SECTION #:

WORK INCLUDED - Packaged Pumping System

PART 1 - GENERAL

1.1 DESCRIPTION

A. Purpose: To provide a single source responsible for the manufacture and warranty of a prefabricated, skid mounted, fully automatic **variable / constant speed** pumping system and enclosure. The pumping system shall automatically maintain a constant discharge pressure regardless of varying flow demands within the station rating.

B. The pumping system shall conform to the specifications herein in all aspects. This specification covers the minimum requirements, but should not be considered to be all inclusive. It is the successful vendor's responsibility to include all necessary appurtenances to provide for a complete, smooth operating, and reliable pump system. The manufacturer shall supply a complete set of general arrangement drawings, electrical power schematics, and control schematics in the operation and service manual.

C. Manufacturers seeking authorization to furnish their product shall be a registered **ISO9001:2008** manufacturer, and shall hold a current Quality Management Certificate for the assembly of custom packaged pumping systems and controls for use in commercial, irrigation, municipal, industrial, and fire applications.

1.2 REFERENCES

A. American National Standards Institute (ANSI)

B. American Society for Testing and Materials International (ASTM):

1. A36: Standard Specification for Carbon Structural Steel.
2. A48: Standard Specification for Gray Iron Castings.
3. A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
4. Al05: Standard Specification for Carbon Steel Forgings for Piping Applications.
5. A276: Standard Specification for Stainless Steel Bars and Shapes.
6. A307: Carbon Steel Bolts and Studs.
7. A582/A582M: Standard Specification for Free-Machining Stainless Steel Bars.
8. B148: Standard Specification for Aluminum-Bronze Sand Castings.

C. American Society of Mechanical Engineers (ASME)

1. ASME B16.5: Pipe Flanges and Flanged Fittings

D. American Water Works Association (AWWA)

E. American Petroleum Institute (API)

F. Hydraulic Institute (HI)

G. National Electric Code (NEC)

1. National Electrical Manufacturers Association NEMA – MG1

1.3 MANUFACTURER

A pumping system shall be of the type manufactured by **TIGERFLOW** Systems, LLC. The station manufacturer shall be certified to provide a UL listing for both the control panel and the pump station as a complete system, to **ANSI-NSF-61** certification standards. The primary line of business of the pump station manufacturer shall be the design & manufacture of centrifugal pump booster stations. For consideration of a proposed equal system, the contractor shall furnish the following data to the Engineer at least 10 days prior to the date of the bid opening:

1. A complete specification for the pumping system proposed as an equal.

2. A statement of full conformance to the specifications signed by an authorized representative of the manufacturer.

3. A D-size layout drawing showing overall dimensions and all piping discharge locations.

4. Complete submittal data for all major equipment such as pumps, motors, control components, valves, and motor starters.

5. A D-size one-line electrical schematic showing power wiring.

6. Manufacturer's electrical control panel UL508A file number.

7. A copy of the manufacturer's certificate of insurance showing as a minimum, general liability coverage of $1,000,000 and an excess liability coverage of $5,000,000.

8. If, in the opinion of the Engineer, the data submitted shows the pumping system to be an equal to the system specified, the bidding contractors shall be notified not less than 14 days prior to the bid opening.

**1.02 SUBMITTALS**

A. Submittals shall be in accordance with all the requirements of the general specification. Submit electronic copies to the engineer for approval. All submittals shall include the following.
B. Component Data: Submit the manufacturer’s technical data sheets for all system components including but not limited to valves, piping accessories, control devices, variable speed drives that are furnished,

including dimensions, capacities, electrical characteristics, material finishes and performance data. Installation & startup procedures must be included as well

C. Shop Drawings : Submit shop drawings for the variable speed packaged pumping system including but not limited to the following information:
   1. System Engineering Data Sheet.
   2. Autodesk Inventor 2010 suite including the following modules:
      a. Mechanical desktop
      b. Solids Works 3D AutoCAD
      c. FEA analysis tools
      d. Hydraulic modeling tools
      e. BIM Compliant drawings
   3. Piping & instrumentation drawings (P&ID) showing all system instruments included in this specification.
   4. Bill of Material with a complete detailed description of the function and a manufactures specification sheet of each component. Components include but are not limited to pipe, fittings, strainers, flexible connectors, type of pipe, sensors, transmitters, variable speed drives, pumps, control valves, manually operated valves, check valves, pumps, air separators, expansion tanks, switches, control boards, hoist, trolley, PLC, HMI, etc..
   5. Complete wiring diagram of the power wiring including conduit size, wire size and all components.
   6. Complete wiring diagram of the control system including all control and sensing components. Clearly define what is to be field installed and what will be factory installed and tested.
   7. Written description of the sequence of operation.
   8. General arrangement drawing showing all system dimensions including footprint, customer interface dimensions for supply & return piping, electrical connections with each component labeled and described on the drawing.
   9. Manufacturer's pump data sheet including:
      a. Pump curve including design point.
      b. Materials of construction.
      c. Construction drawing
      d. Human Machine Interface (HMI) software and equipment & layout including menu structure and points list.
      e. Controller equipment including PLCs, HMI and all instrumentation factory or field installed
   10. Manufacturer shall submit a certificate of product liability insurance for no less than five million dollars ($5,000,000.00). Furnish a written certification that the manufacturer's listing with Underwriters Laboratories is an approved manufacturer of factory assembled packaged pumping systems.

## 1.03 DELIVERY, STORAGE & HANDLING

A. The complete packaged pumping station shall be manufactured and tested as a complete unit
B. Systems that require modular construction to allow access to the site due to freight restrictions shall be shipped in separate modules and re-assembly at the jobsite is the responsibility of the contractor. The modular system will be approved by the engineer and coordinated between the contractor and the station manufacturer
C. Drain plugs shall be removed from the system to prevent freezing during storage and shipping.
D. Comply with all Hydraulic institute standards and TIGERFOWS submittal data for storage of the station.
E. Comply with the station manufacture's recommendations for transportation, rigging and off loading

## 1.04 OPERATION & MAINTENANCE MANUALS

A. The end user shall be provided with electronic copies of the operation & maintenance manuals. The electronic manual shall be in Adobe acrobat 9.0 format and include the following information:
   1. Name and contact information for the design engineer, installing contractor, index of equipment including the vendors name and contact information.
   2. Complete specification sheets, manufacturing drawings, brochures and bill of material for each component provided. Bill of material shall contain part specific model numbers and manufacturer
   3. Operational sequence of operation
   4. P&ID and general arrangement drawings
   5. Electrical power and control wiring diagrams including all the information required for the owner to troubleshoot repair and expand the system.
   6. Complete operation & maintenance manuals from the manufacturers for all major station components.

