Item No. 514
Horizontal Split-Case Pumps

Notes to Specifier:

Delete these notes and not used paragraphs.

Where options are given, make appropriate selection and delete the other option, fill in all blanks. Electrical requirements must be reviewed by an electrical engineer.

Manufacturers should review this Section prior to Bid.

Verify all references to paragraphs within this Section and to any applicable Sections, standards or other specified sources of information.

Include Attachment A (pump data sheet), Attachment B (motor data sheet), and Attachment C (system curve, hypothetical pump curve, and key rated operating points) at the end of this specification.

514.1 Description

A. This item shall govern furnishing labor, materials, equipment, and incidentals necessary to design, manufacture, fabricate, test, deliver, and install a total of **[specify number]** horizontal centrifugal pumping units and electric motor drivers to be used in the **[Facility Name]** Pump Station. The pumping units shall be designated as:

1. **[Include tag for all pumps with horsepower, and pump number. Edit as desired to meet project requirements. The intent of the first line is to give a nominal reference to the pump. The two sections are meant to indicate two sizes or locations of pumps in a given project.]**
2. **[Pump Station 1 (5 MGD/200 HP):]**
    i. **[Pump 200-1]**
    ii. **[Pump 200-2]**
3. **[Pump Station 2 (1.25 MGD/100 HP):]**
    i. **[Pump 100-1]**
    ii. **[Pump 100-2]**

B. All pumps shall be of the same pump manufacturer. All motors shall be of the same manufacturer.

C. Pumping units include but are not necessarily limited to horizontal split-case, double suction centrifugal pump with **[side suction] [bottom suction]** and side discharge, horizontal motor, coupling, common pump and motor base, anchor bolts and template, electrical, instrumentation, special services, spare parts, and all lubrication and oil. Furnish accessories as required for a complete functioning pumping unit in accordance with the specified performance and installation conditions.

D. For this Section, the Equipment Manufacturer is defined as the pump manufacturer or its designated representative. Equipment Manufacturer is responsible for

supplying and coordinating the design, testing, and supervising the installation of the pump and motor. Equipment Manufacturer shall be responsible for the adequacy and compatibility of the pump and motor. The motor manufacturer shall act as a supplier of the Equipment Manufacturer. Motor manufacturer shall provide a representative capable of coordinating the design, testing, and installation of the motors. Contractor will install the pumping unit under the supervision and guidance of the Equipment Manufacturer's representative.

Note to Specifier: Select paragraph below for type of starter. Insert project specific specification numbers and names.

E. Pumping units shall be operated by a variable frequency drive (VFD). Motor manufacturer shall issue a letter of compatibility with the VFD manufacturer, reference Section **[insert spec section here], "[insert title of VFD spec here]".**

Note to Specifier: Delete the paragraph below if pumps and motors will not have vibration sensors and switches. If Engineer recommends vibration monitoring, the Engineer must coordinate with NBU on the type of system and how monitored/controlled and used in pump controls.

F. Pumping units will be supplied with vibration sensors and switches as specified herein. Vibration sensors shall be installed at the pump and motor factory. Field installing vibration sensors to pump or motor will not be accepted.

Note to Specifier: Delete the paragraph below if pumps will not be bid as Competitive Sealed Proposals. Minimum guaranteed pumping efficiency requirements must be approved by NBU.

G. Pumping units must meet the minimum guaranteed efficiencies submitted with the Proposal, as well as the minimum performance requirements indicated herein.

514.2 Approved Manufacturers

A. Pumps:

1. Deming.
2. Flowserve.
3. Patterson.
4. Pentair (Fairbanks Nijhuis).
5. Sulzer.
6. No other manufacturers will be accepted

B. Motors:

1. Baldor (Reliance).
2. General Electric (GE).
3. Nidec (US Electric Motors)
4. TECO-Westinghouse.
5. No other manufacturers will be accepted.

514.3 Quality Assurance

A. Experience Requirements:

1. Pumping unit shall be the product of manufacturers who have had at least 10 years of successful experience in the design, manufacture, and application of pumping units of the type, size, and performance capabilities as specified. The pump manufacturer shall have at least three similar size pumps of the model, type, and size of pump in service and operational for at least 5 years. It will be acceptable for the manufacturer to meet the pump installation experience requirements by referencing installations belonging to the pump's heritage line (previous ownership of the pump by a different company). The pumps referenced for the experience requirement shall be the same pump being proposed and the pump shall not have undergone substantial, material changes in engineering, design, and/or hydraulic characteristics. The assembly shall be an existing design that has been manufactured and is in operation. Prototype pumps will not be allowed.
2. Equipment Manufacturer shall maintain a quality assurance system in compliance with ISO 9001:2015 during the life of the contract.
3. All components of the pump and baseplate shall be supplied, assembled, and warranted by one of the approved pump manufacturers. Pump components shall NOT be acquired from separate entities and assembled as a final product by a manufacturer's representative.

B. Factory Inspection and Tests:

1. Pumps:

i. Pumps shall be factory performance tested and certified copies of test data and test curve shall be furnished to the Engineer. The efficiency, capacity, and horsepower requirements shall be determined for not less than 10 points throughout the specified head range from shut-off to maximum specified operating capacity. The tested points shall include Shutoff Head, MCSF, POR high flow, BEP, POR low flow and AOR high flow at 100 percent speed. In addition, test for all rated points.

ii. [All pumps shall be tested with the previously tested job motors at maximum speed. Units shall be tested with each of their specified job motors.] [All pumps may be tested with a calibrated factory test motor or a previously tested job motor at maximum speed.] [Factory testing with variable frequency drive is not required.]

iii. Test procedures, interpretation, and conversion of data shall conform to the latest requirements of the Hydraulic Institute standard for Hydraulic Performance Acceptance Tests (ANSI/HI 14.6), except as modified herein.

iv. Vibration levels shall not exceed the factory testing limits specified in the latest Hydraulic Institute standard for Vibration Measurements and Allowable Values (9.6.4).

v. The pump test results shall indicate that the performance of the pump from run-out head to shutoff head is similar to the pump curve submitted with the Proposal. If the test results indicate that the pump performs differently from the curve submitted with the Proposal, the Owner, at its

option, may accept the unit at a reduced price, or may refuse to accept the unit as a consequence of breach of contract on the part of the Equipment Manufacturer.

vi. Test results shall show no minus tolerance or margin with respect to capacity, total head or guaranteed efficiency at the specified conditions. Pumps shall have a continuous down slope in the head-capacity curve. Pumps shall be within the following plus tolerance, in accordance with HI 14.6, Grade 1E, except as modified below:

a) At rated head: 0 to +/-5 percent of rated capacity.

b) At rated capacity: 0 to +/-3 percent of rated head.

c) At rated efficiency: -0% of rated efficiency.

d) Pump head capacity curve must pass through both tolerance bands.

e) The tested pump horsepower cannot exceed nameplate motor horsepower when operating at any head between shutoff and minimum specified operating heads.

f) The “line from origin” method may be allowed for evaluation of guaranteed efficiency.

vii. Following completion of factory performance tests, the Equipment Manufacturer shall furnish certified copies of all test data and test curves for the pump to the Engineer for review and approval. Test curves shall also show calculated curves for expected performance at 100 percent speed for all pumps and 90, 80, 70, and 60 percent of rated speed for variable speed pumps. Engineer shall promptly review test data and will give authorization for shipment upon determining that the pump meets contract requirements. Shipment shall not be made without written approval of test data by the Engineer, except at the risk of the Equipment Manufacturer.

viii. Equipment Manufacturer shall perform a hydrostatic pressure test on the casing assembly at 1.5 times the shut-off head for a minimum of 30 minutes with no leakage.

ix. Pumps for potable water service must be thoroughly cleaned and disinfected if testing was completed using non-potable water. Disinfection chemicals should be removed, and surfaces flushed such that corrosive chemicals are not in prolonged contact with pump parts.

2. Motors:

i. All motors shall receive a short commercial test in accordance with NEMA MG1 and IEEE 112, latest version. Substitutions or waivers of the tests and methods listed herein will not be permitted.

ii. Following completion of factory tests, the Equipment Manufacturer shall furnish to the ENGINEER for review and approval four (4) certified copies of all test data and test curves for each motor. The ENGINEER shall promptly review test data and, upon determining that the motor meets contract requirements, authorization will be given for shipment. Shipment

shall not be made without written approval of test data by the ENGINEER, except at the risk of the Equipment Manufacturer.

C. Service of Manufacturer's Representative:

1. Pump Manufacturer's Representative:

a. The pump manufacturer shall furnish the services of a competent factory representative, who shall have had a minimum of 5 years of experience in the installation, adjustment, and operation of the equipment which is being furnished under this Section. This service is to ensure proper installation and adjustment of the equipment; instructing operating personnel in proper operation, maintenance, and care of the equipment; for making operation tests of equipment and making recommendations for obtaining the most efficient use thereof.

b. Contractor shall be responsible for installing the pumping units including all labor, tools, and equipment required for assembling, setting, aligning, connecting, adjusting, and testing the pump and motor assemblies.

c. The pump manufacturer's representative shall be at the Site at any time the Contractor is assembling, setting, aligning, connecting or adjusting and testing the pump and motor assembly.

d. The pump manufacturer's representative shall certify in writing to the Owner that the pumping unit installations have been properly completed and operated satisfactorily during acceptance tests. Contractor shall coordinate the field installation and testing.

e. The pump manufacturer shall have total responsibility to see that all connections (mechanical, electrical, and control) made to the installed pumping units are correct prior to startup and testing.

f. The minimum time required to be on-site for 8 hours per day, not including traveltime, is as follows:

Note to Specifier: Minimum time required shown below is variable. Adjust based on the number of pumps to be installed.

