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KA 'OIHANA OLAKINO
SAFE DRINKING WATER BRANCH
[redacted]

In reply, please refer to:
File: SDWB
[redacted]

October 11, 2024

US EPA BABA WAIVER OFFICE
[via BABA-OW@epa.gov only]

Dear BABA Compliance Waiver Team:

SUBJECT: BUILD AMERICA, BUY AMERICA, (BABA) WAIVER REQUEST – PROJECT – SPECIFIC NONAVAILABILITY WAIVER OF BABA REQUIREMENTS TO HAWAII DEPARTMENT OF WATER SUPPLY (HDWS), WAIMEA WATER TREATMENT PLANT (WTP) BACKWASH & SERVICE WATER BOOSTERS

The Hawaii Department of Health (HDOH), Drinking Water State Revolving Fund (DWSRF) hereby applies for a BABA waiver for "open line shaft water lubricated vertical turbine well pump assemblies" as part of phased Waimea WTP Backwash & Service Water Boosters project. The project will be considered a DWSRF equivalency project and is therefore subject to BABA compliant materials.

- **Waiver Type:** Nonavailability of a domestic production sufficient and reasonably available quantities or of a satisfactory quality.
- **Waiver Level and Scope:** Project-level waiver for a single product type for a single project within one award.
- **Product:** Four (4) well pump assemblies, which includes vertical hollow shaft motor, pump discharge head, column pipe assembly pump bowl assembly, and other associated components. See **Enclosure 1** for specifications.
- **Estimated Cost of Products Included in the Waiver:** Estimated costs per pump assembly is roughly $[redacted]. Therefore, the total cost of equipment is $[redacted].
- **Project Summary:** The Waimea WTP Backwash & Service Water Boosters – Refurbishing Equipment project will consist of
    1. Demolishing two (2) existing backwash booster pump stations, along with the control equipment for all four (4) of these stations.
    2. Constructing new concrete pump pads, casing and sole plates, construction of new discharge piping, construction of new starting and control equipment, and SCADA integration work.
- **Recipient's UEI:** EPPEQ6N7ZH13 (Department of Water, County of Hawaii); HDOH's UEI is LFVFLBD6XZB5.

- **Project Cost:** The current material bid and labor is estimated at $[redacted]. Material bid will be separate from the contractor (labor) bid to maintain better control over BABA-compliant materials.
- **Project Timeline:** Project is expected to have funding awarded in December 2024, with the Notice to Proceed in January 2025, making project completion (210 calendar days) expected in August or September 2025.

An informal market review was initiated and completed for many of the products needed for this project:

- **Market Findings:** The EPA conducted market research in August/September 2024. Domestic manufactures were presented to the HDWS by email on Wednesday, September 25, 2024. See **Enclosure 2**.
- **Manufacturer Confirmation and Domestic Product Review:** Manufacturers suggested by EPA confirmed the pump assembly is either not BABA compliant [redacted] or a BABA compliant version of the pump assembly will result in unacceptable reduced efficiency [redacted]. See **Enclosure 3**.
- **Waiver Requested:** HDWS asked HDOH to pursue a waiver on September 25, 2024.

If there are any questions, please contact doh.dwsrf@doh.hawaii.gov. Additionally, you may reach Ms. Devin Donaldson, Environmental Protection Specialist in the SDWB Engineering Section at (808) 586-4258 or devin.donaldson.nsw@doh.hawaii.gov or Ms. Judy Hayducsko, DWSRF Engineer at (808) 586-4267 or judy.hayducsko@doh.hawaii.gov.

Sincerely,

Gaudencio C. Lopez

GAUDENCIO C. LOPEZ, P.E., CHIEF
Safe Drinking Water Branch

DD:cw

Enclosures
1. Enclosure 1 – Specifications
2. Enclosure 2 – EPA Market Research
3. Enclosure 3 – Manufacturer Responses

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SECTION 304 – MECHANICAL AND ELECTRICAL

The following shall supplement Section 304 “Mechanical and Electrical”, in the Water System Standards, 2002.

304.05 – OPEN LINE SHAFT WATER LUBRICATED VERTICAL TURBINE WELL PUMP ASSEMBLY

A. GENERAL

1. Summary

   a. The work under this section shall consist of furnishing all labor, materials, equipment, and appurtenances required for the installation and testing of an open line shaft water lubricated vertical turbine well pump assembly, in accordance with the details shown on the plans (if provided), and the requirements of these specifications. The open line shaft water lubricated vertical turbine well pump assembly includes vertical hollow shaft motor, pump discharge head, column pipe assembly, pump bowl assembly, and all associated components.

   b. It is the intent of these Specification to obtain a high efficiency, durable, open line shaft water lubricated vertical turbine well pump assembly of heavy-duty construction for continuous service or for intermittent service, whichever imposes the most severe conditions on the pump. Pumps that have mechanical defects or do not meet the range or head-capacity characteristics, horsepower, and efficiency requirements will be rejected after testing and shall be expediently replaced without additional cost to the Department of Water Supply for furnishing, removal, reinstallation, and retesting. Mechanical defects shall include the following:

      i. Excessive vibration

      ii. Improper balancing of any rotating parts

      iii. Improper tolerances

      iv. Binding

      v. Excessive bearing heating

      vi. Defective materials, including materials that do not conform to the specifications

      vii. Improper fitting of parts

      viii. Any other defect which will in time damage the pump or unreasonably impair the efficiency of the pump.

2. Reference Standards

   a. Design, manufacturing and assembly of elements of the equipment specified herein shall be in accordance with the following, where applicable:

Reference Standards
American Iron and Steel Institute (AISI)

Reference Standards
American Society of Mechanical Engineers (ASME)
American National Standards Institute (ANSI)
American Petroleum Institute (API)
American Society for Testing Materials (ASTM)
American Water Works Association (AWWA)
American Welding Society (AWS)
American Bearing Manufacturers Association (ABMA)
Hydraulic Institute (HI) Standards
Institute of Electrical and Electronics Engineers (IEEE)
International Organization for Standardization (ISO)
National Electrical Manufacturers Association (NEMA)
National Sanitation Foundation (NSF)
The Society for Protective Coatings (SSPC)

b. Where reference is made to one of the above standards, the revision in effect at the time of the bid opening shall apply. Where conflicts exist between the specification and the above standards, these specifications shall govern.

3. System Description

   a. The equipment to be furnished under this section shall include one (1) assembly for installation and three (3) assemblies for future work, inclusive of, vertical hollow shaft motor, discharge head, column assembly, pump bowl assembly, appurtenances and accessories, all as specified herein. Contractor shall coordinate with Manufacturer(s) and be fully responsible for proper operation and compatibility between items in this scope of work.

4. Qualifications

   a. To assure unity of responsibility, the vertical hollow shaft motor, discharge head, column assembly, and pump bowl assembly shall be furnished and coordinated by the Contractor. The Contractor shall either directly or by designated third-party vendor(s), furnish all equipment and related services indicated as included under unity of responsibility as mentioned above. The Contractor and Manufacturer shall assume responsibility for the first-class installation and operation of the entire pumping system including vertical hollow shaft motor, discharge head, column assembly, and pump bowl assembly as specified. The Contractor shall furnish to the Department ten (10) calendar days prior to the time of bid opening, a signed guarantee from the Manufacturer of the detailed list of equipment being furnished and included under warranty. If no submission is received by the deadline, it shall be inherently assumed and mutually agreed that the vertical hollow shaft motor, discharge head, column assembly, and pump bowl assembly shall be covered under unit warranty by the Contractor.

b. The equipment covered by this Section is intended to be standard pumping equipment of proven ability and performance as manufactured by companies possessing extensive experience in the production of such equipment similar to the applications stated in Section 304.05, Parts A.3., B.1. and B.2. Units specified herein shall be furnished by a single manufacturer. The equipment furnished shall be designed, constructed and installed to operate faultlessly when installed per the Manufacturer's recommended installation procedures with the equipment indicated on the Manufacturer's submittals.

c. The pump bowl assembly shall be manufactured in accordance with the Hydraulic Institute Standards, except where otherwise specified herein.

d. The Contractor shall be fully responsible for coordinating with the Manufacturer for the design, arrangement, and operation of all connected rotating components of the assembled pumping unit to ensure that neither harmful nor damaging vibrations occur at any speed within the specified operating range.

e. The Manufacturer or its representative shall have an authorized warranty center within a 4-day shipping radius of the job site, fully staffed with factory trained mechanics, and equipped with a stock of strategic spare parts for the model of pump and/or motor furnished under this contract. The service facility and strategic spare parts shall be established during the submittal review process prior to delivery of equipment for this project.

f. All equipment furnished under this Specification shall be new and unused, shall be the standard product of manufactures possessing a successful record of manufacturing and servicing similar equipment and systems installed in similar applications to that specified herein for a minimum of ten (10) years.

g. The pumping equipment shall be furnished complete with accessories required and shall meet the detailed requirement of the Specifications.

h. The Manufacturer shall be certified to the ISO 9001 standard for the design and manufacture of open line shaft water lubricated vertical turbine pumps.

i. Welding of pressure-containing fabrications shall be by welders qualified to ASME Code Section 9 or AWS D1.1 Structural Welding Code – Steel.

j. All well assembly components shall be suitable for potable water use; however NSF-61 certification shall not be required.