**1.05 QUALITY ASSURANCE**

A. The manufacturer of the pumping station shall be listed by Underwriters Laboratories as an approved manufacturer of for packaged pumping stations under category "QCZJ" including all controls, pumps, motors, piping specialties, valves and fittings. In addition the control panel shall be listed by underwriters Laboratories U.L. 508A (Industrial Control Panels). Proof of the listing shall be provided as part of the submittals and operation and maintenance manuals.
B. The manufacturer of the pumping station shall provide as part of the submittals published catalog data that the packaged pumping station is part of the standard product line.
C. The manufacturer of the pumping station shall have a minimum of 20 years experience in the manufacturing and application of packaged pumping station and shall be responsible for the proper operation of the complete station
D. The manufacturer of the pumping station and the control system shall be one in the same. The pump station and control system shall be manufactured in the same facility. The use of commercial grade controllers shall not be acceptable
E. The packaged pumping station manufacturer shall have in place a quality control /quality assurance program to ensure the quality of the engineering, design and manufacture of the pump station. The manufacturer of the pump station shall provide with the submittals documentation of the program including the complete testing procedure for the system.
F. The station manufacturer shall perform a factory performance test prior to shipment. The test shall demonstrate the system ability to perform at 25, 50, 75 and 100% of the station rated flow rate. Efficiency, flow, system dynamic head and KW shall be recorded for each point listed above.
G. The complete testing stand shall be traceable to National Institute for standards and testing (NIST)

**1.06 WARRANTY**

A. The system shall as a minimum be warranted for a period of 12 months after startup and 18 months after shipment whichever comes first.
B. The manufacturer's warranty shall cover all equipment, components, and systems provided in or with the station by the manufacturer of the station.

**PART 2 – PRODUCTS**

## 2.01 PERFORMANCE AND DESIGN REQUIREMENTS

A. The pump station shall be manufactured by **TIGERFLOW** Systems, LLC. Dallas Texas and be a **TIGERFLOW** MODEL NUMBER _____. The pump station shall operate the pumps in order to produce a system flow rate of _____GPM @ _____ PSIG.

| | GPM | TDH | EFF at BEP | Min HP | Motor Speed |
|---|---|---|---|---|---|
| P-1 | | | | | |
| P-2 | | | | | |
| P-3 | | | | | |
| P-4 | | | | | |

## 2.02 MECHANICAL

A. The pump station shall be a completely skid mounted unit built by a single manufacturer. All equipment including but not limited to pumps, motors, valves, instrumentation and controls mounted on a common structural carbon steel structure to form a complete operating system.

B. Structural steel base
   1. All components shall be mounted on a structural carbon steel base of open construction. The base shall be designed to support al the systems components including but not limited to pump, drivers, piping, valves and controls. The base depth shall be equal to 1/12 the longest span between the lifting eyes but no greater than 12". The minimum depth shall not be less than 6". The base shall be designed to accept grout or concrete to be installed by the contractor after all field connections are complete. Steel shall be ASTM A-36, prime steel stored inside to avoid rust or pitting
   2. Optional – The structural steel skid shall be covered in ¼" carbon steel diamond deck plate. The deck plate shall be 100% seal welded on top and skip welded to the sub-structure from below. The deck plate will eliminate the need to fill the base with grout or concrete. Steel shall be ASTM A-36, prime steel stored inside to avoid rust or pitting.

Attention spec writer
choose pump type

C. Pumps
   1. To ensure stable operation, the pump curve shall be constantly rising from run out to shut off. To ensure cavitation free operation, each pump NPSHr must be low enough to permit stable continuous operation at 120% of greater of the BEP (best efficiency point). Each pump shall be capable of continuous operation without producing noise in excess of Hydraulic Institute and OSHA guidelines
      a. Pumps shall be of the close coupled end suction type designed to deliver the scheduled flow rate at the specified total dynamic head (in feet).
         1. Pumps shall be close grained cast iron fitted with a replaceable bronze impeller. All pumps shall be of the back pull out design so the rotating element can be removed from the casing without disconnection from the suction or discharge piping.

2. Pump impeller shall be of the enclosed type cast bronze and shall be statically and dynamically balanced. Impeller diameter shall be trimmed for the project specific design conditions.
3. Shaft shall be sealed, fitted with a leak less mechanical seal suitable for the pressures and temperatures scheduled.

b. Pumps shall be of the vertical multistage type designed to deliver the scheduled flow rate at the specified total dynamic head (in feet).
   1. Pumps shall be close grained cast iron based fitted with a stainless steel impeller. All pumps shall be of the vertical stacked design so the pump assembly can be removed without disturbing from the suction or discharge piping.
   2. Pump impeller shall be of the enclosed type stainless and shall be statically and dynamically balanced.
   3. Shaft shall be cartridge type mechanical seal, suitable for the pressures and temperatures scheduled.

c. Pumps shall be of the base mounted, flex coupled end suction type designed to deliver the scheduled flow rate at the specified total dynamic head (in feet)
   1. Pumps shall be close grained cast iron fitted with a replaceable bronze impeller. All pumps shall be of the back pull out design so the rotating element can be removed from the casing without disconnection from the suction or discharge piping
   2. Pump impeller shall be of the enclosed type cast bronze and shall be statically and dynamically balanced. Impeller diameter shall be trimmed for the project specific design conditions.
   3. Shaft shall be sealed, fitted with a leak less mechanical seal suitable for the pressures and temperatures scheduled.
   4. Pumps shall be mounted on a heavy duty cast in one piece cast iron bearing frame
   5. Pump and motor shall be mounted on a cast iron or fabricated steel base adequately reinforced against deflection. Pump shall be connected to the motor with a flexible coupling capable of withstanding all torsion, radial and axial loads. Coupling and all rotating components of the pump and motor shall be protected by a OSHA approved guard. Pump base shall have sealed ends for grouting.

