

**Giant Springs Trout Hatchery Pump & Control Project (FWP #7173110)**  
**SPECIFICATIONS LIST – Bid Set**

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## **SPECIAL PROVISIONS:**

### **1. CONTRACT TIME AND CONSTRUCTION SCHEDULE**

**A period of 90 calendar days is allowed for the Work.** Construction tasks requiring flow shut-off to the Rearing Building cannot begin until August 1<sup>st</sup>, and tasks requiring flow shut-off to the Outdoor Raceways cannot begin until September 20<sup>th</sup>. The Owner anticipates issuing a Notice to Proceed upon request from the Contractor to accommodate these timeframes, with Submittal review allowed beforehand. The Contract Time may be temporarily suspended at the Contractor's request and with the Owner's concurrence if major equipment deliveries become protracted. The Owner's goal is to have construction completed by the end of October while Hatchery fish populations are at a seasonal low, and the Owner will need to relocate fewer fish because of construction-related water supply interruptions.

### **2. CONTRACTOR'S FLOW INTERRUPTION PLAN**

The Contractor is advised that (spring) water flow to the Hatchery's Outdoor Raceways, Show Pond, and Rearing Building facilities must be maintained a normal flowrates, other than the allowable times for flow interruption listed below. This is critical to maintain viability of resident fish, fry, and eggs.

In conjunction with his/her Construction Schedule submittal, the Contractor shall clearly identify (by date and time) those exact intervals during which water supply flows to any Hatchery facilities are proposed to be reduced or interrupted. This is necessary in order for the Hatchery to reduce resident populations or transport resident fish off the premises during those periods.

At least 30 days prior to any construction mobilization or activity at the site, the Contractor shall submit the Flow Interruption Plan conforming to the requirements above for Submittal review.

### **3. ENGINEER AS "ADDITIONAL INSURED" ON CONTRACTOR'S INSURANCE**

In addition to the requirements of Section 11.2.4 of the General Conditions, the Contractor shall add to all policies and coverages the necessary endorsements for the Engineer (Beard Environmental & Technical Assistance, LLC, d.b.a. BETA) to be listed as an Additional Insured party.

### **4. CONSTRUCTION SURVEY BY CONTRACTOR**

The Contractor shall provide with his/her own equipment, tools, material and labor, all other horizontal and vertical control necessary to install the work within the tolerances shown and specified. The Contractor shall be responsible for any surveying and construction staking necessary for the improvements.

Survey discrepancies between Drawings, Specifications, and existing conditions shall be referred to the Engineer for adjustment before work is performed.

The Contractor is cautioned that survey control points as reported on the 1985 (Rearing Building construction) Plans do not agree with the subsequent datum used in the 1999 Pumphouse construction. [The 1985 and 1999 Plans are available on request.]

## 5. WATER POLLUTION & SEDIMENT CONTROL

The Contractor shall comply with all laws and regulations of MDEQ and the USEPA regarding pollution of the environment. The Contractor shall take necessary precautions to prevent pollution of surface and ground waters with fuels, oils, bitumen, chemicals, or other harmful materials.

The Contractor shall make his/her own determination if a Storm Water Pollution Prevention Plan (SWPPP) is required, and if so, execution of that process and payment of associated fees.

Sediment control provisions shall be used whenever excavation is done adjacent to drainage ways or Hatchery open waterways to control silt in runoff. Adequate silt barriers or sediment traps shall be used. Trench dewatering water shall be impounded and settled or filtered prior to discharge.

## 6. SANITARY FACILITIES

The Contractor shall furnish, install and maintain sanitary facilities for his/her workers, including an adequate number of enclosed portable toilets. The Park's and Hatchery's restrooms are not to be used by construction workers.

## 7. SYSTEM TESTING & DEMONSTRATION

Functional and Performance Tests as described below are required for the new PLC-controlled pumping systems, including VFDs and SoftStart sequencing, level transmitter, flowmeter, and flow sensors, and float switch alarms. System testing and demonstration requirements are in addition to requirements for Manufacturers Field Services, as specified in individual equipment Specifications.

- A. Field Tests:
  - 1. Functional Test:
    - a. Prior to startup, all equipment shall be inspected for proper alignment, quiet operation, proper connection, and satisfactory performance by means of a field Functional Test.
    - b. Functional testing may be conducted concurrently with the Manufacturers' Field Services specified in the respective control and pump equipment sections of these Specifications. Manufacturer's Field Services shall nonetheless meet both the topical and time requirements specified therein, excluding any delays caused by Functional Test problems or failures.
    - c. Prior to the Performance Test, all supporting control, monitoring alarm, and flow delivery systems shall be in place, tested, and functional. The Functional Test shall be satisfactorily passed to the satisfaction of the Engineer, before proceeding to the Performance Test, below.
  - 2. Performance Test:
    - a. Ahead of performance testing, the Contractor shall provide a written Performance Testing Plan(s) for each sub-system, indicating methods to be used and step-by-step tests to be conducted, along with the proposed time and date for testing.

- b. Field Performance Tests shall be performed individually on each newly installed pump or set of pumps and include simulated failure of each “Lead” (VFD) pump in order to trigger the backup “Follower” (SoftStart) pump(s). The tests shall demonstrate compliance with the specified performance. Data shall be recorded as follows:
  - i. Flow, as measured by effluent flow meter, and
  - ii. Discharge pressure simultaneously measured by pressure gage in flowmeter vault.
  - iii. Continuous recording of Rearing Building Packed Column Aerator Receiving Sump levels during testing.
- c. Performance Test of each pumping system shall be demonstrated and tested over their full “low to high” flow range – using simulated level inputs for Rearing Pumps, and manual flow selection at the PLC for Raceway Pumps. Pumphouse Wet Well level float switch controls shall also be successfully demonstrated both in “high alarm” and “low level shutdown” modes.
- d. Hatchery spring water will be available to the Contractor for testing, and can be discharged through Outdoor Raceways or the Rearing Building.
- g. If any Performance Tests fail or do not achieve the operation shown and specified, the Contractor shall correct deficiencies and repeat the Performance Test until successful.
- h. After successful performance testing to the satisfaction of the Engineer, the Contractor may proceed with full commissioning of the new system.

**B. Testing Certifications:**

The following shall be provided:

- 1. Manufacturer's Certification of “proper installation” and “successful performance testing” for each pump and control system.
- 2. Field Functional Test reports, including test data.
- 3. Performance Test reports, including test data.

**8. PERMITTING**

The Contractor is responsible for acquiring all construction permits necessary for the project. Required permits include, but may not be limited to the following:

- Electrical permit.

**9. MEASUREMENT & PAYMENT**

9.1 Scope: This section described the method of measurements and the basis of payment for all work covered by the Contract. For purposes of this Contract, this Measurement & Payment section shall govern and shall take precedence over all other references to measurement and payment referenced in the Specifications.

The basis of payment for each bid item listed on the Bid Proposal shall be as follows:

9.2 Mobilization, Bonding & Insurance (Not to Exceed 10.00% of Total Bid)

- A. Work Included:
- i. Transport, cleaning and setup of all equipment, materials and other items needed to complete the project.
  - ii. Bonding and insurance.
  - iii. Preparation, review, and submittal of the Construction Schedule with regular updates; the Flow Interruption Plan; and equipment and materials submittals, including modification and resubmittal when required.
  - iv. Traffic and pedestrian control, including construction signage, protective barriers, and all safety provisions necessary to protect Hatchery and Park visitors and staff.
  - v. Site access provisions.
  - vi. Provision of any elective on-site electrical power for construction, and provision of temporary sanitary facilities for workers.
  - vii. Site(s) cleanup and equipment de-mobilization.
  - viii. Contractor Reports and Certifications upon completion of the Work.
- B. Measurement: Measurement shall be one lump sum bid item, not exceeding 10% of the total bid.
- C. Payment: Payment will be allowed at 100% of this lump sum bid item once the Contractor is fully mobilized on site, bonds and insurance certificates are provided and approved, and a Construction Schedule is submitted and approved.

9.3 Lump Sum Bid Price for Pump & Control Upgrades:

- A. The Lump Sum for the Pump & Control Upgrades as entered on the Bid Proposal shall cover all work shown on the Drawings and required by the Specifications and other Contract documents. All costs in connection with the Work, including furnishing all materials, equipment, supplies and appurtenances; providing all required construction support plans, equipment and tools; constructing and maintaining dewatering and shoring systems; and performing all necessary labor and supervision to fully complete the Work, shall be included in the Lump Sum price in the Bid Proposal. The cost of all such incidentals shall be included in the Lump Sum bid price.
- B. The Drawings and Specifications do not necessarily portray all of the incidental items required to complete the Work. Also considered incidental to the Work are preparation, review and furnishing of material and equipment Submittals, including modification and resubmittal when required. The bid price shall also include all performance testing, and manufacturer-assisted startup and Owner training as specified; re-testing and repairs if/as necessary; and furnishing spare parts where specified. Mandatory code inspections and permits shall also be incidental to the work.
- C. Measurement: Measurement shall be per this lump sum bid item, with increments of completion measured based on the approved Schedule of Values submittal.

- D. Payment: Payment shall be per this lump sum bid item, with interim progress payments allowed for measured incremental completion based on the approved Schedule of Values submittal.

#### 9.4 Inclusiveness of Bid Price(s):

The total amount shown on the Bid Proposal shall be the Contract Price, unless otherwise adjusted by Change Order.

No item that is required by the Contract Documents for the proper and successful completion of the work will be paid for outside of or in addition to the Lump Sum prices submitted in the Bid Proposal. All work not specifically set forth as a pay item in the Bid Proposal shall be considered a subsidiary obligation of the Contractor, and all costs in connection therewith shall be included in the prices bid.

### **10. EXPLORATORY EXCAVATION FOR EXISTING CISTERN LINES**

As shown on the Drawings, the existing Cistern that feeds the Rearing Building will be abandoned. Existing pipelines to/from the Cistern must be located, cut, and plugged to divert Rearing Pump flow directly into the building. Exploratory excavation will be necessary to locate and expose the existing lines to be cut and plugged. Existing plan records (see Drawings) are limited and partly contradictory; no pipe depth information is noted [The 1985 and 1999 Hatchery plans, and the 1993 Park Comfort Stations plans are available on request.

Exploratory excavation for pipeline location is considered incidental to the Work, and no additional compensation will be allowed.

### **11. EXCAVATIONS IN GIANT SPRINGS STATE PARK**

Excavation of existing pipelines to be modified for Cistern Abandonment will occur in Giant Springs State Park. As such, construction, restoration, and protection of the public must be appropriate to the Park environment. Specific requirements for concrete and vegetative restoration apply – see Technical Specifications.

Excavations and operating machinery must be safely and fully isolated from contact or incursion by the public, using signage and barriers as the Contractor deems appropriate. The Contractor shall prepare and provide a Safety and Signage Plan for his/her excavation and work within the State Park per the requirements for Submittal Review; the Plan will be subject to concurrence by the Owner.

The State Park Comfort Station (restroom) on the west end of the Rearing Building may be temporarily closed and signed accordingly during the Contractor's work on Cistern Abandonment piping modifications. The Contractor must provide 7 calendar days written notice to Giant Springs State Park before temporarily closing the Comfort Station.

### **12. AIR QUALITY COMPLIANCE**

Best Management Practices shall be observed by the Contractor to mitigate release of airborne particulates from fugitive dust and vehicle/equipment emissions.

### **13. HISTORICAL AND ARCHAEOLOGICAL SITES**

No known historical or archaeological sites are anticipated to be encountered in the construction area(s). In the event that cultural, historical or archaeological materials are inadvertently encountered during the conduct of the Work, the Contractor shall prevent further disturbance to such items and immediately notify the Owner and the Engineer, who will contact the Montana State Historic Preservation Office for investigation.

### **14. ELECTRICAL POWER**

The Contractor may use Hatchery Pumphouse or Rearing Building electrical power (through existing outlets) for 110V tools and equipment for construction activity requiring no more than 40A in aggregate connected load at each building. The Contractor is responsible for full repair of any damage to the existing electrical systems from his/her use of Hatchery power.

For greater power requirements or higher voltage, the Contractor shall provide portable generators or a temporary power drop (from Northwestern Energy), but at his/her sole cost.

Once new dosing pumps and controls are placed, wired and ready for testing, Hatchery 480V and 110V power will be provided without cost to the Contractor for pump and instrumentation startup, testing, troubleshooting, and system demonstration purposes.

### **15. NOXIOUS WEED AND WHIRLING DISEASE DETERRENCE**

The Contractor shall be solely responsible for effective noxious weed deterrence during the course of construction. The Contractor shall thoroughly power-wash all delivery and construction equipment and vehicles prior to their entry or re-entry onto the work site within Giant Springs State Park. Materials to be brought into the State Park site shall be cleaned and handled in a manner to avoid introduction of weed remnants or seeds.

To deter Whirling Disease within the Hatchery, all Contractor equipment, tools, personal gear (including boots, waders, and gloves) used in areas of potential contact with Hatchery supply or raceway water shall be mud-free and bleach disinfected before being brought on-site (or upon reentering the work site after leaving).

### **16. WILDFIRE AWARENESS**

The Contractor is cautioned to conduct all operations on the work site(s) with fire safety and wildfire prevention in mind. No open burning is allowed, and all vehicles and equipment (including gas power tools) shall have effective, operable spark arrestors. Adequate fire extinguishers shall be on-board all equipment. The Contractor must comply with any Fire Restrictions promulgated by the State Park, Cascade County, or the State of Montana during the course of construction.

### **17. EXIST. GEN-SET AND TRANSFER SWITCH TESTING & ADJUSTMENT**

The 1999 existing *Olympian* model *D150P1* diesel-powered 187.5 kVA emergency generator in the Pumphouse supplies full backup power, with load-stepping, for the facility. Load is transferred through an MCC-mounted *Zenith Entelli-Switch 250* automatic transfer switch (ATS).

When the new MCC including pump VFDs and Reduced Voltage Soft Starters is added, the ATS and gen-set system will require testing with the new equipment loads, along with possible load-step adjustment. [See Electrical Specifications for detailed discussion and requirements.]

## **18. SOILS & GROUDWATER INFORMATION**

- 18.1 No soils information, soils logs, or groundwater (depth) information have been developed for this project, and no soils information can be located for past projects at the site.
- 18.2 The Montana Groundwater Information Center ( <http://mbmaggwic.mtech.edu> ) does list limited well logs in the area, including:
- GWIC Id#186590 for the Giant Springs State Park well (west of the Rearing Bldg.) where static water level is listed at 4 ft BGS in the 25 ft deep well; no soil lithology is reported.
  - Multiple shallow test wells directly east of the Outdoor Raceways where static water levels observed range from 1.2 to 5.1 ft BGS.
- 18.3 The limited information suggests that groundwater may be present in excavated trenches for Cistern Abandonment piping modifications, depending on existing pipe depth. The Contractor is cautioned that trench dewatering may be required. Dewatering, if required, is considered incidental to the Work, and no additional compensation will be allowed.



## *SECTION 01610*

### **GENERAL EQUIPMENT STIPULATIONS**

#### **PART 1: GENERAL**

##### 1.1 Section Includes

- A. All equipment furnished and installed under this Contract shall conform to the general stipulations set forth in this section except as otherwise specified in other sections.

##### 1.2 General

- A. **Manufacturer's Experience:** Unless specifically named in the Specifications, a manufacturer shall have furnished equipment of the type and size specified which has been in successful operation for not less than the past five years.
- B. **Coordination:** Contractor shall coordinate all details of the equipment with other related parts of the Work, including verification that the structures, piping, wiring and equipment components are compatible. Contractor shall be responsible for all structural and other alterations in the Work required to accommodate equipment differing in dimensions or other characteristics from that contemplated in the Contract Drawings or Specifications.
- C. **Workmanship and Materials**
  - 1. Supplier shall guarantee all equipment against faulty or inadequate design, improper assembly or erection, defective workmanship or materials, and leakage, breakage, or other failure. Materials shall be suitable for service conditions.
  - 2. All equipment shall be designed, fabricated, and assembled in accordance with recognized and acceptable engineering and shop practice. Individual parts shall be manufactured to standard sizes and gauges so that repair parts, furnished at any time, can be installed in the field. Like parts of duplicate units shall be interchangeable. Equipment shall not have been in service at any time prior to delivery, except as required by tests.
  - 3. Except where otherwise specified, structural and miscellaneous fabricated steel used in equipment shall conform to AISC standards. All structural members shall be designed for shock or vibratory loads. Unless otherwise specified, all steel which will be submerged, all or in part, during normal operation of the equipment shall be at least 1/4-inch thick.

D. Value Engineering

1. Manufacturer may submit for review and approval proposed modifications to the design, materials or arrangements specified. Request shall clearly state the advantages, cost savings or other reasons for the proposed change. Acceptance of any proposed changes will be the sole discretion of the Engineer as proscribed under the "or equal" and "substitute item" clauses of the General Conditions.

E. Seismic Loading Design Provisions

1. Machinery, equipment, and components such as tanks, piping, and electrical panels, including their supports and anchorages, designed by manufacturers or suppliers, shall be designed in accordance with the provisions of the latest edition of the International Building Code to withstand seismic loads for the project area in addition to other loads. Design shall be performed by a licensed professional engineer familiar with seismic design. Submittals shall be certified, by the Design Engineer, that equipment designs conform to all applicable IBC requirements including provisions to withstand seismic loads.

F. Elevation

1. The elevation of the site is approximately 3300 feet above MSL. All equipment furnished shall be designed to meet stipulated conditions and to operate satisfactorily at this elevation.

G. Manufacturers' Reference

1. The use of a manufacturer's name, model or catalog number is intended to establish a standard of quality and the general configuration required, subject to the requirements for Submittal review.

H. Single Source

1. Like items of equipment shall be the end product of one manufacturer in order to achieve standardization. A single manufacturer is required to supply and warranty the new MCC including VFDs and SoftStarts to be supplied on this Project.

I. Manufacturer's Representative

1. Manufacturer shall provide a Manufacturer's Representative as required to assist in the installation, adjustment, startup, certification and operating training.