Service	Min. Time
Pump and motor installation	4 days (2 trips minimum)
Pump startup and testing	4 days (2 trips minimum)
Troubleshooting	2 days (1 trips minimum)
Personnel training	1 day (1 trip minimum)

2. Motor Manufacturer's Representative:

a. The motor manufacturer shall furnish the services of a competent pump and motor mechanic, who shall have had a minimum of 5 years of experience in the installation, adjustment, and operation of the equipment which is being furnished under this Section. This service is to ensure proper installation and adjustment of the motor; instructing operating personnel in proper operation, maintenance, and care of the equipment;

for making operation tests of equipment and making recommendations for obtaining the most efficient use thereof.

b. Pump manufacturer's representative may also serve as the motor manufacturer's representative upon written notification of the motor manufacturer assigning that responsibility.

c. The motor manufacturer's representative shall verify the proper installation, alignment, wiring, lubrication, and connection of all appurtenances prior to startup. Representative shall be present during testing, and startup and shall certify to the Owner in writing that the motors have been properly installed and operate satisfactorily.

514.4 Submittals

All submittals must be in English with US Customary Units. Submittals must be in accordance with this Section and the General Requirements. ANY DEVIATIONS FROM THE SPECIFICATIONS MUST BE CLEARLY NOTED AND IDENTIFIED IN THE SUBMITTALS.

The submittal requirements of this specification item must include:

A. Shop Drawings:

1. Drawings shall show complete physical description and performance capabilities of the equipment, including, but not necessarily limited to dimensions, weights, materials, assemblies, sectional views, performance curves, and WR^2 power requirements and ratings, rated voltage and amperage, applicable wiring diagrams, and on-site storage requirements.

2. Submittal shall include all information requested in the Data Sheet (for both the pump and motor, Attachments A and B) submitted with the Proposal. The data sheet shall be updated as necessary.

3. Submit drawings as a complete package of all equipment furnished. Partial drawings will not be reviewed. Shop Drawings shall include the following:

Note to Specifier: Adjust Shop Drawing requirements for the Project.

i. Pump Outline drawings of the pumps, motors and appurtenances, showing layout dimensions for all components, anchor bolts, external connections, and appurtenances.

ii. Pump Sectional drawings with all components and materials of construction identified.

iii. Characteristic Pump Curves: Curves shall show the capacity, head, minimum continuous stable flow (MCSF), preferred operating range (POR), best efficiency point (BEP), allowable operating range (AOR), efficiency, required NPSH, and brake horsepower throughout the operating range of the pump from shut-off to maximum specified operating capacity. Overlay the system curves included in Attachment C. **[Submit curves with the above data at speeds of 60 to 100 percent.]** Characteristic curves shall have the capacity plotted as abscissa and the

operating head, brake horsepower, efficiency and required NPSH plotted as ordinates. Provide WR^2 for the pump.

iv. Data Sheet: Submit information requested on the Data Sheet (for both the pump, Attachment A, and motor, Attachment B).

v. Pump speed vs. torque curves for applicable starting conditions. This information should be provided with the submittal package and updated after factory performance testing is complete.

vi. Pipe layout drawings for drainage and seal piping.

vii. Weights, including “wet” and “dry” weights of equipment, shipping weights and dimensions, and center of gravity for lifting.

viii. Bearings information, cut sheets, plan and section, data sheets, and bearing life calculations for pump and motor.

ix. Provide anchor bolt design calculations using a sleeve type anchor bolt design that extends from the floor foundation. **[Provide anchor bolt design calculations for a post-installed type anchor bolt in an existing foundation.]**

x. Name plate data sheets.

xi. Oil type and maintenance procedures.

xii. Paint selection chart.

xiii. Identify sequence and tags for terminal strips and wiring

xiv. Submit drawings of lab testing set-ups, test procedures, testing equipment calibration certification, and sample performance calculations.

xv. Provide a description of the components that will be shipped separately, thus requiring field assembly. Provide a general description of the installation requirements, including sequence and installation tolerances.

xvi. Submit motor documentation as required per Paragraph 514.19 Incomplete data submitted will not be reviewed and will be returned “Not Approved, Revise and Resubmit.”

xvii. Provide a copy of the Equipment Manufacturer’s quality system registration to ISO 9001:2015.

xviii. Provide resume of proposed the Equipment Manufacturer’s representative for field services.

xix. Provide an updated plan and a schedule indicating dates for submittals, manufacturing, testing, and delivery.

xx. Provide a quality control plan that indicates materials and components included in the pump, the quality control procedure, and whether a Certified Test Report will be provided to the Engineer.

B. Operation and Maintenance Manuals:

1. Submit manuals with instructions for installation, adjustment, lubrication, operation and maintenance of the equipment.

2. Manuals shall be prepared by the Equipment Manufacturer and shall also incorporate appropriate final Shop Drawings, Certified Test Reports, certified performance curves, and test data. Manual shall include nameplate data including serial numbers. Provide O&M data for all pump, motor, and accessories. Provide set points for **[vibration sensors], [motor thermal switches], [RTD's],** and all other protection devices. Manuals may be manufacturer's standard instructions, supplemented as necessary to cover any special feature not included in standard material. Submit preliminary manuals for review prior to delivery of the equipment. Separate or combined manuals may be provided for the pump and motor.

C. Certified Test Reports:

1. Submit the following Certified Test Reports (CTR) for pump and motor at the time of factory pump performance test. Shipment shall not be made without written approval of test data by the Engineer, except at the risk of the Equipment Manufacturer.

i. Provide CTR for pump factory performance tests.

ii. Provide CTR for motor factory performance tests.

iii. Provide CTR for stress relieving of components.

iv. Provide CTR for pump casing hydrostatic tests.

v. Provide CTR for coatings (DFT and holiday tests).

vi. [Provide photo of inside of pump RTD junction box showing how terminal blocks are labeled identifying which RTD is on inboard and outboard bearings. Photo shall be submitted to the Engineer for review prior to shipping the pump.]

vii. [Provide photo of inside of pump vibration sensor junction box showing how terminal blocks are labeled identifying vibration sensors (inboard, outboard, x, y, and z). Photo shall be submitted to the Engineer for review prior to shipping the pump.]

2. Submit the following CTRs for pump and motor at the time of installation and field pump performance test.

   i. Provide CTR for pump and motor alignment.

   ii. Provide CTR (with EIR) for pump field tests.

   iii. Provide CTR (with EIR) for motor field tests.

D. Equipment Installation Report:

1. Submit Equipment Installation Reports (EIR) from the motor manufacturer, pump manufacturer, indicating the equipment was installed in accordance with the manufacturers' instructions and that the equipment was adjusted and aligned to be in the best operating condition.
2. The report shall indicate that the equipment is operating satisfactorily in accordance with the Specifications.

514.5 Standards

The applicable provisions of the following standards shall apply as if written here in their entirety:

1. American National Standards Institute (ANSI) Standards:

ANSI B16.1	Cast Iron Pipe Flanges and Flanged Fittings
NSF/ANSI Standard 61	Drinking Water System Components – Health Effects
NSF/ANSI Standard 372	Drinking Water System Components – Lead Content

Note to Specifier: Edit ASTM Standards for materials used in this project.

2. American Society for Testing and Materials (ASTM) Standards:

ASTM A48	Standard Specification for Gray Iron Castings
ASTM A276	Standard Specification for Stainless Steel Bars and Shapes
ASTM A345	Standard Specification for Flat-Rolled Electrical Steels for Magnetic Applications
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A582	Standard Specification for Free-Machining Stainless Steel Bars

3. American Water Works Association (AWWA) Standards:

AWWA C210	Liquid Epoxy Coating Systems
AWWA E103	Horizontal and Vertical Line-Shaft Pumps

4. Hydraulic institute Standards (ANSI/HI)

All applicable sections for Centrifugal and Rotodynamic Pumps

5. American Society of Mechanical Engineers (ASME):

Section V	Nondestructive Examination
Section VIII	Pressure Vessels
Section IX	Welding, Brazing, and Fusing Qualifications

6. American Petroleum Institute (API):

API 610	Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries
API 682	Pump-Shaft Sealing Systems for Centrifugal and Rotary Pumps

7. International Standards Organization (ISO):

ISO 21940-11:2016	Mechanical Vibration – Rotor Balancing – Part 11: Procedures and Tolerances for Rotor with Rigid Behavior
ISO 9001:2015	Quality Management System – Requirements

8. Manufacturers Standardization Society of the Valves and Fittings Industry (MSS):

SP-55	Quality Standard for Steel Castings for Valves, Flanges, Fittings, and Other Piping Components, Visual Method for Evaluation of Surface Irregularities

9. National Electrical Manufacturers Association (NEMA).

10. Institute of Electrical and Electronic Engineers (IEEE).

11. National Electrical Code (NEC).

12. Underwriters Laboratories (UL).

514.6 Delivery and Storage

A. Openings shall be covered in a manner to protect the opening and interior. Provide steel plugs at threaded openings. Do not use non-metallic plugs or caps.