d. Pumps shall be of the vertical inline type designed to deliver the scheduled flowrate at the specified total dynamic head (in feet)
   1. Pumps shall be close grained cast iron fitted with a replaceable bronze impeller. All pumps shall be of the back pull out design so the rotating element can be removed from the casing without disconnection from the suction or discharge piping. Models 3” and larger shall have a balanced double volute design to reduce radial thrust and prolong seal and bearing life.
   2. Supply and return connections shall be the same size, flanged ANSI class (125) (150) (250) rating, 180 degrees opposite on center line for pipeline mounting.
   3. Casing shall have a bronze replaceable wear ring
   4. Pump impeller shall be of the enclosed type cast bronze and shall be statically and dynamically balanced. Impeller diameter shall be trimmed for the project specific design conditions.
   5. Motor shaft shall be one piece carbon steel with bronze shaft sleeve
   6. Shaft shall be sealed, fitted with a leak less mechanical seal suitable for the pressures and temperatures scheduled.

e. Pumps shall be of the double suction horizontal split case designed to deliver the scheduled flow rate at the specified total dynamic head (in feet).
   1. Pump casing shall be close grained cast iron. The casing material shall have a minimum strength of 35,000 PSI. The pump casing shall be divided on the horizontal centerline. The casing halves shall be accurately machined bolted and doweled together. A non-asbestos type gasket material shall be furnished between the casing halves. Removable of the upper half and bearing assemblies shall permit removal of the rotating assembly without disturbing the piping connections. Pumps shall be provided with removable bearing housings which will permit inspection and/or removable of the mechanical seals, shaft, sleeves and bearings without distributing the rotating assemblies.
   2. Suction and discharge flanges shall be drilled to ANSI Class (125) (150) (250) and machined flat.
   3. Pumps shall be fitted with bronze renewable casing wear rings, indexed with a dowel pin for fixed positioning.
   4. The pump shaft shall be made of high strength precision ground to provide true running rotating element.
   5. The pump shaft shall be adequately supported by the pump bearings to limit shaft deflection to .0002 inches. Bearings shall be ball type and locked to the shaft with positive locks of ample size to withstand axial loads. Each bearing housing shall be bolted to the upper and lower casing halves for a full 360 degree support registered fit to ensure positive alignment. Bearings shall provide a minimum life of 10 years when calculated at 50% best efficiency point (BEP) for the scheduled pump.
   6. The pump manufacturer shall recommend the proper mechanical seal based on pressure, temperature and fluid properties as outlined in the equipment schedule. Mechanical seals at a minimum shall have stationary seats, carbon rotating elements and Buna elastomers.
   7. Pumps shall be mounted on cast iron or fabricated steel base, adequately reinforced against deflection. Pumps shall be connected to the motor by a flexible coupling capable of withstanding all torsional, radial and axial loads. Coupling and all rotating components of the pump and motor shall be protected by an OSHA approved guard
   8. Pump base shall have closed ends to allow access for grouting.

f. Pumps shall be of the vertical turbine type designed to deliver the scheduled flow rate at the specified total dynamic head (in feet).
   1. Bowl assembly: the intermediate bowls, discharge cases and suction bowls shall be flanged type constructed from close grained cast iron, and shall conform to ASTM A48, class 30. They shall be free from defects and accurately machined and fitted to class tolerances. The intermediate bowls shall have epoxy enameled coated waterways for maximum efficiency. All threaded discharge cases shall be threaded with 8 TPI BUTT standard for water lubricated column assembly. All assembly bolting shall be stainless steel.
   2. The impellers shall be produced by investment cast method and shall be bronze and of the enclosed type. They shall be free from defects, machined and balanced for optimum efficiency and performance. They shall be securely fastened to the bowl shaft with stainless steel taper lock collets.
   3. The impellers shall be adjustable by means of a top shaft adjusting nut or adjustable solid shaft coupling.

4. The bowl shaft shall be constructed from pump shaft quality (PSQ) 416 stainless steel, ASTM A582 pump shaft material. It shall be precision machined and straightened to within .002-.004 tolerance.
5. The discharge head shall be sized for the pumps capacity and shall be constructed from high strength ductile iron, ASTM A536, class 65 or fabricated steel and shall be the high profile type with integral motor base which will allow the motor shaft to be coupled to the top shaft above the stuffing box. A separate motor stand is not acceptable. The discharge flanges shall be drilled to ANSI Class (150) (250), machined flat and supplied with a ¼" NPT tap. The head shall be threaded with 8 TPI BUTT standards to accept the column pipe.
6. The stuffing box shall be constructed from ductile iron, Rated for 250 PSI and be fitted with a balanced mechanical seal. It shall have an available fitting for pressure relief. The follower gland shall be 201 stainless steel and secured by stainless steel studs and nuts. The packing box bearing shall be bronze B-505-836. A rubber water slinger shall be provided to operate on the top shaft above the packing gland.
7. The column pipe shall be ASTM A53, grade steel pipe. The column ends shall be machined with 8 TPI BUTT standard threads and faced parallel to the threads to ensure proper alignment. The pipe shall be connected with threaded sleeve type ductile iron couplings that will accept ¾" stainless steel bearing retainers. Intermediate column lengths and line shaft bearing spacing shall not exceed 7' with pump speeds up to 1800 RPM. Pumps running at speed over 1800 RPM shall have column and bearing spacing over 5".
8. The line shaft shall be 416 stainless steel, ASTM A582 and sized according to horse power requirements of the specified pump. To ensure proper alignment the shafts shall be straightened to .004 tolerance and the butting faces shall be machined perpendicular to the axis of the shaft. These shafts shall be coupled with 416 stainless steel lineshaft couplings.

D. MOTORS:
   1. The motors shall be sized to operate continuously without exceeding the horsepower rating as outlined on the equipment schedule regardless of the flow and head throughout the operating range of the "System Curve".
   2. Motors shall be of the horsepower and speed shown on the pump schedule. Pumps requiring a larger horsepower(s) shall not be acceptable. Pumps shall be (close coupled) (flex coupled) to a (3) (1) phase, (60) (50) hertz, (460) (208), (TEFC) (ODP), (high efficiency) (premium efficiency) motor with a 1.15 service factor, 400 C ambient.
   3. Motors in variable speed applications shall be equipped with grounding rings to prevent electro-mechanical-grounding (EMD), fusion craters and pitting of the bearings. The grounding rings shall safety divert shaft and bearing currents to ground increasing the motor and bearing life.

