SECTION 4000 − LIFT STATIONS

LIFT STATIONS

PART 1 − GENERAL

1.01 Section Summary

A. Contractor shall provide all labor, equipment, and materials necessary to construct a lift (pump) station in accordance with these Specifications, Project Plans and manufacturer's recommendations.

B. The specifications shall govern all work necessary to furnish, install and place into operation a lift station, including all appurtenances required to complete the Work. This section includes but may not be limited to electric submersible non-clog pumps to be supplied with motor, close coupled volute, cast iron discharge elbow guide bars and brackets, Power cable, wet well and valve vault installation and all accessories, control panels and all appurtenances, including feeds lines, conduits, and conductors. Pumps shall be UL listed for Class 1 Div. 1, group C and D hazardous locations.

1.02 Related Sections

A. Section 600 − Project Testing Requirements

B. Section 900 − Submittal Procedures

C. Section 1000 − Quality Requirements

D. Section 1300 − Product Requirements

E. Section 1400 − Operations and Maintenance Manuals

F. Section 1800 − Excavation and Embankment

G. Section 2000 − Trench Excavation and Backfill

1.03 References

A. Publications listed below form part of this Specification to extent referenced in the text by basic designation only. The latest edition of publication governs unless otherwise noted.

1. ANSI - American National Standards Institute

2. AWWA - American Water Works Association Standards

3. ASTM - American Society for Testing and Materials

4. IEC − International Electrotechnical Commission

5. IEEE - Institute of Electrical and Electronics Engineers

6. NFPA − National Fire Protection Association

   a. NFPA 70 − National Electrical Code (NEC) 2008.

7. NDDOT − North Dakota Department of Transportation "Standard Specifications for Road and Bridge Construction" 1024 Edition, as revised

8. NEC - National Electric Code

9. NEMA - National Electrical Manufacturers Association

   a. NEMA ICS-@ - Industrial Control Devices, Controllers and Assemblies.

   b. NEMA 250 − Enclosures for Electrical Equipment.

10. Hydraulic Institute Standard for Centrifugal, Rotary and Reciprocating Pumps.

11. UL − Underwriters Laboratories, Inc.

    a. UL-698A − Industrial Control Panels Relating to Hazardous Locations with Intrinsically Safe Circuit Extensions.

1.04 Quality Assurance

A. Testing.

1. Test the installed pumps in the presence of the Engineer and Owner to demonstrate the proper operation at the design criteria specified herein. Test records shall be retained by the manufacturer and be made available to the Owner in accordance with the Section 900 of the City of Minot Standard Specifications and as outlined herein.

B. The pumps shall be essentially the standard products of a manufacturer who has been regularly engaged in the successful production of high-quality equipment of this type for at least ten years and shall be manufactured in a facility with ISO 9001:2008 certification.

C. All equipment furnished under this section shall be from a single supplier which shall assume full responsibilities for system operation regardless of manufacturer.

D. Provide factory-trained manufacturer's representative to supervise start-up and testing of pumping units and controls.

E. Equipment Warranty

1. All pumping equipment shall carry an extended warranty period of two years from the date of acceptance. Additionally, the manufacturer of the pumps shall warrant the pump and motor to be free from defects in materials and workmanship for an extended five-year prorated warranty from the date of shipment shall be provided against defects in material and workmanship.

1.05 Submittals

A. Submit in accordance with Section 900, 1300 and 1400 for shop drawings and applicable Operations and Maintenance Manuals for the lift station demonstrating compliance with these Specifications including:

1. Manufacturer's literature, illustrations, specifications, and engineering data defining materials of construction, dimensions, weights and pump and motor performance.

2. Complete electrical schematics and dimensional drawings.

3. Parts list, including a list of recommended spare parts and maintenance tools.

4. Submit certified curves for approval.

B. Furnish manufacturer's installation certificate in accordance with Section 1300.

C. Furnish operation and maintenance data in accordance with Section 1400.

D. In addition to the requirement of Sections 900, 1300 and 1400 of the City of Minot Standard Specifications, the Contractor shall submit the following prior to final closeout of the Project:

1. Certified final factory test report shall be provided to Owner, certifying the unit’s full power rating, stability, voltage and frequency regulation.

2. Three (3) sets of complete pump and generator O&M manuals with part list.

3. Three (3) sets of catalog cuts and wiring diagrams for approval.

4. Three (3) sets of impeller and design information (pump curves).

5. Three (3) sets of factory performance test results for each pump.

6. Three (3) sets of Control Panel O&M manuals.

7. Reports showing that all manufacturer recommended maintenance has been performed on the pumps since delivery was taken.

1.06 Delivery, Storage and Handling

A. Deliver, store and handle all pumping equipment and controls in accordance with the General and Supplementary Conditions and the manufacturer's recommendations.

PART 2 − PRODUCTS

2.01 Submersible Pumps

A. General

1. All hardware including but not limited to bolts and nuts shall be Type 316 stainless steel.

2. Type 316 stainless steel anchor bolts shall be furnished and sized in accordance with manufacturer's recommendations.

3. Each pump shall be furnished with a stainless-steel data plate securely attached to the unit. Data plates shall contain the manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head rating and other pertinent data.

4. Paint pumps and motors in accordance with manufacturer's recommendations. Submersible pumps shall be of the centrifugal non-clog type, and shall be complete with a self-cooled and contained submersible electric motor as hereafter specified, base elbow, stainless steel pump rails, stainless steel chain, and all other items necessary for a complete installation. The pumps shall be designed to run continuously with their motors entirely submerged.

5. The pumps installed in the lift station shall be installed as shown on the Plans. These pumps will be of a type suitable for a submersible application, shall be design for either raw wastewater or storm water depending on the application, shall have a minimum discharge diameter of 4 inches. Shall be able to pass 3-inch diameter solids. Shall be rated 480 volts, three phase, 60 Hz service.

6. Manufacturer:

a. The submersible pumps shall be the product of ABS, Fairbanks Morse, Xylem-Flygt or as explicitly specified otherwise or approved equal.

B. Non-clog Submersible Pumps

1. Pump Design

a. The pump(s) shall be automatically and firmly connected to the discharge connection, guided by no less than two guide bars extending from the top of the station to the discharge connection. There shall be no need for personnel to enter the wet-well. Sealing of the pumping unit to the discharge connection shall be accomplished by a machined metal to metal watertight contact. Sealing of the discharge interface with a diaphragm, O-ring or profile gasket will not be acceptable. No portion of the pump shall bear directly on the sump floor.

2. Impeller

a. Impeller shall be of the statically and dynamically balanced non-clogging type matched to its constant velocity equalizing pressure with smooth fluids passage to prevent clogging of stringy, fibrous material or other matter found in normal sewage applications. Impeller shall be made of close-grained cast iron conforming to ASTM A48 Class 30. Unless specified otherwise, the impeller shall be of one-piece construction, single suction, enclosed, recessed vortex type, two-vane, radial flow design with well-rounded leading vanes and then tapered toward the trailing edge for a circular flow pattern to prevent the accumulation of solids and stringy material.

b. If specified, based on the application type, Grinder type impellers shall be multi-vane, semi-open with replaceable cutting heads.

c. The clearance between the impeller outside diameter and cutwater shall be capable of passing a 3-inch solid sphere.

d. The impeller is to be dynamically balanced and secured to the shaft by means of a bolt, washer, and key. The arrangement shall be such that the impeller cannot be loosened from torque in either forward or reverse rotation.

e. Wiper vanes on the back impeller shroud are not allowed.

f. Impeller shall be trimmed to specifically meet the conditions of operation.

3. Volute/Casing

a. Volute is to be cast made of close-grained cast iron conforming to ASTM A48, Class 30. It is to be one-piece, constant velocity equalizing pressure with smooth fluid passages large enough to pass any size solid that can pass through the impeller.

b. The volute shall have an integral tapered suction inlet area to direct flow to the impeller eye and have a centerline-flanged discharge. Volute discharge shall be minimum 4″ diameter as measured on the inside diameter of the discharge flange opening.

c. A sliding bracket assembly shall be a part of the pumping unit constructed so that when lowered to the discharge base/elbow, the knifing action of the vertical metal-to-metal seal provides a self-cleaning, non-clogging, non-sparking UL Listed explosion-proof assembly.