B. Coat exterior machined surfaces with rust preventative.

C. Identify lifting points and lifting lugs on equipment or equipment package. Identify recommended lifting arrangement on boxed equipment.

D. Equipment Manufacturer shall be responsible for delivery of the base, pumps, drivers, and accessories, to the job site or to such storage site as may be designated by the Owner or Contractor in good condition and undamaged. Equipment Manufacturer shall submit a shipping notice and delivery, unloading, assembly, storage and installation instructions at least 7 days prior to shipment.

E. Unloading and storage of the equipment shall be the responsibility of the Contractor who shall inspect the equipment for apparent damage. Equipment which is found to be damaged will not be accepted until properly repaired or replaced by the Equipment Manufacturer.

F. The pump, motor, and accessories shall be stored indoors, and the motor space heaters (if included) shall be energized. Maintain humidity, temperature and other environmental parameters within limits prescribed by the Equipment Manufacturer. If motors are to be stored for longer than 14 days, the oil reservoirs should be filled. Equipment Manufacturer is responsible for the supply of this oil. Contractor shall rotate the motor rotor by hand as recommended by the motor manufacturer, but no less than several rotations each week until the motor is placed into service.

G. Furnish anchor bolts and anchor bolt template as necessary to meet the Contractor's schedule prior to delivery of pumping units.

H. Spare parts shall be shipped with pump(s) and motor(s). Spare parts packaging shall be suitable to enable long term storage at a location designated by the Owner.

514.7 Equipment Warranty

Note to Specifier: Adjust warranty section as needed for the Project. Minimum 2-year warranty is required. Adjust 12-month time window after delivery in Paragraph C if pump is expected to ship well ahead of startup. Clarify party responsible for removal and re-install and will depend on how pump was procured.

A. Equipment Manufacturer shall warrant the equipment furnished under this Section for a period of 2 years against defects in materials and workmanship, equipment design, and operational failure.

B. In the event of failure in material, workmanship, or equipment design of any part or parts of the equipment during the warranty period, and provided that the equipment has been operated and maintained in accordance with good practice, the Equipment Manufacturer shall furnish, deliver, and install a replacement for the defective part or parts at its own expense. During the warranty period, the Equipment Manufacturer will remove and load the failed/defective equipment on a vehicle provided by the Equipment Manufacturer if it is necessary to return the failed/defective equipment to the Equipment Manufacturer for correction of defects during the Warranty Period. Equipment Manufacturer will reinstall the replacement equipment when equipment is returned to the Site after defects have been corrected. Equipment Manufacturer is to provide all parts, labor and incidental cost for making repairs, shipping the replacement equipment to the Site and providing startup services in accordance with the Specifications.

C. The warranty period shall be interpreted as the 24-month period following the installation, adjusting and acceptance testing, and the start of actual operation of the equipment, or **[36]** months after complete delivery, whichever occurs first.

514.8 Pumping Criteria, Performance Requirements and Data

Note to Specifier: Adjust general criteria describing the pump for each project.

A. General Criteria:

1. Pump shall operate alone, as well as in parallel with other pumps. The system curves in Attachment C show the maximum and minimum system heads at which the pumps will operate.

2. The pumping heads tabulated below are total dynamic heads (TDH) under field conditions and are inclusive of all pump losses from pump suction flange to pump discharge flange. The more explicit definition is “Pump Total Head” as defined by ANSI/HI 14.6, Paragraph 14.6.1.3.1.31. The Total Discharge Head component of the Total Head calculation shall be understood as the head produced at the discharge flange of the pump as installed in the field.

3. Pumps shall have a continuously rising performance curve from pump run-out to shut-off head with no intermediate flat places.

4. The motors provided under this Section shall be of sufficient size to drive the pumps at the rated head capacity and head. Horsepower requirements cannot exceed nameplate motor horsepower when operating at any head between shutoff and minimum specified operating heads.

Note to Specifier: Adjust the conditions of the water for each project. Solids, sand, abrasive materials, oxidants, and corrosive chemicals are particular concerns.

5. **[Potable Example]** Liquid to be pumped is potable water with **[chlorine] [chloramine]** residual.

Note to Specifier: Adjust the suction description for each project. If using an in-line booster application, several parameters will need editing in following sections.

6. The pump suction will be from the **[treatment plant clearwell(s)] [ground storage tank(s)] [intake tower and reservoir]**, which are open to the atmosphere.
7. The pumps and motors will be mounted on a steel baseplate provided with the pumps.

Note to Specifier: If project is using VFDs for motor/pump control then supply pump with a passive swing check valve and utilize the VFD to control the ramp up/ramp down of the motor/pumps. Adjust the description of the starting sequence accordingly. Edit Subparagraph 9 below as well.

8. **[Cla-Val Style PCV Example]** Pumps will be started and stopped against a closed pump control valve which will open and close slowly (2 to 5 minutes per cycle) to minimize transient pressure surges in the discharge pipeline. The pump shall be designed for full shut-off head pressures during starting and stopping.
9. **[Check Valve Example]** Pumps controlled by **[VFD(s)]** will be started against a check valve. The check valve will open slowly (approximately **[x] [minutes] [seconds]** per cycle). During power failure, the check valve will quickly close to prevent reverse flow through the pump.

Note to Specifier: For the following two sections, adjust the description. Delete the paragraph that does not apply.

10. **[VFD Example]** The pump and motor shall be compatible for use with a variable frequency drive with speeds from **[X]** to 100 percent. The pumping unit will be started using a VFD which will ramp to a preset speed and will remain at this speed until the check valve is fully open, at which time an operator will adjust the speed as needed. The starting speed will be confirmed by the selected pump manufacturer for starting such that the pump is within AOR for likely system head conditions.
11. **[VFD Bypass Example]** The pump and motor can also be started across-the-line using full-voltage non-reversing starters if the VFD is not in service using the installed bypass.
12. The top of the pump casing shall have a 2-inch threaded outlet for an [air valve assembly, ball valve or hose bibb] that will release air if the pump is drained and re-filled. The air-valve assembly will be provided and installed by the Contractor.
13. Pump shall operate alone, as well as in parallel with other pumps. The system curves in Attachment C show the maximum and minimum system heads at which the pumps will operate.

Note to Specifier: Adjust description below. Recommend using two points and clarifying where the BEP is in relation to these points.

14. It is desired that the pump has its highest efficiency to the **[left of Rated Point 1]**, and this efficiency, **[as well as the efficiency at Rated Point 2]** will be considered in evaluating the pump. **[The efficiency at these two points will be averaged for the proposal evaluation.]** In addition, the efficiency at the minimum and maximum operating heads may be used in evaluating the pumps.
15. The motors provided under this Section shall be of sufficient size to drive the pumps at the rated head capacity and head. Horsepower requirements cannot exceed 95 percent of nameplate motor horsepower when operating at any head between shutoff and minimum specified operating heads.

Note to Specifier: Include statement below for all pumps in a water system even for raw water pumps. Review for compliance with latest EPA and state rules.

16. All wetted materials shall be designed for drinking water contact and shall meet the intent of NSF/ANSI 61 and NSF/ANSI 372. Leaded bronze materials shall not be used.

Note to Specifier: Adjust description of pipe arrangement below.

17. The discharge piping includes a [**flexible expansion and dismantling joint]** between the pump discharge flange and the pump control valve as shown in the Drawings. The suction piping includes a **[flexible expansion joint]** immediately upstream of the pump suction flange.

Note to Specifier: Delete the subparagraph below if a bridge crane will not be used. Modify accordingly for bridge crane capacity and hook height.

18. The weight of each motor and the fully-assembled pump (exclusive of motor) shall not exceed **[specify]** Tons. This weight limitation allows assembly and disassembly of the pumping units with the bridge crane rated capacity. Additionally, the maximum hook height is approximately **[specify]** feet measured from the finished floor elevation, and the pumping units shall be designed to allow assembly and disassembly of the pumping units with the bridge crane capacity and hook height, including the rigging.

19. [**Provide description of other important criteria, unique starting conditions, unique operating conditions, etc.]**

B. Performance Requirements

Note to Specifier: Adjust pumping conditions in the table as needed for each project. The included text and yellow highlights are examples and should be deleted or edited to fit the Project. Additional criteria should be included when needed.

1. The tabulations below show the required flows and various head conditions at which the pumps must operate and the pump setting requirements for all **[number of]** pumps. See Attachment C for System Curves.