E. PIPING:
   1. Piping 6" diameter and smaller shall be 304L, S40 stainless steel ASTM A312, fittings shall be ASTM A 403, and flanges shall be ASTM A 182.
   2. Piping 8" and larger shall be carbon steel ASTM A53; grade B, type E (electrical resistance welded). Pipe fittings shall be ASTM A234, and flanges shall be ASTM A105. All piping shall be internally coated with an ANSI/NSF-61 approved fusion bonded epoxy (FBE) coating for potable water per AWWA C213-07.

3. Piping that is to be coated internally coated shall be hydrostatically tested prior to coating application and all results recorded on a hydrostatic test report.
4. Suction and discharge headers shall be supplied with drains at all low points and automatic air release valves at the high points in the system.
5. Drains shall be provided above all check valves to accommodate draining the system.
6. All welding shall be performed by ASMR section IV certified welders. All welding documentation shall be included in the submittal information including WPS, PQR and WPQ.
7. All piping shall be hydrostatically tested to 150% of working pressure or 200 PSI whichever is greater. All results shall be recorded on a hydrostatic test report.

F. BUTTERFLY VALVES
1. The valves shall be designed, manufactured and tested in accordance with American Water Works Association (AWWA) standard C-504.
2. All butterfly valves shall be in accordance with AWWA C-504 and be installed as indicated on the drawings. Valves shall be certified to ASME/NSF-61 Drinking Water System Components.
3. Flanged end connection shall fully conform with ANSI B16.1 for class 125, 250 iron flanges, or AWWA C207, class D. both class 125 & 250 shall be flat face.
4. Wafer end connections shall be designed for installation between ANSI B16.1 Class 125 iron flanges.
5. Valves 6" and smaller shall be equipped with lever operator. Valves 8" and large shall be equipped with gear operators.
6. Valve exteriors shall be coated with a universal, Alkyd Primer. Valve interiors shall be coated with an ANSI/NSF-61 epoxy coating approved for potable water.

G. GATE VALVES:
1. The valves shall be designed, manufactured and tested in accordance with American Water Works Association (AWWA) standard C-509.
2. Valves shall be supplied with flanges in accordance ANSI B16.1, Class 125.
3. All gate valves shall be in accordance with AWWA C-509 and installed as indicated on the drawings. Valves shall be certified to ANSI/NSF-61 Drinking Water System Components.
4. The valves shall have a cast or ductile iron body, bonnet and wedge. The wedge shall be totally encapsulated with rubber.
5. The valves shall be either non-rising or rising stem. Valves mounted above 7' AFF shall be equipped with chain operator.
6. All internal parts shall be accessible without removing the body from the line.

H. NON-SLAM CHECK VALVES:
1. Check valves shall be located on the discharge of each pump and anywhere else as indicated on the drawings.
2. Valves shall be of the silent operating type that begins to close as the forward velocity diminishes, and be fully closed at zero velocity preventing reverse flow.
3. The check valve bodies shall be ASTM A126, grade B cast iron, or better. And shll be free from blow holes, sand holes or other impurities.
4. The check valve design shall be center guided, spring loaded poppet guided at opposite ends, and shall have a short linear stroke that generates a flow area equal to the pipe diameter.
5. The internals shall be machined bronze disc seat, and stem guide. The seat shall contain a Buna-N seal to provide zero leakage.
6. The valves shall be sized to permit full pump capacity to discharge through them without exceeding a pressure drop of 2.0 PSIG.

I. PRESSURE RELIEF VALVES:
   1. The pressure reducing control valve shall be a pilot operated diaphragm valve designed to automatically reduce a fluctuating higher upstream pressure to a constant lower downstream pressure regardless of varying flow rates.
   2. The main valve shall be hydraulically operated, single diaphragm actuated, globe or angle pattern valve. Y-pattern valves shall not be acceptable. The valve shall contain a disc and diaphragm assembly that forms a sealed chamber below the valve cover, separating the operating pressure from line pressure. The diaphragm shall be constructed from nylon reinforced Buna-N, and shall not seal directly against the valve seat and shall be fully supported by the valve body and cover.
   3. The main valve body shall be ductile iron ASTM A536, and all internal cast components shall be ductile iron or CF8M (316) stainless steel. All ductile iron components, including the body and cover, shall be lined and coated with ANSI/NSF-61 approved epoxy coating allied by the electrostatic heat fusion process. The main valve throttling components (valve seat & disc guide) shall be stainless steel. The valve and cover must be machined with a 360-degree locating tip to ensure proper alignment.
   4. The disc and diaphragm assembly shall contain a Buna-N synthetic rubber that is securely retained on 3-1/2 sides by a disc retainer and disc guide. Diaphragm assemblies utilizing bolts or cap screws for component retention will not be permitted.
   5. Pilot control systems for valves 3” and smaller shall contain a flow clean strainer, fixed orifice closing speed, adjustable speed control and pressure reducing pilot. Pilot control systems for valves 4” and larger shall contain an external Y-strainer, fixed orifice closing speed, Pressure reducing pilot and isolation ball valves on all body connections. All pilot control systems shall utilize stainless steel braided flexible tubing and brass fittings regardless of valve size. The adjustment range of the pressure reducing pilot shall be 30-300 PSI.