4. Wear Rings

a. Except for recessed vortex type impellers, replaceable wear rings shall be fitted to provide efficient sealing between the volute and the impeller. Wear rings shall be provided on both the impeller and front head so that clearances can be maintained throughout the life of the rings and minimize recirculation.

b. Impeller wear rings shall be of the axial- or face-type.

c. Front head wear rings shall be of the axial- or face-type.

d. Wear rings shall be attached to the impeller and front head using an interference fit and Loctite.

e. Wear rings shall be 400 series stainless steel, with a minimum hardness of 300 BHN.

f. Wear ring clearance adjustment shall be attained through impeller adjustment shims.

5. Guide Rail/Bracket

a. Two rails with guide shoes shall be provided to guide the pump assembly when being raised or lowered in the sump. The shoes shall be designed to make contact with the discharge elbow allowing the pump discharge flange to properly engage the discharge elbow providing a leak-tight joint. Single rail or cable guide systems are not acceptable.

b. The rails shall align the pump with the discharge elbow as it is lowered into place.

c. A stainless steel upper rail guide bracket shall be furnished to support and align the rails at the top of the sump. For all rail lengths greater than 20 feet, a stainless steel intermediate rail guide bracket shall be included.

6. Chain and Cable

a. 316 stainless steel chain and cable shall be used to lift the pump/motor assembly from the wet well. The upper end forms a closed loop that attaches to a winch cable and also can be hung up on a rope bracket when not in use. Provide adequate length to reach bracket plus 7 feet. The entire lifting assembly shall be comprised of overhead rated materials with a documented working load rating of 125% of the pump and power cable weight.

7. Discharge Base

a. The installation shall include a rigid discharge base-elbow to support the total weight of the pumping unit. The discharge Elbow shall be made of close grain cast iron ASTM A48, Class 30.

b. The pump shall automatically connect to the discharge elbow when lowered in place.

c. The base is to be bolted directly to the floor with the 90-degree elbow having a 125 lb. ANSI flange discharging vertically.

C. Motor

1. Pump(s) shall be driven by completely sealed, electric submersible squirrel cage induction motors with a minimum 1.15 service factor, 480 volts, 3 phase, 60 Hertz. The motor shall be non-overloading throughout the pump operating range. The motor shall be suitable for constant speed/variable speed service.

2. Submersible equipment shall be UL Listed for Class I, Division 1, Groups C and D explosion-proof hazardous locations as defined by the National Electric Code. All electrical parts shall be housed in an air-filled cast iron, watertight enclosure which is sealed by the use of O-rings and rabbeted joints with extra-large overlaps.

3. The stator winding and lead shall be insulated with moisture-resistant Class F insulation for continuous duty in 105^{O} F ambient.

The motor shall be designed for continuous duty capable of ten (1) starts per hour. Automatic reset, normally closed thermal overloads shall be imbedded in the motor windings to provide overheating protection. Motor winding thermostats must be connected to an electric controller per local and state codes and the National Electric Code.

4. Motor shaft shall be one-piece, 416 stainless steel. Carbon steel shafts or shaft sleeves are not acceptable. Rotor is to be dynamically balanced to meet NEMA vibration limits; all external hardware is to be stainless steel.

5. Cable leads are to enter at the top of the motor, and are to allow the cable-to-motor connection to be accomplished in the field without soldering. All power and control lead wires are to be double sealed s it enters the motor in such a manner that cable-wicking will not occur. This sealing system shall consist of a rubber grommet followed by epoxy that is high in adhesive qualities and has a low coefficient of expansion. Each cable wire is to have a small section of insulation removed to establish a window area of bare wire and each wire is to be untwisted and surrounded by epoxy potting material. A cable strain relief mechanism shall be an integral part of this sealing system. Cable sealing system shall be capable of withstanding an external pressure test of 1200 PSI as well as a cable assembly pull test as required by Underwriters Laboratories. Singular grommet or other similar sealing systems are not acceptable. Motor shall be supplied with 30 feet, minimum (unless specified otherwise) of multi-conductor type "SOW-A" or "W" power cable and control cable. Cable sizing shall conform to NEC specifications and be UL Listed.

6. Power and control leads shall be terminated on a sealed terminal board. The terminal board and its bronze lugs shall be O-ring sealed.

7. Each pump shall have a Type 316 stainless steel plate permanently attached by stainless steel screws or rivets to the pump frame into which the following information shall be impressed, engraved or embossed: manufacturer's name, pump size, serial number, impeller diameter, capacity, head rating, speed, and bearing numbers. Nameplates shall also include information unique to each item of equipment and device to identify its function as described herein. Function nameplates shall be approximately one inch by 3 inches if made separately. Letters of function titles shall be not smaller than 1/4-inch high.

8. Protective coatings for exposed ferrous metal surfaces shall be standard epoxy coating systems of the manufacture for severe duty unless specified otherwise.

D. Shaft Seal Arrangement

1. Pump(s) shall be provided with two separate tandem-mounted mechanical seals to prevent the pumped liquid from entering the rotor/stator cavity area to ensure reliability of operation. The upper and lower seals are mounted to rotate in the same direction.

2. The lower mechanical seal mating surfaces are to be immersed in an oil bath, sealing the pump volute chamber from the oil cavity. Oil in this cavity shall also lubricate the upper mechanical seal faces. Seal faces of both the upper and lower mechanical seals shall be held in contact by independent polymeric elastomer bellows, which act as a spring mechanism. Seals require neither maintenance nor adjustment, but shall be easily inspected and replaced. Pressure generated by the pump assists in sealing the mating surfaces of the lower seal.

3. Component material for the upper seal shall consist of a composite elastomer body, carbon steel snap ring, Buna-N O-ring, carbon rotating face and ceramic stationary face. Lower seal component construction shall include a composite elastomer body, stainless steel clamp and set screws, Buna-N O-ring, silicon carbide rotating face and tungsten carbide stationary face.

4. Two moisture detection probes shall be installed so that they will detect moisture in either the seal or stator cavity measuring resistivity between the probes. They shall be wired internally to the control cable connection at the top of the motor. Float type devices located in the rotor/stator area or single probe-to-ground moisture detectors measuring continuity are not acceptable. O-ring sealed inspection plugs shall be provided in the mechanical seal oil chamber for ease of inspection, draining and filling of oil.

5. The pump shall rotate on a grease lubricated-for-life thrust bearing and grease lubricated radial bearing with a minimum L10 life of 50,000 hours. Lower shaft bearings shall be locked in place to prevent shaft movement and to take thrust loads.

E. Guide and Removal System

1. System shall be designed for pump removal and installation to permit routine maintenance and repair of pumps. Pump supplier/manufacturer shall furnish a reliable, operable system and shall provide technical assistance for installation. Contractor shall

demonstrate the use of the system for each pump by removing and reinstalling each pump with the wet well dry. After start-up of pumps, Contractor shall again remove and reinstall each pump then operate pumps again to demonstrate proper installation. The removal system shall be suitable for lifting the pumps with a crane utilizing a stainless steel cable that will be attached to the pump motor lifting bail assembly. The complete guide and removal system shall be furnished with the pumps.

2. The guide and removal system shall consist of a foot mounted discharge elbow, no less than two 316 stainless steel guide rails, upper rail support bracket, and intermediate rail guide brackets for each pump. Each pumping unit shall be provided with an integral sliding guide bracket. All guide and removal system components, except pump discharge elbow and pump sliding guide bracket, shall be constructed of 316 stainless steel, or better. The pump guide and removal system shall be non-sparking.

F. Fits and Hardware

1. All machined bolts, nuts, and caps crews shall be stainless steel and be of the hex-head type and will not require the use of any special tools.

2. A heavy-duty stainless-steel lifting bail shall be included and be of adequate strength to lift the entire pump and motor assembly.

G. Spare Parts

1. Contractor shall furnish spare parts for each pumping unit. Spare parts shall be as specified herein or as recommended by the manufacturer, shall be undamaged and packaged in original containers, and supplied to the District at time of final acceptance of the work. Contractor shall furnish the following spare parts:

a. Two spare sets of cable entry grommets and O-rings.

b. Two spare sets of mechanical seals.

c. Two spare impellers.

H. Factory Testing

1. A certified factory performance test shall be performed on each pumping unit in accordance with Hydraulic Institute Standards, latest edition. Certified test results shall be submitted to the City of Minot for approval prior to shipping.

2. Pump curves shall reflect data secured during actual test runs and shall be signed by a responsible representative of the pump manufacturer. Test reports and procedures shall conform to applicable requirements of the Hydraulic Institute Standards, except for testing tolerances for the design condition with one pump operating as shown on the pumping unit performance on the Construction Drawings. Testing tolerance for the design condition shall be +5%-0% for the total dynamic head at the discharge capacity. All other pumping unit performance conditions shall be within the limits shown on the Construction Drawings.

