp and larger shall be rated 460 V, 3-phase.
 - b. Dual voltage motors rated 230/460 V, 3-phase are acceptable provided all leads are brought to the conduit box.
 - 2. Motors driving identical machines shall be identical.
 - 3. All motors greater than 1 hp and up to 500 hp shall meet the "NEMA Premium Efficiency" percent listed in NEMA MG-1.
 - 4. Horsepower as specified:
 - a. Horsepower ratings specified are based on vendor's estimates. Provide motors sized for the load of the actual equipment furnished without operating in the service factor.
 - 5. Service factor:
 - a. 1.15 service factor on sine wave power.
 - b. 1.0 when driven by VFD.
 - 6. Torque:
 - a. Provide motors that develop sufficient torque for acceleration to full speed at voltage 10 percent less than motor nameplate rating.
 - b. When started using reduced voltage starters:
 - 1) Provide motors that develop sufficient torque for acceleration to full speed.
 - c. NEMA Design B except where driven load characteristics require other than normal starting torque:
 - 1) In no case shall starting torque or breakdown torque be less than the values specified in NEMA MG-1.
 - 7. Enclosures:
 - a. As specified in the individual equipment Specifications or in this Section.
 - b. Totally enclosed fan cooled:
 - 1) Cast iron conduit box.
 - 2) Tapped drain holes with Type 304 stainless steel plugs for frames 286 and smaller, and automatic breather and drain devices for frames 324 and larger.
 - c. Lifting devices: All motors weighing 265 pounds (120 kilograms) or more shall have suitable lifting devices for installation and removal.
 - 8. Manufactured with cast iron frames in accordance with NEMA MG-1 or manufacturer's standard material for the specified rating.
 - 9. Nameplates:
 - a. Provide all motors with a permanent, stainless steel nameplate indelibly stamped or engraved with:
 - 1) NEMA standard motor data.
 - a) Indicate compliance with NEMA MG-1 Part 31 for inverter duty motors.
 - 2) AFBMA bearing numbers and lubrication instructions.
 - 10. Hardware:
 - a. Type 304 stainless steel.

11. Conduit boxes:
 - a. Cast iron or stamped steel.
 - b. Split from top to bottom.
 - c. Provide gaskets at the following interfaces:
 - 1) Frames and conduit boxes.
 - 2) Conduit boxes and box covers.
 - d. Rotatable through 360 degrees in 90-degree increments.
 - 1) Where available based on the size of the conduit box.
 - e. Exceeding the dimensions defined in NEMA MG-1.
 - f. Provide grounding lugs inside conduit boxes for motor frame grounding.
12. Motor bearings:
 - a. Anti-friction.
 - b. Regreasable and initially filled with grease for horizontal motors and vertical motors per manufacturer's standard design.
 - c. Bearings and lubrication suitable for ambient temperature and temperature rise.
 - d. Suitable for intended application and have ABMA L-10 rating life of 60,000 hours or more.
 - e. Fit bearings with easily accessible grease supply, flush, drain, and relief fittings using extension tubes where necessary.
 - f. Where specified in the equipment Specifications, provide split-sleeve type hydrodynamic radial bearings. Provide a bearing isolator to protect bearings from contaminants.
13. Insulation systems:
 - a. Motors installed in ambient temperatures 40 degrees Celsius or less:
 - 1) Provide Class F insulation.
 - 2) Design temperature rise consistent with Class B insulation.
 - 3) Rated to operate at an ambient temperature of 40 degrees Celsius at the altitude where the motor will be installed.
14. Motor leads:
 - a. Insulated leads with non-wicking, non-hydroscopic material. Class F insulation.
15. Noise:
 - a. Maximum operating noise level in accordance with NEMA MG-1.
- B. Vertical motors:
 1. Enclosures:
 - a. Totally enclosed fan cooled (TEFC).
 2. Thrust bearings:
 - a. Selected for combined rotor and driven equipment loads.
 - b. Coordinate with driven equipment supplier for maximum vertical thrust of driven equipment.
 3. Anti-reverse ratchet.
- C. Motors driven by variable frequency drives:
 1. Compatible with the variable frequency drives specified.
 2. Inverter duty rated and labeled.
 3. Meet the requirements of NEMA MG-1 Part 31.
 4. Winding insulation meets the requirements of NEMA MG-1 Part 31.4.4.2.
 5. Capable of running continuously at 1/2 of full speed, with no harmful effects or overheating.

6. Shaft grounding ring:
 - a. Provide a shaft grounding ring for each VFD-driven motor.
 - b. Aluminum frame and internal components.
 - c. Conductive microfiber brushes.
 - d. Maintenance free design.
 - e. Aegis Bearing Protection ring as manufactured by Electro Static Technology or equal.
- D. Motors installed in corrosive environments:
 1. Stator double dipped in varnish and baked.
 2. Stator and rotor coated with corrosion resistant epoxy.
 3. Frame, brackets, fan guard and conduit box coated with minimum of 2 coats of epoxy paint.
 4. Withstand salt spray tests in accordance with ASTM B117.

2.06 COMPONENTS (NOT USED)

2.07 ACCESSORIES

- A. Motor winding heaters:
 1. Provide all 3-phase motors with belted or cartridge space heaters mounted within the motor enclosure.
 2. Space heater rating shall be 120 volts, single-phase, unless otherwise indicated on the Drawings.
 3. Power leads for heaters wired into conduit box.
 4. Installed within motor enclosure adjacent to core iron.
- B. Winding temperature detectors:
 1. Temperature switches with normally closed contacts as indicated on the Drawings.

2.08 MIXES (NOT USED)

2.09 FABRICATION (NOT USED)

2.10 FINISHES (NOT USED)

2.11 SOURCE QUALITY CONTROL (NOT USED)

PART 3 EXECUTION

3.01 EXAMINATION (NOT USED)

3.02 PREPARATION (NOT USED)

3.03 INSTALLATION

- A. Install motors in accordance with manufacturer's instructions.
- B. Install shaft grounding ring on VFD-driven motors in accordance with the manufacturer's instructions.

3.04 ERECTION, INSTALLATION, APPLICATION, CONSTRUCTION (NOT USED)

3.05 REPAIR/RESTORATION (NOT USED)

3.06 RE-INSTALLATION (NOT USED)

3.07 COMMISSIONING AND PROCESS START-UP

A. Factory testing:

1. Motors less than 250 hp:

a. Perform manufacturer's standard production tests including but not limited to:

- 1) No load current.
- 2) High potential test.
- 3) Winding resistance.

b. Furnish copies of standard test reports on prototype or identical units.

3.08 FIELD QUALITY CONTROL (NOT USED)

3.09 ADJUSTING (NOT USED)

3.10 CLEANING (NOT USED)

3.11 PROTECTION (NOT USED)

END OF SECTION

ATTACHMENT A - MOTOR DATA SHEET

MOTOR DATA SHEET

MOTOR/ EQUIPMENT TAG _____ MOTOR NUMBER _____			
SPECIFICATION NUMBER OF DRIVEN MACHINE _____			
MOTOR NAMEPLATE DATA			
MANUFACTURER _____	MODEL/SERIES _____	MODEL NO. _____	
FRAME _____	ENCLOSURE _____	NEMA DESIGN _____	
HP _____	SERVICE FACTOR _____	RPM _____	
INSULATION CLASS _____	VOLTS _____	FULL LOAD AMPS _____	
AMBIENT TEMP _____	PHASE _____	NO LOAD AMPS _____	
DESIGN TEMP _____	HERTZ _____	LOCK ROTOR AMPS _____	
INRUSH CODE LETTER _____			
	100% LOAD	75% LOAD	50% LOAD
GUARANTEED MINIMUM EFFICIENCIES:	_____	_____	_____
GUARANTEED MINIMUM POWER FACTOR:	_____	_____	_____
MAXIMUM SIZE OF POWER FACTOR CORRECTION CAPACITOR: _____ KVAR			
ACCESSORIES			
MOTOR WINDING HEATER _____ VOLTS		_____ WATTS	
WINDING THERMAL PROTECTION _____			
WINDING TEMP SWITCHES (YES/NO) _____			
RTD:			
TYPE _____	QUANTITY PER PHASE _____	# OF WIRES _____	
NOMINAL RESISTANCE _____	NOMINAL TEMP _____	COEFFICIENT _____	
RECOMMENDED ALARM _____	DEGREES CELSIUS _____	RECOMMENDED TRIP _____	DEGREES CELSIUS _____
SPECIAL APPLICATIONS			
INVERTER DUTY* (YES/NO) _____		PART WINDING (YES/NO) _____	
WYE - DELTA (YES/NO) _____		2 SPEED, 1 WINDING (YES/NO) _____	
2 SPEED, 2 WINDING (YES/NO) _____		AREA CLASSIFICATION:	
CLASS _____	DIVISION _____	GROUP _____	TEMP CODE _____
* Conforms to NEMA MG-1 Part 31.			

SECTION 43_23_13.37

VERTICAL CHOPPER CENTRIFUGAL PUMPS

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Vertical dry pit, flexibly coupled, centrifugal chopper pump with drivers and features as specified.
- B. Tag numbers: As specified in Pump Schedule.

1.02 REFERENCES

- A. American Bearing Manufacturers Association (ABMA):
 - 1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. American Society of Mechanical Engineers (ASME):
 - 1. B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, and 250.
- C. ASTM International (ASTM):
 - 1. A48 - Standard Specification for Gray Iron Castings.
 - 2. A108 - Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - 3. A148 - Standard Specification for Steel Castings, High Strength, for Structural Purposes.
 - 4. A276 - Standard Specification for Stainless Steel Bars and Shapes.
 - 5. A536 - Standard Specification for Ductile Iron Castings.
 - 6. A582 - Standard Specification for Free-Machining Stainless Steel Bars.
 - 7. E10 - Standard Test Method for Brinell Hardness of Metallic Materials.
- D. Hydraulic Institute (HI):
 - 1. 9.1-9.5 - Pumps - General Guidelines.
 - 2. 14.1-14.2 - Rotodynamic Pumps for Nomenclature and Definitions.
 - 3. 14.3 - Rotodynamic Pumps for Design and Application.
 - 4. 14.4 - Rotodynamic Pumps for Installation Operation and Maintenance.
 - 5. 14.6 - Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

1.03 DEFINITIONS

- A. Pump head (total dynamic head, TDH), flow capacity, pump efficiency, net positive suction head available (NPSHa), and net positive suction head required (NPSHr):
As defined in HI 9.1-9.5, 14.1-14.2, 14.4, 14.6 and as modified in the Section.
- B. Suction head: Gauge pressure available at pump intake flange or bell in feet of fluid above atmospheric; average when using multiple suction pressure taps, regardless of variation in individual taps.

- C. Allowable Operating Region (AOR): The region over which the service life of the pump is not seriously compromised by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.
- D. Preferred Operating Region (POR): The region over which the service life of the pump will not be significantly affected by hydraulic loads, vibration, or flow separation where the pump's vibration, noise, and cavitation are within acceptable limits.
- E. Tolerances: In accordance with HI 9.1-9.5, and 14.1-14.4, and 14.6, unless specified more restrictively.

1.04 SUBMITTAL

- A. Submit as specified herein, and as specified in Section 26_05_09 – Low Voltage Motors up to 500 Horsepower. The information submitted shall verify full conformance to all aspects of the Specifications and shall include, but is not limited to the following:
 - 1. Pumps:
 - a. Pump and motor dimensional layout drawings.
 - 1) At a minimum, dimensions shall consider:
 - a) Field verified suction and discharge orientations for each pump.
 - b) Pump feet locations/orientation, associated with the concrete pedestal design.
 - b. Pump curves and performance data. Pump Curves shall be in units of gallons per minute (gpm). Pump curves shall include the full AOR, and true minimum operating speed, regardless of the specified operating conditions.
 - c. Pump construction details.
 - d. Bearing life calculations.
 - e. Shaft deflection calculations.
 - f. Rotordynamic analysis, when specified.
 - g. Pump base (and suction elbow) design and layout details.
 - h. Certifications:
 - 1) Submit Certification of Rockwell C Hardness for cutter bars and impeller.
 - 2. Motor nameplate data, dimensions and construction details.
 - 3. List of materials for pumps, motors, driveshafts, VFD's, and accessory items.
 - 4. Any proposed deviations from the Specifications and Drawings.
- B. Rotordynamic analysis: Submit as specified in Section 46_05_10 - Common Work Results for Mechanical Equipment when scheduled.
- C. Calculations:
 - 1. Rotordynamic analysis: Submit as specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.
 - 2. Pump Manufacturer to Provide calculations and details sealed by a Professional Engineer (registered in the State of Washington), to substantiate the pump base design, and associated anchorage to the existing concrete structure. Calculations shall consider dead, live, seismic, pressure loads,

torque and thrust loads in the design. Also consider vibration criteria indicated in Section 46_05_94 - Mechanical Equipment Testing.

- D. Operation and maintenance manuals.
- E. Commissioning submittals:
 - 1. Provide Manufacturer's Certificate of Source Testing.
 - a. The form shall be completed by the manufacturer to confirm that the specified source tests have been performed and the results conform to the specified requirements. The form is provided in Attachment A at the end of this Section.
 - 2. Provide Manufacturer's Certificate of Installation Verification:
 - a. The form shall be completed by the manufacturer to confirm that the equipment or system is installed in conformance with the Contract. The form is provided in Attachment B at the end of this Section.
 - 3. Provide Manufacturer's Certificate of Functionality Compliance.
 - a. The form shall be completed by the manufacturer to confirm that testing of the installed equipment or system has been performed and the results conform to the specified performance. The form is provided in Attachment C provided at the end of this Section.

1.01 QUALITY ASSURANCE

- A. Rotordynamic analysis: Provide equipment vibration analysis as specified in this Section.
 - 1. Rotordynamic analysis level: Level 1, as specified in Section 46_05_10 - Common Work Results for Mechanical Equipment.
- B. Manufacturer's Certificate of Installation and Functionality Compliance.