J. PRESSURE REDUCING VALVE SITH SURGE ANTICIPATING FEATURE:
   1. The pressure reducing control valve shall be a pilot operated diaphragm valve designed to automatically reduce a fluctuating higher upstream pressure to a constant lower downstream pressure regardless of varying flow rates, and quickly modulate toward a closed position when a sudden high pressure downstream condition occurs.
   2. The main valve shall be hydraulically operated, single diaphragm actuated, globe or angle pattern valve. Y-pattern valves shall not be acceptable. The valve shall contain a disc and diaphragm assembly that forms a sealed chamber below the valve cover, separating the operating pressure from line pressure. The diaphragm shall be constructed from nylon reinforced Buna-N, and shall not seal directly against the valve seat and shall be fully supported by the valve body and cover.
   3. The main valve body shall be ductile iron ASTM A536, and all internal cast components shall be ductile iron or CF8M (316) stainless steel. All ductile iron components, including the body and cover, shall be lined and coated with ANSI/NSF-61 approved epoxy coating allied by the electrostatic heat fusion process. The main valve throttling components (valve seat & disc guide) shall be stainless steel. The valve and cover must be machined with a 360-degree locating tip to ensure proper alignment.
   4. The disc and diaphragm assembly shall contain a Buna-N synthetic rubber that is securely retained on 3-1/2 sides by a disc retainer and disc guide. Diaphragm assemblies utilizing bolts or cap screws for component retention will not be permitted.
   5. Pilot control systems for valves 3” and smaller shall contain a flow clean strainer, fixed orifice closing speed, opening speed control, downstream surge control pilot and pressure reducing pilot. Pilot control systems for valves 4” and larger shall contain an external Y-strainer, fixed orifice

closing speed, downstream surge control pilot, pressure reducing pilot and isolation ball valves on all body connections. All pilot control systems shall utilize stainless steel braided flexible tubing and brass fittings regardless of valve size. The adjustment range of the pressure reducing pilot shall be 30-300 PSI and the surge control pilot shall be 20-200 PSI.

K. GAUGES:
   1. Pressure gauges shall be provided at the suction and discharge connections of each pump as well as the suction and discharge headers. Gauges shall be mounted at the control module. Pump and pipe mounted gauges shall not be acceptable.
   2. All gauges shall be a minimum of 4" diameter, liquid filled, brass connection port, stainless steel case and bayonet ring and be in accordance with ASME B40-100, grade 1A.
   3. Gauge accuracy shall be +/- 1% of span throughout the full range. Gauges shall be selected to read at mid point when operating at design conditions.
   4. Gauge operating temperature shall be $-40^0$F to $140^0$F ($-40^0$-$+60^0$C) ambient and $+140^0$F ($+60^0$C) medium maximum.

L. BLADDER TANKS
   1. Provide an ASME listed bladder tank as listed on the schedule
   2. Tank must have FDA approved bladder
   3. Steel Shell Epoxy coated
   4. Tank must have max pressure rating of pump maximum shut off pressure at the design curve trim impeller plus maximum suction pressure.

M. TURBINE TYPE FLOW METER:
   1. The system shall be equipped with a dual turbine insertion type flow meter and shall provide a high resolution signal to the station controller.
   2. Flow meter accuracy shall be 1%+/- of reading
   3. All wetted metal components shall be electro plated brass or 316 stainless steel.
   4. Flow meter shall be rated for 400 PSI operating pressure maximum and a $-5^0$ to $150^0$ F ambient temperature and $180^0$F liquid temperature maximum.
   5. Meter shall be as sized on the drawings. Meter output shall be displayed o the station HMI.
   6. Flow meter shall be installed per the manufacturer's recommendations for upstream and downstream clear piping requirements.

N. MAGNETIC TYPE FLOW METER
   1. The system shall be equipped with a magnetic type flow meter and shall provide a high resolution signal to the station controller.
   2. Electromagnetic flow meter shall include a polyurethane liner, ANSI B16.5 flanged ends, 316 SS electrodes, and includes 0.5% calibration
   3. Meter shall include a Nema 4X housing and require a 24VDC power supply, output of the meter shall be 4-20mA based on full scale range.
   4. Meter to include grounding rings mounted in each end of the meter. Grounding rings are not required if the internal potable coatings have been removed.
   5. Meter shall be as sized on the drawings. Meter output shall be displayed o the station HMI.
   6. Flow meter shall be installed per the manufacturer's recommendations for upstream and downstream clear piping requirements.

**2.03 CONTROLS**

A. Provide complete electrical distribution, control and instrumentation to automatically start, stop and modulate the stations pumps to smoothly, efficiently and reliably deliver designed flow rates at a constant discharge pressure. The electrical system shall provide alarms, and safety features needed to protect the equipment, piping system and personal.
   1. The electrical distribution, control panel and instrumentation design, installation and testing along with integration of component parts shall be the responsibility of the pump station manufacturer.
   2. Control panels must be manufactured in the same facility as the pump station. The manufacturer of the control panel and pump station shall be one in the same. Control panels not designed and manufactured by the manufacturer of the pump station shall not be accepted.
   3. The control panel shall bear the U.L. 508A label for Industrial Control Panels and shall meet the requirements of IEEE 519.
   4. All electrical distribution, instrumentation and controls shall be in accordance with NEC 70 latest edition.

B. CONTROL PANEL
   1. The manufacturer of the pump station shall assemble the complete control panel in accordance with NEC 70 latest edition and be so authorized under U.L. 508A. All components and wiring shall be housed within a U.L. listed electrical enclosure. All components shall be labeled for proper identification. Adjustment of all operating parameters shall be accomplished from the front of the panel through an industrial grade HMI (human interface machine). A complete wiring diagram shall be permanently affixed to the inside door of the control panel including a legend and. All wiring shall terminations shall be numbered with pre-laminated wire labels.
   2. The control system shall be microprocessor based Direct Digital Control (DDC) and shall have stand alone capability. The controller shall be completely wired, programmed and fully tested before shipment. All testing shall be recorded on the appropriate quality control documents and be provided as part of the IO&M manual.
   3. All the control panel components shall be housed in a Nema 4/IP55 enclosure. Enclosure shall be manufactured from carbon steel and have a polyester power coating applied to the interior and exterior, quarter turn latches and full seamless gasket.
   4. The programmable logic controller (PLC) shall be equal to Eaton Corporation PB14ELC or better. The PLC shall provide program capacity to a minimum of 15 steps, shall have (2) built in serial ports, (1) RS485 port and 512 local I/O points as a minimum. The PLC shall be capable of supporting Ethernet, Modbus, Devicent and Profibus communications.
   5. The system operator shall be capable of starting or stopping the pumps manually and allowing the system to operate automatically via a signal from the operator. The pump controller shall include individual H-O-A switches mounted on the panel face.

C. 6” Color Human interface machine (HMI) for local interface. The unit shall be mounted in the controller door and shall not affect the Nema rating of the enclosure. The HMI shall be microprocessor based and hold its firmware in EPROM memory. Online programmable data entries such as system set points, calculated results and tantalization shall be stored in non-volatile memory. All data and set points shall be field adjustable thought an escalating series of passwords. All the set points shall be modifiable though the controller mounted HMI using standard engineering units such as system flow (GPM), system pressure (PSI), elapsed pump runs time and feet of head. The program shall be modifiable by remote operator as well via optional SCADA system.
   1. The operator display shall be provided in a single integrated graphic display screen with s separate processor for control. The processor shall be an industrial PLC as manufactured by Eaton Corporation. The use of a computer for process control is not acceptable.

