UPDATE LOG FOR TECHNICAL PROVISIONS – DIVISION 5		
Date	Item(s) Changed	Page #
12/1/10	**TECHNICAL PROVISIONS** **DIVISION 5 – ELECTRIC MOTOR-DRIVEN PUMP SPECIFICATIONS** **5.4 Vertical Hollow Shaft Electric Motor Specification** 5.4.15 Strip Heaters Motors shall be equipped with 120 volt, single phase strip heaters capable of raising motor temperature 10 degrees C above ambient temperature to prevent condensation. All strip heater leads shall terminate in ~~motor terminal box~~ motor control center. Strip heater sizing shall be determined by motor frame size and strip heater manufacturer's sizing charts. Strip heaters shall be manufactured by Electro-Film or approved equal.	5-12

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DIVISION 5

ELECTRIC MOTOR-DRIVEN PUMP SPECIFICATIONS

5.1 General

5.1.1 Scope

All pumping units shall be comprised of vertical turbine line shaft pumps and vertical hollow shaft motors, unless specified otherwise. Other types of pumping units will be considered only for special applications for which vertical turbine pumping units are unavailable or inappropriate.

5.1.2 Submittals

5.1.2. 1 Contractor shall submit with his bid the following:

a. A certified pumping unit component drawing for each different pumping unit to be furnished. Drawing shall show dimensions of pumping unit and its components including bowl assembly, column assembly, tube and shaft assembly, discharge head assembly, motor, and related appurtenances.

b. A certified pump performance curve together with design calculations for each different pump is 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 the 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 8½ inches (ordinate) x 11 inches (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.

(1) Discharge capacity in gallons per minute

(2) Total discharge head in feet (bowl head)

(3) Pump bowl efficiency

(4) Brake horsepower (including losses in pump, shaft, column, and head)

(5) Wire to water efficiency (including losses in motor, pump, shaft, column, and head)

(6) Down thrust and momentary up thrust

(7) Net positive suction head (close coupled booster application only)

c. 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.

5.1.2.2 Prior to fabrication or manufacture of any selected pumping unit and appurtenances, Contractor shall submit the following to Owner:

a. A detailed, certified factory drawings of pump and motor components and materials for each different unit to be furnished. Said certified drawings shall fully describe all pump and all motor materials through the use of notes, dimensions, sections, and standards (such as ASTM) with which said materials comply. Contractor shall also submit written certification of pump head and pump bowl assembly capability to withstand specified pressures. In the absence of written certification, Contractor shall furnish test results demonstrating compliance with specified pressure requirements.

b. All necessary booklets, pamphlets, and other printed literature describing operation and maintenance of all pumping units and appurtenances supplied by him.

5.2 Deepwell Vertical Turbine Pump Specification

5.2.1 General

Deepwell vertical turbine pumps shall be enclosed line shaft (oil lubricated) or open line shaft (water-lubricated) type, whichever is specified, with above-ground, 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 specified otherwise herein, all applicable provisions of AWWA E 101 (Part A), latest, are hereby made a part of these specifications.

Pumps shall be manufactured by a manufacturer shown on the Approved List of Materials in Section 3 of the Special Provisions.

5.2.2 Pump Bowls

Bowls shall be of close-grained, gray cast iron, Class 30 or better, precision cast, free from blow holes, sand pockets, and other detrimental defects. 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. Each bowl shall be assembled with stainless steel bolts.

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 two inches or more). Bowls shall be capable of withstanding 1½ 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.

Lip seal shall be installed on T-bushing for bowls when oil-lubricated line shafting is used.

5.2.3 Pump Impellers

Impellers shall be of the enclosed type, constructed of bronze, brass, cast iron, or stainless steel. 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.

5.2.4 Pump Shaft

Pump shaft shall be constructed of ASTM-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.

5.2.5 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.

5.2.6 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 lip seal or better 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 discharge case throttle bushing.

5.2.7 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.

5.2.8 Strainer

The strainer shall be stainless steel, bronze, or equivalent and shall have a net inlet area of a 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.

5.2.9 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.