3. Tests shall be sufficient to determine the curves of head, input horsepower, and efficiency relative to capacity from shutoff to 150% of design flow. A minimum of six points, including shutoff, shall be taken for each test. At least one point of the six shall be taken as near as possible to each specified condition.

2.02 Wetwell, Valve Vaults and Equipment

A. Wet wells and valve vaults shall conform to the requirements of precast manholes in Section 2300 of the Minot Standard Specifications, including the lining system for corrosion protection. Base sections shall be designed in accordance with soil boring logs.

B. Equipment Access Hatches

1. Furnish and install a single or double leaf equipment access hatch with safety grates and integral cable troughs as shown on the Plans or specified otherwise. The top of the access hatch shall be flush with the top slab of the concrete wet well or valve vault roof. The minimum clear hatch opening dimensions shall be as shown on the Plans or specified otherwise. The access hatch shall be pre-assembled from the manufacturer. The manufacturer shall warranty that the assembled access hatch shall be free of defects in material and workmanship for a period of (5) years from date of project acceptance. The access hatch shall be as manufactured by Xylem-Flygt, Bilco Halliday or equal.

2. The access hatch covers, frame, cable trough, components, and hardware shall be constructed of 316 stainless steel. Hatch covers shall be 3/16" (minimum) thickness with a diamond pattern. Safety grates shall be provided beneath the hatch covers for fall through protection when the covers are open. The hatch covers and safety grates shall be reinforced to support a minimum live load of 300 psf with a maximum deflection of 1/150th of the span. Each safety grate shall be provided with a permanent hinging system that will lock the grates in the 90-degree position once opened. Safety grate hinges shall be specifically designed for horizontal installation and shall be

through bolted to the safety grate with tamperproof stainless steel lock bolts and shall be through bolted to the equipment access hatch frame with stainless steel bolts and locknuts. Safety grate openings shall be 5" by 5" to allow for visual inspection of the wet well or valve vault while the grating is in place. The hatch frame shall be angle type and shall be provided with full anchor flange around the perimeter.

3. Each cover leaf shall be provided with a lift handle that remains flush with the cover when not in use. A removable exterior turn/lift handle with slam lock shall be provided to open the top leaf. The latch release shall be protected by a flush, gasketed, removable screw plug. The top leaf shall also be provided with a recessed padlock clip and cover box. Each cover leaf shall be equipped with a hold open arm, which automatically locks the covers in the open position. The pump access covers for the wet wells shall consist of access covers installed and positioned.

C. Float Switches (Qty. 4)

1. Polypropylene with encapsulated mechanical tilt (non-mercury) switch.

2. Contact rating: 3 amps, 120 VAC, resistive.

3. Operating differential: 1 inch, nominal.

4. Extra flexible cord in length as required for application.

5. All floats shall be weighted.

6. Float Switches shall be manufactured by Roto, Xylem-Flygt or approved equal.

D. Float Weight Kit

1. For high flow situations, provide 8 lb. vinyl coated cast iron boat anchor for securing the floats in the wet well.

2. Anchor shall be secured by a 3/32-inch stainless steel support cable.

3. Floats and transducer shall be attached to the support cable.

4. Use all stainless steel clamps and fittings.

5. See contract drawings for details.

E. Submersible Transducer

1. Submersible style transducer with welded 316 stainless steel construction.

2. IP68 and NEMA 6P housing protection rating.

3. Minimum 0.5% accuracy over entire range of wet well.

4. $^{5}/_{8}$-inch nylon braded rope.

5. Provided appropriate zener style UL listed barrier with transducer to certify the use transducer in a Class 1, Division 1 area.

6. Transducer shall be a 2-wire/loop powered device which gets its power from the control panel and provides a 4-20 mA signal proportionate to the level of the wet well.

7. Transducer range shall be picked in accordance with the wet well requirements.

F. Vent Pipe

1. Vent pipe and all associated hardware shall be stainless steel, type 304 min.

2. Vent opening shall include an insect screen.

G. Floor Drain

1. Body shall be coated cast iron with integral gas-tight trap, side outlet, seepage pan, and backwater valve, Zurn Z450B-V.

2. Vent opening shall include an insect screen.

H. Grating

1. Grating, if present, shall be fiberglass pultruded composite with vinyl ester resin coating.

2. Platform systems, if present, shall be designed by a professional engineer licensed in North Dakota.

2.03 Piping and Valves

A. Check valves

1. Check valves shall have a minimum working pressure of 250 psi working pressure conform to AWWA C508, shall be resilient seated, flanged, bronze disc ring and seat ring, neoprene faced, weight and lever, cushioned swing operated type valves. The cushion chamber shall be attached to the side of the valve body externally and so constructed with a piston operating in a chamber that will effectively permit the valve to be operated without any hammering action. The shock absorption shall be by air, and the cushion chamber shall be so arranged that the closing speed will be adjustable to meet the

service requirements. All hardware shall be stainless steel. All surfaces shall conform to AWWA C116 and C550 for fusion-bonded epoxy coatings. All valves shall have a mechanical indicator.

B. Gate Valves

1. Gate valves shall be 250 psi working pressure, ductile iron body, bronze mounted, resilient seat type, with O-rings seals. Valves shall conform to AWWA C515 and shall be suitable for wastewater applications. Shall have standard 2-inch operating nut. All hardware shall be stainless steel. Gate Valves shall have mechanical joint ends conforming to AWWA C111 and A21.11. All surfaces shall conform to AWWA C116 and C550 for fusion-bonded epoxy coatings.

C. Piping

1. Piping shall be of the diameter as shown on the Plans. All pipe shall conform to Section 2100 of the Minot Standard Specifications.

D. Fittings

1. All pipe fittings shall be ductile iron conforming to Section 2100 of the Minot Standard Specifications.

E. Each discharge line shall be equipped with a tapped fitting, petcock, and a 4" glycerin filled pressure gauge reading in feet, with the range and scale appropriate for the application. The gauge shall read in the center of the range during normal operations.

F. Air release valves shall conform to AWWA C512 and be suitable for wastewater applications. Size and location shall be as indicated on the Plans. All hardware shall be stainless steel. All surfaces shall conform to AWWA C116 and C550 for fusion-bonded epoxy coatings. Air Release Valves shall be as manufactured by Val-Matic, Model VMC-48 for severe service wastewater applications, or approved equal.

G. If indicated or shown on the Plans, two emergency signs shall be attached to gate or fence in a location which is readily visible from the street. The sign shall be constructed from 1/8th inch aluminum and be bolted on the gate. All lettering shall be block style in black on a white reflective background. One sign shall contain the emergency phone information and the other shall contain the street address of the facility. Size and wording shall be as indicated on the drawings. Facility number and address shall be provided by The City of Minot Department of Public Works.

2.04 Controls

A. General

1. It is the intent of the Contract Documents that all equipment specified in this section of the specification be supplied by a single-source supplier ("Controls Supplier") except as specifically indicated. Unless specifically indicated, the Controls Supplier shall assume full responsibility for furnishing, installing and field commissioning procedures so as to make the system operate per the intent of the contract documents.

2. Except as specifically indicated, the work specified in this Section includes furnishing, installing, start-up, testing and adjusting of all required equipment, including instruments, equipment, hardware, software, wiring, accessory equipment, and training.

3. It shall be the responsibility of the Controls Supplier to furnish complete and fully operating lift station control panels that automatically operate the respective lift stations on a stand-alone basis. The control panels will be shipped telemetry ready, but all SCADA programming, configuration, and field commissioning will be by others. The Controls Supplier shall be responsible for all details which may be necessary to properly install, adjust and place the control panels in stand-alone operation.

B. Quality Assurance

1. The Controls Supplier, as a business entity, shall have a minimum of 5 years' experience in systems integration related to water and waste water control systems. Controls Suppliers without the required minimum experience as a business entity shall not be allowed to substitute experience of individuals in lieu of the required business experience.

2. The Controls Supplier shall maintain a $1,000,000 product liability insurance policy.

    a. The Control Supplier must maintain and operate a panel shop with both UL-508A and UL-698A labels.

    b. The Controls Supplier shall have PLC programmers and field service personnel who are permanent, full time employees.

3. The Control Supplier shall have at least 5 references who are owners of successful, Allen Bradley based PLC control panels, provided by the Controls Supplier.

4. Contractor shall provide data supporting their compliance to the above items within 48 hours, upon request from the OWNER or ENGINEER.