5. Equipment and Material Requirements

a. The Contractor shall ensure that all equipment and material provided do not exceed physical diameter and depth limits of the pump gallery or the available space on the inclined lift equipment or tunnel. If pump dimension changes substantially from existing, the Contractor shall direct the pump manufacturer to perform a computational fluid dynamic (CFD) analysis; and perform a process simulation of the well assembly within the existing pump gallery to ensure the proposed equipment reliably provides the required level of performance, without issues of cavitation, vortex formation, piping pulsation, or vibration. The Contractor shall be responsible for furnishing the required field measurement and

photographs required by the pump manufacturer for the analysis and simulation. The Contractor shall assume all costs in association with the verification of the substituted equipment's fitment in the pump gallery. The Contractor shall guarantee all requirements are met prior to ordering.

b. This project shall be subject to the American Iron and Steel (AIS) requirement, such that all products made primarily of iron or steel must be produced in the United States. The Contractor shall submit certification that the material was produced in the United States or information necessary to verify an approved waiver of the AIS Requirement. Additionally, Contractor shall comply with, and shall execute and submit any written documentation or certification required by the AIS or other applicable law, rule or regulation. Failure to comply with AIS Requirements by the Contractor shall permit the Department to recover, as damages against the Contractor, any loss, expense, or cost (including, without limitation, attorney's fees) incurred by the Department resulting from any such failure (including, without limitation, any impairment or loss of funding, whether in whole or in part, from the State or any damages owed to the State by the Department).

    i. Mechanical and electrical components, equipment and systems, including housing/covers, are not construction material and are not required to be produced in the United States, including:

        a) Pumps, motors, gear reducers, drives (including variable frequency drives (VFDs)), electric/pneumatic/manual accessories used to operate valves (such as electric valve actuators), mixers, gates, motorized screens (such as traveling screens), blowers/aeration equipment, compressors, meters, sensors, controls and switches, supervisory control and data acquisition (SCADA), membrane bioreactor systems, membrane filtration systems, filters, clarifiers and clarifier mechanisms, rakes, grinders, disinfection systems, presses (including belt presses), conveyors, cranes, HVAC (excluding ductwork), water heaters, heat exchangers, generators, cabinetry and housings (such as electrical boxes/enclosures), lighting fixtures, electrical conduit, emergency life systems, metal office furniture, shelving, laboratory equipment, analytical instrumentation, and dewatering equipment.

    ii. De minimis waiver: up to five percent (5%) of the total cost of the project's materials may be used for de minimis incidental components that are of an unknown origin or are not compliant with AIS. The cost of any individual item may not exceed one percent (1%) of the total cost of the materials used in and incorporated into a project. These incidental components include small washers, screws, fasteners (nuts and bolts), miscellaneous wire, corner bead, ancillary tube, etc.

c. This project shall be subject to the Build America, Buy America (BABA) requirements in conjunction with the AIS requirements. Contractors shall be responsible for reviewing the Instructions to Bidders, Section 25, "BUILD

AMERICA, BUY AMERICA ACT 2021 (BABA)" for details regarding BABA requirements.

d. Should the pump manufacturer be unable to satisfy the minimum performance requirements specified after exhaustive rework on the pump, the pump may be accepted at the Department's discretion, under the condition that the pump manufacturer shall be responsible for the cost differential associated with the lower pump efficiency for the life of the pump. No exceptions shall to this provision shall be allowed. The calculations for energy cost due to the deficiency in pump efficiency shall be based on the following equation:

i. $CC = 365 \left(\frac{0.746 Q H c c}{3960 \mu_p \mu_m} \right) RR$

a) Where:

i) C = Cost per Year

ii) Q = Pump Flow Rate

iii) H = Pump Head

iv) c = Cost per kWH

v) μ_p = Pump Efficiency

vi) μ_m = Motor Efficiency

vii) R = Daily Runtime

b) Parameter Values

i) Expected pump service life: 10 years

ii) Daily runtime: 24 hours

iii) Cost per kWH: $0.44

c) Energy costs shall be calculated as the difference between the guaranteed pump efficiency submitted to the Department at the time of pre-bid submittals and the pump efficiency on the certified pump curve submitted by the Contractor prior to delivery of equipment.

6. Submittals

a. Prior to Bid Opening

i. The Contractor shall submit datasheets from the pump and motor manufacturers, respectively, ten (10) days prior to the bid opening or by _____. The datasheet for the pump bowl assembly shall at a minimum identify the manufacturer; pump model; number of stages; table of materials of construction or statement of guarantee from the manufacturer that materials of construction shall conform to the bid specification; guaranteed pump bowl efficiency at the specified performance point, inclusive of any derates for materials of construction; and physical dimensions and weight of the pump bowl assembly. The datasheet for the motor shall at a minimum identify the manufacturer; motor model; performance (efficiency, power factor, amps,

input power and RPM) versus horsepower curve; guaranteed motor efficiency at the specified performance point; and physical dimensions and weight of the motor. The failure to submit datasheets with the required information by the specified deadline shall disqualify that manufacturer from consideration from this solicitation.

b. Schedule of Work

   i. The Contractor shall furnish a firm schedule of work to the Project Engineer upon approval of all submittals within 14 calendar days thereafter. Schedules shall be immediately updated upon notification of changes to manufacturer's production, testing or delivery schedules. The Contractor shall closely adhere to the schedule of work and shall notify the Project Engineer to any changes to the schedule regarding work on-site, a minimum of 48-hours prior to the performance of the specified work. Failure of the Contractor to submit a firm schedule of work by the specified deadline and timely schedule updates, shall disqualify the Contractor for consideration for project time extensions, as provided for in Part 9 of the Instruction to Bidders on page IB-15.

c. Prior to Ordering

   i. The Contractor shall submit the following and receive Department written approval prior to ordering:

      a) One (1) set of shop drawings and literature shall be submitted for each open line shaft water lubricated vertical turbine well pump assembly. All submittals and copies thereof shall be clean, legible prints that are easily reproduced and shall reference the project name and job number. Shop drawings and literature together with an assembly drawing showing the entire pump and motor assemblies shall include detailed specifications and drawings indicating:

         i) Motor

            a)) Required Information

               i)) Manufacturer

               ii)) Model

               iii)) Horsepower

               iv)) Thrust bearing rating

               v)) Dimensioned assembly drawing

               vi)) Component materials

               vii)) Unit weight of complete assembly

               viii)) Certified performance data as follows:

                  a))) Complete initial test data for a comparable motor shall include, but not be limited to: full load heat rise, percent slip, no-load current, full-load current, locked rotor current, locked rotor torque, breakdown torque

(calculated), efficiency & power factor at 25%, 50%, 75% and full load, insulation resistance per IEEE Standard 43, winding resistance, and high potential, shall be submitted for review as part of the shop drawing submittals.

ix)) Compliance with BABA by furnishing the following document:

a))) Signed letter on the manufacturer's letter head describing the product and the location of the facility that manufactured the product.

ii) Discharge Head Assembly

a)) Required Information

i)) Manufacturer

ii)) Dimensional drawing and unit weight

iii)) Materials of construction

iv)) Abrasive Flow Machining Contractor information

a))) Name

b))) Company résumé

v)) Coating materials, manufacturer(s), certifications

vi)) Compliance with BABA by furnishing the following document:

a))) Signed letter on the manufacturer's letter head describing the product and the location of the facility that manufactured the product.

iii) Stuffing Box Assembly

a)) Required Information

i)) Dimensional drawings including cross sections and unit weight

ii)) Materials of construction

iii)) Compliance with BABA by furnishing the following document:

a))) Signed letter on the manufacturer's letter head describing the product and the location of the facility that manufactured the product.

iv) Mechanical Seal

a)) Required Information

i)) Manufacturer

ii)) Dimensional drawing

iii)) Support plan details

iv)) Compliance with BABA by furnishing the following document:

a))) Signed letter on the manufacturer's letter head describing the product and the location of the facility that manufactured the product.

v) Column Pipe Assembly

a)) Required Information

i)) Manufacturer

ii)) Detailed column flange dimensions inclusive of flange O.D.; flange thickness; flange bolt circle diameter; flange bolt hole quantity & size; register diameter; and register depth.

iii)) Detailed drop-in bearing retainer dimensions inclusive of bearing retainer outer ring O.D.; bearing retainer outer ring I.D.; bearing retainer outer ring thickness; bearing retainer inner hub O.D.; bearing retainer inner hub I.D.; and bearing retainer inner hub depth.

iv)) Detailed line shaft bearing (uninstalled) dimensions inclusive of bearing O.D., bearing I.D.; bearing length; bearing fluting quantity & size; and bearing fluting angle of twist.

v)) Detailed line shaft dimensions inclusive of line shaft O.D.; line shaft length; line shaft threading standard (*e.g. 10 TPI UNS-3A, ASTM B1.1, L.H.*); and line shaft overall thread length.

vi)) Detailed line shaft coupling dimensions inclusive of line shaft coupling O.D.; line shaft coupling I.D.; line shaft coupling length; and line shaft coupling threading standard (*e.g. 10 TPI UNS-3B, ASTM B1.1, L.H.*).

vii)) Certification of the column pipe and flange materials of construction in conformance to the specifications.

viii)) Certification of the column pipe flange axial alignment in conformance to the specifications.

ix)) Certification of the drop-in bearing retainer materials of construction in conformance to the specifications.

x)) Certification of the drop-in bearing retainer axial alignment of the inner hub to outer ring and inner hub to column flange in conformance to the specifications.

xi)) Certification of the drop-in bearing retainer concentricity of the inner hub to outer ring in conformance to the specifications.

xii)) Certification of the line shaft materials of construction in conformance to the specifications.

xiii)) Certification of the line shaft runout and mechanical method of straightening in conformance to the specifications.

xiv)) Certification of the line shaft surface finish in conformance to the specifications.