5.2.10 Line Shaft

Line shaft shall be comprised of ASTM-416 stainless steel material, or approved equal. Line shaft sections excluding head and bottom sections shall match column sections (10-foot or 20-foot nominal length). Head and bottom shaft sections shall match top and bottom column sections.

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.

5.2.11 Head Shaft

Head shaft shall be constructed of ASTM-416 stainless steel and shall be accurately machined to provide smooth operation. It shall easily withstand torsional loads and other stresses encountered within the discharge head and motor.

The head shaft shall be two-piece with a coupling within the discharge head, and shall be equipped with a suitable steel coupling for connection to the line shaft for installations using a mechanical seal within the discharge head. One-piece head shafts shall be used in all other applications.

5.2.12 Discharge Head

Discharge head shall be constructed of high grade cast iron or fabricated steel 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 Owner, 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 and shall be equipped with a removable safety screen. Drain plugs shall be provided at the bottom. Unless specified otherwise, discharge head shall accommodate two-piece head 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 1½ 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.

Discharge head assembly shall be painted according to Division 8 of the Technical Provisions. Contractor to submit color chart for District selection.

5.2.13 Lubrication 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 one gallon 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.

5.2.14 Nameplate

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.

5.3 Booster Vertical Turbine Pump Specification (Close Coupled)

5.3.1 General

Booster vertical turbine pumps shall be close coupled open line (water lubricated) shaft-type with an above-ground flanged discharge and either enclosed or semi-open impellers. All parts of the pump exposed to water shall be of stainless steel, brass, heavy cast iron, or equivalent corrosion resistant material.

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

Pumps shall be manufactured by a manufacturer shown on the Approved List of Materials in Section 3 of the Special Provisions.

5.3.2 Pump Bowls

Bowls shall be of close-grained, gray cast iron, Class 30 or better, precision cast, free from blow holes, sand pockets, and other detrimental defects. Water passageways in said bowls shall be smooth so as to allow freedom from cavitation and permit maximum efficiency. Each bowl shall have end and/or side seal to prevent slippage of water between bowl and impeller. Each bowl shall be assembled with stainless steel bolts.

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 suction can with proper clearance (velocity of water between bowls and can of seven (7) feet per second maximum at specified capacity). Bowls shall be capable of withstanding 1½ times the pump shutoff head pressure (zero discharge) or twice the rated capacity pressure, whichever is greater. Bowl material shall have a minimum tensile strength of 30,000 psi.

5.3.3 Pump Impellers

Impellers shall be of the enclosed type, constructed of bronze, brass, cast iron, or stainless steel. 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.

5.3.4 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 and bottom case section, and shall be equipped with a suitable steel coupling for connection to the line shaft.

5.3.5 Pump Bearings

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

5.3.6 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.

5.3.7 Suction Case

Suction case shall securely fasten the suction bell 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.

5.3.8 Suction Bell

Unless specified otherwise, a suction bell of the same material and diameter as the bowl assembly shall be provided. The suction bell inlet shall be set two (2) suction bell diameters, 18 inches minimum, from bottom of suction can.

5.3.9 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

Column pipe sections shall be connected with threaded steel sleeve- or flanged-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.

5.3.10 Line Shaft

Line shaft shall be comprised of ASTM-416 stainless steel material, or approved equal. Line shaft shall be 18 inches minimum length.

5.3.11 Discharge Head

Discharge head shall be constructed of high grade cast iron or fabricated steel and shall be capable of withstanding all loads imposed during normal operation. Discharge head shall be furnished with a shaft stuffing box, as approved by Owner, unless specified otherwise.

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 and shall be equipped with a removable safety screen. Drain plugs shall be provided at the bottom. Unless specified otherwise, the discharge head shall accommodate a two-piece head 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 1½ times the pump shutoff 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.

Discharge head assembly shall be painted according to Division 8 of the Technical Provisions. Contractor to submit color chart for District selection.

5.3.12 Nameplate

Nameplate, easy to read and corrosion resistant, shall be provided with each pump and said nameplate 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.

5.3.13 Suction Cans

5.3.13.1 General

Booster pump suction cans used in conjunction with close coupled line shaft vertical turbine pumping units shall have diameter, length, lining, coating, wall thickness, orientation of suction inlet, drilling of top flange, and dimensions, all as specified by Owner. Unless specified otherwise, suction cans shall be provided with all booster pumping units.