Pumping Conditions at Full Speed (U.N.O.)	**[Pump Tag #]**	**[Pump Tag #]**
Minimum Capacity at Rated Head **[1]**, (gpm) (full speed)	**6945 (2 pumps running)**	**868**
Rated Head **[1]** (ft) (full speed)	**168 (2 pumps running)**	**250**
Maximum Operating Head, (ft) (full speed, w/in **[AOR] [POR]**)	**185**	**265**
Minimum Operating Head, (ft) (full speed, w/in **[AOR] [POR]**)	**60**	**185**
NPSHa at Rated Head 1, (ft) (with 5' margin applied)	**47**	**47**
NPSHa at Rated Head **[2]**, (ft) (with 5' margin applied)	**47**	**47**
Maximum Shutoff Head (ft)	**356**	**316**
Maximum Pump Brake Horsepower (HP)	**200**	**100**
Motor Voltage	**460**	**460**

Pumping Conditions at Full Speed (U.N.O.)	[Pump Tag #]	[Pump Tag #]
Maximum Motor Horsepower, (HP)	**X**	**X**
Maximum Motor Speed, (RPM)	**1800**	**1800**
Minimum Speed (% of max rated)	**X%**	**X%**
Minimum Pump Efficiency at Duty Points (%)	**X%**	**X%**
Reduced Speed Duty Point #1, **[X]** gpm @ **[X]**' TDH Manufacturer to Confirm Speed	**X%**	**---**

C. Pump Setting Requirements:

Note to Specifier: Adjust setting requirements per the Project. Add footnotes as needed for clarifications. Setting table is for side-suction pump and different elevation and dimension info will be needed for bottom-suction.

Pump Setting Requirements	[Pump Tag #]	[Pump Tag #]
Elev. **[Existing]** Concrete Support Block	**[TBD by mfr.] [Spec Elev. 1]**	**[TBD by mfr.] [Spec Elev. 1]**
Elev. Operating Floor	**646.0'**	**646.0'**
Elev. Pump Centerline	**650.75'**	**650.75'**
Discharge Diameter (I.D.), (in) (min. TBD by pump manufacturer)	**8**	**4**
Suction Diameter (I.D.), (in) (min. TBD by pump manufacturer)	**10**	**5**
Max. Dimension Suction Flange to Discharge Flange, (in)	**40**	**25**
Max. Dimension Pump and Motor Base, (in)	**36 x 94**	**24 x 68**
Elev. Max. Water Level, **[Clearwell, Tank, Reservoir]**	**665.1'**	**665.1'**
Elev. Min. Water Level, **[Clearwell, Tank, Reservoir]**	**639.1'**	**639.1'**
Max. Dry Weight of Pump, Motor or Base, TONS	**2.5**	**2.5**

1. **[The height of the existing block will not be modified to allow proposed pump to fit. The baseplate shall be designed to fit pump on existing block and match existing pipe.]**

2. Approximate dimension is to outer edge of motor, pump or baseplate, whichever is greater. Equipment Manufacturer shall field verify with the assistance of

Contractor and provide a base that will support the pump and new motor per the Contract Documents.

Note to Specifier: Adjust NPSHr requirements per Project. Refer to HI 9.6.1.5.5 guideline for margin. This specification requires 5 feet minimum.

D. The pump shall have suitable Net Positive Suction Head Required (NPSHr). Note that NPSHr is defined as the 3 percent head drop net positive suction head requirement. The NPSH margin, i.e., ratio of NPSHa to NPSHr shall be consistent with the suction energy conditions as defined by the HI standards. Minimum margin shall be 10 percent within POR, or 5 feet, whichever is greater. **[Minimum margin shall be 20 percent within AOR, or 5 feet, whichever is greater.]** The NPSHr with the margin applied within POR shall be less than the NPSHa with the minimum suction water level as shown in the pump setting table. The NPSHr with the margin applied at pump run-out shall be less than **[50 feet] [the NPSHA with the minimum suction water level as shown in the pump settings table]**. The **[Clearwell, Tank, Reservoir]** will be open to the atmosphere. For the purposes of calculating NPSHa, the manufacturer may assume the total friction and minor losses in the suction piping (to pump flange) to be **[2.0 feet (Rated Point 1) and 1.0 feet (Rated Point 2) from the clearwell]** to the pump for analysis.

514.9 Pump Materials

A. General

Note to Specifier: Bottom suction style pump will need edits. This image is provided as a reference for rotation/orientation and must be deleted from the specification.

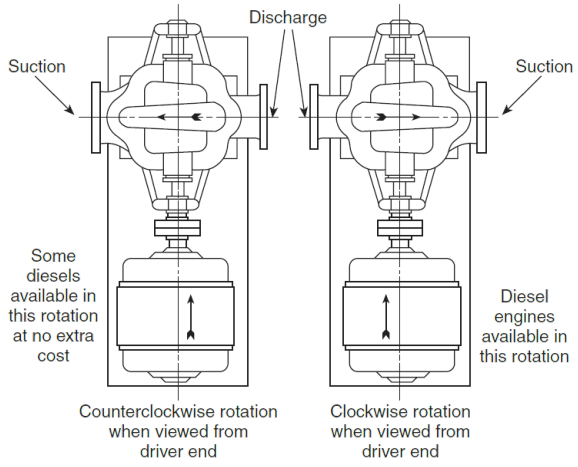


FIGURE A.4.23(a) Horizontal Pump Shaft Rotation.

1. Pumps shall be horizontal, single-stage, axial split-case, double-suction, double volute, centrifugal pumps with side suction **[bottom suction]** and side discharge for pumping **[potable]** water. When viewed from the driver end, the discharge shall be on the **[left-hand]** side of the pump and rotation shall be **[clockwise]**.

2. Pumps shall be designed, manufactured, inspected and tested in accordance with the applicable requirements of AWWA E103, the Hydraulic Institute Standards and special requirements of this Section.

3. The pump supplier shall furnish all bolts, nuts, washers, and gaskets for the pumping units, except bolts, nuts, washers, and gaskets for the suction and discharge flanges, which shall be supplied by the Contractor. All bolts, nuts and washers shall be stainless steel.

4. Pumps shall be designed, manufactured, and installed to meet all requirements of the ANSI/HI 9.6.4-2016 standards for “Allowable Field Vibration Limits”.

5. Equipment Manufacturer shall stress relieve all fabricated components, and pump/motor base prior to final machining in accordance with ASME Code, Section VIII, Division 1; ASME Code Section IX, and API Standard 610.

B. Casing:

1. Pump casing shall be of strong close-grain cast iron in accordance with ASTM A48 Class 30 or cast ductile iron in accordance with ASTM A536 designed for heavy duty service, **[single or]** double volute design, free of blow holes, or other detrimental defects. The casing shall be horizontally split with the suction and discharge flanges cast integrally with the lower half in order that the upper part may be removed for inspection of the rotating element without disturbing pipe connections or pump alignment. The joint between halves of the casing shall be heavily flanged and bolted and provided with dowel pins for accurate alignment. The interior shall be smooth and free from surface defects. The diameter and drilling dimensions of suction and discharge flanges shall be ANSI B16.1 drilling and shall be adequate to withstand shut-off pressure plus 50 percent.

2. Casings shall be drilled and tapped for air release valve, gauge, and drain connections. Suitable lifting lugs or eye bolts shall be provided. Casing shall be tested in accordance with Hydraulic Institute Standard 14.6 under a hydrostatic pressure of 150 percent of maximum shut-off head.

C. Rotating assembly:

1. Shaft:

   i. Pump shaft shall be of ample conservative design such that it will be suitable to transmit the maximum brake horsepower required by the pump and be of sufficient stiffness to prevent contact of the wearing rings under any condition of operation.

   ii. The shaft shall be stainless steel, ASTM A276 Type 410 Condition 1 or ASTM A582 Type 416. Keyways in the shaft shall be provided with stainless steel keys. Assemble using anti-seize compound on fasteners to prevent galling.

2. Impeller:

   i. Impellers shall be of strong dense castings free of structural defects with uniform thickness of vanes and shrouds. They shall be the enclosed type

with staggered vane design, have smooth water passages for high efficiency, and shall be statically and dynamically balanced. Perform a single or two plane dynamic balance to ISO 21940-11 Grade G2.5 or better. Thinning of the shroud shall be allowed only when uniform and spread over as wide an area as possible. An engineering evaluation shall be made by the manufacturer as to the amount of thinning which can be done and still preserve the integrity of the casting. In no case shall the thickness of the shroud be less than this value.

Note to Specifier: NBU standard for impeller materials is ASTM A487 or A351 stainless steel. Cast Ni-AL-Brz may be used with NBU approval to allow for greater pool of allowable pumps or when lead times for stainless steel impellers are excessive.

ii. Impellers shall be of cast stainless steel, ASTM A487, CA-6NM Class "B" containing 13 percent chrome and 4 percent nickel or ASTM A351 CF8M containing 18 percent chrome and 9 percent Nickel **[or cast Ni-Al-Brz, ASTM B148 C95800]**.

iii. Welding on the raw castings will be allowed as long as the proposed repaired defect is within allowable standards and prior to any machining, polishing, and/or balancing. Welding, fillers or coatings for head, flow, and/or efficiency performance reasons will not be allowed. Notify Contractor, Owner, and Engineer prior to making major repairs on the impeller. Major repairs are defined as those that are: 1) >20 percent of material thickness; 2) 1 inch or greater in depth; or 3) exceed 10 square inches. Submit welding procedures and welder qualifications prior to welding on impeller castings. Welders must be qualified to ASME Section IX.

iv. The impeller shall be keyed to the shaft and securely held in axial position on the shaft by means of stainless steel sleeves properly secured to the shaft so that it cannot become unfastened when the pump is reversed. All rotating parts of pumps shall be machined true for rotational balance with the impeller, coupling, and other parts that may be mounted on the shaft, such that the pump shall operate within a maximum of allowable vibration tolerances specified.