xv)) Certification of the line shaft coupling materials of construction in conformance to the specifications.

xvi)) Certification of the line shaft coupling axial alignment in conformance to the specifications.

xvii)) Certification of the line shaft coupling concentricity of the coupling I.D. to coupling O.D. in conformance to the specifications.

xviii)) Compliance with BABA by furnishing the following document:

a))) Signed letter on the manufacturer's letter head describing the product and the location of the facility that manufactured the product.

vi) Pump Bowl Assembly

a)) Required Information

i)) Pump performance curve and literature (see list below)

ii)) Manufacturer

iii)) Model and number of stages

iv)) Design full-load speed

v)) Size and type of suction intake screen

vi)) Component materials

vii)) Coating types, manufacturers, and associated certifications / approvals

viii)) Unit weights of components and complete assembly

ix)) Any other noteworthy design features

b)) The pump performance curve and literature, for the specific impeller diameter and number of stages, for the entire operating range of the pump including shut-off head, shall include:

i)) A head-capacity curve with design point indicated

ii)) A horsepower requirement curve

iii)) An efficiency curve

iv)) A thrust factor (K) curve

v)) A NPSHR curve

vi)) Pump lateral

vii)) Pump shaft diameter

viii)) Impeller type and diameter

ix)) Dimensioned assembly drawing detailing the entire vertical turbine well pump, including column pipe, and pump discharge head

x)) Calculations indicating expected "wire-to-water" efficiency

xi)) A detailed table for materials of construction with conforming materials standards

xii)) Compliance with BABA by furnishing the following document:

a))) Signed letter on the manufacturer's letter head describing the product and the location of the facility that manufactured the product.

vii) Any materials or equipment procured by means of contract change order.

a)) Materials or equipment may be subject to compliance with AIS or BABA.

b) Test Reports

i) Description of proposed pump factory test procedures and equipment.

ii) A schedule of the date of factory testing.

d. Prior to Shipment

i. The Contractor shall submit the following and receive Department written approval <u>prior to shipment</u>:

a) One (1) <u>certified witnessed</u> copy of the performance curve and test data sheets of a factory laboratory running test conducted for the actual bowl assembly to be furnished, witnessed by a factory registered licensed professional engineer (P.E.). The Contractor shall verify that the <u>certified witnessed</u> pump efficiency is at least the minimum as specified at the rated conditions. The curve and data sheet must be approved by the Department before the pump is shipped. The running test shall be conducted in accordance with the latest edition of the "American National Standard for Deepwell Vertical Turbine Pumps – Line Shaft and Submersible Types", Hydraulic Institute, and the American Water Works Association to show that the specified conditions can be met by the bowl assembly furnished. The performance curve shall show the head-capacity at rated speed, efficiency-capacity, and required brake horsepower-capacity curves for the bowl assembly, as well as the guaranteed maximum net positive suction head required (NPSHR), minimum submergence, and tabular data for flow (GPM), head (FT), pump bowl efficiency (%), input voltage (V), input current (A), and input power (kW) for all measured capacity points. The pump shall be operated at shut-off condition and at a minimum of nine (9) equally spaced capacity points, with the 7th point at the specified design conditions. <u>The test shall be performed at full design capacity, and speed</u>. No normalized test values performed at reduced test parameters shall be

accepted. To accommodate pressure limitations of the testing facility, if the pump TDH exceeds 1,000', the pump may be destage into no more than two subassemblies. All pump bowls shall be required to be tested. The factory registered licensed professional engineer shall be provided by the manufacturer. It shall be the responsibility of the manufacturer's professional engineer to verify the manufacturer/testing facility is adhering to the following procedures i) – ii):

i) The required pump test acceptance grade exceeds all grades listed under ANSI/HI 14.6. Corresponding tolerance band shall be as follows (No exceptions to this provision shall be allowed):

   a)) Rate of flow: -0% to +4%

   b)) Total head: -0% to +2%

   c)) Efficiency: -0%

ii) If the testing facility resides within the following states (Arizona, Arkansas, California, Colorado, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, New Mexico, New York, North Dakota, Ohio, Oklahoma, Pennsylvania, South Dakota, Texas, Utah, West Virginia, Wisconsin, or Wyoming) or known to source water from a hard water source (≥ 6 grains per gallon), the pump shall be flooded, soaked, and cleaned with a NSF-61 approved cleaning agent to remove all hard water from the pump. All components shall be dried by forced dry air (RH% ≤ 20%) for a minimum of two (2) hours, or by other method as reviewed and approved by the Department. Upon completion of drying the pump unit, if visible signs of hard water staining are present, those components shall be cleaned and dried again until no visible signs of hard water staining are present. Pump shall then be checked to ensure the pump shaft turns smoothly and that all assembly parameters (lateral, shaft stick-up, etc.) are correct.

iii) If a factory certified wire-to-water efficiency test is specified to be performed, then it shall be in addition to the aforementioned factory certified pump test and performed with the project motor. A factory certified wire-to-water efficiency test report shall be submitted for approval before pump and motor shall be accepted for delivery. The performance curve shall show the head-capacity at rated speed, efficiency-capacity, and required brake horsepower-capacity curves for the bowl assembly, as well as the guaranteed maximum net positive suction head required (NPSHR), minimum submergence, and tabular data for flow (GPM), head (FT), pump bowl efficiency (%), wire-to-water efficiency (%), input voltage (V), input current (A), and input power (kW) for all measured capacity points. The wire-to-water efficiency test shall include a nine (9) equally spaced capacity points over the entire pump curve starting at shut-off conditions, with the 7th point at the specified design conditions. The test shall be performed at

full design capacity, and speed. No normalized test values performed at reduced test parameters shall be accepted. To accommodate pressure limitations of the testing facility, if the pump TDH exceeds 1,000', the pump may be destaged into no more than two subassemblies. All pump bowl shall be required to be tested. Test shall be performed after a 2 hour burn-in run at design conditions. The test acceptance grade shall be the same as stated above for the factory pump test. It shall be the responsibility of the factory registered licensed professional engineer to verify the manufacturer/testing facility is adhering to the preceding procedures i) – ii):

a)) For wire-to-water testing, the minimum overall efficiency shall be 75.1%.

b) Test Reports

i) One (1) certified witnessed copy of the Complete Initial test data for the actual motor being furnished shall include, but not be limited to: full load heat rise, percent slip, no-load current, full-load current, locked rotor current, locked rotor torque, breakdown torque (calculated), efficiency & power factor at 25%, 50%, 75% and full load, insulation resistance per IEEE Standard 43, winding resistance, and high potential, shall be submitted for review as part of the shop drawing submittals.

ii) Tabulated data for the electric drive motor including rated horsepower, full load rpm, power factor, and efficiency curves at 25%, 50%, 75% and full load, service factor, and kW input, including when the pump is at its design point. Submit a certified statement from the motor manufacturer that the motors are capable of continuous operation on the power supply from the existing variable frequency drive without affecting their design life for bearings or windings.

iii) One (1) certified unwitnessed copy of the Reed Critical Frequency (RCF) test data for the actual motors being furnished shall include but not limited to: center of gravity, deflection at center of gravity, unit weight and reed critical frequency.

iv) Structural natural frequency analysis report for discharge head.

a)) If the discharge head and column assembly is not being furnished by the pump manufacturer, it shall be the responsibility of the Contractor to provide the timely submission of all the required information necessary for the pump manufacturer to complete the required structural natural frequency analysis report.

v) Lateral and torsional critical speed analysis report for complete well assembly.

a)) If the discharge head and column assembly are not being furnished by the pump manufacturer, it shall be the responsibility of the Contractor to provide the timely submission of all the

required information necessary for the pump manufacturer to complete the required lateral and torsional critical speed analysis report.

vi) One (1) certified unwitnessed copy of the Vibration test data for the actual motor being furnished.

vii) A schedule of the date of delivery of the equipment to the project site.

c) Instructions, Certifications, and Reports

i) Manufacturer's Installation Instructions.

ii) Manufacturer's certification of installation meeting Manufacturer's installation, operation and maintenance manuals.

iii) Submit warranty information to demonstrate conformance to Section 304.05, Part A.9.

iv) Welder certifications.

d) Upon Completion of Repairs

i) The Contractor shall submit the following after satisfactory completion of repair:

a)) Well Completion Report (WCR) copy for each pump assembly, within 30 days. Any fines levied by the Commission on Water Resource Management for the tardiness of WCR submittals for this project could potentially be passed on to the Contractor.

b)) Well Dimensions: Detail well depth, bottom of discharge head base flange, and static water level elevations. Detail casing diameter, solid casing lengths; discharge head tailpiece diameter and length; column pipe diameter and length; pump length; well drawdown at full operating capacity; depth to pump intake from static water level; total length of column pipe, and pump; and depth of well. All lengths shall be taken from bottom of discharge head base flange and all elevations shall be taken with respect to MSL.

