

## **SECTION 11320**

### **DEEP WELL VERTICAL TURBINE PUMPING UNIT TECHNICAL SPECIFICATIONS**

#### **PART 1 - GENERAL**

##### **1.01 Specific Project Description**

Contractor shall provide a new bowl assemble, as necessary for Well No. 6 in accordance with Schedule I, Fee Schedule Items 112 and Item 1.02, hereafter. Specific pumping unit related work to be performed as part of this project is identified in the Schedule I- Well No. 6 Fee Schedule-Scope of Work, Well No. 6 Pumping Unit Repair Special Requirements, and generally described as follows:

In the event the existing pumping unit is deemed non re-buildable Contractor shall provide one (1) new deep well vertical turbine pumping unit (bowl assembly) to meet the specific project pumping unit requirements described in Section 1.02, below.

##### **1.02 Specific Project Pumping Unit Requirements (if existing pumping unit bowl assembly is deemed non-re-buildable)**

###### **A. General**

The Contractor shall provide a complete new deep well pump bowl assembly (bowls, bearings, impellers, etc) consisting of a cast or ductile iron bowl assembly to meet pumping unit performance requirements specified herein for Well No. 6 as necessary.

The Well No. 6 existing pumping unit consists of a water lubricated line shaft vertical turbine pump. All new pumping unit components shall meet the performance requirements of this specification section, as listed below.

Bidders shall submit fabrication drawings for the new bowl assembly and certified pump performance curves per Section 1.03 herein.

###### **B. Well No. 6 Pump**

1. Performance (Pump preliminary performance criteria set forth is based on the existing Flowserve 8M28 - 7 stage pumping unit).

Discharge Capacity (GPM)	Bowl Head (Feet)	Minimum Bowl Efficiency	Maximum Net Positive Suction Head Required (Feet)
Shutoff Head	270 (min)	NA	NA
50	265	NA	2
100	252	NA	2
150	241	66 %	2.5
200	232	76%	3.5
236*	220	79 %	5
250	219	80 %	5
300	195	79 %	7.5
350	163	71 %	12

\* Design condition

2. Pumping unit shall be of the water lubricated line shaft (water lubricated), enclosed impeller deepwell vertical turbine unit design.

3. Maximum Horsepower - Speed – Maximum Thrust Factor:

40 hp - 1770 rpm – 2.75 lb/ft.

At no point on the pump curve shall the existing driving equipment be overloaded.

4. Bowl Assembly Diameter: 8" maximum, (double bolted ductile iron bowl and discharge case assembly if required per bowl pressure specification requirements).
5. Column Piping: Wire brush, steam clean, scrape, and reuse 210' of existing 6" diameter column piping from Well No. 6. In the event that a portion of the pump column is deemed unsuitable for service, Vendor shall contact District for approval of replacement of the column with new column piping quoted in Bid Schedule I.
6. Refurnish and install 210'± of existing repaired (as necessary) 1-3/16" stainless line shafting (water lubricated). Vendor will be required to verify dimensions. Provide all couplings, bearings, keys, bolts and nuts.
7. Discharge Head: Reuse existing cast iron discharge head and right angle gear drive. Vendor shall repair existing discharge head and gear drive as required for reinstallation of pumping unit. Vendor shall re-plumb and reinstall pump line shaft and water lubrication line to the discharge head.

Existing discharge head: Cast Iron.

8. Pump manufacturer shall select pump and verify performance in the event the existing pumping unit is non-rebuildable. Selected pump shall be approved by District.
9. Existing pump: Flowserve – 8M28- 7 stages (See Appendix C for specific

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information)

E. Existing Motor

1. a. Horsepower: 40 Hp.  
b. Brake Horsepower (Field) shall not exceed nameplate rating within entire operating range.
2. Power: 3 phase, 60 hertz, 460 volts.
3. Speed: 1800 RPM (no load).
4. Starting Characteristics: Full Voltage Contactor.

**1.03 Pumping Unit Data to be Submitted by Bidder**

Unless specified otherwise in Section 1.02 herein, bidder shall submit a certified pumping unit component drawing for each different pumping unit to be furnished and it shall show dimensions of pumping unit and its components including bowl assembly, connection to existing column assembly and shaft assembly, discharge head assembly, motor, and related appurtenances.

Bidders shall submit a certified pump performance curve together with design calculations for each different pump to be furnished. Each curve shall show head versus capacity, pump bowl efficiency versus capacity, brake horsepower versus capacity, overall (wire to water) efficiency versus capacity, all for full operating range specified.