C. Lift Station Control Panel(s)

1. The control panel shall be constructed in accordance with Underwriters Laboratories (UL) Standard 698A - "*Industrial Control Panels for Hazardous Locations*". In addition to intrinsically safe circuitry the 698A standard requires that the control panel comply with applicable portions of UL Standard 913 - "*Intrinsically-Safe Apparatus and Associated Apparatus for use in Class I, II and III, Division 1, Hazardous Locations*" and UL standard 508a – "*Industrial Control Panels*". The panel(s) shall be shop-inspected by UL, or constructed in a UL-recognized facility. Each completed panel shall bear a serialized UL label indicating acceptance under Standards 698A, 913, and 508A.

2. Enclosures

    a. NEMA 3R tamper resistant polished stainless steel, 2 door enclosure with minimum dimensions of 48″ H x 60″ W x 18″ D. The enclosure shall contain an interior sub-panel for mounting all control components and the enclosure shall be sufficiently large to accept all control components without crowding. The panel shall be of not less than 12-gauge type 316 stainless steel with continuously welded seams. The enclosure shall contain door and panel stiffeners as required. The front doors shall have a rolled lip and the door flanged and the corners ground smooth. All enclosure welding seams shall also be ground smooth.

    b. The doors shall be fastened to the enclosure with a continuous type stainless steel piano hinge and locking three-point minimum, stainless steel hardware. The inside of the door shall contain data pockets. The sub-panel shall be painted white.

    c. Enclosure shall have full-height dead-front inner 12-gauge carbon steel hinged doors that house all front-panel components including switches, indicating lights, running time meters, overload reset pushbuttons, and other controls that require operator access.

    d. Circuit breakers that cannot be mounted directly to the inner door shall be elevated from sub-panel such that their operators are exposed through cut-outs on the inner door. The use of lever operators with extension shafts is prohibited.

    e. The enclosure shall have a thermostatically-controlled climate control system to prevent overheating as well as condensation and freezing within the enclosure, consisting of a heater, intake/exhaust fans, and/or air-conditioning equipment. The system shall maintain the temperature within

the enclosure at levels within the equipment manufacturer's recommended ranges.

f. Insulated with ½" cell foam insulation. Insulation shall be mechanically secured.

g. 18-inch stainless steel floor stands, with stainless steel louvered skirts.

3. Service Entrance

a. Each lift station control panel shall be service entrance rated.

b. Provide mechanically interlocked Normal and Emergency Service circuit breakers. Size these breakers per the one-line diagrams included in the plan set.

c. Acceptable manufacturers for circuit breakers include: Allen Bradley or Cutler Hammer or approved equal.

4. Generator Receptacle

a. Each lift station control panel shall be equipped with a generator receptacle for emergency power. Generator Receptacle shall be Appleton ADR20044.

5. Full Voltage Motor Starters

a. Starters shall be NEMA rated. The Controls Supplier shall size the motor starters as required, per the requirements of the pump supplier.

b. Provide external ambient compensated class 10 overload relays with bi-metallic heater elements. Overload relay shall be reset via push button on the inner door. Overload relays shall be NEMA rated and shall be sized to protect the motors. The Controls Supplier shall size the overloads as required, per the requirements of the pump supplier.

c. Provide branch protection MCP style, magnetic trip only, breakers with adjustable trip. Use a UL listed combination motor controller per NEC 430.52. C.6. Size MCP such that instantaneous trip value is a maximum of 1300 percent of full-load current.

d. Insure that the MCP style branch protection for each starter has a combination listed short circuit rating of at least 35 KAIC. Use the combination interrupt rating to properly calculate the control panels short circuit rating per UL508A supplement B.

e. All motor starters shall be 480 volts, 3 phase, 60 Hz.

f. Acceptable full voltage motor starter manufacturers include: Allen Bradley, Cutler Hammer or approved equal.

6. Relays shall be of the plug-in type with associated sockets and retaining clips. The relays shall have dust covers. All contacts shall be rated for not less than 10 amps at 120 VAC. Relays shall have either 2 or 3 poles. Relays shall be as manufactured by Cutler-Hammer, Allen Bradley, Idec, or equal.

7. All circuit breakers shall be UL labeled and shall be of the size shown on plans. All circuit breakers ahead of the transformer shall have an interrupting rating of not less than 35,000 amps, sym. Circuit breakers after the transformer shall have an interrupting rating of not less than 10,000 amps, sym.

8. The control panel shall have an interrupt rating of not less than 35 KAIC. Use the UL508A supplement SB analytical method to determine the short-circuit current rating of the control panel. Insure that lowest component SCCR or overcurrent protective device interrupt rating for devices downstream of the transformer is 2KA or greater so that the transformer's primary overcurrent device (fuse) interrupt rating can be applied to the entire transformer circuit.

9. The panel shall be equipped with an interior convenience receptacle that is accessible on the front of the inner door. This receptacle shall be a 15 amp, UL-listed ground fault interrupter.

10. All field wiring shall be terminated on terminal blocks. Each terminal shall be of the flat head screw type. The contacts shall be capable of carrying 10 amps at 600 VAC. The contacts shall be large enough to accept up to and including No. 12 AWG wire.

11. Number all terminals and tag all conductors on both ends to correlate with the schematic drawings. All conductor tags shall be computer printed shrink style. Brady or equal.

12. Surge Arrestors

    a. Panel shall include a surge protector for all incoming phases. Surge suppressor shall be TVSS type, UL1449 second edition. Square D or equal.

    b. Control circuit shall include a surge protector as indicated on drawings. UL 1449 recognized, with diagnostic indicator. Edco or equal.

13. Phase Monitors

a. Panel shall include a 3-phase power monitor for monitoring incoming 3 phase power. Phase monitor shall be Time Mark C2644 or equal.

b. Control circuit shall include phase failure protection as indicated on drawings. PLC shall also monitor phase failure contact.

14. Indicating Lights

a. 30 mm, opaque colored lens.

b. Heavy-duty, oil-tight.

c. Push-to-test.

d. Provide the following lights on the inner door: Add additional lights, etc. if more than 2 pumps.

i. Pump 1 Run (Green)

ii. Pump 2 Run (Green)

iii. Pump 1 Thermal Fail (Red)

iv. Pump 2 Thermal Fail (Red)

v. Pump 1 Seal Fail (Red)

vi. Pump 2 Seal Fail (Red)

vii. Pump 1 Fail (Red) – based upon contact from overload relay.

viii. Pump 2 Fail (Red) – based upon contact from overload relay.

ix. Wet well High Level (Red)

x. Wet well Low Level (Red)

xi. Float Mode Active (Red)

e. Indicator Lights shall be Cutler-Hammer Type T, Allen Bradley Bulletin 800T, Idec TWTD series, or equal.

15. Inner Door Mounted Switches and Push Buttons

a. 30 mm, Heavy-duty, oil-tight.

b. Pump 1 Hand-Off-Auto.

c. Pump 2 Hand-Off-Auto.

d. Pump 1 Overload Reset (Mounted on swing door in front of overload relay. Provide rod extension kit that extends from swing door to reset push button on the overload relay.)

e. Pump 2 Overload Reset (Mounted on swing door in front of overload relay. Provide rod extension kit that extends from swing door to reset push button on the overload relay.)

f. Lamp Test.

g. Reset Backup Mode.

h. Pump 1 Overtemp Reset.

i. Pump 2 Overtemp Reset.

j. Acknowledge Alarms.

k. Lead-Lag Selector Switch. (3 position: 1-2, 2-1, Auto)

l. Switches and push buttons shall be Cutler-Hammer Type T, Allen Bradley Bulletin 800T, or Square D Class 9001 units, Idec TWTD series, or equal.

16. Uninterruptible Power Supply (UPS)

a. The UPS shall continuously sustain operation of the control panel's PLC, transducer, floats and telemetry in the event of a power failure.

b. 120 VAC, 60 Hz, single phase input and output.

c. Minimum 900 VA capacity.

d. The control panel shall implement a control relay logic circuit that allows the UPS to be removed from the control panel and automatically provides the controls with bypass power. Additionally, this relay logic circuit shall provide a contact closure to the PLC that indicates a UPS failure.

e. Manufacturer shall be Eaton or approved equal.

17. Elapsed Time Meters

a. Provide Qty. 3 (Pump 1 Run, Pump 2 Run, Pump 1&2 Run) add for additional pumps.

b. Six digit, hours and tenths.

c. Non-resettable.

d. Round, flush mounted.

e. Redington Model 722 or approved equal.

18. Enclosure Heater

a. Manufactured unit with metal housing with integrated fan and integral thermostat and 0 − 1000OF adjustable range.

b. UL labeled.

c. 200 Watt.

d. Hoffman "Design-Aire", or equal.