1.02 WARRANTY

- A. Two (2) years from date of startup (completion of functional testing, and acceptance of associated test report) or thirty (30) months from the date of shipment, whichever occurs sooner.
- B. Submittals:
 - 1. For each item of material or equipment furnished under the Contract:
 - a. Submit manufacturer's warranty prior to fabrication and shipment of the item from the manufacturer's facility.
 - 1) Include each required warranty in proper form, with full information, certified by manufacturer as required, and properly executed by Installing Contractor, or supplier.
 - 2) Provide name, address, phone number, and point of contact of manufacturer, supplier, as applicable.
- C. Owner's Rights:
 - 1. Owner reserves the right to reject warranties.
 - 2. Owner reserves the right to refuse to accept Work for the project if the required warranties have not been provided.

- D. Relationship to Warranty and Correction Period:
 - 1. Warranties specified for materials and equipment shall be in addition to, and run concurrent with, both the warranty and the correction period requirements.
- E. Manufacturer's Warranty Minimum Requirements:
 - 1. Written warranty issued by item's manufacturer.
 - 2. Project-specific information, properly executed by product manufacturer, and expressly states that its provisions are for the benefit of the Installing Contactor.
 - 3. Covers all costs associated with the correction of the defect, including but not limited to removal of defective parts, new parts, labor, and shipping.
 - 4. Provides a timely response to correct the defect.
 - a. Manufacturer shall provide, in a timely fashion, temporary equipment as necessary to replace warranted items requiring repair or replacement, when warranted items are in use and are critical to the treatment process, as defined by Owner.
 - 5. Warranty to commence upon on the date of successful completion of functional testing, and acceptance of associated test report.
 - a. For items of Work for which acceptance is delayed beyond completion of functional testing and acceptance of associated reporting, submit warranty within 10 calendar days after acceptance, listing date of acceptance as beginning of warranty period.
- F. Warranty Work:
 - 1. Replacement cost:
 - a. Upon determination that work covered by warranty has failed, replace or rebuild the work to an acceptable condition complying with requirement of this Section.
 - 1) Manufacturer is responsible for the cost of replacing or rebuilding defective work regardless of whether Owner has benefited from the use of the work through a portion of its anticipated useful service life.
 - 2. Owner's recourse:
 - a. Written warranties are in addition to implied warranties, and shall not limit the duties, obligations, rights, and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitation on time in which Owner can enforce such other duties, obligations, rights, or remedies.
 - 3. Reinstatement of warranty:
 - a. When work covered by a warranty has failed and has been corrected by replacement or rebuilding, reinstate the warranty by written endorsement.
 - 1) The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

1.03 OPERATION AND MAINTENANCE MANUALS

- A. Provide operation and maintenance manuals within 20 days after the completion of specified Functional Testing. Include the following:
 - 1. Record (as-built) wiring diagrams, interconnection diagrams, and equipment drawings.
 - 2. List of current names, addresses, and telephone numbers of those who should be contacted for service, information, and assistance.

3. Test results:
 - a. Source Testing.
 - b. Field Testing.
- B. The O&M information is to be in sufficient detail to allow the operation, removal, installation, adjustment, calibration, and maintenance of equipment provided under this Section.
- C. Assemble each set of manuals in one or more three-ring binders, each with a title page, table of contents, and heavy section dividers with labeled index tabs. When more than one binder is required, label the binders as "Volume 1," "Volume 2," etc. The table of contents is to encompass the entire set of O&M Manuals, list the contents of each volume, and appear in each binder.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Vaughan Co, Inc.

2.02 DESIGN AND PERFORMANCE CRITERIA

- A. Vertical, chopper centrifugal pumps with components: Pumps, drivers, motors, and drive arrangements as specified or as scheduled with shafts, seals or packing, couplings, suction elbow, base plates or pedestals, guards, supports, anchor bolts (sizing and installation details), taps, lifting eyes, stands, and other items as required for a complete and operational system.
- B. Design requirements:
 1. Pump performance characteristics:
 - a. As specified in the Pump Schedule.
 - b. All required conditions (flow/head) shall be within the pump manufacturer's Allowable Operating Range (AOR).
 - c. Performance tolerances shall be the same as the specified test tolerances.
 - d. Test tolerances shall be in accordance with appropriate HI Standards, except the following modified tolerances apply:
 - 1) From 0 to plus 5 percent of head at the rated design point flow.
 - 2) From 0 to plus 5 percent of flow at the rated design point head.
 - 3) No tolerance for head and flow when ranges are specified.
 - 4) No negative tolerance for the efficiency at the rated design point, and other specified conditions.
 - 5) Use of specified test tolerances shall not result in motor overload while operating at any point on the supplied pump operating head-flow curve, including runout.
 - 6) No positive tolerance for vibration limits. Vibration limits and test methods in HI Standards do not apply, use limits and methods specified in this Section.
- C. Motor characteristics: As specified in the Pump Schedule.

- D. Chopping/maceration of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter box at the intake opening.
- E. The pumps shall be capable of continuous operation while pumping sludge containing up to 6 percent solids with heavy rags, plastics, grease, hair, grit, and other stringy fibrous material.
- F. Component Weight: Neither the Pump, motor, nor base (with suction elbow) are to exceed the weight indicated in the Pump Schedule. Hoisting equipment associated with the pump and/or associated components have been sized for the scheduled weight.
- G. Hoisting Clearance: Pump assembly (fully assembled on pump base, with suction elbow) must be capable of passing through an opening of dimensions indicated in the Pump Schedule. The pump assembly is to pass through the opening such that the volute does not require rotation about the horizontal axis (i.e., pump passes through in its installed orientation).
- H. Pump Height: The top of motor (relative to pump discharge centerline) shall not exceed the dimension indicated in the Pump Schedule.

2.03 MATERIALS

- A. General: Materials in the Pump Schedule shall be the type and grade as specified in this Section.
- B. Cast iron: ASTM A48, Class 30 minimum.
- C. Ductile iron: ASTM A536.
- D. Cast steel: ASTM A148, Grade 90 - 60; minimum Rockwell C hardness number as scheduled.
- E. Steel: ASTM A108, Grade as scheduled.
- F. 316 Stainless: ASTM A276, Type 316 stainless steel; nickel - chrome - boron coating as scheduled.
- G. 420F Stainless: ASTM A582, Type 420 Stainless Steel.

2.04 GENERAL PUMP CONSTRUCTION

- A. Type: Industrial (heavy) duty chopper centrifugal pumps.
- B. Other requirements:
 - 1. Vibration: As specified in Section 46_05_94 - Mechanical Equipment Testing.

2.05 PUMP CASINGS

- A. Material: As scheduled.
- B. Provide a single piece casing with integrally cast discharge flange.
- C. Design to withstand a design working pressure not less than 1.10 times the maximum shutoff total dynamic head with the maximum diameter impeller at the maximum operating speed plus the maximum suction static head.
- D. Design to withstand a 5-minute hydrostatic test pressure not less than 1.5 times the design working pressure.
- E. Suction and discharge orientation: Discharge angle to be determined by either Engineer and/or Installing Contractor for each pump. An approval drawing will be provided for the Engineer and/or Installing Contractor to review and verify that the discharge angles on the approval drawing are correct. If correct, either the Engineer or Installing Contractor will sign the approval drawing to give the permission to release to manufacturing the affected pump components.
- F. Provide suction and discharge flanges with ASME B16.1 Class 125 bolt patterns.
- G. Provide a cast cleanout to permit inspection and cleaning of the pump suction area.
 - 1. The cleanout shall have a bolted cover with inner contour that matches contour of suction piece.
- H. Provide casings with 1/2-inch NPT high point vent, and threaded plug to facilitate installation of pipe nipples with threaded gate valves (by Installing Contractor).
- I. Provide 1/4-inch NPT taps for pressure gauges on the suction and discharge flanges.
- J. Suction elbow:
 - 1. Style: 90-degree, long radius, pedestal base type.
 - 2. Size 14 inch x 14 inch.
 - 3. Material: Steel.
 - 4. Features:
 - a. Minimum 6-inch diameter removable cleanout handhole. Provide bolted covers with inner contour that matches contour of suction elbow.
 - b. Provide 2-inch NPT low point drain, and threaded plug to facilitate installation of pipe nipples with threaded gate valves (by Installing Contractor).
- K. Discharge transition piece: Provide transition piece, and associated hardware, at pump discharge flange to allow fit-up to 14-inch pump discharge piping. Laying length of transition piece shall not exceed 4 1/4-inches. Final thickness to be verified in the field, and adjusted by manufacturer, as required to accommodate final fit.

2.06 BACK PLATES

- A. Material: As scheduled.
- B. The back pullout plate shall be a separate component part and shall allow removal of the pump components from above the casing.
- C. The back pullout plate shall allow external adjustment of the impeller to cutter bar clearance.
- D. The pump shall include a rear cutting mechanism designed to cut against the pump out vanes and the impeller hub, reducing and removing stringy materials from the mechanical seal.

2.07 CUTTER BAR

- A. Material: As scheduled.
- B. Design cutter bar plate to prevent blockage of intake and binding of debris at the shaft and impeller vanes.
- C. Cutter bar shall be replaceable without replacement of the suction flange or suction plate.
 - 1. Cutter bars, which are integral to the suction flange, or suction plate are not acceptable.

2.08 IMPELLERS

- A. Material: As scheduled.
- B. Type: Single-passage, semi-open chopper-centrifugal impeller with smooth water passages to reduce clogging by rags, stringy or fibrous materials on impellers or shafting.
- C. Provide dynamic balance of impeller and complete rotating element.
- D. Provide for external adjustment of impeller to cutter bar clearances without pump disassembly or disturbances of suction or discharge piping.

2.09 PUMP SHAFTS

- A. Material:
 - 1. As scheduled.
 - 2. Hard faced or with hardened sleeve where shafts pass through bearings.
 - 3. If mechanical seals are scheduled and mechanical seals cannot be installed on hardened shaft, shaft is not to be hardened in the mechanical seal area.
 - 4. If sleeve provided, sleeve to be renewable and key locked in place.
- B. Strength: Able to withstand minimum 1.5 times maximum operating torque and other loads.

- C. Resonant frequency: As specified in Sections 46_05_10 - Common Work Results for Mechanical Equipment and 46_05_94 - Mechanical Equipment Testing.
- D. Deflection: Maximum 0.002 inches under operating conditions.
- E. Impeller attachment: Readily removable without use of special tools.
- F. Shaft seal type:
 - 1. Flushless mechanical seals, meeting the following requirements:
 - a. Cartridge-type, specifically designed to require no seal flush.
 - 1) The cartridge seal shall be pre-assembled, and pre-tested so that no seal settings or adjustments are required from the installer.
 - 2) The cartridge shall include a 17-4PH, Heat-treated seal sleeve and ductile iron seal housing.
 - b. Balanced hydraulically.
 - c. Faces: Silicon Carbide (or Tungsten Carbide).
 - d. O-Ring: Viton™.
 - e. Any springs used to push the seal faces together must be shielded from the fluid to be pumped.

2.10 STUFFING BOXES

- A. Materials: As scheduled.
- B. Provide stuffing box housing large enough to retrofit with double mechanical seal.

2.11 BEARINGS AND BEARING FRAME

- A. Bearing type: Back-to-back mounted single-row angular contact ball bearing and radial bearings, self-aligning spherical roller type radial bearings, angular contact ball type, or tapered roller for thrust bearings.
- B. Bearing lubrication: As scheduled.
- C. Bearing life: Minimum L10 life of 100,000 hours at rated design point or 24,000 hours in accordance with ABMA 9 or 11 at bearing design load imposed by pump shutoff with maximum sized impeller at rated speed, whichever provides longest bearing life in intended service.
- D. Pump bearing frames:
 - 1. Material: As scheduled.
 - 2. Provide a 1-piece rigid construction with bearing housing.

2.12 COUPLINGS

- A. General:
 - 1. Type and ratings: Non-lubricated designed for not less than 50,000 hours of operating life.
 - 2. Sizes: Provide as recommended by manufacturer for specific application, considering horsepower, speed of rotation, balance, and type of service.

3. Suitable for an ambient temperature range between -40 degrees to +200 degrees Fahrenheit.
- B. Type: Flexible
1. Manufacturers: One of the following or equal:
 - a. Rexnord.
 - b. T.B. Woods.
 2. Provide flexible couplings designed to accommodate shock loading, vibration, and shaft misalignment or offset.
 3. Provide flexible connecting element of rubber and reinforcement fibers.
 4. Provide service factor of 1.5, minimum.
 5. Connect stub shafts through collars or round flanges, firmly keyed to their shafts with neoprene cylinders held to individual flanges by through pins.

2.13 SUPPORTS, PEDESTALS, AND BASEPLATES

- A. Pump base:
1. Design a minimum 3/8-inch fabricated structural steel base and support system for the drive arrangement scheduled.
 2. Provide details of anchorage requirements.
 3. Provide template to facilitate the Installing Contractor installation of the base anchorage system.
- B. Pump, driver, and bearing support strength: Able to withstand minimum 1.5 times maximum imposed operating loads or imposed seismic loads, whichever is greater.
- C. Configuration: Allow easy access to stuffing boxes, bearing frames, and couplings.
- D. Anchor bolts: Manufacturer to size and provide installation details. Anchors to be provided by Installing Contractor.

2.14 EQUIPMENT GUARDS

- A. Provide safety guards on rotating components.
1. Allow visual inspection of moving parts without removal.
 2. Allow access to lubrication fittings.
 3. Easily removable for maintenance.
- B. Materials:
1. Sheet metal: Stainless steel, 12-gauge minimum thickness.
- C. Fasteners: Type 316 stainless steel.

2.15 DRIVERS

- A. Horsepower:
1. As scheduled.
 2. Listed driver horsepower is the minimum to be supplied.
 - a. Increase driver horsepower if required to prevent driver overload while operating at any point of the supplied pump operating head-flow curve including runout.

- b. When scheduled driver is a motor, increase motor horsepower if required to prevent operation in the service factor.
 - c. Make all structural, mechanical, and electrical changes required to accommodate increased horsepower.
- B. Motors: Provide motors as specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower and as specified in this Section:
 - 1. Revolutions per minute: As scheduled.
 - 2. Enclosure: As scheduled.
 - 3. Electrical characteristics: As scheduled.
 - 4. Efficiency, service factor, insulation, and other motor characteristics: As specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower.
 - 5. Motor accessories: As specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower and in this Section.
 - 6. Coordinate motors with the variable frequency drive manufacturer to ensure compatibility between the motor and variable frequency drive.