Each certified pump curve shall be continuous from zero capacity to maximum pumping unit capacity on the abscissa. It shall be furnished full size on 8-1/2" (ordinate) x 11" (abscissa) paper. Bidder shall indicate certified values on each curve for the following characteristics at all specified design points since consideration will be given thereto in selecting units to be furnished.

- A. Discharge capacity in gallon per minute.
- B. Total discharge head in feet (bowl head).
- C. Pump bowl efficiency.
- D. Brake horsepower (including losses in pump, shaft, column, and head).
- E. Wire to water efficiency (including losses in motor, pump, shaft, column, and head).
- F. Down thrust and momentary up thrust.
- G. Net positive suction head (close coupled booster application only).

Bidder shall submit a guaranteed motor performance curve together with other performance data for each different motor to be furnished. Each curve shall denote horsepower, service factor, efficiency, locked rotor current, and temperature rise and each curve shall show efficiency, power factor, speed, kilowatt input, current, and line voltage under operating range between full load and half load.

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#### **1.04 Vendor Submittals (Provide Submittals Only for New Equipment)**

Complete submittals (shop drawings) showing performances, fabrication, assembly, and installation, together with detailed specifications and data covering performance and materials of construction, power drive assembly, parts, devices, wiring diagrams, and other accessories forming a part of the pumping units shall be submitted. Submittals shall include, but shall not be limited to, the following:

**A. Submit the following minimum information for each pumping unit specified herein for the District's review and approval:**

1. Items as specified in Section 1.03.
2. Type and model number with reference to pumping units suitability for service for pumps specific intended use.
3. Assembly drawing, nomenclature and material list.
4. Type, manufacturer, model numbers, location and spacing of bearings.
5. Impeller diameter, eye area, sphere size, and identification number.
6. Maximum rotative speed.
7. Complete performance curves indicating total dynamic head, flow rate, brake horsepower, shutoff head, net positive suction head required, RPM, and efficiency.

The manufacturer shall indicate by arrows to points on the H/Q curves the limits recommended for stable operation, between which pumps are to be operated to prevent surging, cavitation, and vibration. The stable operating range shall be as large as possible and shall be based on actual hydraulic and mechanical characteristics of the units.

Provide certified performance curves prior to shipment.

8. Motor data, including the manufacturer, size, type designation, minimum guaranteed efficiency and power factor at full load, 3/4 load, and 1/2 load, locked motor current in amps, full load current in amps, the motor speed in rpm, mounting details, and other data as required in the Contract Documents.
9. Outline dimensions and weights of pumping unit components and as assembled.
10. Materials of pump construction including bowls, bowl lining, shafts bearings, impellers and castings. Written certification of pumping unit's capability to withstand specified pressures.
11. Protective coating of pumping unit.
12. Installation instructions.

13. Operation and maintenance manuals.

**1.06 Quality**

- A. All pumping equipment furnished under this Section shall be of a design and manufacture that has been used in similar applications. Manufacturer shall demonstrate to the satisfaction of the District that pumps of similar construction are in service and functioning properly. Manufacturers as specified herein manufacture pumping units with acceptable quality or experience. Manufacturers must, however, meet the performance requirements stated herein for the actual pumps specified. Listing of said manufacturers does not imply that said performance requirements can be met for each pumping unit specified. Contractor shall be responsible to verify that manufacturers supplying equipment meet the size and capacity requirement specified herein.
- B. Pump manufacturer shall verify applicability of pumping equipment with respect to NPSHA, suction piping, can and discharge geometry to assure prevention of cavitation, vibration, surging, overheating, corrosion, and vortexing.
- C. Pumping unit Supplier shall be an authorized distributor approved by District. Said distributor shall have adequate service facilities within a 60 mile radius of District's office and shall have a service organization, machine shop facilities, and parts inventory such that servicing or replacement of pumping units can be provided with minimum delay.

## **PART 2 - PRODUCTS**

### **2.01 General**

Deepwell vertical turbine pumps shall be enclosed line shaft (oil lubricated) or open line shaft (water lubricated) type, whichever is specified, with aboveground flanged discharge and enclosed impellers.

All parts of the pump exposed to water shall be of stainless steel, brass, heavy cast iron, or equivalent corrosion resistant material.