19. Alarm Beacon

a. Weatherproof, vandal-proof unit with red polycarbonate globe and 120VAC lamp.

b. Suitable for top mounting on panel.

c. UL labeled.

d. Edwards Model 104FLEDR or equal.

20. Intrinsically-Safe Barriers

a. Provide UL listed isolated switch style barriers for the float signals.

21. Programmable Logic Controller

a. Used for telemetry and for transducer control of the lift station pumps.

b. Allen Bradley Micrologix 1400 1766-L32AWA with memory module. Select base unit and expansion I/O modules based upon I/O count.

c. In Addition to I/O count provide the following spare I/O:

i. Qty. 3 spare digital inputs.

ii. Qty. 2 spare digital outputs.

iii. Qty. 2 spare analog inputs.

22. PLC I/O Count

a. Controls Supplier responsible for programming and testing all PLC I/O.

b. Digital Inputs (May need to be adjusted for more than 2 pumps).

i. Pump 1 Run

ii. Pump 1 Seal Fail

iii. Pump 1 Thermal Fail

iv. Pump 1 Failure (based upon motor starter overload relay)

v. Pump 2 Run

vi. Pump 2 Seal Fail

vii. Pump 2 Thermal Fail

viii. Pump 2 Failure (based upon motor starter overload relay)

ix. Control Power Failure

x. UPS Failure

xi. Enclosure High Temperature Alarm

xii. Enclosure Low Temperature Alarm

xiii. Alarm Acknowledge

xiv. Lead-Lag Selector Switch in 1-2

xv. Lead-Lag Selector Switch in 2-1

xvi. Wet well Low Level Float

xvii. Wet well Stop All Pumps Float

xviii. Wet well Start Lead Pump Float

xix. Wet well Start Lag Pump Float

xx. Wet well High Level Float

xxi. Float Mode Active

xxii. Phase Failure (where applicable)

c. Digital Outputs

i. Pump 1 Start/Stop

ii. Pump 2 Start/Stop

iii. Wet well Low Level Alarm Light

iv. Wet well High Level Alarm Light

v. Pump 1 Thermal Fail Alarm Light

vi. Pump 2 Thermal Fail Alarm Light

vii. Pump 1 Seal Fail Alarm Light

viii. Pump 2 Seal Fail Alarm Light

ix. Pump 1 Failure Alarm Light

x. Pump 2 Failure Alarm

d. Analog Inputs

i. Pump Motor Current Transducer

23. Operator Interface

a. Mounted on inner panel door. Used for alarm viewing, wet well monitoring, data viewing (ex. pump motor current), and set point changes.

b. Provide an LCD Based 6″ Grayscale touch screen display, Allen Bradley Panel view or Automation Direct C-more.

24. Alarm Thermostat

a. Provide a High and Low temperature alarm thermostats for the enclosure.

b. Stego or equal.

25. Pump Motor Current Monitoring

a. Provide fixed core current transducer for monitoring pump motor current.

b. Provide a separate power distribution block such that the current transducer measures the current going to the motor starters only. Current transducer shall be located upstream of the motor starters.

c. Current transducer shall incorporate true RMS technology and be accurate on distorted waveforms such as VFD or SCR outputs and be accurate under noisy power conditions.

d. Current transducer shall have a 4-20 mA output and will be wired into an analog input on the PLC.

e. The operator interface shall be programmed to allow the operator to view the pump(s) current.

f. Current transducer shall be sized to accommodate the expected full load amps of both pumps running simultaneously.

g. Provide Acuamp ACTR or approved equal.

26. Power Supplies

a. UL Listed

b. Switching style with 2% maximum point-to-point ripple voltage.

c. Overcurrent protection with automatic reset. Overvoltage protection with 120% minimum shutdown.

d. Environmental: Operating temperature of 14ºF to +140ºF, 20-90% relative humidity (non-condensing nonfreezing)

e. Din Rail mountable, with 10% voltage adjustment on front.

f. Idec PS5R or equal.

27. Use Engraved-Plastic Labels, white letters on black background, to label all components on the inside panel door.

D. SCADA Provisions

1. The controls supplier shall equip the control panel with the specified components to allow the control panel to be integrated into the City's existing telemetry system. The controls supplier shall provide all necessary equipment for radio communication. Controls supplier shall coordinate with City to determine which mode of communication equipment needed tp communicate with the City SCADA system. Power to communication equipment shall be wired such that it is UPS backed.

2. All SCADA programming, SCADA startup, and SCADA configuration will be provided by Owner.

PART 3 - EXECUTION

3.01 Installation

A. The Contractor shall install all equipment and appurtenances in strict accordance with the manufacturer's specifications and installation instructions. Care shall be used in handling to avoid bumping, twisting, dropping, or otherwise damaging the equipment. When code requirements apply to installation of materials and equipment, the more stringent requirements, code, or manufacturer's specifications and installation instructions shall govern the work.

All pump manufacturers shall furnish the services of factory-trained personnel as required to examine the installation, supervise start-up of equipment installed, and repair the equipment at no additional expense to the City.

B. Contractor shall verify all dimensions and conditions at the site and cross check details and dimensions shown on the Plans with related requirements on the Civil, Mechanical, and Electrical Drawings and Equipment Shop Drawings. Floor and wall openings, sleeves, variations in the structural slab elevations and other civil, mechanical, or electrical requirements must be coordinated before the contractor proceeds with construction.

C. The precise dimensions and locations of all openings shall be determined from structural, civil, mechanical, electrical, or similar requirements for the actual equipment being furnished. Shop Drawings with adequate accurate dimensions must be submitted and reviewed prior to contractor constructing facilities including concrete, wall, connecting piping or electrical that are affected by said equipment.

D. The contractor is advised that the work on this project may involve working in a confined air space. Contractor shall be responsible for all confined air space entry and exit safety procedures and protocols.

E. Contractor shall clean inside of all new pipelines by flushing after successful passing of pressure testing.

3.02 Coordination

A. The Plans show the general arrangements desired for the principal equipment, piping, and similar appurtenances, and shall be followed as closely as possible. Proper judgment must be exercised in carrying out the work to secure the best possible headroom and space conditions throughout, to secure neat arrangement of piping, valves, fixtures, hangers, and similar appurtenances, and to overcome local difficulties and interferences of structural conditions wherever encountered.

B. The Contractor shall take all measurements for his work at the installation sites, verify all subcontractor drawings and be responsible for the proper installation, within the available space for the equipment and material specified and shown on the Plans, and must secure the approval of the City for any variations before making any changes.

3.03 Inspection

A. Inspect each item of equipment for damage, defects, completeness, and correct operation before installing. Inspect previously installed related work and verify that it is ready for installation of the equipment.

3.04 Preparation

A. Prior to installing equipment, ensure that installation areas are clean and that concrete or masonry operations are completed. Maintain the areas in a broom-clean condition during installation operations. Clean, condition, and service equipment in accordance with the reviewed Instruction manuals and requirements in other Sections of these Specifications before installing.

3.05 Workmanship

A. Preparation, handling, and installation shall be in accordance with manufacturer's written instructions and technical data particular to the product specified and/or approved, except as otherwise specified.

B. Work shall be furnished and placed in coordination and cooperation with other trades.

C. Electrical work shall conform to the National Electrical Contractors Association Standard of Installation for general installation practice.

3.06 Grading and Site Work

A. Unless specified otherwise on the Plans, all grading and site work shall be per City Standard Details, Specification Sections 1200, 1800 and 2000 and as specified hereinafter.

B. Site grading shall be performed in accordance with contract documents, soils report, and grading requirements of the City of Minot, including any special requirements of any applicable permits. An approved copy of the site/grading plan shall be on site while work is in progress.

C. Excavated soils may be utilized for selected fill material provided these materials are free of vegetative matter and other deleterious substances and shall not contain rocks or irreducible materials with a maximum dimension greater than 6 inches. The final surfaces shall be wheel rolled to a smooth, well compacted surface at both subgrade and at finished grade.

D. Selected backfill material around proposed wet well shall be placed in layers which, when compacted, shall not exceed 6 inches in thickness. Each layer shall be spread, moistened, and compacted uniformly to insure all backfill is properly compacted. After each layer of backfill has been placed, mixed, and spread evenly, it shall be thoroughly compacted to a minimum relative compaction of 95 percent.