7. Manufacturer Services Including Operating Instructions

a. Analysis

i. The pump manufacturer shall perform a lateral and torsional critical speed analysis of the complete pumping assembly that includes the motor, discharge head, shafts, couplings, and bowl assembly demonstrating that the lateral and torsional critical speeds are avoided through the pump's complete operational speed range:

a) The analysis shall be performed by a qualified and experienced analyst with at least 10 years of recent direct experience in performing the type of analysis required.

b) The analysis shall be performed in accordance with the methods described in API 610 for dynamic analysis and shall include vane pass frequencies of the pump.

c) The pumping assembly shall be designed so that the assembly's first lateral and torsional critical speeds are at least 20% above the maximum scheduled pump speed and the assembly's second lateral and torsional critical speeds are at least 10% above or below any possible excitation frequency within the pump's scheduled operating speed range.

d) As a minimum, the following shall be submitted for review:

i) Description of the method used to calculate the lateral and torsional critical speeds.

ii) Diagram of the mass elastic system used in the analysis.

iii) Table of the mass moment and torsional stiffness of each element of the mass elastic system.

iv) Campbell or Interference Diagram showing plots of critical speeds versus pump rotational speeds.

ii. If either the well assembly's lateral or torsional critical speeds fall within the separation margin specified, the pump manufacturer shall perform a stress analysis at no additional cost to the Department to demonstrate that resonant frequencies have no adverse effect on any element of the pumping assembly or any element foundation or support in terms of overstress, shortened life due to fatigue, excessive deflection, and/or reduced bearing life. The magnitude of excitation and degree of dampening used in the stress analysis shall be clearly stated and agreed to by the Project Engineer prior to submitting the final analysis. A mode shape diagram showing peak stresses for each resonant frequency shall be provided along with a fatigue and deflection analysis of the affected item(s), and a revised calculation of bearing.

b. Operating and Maintenance Manual

i. Operating and maintenance manual shall be furnished by the Manufacturer to the Department. The manuals shall be prepared specifically for this installation and shall include all required cuts, drawings, equipment lists, descriptions, etc. that are required to instruct operating and maintenance personnel unfamiliar with such equipment. The maintenance instructions shall include troubleshooting data, full preventative maintenance schedules, and complete spare parts lists with ordering information.

c. Installation Inspection and Startup

i. The Contractor shall include in this bid price the services of a Manufacturer's factory representative who has complete knowledge of proper operation and maintenance shall be provided to instruct representatives of the Department on the proper operation and maintenance. This work may be conducted in conjunction with the inspection of the installation and start-up. If there are difficulties in operation of the equipment because of the Manufacturer's

design or fabrication, additional service shall be provided at no additional cost to the Department. The listed service requirements are exclusive of travel time, and shall not limit or relieve the Contractor of the obligation to provide sufficient service necessary to place the equipment in satisfactory and functioning condition.

ii. Provide written certification that the installation is complete and operable in all respects, and that no conditions exist which may affect the warranty. Qualified supervisory services, including Manufacturer's Factory representatives, shall be provided to ensure that the installation is done in a manner fully approved by the Manufacturer. The Manufacturer's factory representative shall specifically supervise the installation of the pump and motor. If there are difficulties in the start-up or operation of the equipment due to the Manufacturer's design or fabrication, additional service shall be provided at no additional cost to the Department. Services of the Manufacturer's factory representatives and training shall be provided when the well pump is started.

d. Training

i. The Manufacturer shall provide detailed manuals. The manuals shall include specific details of equipment supplied and operations specific to the project.

e. The Contractor shall solely be responsible for requesting these services, and shall coordinate these requests with all other relevant trades, to ensure the effectiveness of the Manufacturer's service. In the event that the lack of coordination by the Contractor results in the need to recall the Manufacturer's factory representative, the lost time shall not be counted against the above days.

8. Product Delivery, Handling & Storage

a. Delivery, handling, and storage of equipment shall be in accordance as specified herein.

b. All equipment and parts must be properly protected against any damage during shipment. The equipment shall be stored in accordance with Manufacturer's recommendations.

c. Equipment and Material Storage

i. All parts shall be properly protected so that no damage or deterioration will occur during a prolong delay from the time of fabrication, including storage in accordance with Manufacturer's requirements, until the unit and equipment are ready for operation.

ii. Pump and Motor Equipment

a) Upon the completion of testing and preparations for shipment, as specified in Section 304.05, Part A.6.d.i.a) – c), the factory registered professional engineer shall complete an equipment inspection report for each pumping assembly, included as Appendix 1 – 4 within these specifications, prior to the equipment being crated.

b) The pump shall be enclosed in full coverage substantial containers for protection from damages during normal handling and transit. Containers shall be weather/water-tight and constructed of structural untreated lumber and CDX grade plywood with corrosion-resistant wood screws or bolts. No nails shall be permitted. The pump shall be continuously supported by parallel rails (aligned to the length of the equipment) that prevent movement within the containers. The rails shall be level and aligned to prevent any twisting or bending stresses on the supported equipment. The structural untreated lumber shall be sized in dimension as required to ensure zero deflection when the crate is lifted by straps positioned at each end of the crate, or forklift positioned in line with the center of the crate; and the CDX plywood shall be ¾" minimum thickness. Structural members shall be a single continuous length whenever possible. Top board of crate shall lap top edge of all side and end boards, side and end boards shall lap all edges of floor board, and side boards shall lap side edges of end boards to ensure weather/watertight construction. Crates shall be clearly marked with weatherproof, embossed plastic labels showing nameplate information of contents within, on the top, one side and one end of the crate. Pump nameplate shall list pump model, capacity, head, serial number, bowl diameter, and overall length. The Department will not approve any crate for delivery until vendor provided photographic proof that all of the above crating requirements have been satisfied.

iii. If storage is required on-site, the Contractor shall follow the Manufacturer's detailed recommendations for storage.

d. Factory assembled parts and components less than 30 feet in length shall not be dismantled for shipment unless permission is received in writing from the Department.

e. For units greater than 30 feet in length that are shipped unassembled, all connecting parts shall be "matched-mark" by the Manufacturer to ensure correct assembly on-site by the Contractor.

f. The finished surfaces of all exposed flanges shall be protected by wooden or equivalent blank flanges, strongly built and securely bolted thereto.

g. No shipment of equipment shall be made until approved by the Department in writing.

h. The Contractor shall inspect and test equipment for defects, at no additional cost to the Department, if the exterior condition of the container or equipment show evidence of having been dropped, damaged, or subject to abnormally rough handling.

i. The Contractor shall coordinate the delivery time and storage site with the Project Engineer or their designated representative.

j. Storage of the column assembly components at the job site shall be orderly and acceptable coverings (end caps and plugs) shall be provided to prevent contamination by dirt, algae, debris, or vermin, on or within the column assembly

materials, if the materials are to be left in the open for more than two weeks. The protection of materials shall be at no additional cost to the Department.

9. Warranty
    a. The Contractor shall assume responsibility for the primary components of the pumping assembly (vertical hollow shaft motor, and pump bowl assembly) with a minimum 1-year warranty. A written guarantee of warranty by the Contractor shall be furnished to the Department of Water Supply, as a prerequisite to the Department's issuance of final acceptance of work. No exceptions for this provision shall be allowed.
        i. Unit warranty shall be defined as the sole entity (Contractor) providing warranty on the complete pumping assembly (vertical hollow shaft motor, discharge head assembly, column assembly, and pump bowl assembly) for the duration of the specified warranty period.
        ii. Issues relating to fitment and assembly of equipment furnished as an equipment set, shall be guaranteed for the life of the equipment, independent of the one-year warranty. Upon use, if it is determined that equipment furnished as a set does not properly assemble; missing parts required for assembly; or other exist conflicts that prevent the proper assembly of the furnished equipment, it shall be the responsibility of Contractor to correct the issue in an expedient manner, and assume all costs including round-trip shipping.
    b. All material furnished or refurbished by the Contractor shall be guaranteed against defects for a period not less than one (1) year after the Department's final acceptance of work and shall be replaced with new materials in a timely manner, and at no additional cost to the Department, in the event of failure.
    c. Prior to final acceptance of work, in the event of any failure of performance of the well assembly, it shall be the sole responsibility of the Contractor to furnish all corrective work required to demonstrate that the well assembly achieves a level of acceptable performance. All necessary work shall be completed in a timely manner, and at no additional cost to the Department.
    d. Where there is a failure of performance of the well assembly during the warranty period, the Contractor hereby agrees they shall be responsible for all corrective work and associated costs required to return the well assembly back to a level of acceptable performance in a timely manner. Only after the successful completion of warranty repairs, shall responsibility of costs be determined.
        i. If determined that failure of performance was due to materials or equipment furnished or refurbished by the Contractor, or due to improper or poor workmanship, all costs associated with warranty repairs shall be the sole responsibility of the Contractor.
        ii. If determined that failure of performance was due to materials or equipment not furnished or refurbished by the Contractor, or issues unrelated to workmanship, all costs shall be paid by the Department under the method of force account.

iii. It shall be the sole responsibility of the Contractor to ensure that the Department is trained and instructed to operate and maintain the well assembly per the manufacturer's recommendations; to provide the manuals, tools, devices, and appurtenances required to operate and maintain the well assembly per the manufacturer's recommendations; to provide the devices and instrumentation to gather and record the information required to verify that the well assembly was operated and maintained per the manufacturer's recommendation; and to provide the equipment or device(s) required to ensure the well assembly is protected per the manufacturer's recommendation. For any tool(s), device(s), instrumentation, equipment, or appurtenances required to ensure conformance with manufacturer's recommendations, but not included within the contract scope of work, the Contractor shall submit a proposal for additional work for review by the Department.

a) A failure by the Contractor to fulfill the previous requirement shall not relieve the Contractor from warranty obligations of or relating to those circumstances, and any and all associated warranty costs shall become the sole responsibility of the Contractor.

iv. It shall be the sole responsibility of the Department to operate and maintain the well assembly in conformance with the training and instruction provided by the Contractor, as well as the diligent collection of data on the operation and maintenance of the well assembly; and the maintenance of the associated tool(s), device(s), instrumentation, equipment, or appurtenances required for data collection or protection of the well assembly as furnished by the Contractor.