Unless otherwise specified herein, all applicable provisions of AWWA E 101 (Part A), latest, are hereby made a part of these Specifications.

Pumps shall be manufactured by Flowserve, Floway, Goulds, Peerless, or approved equal.

### **2.02 Pump and Components**

#### **A. Pump Bowls**

Bowls shall be of ductile iron double bolted or close-grained, gray cast iron, Class 30, precision cast, free from blow holes, sand pockets, and other detrimental defects as required by pump working and shutoff pressures specified under Item 1.02. Water passageways in said bowls shall be smooth so as to allow freedom from cavitation and permit maximum efficiency. Each bowl shall have end or side seal (or both) to prevent slippage of water between bowl and impeller.

Bowls shall be lined with vitreous porcelain enamel, or equal, to produce long effective life (said lining shall not be applied for the purpose of short time gain in efficiency). Lining, identical to that furnished hereunder, shall have been used in the field under similar conditions with satisfactory results for at least a five-year period.

Bowls shall be of such size to fit the well casing with proper clearance (net clearance of 2 inches or more). Bowls shall be capable of withstanding 1-1/2 times the pump shut-off head pressure (zero discharge) or twice the rated capacity pressure, whichever is greater. Bowl materials shall have a minimum tensile strength of 30,000 psi. Bowl assembly shall be provided with ductile iron double bolted construction (as necessary) to meet specific requirements set forth in Section 1.02, herein.

#### **B. Pump Impellers**

Impellers shall be of the enclosed type, constructed of SAE 40 bronze. They shall be balanced hydraulically and dynamically to prevent vibration and shall be smoothly finished on all surfaces for minimum friction. Impellers shall be accurately fitted and securely locked to the pump shaft. Vertical adjustment of impellers shall be possible by adjusting top shaft nut. Impellers in multi-stage pumps shall all have the same diameter and trim.

C. Pump Shaft

Pump shaft shall be constructed of AISI-410 or 416 stainless steel and shall be accurately machined to provide smooth operation. It shall easily withstand torsional loads and other stresses encountered within the pump. Pump shaft shall have adequate bearing support at every bowl section and at top bottom and case section, and shall be equipped with a suitable steel coupling for connection to the line shaft.

D. Pump Bearings

Pump bearings shall be sleeve type constructed of SAE 40, 64, 67, or 660 bronze, or approved equal. Bearing area, bearing cooling, and bearing lubrication shall be ample for long, trouble-free operation.

E. Discharge Case

Discharge case shall securely fasten the pump bowl assembly to the column piping. It shall be heavily reinforced with streamlined fluid passages and it shall contain sleeve bearings for the pump shaft. Discharge case shall be provided with a means of reducing to a minimum the leakage of water into the shaft enclosing tube. It shall have bypass ports of sufficient area to permit the escape of water that leaks through the seal bushing.

F. Suction Case

Suction case shall securely fasten the suction piping to the bowl assembly. It shall be heavily reinforced with streamlined fluid passages and it shall contain a sleeve bearing for the pump shaft which is effectively plugged at the bottom to form a grease container. A sand collar shall prevent sand from entering the suction case bearing.

G. Suction Pipe and Strainer

Unless specified otherwise, the suction pipe shall be 10 feet in length and comprised of the same material and diameter as the column piping. A cone type strainer shall be provided for attachment to the suction pipe. The strainer shall be galvanized steel, bronze, or equivalent and shall have a net inlet area of at least four times the suction pipe area. The maximum strainer opening shall not be more than 75% of the minimum opening of the water passage through the bowl or impeller.

H. Column Piping

Column piping shall be threaded pipe conforming to the following diameters and weights per foot, unless specified otherwise.

Nominal Size (Inches)	Outside Diameter (Inches)	Weight Per Foot (Pounds)
6	6.625	18.97
8	8.625	24.70
10	10.750	34.24
12	12.750	43.77
14	14.000	54.57
16	16.000	62.58

Pipe shall be furnished in interchangeable sections of 20-foot nominal length for enclosed line shaft and 10-foot length for open line shaft, with the exception of the top column section which shall be of 5-foot nominal length and the bottom column section which may be of shorter length. Column pipe sections shall be connected with threaded steel sleeve type couplings. Ends of each pipe section shall be faced normal to section axis and machined with threads to permit ends to butt to ensure proper alignment when assembled. Coating of the column piping, either interior or exterior, is not required.