3.07 Equipment Installation

A. Structural Fabrications

1. Conform to the AISC Code and Specifications.

B. Equipment

1. Conform to reviewed Instruction Manuals. Employ skilled craftsmen experienced in installation of the types of equipment specified. Use specialized tools and equipment, such as precision machinist levels, dial indicators, gauges, and micrometers, as applicable. Produce acceptable installations free of vibration or other defects.

C. Anchor Bolts

1. Deliver bolts with templates or setting drawings and verify that bolts are correctly located before structural concrete is placed.

D. Base and Bedplate Grouting

1. Do not place grout until initial fitting and alignment of connected piping is completed. Level and align equipment on the concrete foundations, then entirely fill the space under base or bedplates with grout. Grout shall be non-metallic non-shrink type. Bevel exposed grout at 45-degree angle, except round exposed grout at horizontal surfaces for drainage. Trowel or point exposed grout to a smooth dense finish and damp cure with burlap for three days. When grout is fully hardened, remove jacking screws and tighten nuts on anchor bolts. Check the installation for alignment and level, and perform approved corrective work as required to conform to the tolerances given in the applicable Instruction Manual.

3.08 Conduit Installation

A. General

1. Contractor shall install conduit and electrical equipment in locations that will cause minimal interference with the maintenance and removal of mechanical equipment. Conduits and connections will be installed as shown on the Plans or directed otherwise. Contractor shall run conduit in a neat manner parallel or perpendicular to walls

and slabs, and wherever possible, installed together in parallel runs. All conduits shall be installed straight and true with reference to the adjacent work.

2. Locations of conduit runs shall be planned in advance of the installation and coordinated with the mechanical work in the same areas, and shall not unnecessarily cross other conduits or pipe, nor prevent removal of nor block access to mechanical or electrical equipment.

3. Unless noted otherwise on the Plans, buried conduit shall be installed with a minimum of 27 inches of cover. Buried conduit shall be marked with red marking tape 6 inches below the finished grade above the center of the conduit installed. Conduit trench backfill shall be compacted to a minimum of 90 percent relative compaction.

   Buried conduit shall be installed using approved spacers and cradles, properly supported/anchored and at sufficient intervals to prevent movement during backfilling operations (maximum spacing of five feet). Where change in direction is required, long radius PVC-coated Rigid Galvanized Steel elbows shall be installed for GF, PF, and MSF conduits. Prior to installation of conductors in underground conduits, a testing mandrel not less than six (6) inches long and with a diameter 1/4 inch less than the conduit diameter shall be drawn through after which a stiff bristle brush of the proper size for the conduits shall be drawn through until the conduits are free of all sand and gravel. Test shall be accomplished prior to placing concrete.

4. Unless noted otherwise on the Plans, conduit cast in concrete, under concrete slabs or footings, or through concrete walls, slabs, or masonry walls shall be PVC coated Rigid Galvanized Steel. Conduits shall be installed beneath concrete slabs, footings, or trenches, and shall be provided with a minimum of 6 inches of clearance between conduit and bottom of concrete. Conduits shall be cast in concrete only where specifically shown on the Plans or directed by the Engineer.

5. Buried conduit shall be PVC Schedule 40 Rigid Non-Metallic. Transition from PVC to PVC-coated Rigid Galvanized Steel shall be made at the horizontal leg of the buried conduit bend.

6. Exposed or above grade conduit shall be PVC-coated Rigid Galvanized Steel.

7. Spare conduits shall be flush with the top of concrete slab or wall, and be provided with threaded cap and polyethylene pull rope with 100-pound (minimum) tensile strength.

8. All conduits shall be tightly sealed during construction by use of conduit plugs. All conduit in which moisture or any foreign matter has collected before pulling conductors shall be cleaned and dried to the satisfaction of the City.

9. Conduits shall be securely fastened to cabinets, boxes, and gutters using locknuts (one inside and one outside enclosure) and an insulating bushing or specified insulated connectors. Grounding bushings or bonding jumpers shall be installed on all conduits terminating at concentric knockouts.

10. Where conduit is stubbed up through concrete slabs or footings into electrical panels, provide a minimum of 1-1/2-inch clearance between rebar and conduit and a minimum of 1-inch clearance between conduits. Adjust rebar spacing as necessary to a maximum of 1/2 the nominal spacing such that maximum rebar spacing does not exceed 1-1/2 times that specified. The total amount of reinforcing steel shall not be reduced.

11. Conduits shall terminate within the respective panel section, or in adjacent section if additional space is required. Contractor shall adjust location of conduit terminations based on the approved panel layout.

12. Underground pull boxes shall be sized and located as shown on the Plans. Additional pull boxes shall be provided as necessary for conductor pulling (total bends between pull boxes shall not exceed 360°). Depending upon the duct bank configuration and pull box knockout area, larger size pull boxes may be necessary. Cost of additional or larger pull boxes shall be borne by Contractor. Pull boxes shall in accordance with Minot City Standards.

13. Contractor shall furnish and install conduit and conductors as shown on the Plans, as shown on the control diagrams, and as listed on the appropriate Approved Shop Drawing Schedules relating to conduits and conductors.

B. Identification

1. Each end of a conduit shall be provided with an identification tag securely attached to its conduit with a #10 single-jack brass chain or brass fasteners. Each tag shall be provided with a hole for securing tag with chain or fasteners.

C. Rigid Non-Metallic Conduit

1. Unless noted otherwise on the Plans, PVC conduit shall be used underground. PVC conduits shall not be run exposed. Risers to

exposed or above grade locations shall be PVC-coated Rigid Galvanized Steel.

D. PVC-Coated Rigid Galvanized Steel Conduit

1. Threadless couplings will not be acceptable. Where necessary for connecting conduit, UL listed PVC-coated couplings shall be used. All ends and joints shall be reamed smooth after cutting.

E. Supports

1. Exposed conduit shall be supported with channel supports spaced per NEC requirements (8'-0" maximum spacing) and within 18 inches of couplings, bends, boxes, etc., unless specifically shown otherwise on the Plans.

F. Termination and Joints

1. Raceways shall be joined using specified couplings or transition couplings where dissimilar raceway systems are joined.

2. Conduit terminations exposed at weatherproof enclosures and cast outlet boxes shall be made watertight using approved connectors and hubs.

3. Conduit bodies (condulets) are not acceptable as enclosures for splices.

4. At all conduit terminations and boxes, conductors shall be protected by a fitting equipped with a plastic bushing having a smoothly rounded insulating surface.

3.09 Conductor and Cable Installation

A. General

1. Conductors shall not be installed in conduit runs until all work is completed for each individual conduit run. Care shall be taken in pulling conductors such that insulation is not damaged. UL approved pulling compounds shall be used.

2. Unless noted otherwise on the Plans, all conductors or cables shall be installed in conduit or electrical enclosures.

3. All cables shall be installed and tested in accordance with manufacturer's requirements and warranty.

4. All field wiring to control panel(s) shall terminate at terminal strips in the respective panels and buckets.

5. Contractor is advised that interconnecting wiring within and between lineups (assembled panels with common interconnecting horizontal wire ways) of control panels is not specifically listed or shown on the Plans. Contractor is directed to control diagrams and RTU connection diagrams on the Plans for these connections, which are subject to change according to approved shop drawings. Contractor shall install wiring for said connections within the bottom wire way of panels.

6. No splices unless specifically approved by the City.

B. Identification

1. All branch-circuits shall be securely tagged, noting the purpose of each.

2. All conductors shall be numbered and labeled with vinyl wrap-around markers. Where more than two conductors run through a single outlet, each conductor shall be marked with the corresponding circuit number at the panel board.

3. Conductors size #6 AWG and larger shall be color coded using specified phase color markers and identification tags.

4. All terminal strips shall have each individual terminal identified with specified vinyl markers.

5. Inside of all junction box cover plates shall be identified via felt-tip pen or decal label, denoting the panel and circuit numbers and voltage contained in the box.

6. All receptacles and switches shall be decal labeled on the plate, denoting the panel and circuit number.

C. Connections to Circuit Breakers, Switches, and Terminal Strips; Stranded Copper Conductors

1. #12 through 8 AWG: Conductor shall be terminated in locking tongue style, pressure type, compression lugs, unless clamp type connection for stranded conductor is provided with device.

2. #6 AWG and larger: Conductor shall be terminated in one-hole flat-tongue style, compression type lugs, or by connectors supplied by the manufacturer.

D. Grounding

1. Enclosures of equipment, raceways and fixtures shall be permanently and effectively grounded. A code-sized, copper, insulated green equipment ground shall be provided for all branch circuit and feeder runs. Equipment ground shall originate at panel board ground bus

and shall be bonded to all switch and receptacle boxes and electrical equipment enclosures. Ground terminals on receptacles shall be connected to the equipment grounding conductor by an insulated copper conductor.