2. The HMI shall be suitable for mounting in a door a Nema 4 enclosure so that it maintain the enclosures Nema 4 rating.
3. The HMI shall be mounted at a suitable height to assure proper visibility and easy access by the operator
4. The HMI shall provide as a minimum the following:
   a. CPU: Minimum 32 bit Micro-controller / 206.4 MHz
   b. System memory: 8Mb
      - Program: 7Mb
      - History: 360Kb
      - Recipe: 128 Kb
      - Alarm: 16Kb
      - Data: 64Kb volatile/1Kb non-volatile
      - Backup memory: 512Kb
   c. Storage memory: SM card and USB memory disk capable
   d. Serial ports: Total 3, with at least two (2) ports configurable for RS232/422/485
   e. Ethernet Expansion Module: provides Ethernet RJ-45 connector port with Auto MDI/MDX, 10/100 mps auto detection
   f. The HMI shall be industrial rated and certified for the following conditions:
   g. Relative humidity 10% to 90% @0-40$^0$C, 10%-55% @41-50$^0$C
   h. Vibration: 30G@ 11msec
   i. The HMI shall be industrial rated and certified for agency approval for the following:
   j. IP65 /Nema 4/CE/UL/CUL/C-TICK
   k. The HMI shall be certified for compliance with electromagnetic immunity susceptibility for the following:
   l. EMC directive 89/336/EEC + 92/31/EEC + 93/68/EEC, EN61132
5. The system controller shall include a pump failure alarm for each pump. The pump alarm shall consist of a differential pressure switch of the current switch type with adjustable time delay, alarm light and manual reset. When pump failure is detected, the pump shall be stopped and locked out of service until the alarm is manually reset via a panel mounted reset button. The control system will upon pump failure replace the failed pump with the next pump in the sequence
6. U.L./C-U.L. 508 Label

- Single point power connection
- Through door control power disconnect with safety interlock to prevent door from being opened while in ON position.
- Fused 120 V AC control voltage transformer
- Fused 24 V DC power supply, 1 Watt.
- Suction and system pressure transducers
  - All wetted parts are to be stainless steel.
  - 4-20 mA signal with a minimum accuracy of $\pm$1%.
- Micro Controller: PLC with non-volatile memory (battery backup not required)
- Operator interface: 6-inch blue scale touch screen HMI (Human Machine Interface) including but not limited to the following:
  - Main Screen with the following features:
    - Individual pump HOA (Hand – Off – Auto) switches
    - Pump run indication, including current % speed
    - Pump Failure indication
    - Current pressures readings in psig (suction and system)

- Current flow in GPM (if flowmeter specified)
- Adjustable manual (hand) speed setting
- Direct access to menu screen

- Menu screen providing direct access to all system settings and status screens
- Pump settings screen displays current settings and allows user changes
  - Lead and lag pump start and stop pressures, psig.
  - Lead and lag pump ON and OFF delay times, seconds.
- Alarm settings screen displays current settings for all alarms and allows user changes.
  - Low suction alarm settings
    - Low suction pressure, psig
    - ON and OFF delays, seconds
    - Manual or automatic reset
  - Low system alarm settings
    - Low system pressure, psig
    - ON and OFF delays, seconds
    - Manual or automatic reset
  - High system alarm settings
    - High system pressure, psig
    - ON and OFF delays, seconds
    - Manual or automatic reset
  - High suction economy mode
    - Economy mode suction pressure, psig
    - Economy mode enable / disable
    - ON and OFF delays, seconds
- Separate Alarm Silence and Alarm Reset buttons
- Current system status screen displays:
  - Pump(s) currently running
  - Active alarms and warning messages
- System event history screen displays a minimum of the last 10 system events, including pump start /stops, alarm conditions and alarm acknowledgements.
- Pump run time screen displays the total operating time for each pump. Provide individual resets for each pump run time.
- Lead pump alternation options will include:
  - Automatic alternation on lead pump shutdown.
  - Manual alternation when operator touches alternate button
  - Timed alternation:
    - Daily (user specified time of day)
    - Weekly (user specified day of week and time of day)
    - Monthly (first week of month on user specified day of week and time of day)
- -Multi Level Security
  - 8 Password protected security levels (field changeable passwords)
- Common alarm relay provides dry contacts for customer monitoring.
- Alarm horn, 85 db, annunciates all alarm conditions.

## 2.04 VARIABLE SPEED DRIVES

A. Description

1. This specification is to cover a complete Variable Frequency motor Drive (VFD) consisting of a pulse width modulated (PWM) inverter designed for use on a standard NEMA Design B induction motor.
2. The drive manufacturer shall supply the drive and all necessary options as herein specified. VFD's that are manufactured by a third party and "brand labeled" shall not be acceptable. All VFDs installed on this project shall be from the same manufacturer.

B. Referenced Standards:
- Standard 519-1992, IEEE Guide for Harmonic Content and Control.
- UL508C
- ICS 7.0, AC Adjustable Speed Drives
- IEC 16800 Parts 1, 2 and 3
- NEC 430.120, Adjustable-Speed Drive Systems
- IBC 2006 Seismic – referencing ASC 7-05 and ICC AC-156

C. Qualifications:
1. VFDs and options shall be UL listed as a complete assembly. The base VFD shall be UL listed for 100 KAIC without the need for input fuses.
2. CE Mark – The VFD shall meet product standard EN 61800-3 for the First Environment restricted level. (RFI / EMI Filter spec).
3. The entire VFD enclosure, including the bypass shall be seismically certified and labeled in accordance with the IBC 2006 International Building Code:
   a. VFD manufacturer shall provide Seismic Certification and Installation requirements at time of submittal.
   b. Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake test data as defined by ICC AC-156.
   c. Seismic ratings based upon calculations alone are not acceptable. Certification of Seismic rating must be based on testing done in all three axis of motion by a certified lab.