1. Line Shaft

Line shaft shall be comprised of AISI C-1045 material for oil lubricated pumps and Type 316 stainless steel for water lubricated pumps, or approved equal. Line shaft sections excluding top and bottom sections shall match column sections (10-foot or 20-foot nominal length). Top and bottom shaft sections shall match top and bottom column sections. Unless specified otherwise, top shaft shall be two (2) piece with coupling within discharge head.

Shaft enclosing tubing shall be Schedule 80 extra heavy steel pipe, maximum 5-foot lengths. Enclosed line shafting shall be supported by bronze bearings which shall also join tube sections. Open line shafting shall be supported by rubber bearings with bronze retainers which shall also join column sections.

When enclosed line shaft is specified, molded rubber stabilizing spiders that will deform to permit proper alignment of the shafting and tubing assembly within the column shall be furnished and spaced every 40 feet maximum throughout the column length.

**2.03 Discharge Head (Not Required-Refurbish and Reuse Existing Discharge Head)**

Discharge head shall be constructed of high grade cast iron or fabricated steel as shown on the Drawings as specified in Section 1.02, and shall be capable of withstanding all loads imposed during normal operation. Discharge head shall be furnished with a tube tension and seal assembly, as approved by District, for enclosed line shaft and a stuffing box assembly for open line shaft.

Discharge head shall be suitably enclosed to prevent the entrance of dust and foreign material. Access to the tube tension and seal or stuffing box assembly shall be ample. Drain plugs shall be provided at the bottom. Unless specified otherwise, discharge head shall accommodate two (2) piece top shaft with coupling.

Discharge head shall have a standard flanged outlet of the size specified except where otherwise permitted. If the discharge flange is not the size specified, an adapter consisting of a smooth eccentric increaser (with bottoms level) or reducer (with tops level) shall be provided. Said adapter shall be flanged to mate the discharge head at one end and as specified at the other.

Discharge head assembly shall be capable of withstanding 1-1/2 times the pump shut-off head pressure (zero discharge) or twice the rated capacity pressure, whichever is greater.

Motor base, column flange face, and discharge flange face shall be accurately machined, faced, and drilled to NEMA and ASA Standards. Upon assembly, motor and discharge head shall form an integral unit.



## **2.04 Lubrication System (Not Required Reuse Existing Water Lubricated System)**

Oil lubrication system shall be automatic gravity feed and it shall consist of an oil reservoir, solenoid control valve, sight feed valve, and appurtenant supports and oil lines. It shall be furnished with sight glass or other plainly visible oil indicator device.

Unless specified otherwise, oil reservoir shall have a capacity of two (2) gallons and it shall be Peerless or approved equal. It shall be mounted on the pump discharge head unless specified otherwise.

Oiler solenoid control valve shall open or close upon command of control system and it shall be ASCO 826111, or approved equal. It shall automatically start or stop the flow of lubricating oil to the bearings. It shall also permit manual operation upon control system failure. It shall be rated 120 psi minimum, 120 volt, 60 hertz, unless specified otherwise.

Oil piping shall be sized according to the viscosity of the oil recommended by the pump manufacturer and ambient temperature at the pumping unit. Said piping shall permit conveyance of full oil supply required by pumping unit.

Water lubrication system shall be automatic unless specified otherwise. It shall consist of piping or tubing from a source of water pressurized when pump is off, solenoid control valve, and appurtenant piping supports. System shall comply with pump manufacturer's recommendations for flow.

Water solenoid control valve shall open or close upon command of control system. It shall automatically start or stop the flow of water to the shaft bearings. It shall also permit manual operation upon control system failure.

## **2.05 Nameplate (Required)**

Nameplate, easy to read and corrosion resistant, shall be provided with each pump and shall contain complete pump information including manufacturer, serial number, model number, capacity in gallons per minute, total dynamic head in feet, and pump speed, all at specified design point. Said nameplate shall be mounted on pump head.

## **2.06 Vertical Hollow Shaft Electric Motor (Not Required –Refurbish and Reuse Existing Motor)**

### **A. General**

Vertical hollow shaft electric motors shall be Design B, high thrust, squirrel cage, induction type having NEMA weather protected Type I enclosures unless specified otherwise. Motors shall be built to form an integral part of pump head assembly and shall be suitable electrically and mechanically to efficiently and effectively drive pumps specified. Motors shall operate in accordance with these Specifications.