2.16 FINISHES

- A. Surface preparation: SSPC-SP6 commercial sandblast with a prime coat of Tnemec 431 epoxy and finish coat of Tnemec 431 epoxy for total finish of 30 MDFT minimum.

2.17 NAMEPLATES

- A. Fastened to equipment at factory in an accessible and visible location.
- B. Metal engraved or stamped with text, holes drilled or punched for fasteners.
- C. Material: Aluminum or stainless steel.
- D. Fasteners: Number 4 or larger oval head stainless steel screws or drive pins.
- E. Text:
 - 1. Manufacturer's name, equipment model number, equipment serial number, and identification tag number.
 - 2. Indicate the following additional information as applicable:
 - a. Maximum and minimum rotating speed.
 - b. Rated total dynamic head in feet of fluid.
 - c. Rated flow in gallons per minute.
 - d. Impeller size.
 - 3. Include for motors:
 - a. Drive speed.
 - b. Motor horsepower with rated capacity.

2.18 SPARE PARTS AND SPECIAL TOOLS

- A. Spare parts: Deliver the following:
 - 1. Mechanical seal: 1 complete seal assembly for each type supplied.
 - 2. Pump bearings: 1 set of radial and 1 set of thrust bearings.
 - 3. Impeller cutter bar: 1 set.

- B. Special tools: Provide 1 set of all special tools (including but not limited to the impeller install/removal tool) required for complete assembly or disassembly of all the pump system components.

PART 3 EXECUTION

3.01 COMMISSIONING

- A. Manufacturer services:
 - 1. Provide certificates:
 - a. Manufacturer's Certificate of Source Testing.
 - b. Manufacturer's Certificate of Installation and Functionality Compliance.
 - 2. Manufacturer's Representative onsite requirements for each pump:
 - a. Installation: 1 trip, 1-day minimum.
 - b. Functional Testing: 1 trips, 1-day minimum.
 - 3. Training:
 - a. Maintenance: 4 hours per session, 2 sessions.
 - b. Operation: 2 hours per session, 2 sessions.
- B. Source testing:
 - 1. Test level as scheduled; test as specified in Section 46_05_94 - Mechanical Equipment Testing.
 - 2. Source Test Plan:
 - a. Engineer approval of Source Test Plan required prior to testing.
 - 3. Witnessed in person when scheduled.
 - 4. If the Source Test is not ready on the scheduled date or if the Source Test fails:
 - a. Manufacturer is responsible for associated costs:
 - 1) First test costs that are non-refundable, if applicable.
 - 2) Repeat test costs:
 - a) Trip costs, if applicable.
 - 5. If the Source Test is not ready on the scheduled date or if the Source Test fails:
 - a. Manufacturer is responsible for associated costs:
 - 1) First test costs that are non-refundable, if applicable.
 - 2) Repeat test costs:
 - a) Trip costs, if applicable.
 - 6. Source testing is complete after successful testing, submittal of test report, and Manufacturer's Certificate of Source Testing.
 - 7. Engineer approval of Source Testing Report is required.
- C. Functional testing services:
 - 1. Provide field services to the Installing Contractor as necessary to conduct the test level as scheduled; test as specified in Section 46_05_94 - Mechanical Equipment Testing.

3.02 PUMP SCHEDULE

Tag Numbers	PMP-1221 PMP-1222 PMP-1223 PMP-1224
<u>General Characteristics</u>	
Service	Raw Sewage
Quantity	4
Named Manufacturer's Model Number	Model PE12W
Maximum Noise, dBA at 3 feet	85
Minimum Pumped Fluid degrees Fahrenheit	50
Normal Pumped Fluid degrees Fahrenheit	70
Maximum Pumped Fluid degrees Fahrenheit	85
Maximum Component Weight, tons	1.5
Hoisting Clearance, inches x inches	52 x 52
Maximum Pump Height, inches	86
<u>Pump Characteristics</u>	
Impeller	Semi-open with chopper
Impeller Bearing Lubrication	Oil or Grease
Speed Control	Variable Frequency Drive
Maximum Pump revolutions per minute	500
Minimum Pump revolutions per minute	350
<u>Rated Design Point (at Maximum Revolutions per Minute):</u>	
Flow, gallons per minute	4,000
Head, feet	27
Min. Efficiency, percent	77
<u>Required Condition 2 (at Maximum Revolutions per Minute):</u>	
Flow, gallons per minute	2,200
Head Range, feet	31 to 35
Min. Efficiency, percent	60
<u>Required Condition 3 (at Maximum Revolutions per Minute):</u>	
Flow Range, gallons per minute	5,000 to 5,600
Head, feet	20
Min. Efficiency, percent	72

Tag Numbers	PMP-1221 PMP-1222 PMP-1223 PMP-1224
<u>Required Condition 4 (at Reduced Revolutions per Minute):</u>	
Flow, gallons per minute	2,000
Head, feet	17
Min. Efficiency, percent	65
<u>Other Conditions:</u>	
Maximum Shut Off Head, feet	40
Minimum Shut Off Head, feet	33
Max. NPSHr at Every Specified Flow, feet	12
Min. NPSHa at Every Specified Flow, feet	25
Min. Suction Static Head, feet	-4
Max. Suction Static Head, feet	25
<u>Pump Materials</u>	
Pump Casing	Ductile Iron or Cast Iron
Impeller	Cast Steel, 60 Rockwell C
Cutter Bar	T-1 Alloy Steel or Cast Steel, 60 Rockwell C
Shaft	Steel, Grade 4140
Shaft Sleeve	17-4PH
Stuffing Box	Cast Iron
Pump Bearing Frame	Cast Iron
Nuts and Bolts	316 Stainless
<u>Driver Characteristics</u>	
Driver Type	Motor
Drive Arrangement	Vertical Dry Pit
Non-reverse Ratchets	None
Minimum Driver Horsepower	40
Maximum Driver Speed, revolutions per minute	514
<u>Motor Characteristics (when motor is driver type)</u>	
Inverter Duty Rated	Yes
Motor Voltage/Phases/Hertz	460/3/60
Enclosure Type	TEFC
<u>Source Testing</u>	
Test Witnessing	Witnessed
Performance Test Level	2

Tag Numbers	PMP-1221 PMP-1222 PMP-1223 PMP-1224
Vibration Test Level	2
Noise Test Level	1
<u>Functional Testing</u>	
Performance Test Level	3
Vibration Test Level	2
Noise Test Level	2

END OF SECTION

ATTACHMENT A – MANUFACTURER’S CERTIFICATE OF SOURCE TESTING

MANUFACTURER'S CERTIFICATE OF SOURCE TESTING

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

Comments: _____

I hereby certify Source Testing has been performed on the above-referenced equipment/system as defined in the Contract, and results conform to the Contract Document requirements. Testing data is attached.

Date of Execution: _____, 20____

Manufacturer: _____

Manufacturer's Authorized Representative Name (*print*): _____

(Authorized Signature)

If applicable, Witness Name (*print*): _____

(Witness Signature)

ATTACHMENT B - MANUFACTURER'S CERTIFICATE OF INSTALLATION VERIFICATION

MANUFACTURER'S CERTIFICATE OF INSTALLATION VERIFICATION

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

I hereby certify the installation of the above-referenced equipment/system as defined in the Contract Documents.

NOTES:

Attach written certification report prepared by and signed by the electrical and/or instrumentation subcontractor.

Comments: _____

I, the undersigned manufacturer's representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate this equipment/system, and (iii) authorized to make recommendations required to ensure that the equipment/system furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Manufacturer: _____

Manufacturer's Authorized Representative Name (*print*): _____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

ATTACHMENT C - MANUFACTURER'S CERTIFICATE OF FUNCTIONAL COMPLIANCE

MANUFACTURER'S CERTIFICATE OF FUNCTIONAL COMPLIANCE

OWNER _____ EQPT/SYSTEM _____
PROJECT NAME _____ EQPT TAG NO. _____
PROJECT NO. _____ EQPT SERIAL NO. _____
SPECIFICATION NO. _____
SPECIFICATION TITLE _____

I hereby certify the Functional Testing of the above-referenced equipment/system as defined in the Contract Documents.

NOTES:

Attach test results with collected data and test report.

Attach written certification report prepared by and signed by the electrical and/or instrumentation subcontractor.

Comments: _____

I, the undersigned manufacturer's representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate this equipment/system, and (iii) authorized to make recommendations required to ensure that the equipment/system furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____

Manufacturer: _____

Manufacturer's Authorized Representative Name (*print*): _____

By Manufacturer's Authorized Representative: _____
(Authorized Signature)

WITNESSES

By Owner's Authorized Representative: _____
(Authorized Signature)

By Engineer's Authorized Representative: _____
(Authorized Signature)

SECTION 46_05_10

COMMON WORK RESULTS FOR MECHANICAL EQUIPMENT

PART 1 GENERAL

1.02 SUMMARY

- A. Section includes:
 - 1. Mechanical equipment requirements for:
 - a. Basic design and performance criteria.
 - b. Prescriptive requirements for common components.

1.03 REFERENCES

- A. American Bearing Manufacturers Association (ABMA):
 - 1. 9 - Load Ratings and Fatigue Life for Ball Bearings.
 - 2. 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. American Gear Manufacturer's Association (AGMA) Standards.
- C. ASTM International (ASTM):
 - 1. A193 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
 - 2. A194 - Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
 - 3. A320 - Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
 - 4. F593 - Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
 - 5. F594 - Standard Specification for Stainless Steel Nuts.
- D. Hydraulic Institute (HI):
 - 1. 9.6.8 - Guideline for Dynamics of Pumping Machinery.
- E. International Concrete Repair Institute (ICRI):
 - 1. Guideline No. 310.2R, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, Polymer Overlays, and Concrete Repair.
- F. International Organization for Standardization (ISO):
 - 1. 21940 – Mechanical Vibration – Rotor Balancing – Part 1: Introduction.
- G. National Electrical Manufacturers Association (NEMA):
 - 1. MG-1 - Motors and Generators.
- H. Society for Protective Coatings (SSPC):
 - 1. SP-1-Solvent Cleaning.

1.04 DEFINITIONS

- A. Definitions used in this specification and equipment submittals for terms related to rotor-dynamic pumps shall be in accordance with HI 9.6.8, Appendix A, as clarified below.
- B. These definitions shall be applied to equipment other than pumps, unless otherwise specified in technical sections.
- C. Rotordynamic Analysis Level:
 - 1. The level of detail required for rotordynamic analysis is indicated in the technical sections schedules as None (no analysis required), Analysis Level 1, Analysis Level 2, or Analysis Level 3, which correlate to increasing levels of required detailed equipment design analysis. Analysis Levels 1, 2 and 3 are based on HI 9.6.8.
 - 2. Where these specifications differ from HI the more stringent shall apply.
- D. Resonant Frequency:
 - 1. The frequency of a periodic excitation force that is close to the natural frequencies of an object. Also known as critical frequency, critical speed, or resonant speed.
 - 2. An undamped resonant frequency within the separation margin is always considered harmful under Level 1 analysis.
 - 3. A resonant frequency that occurs within a separation margin of 15 percent above or below the operating speed range and has a log decrement greater than +0.3 is considered harmful under Level 2 and Level 3 analysis.
- E. Separation margin:
 - 1. The span of operating speeds within which interference between excitation orders and resonant frequencies indicate the possibility of harmful vibrations.
 - 2. The separation margin for a specific application extends 15 percent above and 15 percent below the span of operating speed required for the specified performance conditions.

1.05 SUBMITTALS

- A. Items in this Section are components of equipment or systems specified in other sections.
 - 1. Include data for this Section's components with the equipment or system submittal.

PART 2 PRODUCTS

2.01 DESIGN AND PERFORMANCE CRITERIA

- A. General:
 - 1. Equipment manufacturer's responsibility extends to selection and mounting of motors or other prime movers, accessories, and auxiliaries to provide a complete, operable unit.

2. Manufacturer shall analyze all equipment identified as non-reversing in the technical sections for reverse rotation and provide non reversing motor ratchets.
 3. Equipment that prevents reverse rotation shall be capable of both:
 - a. Handling 150 percent of the maximum torque at maximum operating speed.
 - b. 150 percent of torque that will be generated in reverse direction due to equipment shutoff head as calculated by the manufacturer.
 4. The motor shall be designed to run safely in the reverse direction at up to 140 percent times the reverse runaway speed under shutoff head conditions.
- B. Rotordynamic analysis and vibration testing:
1. Submit information for the Rotordynamic Analysis Level specified for each piece of equipment as shown in the Technical Sections prior to manufacture of the equipment.
 2. Rotordynamic analysis shall be performed on "like-new" and "as-worn" conditions, representing conditions when first installed and conditions when parts wear to the manufacturer's maximum allowable operating tolerances. Conditions assumed for the "as-worn" condition shall be 2 times the "like-new" tolerances unless specified otherwise.
 3. Submit factory and field testing requirements as specified in the Technical Sections and specified in Section 46_05_94 - Mechanical Equipment Testing after manufacture and installation respectively.
 4. Repair, replace, and modify equipment exhibiting vibration performance that does not meet criteria specified in this Section at no additional cost to Owner. Acceptable remedies include adjustments to equipment component geometry, materials, energy absorbing couplings, etc. Locking out speed interval(s) within equipment specified operating range is unacceptable.
 5. The analysis shall be supplemented with additional field investigation and analysis should conditions during field vibration testing activity indicate non-compliance with these specifications; supplemental field investigation and analysis shall indicate remedies to comply with the specifications and shall be stamped by a registered professional mechanical engineer.
 6. Rotordynamic Analysis Level 1:
 - a. Before the equipment is released for manufacture it shall be determined that the equipment-shaft/motor structures do not have any harmful resonant frequencies in the lateral and torsional modes. Representative analysis results for identical equipment may be submitted.
 - b. Calculate rotor lateral and torsional and equipment structural components' lateral frequencies with a spreadsheet calculation or finite element analysis software.
 - 1) Equipment structure lateral frequency shall include the motor.
 - 2) Speed changing drive systems (belt, gear) effects on rotational inertia and stiffness shall be incorporated.
 - c. Determine the equipment system components (rotor and structure) resonant frequencies.
 - d. An intersection of an equipment component resonant frequency with the 1x run speed excitation order that occurs within separation margin is unacceptable.