5.3.13.2 Suction Can Requirements

a. Can shall be sized so that velocity of water passing bowl(s) within can shall be 7 feet per second maximum at specified capacity.

b. Can shall be of sufficient length to provide for column piping of 18 inches minimum length and 18 inches minimum clearance between bottom of pump bowl assembly (suction bell or strainer, whichever is specified) and bottom of can.

c. Can inlet shall be 36 inches minimum and 60 inches maximum from bottom of can.

d. Cans shall be manufactured of ¼-inch minimum steel plate. Cans shall be provided with suitable baffles, if necessary, to prevent excessive turbulence.

e. Can shall be cement mortar-lined, 3/8-inch thick for can diameters 18 inches and less and ½-inch thick for can diameters over 18 inches.

f. Can shall be cement mortar-coated, 5/8-inch thick for can diameters 18 inches and less and ¾-inch thick for can diameters over 18 inches.

5.4 Vertical Hollow Shaft Electric Motor Specification

5.4.1 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 a manufacturing company as shown on the Approved List of Materials in Section 3 of the Special Provisions. 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), American Standards Association (ASA), and the Anti-Friction Bearing Manufacturers Association (AFBMA).

5.4.2 Power

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

5.4.3 Speed

Unless specified otherwise, motors shall be 4-pole and shall have a no load speed of 1,800 rpm.

5.4.4 Starting Characteristics

Motors rated 50 hp and larger shall be minimum 6-lead unless specified otherwise. Motors shall be suitable for use with reduced voltage autotransformer starters where indicated.

5.4.5 Efficiency

All motors shall be rated premium efficiency = 94%, 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.

5.4.6 Service Factor

Rated service factor shall be 1.15 or greater.

5.4.7 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 hours' 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).

5.4.8 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.

5.4.9 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.

5.4.10 Load Conditions

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

5.4.11 Motor Balance

Motors shall be dynamically balanced to a maximum of 0.0005 inches measured peak to peak amplitude, especially at upper bearing housing. Steady bushings shall be installed on motor when mechanical seals are used.

5.4.12 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 Owner. 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 a minimum three-year B10 life (26,300 hours) based on continuous design thrust load or minimum one-year B10 life (8,770 hours) based on maximum pump shut-off thrust load, whichever is greater. Bearings shall also provide for minimum momentary upthrust equal to 30% of rated downthrust.

5.4.13 Bushings

All motors, rated at 50 horsepower and above, shall be equipped with lower end head shaft steady bushings unless specified otherwise.

5.4.14 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.

5.4.15 Strip Heaters

Motors shall be equipped with 120 volt, single phase strip heaters capable of raising motor temperature 10 degrees C above ambient temperature to prevent condensation. All strip heater leads shall terminate in motor control center. Strip heater sizing shall be determined by motor frame size and strip heater manufacturer’s sizing charts. Strip heaters shall be manufactured by Electro-Film or approved equal.

5.4.16 Non-Reverse Protection

Motors shall be equipped with non-reverse mechanisms which shall limit maximum reversal to within 10 degrees of rotation. Said mechanism shall be attached to the head shaft using an "L" shaped GIB key and installed between driver and shaft.

5.4.17 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.

5.4.18 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.

5.4.19 Nameplates

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

a. 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.

b. Connection Data Nameplate - Motor start, motor run characteristics, and motor connection diagram.

c. 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.

5.4.20 Painting

Electric motor manufacturers shall prepare and prime surface of motor case. Prime coat shall conform to Division 8 of these Technical Provisions. Prime coat paint shall be compatible to final paint system. Prime coat and final color coat shall be a minimum 3 mils thickness each for a total minimum coating thickness of 6 mils. Contractor to submit color chart for District selection.

5.5 Pumping Unit Requirements

5.5.1 Pumping Unit Contractor (Bidder)

Pumping unit Contractor shall be an authorized distributor approved by Owner. Said distributor shall have adequate service facilities within a 60-mile radius of Owner'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.