2. Manufacturer's Representative shall be an employee or certified sales representative of the manufacturer who is factory trained and knowledgeable in the technical aspects of the products and systems.
3. When the services of the representative are specifically required for a listed time period, "days" shall represent 8-hour full days, exclusive of Saturdays, Sundays and holidays. Travel time is considered incidental to the work and will not apply to the required listed time.
4. The Contractor shall make clear and audible video recordings of the full duration all "Operator Training" portions of the manufacturer's representatives' on-site services. Duplicate copies of these video recordings in a commonly readable electronic format shall be provided to the Engineer on previously unused USB flash drives.
4. If listed time is not required by or is modified by determination of the Owner after Contract award, an appropriate adjustment in payment shall be made.
5. If the provided Manufacturer's Representative is found deficient in training or experience by the Owner or Engineer, the manufacturer shall furnish another acceptable representative.

### 1.3 Submittals

#### A. General

1. **Submittals and shop drawings for review and approval shall be submitted electronically** to the Engineer at [beta97@blackfoot.net](mailto:beta97@blackfoot.net). All electronically provided submittals must be in no larger than 11x17 paper-size format and must bear signature or other notation indicating the Contractor's own review and approval prior to submission. The governing Technical Specification section(s) for each submittal shall also be indicated therein by the Contractor.
2. The submittals shall include satisfactory identification of items, units, and assemblies in relation to the Specification section number, and the system or equipment identification or tag number shown on the Drawings, or as provided in the applicable specification section.
3. Should the Contractor propose any item on his/her shop drawings, or incorporate an item into the work, and that item should subsequently prove to be defective or otherwise unsatisfactory, (regardless of the Engineer's preliminary review), the Contractor shall, at his/her own expense, replace the item with another item that will perform satisfactorily.

4. See also Submittal requirements of Article 3.12 of General Conditions.

B. Shop Drawings

1. The Supplier shall submit, as applicable, the following for all prefabricated or manufactured structural, mechanical, electrical, plumbing, process systems, and equipment
2. Shop drawings or equipment drawings, including dimensions, size and location of connections to other work, and weight of equipment.
3. Catalog information and cuts
4. Installation or placing drawings for equipment, drives, and bases
5. Supporting calculations for equipment and associated supports specified to be designed by equipment manufacturers or suppliers.
6. Wiring and control diagrams of systems and equipment.
7. Complete manufacturer's specifications, including materials description and painting system.
8. List of special motor features being provided (i.e., space heaters, altitude corrections, thermal protectors, etc.).
9. Complete motor rating for all motors, including inverter-duty, motor no-load, starting, and full-load current at rated voltage; full-load speed and full-load current at 110 percent voltage; motor efficiency and power factor at 1/2, 3/4, and full load at rated voltage.
10. Performance data and pump curves, including pump head-capacity at reduced speeds by 100 rpm increments for all pumps called for VFD operation.
11. List of spare parts to be furnished under the Contract.
12. List of any additional manufacturer-recommended spare parts with current price information.
13. List of special tools required for checking, testing, parts replacement, and maintenance (Special tools are those which have been specially designed or adapted for use on parts of the equipment, and which are not customarily and routinely carried by maintenance mechanics).

14. List of special tools furnished with the equipment.
15. List of materials and supplies required for the equipment prior to, and during startup.
16. List of lubricants and supplies furnished with the equipment.
17. Samples of finish colors for selection, if/as applicable.
18. Special handling instructions.
19. Requirements for storage and protection prior to installation.
20. Requirements for installation and recommended installation procedures.
21. Requirements for routine maintenance required prior to equipment startup.
22. List of all requested exceptions to the Contract Documents.

C. Submittals Required for Foreign-Manufactured Items

1. In addition to the submittal requirements stated above, suppliers of foreign-manufactured items shall submit the names and addresses of companies within the United States that maintain technical service representatives and a complete inventory of spare parts and accessories for each foreign-made item proposed for incorporation into the work. Failure to prove the foregoing capabilities shall be just cause for rejection of the foreign-manufactured items.

D. Interface Information (Connection and Relationship with Other Work)

1. Where called for in the Specifications, and as determined to be necessary by the Engineer, interface information shall be submitted as specified. This interface information shall be accurate, and contain all information necessary to allow the completion of detail design and construction of the interfacing or connecting work.

E. Certification of Compliance

1. Where specified, furnish certification of compliance for products specified to a recognized standard or code prior to the use of such products in the work.
2. Certifications shall be signed by the manufacturer of the product; state that the components involved comply in all respects with the requirements of the Specifications.

3. Products used on the basis of a certification of compliance may be sampled and tested at any time. The fact that a product is used on the basis of a certification of compliance shall not relieve Contractor of responsibility for incorporating products in the work which conforms to requirements of the Contract. Products not conforming to such requirements will be subject to rejection whether in-place or not.
4. Engineer reserves the right to refuse permission for use of products on the basis of a certification of compliance.

F. Manufacturer's Certification of Proper Installation

1. When manufacturer's certification is required in the Specifications, the manufacturer shall provide certification stating the following:
  - a. The product or system has been installed in accordance with the manufacturer's recommendations.
  - b. The product or system has been inspected by a manufacturer's authorized representative.
  - c. The product or system has been serviced with the proper lubricants.
  - d. Applicable safety equipment has been properly installed.
  - e. Proper electrical and mechanical connections have been made.
  - f. Proper adjustments have been made and the product or system is ready for functional testing, plant startup, and operation.

G. Functional Test Certification

1. Where a certification of functional testing is specified for certain equipment, Contractor (as applicable to the equipment furnished) shall state in writing that:
  - a. Necessary hydraulic structures, pumps, valves, etc., and have been successfully tested.
  - b. Necessary equipment systems and subsystems have been checked for proper installation, started, and successfully tested to indicate they are operational.
  - c. Adjustments and calibrations have been made.
  - d. The systems and subsystems are capable of performing their intended functions.
  - e. The facilities are ready for performance testing, or for startup and intended operation, as applicable.

H. Performance Test Reports

1. Prepare and submit performance test reports where specified for equipment and systems.

## I. Shop Drawing Submittal Procedures

### 1. Procedures

- a. Combine submittals specified in each Specification section into a single package. Partial packages will not be reviewed until all submittals required for the section have been received.
- b. Sequentially number the transmittal forms; resubmittals to have original number with a decimal numeric suffix – for example, original Submittal No. 1.0, second (or resubmittal) Submittal No. 1.1, etc.
- c. Revise and resubmit submittals as required; identify all changes made since previous submittal.

## J. Accessories

1. All equipment shall be provided with the following accessories as applicable.
2. Safety Guards:
  - a. All belt or chain drives, fan blades, couplings, and other moving or rotating parts shall be covered on all sides by a safety guard in complete accordance with the requirements of OSHA. Safety guards shall be fabricated from 16 USS gauge or heavier galvanized or aluminum-clad sheet steel or 1/2 inch mesh galvanized expanded metal. Each guard shall be designed for easy installation and removal. All necessary supports and accessories shall be provided for each guard. Supports and accessories, including bolts, shall be galvanized. All safety guards in outdoor locations shall be designed to prevent the entrance of rain and dripping water.
3. Anchor Bolts:
  - a. Equipment manufacturers shall provide anchor bolt size, location and loads, including seismic loading. Anchor bolts will be provided by others, unless noted to be supplied by the equipment manufacturer in the Equipment Specifications.
4. Lifting Lugs:
  - a. Equipment weighing over 100 pounds shall be provided with lifting lugs.

5. Identification Plates:

- a. A 16-gauge stainless steel identification plate shall be securely mounted on each piece of equipment in a readily visible location. The plate shall bear the 1/4-inch die-stamped equipment identification number indicated in this Specification and/or shown on the Drawings.

6. Special Tools:

- a. Equipment requiring periodic repair and adjustment shall be furnished complete with all special tools, instruments, and accessories required for proper maintenance. Equipment requiring special devices for lifting or handling shall be furnished complete with those devices.

7. Spare Parts:

- a. Furnish all spare parts specified or purchased prior to requesting the issuance of a Certificate of Completion and/or operation of the equipment by the Owner.
- b. Spare parts and special tools shall be properly packaged to avoid damage, in their original cartons insofar as possible, and shall be stored in a location as determined by the Engineer. Any spare parts found to be damaged or otherwise inoperable at the time of delivery shall be replaced or, if approved by the Engineer, satisfactorily repaired.
- c. Spare parts and special tools shall be labeled with a minimum 3-inch by 6-inch manila spare parts tag with such information as the part description, the manufacturer's part number, the applicable equipment description and manufacturer, the quantity of parts delivered in each package, the applicable specification section, and the Contractor's and Project's name. This tag shall be firmly affixed to, and prominently displayed on the outside of each package.

K. Miscellaneous

1. Lubrication

- a. Equipment shall be adequately lubricated by systems which require attention no more frequently than weekly during continuous operation. Lubrication systems shall not require attention during startup or shutdown and shall not waste lubricants.



- b. Lubricants of the type recommended by the equipment manufacturer shall be provided in sufficient quantity to fill all lubricant reservoirs and to replace all consumption during testing, startup, and operation prior to acceptance of equipment by Owner.
- c. Lubrication facilities shall be convenient and accessible. Oil drains and fill openings shall be easily accessible from the normal operating area or platform. Drains shall allow for convenient collection of waste oil in containers from the normal operating area or platform without removing the unit from its normal installed position.

## 2. Shop Painting

- a. All steel and iron surfaces shall be protected by suitable paint or coatings applied in the shop meeting the requirements of TS 09900. Surfaces which will be inaccessible after assembly shall be protected for the life of the equipment. Exposed surfaces shall be finished, thoroughly cleaned, and filled as necessary to provide a smooth, uniform base for painting. Electric motors, speed reducers, starters, and other self-contained or enclosed components shall be coated with a high-grade, oil-resistant enamel. Coatings shall be suitable for the environment where the equipment is installed. Color shall be the manufacturer's standard, unless stated otherwise in the Technical Specifications.

## L. Preparation for Shipment

### 1. Preparation

- a. All equipment shall be suitably packaged to facilitate handling and protect against damage during transit and storage. All equipment shall be boxed, crated, or otherwise completely enclosed and protected during shipment, handling, and storage. All equipment shall be protected from exposure to the elements and shall be kept dry at all times.
- b. Painted surfaces shall be protected against impact, abrasion, discoloration, and other damage. Painted surfaces which are damaged prior to acceptance of equipment shall be repainted to the satisfaction of Engineer.
- c. Grease and lubricating oil shall be applied to all bearings and similar items.

- d. Each item of equipment shall be tagged or marked as identified in the delivery schedule or on the Shop Drawings. Complete packing lists and bills of material shall be included with each shipment.

M. Operation and Maintenance (O&M) Manuals

1. **The Contractor shall furnish four hard (4) copies of a complete manufacturer's manual for installation, operation, and maintenance** of each item of mechanical and electrical equipment or system. Each O&M manual furnished shall be clearly labeled to designate the system or equipment to which it applies, including reference to the governing Technical Specification section(s).
2. The manuals shall be furnished at least 21 calendar days prior to the scheduled start-up of the equipment item completion of the work; but in no case shall submission of the manuals be delayed beyond 75 percent completion point of the Work. Submission of the manuals shall precede payment for all work completed in excess of the 75 percent completion level on the particular equipment and systems for which the manuals are due. Any deficiencies found by the Engineer to exist in the manuals submitted shall be corrected within 30 calendar days following notification of the deficiencies.
3. Each instruction manual shall include, but not be limited to the following:
  - a. Diagrams and illustrations.
  - b. Detailed description of the function of each principal component of the system.
  - c. Performance and nameplate data.
  - d. Installation instructions.
  - e. Procedure for starting.
  - f. Proper adjustment.
  - g. Test procedures.
  - h. Procedure for operating.
  - i. Shutdown instructions.
  - j. Emergency operating instruction and troubleshooting guide.
  - k. Safety precautions.
  - l. Maintenance and overhaul instruction which shall include detailed assembly drawings with part numbers, parts list, instructions for ordering spare parts, and complete preventive maintenance instructions required to ensure satisfactory performance and longevity of the equipment.
  - m. Lubrication instructions, which shall list points to be greased or oiled, shall recommend type, grade, and temperature range of lubricants, and shall recommend frequency of lubrication.

- n. List of electrical relay settings and control and alarm contact settings.
  - o. Electrical interconnection wiring diagram for equipment furnished, including all control and lighting systems.
  - p. Troubleshooting guide.
- 4. Manuals shall be complete in all respects for all equipment, controls, accessories, and associated appurtenances.
  - 5. Manuals shall be assembled in one or more binders, each with title page, typed table of contents, and heavy section dividers with numbered plastic index tabs. Each manual shall be divided into sections paralleling the Equipment Specifications. Binders shall be three-ring, hard-back type. All data shall be punched for binding and composition and printing shall be arranged so that punching does not obliterate any data. The project title, division designation, and manual title printed thereon shall be as furnished by the Engineer.
  - 6. When more than one binder is required, they shall be labeled "Vol. 1," "Vol. 2," and so on. The table of contents for the entire set, identified by volume number, shall appear in each binder. Submit manual organization and format to the Engineer for approval prior to manual preparation.
  - 7. Each O&M Manual shall be transmitted to the Engineer prior to installation of the equipment and all equipment shall be serviced in accordance with the manufacturer's recommendations prior to operation. A service record shall be maintained on each item of equipment and shall be delivered to the Engineer prior to final acceptance of the project.

N. Maintenance Summary Form

- 1. Each equipment manufacturer shall furnish a completed Maintenance Summary Form for each piece of mechanical equipment supplied. A blank form shall also be included for the Owner's future use. The completed Maintenance Summary Form shall be included with the Shop Drawing submitted for each piece of equipment.
- 2. Maintenance tasks included on the Maintenance Summary Form shall include all routine operations required to ensure the satisfactory performance and longevity of the equipment. Examples include lubrication, belt tensioning, adjustment of pump packing glands, clearance adjustments, and other routine adjustments.

O. Warranty

1. A manufacturer's warranty is required for each piece of equipment, in addition to the Contractor Warranty, as defined in Article 3.5 of the Contract General Conditions.
2. The One-Year Contractor Warranty Period shall begin at the time of Owner acceptance of the installed system or equipment.

## SECTION 02050

### DEMOLITION

#### PART 1: GENERAL

##### 1.1 Description

- A. This section includes all labor and materials necessary for the work associated with the demolition of miscellaneous facilities as shown on the Drawings and specified herein. This section also covers clearing of trees, brush and vegetation as required for buried piping installations.

##### 1.2 Submittals

- A. The following submittals for construction shall be made in accordance with the requirements for Submittal Review. The Access and Excavation Plan for work within Giant Springs State Park will be subject to review and approval by the Montana Department of Fish, Wildlife & Parks, in addition to the Engineer's review.
  - 1. Demolition Plan, including all scheduling, sequencing and demolition methods to be used for existing equipment removal to facilitate replacement.
  - 2. Access and Excavation Plan, including extent, scheduling, sequencing, access, and equipment methods to be used for existing Cistern pipeline excavations within Giant Springs State Park.
  - 3. Handling and Disposal Plan, including methods and disposal location for all asbestos pipe and asbestos products encountered and removed for the Work.

##### 1.3 Site Conditions

- A. The Contractor shall satisfy himself/herself as to the conditions that exist at the site both prior to bidding and prior to construction.
- B. The Contractor shall confine his operation to within the Construction Limits as indicated on the Drawings.

#### PART 2: MATERIALS

(not applicable)

## **PART 3: EXECUTION**

### 3.1 Safety Requirements

- A. All work shall be done in conformance with the rules and regulations pertaining to safety established by the State of Montana, OSHA, local authorities, and as specified elsewhere in these specifications.

### 3.2 Utilities

- A. The Contractor shall be responsible for locating all utilities within the demolition area before any demolition is started. The Contractor shall not disconnect or cause interruption of service to any electrical, gas, or water or wastewater conveyance or treatment system without prior approval of the Owner and Engineer.

### 3.3 General Demolition

- A. The Drawings are based on the best available information and may not contain all items requiring removal. The Contractor shall be responsible for determining the work required by inspecting the site.
- B. All vegetative and non-vegetative debris generated by demolition shall be hauled off-site and disposed of by the Contractor in a legally permissible manner.
- C. The Contractor shall be solely responsible for de-energizing and locking out all electrical power to equipment being removed or modified, prior to removal or modification.

### 3.4 Clearing

- A. Trees, brush, and vegetative cover cleared for the conduct of the work and installation of new facilities shall be removed to full depth of vegetative roots, or 4' below grade, whichever is less. Voids left by root removal shall be filled with clean native soil, compacted to a density equal to *in situ* conditions.
- B. Rock removal necessary for the conduct of the work and installation of new facilities shall be removed to 5' below grade. Blasting for rock removal shall not be allowed. Voids left by rock removal shall be filled with clean native soil, compacted to a density equal to *in situ* conditions.
- C. Vegetative clearing or rock removal at the site of Cistern Abandonment piping modifications shall be done with minimal equipment intrusion and Park vegetation disruption.

- D. Vegetative clearing for Cistern Abandonment piping modifications shall be confined to construction limits as shown on the Drawings, in order to minimize disruption to the Park environment.

### 3.5 Demolished and Cleared Material

- A. Any mechanical or electrical equipment which is called on the Drawings to be salvaged to the Owner shall be delivered and placed at a location selected by the Owner.
- B. All other materials including excavated materials, rock, vegetation, asbestos cement pipe remnants and cuttings, electrical equipment and wiring, pumps and motors, and piping demolished shall be the responsibility of the Contractor for removal and legal disposal and shall be accomplished at no additional cost to the Owner.
- C. Demolished or cleared material shall not be allowed to obstruct free access and shall be promptly removed from Hatchery and Park property.

## SECTION 02210

### EXCAVATION & BACKFILL

#### 1. GENERAL

##### 1.1 DESCRIPTION

- A. This section covers the work necessary to excavate and backfill for Cistern Abandonment piping modifications, as shown on the Drawings.
- B. See also Piping & Appurtenances Specification for additional pipe installation requirements.