a) A failure of the Department to operate and maintain the well assembly as trained and instructed by the Contractor, or to maintain data collection, or the associated tool(s), device(s), instrumentation, equipment, or appurtenances required for data collection or protection of the well assembly furnished by the Contractor, shall release the Contractor from warranty obligations of or relating to those circumstances.

e. Where performance of repairs under warranty provision are required, upon successful completion, an acceptance of work shall be reissued resetting the one-year warranty period.

f. Any defect due to improper or poor workmanship shall be corrected in a timely manner at the Contractor's cost for a period not less than one (1) year after the Department's final acceptance of work.

g. For all instances where these specifications exceed the manufacturer's terms and conditions (T&C's) the Contractor shall assume full responsibility for fulfilling those requirements specified herein.

h. Where power quality parameters of average voltage unbalance on incoming power of $\leq 5.0\%$ and average current unbalance on the load side of the HECO meter of $\leq 10\%$ is satisfied, warranty shall be provided for installation work performed and materials installed.

i. Pre-existing conditions of the well (such as rust, pH of water, turbidity, loose gravel pack, debris, sand, drill cuttings, well alignment, power quality issues not attributed to acts of nature, and etc.) shall be considered innate and normal and shall not excuse the Contractor from satisfying the performance requirements of the contract or the warranty obligation, whether discovered by the Contractor or not, prior to performance. The Contractor shall be responsible for its own due diligence in inspecting well conditions prior to performance and submit written notification to the Department of their concerns requiring modification of the design and amendment to the contract due to existing condition(s). Should the Contractor proceed with performance without prior submission of written notification, it shall constitute mutual agreement that no existing conditions of concern exists and all future claims to refuse the performance requirements of the contract or warranty on those conditions are foreclosed.

j. This project shall be considered "substantially complete" upon completion of a successful pump efficiency test in which the well assembly produces the rated capacity at or better than the minimum overall efficiency as specified in this contract.

k. The 1-year unit warranty shall commence upon final acceptance of work, with final acceptance of work being granted upon successful performance of a 30 calendar day burn-in period, in which the well assembly produces the rated capacity at or better than the required overall efficiency as specified in this contract; with the motor operating at or below the rated full load amperes; at or below 0.10 ips-peak (at top of discharge head) velocity; and at or below 0.15 ips-peak (at top of motor).

l. The Manufacturer's warranty period shall run concurrent with the Contractor's warranty period. No exceptions to this provision shall be allowed.

B. PRODUCTS

1. General

a. Line shaft vertical turbine well pumps and the materials used in their manufacture shall comply with the most recent revision of the following standards:

Subject	Standard Designation
Vertical Turbine Pumps – Line Shaft and Submersible Types	ANSI/AWWA E101
Discharge Head	Stainless Steel ASTM A744 Gr. CF8M
Column Pipe (Flanged)	Stainless Steel, ASTM A312 Gr. 316L
Drop-In Bearing Carrier	Stainless Steel ASTM A743 Gr. 316L
Line Shaft Bearing	PEEK/PTFE Polymer Alloy [redacted]
Motor Shaft	Stainless Steel ASTM A564M Gr. 17-4 PH PSQ

Subject	Standard Designation
Pump Head Shaft	Stainless Steel ASTM A564M Gr. 17-4 PH PSQ
Line Shaft	Stainless Steel ASTM A564M Gr. 17-4 PH PSQ
Line Shaft Coupling	Stainless Steel ASTM A479 Gr. Nitronic 60
Discharge Case	Cast Stainless Steel ASTM A744 Gr. CF8M; Duplex 2205 Stainless Steel ASTM A890 Gr. 4A
Discharge Case Bearing	Zirconium Dioxide Ceramic (B4200)
Upthrust Washer	Stainless Steel ASTM A582 Gr. 316
Intermediate Bowl(s)	Cast Stainless Steel ASTM A744 Gr. CF8M; Duplex 2205 Stainless Steel ASTM A890 Gr. 4A
Intermediate Bowl Bearing(s)	Zirconium Dioxide Ceramic (B4200)
Impeller Wear Ring(s)	PEEK/PTFE Polymer Alloy [redacted]
Stationary Wear Ring(s)	PEEK/PTFE Polymer Alloy [redacted]
Impellers	Nickel Aluminum Bronze ASTM B148 Alloy C95500
Taper Lock Collets	Stainless Steel ASTM A582 Gr. 316
Suction Case	Cast Stainless Steel ASTM A744 Gr. CF8M
Suction Case Bearing	Zirconium Dioxide Ceramic (B4200)
Sand Collar	Stainless Steel ASTM A582 Gr. 316
Pump Shaft	Stainless Steel ASTM A564M Gr. 17-4 PH PSQ
Discharge Bearing Plug	Stainless Steel ASTM A582 Gr. 316
Cone Strainer	Stainless Steel ASTM A240 Gr. 316
Bowl Assembly Hex Bolts	Stainless Steel ASTM A193 Gr. B8S Nitronic 60

2. Conditions of Operation
    a. Design Information:
        i. The pump shall be designed for the conditions of service tabulated as follows and shall operate within the system head curve envelope as defined below. All pumps shall have a continuously rising (from runout toward shutoff) head-flow rate performance for stable pump operations within the allowable operating range.

Design Information	
Approx. Elevation – Grade (ft MSL)	+10.11’
Well Casing Sole Plate (ft MSL)	+11.44’
Casing Diameter, Nominal (in)	20.0”
Open Hole Diameter, Nominal (in)	N/A
Solid Casing Length (ft)	N/A
Perforated Casing Length (ft)	13.00’
Open Hole Depth (ft)	0.00’
Approx. Elevation – Well Bottom (ft MSL)	-17.00’
Static Water Level (ft MSL)	+4.00’
Drawdown (ft)	0.40’
Specific Capacity (gpm/ft)	3,500.00
Water pH	7.6
Water Temperature (°F)	70.5
Ambient Temperature (°F)	68.0 – 81.0

b. Performance Requirements:

i. Pump bowl assembly shall meet or exceed the performance requirements tabulated as follows. The pump shall be selected such that the highest efficiency is obtained for the average pumping conditions as identified below.

Performance Requirements	
Design Flow Capacity (gpm)	1,400
Design Head, TDH (ft)	670.0’
Available Submergence (ft)	12.3’
Minimum Bowl Efficiency (%)	82.0%
Maximum Pump Brake Horsepower (hp)	300
Desired Pump Performance Characteristics:	
0 GPM at 992.0—ft. head (Shut-Off Head)	
560 GPM at 901.0—ft. head (Bowl Efficiency 58.5%)	
840 GPM at 855.0—ft. head (Bowl Efficiency 74.4%)	
1,120 GPM at 795.0—ft. head (Bowl Efficiency 83.3%)	
1,400 GPM at 675.0—ft. head (Bowl Efficiency 84.4%)	
1,680 GPM at 496.0—ft. head (Bowl Efficiency 78.4%)	

3. Vertical Hollow Shaft Motor

a. General

i. Motor shall be capable of continuously delivering the necessary brake horsepower (BHP) along the complete pump curve.

ii. The vertical hollow shaft motor shall be 1,800 RPM (4-Pole), 3 phase, 60 Hz, 4,160V with non-reverse ratchet, P-base, squirrel cage induction design. Enclosure shall meet NEMA Weather Protected Type I (WP-I) design and motor shall be a [redacted] cast frame. Motor shall have a Class H insulation with temperature rise as specified by NEMA standards for class of insulation used and shall have 1.15 service factor. Motor shall be premium efficiency with special balance.

iii. Motor shall be fitted with accessories inclusive of High Lead Tin Bronze, ASTM B505 Alloy C93200 steady bushing; shaft grounding rings, [redacted] or equal by approval; 115V silicone rubber space heater; and oil drain assembly (stainless steel close pipe nipple and 3-piece full-port stainless steel ball valve, Apollo 86A-100 Series). Oil drain assembly to be furnished and installed by Contractor prior to filling motor with oil.

iv. Thrust bearing shall be chosen to handle the continuous down thrust as specified by the pump manufacturer with a minimum ABMA L_{10} life of 88,000 hours or ABMA L_{50} life of 440,000 hours under design conditions. Provisions shall be made for momentary upthrust equal to 30% of rated down thrust.

v. The motor rating shall be such that at design it will not be loaded beyond nameplate rating and at no place on the pump curve shall the loading exceed the service factor.

vi. The Velocity Amplitude of any line of resolution, measured at all bearing positions in any direction (radial or axial) shall not exceed the Line-Amplitude Band Limit value of 0.10 ips-peak.

vii. The Acceleration Overall Amplitude measured at all bearing positions in any direction (radial or axial) shall not exceed the Band-Limited Overall Amplitude Acceptance Limit value of 0.50 g-peak.

viii. Motor shall be furnished with one (1) 13.7 ounce tube of [redacted], conforming to manufacturer's recommendations.

ix. Motor shall be in domestically manufactured and in conformance with P.L. 117-58, §§ 70901-52, "Build America, Buy America" Act, 2021 requirements.

b. Motor Details

Motor Details	
Horsepower (HP)	300
Voltage (V)	4,160
Phase (Ø)	3
Full Load Amps (A)	38

Motor Details	
Nominal Speed (RPM)	1,785
Service Factor	1.15
Minimum Efficiency @ Full Load (%)	94.1
Minimum Power Factor @ Full Load (PF)	86.1
Enclosure	TEFC
Frame	5008PH
Base Diameter (in)	20.0
Motor "CD" Dimension (in)	57.0625
Drive Coupling Size (in)	1.9375
Steady Bushing Size (in)	1.9375
Non-Reverse Ratchet	Required

c. Mounting Dimensions

i. The motor manufacturer shall disclose all discharge head end mounting dimensions (flange register dimension, flange bolt pattern and hole size, shaft stick-down height and shaft keyway configuration) to the Contractor at the time of submittals.