5.5.2 Pumping Unit Factory Performance Test

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 as a complete unit (pump bowl assembly and motor) at all design points for verification of certified performance curve furnished by Bidder and approved by Owner.

Tests shall be performed using suitable equipment for measuring bowl capacity, bowl head, power (input, brake, and water), and speed, all as approved by Owner. 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 Owner. Owner reserves the right to have a representative present during any tests and to witness same.

5.5.3 Pumping Unit Installation

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 start-up procedures accordingly, unless specified otherwise. 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 Owner.

5.5.4 Pumping Unit Field Performance Test (Efficiency and Acceptance Test)

After equipment has been completely installed, field efficiency and performance tests will be performed by Contractor, and witnessed by Owner. Each pumping unit furnished hereunder shall be operated for a period of two weeks during which time field efficiency and conformance tests will be conducted by Contractor. These tests will be utilized to determine the Contractor's compliance with the contract documents. The following shall be determined for at least three different operating conditions in the operating range of the pumping unit, including the specified design points, for comparison with the certified pump curves and the factory performance tests results, all as approved by Owner. The Contractor shall use the "Record Pump Performance Test" form located at the end of Division 5, Page 5-21.

- Discharge Pressure (PSI)
- Discharge Head (FT)
- Suction Head (FT)
- Total Head (FT)
- Capacity (GPM)
- Acre-Feet Pumped in 24 Hours
- KW Input to Motor
- HP Input to Motor

- Motor Load (%)
- Measured Speed of Pump (RPM)
- KWH per Acre-Foot
- Overall Plant Efficiency (%)
- Customer's Meter (GPM)

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. In addition, the minimum wire to water efficiency shall be 70%. If the equipment furnished does not perform in accordance with these specifications, the Contractor shall promptly make all necessary repairs or corrections so that the equipment fully complies with these specifications. Contractor shall remove, restore, or modify the pumping units with *the* Owner's approval and replace the equipment if required. Factory and field performance tests shall be rerun as necessary. The pump manufacturer's field service engineer shall assist Owner in the proper conduct of the above field acceptance tests. Contractor shall be responsible for all re-tests, including District costs for achieving the minimum wire-to-water efficiency. Contractor shall follow field testing procedures outlined in AWWA Standards E101 Appendix A for determining overall efficiency of pumping unit. Contractor shall submit testing procedures a minimum of two (2) weeks prior to initiating testing. Testing procedure shall include the following, as a minimum:

1. Testing Schedule
2. Testing Personnel
3. Testing Instruments and Calibration of Instruments and Accuracy
4. Testing Measurements Including Calculations and Adjustments

5.5.5 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 0.0015 inches, measured peak to peak amplitude for deep well turbines and 0.001 inches, measured peak to peak amplitude for close coupled boosters. Contractor shall field measure vibration with a suitable calibrated instrument and all measurements shall be witnessed by Owner. Vibration shall be measured at motor thrust bearing housing and at any other locations on the pumping unit as directed by Owner.

5.6 Electric Motor Repair Requirements

5.6.1 Purpose

The purpose of this specification is to provide a minimum standard for motor repair work performed by outside vendors.

5.6.2 General Information

Professional outside repair service is required on a variety of motors and pump/motor units operating potable water, reclaimed water, and sewage environments.

Motors requiring repair will include single-phase and three-phase applications up to 500 hp. Motor applications include horizontal, vertical, submersible pump motors, and end suction pump motors.

This document provides minimum specifications for repair or rewind. Departure from these specifications requires approval before proceeding with the job. Any unauthorized work will be at the vendor's expense.

All non-emergency work shall be quoted before the motor is delivered. This shall be in accordance with District policy and present government guidelines. Quoted prices are to be based on a straight time rate for work as outlined in the specifications that follow. The quoted price will be based upon the stated problem with the motor as defined by the District's electrical services and/or pump personnel. If overtime is required, this will be quoted as a separate item.

All repair materials and work methods shall conform to the current standard and latest revisions of the Electrical Apparatus and Service Association (EASA), National Electrical Manufacturers Association (NEMA), National Electric Code (NEC) and Underwriters Laboratories (UL), where applicable.