#### 2. MATERIALS

##### 2.1. GENERAL

- A. The following referenced specifications shall apply to all excavations and backfill placement:

Montana Public Works Standard Specifications (MPWSS) – 6<sup>th</sup> Edition (April 2010)

Section 02221 – Trench Excavation and Backfill for Pipelines and Appurtenant Structures

#### 3. MODIFICATIONS

##### 3.1 GENERAL

- A. Measurement and Payment Section does not apply.
- B. Detectable Warning Tape is required per *MPWSS* 02221-2.4 for all existing pipe exposed during excavations.
- C. Blasting provisions per *MPWSS* 02221-3.3.D do not apply. Blasting will not be allowed on the site.

##### 3.2 PREPARATIONS AND EXECUTION

- A. Contractor shall remove, segregate, and stockpile all native topsoil to its full depth prior to pipeline trench excavations. After backfilling, stockpiled topsoil shall be replaced in the upper excavation and compacted to 85 percent of maximum dry density as determined by AASHTO T99.



- B. Contractors are cautioned that the Stater Park has an underground irrigation system in place within the work area for which detailed maps are not available. The Contractor shall locate and preserve existing irrigation facilities to the maximum extent possible. Irrigation lines and sprinkler heads may be removed with the concurrence of the Park but must be replaced to the pre-project condition. Any removed/reinstalled irrigation equipment must be pressure tested and demonstrated operable after reinstallation.
- C. The Contractor shall be responsible to repair any damage to buried utilities or Park facilities and replace same if damaged to the pre-project condition and the full satisfaction of the Owner.
- D. Testing requirements for fill materials may be waived at the option of the Engineer.

#### 3.4 FINAL GRADING AND CLEANUP

- A. All exposed fill surfaces shall be fine-graded to  $\pm 1.0$  inches as measured across a five-foot span, and shall be suitable to receive seeding.
- B. The Contractor shall maintain a clean and non-hazardous work site to the satisfaction of the Owners. The Engineers, Montana FWP representatives, and State Park staff are not trained in construction safety, and work site safety is the sole responsibility of the Contractor, including protection of his/her personnel, the public, area residents and property, and all other property.
- C. The Contractor shall promptly clean up and properly dispose of all debris, litter, and leftover materials following completion of the Work and leave the site in conditions meeting the Owner's approval.

## SECTION 02600

### PIPELINES & APPURTENANCES

#### 1. GENERAL

##### A. DESCRIPTION

1. This section covers the work necessary to modify existing buried piping for Cistern Abandonment, as shown on the Drawings.
2. Existing buried piping to be modified is asbestos-cement; see Drawings and Demolition Specification for safety, handling, and disposal requirements.

#### 2. MATERIALS

##### A. GENERAL

1. The following referenced specifications shall apply to all buried pipelines for water service, including fittings, and the installation thereof, unless specifically modified below:

Montana Public Works Standard Specifications (MPWSS) – 6<sup>th</sup> Edition (April 2010)

Section 02660 – Water Distribution (applies to pressure pipelines)

#### 3. MODIFICATIONS

##### A. GENERAL

1. Measurement and Payment Section does not apply.
2. Specifications for Ductile Iron Pipe and Fittings per *MPWSS 02660-2.2.B* do not apply for exposed (Pumphouse) piping applications and shall be as called on the Drawings.
3. Specifications for PVC Pressure Pipe per *MPWSS 02660-2.2.C* do not apply for exposed piping (Pumphouse and Rearing Building) applications and shall be as called on the Drawings.
4. Specifications for Service Clamps (Saddles) per *MPWSS 02660-2.5* do not apply for exposed (Pumphouse and Rearing Building) piping applications, and service clamps and saddles shall be as called on the Drawings or otherwise specified.
5. See Excavation & Backfill Specification for pipe bedding requirements.
6. Performing pressure testing per *MPWSS 02660-3.4* is not required for the new plugs installed on existing pipelines being retained with Cistern Abandonment.

**End of Section**

## SECTION 02910

### SEEDING AND SODDING

#### 1. GENERAL

##### A. DESCRIPTION

1. This section covers the work necessary for sod replacement on all un-paved Giant Springs State Park areas disturbed by construction.
2. Re-seeding of disturbed areas within the Park is not allowed, and sodding is required.

#### 2. MATERIALS

##### A. GENERAL

1. The following referenced specifications shall apply to all seeding, sodding, fertilizing and related activities, unless specifically modified below:

Montana Public Works Standard Specifications (MPWSS) – 6<sup>th</sup> Edition (April 2010)

Section 02910 – Seeding

#### 3. MODIFICATIONS

##### A. GENERAL

1. Measurement and Payment Section does not apply.
2. Hydraulic Seeding per *MPWSS 02920* is not allowed.

##### B. SOD

1. Sod shall have a good cover of living and growing grass, which includes grass that is seasonally dormant during cold or dry seasons but is capable of renewing growth after the dormant period. All sod shall be obtained from areas where the soil is fertile and contains a high percentage of loamy topsoil. Sod shall be cut or stripped from living, thickly matter turf relatively free of weeds or other undesirable plants, stones, or foreign roots. Sod shall be 100% Kentucky Bluegrass. Sod shall be cut with a sod cutter when harvested.
2. Sod, including the soil containing roots, shall be cut uniformly to a thickness not less than 2 inches.

3. Existing sod in the Park may be cut, carefully removed, rolled, and kept moist and viable for reuse in re-sodding, if care and handling meet the requirements herein. Any existing sod torn, fragmented, or in withered condition may not be reused. Reuse of existing sod does not relieve the Contractor of procuring additional sod as required to establish full sod coverage on unpaved, disturbed areas.

C. SOIL PREPARATION

1. All areas to be sodded shall be fine-graded and raked to a nominal surface profile of  $\pm 1/2$ " before fertilizer application or sod placement. All stones larger than 2-inch diameter, sticks and other debris shall be removed ahead of sod placement.
2. Sod may not be placed on frozen ground, and the sod itself cannot exhibit any frost or frozen conditions when placed.
3. Soil substrate shall be thoroughly watered immediately before sod placement, to establish moist conditions to a minimum soil depth of 4".

D. FERTILIZING

1. Fertilizer shall be applied to the prepared soil surface ahead of sod placement. Amendment shall inorganic dry chemical fertilizer with the following characteristics and application rates:
  - a. Nitrogen (elemental) 40 lb/ac
  - b. Phosphorous ( $P_2O_5$ ) 60 lb/ac
  - c. Potassium ( $K_2O$ ) 30 lb/ac
2. Fertilizer shall be used on all areas to receive sod.
3. Fertilizer application shall be by broadcast method in a uniform pattern, and protected from runoff or ponded water dissolution or concentration.

E. SOD PLACEMENT AND CARE

1. Sod placement shall be done on all completed project areas prior to October 15<sup>th</sup>, or after April 1<sup>st</sup>.
2. Sod strips shall be uniformly placed and butted completely together to leave no gaps or rills between adjacent sod pieces. Sod strips shall be trimmed to mate to existing turf along ends and edges.
3. The Contractor shall thoroughly hand-water placed sod immediately after placement, and twice daily for 7 days afterwards. Thereafter the Park irrigation system will provide ongoing watering.
4. Sod placed shall be protected against foot traffic by warning signs, suspended perimeter taping, or other barricades acceptable to the Owner for a period of 30 days after placement.

## SECTION 03300

### CONCRETE

#### 1. GENERAL

##### A. DESCRIPTION

1. This section covers new cast-in-place concrete and reinforcing steel for structure bases, valve/fitting thrust blocks, concrete sidewalk replacement, and non-shrink grout beneath equipment and pump bases.

#### 2. MATERIALS

##### A. GENERAL

1. The following referenced specifications shall apply to all concrete and reinforcing steel, and sidewalk replacements unless specifically modified below:

Montana Public Works Standard Specifications (MPWSS) – 6<sup>th</sup> Edition (April 2010)

Section 03210 – Reinforcing Steel

Section 03310 – Structural Concrete

Section 02529 – Concrete Sidewalks, Driveways, Approaches, Curb Turn  
Filletts, Valley Gutters, and Misc. New Concrete  
Construction

#### 3. MODIFICATIONS

##### A. GENERAL

1. Measurement and Payment Section does not apply.
2. All reinforcing steel shall be Grade 60.
3. *MPWSS* “Class M-3000” concrete shall be used for all applications.

##### B. NON-SHRINK GROUT

1. Non-shrink grout shall be used beneath new Rearing Pump bases to completely fill the void between bases and existing concrete pylons, after pump levelling.
2. Non-shrink grout shall be furnished factory-premixed so only water is added at the job site. Grout shall be mixed in a mechanical miser. No more water shall be used than necessary to produce a flowable grout.

3. Concrete substrates to receive non-shrink grout shall be thoroughly wetted and kept wet for 24 hours prior to grouting.
4. Grout shall be placed in accordance with the manufacturer's directions. Grout shall fill all spaces and cavities between equipment baseplates and concrete supports, completely filling the voids. Forms shall be provided to confine the grout, including the interior annulus of existing pump slab openings to avoid grout entering the Pumphouse Wet Well.
5. Exposed edges of grout shall be finished smooth at all locations where the top surface or edge of the grout will be exposed to view. Unless otherwise shown on the Drawings, exposed edges of grout pads shall be struck to a 45-deg slope after grout has reached its initial set.
6. Non-shrink grout shall be protected against moisture loss while curing by covering with wet rags or polyethylene sheets. Grout shall be wet-cured in this fashion for at least 7 days after placement.
7. Non-shrink ground shall be *Sika Grout 212*, or equal.

#### C. PUMPED CONCRETE

1. At the Contractor's option, concrete pumping may be used to reach portions of the work site. Where pumped concrete is used, mix formulation shall include plasticizer or other admixtures to enhance pumping characteristics, subject to the requirements for Submittal review.

#### D. CONCRETE MIX DESIGN AND TESTING

1. Where total quantities of cast-in-place concrete for the work do not exceed 10 cy, *MPWSS 03310* requirements for a Mix Design and for Concrete Testing may be waived at the discretion of the Engineer. If Mix Design and/or Testing requirements are waived, the Contractor and his/her concrete supplier will be required to furnish past documentation for similar mix designs and concrete test results.

#### E. PARK SIDEWALK REPLACEMENT

1. Where existing sidewalks must be removed for Cistern Abandonment piping modifications that have special architectural tinting, finishes or other aesthetic treatments, those sidewalks must be replaced in identical fashion to the pre-project condition.
2. Any sidewalks undermined by excavations for Cistern Abandonment piping modifications must be replaced to the pre-project condition. Horizontal tamping of fill to attempt to restore foundation integrity beneath existing sidewalks is not allowed.

## SECTION 11790

### VERTICAL TURBINE PUMPS

#### PART 1 GENERAL

##### 1. WORK INCLUDED

- A. This specification covers the provision and installation of two new (replacement) vertical turbine Rearing Pumps in the Hatchery Pumphouse. New Rearing Pumps will deliver water to the existing packed column aerator at the Rearing Building, and are controlled by the water level in the receiving sump under the packed column [see Process Instrumentation and Control Specification].
- B. A new VFD will regulate the “Lead” Rearing Pump and the other pump will operate as a “Follower” behind the “Lead” Pump [see Variable Frequency Drives Specification]. The “Follower” pumps will be equipped with a Reduced Voltage Soft Starter, housed in a new MCC along with the new VFD.
- C. See also the General Equipment Stipulations Section of these Specifications for other requirements of the new pumps, motor, and controls.

##### 2. SUBMITTALS

- A. Submittals for the vertical turbine pumps, motor, and controls shall conform to the requirements of the General Equipment Stipulations Section of these Specifications.
- B. Submittal data for the new vertical turbine pumps shall include:
  - 1. Pump performance curves at full RPM and multiple at least 5 intermediate speeds between the specified maximum/minimum specified operating points. Data shall include flow, TDH, horsepower demand, pump efficiency, and net positive suction head (NPSH) over the entire operating range of the pump, including shutoff head and manufacturer’s recommended maximum head-capacity condition for operation.
  - 2. Number of pump stages proposed for head-capacity conditions specified.
  - 3. Manufacturer’s minimum submergence requirements for pump.
  - 4. Cut-away drawing showing pump assembly and components.
  - 5. Dimensional drawing showing pump configuration, overall length, bowl placement, point of water intake, and discharge pipe connection height, offset and configuration.
  - 6. Materials of construction for all pump components.

7. Maximum pump up-thrust and/or down-thrust in pounds are specified operating condition.
  8. Pump motor electrical characteristics, horsepower, efficiency rating, and service factor.
  9. Pump motor electrical connection and required power cable details and materials.
  10. Pump motor construction materials and insulation, including packing and packing drain connection.
  11. Manufacturer's O&M Manual for pumps, including Installation Instructions.
  12. Manufacturer's statement of Warranty for pump and motor.
  13. Address and phone number of nearest manufacturer's certified service center for pump and motor.
  14. Factory hydro-testing and vibration testing of pumps is not required.
- C. References herein to manufacturer's name and model for pumps are intended to establish a level of quality for those items. Products of alternate manufacturers will be considered, subject to compliance with the specification requirements herein and the requirements for Submittal review.

### 3. ELECTRICAL

- A. Pump motor, controls, and wiring shall be in full accordance with the NEC and the requirements of the Electrical Section of these Specifications. Consult Drawings for primary power and disconnect requirements, and locations for pump and control equipment.

## **PART 2 MATERIALS**

### 1. GENERAL

- A. Pumps including motors shall be products distributed by a single manufacturer.
- B. Vertical turbine pumps and motors shall be factory assembled by the manufacturer.
- C. Vertical turbine pumps and motor shall be furnished complete with all accessories and appurtenances for a complete and functional installation, including motor leads, connectors, and cabling.

### 2. RESTRICTION OF GALVANIZED MATERIALS

- A. For fish health reasons, no exposed wetted pump components can be galvanized.

### 3. NEW REARING PUMP AND MOTOR CHARACTERISTICS



- A. New vertical turbine Rearing Pumps and motor shall meet the following operating conditions and characteristics:
1. 480V, 3-ph, 4-wire
  2. 3300' MSL site elevation
  3. Max. Nominal Speed: 1800 rpm (1200 rpm also permissible)
  4. **Max. Capacity (nominal): 700 gpm at 44 ft TDH\***
  5. **Min. Flow (at reduced RPM): 210 gpm at 30 ft TDH\***
  6. Minimum Shut-off Head (at full RPM): 56 ft
  7. Inverter-duty, premium efficiency motors – sized at least 115% of maximum pump HP draw.
  8. Minimum Submergence (to lowest point on bowl): not to exceed 30"
  9. Pumping medium: spring water
  10. Product lubricated
  11. Conventional packing with drains.
  12. "Top nut" impeller adjustment.
  13. Intake strainers: not required
  14. Exist. concrete pump bases have ¾" bolting at 20.0" O.C. each way (provide steel sole plate for pump head if required to match exist. bolting)
  15. Maximum OD of pump lower assembly: 11.250" [to match existing pumps and fit existing floor slab/pump pylon concrete openings].
- [\* note: discharge is an open outlet on an 8" vertical standpipe, so an overage in pump TDH can be dissipated.]
- B. Existing Rearing Pumps to be removed and replaced are *Floway 12DKL*, single-stage, 15hp, 1800 rpm [manufacturer's pump order and build records are available on request].
- C. Pump Materials of Construction:
1. Bowl assembly: The intermediate bowls, suction bell, and discharge bowl shall be flanged type constructed of close grained cast iron, and shall conform to ASTM designation A48, class 30. They shall be free from sand holes, blowholes, or other faults and must be accurately machined and fitted to close tolerances. Bowls shall have epoxy- or ceramic-lined waterways. All bowls shall be fitted with sleeve type bearings of bronze alloy C89835.
  2. Impellers: The impellers shall be constructed from Type 316 Stainless steel or nickel-aluminum-bronze and shall be the enclosed type. They shall be free from defects and must be accurately cast, machined for optimum performance and minimum vibration. Impellers are to be balanced to grade G6.3 of ISO 1940 as minimum. They shall be securely fastened to the bowl shaft with taper locks of C1018 steel and key and split thrust ring of SS. The impeller running position shall be adjustable by shaft adjusting nut in the discharge head or on top of the hollow shaft driver.

3. Suction: The suction bell shall be provided with a bronze bearing, and a bronze sand collar shall be incorporated in the pump design to protect this bearing from abrasives. The bearing housing shall have sufficient opening at the bottom for easy removal of the bearing.
4. Bowl Wear Ring: Bowl assembly shall be fitted with replaceable wear rings of C95200 bronze material in the suction bowl and intermediate bowls. Wear rings shall have the minimum practical clearance to the mating cylindrical surface of the impeller to provide adequate sealing independent of vertical positioning of the impellers.
5. Shaft: The bowl shaft shall be constructed from ASTM 582 type 416 stainless steel. It shall be precision turned and ground with surface finish better than 40 RMS and shall be supported by water lubricated bearings of C89835 bronze alloy.
6. Column pipe: The column pipe shall be furnished in sections not exceeding a nominal length of 10 ft and shall be connected by threaded-sleeve couplings or flanges. The length of the top and bottom sections shall not be more than 5 ft. It shall be of ASTM A53 grade A steel pipe and the weight shall be not less than schedule 30. The threaded pipe shall be with 8 threads per inch with 3/16" taper per foot thread and faced parallel to butt against the centering spiders to form accurate alignment. All column flange faces shall be parallel and machined for rabbet fit to permit accurate alignment. The inside diameter of the pipe shall be such that the head losses shall not be more than 5 feet per 100 feet of pipe.
7. Lineshaft: The lineshaft shall be furnished in interchangeable section not over five feet in length, and shall be coupled with threaded steel couplings machined from solid 316 stainless steel bar. It shall have left-hand thread to tighten during pump operation. The diameter of the shaft shall be based on a combined shear stress of not more than 18% of the ultimate strength or not excess of 30% of the elastic limit in tension of the shafting material. The coupling shall be designed with higher safety factor than shaft. Lineshaft and coupling shall be of type 416 stainless steel. Centering spiders shall be furnished at each column pipe joint for shaft stabilization. Bearings shall be fluted rubber.
8. Discharge Head: It shall be of the high profile type to allow shaft coupled above stuffing box and provided for mounting the driver and support the column and bowl assemblies it shall be of high-grade cast iron, ASTM A48 Class 30, or fabricated steel. The above ground outlet shall be flanged to match 8-inch ANSI class 125 (for cast iron) or class 150 (for steel). It shall have a 1/2" NPT connection for a pressure gauge.
9. Stuffing Box: The stuffing box shall be cast iron and shall contain a minimum of five rings of *Gore-Tex*, or *John Crane 1655C* graphite-impregnated packing with lantern ring. It shall have a pressure relief connection. The packing gland shall be a 316SS split type secured in place with noncorrosive studs and nuts. The bearing shall be C89835 bronze. A rubber slinger shall be secured to the shaft above the packing gland.