- e. Submit Campbell diagrams showing the system component natural frequencies including excitation orders, and operating speed range for both lateral and torsional analysis of lineshaft components.
 - a) Campbell diagram shall include equipment operating range; excitation lines at 1x, 2x run speed, and vane pass (or equivalent); and critical speeds associated with equipment system components including the rotor, each major equipment component with a lineshaft.

2.02 POWER TRANSMISSION SYSTEMS

- A. V-belts, sheaves, shaft couplings, chains, sprockets, mechanical variable-speed drives, variable frequency drives, gear reducers, open and enclosed gearing, clutches, brakes, intermediate shafting, intermediate bearings, and U-joints:
 - 1. Rated for 24 hour-a-day continuous service, or for intermittent service with frequent stops-and-starts, whichever is most severe.
 - 2. Sized with a service factor of 1.5 or greater:
 - a. Apply service factor to nameplate horsepower and torque of prime source of power and not to actual equipment loading.
 - b. Apply service factors in accordance with AGMA or as specified in the Technical Sections.

2.03 BEARINGS

- A. Oil or grease lubricated, ball or roller antifriction type, of standard manufacture.
 - 1. Design lubrication system based on the equipment location to operate.
 - a. Reference Location: MC Chord AFB/Tacoma (approximately 7 miles from site), WA, USA WMO 742060.
 - b. Design Temperature Criteria.
 - 1) Outdoor Criteria in Accordance with ASHRAE Fundamentals Handbook
 - 2) Daily Mean Range: 21.3 degrees Fahrenheit.
 - 3) Winter:
 - a) Suitable for the outdoor winter temperature; at or above this temperature 99.6 percent of the time:
 - (1) 20.6 degrees Fahrenheit dry-bulb.
 - 4) Summer:
 - a) Suitable for the outdoor winter temperature; at or above this temperature 0.4 percent of the time:
 - (1) 86.2 degrees Fahrenheit dry-bulb.
- B. Oil-lubricated bearings:
 - 1. Provide either pressure lubricating system or separate oil reservoir splash-type system as specified in the Technical Section.
 - 2. Design oil-lubrication system to safely absorb heat energy generated in bearings when equipment is operating in the following conditions:
 - a. With the highest load and the temperature 15 degrees Fahrenheit above the anticipated outdoor summer temperature of 90-degrees F.

- C. Grease lubricated bearings, except those specified to be factory sealed:
 - 1. Fit with easily accessible grease supply, flush, drain, and relief fittings.
 - 2. Lubrication lines and fittings:
 - a. Lines: Minimum 1/4-inch diameter stainless steel tubing.
 - b. Multiple fitting assemblies: Mount fittings together in easily accessible location.
 - c. Use standard hydraulic-type grease supply fittings:
 - 1) Manufacturers: One of the following or equal:
 - a) Alemite.
 - b) Zerk.
- D. Ratings: Rated in accordance with ABMA 9 or ABMA 11 L10 life for bearings rating life of not less than 50,000 hours.

2.04 FLANGED PIPING CONNECTIONS

- A. Unless otherwise in the Technical Sections, provide flat face flanges.

2.05 ASSEMBLY FASTENERS

- A. General service: Stainless steel, Type 316:
 - 1. Bolts: In accordance with ASTM F593, Alloy Group 2.
 - 2. Nuts: In accordance with ASTM F594, Alloy Group 2.
 - 3. Washers: Alloy group matching bolts and nuts.
- B. High-temperature service or high-pressure service: Stainless steel, Type 316:
 - 1. Bolts: In accordance with ASTM A193, Grade B8M, Class 1, heavy hex.
 - 2. Nuts: In accordance with ASTM A194, Grade 8, heavy hex.
 - 3. Washers: Alloy group matching bolts and nuts.
- C. Low-temperature service: Stainless steel, Type 316:
 - 1. Bolts: In accordance with ASTM A320, Grade B8M, Class 1, heavy hex.
 - 2. Nuts: In accordance with ASTM A194, Grade B8M, heavy hex.
 - 3. Washers: Alloy group matching bolts and nuts.

2.06 NOT SHIPPING

- A. Prior to shipment of equipment:
 - 1. Bearings (and similar items):
 - a. Pack separately or provide other protection during transport.
 - b. Greased and lubricated.
 - 2. Gear boxes:
 - a. Oil filled or sprayed with rust preventive protective coating.
 - 3. Fasteners:
 - a. Inspect for proper torques and tightness.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 46_05_94

MECHANICAL EQUIPMENT TESTING

PART 1 GENERAL

1.01 SUMMARY

- A. Section includes: Testing of mechanical equipment and systems.

1.02 REFERENCES

- A. American National Standards Institute (ANSI):
 - 1. S1.4 Specification for Sound Level Meters.
- B. Hydraulic Institute (HI).
- C. National Institute of Standards and Technology (NIST).

1.03 SUBMITTALS

- A. Provide Source Test Plans. as specified in Section –43_23_13.37 Vertical Chopper Centrifugal Pumps.
- B. Provide Functional Testing Plans. as specified in Section 43_23_13.37 Vertical Chopper Centrifugal Pumps.
- C. Provide operation and maintenance manual as specified in Section 43_23_13.37 Vertical Chopper Centrifugal Pumps.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

- A. Provide necessary test instrumentation that has been calibrated within 1 year from date of test to recognized test standards traceable to the NIST or approved source.
 - 1. Properly calibrated field instrumentation permanently installed as a part of the Work may be utilized for tests.
 - 2. Prior to testing, provide signed and dated certificates of calibration for test instrumentation and equipment.

- B. Test measurement and result accuracy:
 - 1. Use test instruments with accuracies as recommended in the appropriate referenced standards. When no accuracy is recommended in the referenced standard, use 1 percent or better accuracy test instruments.
 - a. Improved (lower error tolerance) accuracies specified elsewhere prevail over this general requirement.
 - 2. Do not adjust results of tests for instrumentation accuracy.
 - a. Measured values and values directly calculated from measured values shall be the basis for comparing actual equipment performance to specified requirements.

3.02 VARIABLE SPEED EQUIPMENT TESTS

- A. Establish performance over the entire speed range and at the average operating condition.
- B. Establish performance curves for the following speeds:
 - 1. The speed corresponding to the rated maximum capacity.
 - 2. The speed corresponding to the minimum capacity.
 - 3. The speed corresponding to the average operating conditions.

3.03 PUMP TESTS, ALL LEVELS OF TESTING

- A. Test in accordance with the following:
 - 1. Applicable HI Standards.
 - 2. This Section.
 - 3. Equipment sections.
- B. Test tolerances: In accordance with appropriate HI Standards, unless modified in Section 43_23_13.37 Vertical Chopper Centrifugal Pumps.

3.04 MOTOR TESTS

- A. Test motors as specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower.

3.05 NOISE REQUIREMENTS AND CONTROL

- A. Perform noise tests in conjunction with vibration test analysis.
- B. Make measurements in relation to reference pressure of 0.0002 microbar.
- C. Make measurements of emitted noise levels on sound level meter meeting or exceeding ANSI S1.4, Type II.
- D. Set sound level meter to slow response.
- E. Unless otherwise specified, maximum free field noise level not to exceed 85 dBA measured as sound pressure level at 3 feet from the equipment.

3.06 PRESSURE TESTING

- A. Hydrostatically pressure test pressure containing parts at the appropriate standard or code required level above the equipment component specified design pressure or operating pressure, whichever is higher.

3.07 INSPECTION AND BALANCING

- A. Dynamically balance each of the individual rotating parts as required to achieve the required field vibration limits.
- B. Dynamically balance the completed equipment rotating assembly and drive shaft components.
- C. Furnish copies of material and component inspection reports including balancing reports for equipment system components and for the completed rotating assembly.
- D. Critical speed of rotating equipment:
 - 1. Satisfy the following:
 - a. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered rigid such as horizontal pumps, all non-clog pumps, blowers, air compressors, and engines shall be at least 25 percent above the equipment's maximum operating speed.
 - b. The first lateral and torsional critical speed of all constant, variable, and 2-speed driven equipment that is considered flexible or flexibly mounted such as vertical pumps (vertical in-line and vertical non-clog pumps excluded) and fans shall at least 25 percent below the equipment's lowest operating speed.
 - c. The second lateral and torsional critical speed of all constant, variable, and 2-speed equipment that is considered flexible or flexibly mounted shall be at least 25 percent above the maximum operating speed.
- E. Vibration tests:
 - 1. Definitions:
 - a. Root mean square: for pumps operating at speeds greater than 600 rpm, the vibration measurement shall be measured as the overall velocity in inches per second root mean square (RMS).
 - b. Peak-to-peak displacement: The root means squared average of the peak-to-peak displacement multiplied by the square root of 2.
 - c. Peak velocity: The root mean squared average of the peak velocity multiplied by the square root of 2.
 - d. Peak acceleration: The root mean squared average of the peak acceleration multiplied by the square root of 2.
 - e. High frequency enveloping: A process to extract very low amplitude time domain signals associated with impact or impulse events such as bearing or gear tooth defects and display them in a frequency spectrum of acceleration versus frequency.
 - 1) Manufacturers: One of the following or equal:
 - a) Rockwell Automation, Entek Group, "Spike Energy" analysis.
 - b) CSI, "PeakVue."
 - f. Rotor bar pass frequency (RBF), for detecting loose rotor bars.

- g. Low speed equipment: Equipment or components of equipment rotating at less than 600 revolutions per minute.
 - h. High speed equipment: Equipment and equipment components operating at or above 600 revolutions per minute.
 - i. Preferred operating range: Manufacturer's defined preferred operating range (POR) for the equipment.
 - j. Allowable operating range: Manufacturer's defined allowable operating range (AOR) for the equipment.
2. Vibration instrumentation requirements:
- a. Analyzers: Use digital type analyzers or data collectors with anti-aliasing filter, 12-bit A/D converter, fast fourier transform circuitry, phase measurement capability, time wave form data storage, high-frequency enveloping capabilities, 35 frequency ranges from 21 to 1,500,000 cycles per minute, adjustable fast fourier transform resolution from 400 to 6,400 lines, storage for up to one hundred 3,200 line frequency spectra, data output port, circuitry for integration of acceleration data to velocity or double integration to displacement.
 - 1) Manufacturers: One of the following or equal:
 - a) Computational Systems Inc., (CSI) Division of Emerson Process Management, Model 2120A, Data Collector/analyzer with applicable analysis software.
 - b) Pruftechnik, VIBXPERT II.
 - b. Analyzer settings:
 - 1) Units: English, inches/second, mils, and gravitational forces.
 - 2) Fast fourier transform lines: Most equipment 1,600 minimum; for motors, enough lines as required to distinguish motor current frequencies from rotational frequencies, use 3,200 lines for motors with a nominal speed of 3,600 revolutions per minute; 3,200 lines minimum for High Frequency Enveloping; 1,600 lines minimum for low speed equipment.
 - 3) Sample averages: 4 minimum.
 - 4) Maximum frequency (Fmax): 40 times rotational frequency for rolling element bearings, 10 times rotational frequency for sleeve bearings.
 - 5) Amplitude range: Auto select but full scale not more than twice the acceptance criteria or the highest peak, whichever is lower.
 - 6) Fast fourier transform windowing: Hanning Window.
 - 7) High pass filter: Minus 3 dB at 120 cycles per minute for high speed equipment. Minus 3 dB at 21 cycles per minute for low speed equipment.
 - c. Accelerometers:
 - 1) For low speed equipment: Low frequency, shear mode accelerometer, 500 millivolts per gravitational force sensitivity, 10 gravitational force range, plus/minus 5 percent frequency response from 0.5 hertz to 850 hertz, magnetic mount.
 - a) Manufacturers: One of the following or equal:
 - (1) Wilcoxon Research, Model 797L.
 - (2) PCB, Model 393C.
 - 2) For high speed equipment: General purpose accelerometer, 100 millivolts per gravitational force sensitivity, 50 gravitational force range, plus/minus 3dB frequency response range from 2 hertz to 12,000 hertz when stud mounted, with magnetic mount holder.