3. Wear Rings:

i. At the running joint between the duction and discharge chambers, there shall be provided on both the casing and impeller, renewable wear rings with large running surface area and designed for smooth flow areas. The casing rings shall be secured by stainless steel screws, pins, or other suitable methods. Impeller rings shall be securely attached by stainless steel set screws or equal and fastened so they cannot become loose when the pump is reversed.

ii. Wear ring material shall be 400 series stainless steel compatible with the impeller material. Casing wear ring shall be an alloy with a Brinell hardness of 100 points greater than the impeller wear ring.

iii. Wear rings shall have a straight face only. L-shaped wear rings will not be allowed.

D. Stuffing Boxes:

1. Stuffing boxes shall be water sealed and shall be designed for tight seal without excessive wear or friction on the shaft sleeve, and to prevent air leakage into the pump under all conditions of operation.

2. The stuffing box shall be fitted with a mechanical seal. Mechanical seals shall be the split-type as manufactured by Chesterton, Type 442, or John Crane, Model 3740. The hardware shall be 316 stainless steel, rotary face shall be silicon carbide, stationary face shall be carbon, and elastomers shall be EPDM. Stainless steel piping for recirculation shall be provided from the discharge side of pump to the seal (API Plan 11). The seal installation shall be inspected by the seal manufacturer prior to testing the pump.

3. Provide solids extruder bushing, Chesterton SpiralTrac Version F or approved equal.

4. Drip pockets shall be provided for all water sealed glands with 1-inch NPT threaded outlet for connection of piping. Contractor shall provide piping to common drains to handle leakage.

5. Pump manufacturer shall verify compatibility of mechanical seal, throat bushing, and seal water system.

E. Bearings:

1. Bearings shall be oil or grease lubricated anti-friction ball type adequately sized to carry radial and thrust loads without the addition of external cooling. Anti-friction bearings shall have a L-10 bearing life of 100,000 hours at the rated head and flow of the pump in accordance with the standards of the Bearings Manufacturers Association. No cast-in bearings will be allowed, so that a spare rotating assembly could be easily installed.

2. Bearings oil baths shall have a constant level oiler and a sight or bullseye level. Bearing oil bath shall be designed for adequate lubrication at maximum forward and reverse speeds. Oil sample tap for bearing chamber shall be from the bottom of the bearing housing.

3. Provide flood hole on bearings for water to exit instead of flooding the bearings. Provide slinger ring with view ports on bearing housing.

4. Lubrication oil for bearings shall be food grade.

F. Coupling and Guard:

1. Flexible couplings shall be the heavy-duty type, designed so that the pump shaft may be removed without disturbing the position or adjustment of the driving unit. Coupling shall be all stainless steel, Kop-Flex Fast's gear coupling as manufactured by Emerson Power Technologies or approved equal. Minimum factor of safety of 1.5 times shaft strength shall be used. Horizontal surface of the coupling shall be machined parallel to the axis of the shaft, and faces shall be machined perpendicular to the axis of the shaft.

2. Provide an appropriate coupling guard, acceptable to OSHA, securely attached to the pump base with stainless steel bolts and nuts.

G. Pump and Motor Base:

1. Pump and motor shall have a common one-piece base. The length and width of the base shall be of suitable size for the equipment to fit within the limits of the concrete block pump support as shown on the Drawings.

2. The base shall be fabricated steel of sufficient strength and depth to ensure rigidity and so designed as to make a good appearance and provided with adequate grout and air vent holes. Provide seal welded rings around all anchor bolt, grout, and air vent holes to prevent water from wicking into the grout. Provide 1-inch NPT connection for piping to route collected drain water to a drain in the pump room floor. The base shall be heat induced stress relieved, at the factory, prior to machining. The base shall be provided with planed supports or bearing pads for the pump and motor. Base shall be drilled to receive a suitable number of foundation bolts. Base shall have a minimum of eight heavy duty jacking bolts welded to the base, positioned around the motor base to aid in alignment. Jacking bolts cannot be located in the drip rim.

3. The pump and motor shall be mounted on the supports or bearing pads with shims. Provide 316 stainless steel levelling shims custom made to match the full face of the motor foot surface. After final alignment, the total number of shims cannot exceed five shims under any one motor foot.

Note to Specifier: The template is useful for pre-purchased pumps where the foundation will be built well before pump delivery.

4. Equipment Manufacturer shall furnish foundation bolts for each pumping unit. **[Furnish a steel template for setting anchor bolts and sleeves].** Ship foundation bolts **[and template]** ahead of the pumps as necessary to meet the schedule of installation by the Contractor. Provide 316 stainless steel sleeve-type anchor bolt complete with sleeves, washers, nuts, etc.

Note to Specifier: Use the subparagraph example below and edit specific to the Project when installing pump at an existing station.

5. **[There are existing foundation bolts installed at the empty Pump IP-6 slot. These may be used by the Equipment Manufacturer. If the proposed base cannot be made to fit to the existing foundation bolts, the Equipment Manufacturer and Contractor shall provide design and details of a proposed anchoring system for review by the Engineer. If required, 316 stainless steel foundation bolts complete with sleeves, washers, nuts, etc., shall be furnished for each pumping unit.]**

H. Pump Painting:

1. All exterior surfaces, including the pump base, shall be painted per **[System No. {2} as specified in Item No. 530 "High Performance Coatings"].** The prime coatings shall be shop-applied prior to shipment and the final coat shall be field-applied after installation to match adjacent piping. Between the prime coat and intermediate coat, apply a separate stripe coat on all angles, edges, welds, and bolted connections where coating film build will be reduced.

Note to Specifier: Recommend interior Belzona coating for most water pumps.

2. Coat interior of pump casings with a ceramic epoxy coating. Prepare surface to SSPC–SP 10 minimum, or as recommended by the coating manufacturer. Prime and finish coat shall be 10 mils each DFT Belzona 1341NSF efficiency enhancement coating system for potable water. Perform a holiday test and correct all defects. Interior coating shall be applied prior to factory testing. Holiday test coating using high voltage spark testing at a maximum voltage of 125 volts per mil. Wet sponge holiday testing will not be acceptable.

Note to Specifier: Use subparagraph below when factory coating is sufficient. Delete if using the two subparagraphs above.

3. Interior pumps surfaces shall be coated with liquid epoxy, AWWA C210, to give a minimum total dry fil thickness of 15 mils and shall be Tnemec Pota-Pox Series 20 or approved equal. All exterior surfaces, including the pump base, shall be cleaned, primed, and painted with two coats of manufactures standard exterior machinery enamel. Furnish extra touch-up paint for the Contractor's use. Color shall be selected and approved by the Owner.

I. Pump Marking and Nameplates

1. Pump and motor shall each have a standard manufacturer's stainless steel nameplate securely affixed with tapping screws in a conspicuous place, showing the ratings, speed, rotation, serial number, model number, manufacturer, and other pertinent data. Nameplate must be on a vertical section of pump or base.

2. Provide a nameplate with the pump tag number at a readily visible location on the discharge side of the pump, motor, or baseplate. Use polymer nameplates, white with black lettering, and attach with stainless steel screws. Lettering is to be minimum 3-inches tall. Provide Safe-T-Mark by Rowmark or equal.

3. Provide a stainless steel nameplate with the bearing order number on each pump at a readily visible location on each side of the pump.

J. Special Tools

1. Furnish with the equipment, one set of any special tools or devices required for the assembly, operation, and maintenance of all equipment furnished.

K. Lubricant

1. Furnish with the equipment, oil or grease of the recommended type and grade, in sufficient quantity for initial filling, operation during acceptance tests, and as listed in Paragraph **[2.04],** Spare Parts. Advise Owner of type and available sources of lubricants.

514.10 460-Volt Motors

Note to Specifier: This is a guide specification. Engineer should use this specification with care and verify all requirements. Adjust for type of starter. Do not use without editing by Electrical Engineer.

A. General:

Note to Specifier: NBU prefers the motor be inverter-duty rated, whether motor starting method is across-the-line, soft-start, or VFD-driven.

1. Motors shall be horizontal, air cooled, **[copper]** wound stator, **[copper] [aluminum]** bar rotor construction, squirrel cage induction type. Motors to be identical to each other. Motors shall be designed for use with variable frequency drives and across-the-line starters.

2. Motors shall be of a premium efficiency design and rated for inverter duty in accordance with MG-1, Part 31. The variable speed pumps will be varied by a variable frequency drive motor controller **[(provided by others under Division ##)]** and will be operated for extended periods of time at speeds from **[X to 100]** percent of rated synchronous motor speed.

3. The VFD and motor shall be completely compatible electrically. VFD manufacturer and motor manufacturer shall together issue a letter of compatibility at the time Shop Drawings are submitted. The VFD and motor manufacturer shall determine the insulation voltage rating required to accommodate common mode voltages and prevent insulation failure.

4. Horsepower nameplate rating of motor, at the 1.0 service factor, shall be equal to or greater than the total horsepower requirement of the pump when operating at any head between maximum and minimum specified operating heads as specified herein**,** including power requirements for bowl assembly, column and line shaft bearing loss, and motor thrust bearing loss from pump load. Motor shall have a service factor of 1.15 and shall be designed and manufactured in accordance with applicable provisions of the latest NEMA Standard Publication for Motors and Generators, MG-1 Part 20, subject to modifications and additions as herein set forth.