D. Pump Motors:

1. Pump motors shall be vertical hollow shaft squirrel cage premium efficiency inverter-duty motors, suitable for VFD operation. The motor shall comply with NEMA MG-1 standards and shall be NEMA WP-1. The motor shall operate below motor nameplate full load amps for all three phases, over the entire range of the pump curve. Motor insulation shall be Class H, or higher. The following motor information shall be stamped on a permanently affixed, engraved stainless steel motor nameplate:
  - a. Horsepower
  - b. Full load RPM
  - c. Voltage
  - d. Number of phases
  - e. Frequency
  - f. Service Factor
  - g. Design class
  - h. Motor insulation class
  - i. Ambient temperature rating
  - j. NEMA nominal efficiency
  - k. Motor power factor
  - l. Motor duty cycle
  - m. Frame size
  - n. Type
  - o. Full Load Current
  - p. Temperature rise class
2. The motor conduit box shall be provided with a grounding terminal. The conduit box shall be sized to handle required conduit and wire.
3. The motor windings shall be copper with not less than 98% conductivity.
4. The motor shall be capable of continuous operation at full load and at a voltage 10% above or below the rated voltage provided that the sum of voltage and the frequency variation does not exceed 10% with the frequency variation not exceeding 5%.
5. Motor bearings to be lubricated with grease shall be equipped with grease nipples and grease relief plugs. The thrust bearing(s) shall be oil-lubricated with accessible drain and fill plugs on the oil reservoir. The oil level on the reservoir shall be indicated by a sight gauge. The thrust bearing(s) shall have ample capacity to carry 125 percent of down-thrust at pump design performance. The bearing(s) shall have a life rating of at least 50,000 hours at the operating down-thrust presented by the pump assembly at design performance.
6. The motor shall be supplied with non-reverse ratchet, ball bearing type. The ratchet can be quickly fitted at any time or removed for servicing without disturbing the coupling or pump setting.
7. Pump motors shall be *General Electric*, or equal, subject to the requirements for Submittal Review.

## **PART 3 EXECUTION**

### **1. GENERAL**

- A. Vertical turbine pumps/motor assembly and controls shall be installed in full accordance with the manufacturer's recommendations. Manufacturer's O&M Manual including installation instructions shall be available for the vertical turbine pumps and controls, prior to installation.
- B. All electrical wiring, including grounding requirements, for the pump and controls shall meet NEC requirements, and the Electrical Section of these Specifications.

### **2. PUMP SETTING AND TESTING**

- A. After pump setting, the completed installation(s) shall be plumbed and aligned to full compliance with the manufacturer's specifications. Pump impeller clearance shall be carefully adjusted to within manufacturer's specifications, and motor lubrication shall be performed. Lantern rings and packing shall be installed and loosely adjusted.
- B. The Contractor shall verify proper pump rotation before making final electrical connections.
- C. The Contractor shall conduct functional tests in the presence of the Engineer, once the pump is set and all controls are operational.
  - 1. The test shall include operating the pump through a minimum of three start-stop cycles using "hand" operation through each pump's HOA switch. Pump motor amperage draw shall be checked by the Contractor during operation, and equipment shall be monitored for quiet operation, absence of vibration, motor coolness, proper function, and satisfactory performance. Pump packing glands shall be adjusted with pumps running to achieve 250 ml (~1 cup) weepage per minute (or as otherwise recommended by pump manufacturer). Pump discharge pressure shall be monitored by gauge by the Contractor during pump operation at a tap on the pump discharge, and flow measurements by the new Rearing Pump Flowmeter shall be conducted in the presence of the Engineer.
  - 2. Additionally an automated operation function test shall be conducted, using simulated signals if necessary to prompt the system to automatically modulate "Lead" pump speed, sequence "Follower" pump startup and shutdown.
  - 3. Any deficiencies in performance shall be remedied by the Contractor, and the functional tests repeated.

### **3. MANUFACTURER'S SERVICES**

- A. An authorized representative of the pump manufacturer shall provide on-site assistance to advise the Contractor during pump installation and inspect the completed pump and slide-rail system. A minimum of 8 hours of manufacturer's field representative time on site for installation is required.

- B. The pump manufacturer's representative shall also provide on-site training to the Owner in operation and maintenance of the pumps after installation. A minimum of 4 hours of manufacturer's field representative time on site for Owner training is required.
- C. Training of Owner's personnel shall be at such times as requested by the Owner, and may be at a later date than equipment installation and startup. The manufacturer's representative may be expected to make two separate trips to the jobsite without additional compensation.

4. WARRANTY

- A. The vertical turbine pumps and motor one-year warranty period shall commence as of the date of passage of the above functional tests.

**END OF SECTION 11790**

## SECTION 13400

### PROCESS INSTRUMENTATION & CONTROL

#### PART 1: GENERAL

##### 1.1 Description

- A. This section covers process instruments, transmitters, Programmable Logic Controllers (PLCs), and other instruments to be installed for system monitoring and control. Equipment covered in this section includes a magnetic flowmeter, level transmitter, PLCs and related modules, 24vdc power supplies, pressure gages, float switches and alarm panel, and an emergency phone dialer.
- B. Items specified in this section shall include all materials, equipment, and work required for implementation of completely operable instrumentation and control systems. Instruments shall include primary elements for process variable measurements, analog and discrete outputs, and display and control elements (where specified).
- C. The Contractor shall conduct all calibration adjustments, troubleshooting, and startup to assure instruments are properly operating and interfaced with other equipment.
- D. Instruments and controllers specified in this section are subject to the requirements of Section 01610 - General Equipment Stipulations.

##### 1.2 Submittals

- A. In addition to the requirements of Section 01610 - General Equipment Stipulations, the following documentation shall also be provided for this equipment and accompany other required submittals:
  - 1. Electrical drawings including circuit schematics, interconnection diagrams, and all information necessary for connection of electrical power and input/output circuits.
  - 2. Panel elementary diagrams of pre-wired panels, including identification of all switched analog signals and all auxiliary devices such as relays, alarms, fuses, and lights.

3. Interconnecting wiring diagrams to tie instruments to Owner's telemetry system where shown on the Drawings, including all component and panel terminal board identification numbers and external wire numbers. This diagram shall include all intermediate terminations between field elements and panels (e.g., terminal junction boxes, motor control centers, etc.)
4. Hydraulic characteristics and requirements for all flow-, pressure-, or level-related devices.
5. Any special options included for each instrument or its connecting cables.
6. The name, address, e-mail, and phone for the Contractor's proposed System Integrator, including a list of five past projects with comparable programming and system integration requirements using the brand of PLC equipment to be furnished on this project.
  - a. Include a proposed schedule for the System Integrator's work – including programming, field startup, and Owner training activities.
7. Manufacturer's ratings for each instrument, including:
  - a. Certified accuracy and precision (including repeatability).
  - b. Scale range.
  - c. Environmental tolerance (temperature, humidity, electrical induction isolation).
  - d. UL, ANSI, or other ratings.
8. Dimensional drawings, materials, and ratings for all instrument panels and enclosures.
9. Specifications, ratings, and power requirements for any heating or ventilating devices installed in instrument enclosures.

B. Spares Parts:

1. The Contractor shall provide a list of recommended spare parts and quantities to sustain equipment provided under this section. Unit and total costs for the recommended parts inventory shall be indicated.
2. In addition to the spare parts recommendations required above, the Contractor shall provide the following spare parts as part of this Contract (in the quantities indicated) meeting the specifications of this Section:
  - a. Uninstalled NO float switch – (1) each.

- C. Operating and Maintenance Manuals: Manufacturer's O & M manuals shall be provided for each instrument and controller per Section 01610 - General Equipment Stipulations.
- D. Record Drawings: The Contractor shall provide one set of record drawings in both hard copy and electronic format for any field-wired interconnects between instruments or controllers.

### 1.3 Responsibility for Complete System

- A. Unit Responsibility for Process Instruments: Unit responsibility for the Process Instruments shall be provided by the Contractor.
- B. The Contractor shall be responsible for coordination of the work to ensure that:
  - 1. All components provided under this section are properly installed.
  - 2. The proper type, size, and number of control wires with their conduits are provided and installed.
  - 3. Proper electric power and control circuits are provided for all components and systems.
  - 4. Instrumentation cable, power conductors, and conduits, and the installation thereof shall be provided and installed to meet the requirements of the Electrical Specification.

## **PART 2: MATERIALS**

### 2.1 General

- A. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.

### 2.2 Equipment Specifications

- A. Unless superseded by other specifications herein or the manufacturer's standard ratings for a referenced instrument brand and model, all instruments shall be capable of the following minimum accuracy and precision:
  - 1. Accuracy: plus-or-minus 1.0% of full scale
  - 2. Precision: plus-or-minus 0.5% of full scale



B. Environmental Conditions: Unless otherwise noted, equipment shall be suitable for the following environmental conditions:

a.	Temperature	32 °to 120° F
b.	Relative Humidity	10 to 90 percent
c.	Enclosure Rating	NEMA 4X
d.	Classification	Non-hazardous
e.	Process Water Temperature	32° to 100° F
f.	Elevation	3300 ft MSL

C. Wiring:

1. All electrical wiring shall be in accordance with the applicable requirements of the Electrical Specification. Instrumentation cable and power conductors shall meet the requirements stated therein.
2. Wiring for signal circuits and 24VDC shall not be smaller than No. 18 AWG and be separated at least 18 inches from any 120 VAC power wiring.
3. All interconnecting wires between panel mounted equipment and external equipment shall be terminated at numbered terminal blocks. All wires shall be color coded and be identified by permanent plastic number tags placed within 2 inches of each termination.
4. Wiring run in panels and enclosures shall be run in covered wiring duct identified by permanent plastic number tags within two inches of entering and leaving the duct. Wiring duct shall be covered, constructed of plastic and be of a snap-in slot type design.

D. Terminal Blocks:

1. Terminal blocks shall be one-piece molded plastic blocks with screw type terminals and barriers rated for 300 volts. Terminals shall be double sided and supplied with removable covers to prevent accidental contact with live circuits. Terminals shall be numbered and have permanent, legible identification, clearly visible with the protective cover removed.
2. Wires shall be terminated at the terminal blocks of one of the following ways:
  - a. Crimp type, pre-insulated, forked-tongue lugs for screw post terminals.
  - b. Bared wire ends for clamp-type terminals.
3. Lugs shall be of the appropriate size for the terminal block screws and for the number and size of the wires terminated.

## 2.3 Instrument and Controller Specifications

### A. Insertion Magnetic Flowmeters with Transmitters:

1. Flowmeter shall be at the location shown and inserted in 8" DIP as indicated on the Drawings. Medium to be measured is spring water.
2. Flowmeter shall measure forward flow, and include an indicator for reverse flow (without reverse flow measurement).
3. Flowmeter shall be of the wand-insertion type, allowing insertion and removal under pipeline pressure.
  - a. Flowmeter wand when inserted shall extend fully across the pipe ID, with a cushioned snubber resting on the pipe wall opposite the insertion tap. Wand shall have multiple magnetic sensors spaced along its length.
  - b. Flowmeter shall be suitable for mounting within one pipe diameter downstream of piping tees or elbows, provided the insertion wand is in the same plane as those fittings, and maintain its rated accuracy.
  - c. Flowmeter shall be mounted through a new piping tap with SS service saddle of the type shown on the Drawings.
4. Meter shall be full pipe averaging flow meter comes complete with mounting and restraining hardware, AC Converter with 4-20mA output, 25 feet of submersible cable with quick connects at sensor, Stainless Steel body, 316 SS electrodes, NSF-approved fusion-bonded epoxy coating, 2" SS ball valve (minimum of 1-7/8" port ID), 2" x close SS MPT Nipple, and 2-year manufacturer's warranty.
5. Flow meter shall operate from 120V, 1-phase, 60 Hz power.
6. The flowmeter sensor shall meet IP67 standards, and shall have IP68 quick-disconnect plug.
7. The amplifier/signal converter shall provide a 4-20 mA output signal proportional to the flow rate. All outputs shall be short circuit proof to 500 volts.
8. The amplifier shall come provided with LCD display for operator interface. The meter shall display instantaneous flow rate in U.S. gallons per minute, and totalized flow in gallons. Display housing shall be die-cast aluminum

and meet IP67 rating; it shall be suitable for remote wall-mounting where shown on the Drawings. Signal cable in adequate length shall be provided to connect the meter to the display location.

9. Meter accuracy shall be 0.5% of actual flow for all velocities greater than 1.0 fps. Meter repeatability shall be  $\pm 0.2\%$  of flow reading. The meter shall be capable of measuring the flow rate of fluids having a conductivity of 0.5 micromhos per centimeter.
10. Magnetic flow meters shall be *McCrometer FPI Mag* model 395L with remote converter, or equal, subject to the requirements for Submittal Review.

B. Rearing Building Sump Level Transmitter

1. A differential pressure (DP) cell level transmitter will provide primary level measurement in “gage pressure” for the Receiving Sump under the Rearing Building packed column aerator. A 4-20mA analog signal proportional to sump water level shall output to the Remote PLC (then be relayed via PROFINET to the Pumphouse PLC) and pace the Rearing Pumps.
2. DP cell shall be a loop-powered, 4-20mA pipe-mounted level transmitter. Transmitter shall be rated for operation, and sense water depth through an integral aluminum-oxide 99.9% ultra-pure ceramic isolating diaphragm. Filling fluid shall be food-grade silicon oil. Transducer housing shall be powder-coated die-cast aluminum with 1/2” NPT process connection.
3. Transmitter shall include on-board LCD display readout with bar graph, and intuitive keypad.
4. No reference pressure shall be required to set the zero and span adjustments on the transmitter.
5. Unit shall be rated for -25 to +125 deg C operation, and capable of withstanding intermittent 900 psi overpressure.
6. Accuracy shall be  $\pm 0.05\%$  of set span.
7. The transmitter shall be a 2-wire type operating from a supply voltage of 10.5-30 VDC. A 24vdc power supply shall be provided separately, as specified elsewhere in this Specification.
8. Level transmitter shall have pre-calibrated range of 0 to 6 psi (400 mbar) and shall display in feet-of-water with at least two decimal places.

9. Level transmitter shall be furnished with the manufacturer's ½" x ½" FPT bleed-and-block valve manifold for line flushing, complete with manufacturer's wall-mounting bracket(s) suitable for manifold and transmitter support individually or in combination.
10. Level transmitter shall be *Endress + Hauser 'Deltabar M' PMC71* with *DA63M-A* bleed-and-block valve manifold and "option PA/PK" wall-mount, or equal, subject to the requirements for Submittal Review.

C. Float Switches

1. Switches for Pumphouse wet well high/low level alarms and emergency pump shutdown shall be mechanical float switches with polypropylene or Teflon-coated 20-ga stainless steel casing, foam floatation, and sealed internal mechanical reed switch.
2. Float switches shall be suitable for use in a fluid specific gravity of 0.95 to 1.10, and liquid temperatures of 32 to 140 deg F.
3. Float switches shall have PVC- or CPE-jacketed, heavy duty cable, provided in 60' un-spliced length, with potted seal at the float connection. Float cables shall have an external neoprene sleeve wear jacket extending at least 5" above the float connection.
4. Float switches shall be of the NO or NC contact type, as required to meet the control functionality shown on the Drawings.
5. Float switches shall be *Siemens Water Technologies model 9G-EF*, or *ITT Flygt model ENM-10*, or equal.

D. River Flooding Level Alarm Panel

1. Where shown on the Drawings, a "river flooding" (high level) alarm panel shall be installed outside the Pumphouse, with remote float switch mounted in the tailrace of an outdoor raceway to detect river water incursion. Level alarm panel shall be a self-contained unit, including float switch by the panel manufacturer.
2. Level alarm panels shall be NEMA 4X non-metallic enclosures with red alarm beacon. Units shall be UL listed. Separate test and alarm acknowledge buttons shall be provided, and high-alarm shall not reset automatically. Panels shall have a pair of 5A, 120V auxiliary latching NO/NC alarm contacts. High level ("river flooding") alarm shall be wired to the Pumphouse PLC.

3. Unit shall operate on 120 VAC and shall have a three-year limited warranty.
4. Float switches for alarm panels shall be hermetically sealed, neoprene switch floats with 15' water and oil resistant cables and narrow angle NO contacts, as required for the application.
5. Float shall be furnished with an adjustable SS support bracket as called on the Drawings.
6. Level alarm and float switch system shall be *SJE Rhombus Tank Alert 4X* with "3B" (latching) option and no horn, and *Sensor Float* control switch, or equal.