- a) Manufacturers: One of the following or equal:
 - (1) Wilcoxon Research, Model 793.
 - (2) Entek-IRD Model 943.
3. Accelerometer mounting:
 - a. Use magnetic mounting or stud mounting.
 - b. Mount on bearing housing in location with best available direct path to bearing and shaft vibration.
 - c. Remove paint and mount transducer on flat metal surface or epoxy mount for High Frequency Enveloping measurements.
4. Vibration acceptance criteria:
 - a. Testing of rotating mechanical equipment: Tests are to be performed by an experienced, factory trained, and independent authorized vibration analysis expert.
 - b. Vibration velocity limits: Unless otherwise specified, velocity limits shall not exceed the following peak velocity limits:

HI Pump Type	Horsepower	Field Test	Factory Test
		Overall RMS	Overall RMS
Horizontal Solids Handling Centrifugal Pumps	Below 33 hp	0.25	0.28
Horizontal and Vertical In-Line Centrifugal Pumps (other than Non-Clog type) Vertical Solids Handling Centrifugal Pumps	Between 33 and 100 hp	0.28	0.31
	100 hp and above	0.31	0.34
	Below 33 hp	0.30	0.33
Vertical Turbine, Mixed Flow, and Propeller Pumps (solids-handling type pumps)	Between 33 and 100 hp	0.32	0.35
	100 hp and above	0.34	0.35
Non-Solids Handling Centrifugal Pumps HI Types BB1, BB2, BB3, BB4, BB5, OH1, OH2, OH3, OH4, OH5, and OH7	Below 268 hp	0.15	0.19
	268 hp and above	0.19	0.22
Vertical Turbine, Mixed Flow, and Propeller Pumps HI Types VS1, VS2, VS3, VS4, VS5, VS6, VS7, and VS8	Below 268 hp	0.13	
	268 hp and above	0.17	
Slurry Pumps		0.25	0.30
Motors		See Applicable Motor Specification	See Applicable Motor Specification

HI Pump Type	Horsepower	Field Test	Factory Test
		Overall RMS	Overall RMS
Gear Reducers, Radial		Not to exceed AGMA 6000-B96 limits	Not to exceed AGMA 6000-B96 limits
Other Reducers, Axial		0.1	N/A

- c. Vibration displacement limits: In addition to the above-specified vibration velocity limits, for equipment operating at speeds 600 revolutions per minute or less is not to exhibit unfiltered readings in excess of following:

Operating Conditions and Application Data	Overall Peak-to-Peak Displacement	
	Field, mils	Factory, mils
Operation within the POR	3.0	4.0
Operation within the AOR	4.0	5.0
Additive value when measurement location is greater than 5 feet above foundation.	2.0	2.0
Additive value for solids-handling pumps	2.0	N/A
Additive value for slurry pumps	2.0	N/A

- d. Equipment operation: Measurements are to be obtained with equipment installed and operating within capacity ranges specified and without duplicate equipment running.
- e. Additional criteria:
- 1) No narrow band spectral vibration amplitude components, whether sub-rotational, higher harmonic, or synchronous multiple of running speed, are to exceed 40 percent of synchronous vibration amplitude component without manufacturer's detailed verification of origin and ultimate effect of such excitation.
 - 2) The presence of discernable vibration amplitude peaks in Test Level 2 or 3 vibration spectra at bearing inner or outer race frequencies shall be cause for rejection of the equipment.
 - 3) For motors, the following shall be cause for rejection:
 - a) Stator eccentricity evidenced by a spectral peak at 2 times electrical line frequency that is more than 40 percent of the peak at rotational frequency.
 - b) Rotor eccentricity evidenced by a spectral peak at 2 times electrical line frequency with spectra side bands at the pole pass frequency around the 2 times line frequency peak.
 - c) Other rotor problems evidenced by pole pass frequency side bands around operating speed harmonic peaks or 2 times line frequency side bands around rotor bar pass frequency or around 2 times the rotor bar pass frequency.
 - d) Phasing problems evidenced by 1/3 line frequency side band spectral peaks around the 2 times electrical line frequency peak.
 - 4) The presence of peaks in a High Frequency Enveloping spectra plot corresponding to bearing, gear or motor rotor bar frequencies or harmonics of these frequencies shall be cause for rejection of the

equipment; since inadequate lubrication of some equipment may be a cause of these peaks, lubrication shall be checked, corrected as necessary and the high frequency envelope analysis repeated.

5. Vibration testing results presentation:
 - a. Provide equipment drawing with location and orientation of measurement points indicated.
 - b. For each vibration measurement take and include appropriate data on equipment operating conditions at the time vibration data is taken; for pumps, compressors, and blowers record suction pressure, discharge pressure, and flow.
 - c. When Vibration Spectra Data required:
 - 1) Plot peak vibration velocity versus frequency in cycles per minute.
 - 2) Label plots showing actual shaft or part rotation frequency, bearing inner and outer race ball pass frequencies, gear mesh frequencies and relevant equipment excitation frequencies on the plot; label probable cause of vibration peaks whether in excess of specification limits or not.
 - 3) Label plots with equipment identification and operating conditions such as tag number, capacity, pressure, driver horsepower, and point of vibration measurement.
 - 4) Plot motor spectra on a log amplitude scale versus frequency.
 - d. For low speed equipment, plot peak vibration displacement versus frequency as well as velocity versus frequency.
 - e. Provide name of manufacturer and model number of the vibration instrumentation used, including analyzer and accelerometer used together with mounting type.

3.08 TESTING LEVELS

- A. Level 1 Tests:
 1. Level 1 Performance Test:
 - a. General:
 - 1) For equipment, operate, rotate, or otherwise functionally test for 15 minutes minimum after components reach normal operating temperatures.
 - 2) Operate at rated design load conditions.
 - 3) Confirm that equipment is properly assembled.
 - 4) Confirm the equipment moves or rotates in the proper direction.
 - 5) Confirm shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
 - 6) Confirm that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
 - b. Pumps:
 - 1) Comply with general performance test requirements as specified in this Section.
 - 2) Measure flow and head while operating at or near the rated condition; for factory testing, testing may be at reduced speeds with

flow and head corresponding to the rated condition when adjusted for speed using the appropriate affinity laws.

- a) Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower or the applicable equipment section.
 - b) Use actual driver for field tests.
 - 3) Record measured flow, suction pressure, discharge pressure, and make observations on bearing temperatures and noise levels.
2. Level 1 Vibration Test:
 - a. Test requirement:
 - 1) Measure filtered vibration spectra versus frequency in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component.
 - 2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
 - b. Equipment operating condition: Test at specified maximum speed.
 3. Level 1 Noise Test:
 - a. Measure unfiltered overall A-weighted sound pressure level in dBA at 3 feet horizontally from the surface of the equipment and at a mid-point of the equipment height.

B. Level 2 Tests:

1. Level 2 Performance Test:
 - a. General:
 - 1) For equipment, operate, rotate, or otherwise functionally test for at least 2 hours after components reach normal operating temperatures.
 - 2) Operate at rated design load conditions.
 - 3) Confirm that equipment is properly assembled.
 - 4) Confirm the equipment moves or rotates in the proper direction.
 - 5) Confirm shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
 - 6) Confirm that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
 - b. Pumps:
 - 1) Comply with general performance test requirements as specified in this Section.
 - 2) Test 2 hours minimum for flow and head at the rated condition; for factory and field-testing, test at full speed..
 - a) Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower.
 - b) Use actual driver for field tests.
 - 3) Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 5 minutes or longer as

- necessary to measure required performance, vibration, and noise data at each test condition.
- 4) Record measured flow, suction pressure, discharge pressure, and observations on bearing temperatures and noise levels at each condition.
2. Level 2 Vibration Test:
 - a. Test requirement:
 - 1) Measure filtered vibration spectra versus frequency and measure vibration phase in 3 perpendicular planes at each normally accessible bearing housing on the driven equipment, any gears and on the driver; 1 plane of measurement to be parallel to the axis of rotation of the component; measure actual rotational speeds for each vibration spectra measured using photometric or other tachometer input connected directly to the vibration data collector.
 - 2) Vibration spectra versus frequency shall be in accordance with Vibration Acceptance Criteria.
 - b. Equipment operating condition: Repeat test requirements at design specified maximum speed and at minimum speed for variable speed equipment.
 - c. Natural frequency test of field installed equipment:
 - 1) Excite the installed equipment and support system in 3 perpendicular planes, use same planes as operating vibration measurement planes, and determine the as-installed natural resonant frequency of the driven equipment, the driver, gears, and supports.
 - 2) Perform test at each bearing housing, at each support pedestal, and for pumps on the suction and discharge piping.
 - 3) Perform with equipment and attached piping full of intended service or process fluid.
 3. Level 2 Noise Test:
 - a. Measure filtered A-weighted overall sound pressure level in dBA for each of 8 octave band mid-points beginning at 63 hertz measured at 3 feet horizontally from the surface of the equipment at mid-point height of the noise source.
- C. Level 3 Tests:
1. Level 3 Performance Tests:
 - a. General:
 - 1) For equipment, operate, rotate, or otherwise functionally test for at least 4 hours after components reach normal operating temperatures.
 - 2) Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
 - 3) Confirm that equipment is properly assembled.
 - 4) Confirm the equipment moves or rotates in the proper direction.
 - 5) Confirm shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
 - 6) Confirm that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.

- 7) Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure, and temperature readings using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
 - 8) Bearing temperatures: During maximum speed or capacity performance testing, measure and record the exterior surface temperature of each bearing versus time.
- b. Pumps:
- 1) Comply with general performance test requirements as specified in this Section.
 - 2) Test 4 hours minimum for flow and head; begin tests at or near the rated condition; for factory and field-testing, test with furnished motor at full speed.
 - a) Use of a test driver is permitted for factory tests when actual driver is given a separate test at its point of manufacture as specified in Section 26_05_09 - Low Voltage Motors up to 500 Horsepower.
 - b) Use actual driver for field tests.
 - 3) Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 15 minutes or longer as necessary to measure required performance, vibration, and noise data at each test condition.
 - 4) Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices are not required by the equipment section) and record observations on noise levels.
 - 5) Perform efficiency and/or Net Positive Suction Head Required (NPSHr) and/or priming time tests when specified in the equipment section in accordance with the appropriate HI standard and as follows:
 - a) Perform NPSHr testing at maximum rated design speed, head and flow with test fluids at ambient conditions; at maximum rated speed, test at 15 percent above rated design flow, and 25 percent below rated design flow.
 - b) Perform efficiency testing with test fluids at maximum rated speed.
 - c) Perform priming time testing with test fluids at maximum rated speed.
2. Level 3 Vibration Test:
- a. Requirements: Same as Level 2 vibration test except data taken at each operating condition tested and with additional requirements below.
 - b. Perform High Frequency Enveloping Analysis for gears and bearings.
 - 1) Measure bearing element vibration directly on each bearing cap in a location close as possible to the bearing load zone that provides a smooth surface and direct path to the bearing to detect bearing defects.
 - 2) Report results in units of acceleration versus frequency in cycles per minute.

- c. Perform Time Wave Form analysis for gears, low speed equipment and reciprocating equipment; plot true peak amplitude velocity and displacement versus time and label the period between peaks with the likely cause of the periodic peaks (relate the period to a cause).
 - d. Plot vibration spectra on 3 different plots; peak displacement versus frequency, peak acceleration versus frequency and peak velocity versus frequency.
3. Level 3 Noise Test: Measure filtered, un-weighted overall sound pressure level in dB at 3 feet horizontally from the surface of the equipment at mid-point height and at 4 locations approximately 90 degrees apart in plain view; report results for each of 8 octave band mid-points beginning at 63 hertz.

D. Level 4 Tests:

1. Level 4 Performance Test:

a. General:

- 1) For equipment, operate, rotate, or otherwise functionally test for at least 8 hours after components reach normal operating temperatures.
- 2) Operate at rated design load conditions for 1/2 the specified time; operate at each of any other specified conditions for a proportionate share of the remaining test time.
- 3) Confirm that equipment is properly assembled.
- 4) Confirm the equipment moves or rotates in the proper direction.
- 5) Confirm shafting, drive elements, and bearings are installed and lubricated in accordance with proper tolerances.
- 6) Confirm that no unusual power consumption, lubrication temperatures, bearing temperatures, or other conditions are observed.
- 7) Take appropriate capacity, power or fuel consumption, torque, revolutions per minute, pressure and temperature readings, using appropriate test instrumentation to confirm equipment meets specified performance requirements at the design rated condition.
- 8) Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.

b. Pumps:

- 1) Comply with general performance test requirements as specified in this Section.
- 2) Test 8 hours minimum for flow and head; begin tests at or near the rated condition; for factory and field-testing, test with furnished motor at full speed.
- 3) Test each specified flow and head condition at the rated speed and test at minimum as well as maximum specified speeds; operate at each test condition for a minimum of 20 minutes or longer as necessary to measure required performance, vibration, and noise data at each test condition.
- 4) Record measured shaft revolutions per minute, flow, suction pressure, discharge pressure; record measured bearing temperatures (bearing housing exterior surface temperatures may be recorded when bearing temperature devices not required by the equipment section) and record observations on noise levels.

- 5) Bearing temperatures: During maximum speed or capacity testing, measure and record the exterior surface temperature of each bearing versus time.
- 6) Perform efficiency and/or Net Positive Suction Head Required (NPSHr) and/or priming time tests when specified in the equipment section in accordance with the appropriate HI standard and as follows:
 - a) Perform NPSHr testing at maximum rated design speed, head and flow with test fluids at ambient conditions; at maximum rated speed, test at 15 percent above rated design flow, and 25 percent below rated design flow.
 - b) Perform efficiency testing with test fluids at maximum rated speed.
 - c) Perform priming time testing with test fluids at maximum rated speed.
- 2. Level 4 Vibration Test: Same as Level 3 vibration test.
- 3. Level 4 Noise Test: Same as Level 3 Noise Test except with data taken at each operating condition tested.