5.6.3 Pickup Delivery

Pickup and delivery from the specific job site may be required for normal scheduled repair. Unless otherwise noted, normal pickup and delivery will be from the District warehouse.

5.6.4 General Work Requirements

a. Incoming Inspection

All motors will be tested for cause of failure upon arrival at the vendor's location. An insulation test and a surge test phase comparison will be performed. Other tests may be performed as required. If testing confirms a damaged winding, then proceed with the disassembly and rewind of the motor.

b. Nameplate

Motors shall have permanently mounted nameplates attached to the side of the motor. The nameplate should be readable (not covered with paint); if not readable, a new nameplate should be provided and permanently attached.

c. Cleaning

All windings and parts must be cleaned and free from dirt, grit, grease, and oil, then properly dried. Cleaning agents must be removed.

d. Stripping

Defective windings shall be removed in such a manner that no mechanical damage is done to the laminations or frame. Heating of laminations shall be controlled to avoid impairment of the magnetic qualities of the core and distortion of any parts.

e. Core Testing

On all motors 40 hp and above, a stator core test is to be performed before and after the roasting process to determine the integrity of the core iron. The core testing shall be performed in accordance with EASA standards, Section 7, Tech Note No. 17. Results are to be included on the final test report. Attached to this specification is a stator core test form. If the core test fails, halt work until instructions are received from District staff.

5.6.5 Mechanical Procedures

a. Bearings

All bearings on any authorized motor repair will be replaced with the same style bearing, consistent with the motor manufacturer's specification. All anti-friction and sleeve bearings shall have minimum total end-play as specified by the original equipment manufacturer.

b. Shafts

Shafts will be checked for undue wear, scoring, and straightness. The tolerance for permissible shaft runout for standard shaft length shafts, when measured at the end of the shaft extension, shall be 0.002" indicator reading for 0.1875" to 1.625" diameter shafts inclusive and 0.003" diameter indicator reading for over 1.625" to 6.500" diameter shafts inclusive (source: NEMA MG 1-4.05.7). Keyways should be true and accommodate keys to a tap fit. If shaft runout is excessive, or the shaft or keyway is damaged, the District shall be contacted for instructions.

c. Stator Housing

The stator housing shall be inspected for cracks, broken feet, and other damage. If repairs are needed, the District shall be contacted for instructions.

d. Balance

All rotating components or devices will be balanced in accordance with the manufacturer's specification for new equipment at designated apparatus speed. All balancing will yield results not to exceed .02 in/sec peak vibration velocity. This is "very good" on the attached Vibration Severity Graph. Balancing methods shall conform to EASA standards, Section 6, Method 1 or Method 2.

e. Verifying and Restoring Machine Fits

The rotor and rotating parts shall be measured to verify that they are within tolerance according to manufacturer's specification and NEMA standards. Bearing housings shall be measured, recorded, and compared to manufacturer’s specifications (see Anti-Friction Bearing Manufacturers Association Standard 7, EASA Technical Manual Section II). If out of tolerance, please contact the District for instructions before performing machine work.

f. Painting

All motors that are reconditioned by the vendor for the District will be repainted to the original color. The nameplate will be masked to protect nameplate data.

5.6.6 Rewind Procedures

a. Class of Materials

All rewound motors must produce the same torque, speed, horsepower, efficiency, power factor, and temperature characteristics as the original windings.

Materials and methods of application shall be equal to or better than the ones used by the original manufacturer. All components of the insulation system must be compatible with each other and the varnish or coating applied. All insulation materials used must be of the proper NEMA temperature class to meet the proper temperature rise of the motor, class "F" or higher only. All insulation shall be installed in accordance with EASA Standards, Section 3.5. Magnet wire on AC wound motors and DC motors shall have the proper ampacity, insulation, and mechanical qualities suitable to the operational environment and be adequate to withstand the normal life of the motor. If the metal in the magnet wire has been changed, it shall be equal to or better than original.

Lacing and shaping of the coil ends shall be performed to provide the necessary clearance to the rotor, stator, frame, endshields, air deflectors, and frame hardware. All lacing and shaping should be performed in a neat and workmanlike manner.