E. Programmable Logic Controller(s) with Expansion Modules and Peripherals

1. New PLCs include a "Main" PLC at the Pumphouse, and a "Remote" PLC in the Hallway of the Rearing Building. Programming I/O's and logic shall be as listed conceptually on the Drawings – programming by the System Integrator shall achieve all functionality to incorporate the powered equipment, controls, alarms, and status monitors into the PLC system. The Remote (Rearing Bldg.) PLC shall fully mirror the Pumphouse PLC status-reporting and control capability through its HMI, with operator control inputs and system parameterization accessible from the Remote PLC (HMI).
2. The main Programmable Logic Controller (PLC) at the Pumphouse shall have the following components and peripherals. Provide any additional expansion I/O modules if/as required to achieve the functionality shown and specified. [*Siemens* components are listed to establish the basis of capacity and performance, with an "or equal" basis subject to performance equivalency and requirements for Submittal Review.]
  - a. *SIMATIC S7-1200* Power Module PM1207 Stabilized power supply input: 120/230 V AC, output: DC 24 V/2.5 A.
  - b. *SIMATIC S7-1200*, CPU *1214C*, Compact CPU, AC/DC/Relay, Onboard I/O: 14 DI 24V DC; 10 DO Relay 2A; 2 AI 0 - 10V DC, Power Supply: AC 85 - 264 V AC AT 47 - 63 HZ, Program/Data Memory: 100 KB.
  - d. *SIMATIC S7-1200*, Analog input, SM 1231, 8 AI, +/-10 V, +/-5 V, +/-2.5 V, or 0-20 mA/4-20 mA, 12 bit+sign or (13 bit ADC).
  - e. *SIMATIC S7-1200*, Analog input SM 1231 module, 4 AI, +/-10 V, +/-5 V, +/-2.5 V, or 0-20 mA/4-20 mA, 12 bit+sign (13 bit ADC).
  - f. *SIMATIC* HMI, *KTP1200 Basic*, Basic Panel, Key/touch operation, 12" TFT display, 65536 colors, PROFINET interface, configurable from WinCC Basic V13/ STEP 7 Basic V13, with open-source

- software provided.
  - g. *SCALANCE XB008* Unmanaged Industrial Ethernet Switch for 10/100 Mbit/s for setting up small star and line topologies; LED diagnostics, IP20, 24 V AC/DC power supply, with 8x 10/100 Mbit/s twisted pair ports with RJ45 sockets, and Manual available as a download.
  - h. *SIMATIC S7-1200*, Digital input *SM 1221* module, 8 DI, 24 V DC, Sink/Source.
  - i. *SIMATIC S7-1200*, Digital output *SM 1222* module, 8 DO, relay 2 A.
  - j. *VI4 SP2* Portal Software to use in programming.
  - k. *SIMATIC STEP 7* Basic SUS Download TIA Portal one year subscription (renewable at cost), and *SIMATIC STEP 7* Basic V15.1 Floating License download.
2. The remote Programmable Logic Controller (PLC) at the Manager’s Office shall relay status from the main PLC via a PROFINET connection, plus will serial-output system alarms via *Modbus* protocol to the Phone Dialer. The remote PLC will have the following components and peripherals: [*Siemens* components are listed to establish the basis of capacity and performance, with an “or equal” basis subject to performance equivalency and requirements for Submittal Review.]
- a. *SIMATIC S7-1200*, CPU *1212C*, Compact CPU, DC/DC/DC, Onboard I/O: 8 DI 24V DC; 6 DO 24 V DC; 2 AI 0 - 10V DC, Power supply: DC 20.4 - 28.8 V DC, Program/Data Memory: 75 KB.
  - b. *SIMATIC S7-1200*, Analog input, *SM 1231*, 4 AI, +/-10 V, +/-5 V, +/-2.5 V, or 0-20 mA/4-20 mA, 12 bit+sign (13 bit ADC).
  - c. *SIMATIC S7-1200*, Communication module *CM 1241*, RS232, 9-pole D-sub (pin), supports Freeport.
  - d. *SIMATIC* HMI, *KTP1200* Basic, Basic Panel, Key/touch operation, 12" TFT display, 65536 colors, PROFINET interface, configurable from WinCC Basic V13/ *STEP 7* Basic V13, with open-source software provided.
  - e. *SITOP PSU100S* 24 V/2.5 A Stabilized power supply input: 120/230 V AC, output: DC 24 V/2.5 A.
  - f. *VI3 SPI* Portal Software to use in programming.
3. PLCs shall be 120 VAC-to-24 VDC powered, with 12-20 AWG terminals.
4. The Main PLC and Remote PLC will communicate by PROFINET cable connecting the two units.
5. Both PLCs, including expansion modules and peripherals, shall be the products of the same manufacturer.

6. PLCs along with modules, HIMs and power supplies shall be suitable for DIN rail mounting. Equipment shall be installed in NEMA 4X fiberglass enclosures with gasketed, hinged, window covers and DIN rail supports. Enclosures shall be furnished with Type 12/IP54 filtered ventilation (exhaust) grilles at the sizes and locations shown on the Drawings. Grilles shall be light gray in color, and have replaceable fabric filters, accessible by snap-closure.
  - a. Pumphouse PLC enclosure shall be 40”h x 32”w nominal dimensions and 35”h x 27”w window, and shall be *Hoffman ULTRX* model *UU1008030W* with *A40P30* interior panel and grounding kit, or equal.
  - b. Manager’s Office PLC enclosure shall be 24”h x 24”w nominal dimensions and 19” square window, and shall be *Hoffman ULTRX* model *UU606020W* with *A24P24* interior panel and grounding kit, or equal.
  - c. Enclosure ventilation grilles with filters shall be *Hoffman RAL 7035*, *HGO* series exhaust grilles, or equal.

F. Low Pressure Gauge (at Rearing Building Level Transmitter)

1. Low-range pressure gauge shall be capsule-type, with 2 ½” dial and chrome-plated steel case. Wetted parts shall be brass or bronze, and lens shall be polycarbonate.
2. Gauge shall read in Inches-of-Water, and shall have a range of 60” of H<sub>2</sub>O. Gauge shall have ¼” NPT bottom inlet.
3. Low-range pressure gauge shall be *Kodiak Controls Inc. KC25 Series*, or equal.
4. Gauges shall be installed with a diaphragm seal. Diaphragm seals shall have ¼” NPT instrument and male process connections, with 316L stainless steel top and lower housings. Diaphragms shall be 316L stainless steel, and rated for 2500 psi at 100 deg F. Filling fluid shall be food-grade silicon oil. Diaphragm seals shall be *Ashcroft Type 310*, or equal.
5. All pressure gauge assemblies shall include an isolation valve between the pressure gauge (or diaphragm seal) and the carrier pipe. Isolation valves shall be SS body ball valves with standard or full port Teflon seats. Valves shall be rated for min. 600 psi water pressure.

G. Alarm Phone Dialer

1. The Dialer shall be a 110V unit with plug-in power supply and 10-hour continuous battery backup using an internal gel-cell battery with regulated voltage recharging capability.
2. Dialer shall have (56) configurable alarm PLC addresses received through serial cable connection via *Modbus RS232* port, plus line power sensing, data-logging capability, alarm history output to PLCs, and capacity for (4) digital/analog hard-wired alarm inputs. Alarm messaging shall be custom voice programmed, and the dialer shall be programmable by keypad or laptop-connection using the dialer manufacturer's software.
3. Dialer shall include NEMA 12 enclosure.
4. Dialer shall be furnished with manufacturer's 6-foot dialer-to-*Modbus* connection cable (to connect to Remote PLC).
5. The dialer shall be a solid state component capable of dialing up to 96 telephone numbers, each up to 255 digits in length. Phone numbers and Standard pulse dialing or Touch Tone DTMF dialing are user programmable via the system's keyboard or remotely via Touch Tone telephone. In addition, the dialer shall:
  - a. Place Group Alarm Calls - On alarm, system shall selectively call the correct phone number according to the specific alarm(s).
  - b. Detect Telephone Line Fault and indicate condition with Front Panel LED.
  - c. Automatically select Tone versus Pulse Dialing.
  - d. Monitor Call Progress - Detect Busy and Ringing Signals, Abandon Call if Busy, Wait until phone is answered to Annunciate Voice Reports.
  - e. Provide Numeric Pager Support
  - f. Provide PBX Support
5. User Solid State Voice Message Recording & Playback: The unit shall have two different categories of speech message capability, all implemented with permanent non-volatile solid-state circuitry with no mechanical mechanisms. The unit shall allow for message recording from a remote telephone as well as from the front panel.
6. User Field Recorded Messages: The user may record and re-record his own voice messages for each input channel and for the Station ID.



- a. Total Available Message Recording Time at the “high-fidelity” recording rate setting shall be 4.8 minutes.
  - b. The unit shall allow selective recording of both Normal and Alarm advisory messages for each input channel.
  - c. The unit shall provide for automatic setting of the optimum speech recording rate for the total set of messages recorder, in order to achieve optimum recording sound quality.
  - d. Circuit board switches or jumper straps shall not be an acceptable means of manipulating message length or recording rates.
7. Permanent Resident Non-Recorded Messages: Permanent built-in messages shall be included to support user programming operations, to provide supplemental warning messages such as advising that the alarms have been disabled, and to allow the unit to be fully functional even when the installer has not recorded any messages of his own.
  8. User-entered programming and voice messages shall be kept intact, even during power failures or when all power has been removed, for up to ten (10) years. This shall be accomplished through inclusion in the system of a lithium battery separate from the unit’s backup rechargeable gel cell battery.
  9. Internal Surge Protection: All power, phone line, dry contact, and analog signal inputs shall be protected at the circuit board to IEEE Standard 587, category B(6,000 volts open circuit/3,000 amps closed circuit). Gas tubes followed by solid state protectors shall be integral to the circuit board for each line.
    - a. Contractor shall provide and verify proper electrical grounding for the dialer, conforming to the manufacturer’s recommendations.
  10. All keyboard and front panel switches shall be sealed to prevent contamination. Front panel LED’s shall indicate: Normal Operation, Program Mode, Call in Progress, Status for each Channel, AC Power present, AC Power failure, and Low, Discharging, or Recharging Battery.
  11. Phone line testing shall be programmable to test the unit’s phone line at regular intervals and to provide local indication of a failure of the phone line. In this event, when the phone line is later available, the unit shall place alarm report calls to advise that a phone line fault has occurred.
  12. The unit shall be capable of executing user commands for diagnostics on the connected network (i.e. Modbus RTU) to determine the health of the network. The unit shall inform the user of the length of scan time for the set of all configured channels on the network.

13. Alarm Acknowledgement: Alarm report calls shall continue at programmed intervals indefinitely until acknowledged. Acknowledgement of an alarm phone call shall be accomplished by pressing a Touch Tone "9" as the alarm call is being received, and if so configured, by returning a phone call to the unit after having received an alarm call or via the front panel keypad. If so configured, the user's four-digit PIN password shall be required to hear the report and to acknowledge alarms. The unit's log file shall maintain event records of all alarms, acknowledgements and incoming calls, and that log file shall be retrievable at any time to provide an audit trail record.
14. Dialer shall have a standard 5-year parts and labor warranty.
15. Dialer shall be *RACO Catalyst* model *C10-S-020-1450*, or equal.

#### H. 24 VDC Power Supplies (Other than PLC'S)

1. A NEC Class 2 DC power supply shall be provided for Rearing Building sump level transmitter and rated at 2.5A output at 24 VDC using 120VAC input power. Power supply shall have a nominal efficiency of 87.5%, and an MTBF of 740,000 hours. Power supply shall be DIN rail mounted and provided with a male 110V standard wall outlet plug.
2. The DC power supply shall be suitable for DIN rail mounting and mounted in a 12"h x 10"w x 6"d (300mm x 250mm x 150 mm), gasketed NEMA 4, continuous-hinged dead-front 16-ga steel enclosure with back panel and a 9.80" x 6.25" polycarbonate window cover (*Hoffman* model *LWC302515* with *LA3025* interior panel, or equal). Enclosure shall be vented if/as recommended by the power supply manufacturer.

### **PART 3: EXECUTION**

#### 3.1 General

- A. Coordinate process instrument electrical interface, installation and startup of all process instruments.
- B. Follow manufacturers' installation instructions explicitly, unless otherwise indicated. Wherever any conflict arises between manufacturers' instructions, and these Contract Documents, follow Engineer's decision, at no additional cost to Owner. Keep copy of manufacturers' instructions on the jobsite available for review at all times.

#### 3.2 Electrical Power and Signal Wiring

- A. Control and signal wiring external to the control panels and all power wiring shall conform to the requirements of the Electrical Specification.

- B. Control and signal wiring in control panels shall be restrained by plastic ties or ducts. Hinge wiring shall be secured at each end so that any bending or twisting will be around the axis of the wire, and the bend area shall be protected with a sleeve.
- C. Arrange wiring neatly, cut to proper length, and remove surplus wire. Provide abrasion protection for wire bundles passing through holes or across metal edges.
- D. Wiring shall not be spliced or tapped except at device terminals or terminal blocks.

### 3.3 Special Requirements for Manufacturer's Instrument and Sensor Cables

- A. Manufacturer's cables for instruments and sensors shall be routed in conduit, with slack cable provided in boxes or raceways to facilitate device removal and replacement.
- B. Cables shall be completely stress relieved. Support points and tie-off's shall be fully cushioned to prevent cable damage, and in full accordance with manufacturer's installation recommendations.

### 3.4 System Integrator Services

- A. The Contractor shall provide services of a qualified System Integrator with demonstrated programming and system integration requirements using the brand of PLC equipment to be furnished on this project.
- B. The System Integrator shall be responsible for all PLC programming, including integration of control, status, and alarm I/O's from remote transmitters and devices. verification, startup, troubleshooting, and Owner staff training.
  - 1. System Integrator shall also calibrate and integrate the Rearing Building Packed Column Aerator Receiving Sump Level Transmitter with the PLC-based control system.
  - 2. System Integrator shall also program the alarm Phone Dialer, and interface the Dialer with the Remote (Rearing Building) PLC via serial connection. The Owner will provide a written list of phone numbers to be entered into the Dialer, and the Integrator shall provide a list of alarm PLC addresses.
- C. Prior to programming the PLCs, the System Integrator shall develop and provide proposed I/O assignments by PLC module, full circuitry diagrams for interface with remote devices, and control logic itemization or diagrams per the requirements for Submittal Review. After Submittal review and concurrence by the Engineer, the System Integrator may install PLC programming.

- D. After programming, the Integrator shall demonstrate the PLC control system including the Phone Dialer to the Owner, including simulating alarms.
- E. In addition to off-site programming time, the System Integrator shall provide the following field services at a minimum to assist the Contractor in installation and startup -- including to verify PLC and peripherals installation and inter-connection, to truth programming in the field including modifications if/as required, and to train the Owner's staff in system operation and monitoring: [Days indicated must be a minimum of 7 hours on site each.]
1. **3 days** for pre-startup installation assistance to the Contractor, inspection, and functional testing.
  2. **3 days** for startup and system demonstration.
  3. **2 days** for Owner staff training prior to project Substantial Completion, and
  4. **2 days** for system troubleshooting, adjustment, and/or optimization, including supplemental Owner staff training, after project Substantial Completion but within 90 days after the Substantial Completion date.
  5. Training of Owner's personnel shall be at such times as requested by the Owner, and may be at a later date(s) than installation assistance and functional testing. The System Integrator is expected to make multiple separate trips to the Hatchery without additional compensation.

**END OF SECTION 13400**

## SECTION 16005

### ELECTRICAL

#### PART 1: GENERAL

##### 1.1 DESCRIPTION

- A. This section covers electrical work as indicated on the Drawings.
- B. The Work, in general, consists of, but is not limited to:
  - 1. Power cables and conduit, including 480VAC, 240/120VAC, and 24vdc.
  - 2. Instrumentation cable from new flowmeters and level transmitters.
  - 3. PROFINET cable for PLC communications, including connectors.
  - 4. Telephone cable for new phone dialer, including receptacles and connectors.
  - 5. Conduit and wiring for all equipment shown.
- C. See also related Specifications – including Process Instrumentation & Control, Motor Controls, and Variable Frequency Drives.

##### 1.2 SUBMITTALS

- A. In addition to the requirements of the General Equipment Stipulations, the following documentation shall also be provided and accompany other required submittals for equipment specified herein:
  - 1. Complete manufacturer's descriptive information and shop drawings for all equipment, material, and devices furnished under this Section, including certified outline drawings, arrangement drawings, elementary (schematic) diagrams, panel elevation drawings, interconnection and connection wiring diagrams.
  - 2. Manufacturers' installation instructions and Operation and Maintenance Manuals for electrical equipment and controls as specified herein.

##### 1.3 RESPONSIBILITY

- A. The Contractor shall be responsible for:
  - 1. Complete systems in accordance with these Contract Documents.
  - 2. Coordinating the work required under all other Specification Sections that affects the work covered in this section.

3. Field-determining and installing conduit and conductor routings that clear existing obstacles, equipment, piping, and other conduit runs. Conduit runs shown on the Drawings are schematic only and shall be adjusted by the Contractor for field conditions.
4. Furnishing and installing all incidental items not actually shown or specified, but which are required by the NEC, governing ordinances, or good practice to provide a complete and functional systems.

#### 1.4 INTENT OF DRAWINGS

- A. Electrical plan drawings show only general locations of equipment, devices, and raceway, unless specifically dimensioned. The Contractor shall be responsible for the proper routing of raceways, final sizing of conductors, and location of equipment and connections.
- B. The control diagrams for the equipment are schematic and intended to show the desired operation. The Contractor shall install exactly as shown unless this operation will cause failure of the equipment due to unique operating characteristics of the supplied equipment not known to the Engineer.
- C. The contractor shall notify the Engineer of such conflicts within 30 days of the Contract award and receive written resolution before proceeding with the Contract work. Any damage to the Contractor-supplied equipment arising due to improper control shall be the responsibility of the Contractor.

#### 1.5 CODES, PERMITS, AND REGULATIONS

- A. All work shall be performed in strict accordance with the current edition of the Local Laws and Ordinances, National Electrical Code (NEC), National Electrical Safety Codes (NESC), and the Occupational Safety and Health Act. (OSHA).
- B. Wherever the requirements of the Specifications or Drawings exceed those of these codes, the requirements of the Specifications or Drawings shall govern. Code compliance is mandatory. Nothing in the Contract Documents shall be construed as permitting work not in accordance with these laws and codes.
- C. Obtain all electrical permits and inspections, and pay all fees required by any governmental agency having jurisdiction over this work. Upon completion of the work, furnish satisfactory evidence to the Engineer that the work is acceptable to the regulatory authorities having jurisdiction.