E. Status, Alarm, and Control Signal (IO)

1. Status, alarm, and control signal (IO) conductors to and from the RTU terminal strips shall be identified at both ends using labeling designations as approved by the City of Minot.

F. Level Control System

1. Interconnecting cable between transducer and controller shall be supplied with unit, and shall be suitable for a maximum system length of 200 feet. Contractor shall verify length of cable required for each specific installation. Cable shall be installed in a single run with no splices. Cable shall be installed in continuously grounded PVC-coated Rigid Galvanized Steel conduit. Conduit shall be installed a minimum of 8 feet from 480V conduits.

3.10 Electrical Short Circuit Coordination and Arc Flash

A. Contractor shall field verify adjustment of all trip setting with the approved Coordination Study and shall provide arc flash and shock hazard warning labels.

3.11 Concrete Construction

A. All concrete construction shall be in accordance with the appropriate City of Minot Specifications and NDDOT Specification Sections for footings, foundations, subgrade slabs, slabs on grade and suspended slabs.

1. All concrete work shall have a minimum 28-day compressive strength of 4000 psi.

3.12 Pipe Installation

A. All pipe bedding and trench backfill shall be per the City of Minot Standard Detail Plates.

B. Pipe shall be installed in trench condition and as shown on the Standard Detail Plates or as specified otherwise. Backfill shall be completed including compaction tests prior to pressure testing. Backfill in pipe zone shall be compacted to minimum 95 percent compaction of Standard Proctor Test (T-99).

3.13 Pipe Testing

A. All piping shall be hydrostatically tested per City Standards. Unless specified otherwise, piping shall be tested under a pressure 1-1/2 times the design operating pressure of the pipe. Testing against valves is not permitted. Contractor shall provide temporary bulkheads, skillets, and appurtenances as required for testing. All piping under concrete slabs/foundations shall pass pressure testing prior to placing concrete. No visible leakage is permitted in exposed piping.

3.14 Description of Operation

A. Control System Description (2-Pump System)

1. Control the pumps based on the wet well level using a four-float system. As the level increases and reaches the start lead float the PLC shall start the lead pump. If the level continues to increase and reaches the start lag float the PLC shall start the lag pump. When the level decreases and reaches the stop pump float the PLC shall stop all of the pumps.

2. A pump alternator selector switch shall be mounted on the inner door. When the switch is in 'AUTO' the pumps shall alternate the lead position after every cycle. When the switch is in the '1-2' position, pump 1 will always be the lead pump and pump 2 will always be the lag pump. When the switch is in the '2-1' position, pump 2 will always be the lead pump and pump 1 will always be the lag pump.

3. The station's high-level float is set at an elevation above the elevations used for normal control of the pumps and a low-level float is set at an elevation below the elevations used for normal control of the pumps. The floats are used for alarming purposes and to provide a backup control mode of the pumps which is entirely independent of the PLC.

4. Provide the required emergency control circuitry to back up the primary controls. If the wet well level increases and reaches the high-level float in the wet well, override the primary controls and start pump 1 followed by pump 2 after an adjustable time delay. Pump 2 is only started if the time delay expires before the low-level float is reached. A time delay shall be implemented for the high-level float alarm. The high-level float alarm time delay shall be adjustable and set such that the station can run in backup mode (between the high and low float) and not generate a high float alarm every time the backup mode cycles between the floats.

5. The backup control mode shall be latched and a door mounted reset push button shall be provided to allow the system to return back to normal operation. A door mounted pilot light shall illuminate when backup mode is active. The backup mode shall be designed such that

the PLC is entirely isolated from controlling the pumps once backup mode is active. Any design which merely parallels the backup mode with the PLC control will not be acceptable. Any design which does not provide a latched backup mode will not be acceptable.

6. With the exception of the float mode active light, alarm lights on the inner door and the exterior alarm beacon shall flash until the operator presses the "Acknowledge" push button. Upon acknowledgment, the inner door alarm lights will remain on (solid) until the alarm condition is cleared.

7. PLC shall calculate Total Runtimes for pump 1, pump 2, and pump 1&2. PLC shall calculate daily summary information for pump 1 and pump 2. Summary information includes: daily runtime and daily cycles.

3.15 Start-Up, Testing and Training

A. Field Testing and Commissioning of Equipment

1. Prior to City's acceptance, calibration and testing, pre-start-up, start-up, and 7-day live test shall be performed in accordance with these Specifications.

2. The Contractor shall furnish all labor, equipment, and material necessary to perform field testing and commissioning of equipment, including all related appurtenances. All costs for performing calibration and testing, pre-start-up, start-up, and 7-day live test shall be included in the Contract Price, and no extra payment will be made to the Contractor due to overtime, weekend, or holiday labor costs required to perform and complete same. Requirements specified in this Article are in addition to the demonstration and test requirements specified under other Sections of these Specifications.

3. Pre-start-up, start-up, and 7-day live test shall be performed by the Contractor in accordance with the approved procedure plans to demonstrate to City's satisfaction that:

a. All components of the process systems defined herein and the entire lift station system are fully completed and operable.

b. All units, components, systems, and the entire lift station system operate with the efficiency, repeatability, and accuracy indicated and specified.

c. All components, systems, and the entire lift station conform to the Contract Documents and the reviewed shop drawings, samples, construction manuals, materials lists, and other reviewed submittals.

B. Prerequisite Conditions

1. Calibration and testing shall not commence for any equipment item or system until all related structures, piping, electrical, instrumentation, control, and like work has been installed and connected in compliance with the pertaining requirements specified elsewhere in the Specifications.

2. Pre-start-up, start-up, and 7-day live test shall not commence for any equipment item or system until calibration and testing has been completed as specified herein.

C. Demonstration and Testing Materials

1. Furnish materials, necessary fuel, and electrical power for all tests. Use potable water to fill the lift station wet well. Furnish temporary facilities as required such as by-pass or re-circulation piping, diversions, storage, and similar facilities. Use procedures that conserve testing materials and avoid wastage, especially with respect to large quantities of fresh water and electrical power.

D. Inspection and Supervision by Manufacturers

1. Perform pre-start-up and start-up under continuous inspection by City. Technical representatives of the various equipment manufacturers shall be present for the prestart-up and the start-up, shall examine their equipment, and shall supervise the start-up and adjustment procedures.

E. Correction of Defects

1. Immediately correct all defects and malfunctions disclosed by pre-start-up, start-up, and 7-day live test using approved methods and new materials for repairs as required. Upon City's recommendation, interruption time necessary for corrective work may be added to the specified total 7-day live test period.

F. Acceptance

1. Satisfactory completion and approval of required operational 7-day live test is one of the conditions precedent to City's acceptance of the work and does not constitute final acceptance. Upon City's approval of required 7-day live test, Contractor shall check all equipment and confirm proper fluid levels.

G. Manufacturer's Supervision and Installation Check

1. Each equipment manufacturer shall furnish the services of an authorized representative specially trained and experienced in the installation of his equipment during pre-startup and start-up to:

   a. Be present when the equipment is first put into operation.

   b. Inspect, check, adjust as necessary, and approve the installation.

   c. Repeat the inspection, checking, and adjusting until all trouble or defects are corrected and the equipment installation and operation are acceptable.

   d. Witness and supervise field testing and commissioning of equipment to the extent specified.

   e. Prepare and submit to the City, upon successful completion of pre-start-up testing, the specified Manufacturer's Certificate of Proper Installation confirming that all pumping units have been installed, inspected, checked, adjusted, and tested in accordance with the manufacturer's recommendations and requirements specified herein.

H. Calibration and Testing

1. Upon installation of all lift station facilities, Contractor shall perform calibration and testing. At a minimum, calibration and testing shall include the following for all facilities:

   a. Meggering all motors and their conductors.

   b. Meggering all conductors for 3-phase power.

   c. Visually inspecting field wiring against approved shop drawings.

   d. Checking for abnormalities that may have occurred during shipping or installation of all equipment and components including loose wiring, physical damage, or insecure mounting of components.

   e. Complete all testing and labeling required prior to energizing any electrical panels or equipment.

   f. Energizing all panels.

   g. Simulate all controls and equipment start, stop, and shutdown, including checking discrete signals locally at the panel and by jumpering remote devices at the field end to simulate signals (prior to actually operating equipment).

h. Testing all interlock and maintenance switches.

i. Checking analog signals by utilizing loop calibrator as required.

j. Calibrating all control instrumentation and monitoring equipment (flow, level, pressure, etc.)

k. Calibrating panel devices as required including timers and controllers.