END OF SECTION

APPENDIX A

PUMPTECH DRAFT COST PROPOSAL



PumpTech, LLC
12020 SE 32ND Street Suite 2
Bellevue, WA 98005
Phone: 425-644-8501
Fax: 425-562-9213
jjoyce@pumptechnw.com

Page: 1

Sales Quotation

Customer#: 0153900

TO:
Lance Bunch
Tacoma, City of
PO Box 1717
*****Email to: accounts
payable@cityoftacoma.org
Tacoma, WA 98401-1717
Phone: (253) 502-2296

Salesperson: Jim Joyce / Mike Dunn
Lead Time: 40 to 41 Weeks
FOB: FOB ORIGIN - FFA
Ship Via: OTHER

Quote #: 0164849-F
Date: 3/29/2023
Expires: 4/29/2023

Project Name: South Tacoma Lift Station Vaughan Chopper Pumps

Item		Price	Qty	Extend
	PumpTech is pleased to offer for your consideration the following Vaughan Chopper pumps to replace the existing Yeomans pumps in the South Tacoma Pump Station: ----- .	0.00		0.00
PE12W14CS-210	Vaughan Model PE12W14CS-210 Vertical Dry Pit Pedestal Chopper Pump consisting of: - Casing and Backplate, cast ductile iron, with 12" ANSI CL 125 discharge flange - Impeller, Upper Cutter and External Cutter, cast steel, heat treated to minimum Rockwell C60. - Cutter Bar, alloy steel, heat treated to minimum Rockwell C60. - Shaft, heat treated steel to 330 BN - Bearings, oil bath lubricated with minimum 100,000 hour L-10 bearing life. - Bearing Housing, cast ductile iron. - Flushless Mechanical Seal, cartridge type with stainless steel housing, integral stainless steel shaft sleeve, and silicon carbide faces. Elastomers, Buna N. - Custom Pedestal Base with Inlet Flange, 14" 90° steel elbow with cleanout, drain and ANSI CL 150 inlet flange, pedestal mounted on a fabricated steel base plate, 52" x 52". Pump discharge angle to be determined. - Coupling, elastomeric type by TB Woods. - Motor Mount, fabricated steel, piloted for self-aligning mounting of a C-face flange mounted motor. - Pump Finish: Sandblast and coat with minimum 30 MDFT Tnemec Perma-Shield PL Series 431 epoxy. (Except Motor) .	69,889.00	4.00	279,556.00

Continued



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Salesperson: Jim Joyce / Mike Dunn
Lead Time: 40 to 41 Weeks
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Quote #: 0164849-F
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Expires: 4/29/2023

Project Name: South Tacoma Lift Station Vaughan Chopper Pumps

Item		Price	Qty	Extend
MOTORS	Electric Motor: - DRIVE, 40 HP, 514 RPM, 460/3/60, 1.15 SF, C-face, TEFC, flange mounted premium efficient electric motor. Pump/Motor to be operated with VFD at approximately 499 RPM. (VFD to be supplied by others).	53,080.00	4.00	212,320.00
Discharge Transition Piece	Pump Discharge to Discharge Pipe Transition Piece with hardware, to mate the pump discharge to the discharge pipe. The Transition Piece will be field verified and fabricated for proper fit up.	3,536.00	4.00	14,144.00
Spare Parts	Spare Parts included: - 1ea mechanical seal - 1ea pump radial and thrust bearing set - 1ea cutter bar - 1ea impeller	14,400.00	1.00	14,400.00
Special Tools	Special pump repair/service tools	2,565.00	1.00	2,565.00

Continued



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Quote #: 0164849-F
Date: 3/29/2023
Expires: 4/29/2023

Project Name: South Tacoma Lift Station Vaughan Chopper Pumps

Item		Price	Qty	Extend
Factory Services	Factory Services Provided consisting of: - Factory Performance Testing, Witneessed with job motor - Factory Hydrostatic Testing. - Torsional Analysis - Shaft Deflection Calculations - Bearing Life Calculations - Critical Speed Calculations - Factory Vibration Test - Noise Testing - Motor Test . * Factory Submittals - One (1) electronic copy of preliminary submittal. - Up to (8) hardcopies of approved submittals on 20 lbs. 8 ½" x 11" letter size paper in standard Three (3) Ring Binder. . * Factory O&M Manuals - One (1) electronic copy of preliminary O&M. - Up to Eight (8) hardcopies of approved O&Ms on 20 lbs. 8 ½" x 11" letter size paper in standard Three (3) Ring Binder, two (2) CDs (if requested), and one (1) flash drive (if requested) . Pump Anchor Calculations, performed and stamped by a WA State PE.	35,785.00	1.00	35,785.00
Pump Anchor Calculations		5,715.00	1.00	5,715.00
Startup	Startup and commissioning by a factory trained technician, 5 days on site.	19,500.00	1.00	19,500.00
Training	Operator training by a factory trained technician, two days on site	3,125.00	1.00	3,125.00

Continued



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Project Name: South Tacoma Lift Station Vaughan Chopper Pumps

Item		Price	Qty	Extend
On-Call Assistance	On-Call Assistance, by a factory trained techican, to be on-site during the Process Operational Period is not included but can be provided by change order or separate PO for \$2,280/day.	0.00		0.00
Warranty	Warranty included is 2 year from startup or 30 months from shipment.	0.00	1.00	0.00
Freight	Freight to South Tacoma Pump Station included.	0.00	1.00	0.00
Delivery	Delivery: - Submittals - 4 - 6 Weeks after receipt of order. - Equipment - 32 to 34 Weeks after receipt of approved submittals. ** Based on the current lead times for the components, as outlined above, delivery of the pumps will be 42 weeks from the date the order is received. This includes 4 weeks to prepare and assemble the submittals, 2 weeks for submittal review, 34 weeks to produce the pumps, and one week to deliver all the equipment. Based on this time frame, if the order is placed the week of 3/15/2023 delivery will be in late December of 2023. The electric motors are the longest lead items and, based on recent experiences, will be the one component that will most likely impact the delivery date.	0.00		0.00
	NOTE - This proposal is based upon the specification sections 43_23_13, 46_05_10, 46_05_94 and 26_05_09 dated 09/07/2022.and clarifications to the specifications dated 9/9/2022.	0.00		0.00

SubTotal 587,110.00

The above order is subject to Pumptech, LLC's standard terms and conditions and credit approval which are attached and made part of this agreement. We appreciate your interest in our products and services and if you have any questions on our offerings please do not hesitate to call.

By signature below, I accept this offering:

Signed: _____

Name: _____ Title: _____

Sales Tax: 60,472.33

Total: 647,582.33



FORMATION OF CONTRACT: These standard terms and conditions of sale ("Terms and Conditions") together with the sales covenants, the general specifications, the technical specifications, and any addendum thereto, including any acknowledgement by PUMPTech, LLC, comprise the "Proposal" or "Sales Quotation" (collectively the "Quotation"), which upon acceptance by Purchaser become the "Agreement." Subject to prior credit approval by PUMPTech, LLC (see "Credit Approval and Payment Terms" section below), Purchaser may accept the Quotation through: (i) delivering a purchase order that incorporates the Quotation by reference and payment of the initial deposit; (ii) other written indication by Purchaser of its acceptance of the Quotation along with payment of the initial deposit; (iii) delivering a purchase order or other written indication by Purchaser of its acceptance of the Quotation and agreement by both parties on a standard progress payment plan that does not require an initial deposit (see "Credit Approval and Payment Terms" section below); or (iv) receipt by Purchaser of PUMPTech, LLC's acknowledgement without notice of rejection. The effective date of the Agreement shall be the date that PUMPTech, LLC communicates to Purchaser via PUMPTech, LLC's acknowledgement, in writing. PUMPTech, LLC's obligations under the Quotation or the Agreement shall not commence until the effective date. The scope of work for the Agreement is limited to the equipment, machinery, goods, engineering services (if applicable) and/or related commissioning services (if applicable) specifically set forth in the Agreement ("Equipment"). The scope of work does not include installation or any on-site services unless specifically identified as being included in the price in the Agreement. Any terms and conditions contained in any purchase order, plans and specifications, correspondence, or accompanying payment for delivery of the Equipment, which are different from or in addition to the Terms and Conditions herein, shall not be binding on PUMPTech, LLC, whether or not they would materially alter the Agreement, and PUMPTech, LLC hereby objects to and rejects the same unless such terms and conditions are delivered to PUMPTech, LLC prior to Quotation and referenced in the Quotation.

CREDIT APPROVAL AND PAYMENT TERMS: Credit approval is required by PUMPTech, LLC prior to release of order to manufacturer; however, submittal may begin at the time of receipt of purchase order. PUMPTech, LLC's payment terms are net thirty (30) days from invoice date. In some circumstances PUMPTech, LLC may require progress payments. Progress payments are due and payable upon receipt of invoice. PUMPTech, LLC's "Standard Progress Payment Plan" is defined as a payment plan that includes the following terms in the purchase order or the Agreement: 1st: fifteen percent (15%) upon receipt of approved drawings; 2nd: thirty percent (30%) upon order of major components; 3rd: twenty percent (20%) upon receipt of major components at PUMPTech, LLC's facility; 4th: thirty percent (30%) upon shipment; and 5th: five percent (5%) on start-up. If not included within the Quotation, all applicable federal, state and local taxes will be added to each invoice. Time is of the essence with respect to all payments. Payments that are outstanding more than ten (10) days from their respective due date shall bear an interest rate of one and one-half percent (1.5%) per month (eighteen percent (18%) annually) until fully paid, including any interest accruing thereon. If PUMPTech, LLC chooses to turn any past-due balances over to a collection agency, Purchaser agrees to pay costs of the collection to the extent that is allowed by law for commercial accounts.

CHANGE ORDERS: Changes to the design, specifications, scope of supply, delivery schedule, Equipment demonstration site or date, shipping instructions of the Equipment, or any material term of the Agreement, may only be made upon execution by Purchaser and PUMPTech, LLC in writing ("Change Order"). Such Change Order shall state the parties' agreement on (i) change in the specifications, designs, scope of work, delivery schedule or shipping instructions for the Equipment, (ii) an adjustment to the purchase price, and (iii) an adjustment in the date of shipment of the Equipment and/or the period of performance. Both parties agree and acknowledge that unless a Change Order is agreed upon in writing by both parties, the Agreement shall not be modified in any manner. In addition, PUMPTech, LLC has the right to suspend performance of its obligations hereunder without liability during the period while the change is being evaluated and negotiated. In the event Purchaser has communicated proposed changes to PUMPTech, LLC, PUMPTech, LLC, at its sole discretion, shall either: (a) accept the Change Order; (b) reject the Change Order and continue performance under the existing Agreement; or (c) cancel the Agreement. In the event that PUMPTech, LLC elects (b) above, Purchaser shall either (i) agree to continued performance by PUMPTech, LLC pursuant to the Agreement or (ii) cancel the Agreement. In the event of (b)(ii), Purchaser shall pay PUMPTech, LLC for all amounts then due and owing under the Agreement plus all incurred costs not yet billed (e.g., labor and materials) plus fifteen percent (15%) for profit on all incurred costs not yet billed.

SHIPMENT: Estimated shipment from manufacturer can proceed as quoted after receipt of approved submittals and purchase order. Although PUMPTech, LLC shall use commercially reasonable efforts to have the Equipment delivered within the time estimated, any quoted shipment time is based on information from suppliers and is not intended to be an exact date or a guarantee. Any late delivery charges due to shipment beyond the estimated schedule will not be accepted.

WARRANTY: The only warranty/guarantee implied or applied to this Agreement are those as put forth by the original manufacturer. New equipment manufactured by PUMPTech, LLC are warranted to be free from defects in material and workmanship for a period of one (1) year from the date of shipment (ninety (90) days for repaired equipment) provided that the Purchaser has timely made all payments due under the Agreement and the product is properly installed, serviced, and operated under normal conditions. If within one (1) year of installation PUMPTech, LLC receives written notice from Purchaser of defective material or workmanship with respect to Equipment, PUMPTech, LLC's sole obligation shall be, at PUMPTech, LLC's option, either to (i) repair the Equipment, (ii) replace the Equipment, or (iii) refund the amount paid by Purchaser. PUMPTech, LLC shall have no other obligation or liability whatsoever with respect to any defective material(s) or service. Materials to be replaced or items for which services are to be re-performed shall be shipped by Purchaser to, PUMPTech, LLC's shop in Bellevue, Washington or to such location as PUMPTech, LLC may designate. Purchaser is responsible for prepayment of freight and insurance of such shipment. Purchaser shall provide returned items to PUMPTech, LLC in such a state that PUMPTech, LLC may inspect the item immediately upon PUMPTech, LLC's receipt thereof. If found to be defective, PUMPTech, LLC will prepay all freight and insurance costs of the return shipment of the repaired or replaced item. Any repaired or replaced items shall be warranted only for the remaining period of the original warranty. Expedited repairs are subject to expediting fees. Products inspected and proven to be non-defective are subject to service charges and will be returned to Purchaser at Purchaser's expense. THIS AGREEMENT DOES NOT GRANT ANY OTHER WARRANTY OR GUARANTEE OR MAKE ANY REPRESENTATIONS, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION, IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE, WHETHER ARISING BY LAW, CUSTOM, CONDUCT OR USAGE OF TRADE. THE RIGHTS AND REMEDIES PROVIDED HEREIN ARE EXCLUSIVE AND IN LIEU OF ANY OTHER RIGHTS OR REMEDIES. THIS WARRANTY SHALL NOT BE VALID IF THE ITEMS THAT ARE THE SUBJECT MATTER OF THIS AGREEMENT HAVE BEEN SUBJECTED TO ABUSE, MISUSE, ACCIDENT, ALTERATION, MODIFICATION, NEGLIGENCE, UNAUTHORIZED REPAIR, OR EXPOSURE TO CONDITIONS BEYOND THE APPLICABLE ENVIRONMENT. THIS WARRANTY SHALL ALSO BE VOID IF THE ITEMS ARE ASSIGNED, SOLD OR TRANSFERRED TO AN ENTITY OTHER THAN PURCHASER.

LIMITATION OF LIABILITY: PUMPTech, LLC's liability on any claim of any kind (excluding bodily injury or death) whether based on contract, warranty, tort (including negligence), strict liability or otherwise, for any loss or damage arising out of, connected with, or resulting from this Agreement, or from the performance or breach thereof, or from all services and Equipment covered by or furnished under this Agreement, shall in no case exceed the price of the specific service or Equipment which gives rise to the claim. PURCHASER UNDERSTANDS AND ACKNOWLEDGES THAT IN NO EVENT WILL PUMPTech, LLC BE LIABLE FOR SPECIAL, DIRECT, INDIRECT, INCIDENTAL, PUNITIVE, EXEMPLARY OR CONSEQUENTIAL DAMAGES, HOWEVER CAUSED, INCLUDING, BUT NOT LIMITED TO, THOSE FOR LABOR, EXPENSES, LOSS OF PROFITS OR REVENUE, LOST OPPORTUNITIES, OR SIMILAR DAMAGES OF ANY KIND. INDEMNIFICATION: Purchaser agrees to defend, indemnify and hold harmless PUMPTech, LLC and its respective affiliates, officers, directors, employees, shareholders and agents from and against all losses, costs, expenses, damages, suits or liability of any nature incurred in whole or in part as a result of the conduct, negligence, or willful misconduct of Purchaser, its agents, servants, employees or customers or caused by Purchaser's property or property under the responsibility of Purchaser.