## **PART 2: MATERIALS**

### **2.1 GENERAL**

- A. Unless otherwise indicated, provide all first-quality, new materials and equipment, free from any defects, in first-class condition, and suitable for the space provided. Provide materials and equipment listed by UL wherever standards have been established by that agency. No used equipment shall be allowed.
- B. Like items of equipment provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's service.

### **2.2 STANDARD PRODUCTS**

- A. Unless otherwise indicated, provide materials and equipment that are the standard products of manufacturers regularly engaged in the production of such materials and equipment. Provide the manufacturers' latest standard design that conforms to these Specifications.

### **2.3 EQUIPMENT FINISH**

- A. Provide materials and equipment with manufacturers' standard finish system unless otherwise noted. Provide manufacturers' standard finish color, except where specific color is indicated. If manufacturer has no standard color, finish equipment with ANSI NO. 61, light gray color.

### **2.4 OUTDOOR EQUIPMENT**

- A. Equipment and devices to be installed outdoors or in unheated enclosures shall be capable of continuous operation within an ambient temperature range of minus 20° F to 104° F.

### **2.5 CONDUITS**

- A. Rigid Galvanized Steel (RGS) or Intermediate Metal Conduit (IMC): Use rigid steel or intermediate metal conduit, including threaded type couplings, elbows, nipples, and other fittings, galvanized by hot dipping, electroplating, or metalizing process and meeting the requirements of ANSI C80, NEMA FB 1, UL 6, and the NEC.
- B. Electric Metallic Tubing (EMT): Use electric metallic tubing, zinc-coated and enamel-lined with thread-less couplings, bushings, elbows, nipples, and other fittings meeting the requirements of ANSI C80, NEMA FB 1, UL 797, and the NEC.
- C. PVC Conduit: Use rigid PVC Schedule 80 conduit, UL listed for concrete encased, underground direct burial, concealed and direct sunlight exposed use, and UL listed and marked for use with conductors having 90° C insulation. Use conduits,

couplings,  
bushings, elbows, nipples, and other fittings meeting the requirements of NEMA TC 2 and TC 3, Federal Specification W-C-1094, UL 651, NEC, and ASTM specified tests for the intended use.

- D. Flexible Metal Conduit, Liquid-tight: Use UL 360 listed for 105 degrees C insulated conductors, conduit consisting of galvanized steel flexible conduit covered with an extruded PVC jacket and terminated with nylon bushings or bushings with steel or malleable iron body and insulated throat and sealing O-ring. Fittings and conduit bodies shall meet the requirements of NEMA FB 1.
- E. Flexible Conduit, Non-liquid-tight: Use non-liquid-tight flexible steel conduit tubing, consisting of hot-dipped galvanized or electrogalvanized, inside and outside, made in one continuous length of spirally-wound steel strip with uniform interlocking convolution meeting the requirements of UL-1, or any subsequent revisions. Fittings and conduit bodies shall meet the requirements of NEMA FB 1.
- F. Conduit clamps to support conduit on vertical or horizontal surfaces shall match conduit size and shall be galvanized steel strap-type with fasteners on each end. Fasteners shall be suitable for the substrate to which clamps are attached.

## 2.7 CONDUCTORS

- A. All conductors shall be copper. Provide stranded conductors except provide solid conductors where No. 10 AWG and No. 12 AWG are used for branch circuit power wiring in lighting and receptacle circuits.
- B. Wire sizes No. 8 AWG and smaller shall have a thermoplastic PVC insulation with an overall nylon jacket. Stranded wire shall be Class C stranded. The conductor shall be rated THHN/THWN.
- C. Wire sizes larger than No. 8 AWG shall be non-organically filled cross-linked polyethylene insulation Type XHHW or have thermoplastic PVC insulation with an overall nylon jacket rated THHN/THWN.
- D. Cords shall be type SEOW, American Insulated Wire Corp., Coleman Cable Co Seoprene 105, or approved equal.
- E. Multi-Conductor Cable: Provide cables as specified under the following Type numbers.
  - 1. Type 1 (600 Volt Multi-Conductor Control Cable, Type TC)
    - a. General: Multi-conductor control circuit interconnection cable with ground. Suitable for installation in open air, in cable trays, conduit, or other approved raceways. Minimum cable temperature rating shall be 90° C dry locations, and 75° C wet locations.



- b. Individual conductors: No. 14 AWG, 19 strand copper.
  - c. Insulation and Jacket: Each conductor shall have 15-mil PVC insulation with THHN-THWN legend. Conductor group shall be color-coded in accordance with ICEA method 1, Table K2, and shall include one full size green grounding conductor. Group shall be bound with a spiral wrap of barrier tape. Jacket shall be flame retardant and sunlight and oil resistant PVC. Provide 5-, 7-, 12-, 25-, conductor cable as required, including a green grounding conductor.
  - d. Manufacturer and type: *Okonite FMR-Okoseal Type TC; Cablec Corp. XLPE Control Cable Type TC*; or equal.
2. Type 2 (600 Volt Multi-Conductor Power Cable, Type TC)
- a. General: Three or four conductor, with ground and overall jacket. Suitable for installation in open air, in cable trays, conduit, or other approved raceways. Minimum cable temperature rating shall be 90° C dry locations, and 75° C wet locations.
  - b. Individual Conductors: Class B stranded per ASTM B-8. Size as shown.
  - c. Insulation and Jacket: Each phase conductor shall be insulated with chemically crosslinked polyethylene, or ethylene propylene, meeting type XHHW, VW-1 requirements of Underwriters Laboratories. Jacket shall be flame retardant and sunlight and oil resistant Hypalon.
  - d. Manufacturer and type: *Southwire Type TC; Pkonite-FMR Okolon; B/W Cable Systems Inc. Pyronot II*; or equal.
  - e. Provide direct-burial-rated power cable for river-flooding alarm float switch circuit routing along Outdoor Raceways, as shown on the Drawings -- use Type TC XHHW Solonon-jacketed, or equal.
3. Type 3 (Twisted, Shielded Pair Instrumentation Cable, Type TC).
- a. General: Single- or multiple pair instrumentation cable shall be designed for noise rejection for process control, computer, or data applications. They shall be suitable for installation in cable trays, conduit, or other raceways. Minimum cable temperature rating shall be 90° C dry locations, and 75° C wet locations.
  - b. Individual Conductors: Minimum size of No. 18 AWG Soft annealed copper, Class B, seven-strand concentric per ASTM B 8. Size 20 AWG tinned copper drain wire. For long cable runs, the Contractor

shall verify line losses, and up-size instrumentation cable AWG size if/as required.

- c. Insulation and Jacket: Each conductor shall have 15 mil PVC insulation. Jacket shall be flame retardant and sunlight and oil resistant PVC with 35 mils nominal thickness. Shield shall be 0.35 mil aluminum/mylar overlapped to provide 100 percent coverage.
  - d. Multiple-pair Cables: Multiple-pair instrumentation cables shall have both individual shielding on each pair, and an overall cable foil shield, with multiple drain wires. Both foil shielding and drain wires shall be connected to adequate electrical ground(s).
  - e. Manufacturer and type: *Belden* no. *1475A* series; or equal.
- F. Equipment Grounding Conductors: Provide stranded copper conductors with green insulation, size as required by NEC for equipment grounding.
- G. Service Grounding Conductors: Provide bare solid or stranded copper, size as required by NEC for service grounding.
- H. Ground Rods: Ground rods, including clamps, shall be all-copper sized and arranged per NEC requirements for the equipment or system(s) protected.

## 2.8 PROFINET CABLE

- A. PROFINET cables for communication with PLCs shall be stranded 22 AWG 19x34 tinned copper with foil/braid shielding and TPE jacket. Cable shall be outdoor-rated and sunlight-resistant with an operating temperature of -40 to 80 deg C. Cable shall meet IEC 60811-2-1 oil resistance, and C(UL) CM flame ratings.
- B. Manufacturer's Reference: PROFINET cable shall be *Belden DataTuff Cat 5e* model *7962A*, or equal.
- C. Provide *Siemens* Fast Connect, *Lumberg Automation* connectors or *Belden* metal body plugs for PROFINET cable connections.

## 2.9 TELEPHONE CABLE AND WALL JACK

- A. Telephone cable for the new alarm dialer, shall be heavy-duty jacketed two-pair outdoor-rated cable.
- B. Provide RJ11 plugs and connectors, with adapters if/as necessary to plug in to new phone dialer.
- C. Project RJ11 wall jack with stainless steel wall plate for plug in for new dialer.

## 2.10 TERMINAL BLOCKS

- A. Provide terminal blocks for termination of all control circuits leaving or entering equipment, panels, or boxes. Terminal blocks shall be UL 1059, compression screw clamp type with current bar providing direct contact with wire and yoke. Yokes and clamping screws shall be zinc-plated hardened steel. Individual terminals shall be mounted to create a complete assembly. Units shall be UL approved, CSA certified, and rated for 600V ac and currents as required. Marking system shall permit use of preprinted or field-marked tags.

## 2.11 BOX COVER UNITS

- A. Where shown on the Drawings to electrically isolate 110V equipment, provide a single-gang, 15A, 125V rated box cover unit with fuse and on/off switch, wired in series ahead of the device to be isolated. Box cover units shall be rated for up to ½ hp service, and furnished complete with a 5 amp screw-in fuse. Box cover units shall be UL listed.
- B. Box cover units for both indoor and outdoor applications shall be weatherproof, *Cooper Bussman* model *SSN*, or equal.

## PART 3: EXECUTION

### 3.1 GENERAL

- A. Float switches and related wiring for septic and dosing tanks and dosing pumps shall conform to N.E.C. Class 1, Division 2 requirements for hazardous locations per MDEQ *Circular DEQ4* Section 4.2.3.1.
- B. Coordinate electrical work with the Owner and work of other trades to avoid interruption of services or power to Owner's other facilities.
- C. Check the indicated locations of electrical equipment, outlets, and other system components shown on Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, consult the Engineer, and make any approved modifications and changes required.

### 3.2 PROTECTION DURING CONSTRUCTION

- A. Throughout this Contract, provide protection for materials and equipment against loss or damages in accordance with provisions elsewhere in these Contract Documents. Protect everything from the effects of weather.
- B. Items that are subject to corrosion under damp conditions and items containing electrical insulation, such as transformers, conductors, motors, and controls, shall be

stored in clean, dry, indoor, heated locations.

- C. Following installation, protect materials and equipment from corrosion, physical damage, and the effects of moisture on insulation. Cap conduit runs during construction with manufactured seals. Keep openings in boxes or equipment closed during construction.
- D. Protect all conduit, wiring, and connections for Owner's existing equipment, or new equipment specified under other Sections.

### 3.3 MOTOR ROTATION

- A. After final service connections are made, check and correct if necessary the rotation of all motors.
- B. Coordinate rotation checks with the Engineer and the Contractor responsible for the driven equipment. Submit a written report to the Engineer for each motor verifying that rotation has been checked and corrected.

### 3.4 CONDUIT

- A. All power and instrumentations conductors shall be installed in conduit in accordance with the following table, unless otherwise indicated in the Drawings:

<b>AREA</b>	<b>CONDUIT</b>
Exterior	Rigid Steel or IMC
Interior exposed	Rigid Steel or IMC
Interior concealed	EMT
Interior lighting and receptacles exposed or concealed	EMT
Underground, earth burial	PVC
Embedded in concrete	PVC

- B. Special Locations:
  - 1. Use rigid steel conduit or IMC:
    - a. Where conduit changes from underground and/or concrete-embedded to exposed.
    - b. Under equipment mounting pads.
- C. Conduits entering cabinets, pull boxes or outlet boxes shall be secured with double

galvanized locknuts, one inside and outside of box, and bushings.

- D. Conduit shall be sized in accordance with the NEC and shall be of such size and so installed that conductors may be drawn in without injury or excessive strain.
- E. Make final connection to motors, VFDs, instrumentation, and other equipment to facilitate removal or adjustment of equipment, with 18-inch minimum, 36-inch maximum lengths of liquid-tight, PVC jacketed, flexible steel conduit.
- F. All vault and exterior wall penetrations shall be sealed with a waterproof, non-sag sealant.
- G. Prohibition Against Installing Instrumentation Cable in Conduit with Power Conductors:
  - 1. Instrumentation cables, including PROFINET cables, shall be placed in separate conduit runs, and may not be installed in the same conduit as power distribution conductors.
  - 2. Instrumentation cable conduit runs in parallel with power distribution conductors and/or conduits must be laid with a minimum of 18 inches of spatial separation.
  - 3. Instrumentation cable shall not be routed through junction boxes, handholes, or pull boxes shared by power distribution conductors.

### 3.5 GROUNDING

- A. All services, load centers, VFDs, panelboard cabinets, equipment and enclosures, and the complete conduit system shall be grounded securely in accordance with pertinent sections of Article 250 of the NEC. Grounds shall be individual or combined, according to equipment manufacturer's and NEC requirements. All electrically operated equipment shall be bonded to the grounding conduit system.

### 3.6 WIRE PULLING

- A. No wire shall be drawn into conduit until conduit system is complete. Lubricant shall be approved by wire manufacturer.

### 3.7 COLOR MARKINGS

- A. Where two or more conduits run to a single outlet box, each circuit shall be color coded as a guide in making connections. Colors shall be carried continuously throughout the system if more than one multi-wire branch circuit is carried through a single raceway. All circuit conductors of the same color shall be connected to the

same underground feeder conductor throughout the installation.

### 3.8 CIRCUITS

- A. Deviations from conduit runs will be permitted with the Engineer's approval. Combining circuits in single conduit is permitted with proper identification and wire derating, subject to NEC requirements.

### 3.9 LOAD BALANCE

- A. The Drawings indicate circuiting to distribute electrical loads. However, after installation, if necessary, balance electrical load between phases or legs as nearly as possible on power distribution and panel boards.

### 3.10 TESTS

- A. Operations: After the electrical system installation is completed and at such time as the Engineer concurs, conduct an operating test for approval. [See Performance Testing requirements in General Equipment Stipulations.] Demonstrate that the equipment operates in accordance with the requirements of these Specifications and Drawings. Perform the test in the presence of the Engineer. Furnish all instruments and personnel required for the tests.

- B. Existing Emergency Generator and Automatic Transfer Switch Testing After Improvements: After installation of new pumps, instrumentation, and the new MCC including VFDs and RVSSs, the Contractor shall conduct a full field test of the existing 150 kVA diesel-powered *Caterpillar* emergency generator system and Automatic Transfer Switch (ATS).

- 1. The Contractor shall employ the Hatchery's designated gen-set and ATS service technician – Tractor & Equipment Co. of Great Falls (Matt Jensen, ph: 406/761-7900) to design and execute the testing. A maximum of 16 man-hours shall be provided for this subcontracted testing, beyond which the Contractor may be allowed further compensation for additional man-hours.

- a. The testing shall demonstrate incremental full load transfer followed by re-transfer to line (utility) power for at least two full cycles, including the following scenarios:
  - i. Transfer and re-transfer with only the Rearing and Raceway VFD-driven pumps running; and
  - ii. Transfer and re-transfer with both (VFD and RVSS) Rearing Pumps and three (VFD and two RVSS) Raceway Pumps running.

- b. Prior to the testing the technician shall evaluate and modify if

necessary the generator load-steps for pumps and equipment. If test results warrant, the technician shall further adjust load-steps after testing and repeat the test(s).

C. Voltage:

1. When the installation is essentially complete and new electrified equipment is operable, check the voltage at the point of termination of the power company supply system to the project. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
2. If the unbalance (as defined by NEMA) exceeds 1 percent, or if the voltage varies throughout the day and from loaded to unloaded conditions more than plus or minus 4 percent of nominal, make a written request to the power company that the condition be corrected. If corrections are not made, obtain from a responsible power company official a written statement that the voltage variations and/or unbalance are within their normal standards.
4. Equipment Line Current: Check the line current in each phase for each piece of equipment. If the power company makes adjustments to the supply voltage magnitude or balance, make the line current check after the adjustments are made. If any phase current in any piece of equipment is above the rated nameplate current, determine and submit in writing to the Engineer the cause of the problem.

### 3.11 FIELD DOCUMENTATION

A. In addition to the O&M Manual requirements of the General Equipment Stipulations, the following documentation shall also be provided by the Contractor for electrical systems:

1. As-built electric circuit and equipment drawings.
3. Index of all equipment suppliers listing current names, addresses, and telephone numbers of those who should be contacted for service, information, and assistance.
1. As-built Contract Drawings showing all departures from original Drawings. Show all underground cable, conduit, or duct runs dimensioned from established building lines, and all electrical work revisions. Prepared by Contractor on clean set of Contract Drawings.
2. Documentation of all field test results.

**END OF SECTION 16005**



## SECTION 16480

### MOTOR CONTROLS

#### PART 1 GENERAL

##### 1. DESCRIPTION

- A. This section describes general requirements, products, and methods of execution relating to Motor Control Centers (MCCs). A new (replacement) MCC will be provided to interface with an existing MCC housing the Pumphouse main disconnect(s) and emergency power automatic transfer switch (ATS) which are being retained. The following specifications apply to new MCC equipment, other than where specifically referencing the existing MCC to be retained.
- B. New VFDs and RVSSs for Rearing and Raceway Pumps will be installed in the new MCC. [See Variable Frequency Drive Specifications.]

##### 2. QUALITY ASSURANCE

- A. MCC equipment shall be of the latest approved design as manufactured by a nationally recognized manufacturer and in conformity with the governing UL and NEMA standards.

##### 3. DESIGN REQUIREMENTS

- A. Provide MCC based upon NEMA standards and in accordance with the detailed specifications and drawings.
- B. The manufacturer of the MCC shall also be the manufacturer of the across the line motor starters, solid state reduced voltage starters and variable frequency drives. The use of third party supply and assembly is not acceptable and will be rejected.
- C. The contractor shall confirm motor full load amperage ratings and provide those to the MCC manufacturer.