d. Approved Equipment

i. [redacted]

4. Pump Discharge Head

a. Discharge Head Assembly

i. Discharge Head

a) The discharge head assembly shall be furnished by the Contractor and shall provide to the Department, a submittal prior to fabrication, verifying the dimensions of the discharge head, compatibility with the reed critical frequency of the vertical hollow shaft motor (provide calculations), and the compatibility when the pumping assembly is operated by a VFD in the associated frequency range of 10% - 100% of rated flow (provide calculations).

b) To determine the potential for a critical natural structural frequency occurring within the normal operating speed range of the pump, a Level II structural dynamic analysis shall be performed (for both [redacted] and [redacted] motor) in accordance with ANSI/HI 9.6.8 Rotodynamic Pumps Guideline for Dynamics of Pumping Machinery, Table 9.6.8.4 with technical report submitted prior to approval of delivery. The pump structure shall be subject to a natural frequency analysis (modal FEA) in accordance with Section 9.6.8.6.2.3.3. The minimum frequency separation margin obtained by analysis shall be ±20%.

i) The pump manufacturer shall manipulate the design of the discharge head accordingly to achieve the required minimum frequency separation margin, however the following parameters and conditions shall remain fixed, non-adjustable elements of the design:

a)) Baseplate Diameter: 26.00—inch

b)) Baseplate to Discharge Centerline: 10.6875—inch (*to be verified by Contractor with a licensed surveyor prior to submittal; shall be calculated as the surveyed height from discharge centerline to concrete well pad minus 1.5—inch for new sole plate*)

c)) Discharge Flange Face to Discharge Head Centerline: 14.75—inch (*to be verified by Contractor prior to submittal*)

d)) Overall Discharge Head Height: 24.4375—inch

e)) Discharge Head Windows shall be sized with sufficient clearance for the installation of a single mechanical seal, coupling and motor steady bushing.

c) The discharge head shall include a minimum of two (2) windows, oriented 90 degrees perpendicular to the alignment of the discharge piping providing clear access for inspection and servicing the mechanical seal assembly.

d) The discharge head shall be of fabricated ASTM A744 Gr. CF8M cast stainless steel designed for above ground discharge with flanged connection to column assembly and capable of containing the maximum pressure developed by the pump and supporting the driver and the suspended weight load of the column assembly and pump. The discharge head shall incorporate an efficient flow path which minimizes friction losses and shall be diamond-like coating (DLC) coated by third-party vendor.

e) The discharge head shall incorporate a flat face flange in conformance with ANSI B16.1 Class 250.

f) The discharge head shall include two (2) ¾”-14, drilled and tapped, NPT threaded, ports on the right and left side of the discharge, respectively; one (1) ½”-14, drilled and tapped, UNC threaded, drain port on the body of the discharge head; one (1) ¾”-14, drilled and tapped, UNC threaded, port on the body of the discharge head; one (1) 1”-11.5, and one (1) ¼”-18 drilled and tapped, NPS threaded, ports in the base flange of the discharge head. All ports shall be sealed with ASTM A193 B8S pipe plugs and flanged openings sealed with plastic blind flanges.

g) The discharge head NEMA P base mounting flange shall have a rabbet fit alignment register to accurately locate the vertical hollow shaft driver, with a driver BD diameter of 24.5—inches. The NEMA P base mounting flange shall be machined parallel to the discharge head base flange and perpendicular to the axis of the column tailpiece or flange connection.

h) Each discharge head shall be furnished with two (2) Nitronic 60 lifting pins sized and rated for 6.0 times the assembled weight of the motor, discharge head assembly, column assembly, and pump bowl assembly.

i) Each discharge head shall be furnished with one (1) base flange gasket, one (1) discharge flange gasket, NSF 61 approved, [redacted]; [redacted]; 316 stainless steel hex nuts; and NSF-H1 approved anti-seize compound, [redacted] or equal by approval. Furnish all gaskets and fasteners separate from discharge head.

j) Contractor shall be responsible for field verification of all field and installation dimensions with design submittals furnished to the Department for review and approval prior to release for production. Contractor shall be responsible for all costs for corrective work due to dimensional or fabrication errors, and defects. Method of corrective work shall be at the sole discretion of the Department.

k) The pump nameplate shall be securely fastened to the discharge head with threaded fasteners, showing the manufacturer's name, model, number of stages, serial number, capacity in gpm at rated head in feet, and speed in rpm. **Nameplate shall be 316 stainless steel and all information shall be engraved/embossed/machined in "Palatino Linotype" font with a minimum size of 10 point and minimum depth of 0.03125"**, which shall resist weathering and wear over the life of the pump.

l) The Contractor shall be responsible for the coordination of the third-party surface preparation, lining, and coating of the discharge head in compliance with these specifications.

   i) The discharge head shall be prepared for coating per SSPC-SP1 "Solvent Cleaning" followed by SSPC-SP16 "Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals". The wetted flow path shall be prepared by abrasive flow machining to a surface roughness of 10.0 μin (RA) / 11.1 μin (RMS). Both exterior and interior surfaces of discharge head shall be prepared respectively by electropolishing in accordance with Section 304.05, Part B.7.

   ii) Prior to coating of external surfaces, the wetted flow path of the discharge head shall be lined, and flange mating faces, threads, and threaded holes coated with a tetrahedral amorphous carbon (ta-C) diamond-like coating (DLC), applied via plasma-assisted chemical vapor deposition (PACVD) process, or high-power impulse magnetron sputtering (HiPIMS) process, [redacted] or industrial service provider by review and approval, or by an equal coating and method of application subject to review and approval, to reduce friction loss and prevent cavitational damage. External surfaces of discharge head to be painted by third-party contractor, shall be

protected with liquid peelable masking agent prior to application of DLC coating.

iii) The liquid peelable masking shall remain intact on the discharge head to aide in the protection of the external surfaces during transport to the Contractor's third-party painting contractor's shop. The discharge head shall be prepared for transport in an appropriate manner to protect from damage.

iv) All external surfaces of discharge head shall be painted by licensed painting contractor, as selected by the Manufacturer and approved by the Department. Painting work shall be performed within a clean shop space, by HVLP with two (2) primer coats of an appropriate primer for the following specified polysiloxane topcoat, and three (3) topcoats of a polysiloxane, PPG PSX 700, [redacted], or equal by review and approval, 3 mils (dry) thickness per coat, color ANSI Safety Blue [redacted]. Follow all paint manufacturer surface preparation and application recommendations. Discharge head shall be painted prior to release for delivery.

v) All internal surfaces, flange mating faces, threads, and threaded holes shall be protected from paint. Paint finish shall be free of drips, sags, orange peel, and overspray defects.

vi) Quality Control

a)) The Contractor shall provide photo documentation from the manufacturer of the discharge head at each of the following stages prior to proceeding to the next stage:

i)) After completion of SSPC-SP1 and SSPC-SP16 cleaning.

ii)) After lining of wetted flow path.

iii)) After completion of priming.

iv)) After completion of topcoat.

b)) Photos for each stage above, shall be of high resolution and clarity, and from multiple perspectives to allow for a thorough inspection of all appropriate surfaces of the discharge head.

c)) Any work not meeting the quality standards of the Department shall be redone to the satisfaction of the Project Engineer, at no additional cost to the Department.

d)) Upon approval of the photos of the topcoat, the discharge head shall be crated in a manner to protect the discharge head and finish from damage, and released for delivery. The Manufacturer shall provide a quart of primer and topcoat materials each,

respectively, with instructions for application, for use by the Contractor for field touch-up painting as-needed.

b. Stuffing Box

i. The stuffing box shall be stainless steel, ASTM A744 Gr. CF8M, rated at 450 psi and designed for installation of a balanced single or double cartridge mechanical seal. The stuffing box shall have provisions for available fitting for pressure relief, as required, and be fitted with a PEEK/PTFE polymer alloy bearing [redacted].

c. Mechanical Seal

i. The mechanical seal shall be a cartridge type, single cartridge mechanical seal, hydraulically balanced, and designed to withstand 250 psig minimum differential pressure in either direction. The stationary seal faces shall be self sintered silicon carbide, and rotary seal faces shall be resin impregnated carbon graphite. The mechanical seal shall be designed with stationary springs located out of the pumping fluid. Springs shall be Hastelloy C. The gland and set screws shall be 316L stainless steel and O-ring shall be ethylene propylene diene (EPDM). The mechanical seal shall be [redacted] or equal by approval. Interchangeable pre-bent and assembled 316 stainless steel tubing and fitting assemblies for Plan 14 support system, designed specifically for the layout of the cast discharge heads furnished as part of this project, shall be included with the mechanical seal.

d. Sole Plate

i. The sole plate shall be designed with sufficient strength and rigidity to support the bearing load of the vertical hollow shaft motor, discharge head, column assembly, vertical turbine pump, and water column without deflection.

ii. The sole plate shall be of 316L stainless steel, ASTM A240 Gr. 316L.

iii. The sole plate shall be electropolished in accordance with Section 304.05, Part B.7.

iv. Contractor shall be responsible for field verification of all existing dimensions prior to releasing sole plate for production. Design submittals shall be submitted to the Department for review and approval prior to release for production. Contractor shall be responsible for all costs for corrective work due to dimensional or fabrication errors, and defects.