Motors shall be manufactured by General Electric Corporation, U.S. Electrical Motors Division Emerson Electric Co., or Westinghouse Electric Corporation, or approved equal. Unless specified otherwise all materials, workmanship, and tests shall conform with the applicable specifications of the National Electrical Manufacturers Association (NEMA), Institute of Electrical and Electronic Engineers (IEEE), and American Standards Association (ASA), and the Anti-Friction Bearing Manufacturers Association (AFBMA).

B. Power

Unless specified otherwise, motors shall be nameplate rated, 3 phase, 60 hertz, 460 volts.

C. Speed

Unless specified otherwise, motors shall be 4 pole and shall have no load speed of 1.800 rpm.

D. Starting Characteristics

Motors rated 200 hp and smaller shall be full voltage line start and motors rated 250 hp and larger shall be part winding increment start, unless specified otherwise.

E. Efficiency

All motors shall be rated premium efficiency, unless specified otherwise. Rated efficiencies shall be based on NEMA Standard MG1-12.536. Guaranteed efficiencies shall be determined in accordance with IEEE #12, Test Method B and E, latest revision.

F. Service Factor

Rated service factor shall be 1.15 or greater.

G. Insulation System

All motors shall be provided with Class "F" or better insulation systems except that motor lead insulation may be Class "B" or better. Impregnating materials shall be rated Class "F" (155 degrees C) minimum. Completed windings, when tested in accordance with IEEE #57, latest revision, shall show a thermal rating of not less than 150 degrees C for 30.000 hour's life.

Windings shall be held firmly in stator slots to prevent coil shift. Sharp edges and burrs shall be removed from stator slots prior to winding or inserting coils. Slot liners and coil end phase insulation, in addition to the coating, shall be provided. Stator windings shall be of high conductivity copper magnet wire.

Completed stator windings shall be provided with a properly cured, uniform impregnation for mechanical rigidity, moisture resistance, and protection against winding failures from accumulation of foreign conductive matter. The completed insulation system shall be capable of withstanding phase-to-ground RMS voltage of 600 volts continuous and 2,300 volts instantaneous (surge or transient).

H. Temperature Rise

Rated temperature rise above 40 degrees C ambient temperature measured by resistance at service factor load of 1.15 shall not exceed 90 degrees C.

I. Inrush Current

Motors rated between 10 hp and 50 hp shall be rated NEMA locked rotor Code H or better and motors rated 50 hp and larger shall be rated NEMA locked rotor Code G or better except where NEMA locked rotor Code H is specifically permitted.

J. Load Conditions

Actual motor loads shall not exceed the nameplate rating (horsepower) unless specified otherwise.

K. Motor Balance

Motors shall be dynamically balanced to a maximum of .001 inches peak to peak amplitude, especially at upper bearing housing.

L. Bearings

Motors shall be equipped with anti-friction type thrust and guide bearings. Angular contact ball thrust bearings shall be used in preference to spherical roller thrust bearings wherever possible. Angular contact ball thrust bearing shall be self cooled wherever possible. Water cooled angular contact ball thrust bearings shall be used only when approved by District. Spherical roller thrust bearings shall be water cooled.

Bearings shall be of sufficient capacity to carry all static and dynamic up and down thrust loads, both momentary and continuous, imposed by the pump. Bearings shall provide minimum 3 year B10 life (26,300 hours) based on continuous design thrust load or minimum 1 year B10 life (8770 hours) based on maximum pump shutoff thrust load, whichever is greater. Bearings shall also provide for minimum momentary upthrust equal to 30% of rated downthrust.

M. Bushings

Motors shall be equipped with lower end head shaft steady bushings unless specified otherwise.

N. Lubrication System

Motor thrust bearings shall be oil lubricated; however, motor guide bearings may be grease lubricated. Oil lubrication systems shall provide optimum lubrication of bearings. Said systems shall have sufficient oil storage and oil cooling capacity to limit oil bath temperature rise to 45 degrees C above 40 degrees C ambient temperature unless temperature rise of 50 degrees C is specifically permitted. Oil lubricated motors shall have visual level indicators and accessible fill and drain plugs. Indicators and plugs shall be located 180 degrees from pump discharge unless specified otherwise. Grease lubrication systems shall be regreasable and shall provide for automatic flushing or purging of grease cavity during regreasing.