5. The locked rotor torque and breakdown torque shall not be less than shown in NEMA MG-1 20.10.

6. The locked rotor KVA/HP shall not exceed NEMA code Letter **[G]**, **[6.29]** KVA/HP.

7. Motor shall have a sound power level of no more than 85 dBA average at 1-meter (3.3 ft) distance when measured per IEEE Std. 85 “Test Procedure for Airborne Measurements on Rotating Electrical Machinery.”

8. Rotor shall be precision balanced to within an amplitude, peak to peak, in accordance with the requirement of NEMA MG-1.

9. Rotor bars and end rings shall be **[copper] [aluminum]** or copper alloy (no substitution). The rotor bars shall be swaged. The end rings shall be joined to the rotor bars by high frequency induction brazing. The rotor cores shall be held together by through-bolts and end plates.

10. The stator shall have all connections brazed with silver brazing alloy. The stator shall be braced and supported to eliminate any detrimental winding movement.

11. Motor shall be rated at 460 volts, 3 phase, 60 Hertz.

12. Motor efficiency shall not be less than **[95]** percent and (uncorrected) power factor not less than **[85]** percent when operating at maximum speed, full load, and rated voltage and frequency.

Note to Specifier: Include only one of the two subparagraphs below.

13. Motors shall be capable of bringing the pumps up to speed with a closed **[control] [check]** valve and 80 percent of rated voltage.

14. Motors shall be capable of bringing the pumps up to speed with valve at 5 percent open.

15. The motor leads shall have the same insulation level as the motor.

16. Motors shall be painted in the factory with two coats of manufacturer's standard exterior enamel. Furnish touch-up paint for the Contractor's use. Motor color shall be selected by the Owner.

17. Motor shall be rated for VFD use.

B. Enclosure: Motor enclosure shall be **[Totally-Enclosed Fan Cooled (TEFC)]** as indicated in pumping conditions schedule and in accordance with NEMA MG-1. **[Motor to be suitable for an outdoor environment.]**

C. Insulation:

1. Motor windings shall be full Class F insulated. After stator assembly, the stator assembly shall be sealed vacuum-pressure impregnation (VPI) of epoxy resin. The stator shall receive two VPI treatments, each treatment consisting of a dip followed by an oven bake. After the final cure, the stator assembly shall receive a final (third) coating of a durable epoxy varnish to further protect against dust, moisture, and chemical degradation. The windings shall comply with the latest applicable provisions of NEMA MG 1, and end winding coils shall be braced to limit displacement to no more than 5.0 mils under any condition of starting or running.

2. Motor shall operate continuously at rated voltage and frequency (6 to 60 Hz) at 50 deg. C ambient temperature, with a temperature rise not to exceed both.

    i. A Class B rise (70 deg. C), per NEMA MG-1 20.8 measured by resistance at a 1.0 service factor when operating at 100 percent of the nameplate rated horsepower.

    ii. **[And a Class B rise (80 deg. C) per NEMA MG-1 20.8 measured by embedded resistance temperature detector (RTD) at a 1.0 service factor when operating at 100 percent of the nameplate rated horsepower.]**

3. Insulation shall be capable of preventing failure as a result of common mode voltages.

D. Bearings:

1. Motor bearings shall be designed for the maximum load imposed by the pump and motor and shall be selected for a 5-year minimum life and a 25-year average life as defined by the AFBMA. Bearings shall be insulated as necessary to prevent shaft-bearing-frame current. Insulating means shall also be provided for any oil-supply connections and monitoring equipment to prevent electrical bypassing of the bearing insulation.

E. Motor Terminal Box:

1. Motor terminal box shall be suitable for terminations without exceeding the minimum bending radius of the conductors per the National Electrical Code.

Note to Specifier: Delete the subparagraph below item if not required.

2. Motor terminal box shall be oversized to accept the following without exceeding the minimum bending radius of the conductors per the National Electrical Code:

    i. **[Specify]** sets of **[specify]** per phase, **[specify]** ground conductor (**[specify**]-inch conduits).

3. **[Motor terminal box shall be NEMA Type II with motor leads landing on three-phase, insulated bus drilled with NEMA 2-hole pads to terminate the feeder cables. Direct cable-to-cable connections shall not be permitted.]** Motor terminal box shall be located in the **[F1] [F2] [F3]** position. Bottom and front of box shall be removable. Motor terminal box shall receive motor cables from the **[bottom]**. Terminal box shall be adequately insulated to prevent excessive vibration.

4. Terminal box size, position, and layout shall be submitted to the Owner's representative for review and approval.

Note to Specifier: Edit the subparagraph below to align with design considerations for 1) Motor space heaters, 2) RTD's or thermal switches, and 3) Vibration monitoring system. NBU prefers to use thermal switches. For motors 300HP and greater, RTD's are the preferred choice for temperature monitoring. If Engineer recommends vibration monitoring, the Engineer must coordinate with NBU on the type of system and how monitored/controlled and used in pump controls.

F. Accessories Terminal Boxes:

1. Motor shall have accessory leads from [space heaters], [RTDs] and [vibration sensors] terminated in separate boxes. Leads for [space heaters], [RTDs], and [vibration sensors] shall be terminated on [600V NEMA rated] barrier type terminals with stainless steel screws. [Leads from vibration sensors shall be terminated on vibration switch terminals.] [Leads for bearing and winding RTDs shall be brought to the same box.] Leads shall be suitably marked and identified with heat shrink markers. Accessories terminal boxes shall be located in the [F1] [F2] [F3] position. Accessories boxes shall have phenolic nameplates, black and white letters, attached with stainless steel screws. The nameplates shall say ["SPACE HEATER"], ["WINDING & BEARING RTDs"], ["VIBRATION SENSORS"], etc. Accessories boxes shall be bottom [or side entry] and shall be supported by the motor.

2. Terminal boxes shall have provisions for terminating the following conduits:

    i. **[RTD Terminal Box: One 1-1/2-inch conduit.]**

    ii. **[Space Heater Box: One 1-inch conduit.]**

    iii. **[Vibration Sensors: One 1-1/2-inch conduit and One-1-inch conduit.]**

3. **[RTD terminals shall be clearly labeled with nameplate/wire tag identifying which Bearing RTD- Drive End/ Non-Drive End and which Winding RTD- Phase A/B/C they are associated with.]**

G. Grounding Means: Provide a grounding lug threaded into the motor frame within the motor terminal box and other motor conduit boxes. Lug shall be similar and equal to Burndy KC Servit and suitable for terminating **[#X]** ground wire. Provide **[one] [two]** NEMA 2-hole ground pads located near the base of the motor mounted 180 degrees apart. Ground pads shall be stainless steel and suitable for terminating **[#X]** ground conductor.

H. Appurtenances:

1. All wires and electrical connections shall be copper. All wiring penetrating motor frame shall be protected against chaffing with a rubber grommet.

Note to Specifier: Edit the subparagraphs below to align with NBU requirements. NBU prefers for the Motor Space Heater (MSH) to be powered from the motor controller. For renovation projects (existing site) coordinate with NBU for exact source for MSH circuit.

2. Space Heaters: Motor shall be equipped with space heaters for operation on 120-volt, 60-Hertz, single-phase power. They shall maintain the internal temperature above dew point when motor is not operating. Space heaters shall not be located directly in the access holes where they may pose a danger of burn or shock to servicemen. Space heater wiring shall be routed to prevent wire being between the frame and space heater.

Note to Specifier: Use one of the following two paragraphs. For motors 300HP and greater, RTD's are the preferred choice for temperature monitoring.

3. Temperature Monitors: Motors shall be equipped with six 100-ohm platinum RTDs, two per phase, spaced around the motor windings and located at the hot spots of the stator. In addition, each bearing shall have a 100-ohm platinum RTD installed for sensing bearing temperature.] [RTDs for bearings shall be integral to the bearing housing.

4. [Thermal switches: Motors to be equipped with bi-metallic, snap action, temperature actuated switches on the end turns of each phase of the windings. Thermostats to be **[normally open contacts wired in parallel]** and be wired to a set of terminals for customer's use.

Note to Specifier: If Engineer recommends vibration monitoring, the Engineer must coordinate with NBU on the type of system and how monitored/controlled and used in pump controls.

5. **[Vibration sensors/switches: (add description here).]**

6. All appurtenance boxes shall be laid out to avoid overlap and access limitation to the boxes. Appurtenance boxes shall be secured with stainless steel.

7. Conduits:

    i. Liquid tight flexible metal conduit shall be Anaconda Sealtite, Type HTUA by Anamet Electrical, or equal. Fittings used with liquid tight flexible metal conduit shall be of the screw-in type with insulated throat by Thomas & Betts Co.; no equals.

    ii. Rigid aluminum conduit, couplings, factory elbows, and fittings shall be 6063 alloy by Allied Tube & Conduit Co. or approved equal. Conduit hubs shall be insulated throat by Crouse-Hinds.

    iii. Liquid tight strain relief cord and cable connectors shall be Series LS by Crouse-Hinds or approved equal.

    iv. Design neat layout of conduit from **[vibration sensors] [and] [bearing RTDs]** to the accessory terminal boxes. Submit a detailed layout drawing to the Owner's representative for review.

    v. All conduits and wire shall be routed and installed in an identical fashion for like motors.

    vi. Minimum conduit size shall be 3/4 inch.