5. Column Pipe Assembly

a. Column Pipe

i. The column pipe size shall be such that the friction loss shall be less than 5 feet of head per 100’ of column at design operation, but velocity shall not be less than 3.5 ft/s.

ii. The column pipe shall be furnished in sections to the specified lengths as defined in the Proposal.

iii. The column pipe shall be Schedule 40, 316L stainless steel pipe, conforming to ASTM Specification A312, with electropolishing of both internal and external surfaces in accordance with Section 304.05, Part B.7., following the completion of all welding and machining work.

iv. The column pipe shall have the ends finished with 316L stainless steel, socket welded flanges with an o-ring groove and female register, rated for a minimum of 350 psi at 212.0°F. Flange for connection to pump shall have an O.D. of 12.125"; flange thickness of 1.75"; bolted connection of twelve (12) equally spaced ½"-13 UNC threaded holes on 11.125" B.C.; pump bowl register of 10.128" ±0.001" I.D. x 0.76" depth; and socket weld register of 10.88" I.D. x 0.375" depth. Flange for interconnection between column pipes shall have an O.D. of 14.625"; flange thickness of 1.125"; bolted connection of twelve (12) equally spaced 1" thru holes on 13.00" B.C.; socket weld register of 10.88" I.D. x 0.375" depth; and drop-in bearing retainer register of 10.562" ±0.001" I.D. x 0.377" ±0.001" depth. Flanges for connection to discharge head shall be dimensioned accordingly to be compatible. The flanges shall be welded to each end of the column pipe perpendicular to the longitudinal central axis of the column pipe with a tolerance of 0.0001 in/in of face diameter or 0.0005 in/in T.I.R. total, whichever is least. Additionally, the longitudinal central axis of the flanges, shall be parallel to the longitudinal central axis of the column pipe with a parallelism tolerance of 0.0001 in/in. Flanges shall be compatible with drop-in bearing retainers with female register possessing a Class IV transition fit tolerance of ±0.0010". The female register shall be concentric to the axis of the column pipe.

b. Drop-In Bearing Retainer

i. The drop-in bearing retainer shall be CF8M stainless steel, ASTM A743, with electropolishing in accordance with Section 304.05, Part B.7., prior to installation of line shaft bearing.

ii. The outer ring frame shall be 10.562"O.D. x 0.75" height. The inner hub shall be 2.5" I.D. x 3.625" height.

iii. The inner hub of the bearing retainer shall be concentric with the outer ring frame. Outer shoulder of the outer ring frame shall be machined square and parallel to the axis of the inner hub and shall possess a Class IV transitional fit tolerance of ±0.0010" for O.D. and thickness ensuring precise fit within female register of the column flange.

iv. The bearing retainer shall be fitted with [redacted] polymer alloy bearings.

c. Line Shaft Bearings

i. The line shaft bearing shall be [redacted] polymer alloy bearings.

ii. The line shaft bearing shall be machined to face both ends perpendicular to the longitudinal central axis of the line shaft bearing with a tolerance of 0.0001 in/in of face diameter or 0.0003 in/in T.I.R. total, whichever is least.

iii. The line shaft bearing shall be drilled for a central bore with longitudinal central axis of the bore parallel to the longitudinal central axis of the line shaft bearing with a parallelism tolerance of 0.0001 in/in.

iv. The line shaft bearing shall be machined with an O.D., I.D, wall thickness, lead-in chamfer (size and angle) and counterclockwise spiral fluting (quantity, size and shape), per the manufacturer recommendation, and in coordination with the Contractor's experience and best judgement, to guarantee trouble-free operation for a minimum of the typical industry average service life for similar pump configurations. The bearing design shall be submitted to the Department for review and approval prior to release for production.

d. Motor Shaft

i. The motor shaft shall be a turned and ground precision shaft of 17-4PH condition H900 stainless steel, ASTM A276, pump shaft quality with a minimum tensile strength of 210,000 psi, a yield strength of 200,000 psi, and minimum hardness of 421 Brinell.

ii. The motor shaft shall have a uniform diameter (outside diameter tolerance of +0.000" / -0.001") and length shall be as required for proper setting of final lateral for the well assembly.

iii. The motor shaft shall be machined to face both ends perpendicular to the longitudinal central axis of the motor shaft with a tolerance of 0.0001 in/in of face diameter or 0.0003 in/in T.I.R. total, whichever is least.

iv. The motor shaft shall be machined on both ends with external lathe cut, left-hand 10 TPI pitch "straight" threads (Class 2A tolerance), with longitudinal central axis of the thread parallel to the longitudinal central axis of the motor shaft with a parallelism tolerance of 0.0001 in/in. The top end of the motor shaft shall include a machined keyway, sized as appropriate for the expected load with sufficient factor of safety. The keyway shall have a fit tolerance of +0.000 / -0.001.

v. The motor shaft shall be drilled at top end for a central threaded hole, with longitudinal central axis of the threaded hole parallel to the longitudinal central axis of the motor shaft with a parallelism tolerance of 0.0001 in/in. The hole shall be drilled to a depth of 2" and threaded for ¾" – 10 UNC (Class 2B tolerance).

vi. The motor shaft shall have a surface roughness not exceeding 8.0 μin (RA) / 8.8 μin (RMS) with lay perpendicular to the axis of the motor shaft. The motor shaft shall be electropolished in accordance with Section 304.05, Part B.7.

vii. The motor shaft shall be pre-straightened by the manufacturer by <u>mechanical method only</u> with hydraulic press, to within 0.001" T.I.R. in 10'. Spot heat straightening by the manufacturer shall not be permitted.

viii. As required, the Contractor shall straighten the motor shaft by spot heat straightening (maximum of five (5) "burns" per shaft), after completion of all

machining operations, to within 0.003" T.I.R. in 10', immediately prior to installation, at the job site. The motor shaft shall be straightened using roller blocks. Vee blocks shall not be permitted.

ix. If unable to meet 0.001" T.I.R. in 10', the shaft shall be rejected and replaced with a new shaft. Replacement motor shaft shall be furnished with air freight by the Contractor, at no additional cost to the Department.

x. The straightness of the motor shaft shall be checked and corrected by the Contractor at the job site, immediately prior to installation.

e. Silicon Bronze Hex Nut

i. The hex nut shall be machined from commercial wrought or billet material conforming to ASTM B98 Alloy C65500.

ii. The silicon bronze material shall have a minimum tensile strength of 80,000 psi, minimum elongation of 20%, and minimum hardness of Rockwell B85.

iii. The hex nut shall be machined with lathe cut, left-hand 10 TPI pitch "straight" threads (Class 2B tolerance), with a maximum permissible axial misalignment of the thread axis with the nut axis of 0.0005" in 3".

iv. The hex nut shall be furnished with two (2) Nitronic 60 3/8"-16 x 1" UNC cup point set screws, ASTM B18.3.

f. Gib Head Key

i. The gib head key shall be machined from 304 stainless steel, with a fit tolerance of +0.000 / -0.001.

g. Line Shafting

i. The line shaft shall be a turned and ground precision shaft of 17-4PH condition H900 stainless steel, ASTM A564, pump shaft quality with a minimum tensile strength of 210,000 psi, a yield strength of 200,000 psi, and minimum hardness of 421 Brinell.

ii. The line shaft shall have a uniform diameter (outside diameter tolerance of +0.000" / -0.001") and furnished in interchangeable sections compatible in length with the column pipe.

iii. The line shaft shall be machined to face both ends perpendicular to the longitudinal central axis of the line shaft with a tolerance of 0.0001 in/in of face diameter or 0.0003 in/in T.I.R. total, whichever is least.

iv. The line shaft shall be machined on both ends with external lathe cut, left-hand 10 TPI pitch "straight" threads (Class 2A tolerance) with longitudinal central axis of the thread parallel to the longitudinal central axis of the line shaft with a parallelism tolerance of 0.0001 in/in.

v. The line shaft shall have a surface roughness not exceeding 8.0 μin (RA) / 8.8 μin (RMS) with lay perpendicular to the axis of the line shaft. The line shaft shall be electropolished in accordance with Section 304.05, Part B.7.

vi. The manufacturer shall clearly and neatly sequentially number each line shaft from *#1 ... n*, on the bottom end of each line shaft by third-party laser-marking, [redacted], or equal industrial service provider by review and approval. Paint pens and indelible markers shall be strictly prohibited.

vii. The line shaft shall be pre-straightened by the manufacturer by mechanical method only, to within 0.001" T.I.R in 10'. Spot heat straightening by the manufacturer shall not be permitted.

viii. The packing of line shafts shall be limited to a maximum of 25 pieces per crate.

ix. As required, the Contractor shall straighten line shafts by spot heat straightening (maximum of five (5) "burns" per shaft), after completion of all machining operations, to within 0.001" T.I.R. in 10', immediately prior to installation, while on site. Line shafts shall be straightened using roller blocks. Vee blocks shall not be permitted.

x. If unable to meet 0.001" T.I.R. in 10', the shaft shall be rejected and replaced with a new shaft. All replacement line shafts shall be furnished with air freight by the Contractor, at no additional cost to the Department.

xi. The straightness of all line shafts shall be checked and corrected by the Contractor at the job site, immediately prior to installation.

h. Line Shaft Couplings

i. The line shaft couplings shall be threaded sleeve type, fabricated of Nitronic 60 stainless steel, ASTM A479, and designed with a factor of safety of 1-1/2 times the line shaft factor of safety.

ii. The line shaft coupling and line shaft crossover "jump" coupling shall be machined to face both ends perpendicular to the longitudinal central axis of the line shaft coupling with a tolerance of 0.0001 in/in of face diameter or 0.0003 in/in T.I.R. total, whichever is least.

iii. The line shaft coupling shall be drilled for a central bore with longitudinal central axis of the bore parallel to the longitudinal central axis of the line shaft coupling with a parallelism tolerance of 0.0001 in/in.

iv. The line shaft coupling shall be machined with internal lathe cut, left-hand 10 TPI pitch "straight" threads (Class 2B tolerance) with longitudinal central axis of the thread parallel to the longitudinal central axis of the line shaft coupling with a parallelism tolerance of 0.0001 in/in.

v. The coupling shall be machined with a 1/8" diameter sight hole, located precisely mid-length of the coupling to verify the line shafts are butted during installation.

vi. The line shaft coupling shall be electropolished in accordance with Section 304.05, Part B.7., following all machine work.