DISPUTE RESOLUTION: All claims, disputes or controversies (whether in contract or tort, pursuant to statute or regulation, or otherwise, and whether pre-existing, present or future) arising out of or relating to PUMPTech, LLC's services and/or these Terms and Conditions (collectively "Claims") will be resolved, first, by a formal mediation conducted by an experienced mediator mutually agreed upon by PUMPTech, LLC and Purchaser, and, if mediation should fail to resolve the Claims, secondly, by reference to and determination by binding arbitration governed by the Federal Arbitration Act and administered by the American Arbitration Association under its rules for resolution of disputes, or under other mutually agreed procedures. The parties agree that any arbitration proceeding shall be presided over by a neutral arbitrator selected by the parties who shall have at least twenty (20) years of experience practicing law related to sales contract disputes. Any such proceedings under mediation or arbitration shall be conducted in Seattle, Washington. This provision shall survive the termination of the Agreement governed by these Terms and Conditions.

CHOICE OF LAW: This Agreement shall be construed in accordance with the laws of the State of Washington.

ATTORNEY FEES: In any litigation, arbitration, or other proceeding by which one party either seeks to enforce its rights under this Agreement (whether in contract, tort, or both) or seeks a declaration of any rights or obligations under this Agreement, the prevailing party shall be awarded its reasonable attorney fees, and costs and expenses incurred.

FINAL AGREEMENT: This Agreement merges all prior discussions, whether written or oral, and is the entire understanding and agreement of the parties; neither party shall be bound by additional or other representations, conditions, or promises except as subsequently set forth in writing and signed by the party to be bound.

(Purchaser's signature)

Printed Name & Title

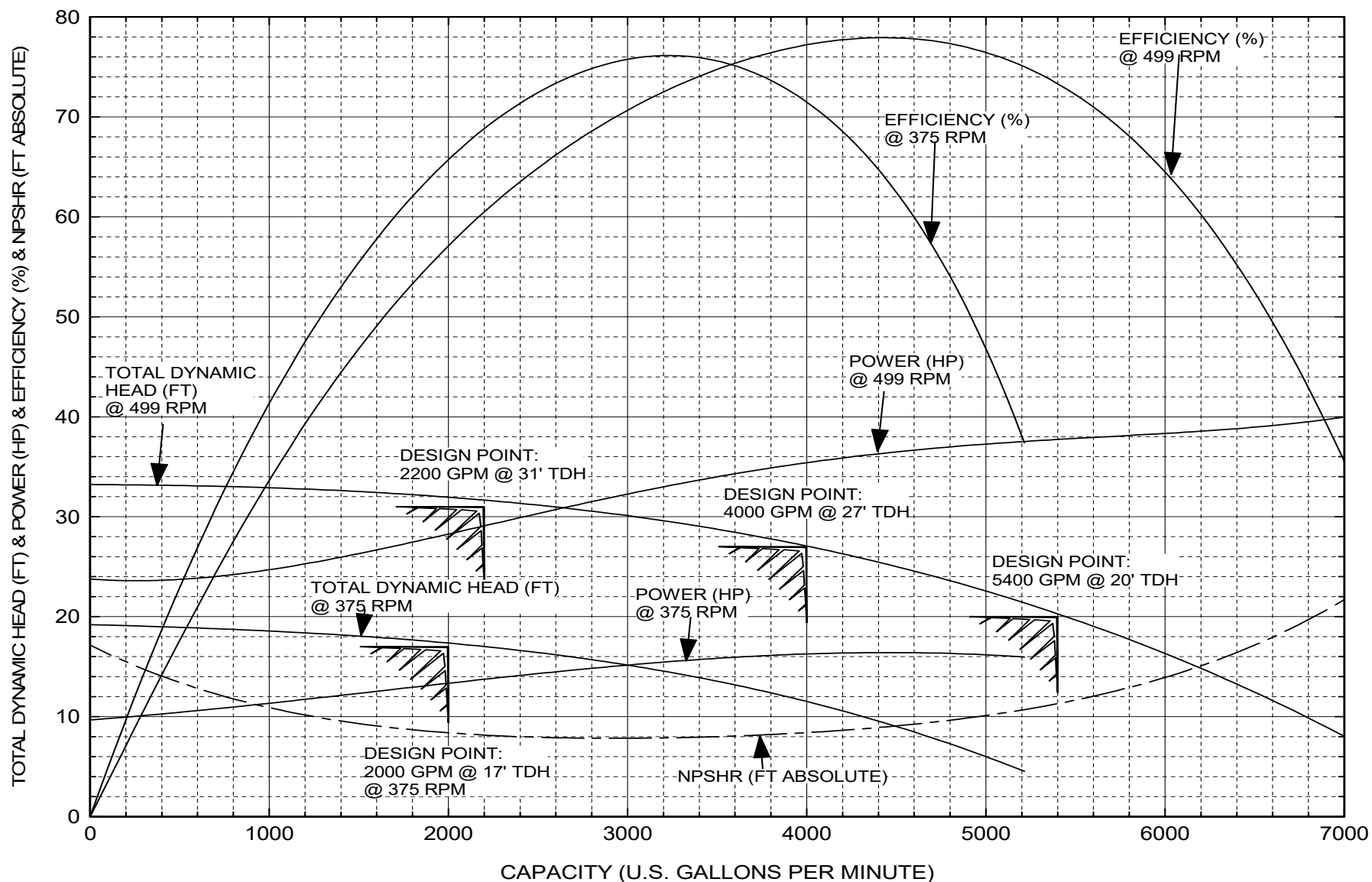
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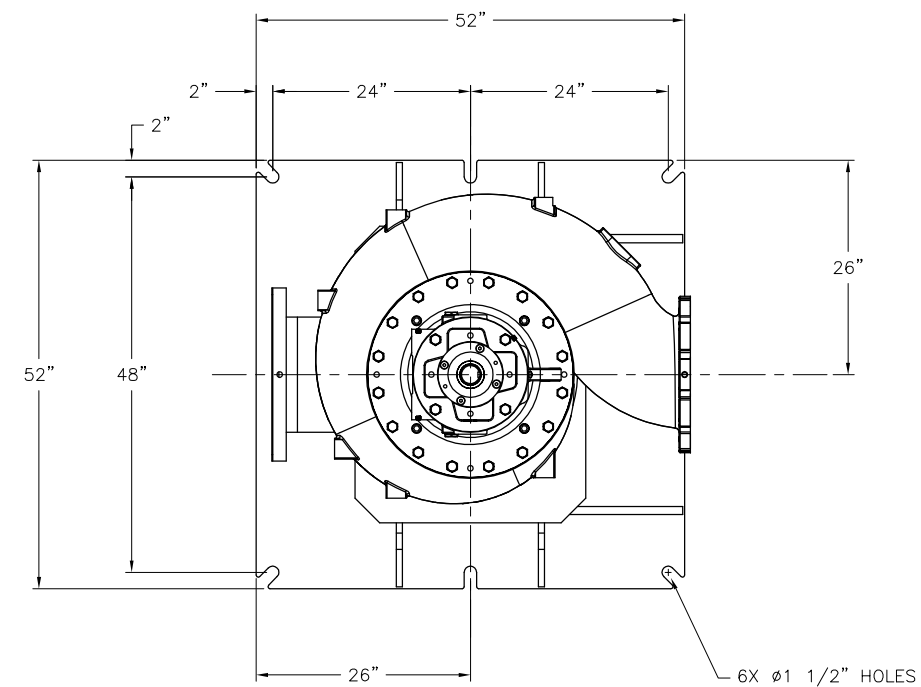
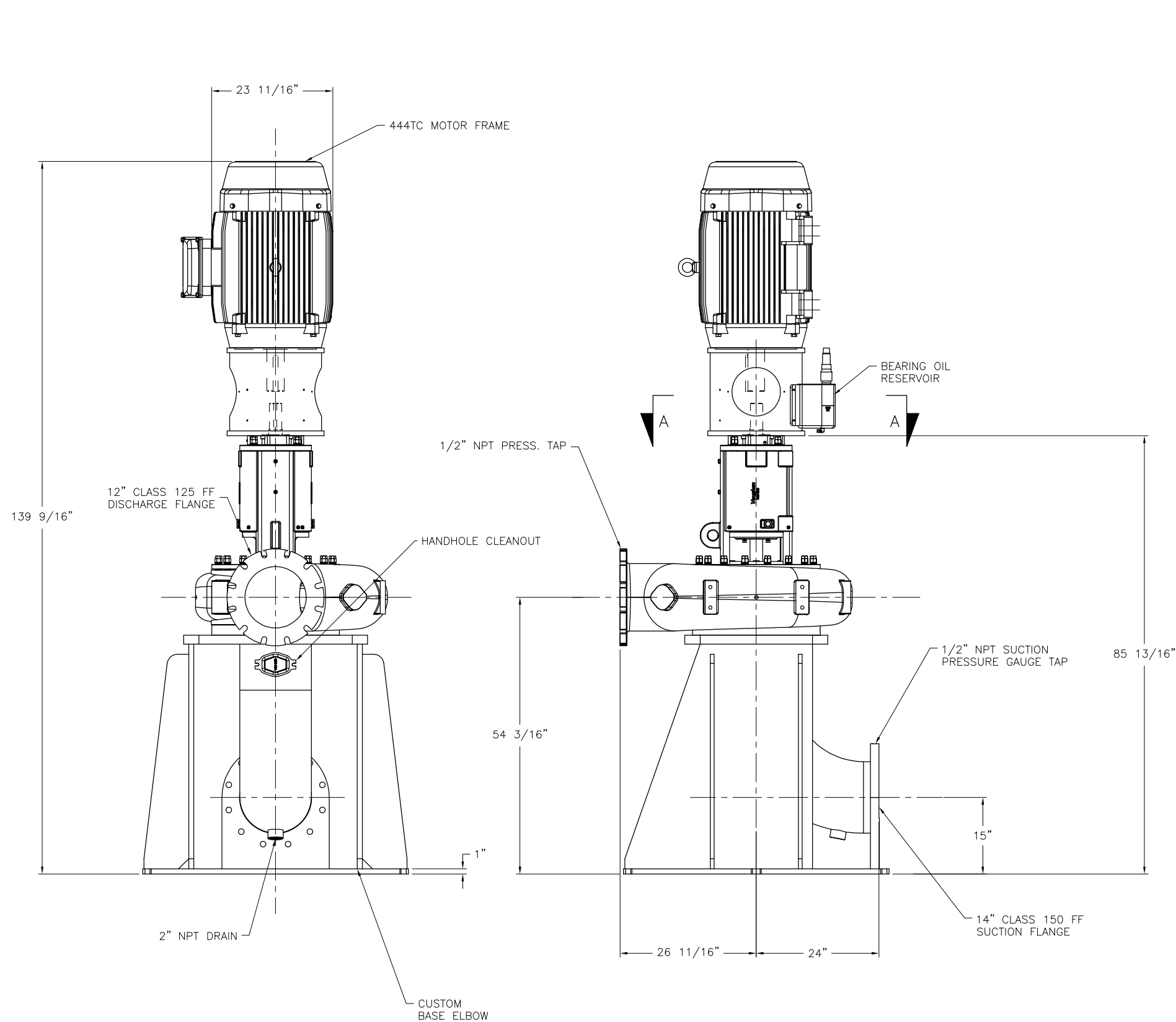


MODEL HE12W18CS-210 @ 499 & 375 RPM

ACCEPTABLE OPERATING RANGE: 2200-6000 GPM @ 499 RPM; 1800-5150 GPM @ 375 RPM

HE12W18CSB-210 @ 499 RPM; TEST # 12370, 12373






SECTION A-A

NOTES:

1. PUMP WEIGHT: BASE 2975 LBS, PUMP 1900 LBS, STOOL 165 LBS = 5040 LBS
2. MOTOR WEIGHT: 2130 LBS
3. TOTAL WEIGHT: 7170 LBS
4. PERFORMANCE REQUIRED: GPM @ TDH
5. MOTOR: HP, RPM
POWER: V, PH, HZ
ENCLOSURE:
MANUFACTURED BY:
6. SURFACE PREPARATION:

		VAUGHAN CO., INC. 364 MONTE-BLA ROAD MONTICELLO, WA 98863 PHONE: (360) 249-4042 FAX: (360) 249-6156		TITLE: OUTLINE DIMENSIONS MODEL: PE12W14CS SOUTH TACOMA PUMP STATION	
THIS DRAWING IS THE PROPERTY OF VAUGHAN COMPANY INC. IT IS FURNISHED FOR YOUR CONFIDENTIAL INFORMATION PURPOSES ONLY, AND IS NOT TO BE DISCLOSED TO ANYONE ELSE OR REPRODUCED OR USED FOR MANUFACTURING PURPOSES WITHOUT THE EXPRESS WRITTEN CONSENT OF VAUGHAN COMPANY INC.		CUSTOMER: CITY OF TACOMA		LOCATION: TACOMA, WA	
		DATE: 8/24/22		VAUGHAN QUOTATION NUMBER: Q47100B	
THIS DRAWING IS A PROPOSAL DRAWING AS SUCH IT IS A PRELIMINARY DRAWING AND IT SHOULD NOT BE USED FOR CONSTRUCTION PURPOSES.		VAUGHAN SALES ENGINEER: BD		JOB ORDER NUMBER:	

APPENDIX A

BID FORMS

**Bid Proposal
Signature Page**



Bid Proposal
Specification No. ES23-0161N

Vendor Name: _____

The City cannot legally accept a substantial deviation from the Specification. Bids/Proposals containing any substantial deviation may be rejected as non-responsive. It is agreed that you will perform according to the highest standard indicated.

Bidder agrees to furnish the following FOB Destination freight prepaid and allowed, City of Tacoma, Environmental Services, 3628 S 35th St, Tacoma, WA 98409.

Enter the cost (Unit Price) for each item below. The unit price and total cost must be shown in the space provided. Total cost shall be determined by multiplying the unit price by the estimated quantity (Quantity). Unit costs shall be all-inclusive and include all components needed for the delivery of the goods and services as described in this solicitation.