D. The VFD package as specified herein shall be enclosed in a UL Listed Type enclosure, (enclosures with only NEMA ratings are not acceptable).
1. Environmental operating conditions: 0 to $40^0$ C (32 to $104^0$ F) continuous. Altitude 0 to 3300 feet above sea level, less than 95% humidity, non-condensing. All circuit boards shall have conformal coating.
2. Enclosure shall be UL rated and shall be UL listed as a plenum rated VFD.

E. All VFDs shall have the following standard features:
1. All VFDs shall have the same customer interface, including digital display, and keypad, regardless of horsepower rating. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs.
2. The keypad shall include Hand-Off-Auto selections and manual speed control. There shall be fault reset and "Help" buttons on the keypad. The Help button shall include "on-line" assistance for programming and troubleshooting.
3. The VFD shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection from AC line transients.
4. The input current rating of the VFD shall be no more than 3% greater than the output current rating. VFD's with higher input current ratings require the upstream wiring, protection devices, and source transformers to be oversized per NEC 430.120.
5. The VFD shall provide a programmable loss-of-load (broken belt / broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and / or over the serial communications bus.

F. All VFDs to have the following adjustments:
1. Run permissive circuit - There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad command, input contact closure, time-clock control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper to open (VFD motor does not operate). When the damper is fully open, a normally open

dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. A minimum of two separate safety interlock inputs shall be provided. When any safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close.

2. The VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates.
3. The VFD shall include a fireman's override input. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlocks, and force the motor to run at a preset speed or in a separate PID mode.

G. Serial Communications
1. The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2, Siemens Building Technologies FLN, and BACnet MS/TP. The use of third party gateways and multiplexers is not acceptable. All protocols shall be "certified" by the governing authority (i.e. BTL Listing for BACnet).

H. EMI / RFI filters. All VFD's shall include EMI/RFI filters. The onboard filters shall allow the entire VFD assembly to be CE Marked and the VFD shall meet product standard EN 61800-3 for the First Environment restricted. No Exceptions.

I. OPTIONAL FEATURES – Optional features to be furnished and mounted by the drive manufacturer. All optional features shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.

J. BYPASS CONTROLLER
1. A complete factory wired and tested bypass system consisting of a door interlocked, padlockable circuit breaker, output contactor, bypass contactor, and fast acting VFD isolation fuses.
2. The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the "Off" position before either enclosure may be accessed.
3. The VFD and bypass package shall have a UL listed short circuit current rating (SCCR) of 100,000 amps and this rating shall be indicated on the UL data label.
4. The drive and bypass package shall be seismic certified and labeled to the IBC: Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake test data as defined by ICC AC-156.
5. Drive Isolation Fuses - To ensure maximum possible bypass operation, fast acting fuses, exclusive to the VFD, shall be provided to allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection. This maintains bypass operation capability in the event of a VFD failure. Bypass designs, which have no such fuses will not be accepted.
6. The system (VFD and Bypass) tolerated voltage window shall allow the system to operate from a line of +30%, -35% nominal voltage range. The system shall incorporate circuitry that will allow the drive or bypass contactor to remain "sealed in" over this voltage tolerance at a minimum.
7. The bypass shall maintain positive contactor control throughout the voltage tolerance window of nominal voltage +30%, -35%. This feature is designed to avoid contactor coil failure during brown out / low line conditions and allow for input single phase operation when in the VFD mode. Designs that will not allow input single phase operation in the VFD mode are not acceptable.
8. Motor protection from single phase power conditions - the bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication. Bypass systems not incorporating single phase protection in bypass mode are not acceptable.
9. The bypass system shall NOT depend on the VFD for bypass operation. The bypass system shall be designed for standalone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair / replacement. Serial communications shall remain functional even with the VFD removed.
10. Serial communications – the bypass shall be capable of being monitored and/or controlled via serial communications. On-board communications protocols shall include Modbus, Johnson Controls N2, Siemens Building Technologies FLN (P1), and BACnet MS/TP.

11. The bypass control shall include a programmable time delay for bypass start and keypad indication that this time delay is in process. A Form C relay output provides a contact closure to signal the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.
12. The user shall be able to select the text to be displayed on the keypad when an external safety opens. Example text display indications include "FireStat", "FreezStat", "Over pressure" and "Low suction". The user shall also be able to determine which of the up to four (4) customer safety contacts is open over the serial communications connection.
13. Smoke Control Override Mode (Override 1) – The bypass shall include a dedicated digital input that will transfer motor from VFD mode to bypass mode upon receipt of a dry contact closure from the Fire / Smoke Control System. In this mode, the system will ignore low priority safeties and acknowledge high priority safeties as required by UL 864/UUKL. All keypad control, serial communications control, and normal customer start / stop control inputs will be disregarded. This Smoke Control Mode shall be designed to meet the intent of UL864/UUKL.
14. Fireman's Override Mode (Override 2) – the bypass shall include a second, programmable override input which will allow the user to configure the unit to acknowledge selectable digital inputs. This programmability allows the user to program the bypass unit to react in whatever manner the local Authority Having Jurisdiction (AHJ) requires. The Override 2 action may be programmed for "Run-to-Destruction". The user may also force the unit into Override 2 via the serial communications link.

K. Warranty

The VFD Product Warranty shall be 24 months from the date of certified start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time and expenses. A toll free 24/365 technical support line shall be available.

## 2.05 ELECTRICAL

A. All power and control wiring shall be run in electrical metallic tubing (EMT) and shall be hot galvanized steel O.D. with organic corrosion resistant I.D. coating and shall be produced in accordance with U.L. Safety Standard #797 and ANSI C80.3 and shall be listed by a NRTL with follow up service.
B. Connections to all motors or other equipment subject to vibration, thermal movement or requiring the flexibility to be moved aside during maintenance shall be made with liquid-tight flexible conduit with proper end fittings. The length of the flexible conduit shall not exceed 36"
C. All conduits entering enclosures shall enter either form the side or bottom. Top entries will not be permitted. All power conduits shall be a minimum of ¾" trade size. All control and instrumentation conduit shall be a minimum of ½" trade size.
D. Electrical Metallic Tubing (EMT) that meets the requirements of UL 797 Electrical Metallic Tubing - Steel, ANSI C80.3 - Steel Electrical Metallic Tubing (EMT), and ANSI/NFPA 70 National Electrical Code, Article 358.
E. For Electrical Metallic Tubing, furnish zinc-plated steel or zinc-plated malleable iron fittings bodies that meet the requirements of UL 514B Conduit, Tubing, and Cable Fittings, and ANSI/NEMA FB1 Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable. Connectors should have insulated throat.
F. Associated fittings shall meet the requirements of UL and ANSI C80 standards for the applicable raceway system, except IMC which uses UL 6 and C80.1 compliant nipples, elbows and couplings.
G. Splices shall not be permitted in power, lighting, control or instrumentation wiring.
H. No run of conduit shall contain more than the equivalent of four 90 degree bends for a total of 360 degrees including those immediately at outlets or fittings. Bend in the conduit shall be made without reducing the internal diameter of the conduit.
I. All conduit runs shall be rigidly supported. Each conduit shall be supported within 1 foot of junction boxes and fittings. Piping shall not be utilized for conduit support.