6. Pump Bowl Assembly

a. Pump Design

i. The vertical turbine well pump shall be a vertical single or multi-stage unit, as required, with enclosed impellers. The vertical turbine well pump shall be of the line shaft, vertical turbine, open water type, furnished as a complete pump bowl assembly, including any accessories required for well service, ready-to-install unit by a single supplier.

ii. Vertical turbine well pump shall be capable of operating at 175% of design head or shutoff head, whichever is greater, for not less than five (5) minutes without excessive vibration, binding, rubbing of rotating parts, or damage to the pump.

iii. The pump curve for the vertical turbine pump shall be as steep as practicable within the constraints of this section, and shall exhibit a continuously rising characteristic to shutoff head, with no points of zero slope or slope reversal.

iv. Unless otherwise indicated, the required pump shaft horsepower at any point on the performance curve shall not exceed the rated horsepower of the motor or encroach on the service factor.

v. Pump selection shall be based on providing the highest possible operating efficiency over the entire operating range with the peak efficiency at or near (to the left of) the design point and a model which shall provide consistent, and reliable long-term service.

vi. **It shall be the pump manufacturer's responsibility to inform the bidders (well contractors) a minimum of 10 calendar days prior to the scheduled bid opening of their guaranteed pump bowl efficiency as determined by their engineering division or inability to meet any other portion of the bid specifications. If the pump manufacturer fails to notify the bidders by the aforementioned deadline, it shall be inherently determined that the pump manufacturer meets all requirements of the bid specifications and shall be obligated to furnish equipment as such or be responsible for the respective energy cost differential charges.**

vii. These specifications shall serve as a complement to ANSI B58.1 and where contradictions occur, these specifications shall govern.

viii. The total under head assembly length from underside of discharge head to bottom of suction case shall be 247.75". Additionally, the column assembly shall be sized accordingly to be compatible with the available installation clearance of 100-1/2", as measured from the bottom of the overhead crane hook to the top of the pump sole plate.

b. Pump Construction

i. The pump bowl assembly shall consist of the discharge case, pump bowls, impellers, shaft, bearings, wear rings, sand collar, suction case with vortex suppressor.

ii. The manufacturer of the pump must provide sufficient clearance in the bowl of the pump bowl assembly, to accommodate any stretching of the shaft under

shut-off head conditions, without the impeller contacting the bottom surface of the bowl, and to allow for any wear to the motor's thrust bearing.

iii. The pump bowl assembly shall contain no more than 0.25% lead content by weighted average. Contractor shall provide certification of 0.25% or less lead content or NSF 372 certification.

iv. The pump discharge case shall be sized for 10—inch column flange connection.

v. Maximum outside diameter of the pump shall be 12.2500—inches.

vi. **The pump bowl assembly shall be statically and dynamically balanced per ISO 1940/1 to a balance quality grade of G 2.5 (2.5 mm/s) or better.**

c. Pump Bowls

i. Pump bowls shall be precision close grained Type 316 stainless steel, free of blow holes, sand holes and other defects. The bowls shall conform to minimum strength according to ASTM A744 Gr. CF8M, or better as required, with a minimum tensile strength of 70,000 pounds per square inch and shall be higher strength materials as needed for the upper pump bowl units.

ii. Bowl internal surfaces shall be polished to a surface roughness of ≤ 32 µin (Ra) / ≤ 35.2 µin (RMS) by abrasive flow machining, followed by electropolishing in accordance with Section 304.05, Part B.7., to achieve the highest efficiency at the performance design point.

iii. The bowls shall be capable of withstanding a hydrostatic pressure equal to 175% the pressure at rated capacity or the pressure at shut-off head, whichever is greater. The pump manufacturer to provide the Project Engineer with pressure ratings of bowls at shut-off conditions as well as full load and associated calculations and pump material specifications.

iv. Each bowl shall be accurately machined and fitted to close dimensions and fitted with heavy-duty, sleeve-type, zirconium dioxide (ZrO_2) ceramic bearings on each side of the impellers. Only Nitronic 60 bolts shall be used if bowls are fastened to one another by bolts.

v. The suction case shall have anti-vortex vanes to suppress vortex formation. The bottom bearing housing in the suction case shall be cast as an integral part of the suction case.

vi. The suction case shall be fitted with a 316 stainless steel sand collar, locked securely to the shaft, to prevent dirt, sand or other foreign particles from entering the shaft bearings.

vii. Pump bowls shall accommodate a lateral adjustment of 2.1250", but shall be furnished with a lateral adjustment appropriate for the application and conditions as determined by manufacturer's calculations.

viii. The intermediate bowls and suction case shall be fitted with replaceable PEEK/PTFE polymer alloy [redacted] stationary wear rings having the minimum practical clearances to the rotating impeller surface.

ix. The discharge case shall be machined with 10—inch column flange connection, accurately machined to the axis of the pump, to ensure an accurately assembly and alignment.

d. Impeller

i. The impellers shall be the fully enclosed type and shall be of nickel aluminum bronze ASTM B148, Gr. C95500, of new ingot material of heavy construction and free from blow holes, porosity and other defects.

ii. The impeller shall be finished all over, accurately fitted and balanced, both statically and dynamically, (hydraulic "balanced thrust" impellers shall not be permitted). **The impellers shall be balanced per ISO 1940/1 to a balance quality grade G 2.5 (2.5 mm/s) or better.** They shall be locked securely to the impeller shaft with a 316 stainless steel tapered collet lock bushing.

iii. The bowls and impellers shall be designed and accurately machined with vanes carefully finished to ensure open and smooth passages with efficient operation and to prevent air locking or sand locking.

iv. The impellers shall be so designed as to permit axial adjustment to compensate for wear. The outer tips of the impeller blades shall not be feathered and shall be of sufficient thickness to withstand considerable wear before affecting performance of the pump.

v. The impellers shall be fitted with replaceable PEEK/PTFE polymer alloy [redacted] wear rings having minimum practical clearances to the mating cylindrical surface of the intermediate bowls and suction case.

e. Impeller Shaft

i. The impeller shaft shall support the impellers and shall be of ground and polished, pump shaft quality 17-4PH stainless steel condition H900, conforming to ASTM A276 and A479, or higher strength material.

ii. The impeller shaft shall possess a surface roughness not exceeding 8.0 µin (RA) / 8.8 µin (RMS) by electropolishing in accordance with Section 304.05, Part B.7.

iii. The shaft shall be supported by suitable non-corrosive bearings on both sides of each impeller with positive means for water lubricating each bearing.

iv. The intermediate bowl and case bearings shall be heavy-duty, two-part (inner and outer sleeve), zirconium dioxide (ZrO_2) ceramic bearings or other non-corrosive, abrasion resistant material by review and approval.

v. The shaft shall be provided with a means to accurately locate the shaft with respect to the bowls and impellers during assembly of the bowl unit.

vi. The size of the shaft, to be determined by the pump manufacturer, shall be capable of transmitting the total thrust and torque loads of the unit in either direction.

vii. The shaft shall be continuous in construction. No threaded and coupled, or bolted joints shall be accepted.

viii. The pump design and construction shall permit the operation of the pump in reverse rotation, or sudden shut down of pump due to a power failure event without causing damage to the pump.

f. Suction Case and Screen

i. The pump suction case shall be fitted with a stainless steel suction screen having a total open area at least three times the cross-sectional area of the column pipe, while still rejecting objects of 0.25”Ø or larger from entering the pump.

7. Electropolished Materials

a. All materials specified for electropolishing shall be in conformance with ASTM B912.

b. The surfaces to be electropolished shall be thoroughly cleaned in conformance with ASTM A380 to remove any contaminants or residues.

c. The surface roughness for wetted surfaces (discharge head internal flow path, line shafting, line shaft couplings, column pipe internal flow path, and pump bowl assembly) shall not exceed 8.0 µin (RA) / 8.8 µin (RMS).

d. The surface roughness for all other surfaces shall not exceed 32.0 µin (RA) / 35.5 µin (RMS).

e. The electrolyte solution, voltage, current density, temperature, and duration shall be determined by the vendor to optimize and achieved the required surface finish to minimize friction, improve flow characteristics, and maximize corrosion resistance.

f. Edge and corner treatment shall be performed to ensure uniformity of the surface finish across the entire component.

g. Following electropolishing, surfaces shall be thoroughly cleaned to remove any contaminants or residues from the process to ensure a clean and smooth finish.

h. The electropolished surface shall be visually inspected for uniformity and absence of defects.

i. Surface roughness shall be measured using appropriate equipment to verify compliance with the specified Ra value.

j. A certificate of conformance shall be provided, indicating compliance with ASTM B912 standards.

k. Detailed records of the electropolishing process parameters and inspection results shall be maintained.

l. Traceability of materials used in the electropolishing process shall be ensured for quality control purposes.

m. Acceptance of the electropolished components shall be based on compliance with the specified surface finish requirements and quality assurance criteria outlined in this specification.