Connections shall be properly soldered or welded with materials that will be mechanically strong enough to withstand the normal operating conditions. Materials such as solder paste, fluxes, inhibitors, and compounds, where employed, shall be neutralized after using.

All connections and splices shall be constructed as to have a resistance equal to or less than the winding. Connections to terminals shall be of the type approved by the NEC that will ensure a good electrical and mechanical contact without injury to conductors.

All connections are to be adequately insulated with materials that will withstand the temperature, voltage, and frequency rating of the motor.

b. Vacuum-Pressure Impregnation Process (VPI)

All motors that are rewound for the District shall be vacuum-pressure impregnated. Time in the tank shall be sufficient to provide adequate penetration of the insulating fluid. The windings shall be cured in a temperature controlled drying oven. Either polyester or epoxy resin may be used for this process.

c. Varnish and Coating of Windings

Varnish shall be compatible with the entire insulation system. Windings of non-rewound motors shall have a minimum of one standard varnish overcoat dip, unless otherwise specified by the District. The windings shall be cured in a temperature controlled drying oven.

5.6.7 Final Tests and Reports

a. Final Testing

After assembly, run the motor with no-load and record phase voltage, amperage, and vibration levels onto the final report.

b. Final Report

A final report shall accompany each motor at the time of delivery. It shall include (but not be limited to):

1. Probable cause of failure.
2. Repair work done by the vendor.
3. Motor I.D. number assigned. (Brass tag motor I.D. number if attached).
4. Motor hp, rpm, frame size and catalog, serial or style number.
5. Bearing size information.
6. Vibration test data after balancing.
7. Results of all tests required by this specification.
8. Results of all tests performed in addition to this specification.
9. Bate motor was delivered to the vendor.
10. Date motor was completed and delivered to the District.

c. Vender Certification of Compliance

A vendor certification of compliance to this specification will be required. This is to be submitted with the final report.

d. Warranty Requirements

Vendor shall guarantee all materials and workmanship for at least one (1) year from the date of repair and will repair, at no expense to the District, motors which fail during this period.

5.6.8 Deliverables

a. Bearings

All old bearings shall be returned with the apparatus, regardless of condition. Old bearings shall be marked or tagged as Drive (DE) or off Drive End (ODE). Old bearings shall be packaged for protection and delivered with the motor.

5.6.9 Inspection

a. Inspection

The District reserves the right to inspect material and equipment during and after completion of repairs.

RECORD OF PUMP PERFORMANCE TEST

Date of Test ___/___/___ Test No. _____ Project Title _____ Project No. _____
Manufacturer's Order No. _____ Plant _____ Unit No. _____

RATED CONDITIONS:
Capacity, G.P.M. (m^3/h) _____ Total Head Feet (m)_____ R.P.M. _____
Overall Efficiency Percent _____ Range of Head _____

DRIVER:
Type _____ Horsepower (kw)_____
Manufacturer _____ Serial No. _____ Test Voltage _____

TEST EQUIPMENT:
Discharge Measurement Method _____ Conversion Factor_____
Discharge Gage _____ Correction _____ Suction Gage _____ Correction _____
Differential Between Gages _____ Inside Diameter Suction _____ Inside Diameter Discharge _____

PUMP DATA:
Type of Pump _____ Size _____ No. Stages _____
Manufacturer _____ Serial No. _____ Suction Size _____ Discharge Size _____

	Run Number	1	2	3	4	5	6	7	8	9	10
	Pressure, P.S.I. (kPg)										
	Head, Feet (m)										
	Gage to Water Level, Feet (m)										
	Velocity Head, Feet (m)										
	TOTAL HEAD, FEET (m)										
	Reading										
	Conversion										
	Flow, G.P.M. (m^3/h)										
	Motor Voltage										
	Amperes										
	Kilowatts										
	Total Horsepower Input										
	Motor Efficiency, %										
	Speed, R.P.M.										
	Dynamometer										
	Brake Horsepower (kW)										
	Water Horsepower (kW)										
	Pump Efficiency, %										
	OVERALL EFFICIENCY, %										

Tested By _____Witnessed By _____ Type of Test _____
(Field or Shop) REMARKS:_____