Item	Description	Quantity	UoM	Cost	Total Cost	Mfr name & Part ID (optional)
1	Variable Frequency Drive Unit (VFD) 3R VFD suitable for 40HP, 78 Amp motor. To Include: <ul style="list-style-type: none">• NEMA 3R Enclosure• 65k AIC Input Breaker• Output Reactor• Raycap Surge Suppressor• HOA Selector Switch• Speed Potentiometer Panel Shop Mods – UL508C <ul style="list-style-type: none">• E-stop, Start/Stop PB Run Stop PL, Time Delay Relay Install 120V I/O Card #DI-101.• Install Ethernet Comm Card # SI-EN3D	4	EA	\$	\$	Yaskawa #U1E3B096PCK7TYZ-PS1



2	Spare VFD Chassis	1	EA	\$	\$	CIMR-UU4A0096AUA
3	Spare Fans: Internal Stirring Fan-Two Per VFD	2	EA	\$	\$	#300-073-958
4	Enclosure Fan – Four Per VFD	4	EA	\$	\$	#UFN000166
5	Filter Element for Enclosure Fan #UFL00002-57 – 2 per Enclosure	2	EA	\$	\$	#UFL00002-57
6	Spare Fuses – VFD Input Fuses	3	EA	\$	\$	#300-054-766
7	CPT Fuses	2	EA	\$	\$	#05P00017-0356
8	PC Interface Cable, USB-A to USB-B, 10'	1	EA	\$	\$	#UWR-0638
9				\$	\$	
10				\$	\$	
					Base Bid	\$
					Sales Tax @ 10.3%	\$
					Total	\$

Successful supplier can deliver materials within by July 1, 2024 after receipt of purchase order.

Prompt payment discount _____ days, net 30.

Supplier agrees to furnish the City with a warranty against defects in material and workmanship, under normal use and according to the manufacturer's warranty guidelines. The start of the warranty commences once the goods are delivered and accepted by the City.

Does your company accept a procurement card? Yes ☐ No ☐

If yes, provide a statement regarding your ability to meet the City's credit card requirements (below) as well as identifying your reporting capabilities (Level I, II, or III). This information is not a consideration in the evaluation process.

SIGNATURE PAGE

CITY OF TACOMA ENVIRONMENTAL SERVICES DEPARTMENT

All submittals must be in ink or typewritten, executed by a duly authorized officer or representative of the bidding/proposing entity, and received and time stamped as directed in the **Request for Bids page near the beginning of the specification**. If the bidder/proposer is a subsidiary or doing business on behalf of another entity, so state, and provide the firm name under which business is hereby transacted.

REQUEST FOR BIDS SPECIFICATION NO. ES23-0161N South Tacoma Pump Station Phase 2 Variable Frequency Drive Unit Procurement

The undersigned bidder/proposer hereby agrees to execute the proposed contract and furnish all materials, labor, tools, equipment and all other facilities and services in accordance with these specifications.

The bidder/proposer agrees, by submitting a bid/proposal under these specifications, that in the event any litigation should arise concerning the submission of bids/proposals or the award of contract under this specification, Request for Bids, Request for Proposals or Request for Qualifications, the venue of such action or litigation shall be in the Superior Court of the State of Washington, in and for the County of Pierce.

Non-Collusion Declaration

The undersigned bidder/proposer hereby certifies under penalty of perjury that this bid/proposal is genuine and not a sham or collusive bid/proposal, or made in the interests or on behalf of any person or entity not herein named; and that said bidder/proposer has not directly or indirectly induced or solicited any contractor or supplier on the above work to put in a sham bid/proposal or any person or entity to refrain from submitting a bid/proposal; and that said bidder/proposer has not, in any manner, sought by collusion to secure to itself an advantage over any other contractor(s) or person(s).

Bidder/Proposer's Registered Name

Signature of Person Authorized to Enter Date
into Contracts for Bidder/Proposer

Address

Printed Name and Title

City, State, Zip

(Area Code) Telephone Number / Fax Number

Authorized Signatory E-Mail Address

State Business License Number
in WA, also known as UBI (Unified Business Identifier) Number

E.I.No. / Federal Social Security Number Used on Quarterly
Federal Tax Return, U.S. Treasury Dept. Form 941

State Contractor's License Number
(See Ch. 18.27, R.C.W.)

E-Mail Address for Communications

Addendum acknowledgement #1_____ #2_____ #3_____ #4_____ #5_____

THIS PAGE MUST BE SIGNED AND RETURNED WITH SUBMITTAL.

APPENDIX B
SUBSTITUTION FORM

Substitution Request Form



City of Tacoma
Environmental Services Department
Science and Engineering Division

Substitution Request Form

Project: _____ Substitution Request Number: _____

From: _____
To: _____ Date: _____

Owner Project Number: _____
Re: _____ Contract For: _____

Specification Title: _____ Description: _____
Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Address: _____ Phone: _____

Trade Name: _____ Model No.: _____

Installer: _____ Address: _____ Phone: _____

History: ☐ New product ☐ 2-5 years old ☐ 5-10 yrs old ☐ More than 10 years old

Complies with American Iron and Steel (AIS) Requirements: ☐ Yes ☐ No ☐ N/A

Differences between proposed substitution and specified product: _____

☐ Point-by-point comparative data attached - REQUIRED BY OWNER

Reason for not providing specified item: _____

Similar Installation:

Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain _____

Savings to Owner for accepting substitution: _____ (\$ _____).

Proposed substitution changes Contract Time: ☐ No ☐ Yes [Add] [Deduct] _____ days.

When is material required to be on site?: _____

Product Requirements

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

The Undersigned certifies:

- Proposed substitution has been fully investigated and determined to be equal or superior in all respects to specified product.
- Same warranty will be furnished for proposed substitution as for specified product.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitution will have no adverse effect on other trades and will not affect or delay progress schedule.
- Cost and schedule data as stated above is complete. Claims for additional costs or time related to accepted substitution which may subsequently become apparent are to be waived.
- Proposed substitution does not affect dimensions and functional clearances.
- Payment will be made for changes to building design, including Engineer design, detailing, and construction costs caused by the substitution.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: _____

Signed by: _____

Firm: _____

Address: _____

Telephone: _____

Attachments: _____

OWNER'S REVIEW AND ACTION

- ☐ Substitution accepted - Make submittals in accordance with Specification Section 01_33_00.
☐ Substitution accepted as noted - Make submittals in accordance with Specification Section 01_33_00
☐ Substitution rejected - Use specified materials.
☐ Substitution Request received too late - Use specified materials.

Signed by:

Date:

Additional Comments: ☐ Contractor ☐ Subcontractor ☐ Supplier ☐ Manufacturer ☐ Owner ☐ _____

Product Requirements

APPENDIX C

INSURANCE REQUIREMENTS



CITY OF TACOMA INSURANCE REQUIREMENTS FOR CONTRACTS

This Insurance Requirements shall serve as an attachment and/or exhibit form to the Contract. The Agency entering a Contract with City of Tacoma, whether designated as a Supplier, Contractor, Vendor, Proposer, Bidder, Respondent, Seller, Merchant, Service Provider, or otherwise referred to as "Contractor".

1. GENERAL REQUIREMENTS

The following General Requirements apply to Contractor and to Subcontractor(s) performing services and/or activities pursuant to the terms of this Contract. Contractor acknowledges and agrees to the following insurance requirements:

- 1.1. Contractor shall not begin work under the Contract until the required insurance has been obtained and approved by the City of Tacoma.
- 1.2. Contractor shall keep in force during the entire term of the Contract, at no expense to the City of Tacoma, the insurance coverage and limits of liability listed below and for Thirty (30) calendar days after completion of all work required by the Contract, unless otherwise provided herein.
- 1.3. Liability insurance policies, except for Professional Liability and Workers' Compensation, shall:
 - 1.3.1. Name the City of Tacoma and its officers, elected officials, employees, and agents as **additional insured**
 - 1.3.2. Be considered primary and non-contributory for all claims with any insurance or self-insurance or limits of liability maintained by the City of Tacoma
 - 1.3.3. Contain a "Waiver of Subrogation" clause in favor of City of Tacoma
 - 1.3.4. Include a "Separation of Insureds" clause that applies coverage separately to each insured and additional insured
 - 1.3.5. Name the "City of Tacoma" on certificates of insurance and endorsements and not a specific person or department
 - 1.3.6. Be for both ongoing and completed operations using Insurance Services Office (ISO) form CG 20 10 04 13 and CG 20 37 04 13 or the equivalent
 - 1.3.7. Be satisfied by a single primary limit or by a combination of a primary policy and a separate excess umbrella
- 1.4. A notation of coverage enhancements on the Certificate of Insurance shall not satisfy these requirements below. Verification of coverage shall include:
 - 1.4.1. An ACORD certificate or equivalent
 - 1.4.2. Copies of requested endorsements
- 1.5. Contractor shall provide to City of Tacoma Procurement & Payable Division, prior to the execution of the Contract, Certificate(s) of Insurance and endorsements from the insurer certifying the coverage of all insurance required herein. Contract or Permit number and the City of Tacoma Department must be shown on the Certificate of Insurance.
- 1.6. A renewal Certificate of Insurance shall be provided electronically prior to coverage



CITY OF TACOMA INSURANCE REQUIREMENTS FOR CONTRACTS

expiration via email sent annually to coi@cityoftacoma.org.

- 1.7. Contractor shall send a notice of cancellation or non-renewal of this required insurance within Thirty (30) calendar days to coi@cityoftacoma.org.
- 1.8. "Claims-Made" coverages, except for pollution coverage, shall be maintained for a minimum of three years following the expiration or earlier termination of the Contract. Pollution coverage shall be maintained for six years following the expiration of the Contract. The retroactive date shall be prior to or coincident with the effective date of the Contract.
- 1.9. Each insurance policy must be written by companies licensed or authorized (or issued as surplus line by Washington surplus line broker) in the State of Washington pursuant to RCW 48 with an (A-) VII or higher in the A.M. Best key rating guide.
- 1.10. Contractor shall not allow any insurance to be cancelled, voided, suspended, or reduced in coverage/limits, or lapse during any term of this Contract. Otherwise, it shall constitute a material breach of the Contract.
- 1.11. Contractor shall be responsible for the payment of all premiums, deductibles and self-insured retentions, and shall indemnify and hold the City of Tacoma harmless to the extent such a deductible or self-insured retained limit may apply to the City of Tacoma as an additional insured. Any deductible or self-insured retained limits in excess of Twenty Five Thousand Dollars (\$25,000) must be disclosed and approved by City of Tacoma Risk Manager and shown on the Certificate of Insurance.
- 1.12. City of Tacoma reserves the right to review insurance requirements during any term of the Contract and to require that Contractor make reasonable adjustments when the scope of services changes.
- 1.13. All costs for insurance are included in the initial Contract and no additional payment will be made by City of Tacoma to Contractor.
- 1.14. Insurance coverages specified in this Contract are not intended and will not be interpreted to limit the responsibility or liability of Contractor or Subcontractor(s).
- 1.15. Failure by City of Tacoma to identify a deficiency in the insurance documentation or to verify coverage or compliance by Contractor with these insurance requirements shall not be construed as a waiver of Contractor's obligation to maintain such insurance.
- 1.16. If Contractor is a government agency or self-insured for any of the above insurance requirements, Contractor shall be liable for any self-insured retention or deductible portion of any claim for which insurance is required. A certification of self-insurance shall be attached and incorporated by reference and shall constitute compliance with this Section.

2. SUBCONTRACTORS



CITY OF TACOMA

INSURANCE REQUIREMENTS FOR CONTRACTS

It is Contractor's responsibility to ensure that each subcontractor obtain and maintain adequate liability insurance coverage that applies to the service provided. Contractor shall provide evidence of such insurance upon City of Tacoma's request. Failure of any subcontractor to comply with insurance requirements does not limit Contractor's liability or responsibility.

3. REQUIRED INSURANCE AND LIMITS

The insurance policies shall provide the minimum coverages and limits set forth below. Providing coverage in these stated minimum limits shall not be construed to relieve Contractor from liability in excess of such limits.

3.1 Commercial General Liability Insurance

Contractor shall maintain Commercial General Liability Insurance policy with limits not less than One Million Dollars (\$1,000,000) each occurrence and Two Million Dollars (\$2,000,000) annual aggregate. This policy shall be written on ISO form CG 00 01 04 13 or its equivalent and shall include product liability especially when a Contract is solely for purchasing supplies. It includes Products and Completed Operations for three years following the completion of work related to performing construction services. It shall be endorsed to include: A per project aggregate policy limit (using ISO form CG 25 03 05 09 or equivalent endorsement)

3.2 Commercial (Business) Automobile Liability Insurance

Contractor shall maintain Commercial Automobile Liability policy with limits not less than One Million Dollars (\$1,000,000) each accident for bodily injury and property damage and bodily injury and property damage coverage for owned (if any), non-owned, hired, or leased vehicles. Commercial Automobile Liability Insurance shall be written using ISO form CA 00 01 or equivalent. Contractor must also maintain MCS 90 and CA 99 48 endorsements or equivalent if "Pollutants" are to be transported unless in-transit Pollution coverage is covered under required Contractor's Pollution Liability Insurance.

3.3 Workers' Compensation

Contractor shall comply with Workers' Compensation coverage as required by the Industrial Insurance laws of the State of Washington, as well as any other similar coverage required for this work by applicable federal laws of other states. Contractor must comply with their domicile State Industrial Insurance laws if it is outside the State of Washington.

3.4 Employers' Liability Insurance

Contractor shall maintain Employers' Liability coverage with limits not less than One Million Dollars (\$1,000,000) each employee, One Million Dollars (\$1,000,000) each accident, and One Million Dollars (\$1,000,000) policy limit.

3.5 Employee Theft Insurance

Contractor shall maintain Employee Theft or Employee Dishonesty Insurance policy with a limit not less than One Million Dollars (\$1,000,000) per occurrence. Such policy shall include the City of Tacoma as Loss Payee.

3.6 Inland Marine (Cargo) Insurance

Contractor shall maintain Cargo Insurance. Coverage shall protect the property from all risk of injury, and coverage shall be in an amount of the full replacement cost of the property, with no coinsurance exposure. Any applicable deductible shall not exceed Five Thousand Dollars (\$5,000).



CITY OF TACOMA

INSURANCE REQUIREMENTS FOR CONTRACTS

3.7 Other Insurance

Other insurance may be deemed appropriate to cover risks and exposures related to the scope of work or changes to the scope of work required by City of Tacoma. The costs of such necessary and appropriate Insurance coverage shall be borne by Contractor.