8. Mounting Hardware: All mounting hardware including but not limited to strut channels, clamps, etc. shall be 316 stainless steel.

Note to Specifier: Edit the subparagraphs below to align with associated pump/motor supporting hardware, such as bearings, vibration monitoring system, temperature monitoring, etc..

I. Documentation: Motor manufacturer shall supply documentation for the motors as follows:

1. Complete dimensional data including the following:

    i. Dimensional outline drawings.

    ii. Maintenance clearances.

    iii. locations and sizes of lubrication connections, vents, drains, etc.

2. Data Sheet: Fill out and submit with the Shop Drawing submittal the information requested on the Motor Submittal Data Sheet (Attachment B) for each size motor being provided.

3. Complete nameplate data.

4. Letter of Compatibility: The pump/motor supplier in conjunction with the VFD supplier shall issue a letter of compatibility stating that the VFD and motor are compatible.

5. Allowable time periods between starts.
6. Subtransient reactance and X/R.
7. Speed-torque curve at 100 percent and 80 percent of rated voltage.
8. Speed-current curve at 100 percent and 80 percent of rated voltage.
9. Acceleration time at 100 percent and 80 percent of rated voltage.
10. Thermal damage curve (I2t).
11. Locked rotor withstand time.
12. Rotor inertia.
13. Schematic and interconnection diagrams.
14. Bearing descriptions.
15. Motor weights.
16. **[Alarm and Trip temperatures for winding and bearing RTDs.]**
17. **[Alarm and shutdown values (in./sec.) for vibration sensors (X and Y axis).]**
18. Detailed conduit layout for motor.
19. Cutsheets on terminal blocks used in accessories terminal boxes.
20. Dimensions (internal and external) and layouts of terminal box and accessories terminal boxes. For main motor terminal box, clearly show the distance from the bottom of the enclosure to the termination lugs. Indicate all dimensions in inches. Final dimension and location are subject to approval by the Engineer.
21. Motor insulation voltage rating.
22. Measured locked rotor current and torque and locked rotor power factor.
23. Motor no load data (i.e., amps, power factor, etc.).
24. Maximum kVAR allowed for power factor correction. Maximum kVAR shall be included on motor nameplate as well.
25. Locked rotor power factor.
26. Instruction manual.
27. Bill of Materials with manufacturer's cut sheets for all major equipment, **[RTD's],** bearings, **[vibration sensors and transducers],** terminal blocks, etc. Clearly identify on cut sheets the exact model number of equipment being provided.
28. Results of motor tests.
29. All documentation listed above shall be supplied with the motor's initial submittal with the exception of the motor test results and instruction manual which shall be furnished later in the Project. Incomplete submittals will be returned "NOT APPROVED - REVISE AND RESUBMIT."

514.11 Spare Parts

Review spare parts closely with NBU.

A. Provide spare parts **[for each size of pump]** as follows:

1. Provide the Owner with a sufficient quantity of lubricant for required service during the first **[12]** months after startup.
2. One complete set of pump bearings.
3. One complete set of casing wear rings.
4. One complete set of Impeller wear rings.
5. One complete set of shaft sleeves.
6. One complete set of gaskets.
7. One complete set of mechanical seals.
8. One complete stuffing box assembly.

514.12 Construction Methods

A. General

1. Equipment Manufacturer's representative, including motor manufacturer, have responsibilities in the installation and field testing of the equipment as described in this Section. Installation of equipment shall be performed by the Contractor who shall be required to assemble the equipment and install it in accordance with installation, operation and maintenance instructions which shall be furnished by the Equipment Manufacturer, the installation Drawings for this Project and applicable installation instructions of the Hydraulic Institute Standards.
2. Contractor shall schedule the service of the Equipment Manufacturer to assist in the assembly installation, lubrication, adjustment, testing and acceptance of the equipment.
3. Contractor shall furnish all labor, tools, equipment and machinery necessary to receive, inspect, unload, store, protect, and install completely, in proper operating condition, the equipment. Contractor shall protect and store the motors indoors and as recommended by the manufacturer, keeping bearings lubricated and the motor space heaters energized during storage and until they are put into service.
4. Contractor shall also furnish such incidental items not supplied with the equipment, but which may or may not be described in the Drawings and Specifications, for complete installation, such as welding, drain lines, gaskets, flange bolts for suction and discharge piping, connecting piping, wiring, conduit, ducts, mounting brackets, anchors and other appurtenances as necessary.
5. Certain items of equipment due to its size or character will be disassembled for shipping and shall be assembled by the Contractor as it is installed. It is the

Contractor's responsibility, in establishing their costs for installation, to determine the degree of disassembly that the equipment will be shipped in.

6. Contractor shall make the power, control, and instrumentation connections at points designated by the Equipment Manufacturer.

B. Field Quality Control

1. General:

i. Equipment Manufacturer shall inspect and determine that the pump and motor base has been installed correctly and field verified to the recommended tolerance prior to installation of the pump. This determination shall be made prior to grouting with the base properly welded or shimmed. Before placing the grout, scarify the adjoining concrete and pour a non-shrink grout. After properly curing, remove the temporary wedges or shims and hand pack voids with grout. Then torque the anchor bolts to the appropriate values. A second inspection shall be made after the base has been completely grouted in place, but prior to installation of the pump.

ii. Contractor shall use a Class II non-shrink grout with a minimum 7000 psi compressive strength at 28 days. Contractor shall provide a submittal on the proposed grouting procedure and grout products to be used.

iii. Calibrated testing equipment shall be provided by the Equipment Manufacturer to measure setting, alignment, speed, noise, temperature, pressure, and vibration of the pump.

2. Preliminary Operational Test:

i. After the pumps have been installed, including all piping connections, and electrical system construction is complete, and after the piping has been tested, the Contractor, with assistance from the Equipment Manufacturer, shall perform preliminary operational tests over a period of not less than **[two 10-hour tests or one 24-hour test]**. The test shall be conducted in a manner approved by and in the presence of the Owner's representative. Equipment shall be checked for excessive noise, alignment, vibration and lateral deflection, general performance, etc.

ii. The pumping units shall be operated throughout its full range of operating heads, if possible, **[and at pump speeds from maximum speed to minimum speed,]** recording data including suction pressure, pump discharge pressure, pump speed, flow rates, water levels, motor voltage and current, power factor, vibration, noise, deflection, pump and motor bearing temperatures, and motor winding temperatures, as applicable. This information shall be properly documented and included in the Equipment Installation Report. The unit must perform in a manner acceptable to the Owner and Engineer before Final Acceptance of the installation will be made.

iii. Vibration shall be no greater than the "Acceptable Field Vibration Limits" as defined by the Hydraulic Institute Standards and as modified by this Section above. Vibration shall be measured in the x, y, and z direction on

the outboard pump bearing and motor bearing. Vibration shall be measured in the x and y direction of the inboard pump and motor bearings.

iv. **[Vibration data shall be recorded for variable speed pumps within the specified operating speed range at increments of 5 percent from minimum speed to full speed. Actual pump rotational speed shall also be recorded with each vibration data set.]**

v. Equipment Manufacturer shall furnish calibrated testing devices to measure setting, alignment, speed, noise, and vibration of the pump. Vibration data shall be recorded with a Vibscanner as manufactured by Pruftechnik or approved equal. Equipment Manufacturer shall supply calibrated pressure gauges on suction and discharge of pump for use during testing.

vi. The Contractor and Equipment Manufacturer shall be responsible for operating the equipment and recording and submitting the necessary data from the test. All information required above shall be properly documented and included in the Equipment Installation Report. The units must perform in a manner acceptable to the Owner and Engineer prior before Final Acceptance of the installation will be made.

vii. Equipment Manufacturer shall submit an Equipment Installation Report to the Contractor certifying that the equipment is properly installed, lubricated, is in accurate alignment and is free from undue stress from connecting appurtenances, that it has been operated under full load conditions and that it is operating satisfactorily. Contractor shall provide copies of the report.

viii. The cost of power required for the test shall be borne by the Contractor**.**

3. System Operational Test:

i. After the preliminary operational test is complete and prior to final acceptance of the Project, the Contractor shall conduct a 30-day system operational test. Owner will be responsible for operating the equipment and recording data during this test. The Equipment Manufacturer, Contractor, and any subcontractors will be responsible for troubleshooting and adjustments to the equipment during the test. **[The purpose of the test is to demonstrate and check the ability of the pump to operate continuously as the system requires.] [The 30-day test is not required to achieve Substantial Completion.]**

ii. The cost of power for the System Operation Test shall be borne by the Contractor.

C. Painting:

1. Touch-up all damage of painting of the pumping unit with extra paint furnished by the manufacturer.

514.13 Measurement

All types Horizontal Split-Case pumps will be measured per each.

514.14 Payment

A. Contractor shall submit Applications for Payment filled out and signed by Contractor and accompanied by such supporting documentation as is required by the Procurement Documents and also as the Owner's representative may reasonably require. The first Application for Payment will be submitted to the Owner after review and acceptance by Owner's representative of all Shop Drawings, Product Data, and Samples required by the Procurement Documents. The Application for Payment will be limited to 5 percent of the total contract amount.