O. Thermal Protection

Motors shall be equipped with 120 volt thermal sensors, one for each phase, affixed to or embedded in motor windings, set to open control circuit at 135 degrees C. All thermal sensor leads shall terminate in motor terminal box. Control modules and reset switches shall be furnished with the thermal sensors. The thermal sensors shall be Texas Instruments 4BA or 7BA, or approved equal. The control modules shall be Texas Instruments 50AA, or approved equal.

P. Space Heaters

Motors shall be equipped with 120 volt single phase belt type space heaters capable of raising motor temperature 10 degrees C above ambient temperature to prevent condensation. All space heater leads shall terminate in motor terminal box.

Q. Non-Reverse Protection

Motors shall be equipped with non-reverse mechanisms which shall limit maximum reversal to within 10 degrees of rotation.

R. Terminal Box

Motors shall be equipped with extra large heavy duty split type conduit boxes. Unless specified otherwise, motor terminal boxes shall be located 90 degrees from pump discharge.

S. Screens

Motors shall be equipped with suitable corrosion resistant safety and rodent screens. Said screens shall not interfere with motor cooling or motor heat dissipation.

T. Nameplates

Nameplates, easy to read and corrosion resistant, shall be provided with each motor and said nameplates shall include the following information:

1. Motor Data Nameplate - Manufacturer, serial number, model number, rated horsepower, service factor, frequency, phase, load voltage, full load current, full load speed, design designation, locked rotor-code, insulation class, temperature rise, ambient temperature, thermal sensor setting, NEMA nominal efficiency, guaranteed minimum efficiency, and full load power factor.
2. Connection Data Nameplate - Motor start, motor run characteristics, and motor connection diagram.
3. Bearing Data Nameplate - Manufacturers, bearing types (thrust and guide), bearing numbers, thrust capacity, oil type, minimum operating oil viscosity, maximum operating oil bath temperature, required cooling water flow, and maximum cooling water pressure.

## **PART 3 - EXECUTION**

### **3.01. Pumping Unit Factory Performance Test (Not Required)**

Each completed pumping unit (pump bowl assembly and vertical hollow shaft motor to be furnished) shall be given a certified factory performance test by pump manufacturer prior to shipment from factory. Pumping unit shall be tested at all design points for verification of certified performance curve furnished by Bidder and approved by District.

Tests shall be performed using suitable equipment for measuring bowl capacity, bowl head, power (input, brake, and water), and speed, all as approved by District. Equipment shall include a power meter for measuring input power (wire), a dynamometer for determination of pump brake horsepower, and a water meter for measuring output power (water). Contractor shall submit three copies of each certified factory performance test for acceptance by District. District reserves the right to have a representative present during any tests and to witness same.

### **3.02. Pumping Unit Installation (Required)**

Contractor shall bear full responsibility for the satisfactory installation and initial operation of all pumping units furnished under these Specifications and shall provide sufficient personal supervision over all installation and startup procedures accordingly, unless otherwise specified. Contractor shall also provide all test equipment necessary to determine initial operating performance.

During installation, Contractor shall disinfect all portions of the pump bowl assembly and column piping with a chlorine solution and method acceptable to District.

### **3.03. Pumping Unit Field Performance Test (Acceptance Test)**

After equipment has been completely installed, field tests shall be performed by the Contractor which shall be witnessed by District. Each pumping unit furnished hereunder shall be operated for a period of two weeks during which time acceptance tests may be conducted. Head capacity, overall efficiency, and input and output horsepower shall be determined for at least three different operating conditions in the operating range of the pumping unit, including the specified design point, for comparison with the certified pump curves and the factory performance test results, both as approved by District.

Pumping units (pump and motor) shall perform in the field substantially in accordance with the certified pump curves and the factory performance test results as adjusted for field conditions. If, in the opinion of District, the equipment furnished does not perform in accordance with these Specifications, Contractor shall promptly make all necessary repairs or corrections so that the equipment fully complies with these Specifications. Contractor shall remove, restore, and replace the equipment if required. Factory and field performance tests shall be rerun if necessary. Pump manufacturer's field service engineer shall assist District in the proper conduct of the above field acceptance tests.

### **3.04. Pumping Unit Vibration**

Completed pumping unit (pump and motor) shall receive a final field trim balance, as may be required, and vibration of unit shall not exceed 0.0025 inches, peak to peak amplitude when operating. Contractor shall field measure vibration with a suitable calibrated instrument and all measurements shall be witnessed by District. Vibration shall be measured at motor thrust bearing housing and at any other locations on pumping unit as directed by District.

**END OF SECTION**