##### 4. PRE-MANUFACTURE SUBMITTALS

- A. Refer to Section 01610 for submittal procedures
- B. Shop Drawings
  - 1. MCC elevations showing dimensional information
  - 2. Structure Descriptions showing
    - a. Bus ratings
    - b. Enclosure ratings
    - c. Short circuit withstand ratings

- d. Other information as required for approval
  3. Conduit locations
  4. Required bus splices (including between existing MCC to be retained, and new/replacement MCC sections)
  5. Unit descriptions including starter sizes, circuit breaker frame sizes, circuit breaker continuous ampere ratings, pilot devices, etc.
  6. Nameplate information
  7. Schematic wiring diagrams
- C. Product Data
  1. Motor Control Center Publications
  2. Data sheets and publications on all major components including but not limited to the following
    - a. Motor starters
    - b. Circuit breaker and fuse information including time current characteristics
    - c. Control power transformers
    - d. Pilot devices
    - e. Relays
- D. UL Certification
  1. The MCC shall be UL listed or recognized.
  2. The MCC shall contain a UL label attached on the inside of the enclosure cabinet.
- E. Testing and Test Reports
  1. Testing shall be per manufacturer's standard.
  2. A copy of the test reports shall be provided as part of the final documentation.
- F. Installation Instructions
  1. Provide a copy of the manufacturer's installation instructions that includes the following:
    - a. General description for reading nameplate data, serial numbers, UL markings and short circuit ratings
    - b. Installation procedures including splicing procedures

- c. Conduit and cable installation
- d. Installing and removing plug-in units
- e. Operation of operator handles and unit interlocks
- f. Checklist before energizing
- g. Procedure for energizing equipment
- h. Maintenance procedures

## 5. FINAL SUBMITTALS

- A. Refer to Section 01610 for procedure on submittal of final documentation.
- B. The contractor shall provide certification that the MCC has been installed in accordance with the manufacturer's instructions.
- C. The contractor shall provide certification that all circuit breaker settings have been adjusted per field requirements.
- D. The contractor shall provide certification that all power fuses have been selected and installed per field requirements.
- E. The contractor shall provide certification that all solid state motor overload settings have adjusted per installed motor characteristics.
- F. The contractor shall provide certification that any timing devices required in the starting circuitry have been properly adjusted.
- G. Final Drawings. The manufacturer shall provide final drawings reflecting the "As-Shipped" status of the MCC. The contractor shall be responsible for making any changes to the "As-Shipped" drawings from the manufacturer to reflect any field modifications.
- H. Maintenance Data
  - 1. MCC installation instructions
  - 2. Installation/Operation manuals for major components such as RVSSs, circuit breakers, etc.
  - 3. MCC spare parts listing and pricing
  - 4. Name and phone number for a local distributor for the spare parts.

## 6. QUALITY ASSURANCE

- A. The manufacturer of the MCC shall be the manufacturer of the motor starters including across the line starters, solid state starters and variable frequency drives, as required on this project.

## 7. REGULATORY REQUIREMENTS

A. Installation shall conform to the requirements of the latest edition of the National Electric Code.

B. MCCs shall be constructed to meet or exceed the latest UL requirements.

## 8. QUALIFICATIONS

A. The manufacturer shall have ISO 9001 registered facilities for the design, manufacture and testing of MCCs.

## 9. DELIVERY, STORAGE AND HANDLING

A. The contractor shall coordinate the shipping splits with the MCC manufacturer for entry into the building.

B. The contractor shall store the MCCs in a clean, dry and heated space.

C. The contractor shall protect the units from dirt, water, construction debris and traffic.

D. During storage the contractor shall connect internal space heaters (if specified) with temporary power.

E. MCCs are to be shipped with external lifting angles at the top and running continuously for each shipping split. Lifting eyelets are not acceptable.

## 10. ENVIRONMENTAL REQUIREMENTS

A. The MCC enclosure rating shall be appropriate for the environment where the MCC is to be located.

## 11. FIELD MEASUREMENTS

A. The Contractor shall verify all field measurements prior to the fabrication of the MCC.

## 12. WARRANTY

A. The manufacturer shall provide their standard parts warranty for eighteen months from the date of shipment or twelve months from the date of being energized, whichever occurs first.

B. The manufacturer shall confirm this warranty as part of the submittal.

## **PART 2 PRODUCTS**

### 1. MANUFACTURER'S REFERENCE

- A. MCCs shall be *Siemens Tiastar 20*, or equal.

## 2. RATINGS

- A. Voltage - Unless shown differently on the drawings, the MCC shall be rated for a 480V or 600V system.
- B. Short Circuit Withstand Rating – Unless shown differently on the drawings, the MCC shall be rated for a fault current of 42,000A.
- C. The MCC shall be fully rated for the available fault current shown. Use of series ratings for overcurrent devices is not acceptable.

## 3. ENCLOSURE

- A. The MCC shall be NEMA Type 1.
- B. Removable end plates on each end of the MCC shall cover all horizontal bus and horizontal wireway openings.
- C. Each section shall be equipped with two full metal side sheets to isolate each vertical section.
- D. All interior and exterior surfaces shall be painted ANSI 49 medium light gray. The vertical wireways and unit back plates shall be painted high visibility gloss white.
- E. All unpainted parts shall be plated for corrosion resistance.
- F. Dimensions shall not exceed 110 inches in width and 90 inches in height.

## 4. STRUCTURE

- A. The MCC shall be of dead front construction and shall consist of one or more vertical sections bolted together to form a rigid, free-standing assembly. The systems shall be designed to allow for the addition of future sections at either end and to permit the interchanging of units.
- B. Vertical sections shall be rigid, free-standing structures.
  - 1. Vertical sections shall have internal mounting angles running continuously within the shipping block.
  - 2. Vertical sections shall be 90 inches high, 15 or 20 inches deep and 20 inches wide except where larger dimensions are required.

3. Vertical sections shall be provided with a removable steel lifting angle on all shipping blocks. The angle shall run the length of the shipping block.
- C. Provide full depth horizontal wireways at the top and bottom of the MCC.
1. The horizontal wireways shall be isolated from the bus.
  2. The horizontal wireways shall have removable covers held in place by captive screws.
- D. Provide a full height vertical wireway, independent of the plug-in units, in each standard vertical section.
1. The vertical wireway shall be isolated from the vertical and horizontal buses.
  2. The vertical wireway shall be covered with a hinged and secured door.
  3. Wireway tie bars shall be provided.
  4. Isolation between the wireway and units shall be provided.
5. COMPARTMENTS AND UTILIZATION
- A. The minimum compartment height shall be 13 inches, and this shall be considered one space factor. One-half space factor compartment shall only be supplied when specified in the drawings.
- B. NEMA Size 5 starters and below shall be provided as plug-in units.
- C. Plug-in units
1. Plug-in units shall consist of unit assembly, unit support pan and unit door assembly.
  2. Units shall be supplied with removable doors. The unit doors shall be fastened to the structure so that the doors can be closed when the unit is removed.
  3. A unit support pan shall be provided for support and guiding units. Unit support pans shall remain in the structure when units are removed to provide isolation between units.
  4. A service position shall be provided for plug-in units that allows for the unit to be supported but disengaged from the bus. The unit shall be capable of being padlocked in the service position.
- D. Power Stabs

1. Unit stabs for engaging the power bus shall be tin plated copper and provided with stainless back-up springs to provide and maintain a high pressure 4-point connection to the vertical bus.
2. Wiring from the unit disconnecting means to the plug-in stabs shall not be exposed to the rear of the unit. A separate isolated pathway shall be provided for each phase to minimize the possibility of unit fault conditions reaching the power bus system.
3. The power cable termination at the plug-in stab shall be a maintenance-free crimp type.

E. Handle

1. Units shall be provided with a heavy-duty, non-conductive industrial, flange mounted handle mechanism for control of each disconnect switch or circuit breaker.
2. The operator units may pivot in the vertical or horizontal plane.
3. The on-off condition shall be indicated by the handle position, red and green color indicators with the words ON and OFF, and the international symbols I and O along with a pictorial indication of the handle position.
4. Handles shall be capable of being locked in the OFF position with up to three padlocks.
5. The operator handle shall be interlocked with the unit door so the disconnect cannot be switched to the ON position unless the unit door is closed. A means shall be provided for purposely defeating the interlock during maintenance or testing.
6. The operator handle shall be interlocked with the unit so that the unit cannot be inserted or withdrawn with the operator handle in the ON position.

F. Pilot Devices

1. Where shown on the Drawings, units shall be furnished with NEMA Type 4/13 water tight/oil tight pushbuttons, selector switches or pilot lights.
2. When three or less pilot devices are utilized, the devices shall be Allen-30.5mm devices. When more than three devices are required, the use of 22.5mm devices is permitted.
3. [See also Variable Frequency Drive Specification for MCC-mounted pilot light requirements associated with VFDs.]

G. Terminal Blocks

1. Control terminal blocks shall be pull-apart on all plug-in units for easy removal of the unit from the structure.
2. Control terminal blocks on factory mounted units shall be fixed type.
3. Provide power terminal blocks on starters, rated NEMA size 3 and below. Power terminal blocks shall be pull-apart for NEMA size 1 and 2. Terminal blocks for NEMA size 3 starters shall be non-pull apart. Power terminal blocks are not required on NEMA size 4 and above.
4. Terminal blocks shall not be located adjacent to or inside the vertical wireway.

## 6. BUS BARS

### A. Horizontal Power Bus

1. The horizontal bus material shall be copper with tin plating.
2. The horizontal bus shall be supported, braced and isolated from the vertical bus with a high strength, non-tracking glass polyester material.
3. For standard sections the horizontal bus shall be continuous within each shipping block and shall be braced within each section.
4. Horizontal bus splices shall have at least two bolts on each side.

### B. Vertical Bus

1. The vertical power bus shall have an effective rating of 600A. If a center horizontal bus construction is utilized, then the rating shall be 300A above and below the horizontal bus for an effective rating of 600A. If a top or bottom mounted horizontal bus is utilized, then the full bus must be rated for 600A.
2. The vertical bus material shall be copper with tin plating.
3. The vertical bus shall attach to the horizontal bus with at least two bolts.
4. The vertical bus shall be continuously braced by a high strength non-tracking glass-filled polyester material and sandwiched by a polycarbonate molded cover.
5. Automatic shutters shall cover plug-in stab openings when units are removed.

### C. Ground Bus



1. Provide a ground bus system consisting of a horizontal ground bus connected to vertical ground buses mounted in each section.
2. Provide an unplated copper (0.25 inch by 1 inch or 0.25 inch by 2 inch) horizontal ground bus mounted in the bottom of the MCC unless otherwise specified in the drawings.
3. Provide a pressure type mechanical lug mounted on the ground bus in the incoming line section.
4. Provide a unit ground stab on all unit inserts. The ground stab shall establish unit insert grounding to the vertical ground bus before the plug-in power stabs engage the power bus. The grounding shall be maintained until after the plug-in power stabs are disengaged.

## 7. DISCONNECTS

### A. Main Circuit Breaker Disconnects

- a. Main circuit breaker shall be thermal magnetic circuit breakers of the size shown on the Drawings.
- b. Provide a circuit breaker of either the thermal magnetic or solid-state type.
- c. Provide a removable protective barrier to reduce the possibility of contact with the line terminals.
- d. Provide one normally open and one normally closed internal auxiliary contact.

### B. Feeder Disconnects and Transformer Disconnects

1. The disconnecting means for feeders and transformers shall be thermal magnetic circuit breakers.
2. The interrupting capacity rating shall be greater than or equal to the bus bracing requirement.
3. The minimum frame size shall be 150 amps
4. Provide one (1) N.O. internally mounted auxiliary contact for indication of "On" or "Off/Tripped."

### C. Motor Starter Disconnects

1. Across the line NEMA starters

- a. The disconnecting means for the across the line starters shall be motor circuit protectors.
- b. The short circuit withstand rating shall be greater than or equal to the bus bracing requirement.
- c. Units shall be supplied based upon the rules / requirements set forth in the NEC, NEMA and UL standards.
- d. Units shall be shipped at the lowest setting per UL standards. The contractor shall field adjust the units based upon the particular motor application.
- e. The minimum frame size shall be 150 amps.
- f. Provide one N.O. internally mounted auxiliary contact for indication of “On” or “Off/Tripped”.

D. Solid State Controllers (Soft Starters and Variable Frequency Drives)

- 1. The disconnecting means for solid state controllers shall be fusible disconnect with current limiting fuses.
- 2. The short circuit withstand rating shall be rated 100,000 amperes (rms symmetrical).

8. SOLID STATE REDUCED VOLTAGE SOFT STARTERS (RVSSs)

A. Operating Specifications

- 1. Power Ratings
  - a. Input: 200 – 460V  $\pm 15\%$ , 3 phase 50 / 60Hz (selectable)  $\pm 15\%$ . Unit(s) will operate with any incoming phase sequence.
  - b. Output: Reduced voltage 3 phase AC derived from phase-angle fired inverse parallel thyristors, ramped to full voltage.
  - c. Current Rating(s): Shall be, at a minimum, capable of the motor Full Load Amps for the Horsepower(s) indicated on the drawings, including any Service Factors.
  - d. Output Overload Capacity: Shall be as follows, based upon motors indicated on the drawings and specified elsewhere;
    - i. For units used on motors where Class 20 overload is required, the soft starter shall be capable 500% of motor FLA for 20 seconds.
  - e. Continuous duty rating shall be for the motor FLA plus + 15%.
  - f. SCCR (Short Circuit Current Rating) Listing: Combination starter units shall be UL listed to withstand the Available Fault Current of

the system as indicated on the drawings or as determined prior to installation.

2. Control Power: 120VAC, 60Hz provided by a Control Power Transformer with primary and secondary fusing, adequate to operate all associated devices in each starter.
3. Power Current Switching Devices (SCRs)
  - a. PIV Ratings: Minimum 2.5 times nominal line voltage.
  - b. Protection: RC snubber network circuits on each phase assembly and MOV protective devices on the gate circuits.
  - c. Efficiency: 98.5% through SCRs, 99.97% when bypass is engaged.
4. Bypass Contactor: All units shall have an integral Bypass Contactor to shunt motor power around the SCRs when at full speed. The soft starter shall include all necessary control circuitry to accomplish this without the need for external timers and engage the Bypass Contactor only when the microprocessor has determined that the motor has reached speed.
  - a. Overload Protection shall be integral and continuous so that it is in the motor circuit at all times, even when the Bypass Contactor is engaged.
  - b. Decel Interlocking shall be integral to allow the soft starter to automatically disengage the Bypass Contactor when a Decel command is given.
  - c. Units which use external Bypass Contactors will be considered, but shall still meet the all of the above control and protection conditions. They shall also meet the SCCR ratings as required above.
5. Ambient Conditions
  - a. Temperature: As a standard of unit design quality, starter shall be documented to show that the open chassis design has been tested for 0 – 50° C (-32 to 122° F) operation. Enclosed units shall be designed for 0 – 40° C ambient unless indicated elsewhere.
  - b. Altitude: 3300 ft (1000 m) without derating, 16,500ft (5000m) maximum.
  - c. Humidity: 0 – 95% RH, non-condensing.
6. Acceleration Control shall be fully adjustable in programming to match any application.
  - a. Ramp Type: Voltage Ramp.
  - b. Maximum Current Limit: To ensure acceptability to power conditions and reliability of starting under any circumstance that the motor can function in, a Current Limit function shall be

- available in all starting ramp modes, adjustable between 150 and 550% of the unit rating.
- c. Ramp Time: The time between Initial and Full Output shall adjustable between 1 and 20 seconds.
7. Deceleration Control (Controlled Ramp Down): To facilitate the controlled deceleration of pumps and other loads, Decel Torque Control and/or Pump Control shall be built in and selectable with the following adjustments, all of which are independent of any Acceleration Ramp settings:
    - a. Deceleration Ramp Time: adjustable from 0 – 20 seconds to allow gentle controlled deceleration in excess of the natural coast-to-stop time of the load.
  8. Motor and Load Protection shall be integral to the starter assembly. All current referenced protection features shall be automatically calculated from the motor nameplate FLA as entered by the user. All time based protection features shall have retentive memory so that they remain active should the power fail and be restored. Starter shall provide the following functions:
  9. Thermal Overload shall be provided by the on-board microprocessor control based on inverse time-current trip curves as defined by NEMA trip curve Classes. The trip curves classes shall be programmable from between Class 5 and Class 30 and the starter shall be UL listed to provide each individual class. The overload protection shall be based on a Motor Thermal Model retained in memory. The Thermistor monitoring circuit shall detect broken or shorted field devices or wiring.
  10. Phase-Loss Protection shall be standard and shut down the starter if current through any leg drops to 20% of the programmed motor FLA or less, independent of line voltage levels.
  11. Ground Fault Protection shall be included which will prevent a start-up if any phase is connected to Ground or trip while running.
  12. Over and Under Voltage Protection will cause a trip if the voltage dips or surges beyond the unit tolerance limits for both the line voltage and the control voltage.
  13. SCR / Welded Contactor Detection shall be standard. This function must automatically prevent the next start when at least one SCR is shorted, or the Bypass Contactor is welded

14. Starter Overtemp Trip shall be built-in and protect the SCRs from excessive heat build-up in the heat sink. This function shall also detect a broken wire or defective sensor.
15. Conformal coatings shall be factory applied to all circuit boards and circuit board components that allow and/or benefit from such treatments.
16. Adjustments shall be made by dashpot(s), with LED indicators for faults and running conditions.
17. SoftStarts shall be hard-wired to the Pumphouse PLC for control communications.
18. Power and control terminations shall be made on factory supplied mechanical lugs of sufficient size to accommodate the required wire for the line and load. Lugs are to be clearly marked as Line (L1, L2, L3) and Load (T1, T2, T3) and with appropriate tightening torque specifications.

B. Manufacturer's Reference

1. Solid state reduced voltage motor starters shall be *Siemens Sirius model 3RW40* (sized as indicated on the Drawings), or equal, subject to the requirements for Submittal review.