I. Pre-Start-Up

1. General - Upon successful completion of calibration and testing, Contractor shall schedule the pre-start-up. A minimum of fourteen (14) days' notice shall be provided to the City prior to the pre-start-up. The pre-start-up shall be performed on one (1) day and Contractor's representative(s), City Operations representative(s), Inspector, and Manufacturer's representative(s) shall attend the pre-start-up. The pumps shall be tested through the force main. Contractor shall provide water for filling the wet-well, operate the pumps, and assure that the discharge piping and force main is completely filled prior to pre-start-up. All equipment shall be operated for a period of 30 minutes unless otherwise specified. All controls and alarm conditions shall be simulated. If the equipment does not perform in conformity with Contract Documents requirements, the Contractor will be required to remove, replace, and restore the equipment to full compliance with the Contract Documents at his expense.

2. The Controls Supplier shall provide a skilled technician for troubleshooting and startup of the lift station control panel in stand-alone / non-SCADA operation. Startup and testing of the SCADA system shall be coordinated with City personnel. Provide all necessary field visits to fully test system before performing a witnessed test with Engineer and Owner.

3. Coordinate installation, start-up, and testing with general Contractor and Engineer.

4. Once witnessed testing is completed, the integrator is responsible for coordinating and providing training and instruction on the operation and maintenance of the equipment furnished in this section. Training shall be provided for a duration of not less than (1) eight (8) hour period.

5. As a minimum, during pre-start-up the Contractor shall demonstrate a complete and operational lift station as follows:

a. Response of equipment to appropriate manual or automatic controls, or combinations of both automatic and manual controls, shall be demonstrated to be correct and accurate. Where applicable, all components shall be tested for both manual and automatic operation. Where a component performs more than one function, every function shall be validated.

i. Pumping equipment shall respond accurately and reliably to liquid level from the wet well. Automatic alternation and back-up pump functions shall also be validated.

ii. Auxiliary equipment items such as alarm signals to remote telemetry, and like items shall respond accurately and reliably to every condition for which they are programmed, in the manner specified.

b. Functionality of all alarm and status lights.

c. Demonstrating uninterruptable power supply.

d. Demonstrating all control and monitoring features of all main control panels, local control panels, and PLCs in conjunction with associated equipment.

e. Measuring and recording voltage and amperage draw readings for all equipment motors under loaded conditions.

f. Testing all components of RTUs, including control systems.

g. Operating all equipment under all conditions and demonstrate all alarms, shutdowns, and operating modes.

h. Performance testing of each Pumping Unit through the discharge piping.

i. Operation of transportable power generator set.

j. Contractor shall refer to various Technical Specifications herein for additional specific equipment testing requirements.

6. Pumping Units

a. Pre-start-up testing for pumping units shall be performed utilizing potable water. The wet well shall be filled to pump operating level and discharge from the pumps shall be through the force main. Pump discharge valves shall be throttled to simulate the design operating condition.

b. Contractor shall provide all required testing equipment to perform pumping unit start-up at no additional cost to the City.

c. Contractor shall provide all instrumentation to confirm pumping unit and electric motor performance, including calibrated test gauges for monitoring discharge pressure, and electrical monitoring equipment to measure current, voltage, power, kVA, and power factor.

d. Contractor shall record pumping unit flow, discharge pressure, motor voltage, and motor amperage, hourly throughout the test period. The pumping units shall operate as specified without excessive noise, surging, cavitation, vortexing, vibration, or clogging, and without overheating of the bearings. Each pumping unit shall operate a minimum of 30 minutes. All automatic and manual controls shall function in accordance with the specified requirements.

e. The Contractor shall perform the following tasks under the supervision of the pump manufacturer:

    i. Completed pumping unit (pump and motor) shall receive a final field trim balance, as may be required, and vibration shall be checked and recorded. The vibration of all pumps shall be equal or less than the amplitude limits recommended in the Hydraulic Institute Standards and it shall be recorded at a minimum of four pumping conditions defined by the Engineer. All measurements shall be witnessed by the City. Vibration shall be measured at motor thrust bearing housing and at any other locations on pumping unit as directed by the District. Vibration shall be measured over the full range of the pump operating speed.

    ii. Each pump's performance shall be documented by obtaining concurrent readings showing motor voltage and amperage, pump flow rate, pump suction head, and pump discharge head. Readings shall be documented at a minimum of three pumping conditions, including the specified design point, to ascertain the actual pumping curves. Another test shall be run at shut-off head. Each power lead to the motor shall be checked for proper current balance.

    iii. Pumping units (pump and motor) shall perform substantially in conformance with the certified pump

curves and the factory performance test results as adjusted for field conditions. Additionally, discharge from pump shall not exceed the design flow rate by more than 20%. If, in the opinion of the City, the equipment furnished does not perform in accordance with these Specifications, Contractor shall promptly make all necessary repairs or corrections so that the equipment fully complies with these Specifications. Contractor shall remove, restore, and replace the equipment if required at his expense. Factory performance tests, pre-start-up, and start-up testing shall be rerun if necessary at Contractor's expense.

iv. Run pumps in the field, witnessed by the manufacturer's representative. Contractor and Engineer to verify operation under field conditions. Measurements shall be taken by the Contractor to determine that the pumping units will operate satisfactorily without cavitation, overheating or overloading of the motor, and free of vibration throughout the entire operating range of head and capacity at rated speed.

v. Pump Manufacturer to supply all required instrumentation to verify pump performance. Instrumentation to be calibrated in accordance with accepted industry standards. No flow meter is required.

vi. Report of testing activities shall be prepared and submitted to the Engineer for approval.

vii. Correct all deficiencies to the satisfaction of the Engineer.

viii. Have factory-trained manufacturer's service representative instruct operating personnel on the care and maintenance of the pumping units. Such instruction to be provided on-site and consist of a minimum of four hours.

J. Start-Up

1. Upon successful completion of pre-start-up and after receipt of all Manufacturer's Certificate of Proper Installation by the City, Contractor shall schedule the start-up. A minimum of three (3) days′ notice shall be provided to the City prior to the start-up. The Contractor's representative(s), City′s Operations representative(s),

Engineering Consultant, Inspector, Design Engineer, and Manufacturer's representative(s) shall attend start-up.

2. All testing described for pre-start-up shall be repeated during start-up and the pumps shall be tested through the force main(s). Contractor shall provide water for filling the force main, operate the pumps, and assure that the force main(s) are completely filled prior to start-up.

K. 7-day Live Test

1. After successful completion of start-up, the Contractor shall participate in a live test of the lift station that shall encompass a 7-day period of trouble free operation. During the 7-day live test of the lift station, the lift station will be operated continuously under normal operating conditions. All alarms shall be transmitted to Contractor and City. The Contractor shall have personnel available within one hour to respond to any problems, and shall diligently pursue repair of the problem. If the City determines the problem to be major, then the City may instruct the Contractor to repeat the 7-day live test. The City may continue to repeat the test until 7 days of trouble-free operation are recorded.

2. Contractor shall provide potable water to fill the wet well at a constant rate as required to start the pumps a minimum of 3 times per day (throughout the entire 7-day period) if the normal operating conditions fail to start the pumps at least three times a day. All costs for potable water, power, and fuel will be borne by the Contractor during this test period. Contractor shall operate a transportable generator for at least two 1-hour periods (different days) and each pumping unit shall be selected in the "lead" position for a minimum of 24 hours during 7-day live test of the lift station.

3. Contractor shall maintain, and submit to City at the end of the 7-day live test, a log of all alarms and problems. The log shall include date of alarm or problem, description of alarm or problem, date of corrective action, and corrective action to fix alarm or problem.

PART 4 − MEASUREMENT AND PAYMENT

A. All work described herein and/or shown on the Plans, except specific items shown on the Bid Form, shall be paid for under the Lump Sum (LS) bid item for the Lift Station(s). Work described in other Sections that is necessary to make the Lift Station complete and is not included in specific bid items shall also be included in the lump sum payment for the "Lift Station." Such work may or may not include, and may not be limited to, site preparation, access road, wet wells, valve vaults, submersible pumps, piping, valves, lifting/hoist systems, control panels, electrical service and feeds,

restoration, start-up, testing, training, manuals and all appurtenances required for complete operation and maintenance of the Lift Station.

B. All costs to properly complete the work specified herein and/or shown on the Plans shall be included in the prices bid for these or other items unless applicable bid items are included on the Bid Form.

END OF SECTION