## 2.06 FINISHING

A. The system manufacturer shall operate and maintain a coating application facility that is in compliance with EPA, OSHA and all local & state code requirements. All coating technicians shall have current OSHA documentation stating they have been tested for the use of approved respirators in the application of industrial coatings.
B. All equipment nameplates including but not limited to pumps, motors, vessels, control panels shall be masked off prior to coating. The masking shall be removed prior to shipment leaving a clean and legible nameplate.
C. All steel components shall be cleaned, degreased and coated per the specification below:
   1. Standard - Mild Exposure Surface Preparation – SSPC-SP1 solvent cleaning. Remove all surface contaminants such as dirt, grease, milling oil, or any other latent chemicals that may reduce adhesion. First Coat – Polyester Urethane applied at 3-5 MDFT directly to prepared substrate.
   2. Optional - Moderate Exposure Surface Preparation – SSPC-SP10 abrasive blasting to a near white metal finish resulting in a 1.5 to 2.5 mil surface profile. First Coat - Polyester Urethane applied at 3-5 MDFT directly to prepared substrate.
   3. Optional - Severe Exposure Surface Preparation – SSPC-SP10 abrasive blasting to a near white metal finish resulting in a 1.5 to 2.5 mil surface profile. First Coat – Zinc Rich Epoxy at 3-4 MDFT directly to prepared substrate. Second Coat - Polyester Urethane applied at 3-5 MDFT directly to the zinc rich epoxy.

## 2.07 TESTING

A. Testing Facility
   The manufacturer of the packaged pumping system shall maintain an operating testing facility at the point of manufacturer of the pumping system. The complete pumping systems subsystems shall be completely tested as a unit. This includes but is not limited to hydrostatic, electrical and performance tests. The test shall include each component and feature of the assembled unit including all remote mounted instruments. The complete testing facility shall include flow meters, pressure gauges, watt meters, digital multimeter, tachometer, and differential pressure transmitters for measuring system performance. The entire testing facility shall be traceable to NIST standards and have documentation of yearly calibration of instruments as required.
B. Factory Tests
   1. After factory assembly is complete the entire pumping system shall be hydrostatically tested as a complete unit. The system shall be tested at 150 PSIG or 150% of working pressure whichever is higher for a minimum of one hour.
   2. Each pump on the system shall be individually tested for performance at full speed. Pump performance measurements shall include shut-off pressure and pump TDH and motor FLS (full load amps) at 25%. 50%, 75% and 100% of the pumps design capacity.
   3. Each pumping system controller must be designed, built and tested at a U.L. 508A facility that is the same as the pumping system manufacturer prior to integrating with the pumping system. Testing shall be in accordance with U.L.508A procedures and include as a minimum verification of wiring, component operation, programming and sequencing.
   4. The pumping system shall be connected to a test tank of sufficient capacity to perform the testing. The tank shall be coated with an NSF approved coating so as not to impart contaminants into the pumping system. The system shall be connected to the tank with all the actual components, valves and sensors specific to this project. During the test any calibrations or adjustments that are required for correct system operation shall be performed. All controls, sequencing and alarms shall be tested verified and documented prior to removal from the testing facility. These tests may be witnessed by the contractor, commissioning agent, owner or engineer if required.
   5. All testing shall be performed with NIST traceable equipment. The NIST traceable instrumentation shall be independently calibrated and tested in accordance with NIST and Hydraulic institute standards.

C. INSPECTIONS VERIFICATION AND PERFORMANCE
   1. The manufacturer of the pumping station shall provide access to the owner or his representative to the manufacturing facility at any time during the fabrication of the pumping system. All testing and production documents shall be made available to the owner or his representative at his request.
   2. Upon completion of fabrication and system testing a written report certified by a company officer of the manufacturing company shall be provided to the owner's representative. This form may be requested prior to release of the system for shipping but shall not affect the payment terms of the contract.

**PART 3 – EXECUTION**

**3.01 INSTALLATION**

A. The contractor shall off load, store, locate, level, anchor, pipe & wire the system and the remote components in accordance with the manufacturers recommendations.
B. Alignment: The system skid shall be set in place in a level state. The base mounted pumps shall be aligned by the contractor after installation of all associated piping and wiring. The pump alignment shall be performed by a qualified millwright and documentations stating such shall be submitted as part of the warranty activation program.
C. The owners' representatives or the contractor shall confirm in writing that all the components necessary for a complete and proper startup and commissioning are installed, piped, wired and operational prior to scheduling startup. A system startup request form shall be filled out and signed by the contractor or owners representative and returned to the factory to certify readiness. This document si part of the warranty activation program as well.
D. All piping in the building chilled water system shall be thoroughly cleaned and free of debris, dirt, welding slag, sand and other impurities. After flushing the system and removable of startup strainers the system shall be deemed ready for service and pumping may commence.
E. During initial start up the contractor shall under the supervision and assistance of the manufacturer or his authorized representative, adjust all mechanical and electrical components to make the system operate properly under actual site conditions.
F. Demonstration – After all field adjustments have been completed, the owner and/or his representatives will receive a through demonstration of the system operation and will receive training in the correct operation, adjustment of all components as well as component maintenance.
G. Optional – The system manufacturer and his representative shall provide up to two (2) 8 hour training days, during not more than one (1) trip to the jobsite for startup, adjustment and training of the owner's personal on the operation and maintenance of the packaged pumping equipment.

END OF SECTION