Milestone	Cumulative % of Contract Price
Approval of Shop Drawings & Product Data	5%
[Delivery of pre-installation materials to the Project Site (templates, anchor bolts)]	**[Invoice value as materials on hand]**
Approval of factory performance tests (pump and motor), Delivery of equipment to job site in good condition and approved Preliminary Operation and Maintenance Manuals	80%
Installation, Testing, Completion of Installation reports, submittal of final Operation and Maintenance Manuals, Completion of special services	95%
Final acceptance of the installed and tested equipment, approved Final Operation and Maintenance Manuals, completed Owner personnel training and other required information	100%

B. The next Application for Payment will be submitted after review and acceptance of the preliminary operation and maintenance manuals by the Engineer, satisfactory completion of all factory tests, and after delivery of the Goods has been accepted by the Buyer, and will be accompanied by a bill of sale, a Certification of Acceptable Delivery, Unloading, and Storage signed by the Contractor and other documentation satisfactory to the Buyer warranting that the Goods are delivered free and clear of all liens, charges, security interests, and encumbrances. Such documentation shall include releases and waivers from all parties who, during Vendor's performance under the Procurement Documents, might have obtained or filed any such lien, charge, security, or encumbrance. The Application for Payment will be limited to 80 percent cumulative of the total contract amount. Portions of this amount may be paid in monthly pay estimates following partial deliveries proportionate to the amount of

Goods delivered provided an itemized Schedule of Values has been submitted and approved.

C. The next Application for Payment will be submitted after completion of equipment installation, testing, completion of the specified Installation Report, submittal of the final operation and maintenance manuals, and completion of Special Services. The Application for Payment will be limited to 95 percent cumulative of the total contract amount.

D. Final payment will be submitted after final acceptance of the pump and motors following the 30-day satisfactory operational test.

Pay Item: _____ Pump, _____gpm _____ hp Per Each

END

ITEM NO. 514 "HORIZONTAL SPLIT-CASE PUMPS" – ATTACHMENT A SUBMITTAL PUMP DATA SHEET

Equipment Supplier: _____

Submit the following data for each size of Pumping Unit:

Pump Data	Tag:
Make and Type Design	
Full Speed	
Speed at Rated Point No. 1	
Speed at Rated Point No. 2	
Impeller Diam. vs. Max. Impeller Diam. for Bowls	
Impeller Material	
Suction and Discharge Flange Sizes	
Shutoff Head	
Max. Allowable Operating Head at 100% Speed	
Min. Allowable Operating Head at 100% Speed	
Impeller Specific Speed	
Maximum Backspin Speed	
Suction Specific Speed	
Maximum Brake Horsepower	
NPSH Required at Rated Head	
NPSH Required at Minimum Head	
Wire-to-Water Efficiency at Rated Point No. 1	
Wire-to-Water Efficiency at Rated Point No. 2	
Rotor polar moment of inertia WR^2 or equivalent WR^2, as viewed from the pump end for the driver, coupling, pump and enclosed fluid as applicable.	
Weights	
Pump	
Base Plate for Pump and Motor	
Motor	
Complete Unit Including Base Plate	
Set Points, If Applicable	
Pump Bearing RTD Alarm and Trip Set Point	
Pump Bearing Vibration Alarm and Trip Set Point	

THIS FORM MUST BE RETURNED WITH THE SHOP DRAWING

END – ATTACHMENT A

ITEM NO. 514 "HORIZONTAL SPLIT-CASE PUMPS"
ATTACHMENT B SUBMITTAL MOTOR DATA SHEET

Submit the following data for each size and type of motor:

Manufacturer		Motor HP	
Frame		Enclosure	
Type		RPM	
Voltage		Phase	
Starting Method		Hertz	
Shaft Size		Rotor WK2 (lb-ft^2)	
Insulation Class		Duty	
Full Load Amps		No Load Amps	
Locked Rotor Amps		Locked Rotor Torque	
Locked Rotor Torque		% Breakdown Torque	
Locked Rotor KVA/HP			

NEMA Design	
Service Factor	
Inrush Current (% of Full Load)	
Max Safe Stalled Time (seconds)	
Number of Safe Starts Per Day	
Number of Consecutive Starts	
*Full Load Temp Rise, in Degree Celsius over 50 deg. C Ambient (at 1.0 S.F.)	
*Service Factor Temp Rise, in Degree Celsius over 50 deg. C Ambient (at 1.15 S.F.)	
*Limiting Temperature Rise	

Resistance (at 25 deg. C)		Bearings:	
Exhaust Air (CFM)		Type/Size	
Exhaust Air Temp Rise (F)		Life	
		Lubrication	

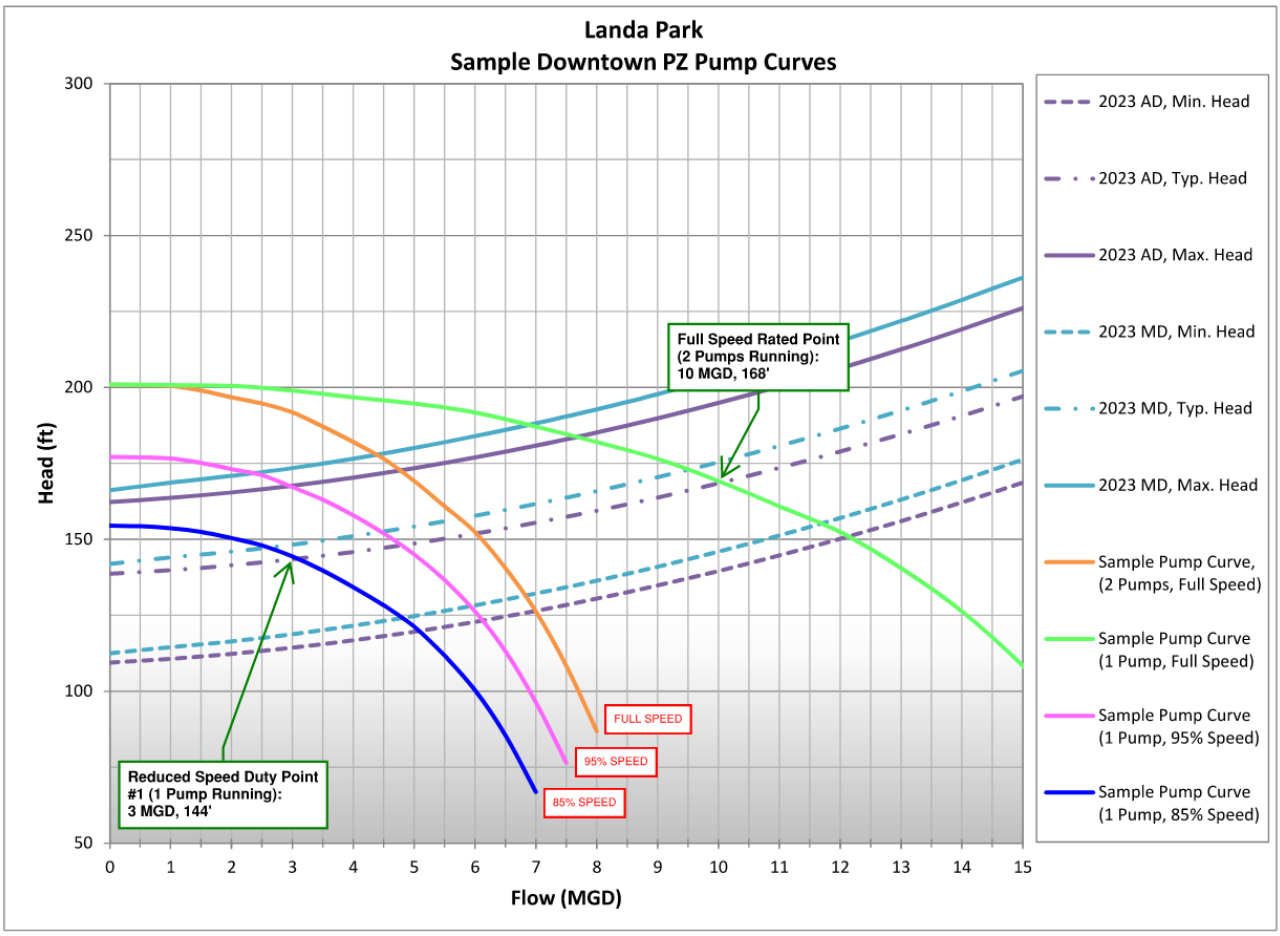
	Efficiency	Power Factor	Current
1.15 S.F. Load			
4/4 Load			
3/4 Load			
1/2 Load			
1/4 Load			

Vibration Alarm and Trip Set Points	
RTD Types and Mounting	
RTD (Winding & Bearing) Trip Set Points	
Motor Sound Power Level	
Maximum kVAR Allowed for power factor correction without overexciting the motor	
Space Heater Voltage	
Space Heater Wattage	

THIS FORM MUST BE RETURNED WITH THE SHOP DRAWING

END – ATTACHMENT B

ITEM NO. 514 "HORIZONTAL SPLIT-CASE PUMPS" – ATTACHMENT C
SYSTEM AND PUMP CURVE



END – ATTACHMENT C