9. COMBINATION NEMA RATED ACROSS-THE-LINE STARTERS (EXHAUST FAN)

- A. Where shown on the Drawings, across-the-line starters shall be provided of the 3-pole Class 20 magnetic type. The overload shall provide overload and phase loss protection.
- B. Starters shall be provided with a minimum of one N.O. and one N.C. auxiliary contact in addition to the hold in contact and auxiliary contacts shown on the drawings up to a maximum of seven beyond the hold-in contact.
- C. Provide a 120 - volt control power transformer with a primary and secondary fuse protection.
- D. Provide a door mounted selector switch for Hand-Off-Auto operation. The Hand Mode shall provide local start control. In the Auto Mode, start control shall be provided through a remote contact. Provide an extra set of contacts on the selector switch for monitoring of switch position.
- E. Provide door mounted 120 - volt transformer type pilot lights for On (Red) and Off (Green) indication, as shown on the Drawings.

10. CONTROL AND LIGHTING TRANSFORMER

- A. Control and lighting transformers shall be as shown on the Drawings. Rating shall be the minimum acceptable rating.
- B. The insulation shall be 180°C insulation with 80°C rise.
- C. Provide thermal magnetic circuit breaker for primary protection.
- D. The primary circuit breaker compartment and transformer compartment shall be wired and interlocked together.
- E. Provide secondary fuse protection for the transformer.
- F. Provide vented doors with filters for NEMA Type 1 with gaskets and NEMA Type 12 structures.

#### 11. LIGHTING PANEL

- A. Provide lighting panel with for 120/240V circuits as shown on the Drawings.
- B. The lighting panel shall be rated for 100A, with 250A aluminum-plated tin bussing, and include an integral main breaker. Panel shall be top-feed, surface-mount, and installed behind a deadfront door in the MCC. Panel shall be *Siemens* catalog #B3100, or equal, subject to the requirements for Submittal Review.
  - 1. Circuit breakers shall be thermal magnetic type of the ratings shown on the Drawings. Breakers shall be molded case, with visible trip indication showing ON/OFF and TRIPPED positions on the operating handle. Multi-pole circuit breakers shall be designed so that an overload on one pole automatically causes all poles to open. Straps between single-pole breakers are not allowed for multi-pole breaker installations.
  - 2. Circuit breakers shall be CH or CHT type, compatible with panels installed.
  - 3. Molded case breakers shall conform to NEMA AB-1 and UL 489.

#### 12. SURGE SUPPRESSION DEVICES (SPDs)

- A. Surge suppression shall be provided on the line side of the new MCC, as shown on the Drawings. Line side surge protection shall be Type 2 SPDs rated for 200 kA per phase, and suitable for integration on the MCC bus. Power characteristics shall be 480V, 3-phase.
- B. Type 2 surge protection devices shall comply with UL 1449 and shall be CSA C22.2 certified.
- C. Type 2 surge protection devices shall be *Siemens* model *TPS3E01*, or equal.

#### 13. VENTILATION AND COOLING

- A. New MCC enclosures shall include ventilation and/or cooling provisions as determined necessary by the manufacturer to adequately dissipate heat from switchgear, VFDs, harmonic filters, and SoftStarts, and maintain operating temperatures within equipment ratings.
- B. Any ventilation or cooling provisions necessary shall be designed by the MCC manufacturer and included with equipment Submittals.

#### 14. NAMEPLATES

- A. Provide etched adhesive plastic nameplates for MCC compartments and all pilot lights and HOA switches.
- B. Nameplates shall be black and a minimum of 1.5” in height with etched white capital lettering 1” tall in Arial or Calibri font.
- C. Nameplate wording shall be as shown on the MCC Elevation view on the Drawings and shall be submitted in accordance with requirements for Submittal Review.

### **PART 3 EXECUTION**

#### 1. CONNECTION BETWEEN NEW AND EXISTING MCC'S

- A. Bus Extensions or Jumpers Between Existing and New MCCs
  - 1. The existing 2-section (1999) MCC to be retained is a Square D model 6. [Factory order documentation and drawings of both existing MCCs, including the one shown for removal/replacement are available on request.]
  - 2. The Contractor shall confirm spatial, dimensional, voltage and ampacity requirements, and conductor and conduit (or raceway) size needed for installing permanent jumpers or extensions between bussing on existing and new MCCs. The connections between existing and new MCCs shown on the Drawings should be considered conceptual only, and are subject to Contractor verification and/or modification as required for NEC and UL compliance.
  - 3. All bus extensions or jumpers shall be fully enclosed in conduit or wireway.
  - 4. Connections between existing and new MCCs must be done in full compliance with the respective manufacturers' requirements of the two MCCs, and in full conformance with NEC and UL requirements. Connections between existing and new MCCs must be done so as to maintain UL-rating on both MCCs.
  - 5. Bonded or lug connections may be used at the discretion of the Contractor, subject to NEC and MCC manufacturers' requirements.
  - 6. The Contractor shall provide a schematic drawing with materials sizes and

ratings for his/her proposed MCC interconnection, in accordance with the requirements for Submittal Review.

4. RATINGS

- A. Ratings indicated on the drawings are for guidance only and do not limit the equipment size.
- B. When electrically driven equipment furnished under other sections of these specifications materially differs from the design, the Contractor shall make the necessary adjustments to disconnects and branch-circuit protection to accommodate the equipment actually installed.

15. CONTROL WIRING

- A. Control wiring and control devices shall be provided under the specification section in which the controlled equipment is specified. Coordinate all related work.

16. OVERLOAD PROTECTION

- A. Manual Starters: Install bimetallic overload relays properly sized based on the nameplate current for the motor actually served.
- B. Magnetic Starters: Adjust setting on solid state overload relay based on the nameplate current for the motor actually served.

17. DISCONNECTS

- A. Adjacent to motor, provide a disconnect means for each motor remotely located, unless the motor is in sight of and within 50' of its overcurrent device.

18. INSTALLATION

- A. Contractor shall install MCC in accordance with manufacturer's instructions.
- B. Contractor shall tighten accessible bus connections and mechanical fasteners to the manufacturer's torque requirements.
- C. Contractor shall select and install fuses in fusible switches based upon field requirements.
- D. Contractor shall adjust circuit breaker settings based upon field requirements.
- E. Contractor shall adjust solid state overloads to match the installed motor characteristics.

19. GROUNDING



- A. The Contractor shall investigate and confirm the adequacy and NEC-compliance of existing (reportedly) concrete-encased electrode and water pipe grounding provided on existing MCC(s) to verify its suitability for reuse with the new MCC. [The 1999 Pumphouse electrical plans are available upon request.]
- B. If existing grounding is found to be inadequate, the Contractor shall provide written notification to the Engineer, including the investigations, tests or inspections performed, the results and deficiencies noted, and a proposed alternate or supplemental grounding method.

20. MANUFACTURER'S SERVICES

- A. In addition to manufacturer's field services required under Section 16483 – Variable Frequency Drives, a manufacturer's representative for the equipment specified herein shall be present at the jobsite and/or classroom designated by the Owner for the minimum times listed for the services as follows, travel time excluded. The startup/training representative's qualifications shall be provided for approval in accordance with the requirements for equipment Submittal Review:

- 1. (10) hours for installation assistance to the Contractor, inspection, startup, functional and performance testing, and certification of the installation.
- 2. (4) hours for operator training to the Owner.

Startup services and training of Owner's personnel shall be at such times as requested by the Owner and may be at a later date than equipment installation and startup. The manufacturer's representative may be expected to make two separate trips to the jobsite without additional compensation.

21. SPARE PARTS

- A. Provide two of each size power fuse utilized, including transformer protection.
- B. Provide two spare pilot light lenses and pilot light bulbs of each color and type used in the equipment.

**END OF SECTION 16480**

## SECTION 16483

### VARIABLE FREQUENCY DRIVES

#### PART 1 GENERAL

##### 1.1 Description

- A. Variable frequency drives (VFDs) shall be solid state, adjustable frequency devices to provide 480V three-phase power, and speed control and flow modulation for “Lead” Raceway and Rearing pumps. Harmonics filters, integrated with the VFDs, are required as specified herein.
- B. VFDs shall be furnished as part of the new MCC, incorporating harmonic filters and human-interface-modules (HMIs) and other controls as shown and specified.
- C. The “Lead” Rearing Pump VFD shall modulate pump flow in response to a Rearing Building Receiving Sump level analog signal (see also Process Instrumentation & Control Specification).

##### 1.2 Certifications and General Operating Conditions

- A. The manufacturer shall have minimum 5 years experience in the design and manufacture of Variable Frequency Drives (VFDs).
- B. The VFD and all associated equipment shall be UL Listed according to UL 508C – Power Conversion Equipment. As verification, a UL label shall be attached on the enclosure.
- C. Each VFD in conjunction with its associated passive harmonics filter shall achieve IEEE519 compliance for total harmonics, including Total Demand Distortion per Table 10-3 of IEEE-519 and Total Harmonic Voltage Distortion per Table 10-2 of IEEE-519. Total harmonic distortion emanating from each drive-and-filter combination shall not exceed 5.0 percent.
- D. The VFD with harmonic filter shall be factory pre-wired, assembled and tested as a complete package.
- E. The VFD shall be designed, constructed and tested in accordance with UL, CSA, NEMA, and NEC standards. The VFD and all associated optional equipment shall be UL listed or recognized. The VFD shall contain a UL label attached on the side of the housing or cabinet.
- F. Certifications: Compliance with low-voltage directive 73/23/EWG EN 60204 and EN 61800-5, certification in compliance with UL and cUL, CE, c-tick, protection class I (with protective conductor system), protection class III (PELV), shock-hazard protection, degree of contamination 2 in compliance with EN 61800-5-1, climatic environmental conditions in operation Class 3K5, environmental/chemical influences Class 3C2, organic/biological influences Class 3B1 in compliance with EN 60721-3-3, compliancy with industrial standard

SEMI F47 for immunity to voltage dips, manufacturing according to RoHS regulations, components according to WEEE, manufacturing location certified in compliance with ISO14001.

- G. Every power converter shall be tested with an AC induction motor while loaded and temperature cycled within an environment chamber.
- H. Wiring for power and control circuits to/from the drives, motors, and external circuits shall meet the requirements of the Electrical Specification.

### 1.3 Submittals

- A. In addition to the requirements of the General Equipment Stipulations, the following documentation shall also be provided for this equipment and accompany other required submittals:
  - 1. Electrical drawings including circuit schematics, interconnection diagrams, and all information necessary for connection of electrical power and input/output circuits.
  - 2. Interconnecting wiring diagrams to tie instruments to Owner's control system where shown on the Drawings, including all component and panel terminal board identification numbers and external wire numbers. This diagram shall include all intermediate terminations between field elements and panels (including disconnect devices, pilot devices, terminal junction boxes, motor control centers, etc.).
  - 3. Power diagram including amperage ratings, circuit breaker frame sizes, circuit breaker continuous amp ratings.
  - 4. Major components list and data sheets for major components, including contactors, circuit breakers and fuse (both power and control), control power transformers, pilot devices, relays and timers, and harmonic filters.
  - 5. Manufacturer's statement relative to IEEE 519 compliance on harmonics.
  - 6. Drive and harmonic filter elevation drawings including dimensional information and conduit routing locations.
  - 7. Active and passive ventilation and heat dissipation features and appliances in each drive or filter, including ratings and electrical characteristics.
  - 8. Ventilation and/or cooling equipment component list: rating, arrangement and wiring; and NEMA and environmental ratings.
  - 9. Any special options or accessories included for each drive and filter.
  - 10. Test procedures prescribed by the drive and filter manufacturers.

- B. Product Data Sheets
  - 1. VFD and Operator Interface publications.
  - 2. Harmonic filter publications.
  - 3. Data sheets and publications on all major components including but not limited to the following:
    - a. Contactors
    - b. Circuit breaker and fuse (power and control)
    - c. Control power transformers
    - d. Pilot devices
    - e. Relays/Timers
    - f. Harmonic filters
- C. Test procedures shall be per the manufacturer's standards.
- D. Operation and Maintenance Data
  - 1. Service and Contact information
  - 2. VFD and Operator Interface User Manuals
  - 3. Harmonic Filter User Manuals
  - 4. Troubleshooting / Service Manuals

#### 1.5 Delivery, Storage, And Handling

- A. Contractor shall coordinate the shipping of equipment with the manufacturer.
  - 1. Contractor shall store the equipment in a clean and dry space at an ambient temperature range with the VFD manufacturer's prescribed tolerances.
  - 2. The Contractor shall protect the units from dirt, water, construction debris and traffic.

#### 1.6 Warranty

- A. The drive manufacturer shall provide their standard parts warranty for eighteen (18) months from the date of shipment or twelve (12) months from the date of being energized, whichever occurs first.

### **PART 2 PRODUCTS**

#### 2.1 Manufacturers Reference

- A. The VFDs shall be *Sinamics G120 PM240-2 AC Drive Units*, provided by *Siemens Industry, Inc.*, or equal, subject to performance equivalency and the requirements for Submittal review.

#### 2.2 Performance Requirements

- A. The VFD shall be listed and labeled as a complete unit and shall include all accessories and requirements as described in this section.
- B. VFDs shall be installed in a NEMA 12 new MCC as shown on the Drawings.

C. Environmental Ratings:

1. Degree of protection: IP20
2. Ambient air temperature operating range: -10to 50°C (without derating).
3. Relative humidity range: 5% to 95%, non-condensing.
4. Operating elevation: 3300 ft MSL
5. Shock: 15G peak for 11ms duration.
6. Vibration: 0.152 mm (0.006 inches) displacement, 1G peak.
7. Seismic: The AC drive shall meet the seismic requirements of the 2003 International Building Code as specified by AC156.

D. VFD Loads and Application Data:

1. Each AC drive shall be sized to operate a variable torque (centrifugal pump) load.
2. The speed range shall be from a minimum speed of 1.0 Hz to a maximum speed of 60 Hz.
3. VFD Loads:
  - a. Rearing Pump VFD shall have an output load rating of at least 26A and operate a new 480V, 3-phase 15 hp vertical turbine pump with 15hp inverter-duty rated motor (see Vertical Turbine Pump Specifications). Note that actual new Rearing Pumps provided could vary from those specified, subject to requirements for Submittal review, and the VFD supplier must verify with the Contractor the exact electrical and load characteristics of the pumps being provided.
  - b. Raceway Pump VFD shall have an output load rating of at least 60A and operate an existing 480V, 3-phase 40hp inverter-duty rated motor on an existing vertical turbine pump (Prime Pump model 12M12-9° with U.S. Motors H040V2BLF 1800 rpm motor).
  - c. VFD output load ratings shall be larger than the minimums listed above, if so recommended by the drive manufacturer for these applications.

E. Features:

1. VFDs shall be pulse-width modulation, modular frequency converters consisting of a power module, plug-in control module and plain text operator panel.
2. The replacement of the power component must be possible without reprogramming and switching off the control module whilst maintaining the field bus communication.

3. Characteristics
  - a. Rated voltage: 3-phase AC 380 – 480V +/-10%
  - b. Rated frequency: 47 – 63Hz
  - c. Overload capability: 150% x rated current for 3 seconds plus 110% of rated current for 57 seconds at a cycle time of 300 seconds
  - d. Efficiency acc. EN 50598: class IE2, 98,1%
  - e. Dedicated Digital Input for hardware enable.
  - f. Conformal coated printed circuit boards.
  - g. Optional onboard 24V DC Auxiliary Control Power Supply.
4. To parameterize the drive an integrated USB interface for PC connection is required; saving and loading parameter records and firmware updates must be possible by a MMC memory card. The terminals have to be identified by replaceable labelling strips for individual marking.
5. Capabilities and Functionality
  - a. The frequency converter must be able to run 2 – 8 pole asynchronous motors of the efficiency classes IE2 to IE4 and synchronous reluctance motors up to 30kW without over dimensioning. The following motor control modes must be foreseen: v/f characteristic linear, parabolic, parameterizable, with flux current control, sensorless vector control. All control modes must have an energy saving mode for additional energy savings. Output frequency 0 – 550 Hz at control mode v/f, 0 – 240 Hz in sensorless vector mode.
  - b. The drive system must be protected through thermal motor protection with PTC/KTY84/PT1000/bimetal, thermal converter protection, monitoring for under voltage and overvoltage, overloading, grounding, short circuiting, stalling and blocking of the motor.
  - c. The control unit shall have the following functionality: set point via analog input, 16 freely parameterizable fixed speeds, integrated motorized potentiometer, and serial interface. Ramp generator with initial and final rounding, automatic adaption of ramp up and down times, slip compensation, dc braking, 4 switchable drive data sets, 4 switchable command data sets (manual/auto), runtime counter, error message memory with time stamp, function blocks for logical, arithmetical and technological operations, automatic restart after power failure or stoppage, synchronization to running motor, load torque monitoring with or without encoder for overload protection or belt monitoring, 4 parametrizable skip frequencies to avoid mechanical resonances, technology controller with PID behaviour. The following safety function has to be integrated: Safe Torque Off (STO) according Cat. 3 / EN 954-1, Level d / EN ISO 13849-1, SIL2 / IEC 61800-5-2. The safety function has to be enabled via fail-safe digital inputs.

6. PROFINET Control Unit: VFDs will be controlled through the PLC-based control system. An integrated PROFINET interface with PROFIdrive profile version 4.1 is required, the bus address has to be set via DIP switches or parameters. The safety function has to be enabled via fail-safe digital inputs or PROFIsafe via the PROFINET communication. Control capabilities shall include the following:
  - a. Ability to control outputs and manage status information locally within the VFD.
  - b. Ability to function stand-alone or complimentary to remote PLC control.
  - c. Ability to speed reaction time by processing in the VFD.
  - d. Ability to provide scaling, selector switches, or other data manipulations not already built into the VFD.
  - e. Ability to read inputs/outputs to exclusively control the VFD.
  - f. Ability to provide override control if communication is lost with PLC.
7. Inputs and Outputs (I/Os)
  - a. All digital and analog inputs and outputs must be freely parameterizable and assigned to a specific function in the factory setting.
  - b. VFDs must have at least the following minimum I/O capabilities: 6 isolated digital inputs, 2 digital output as isolated contacts (30 V DC, 0,5 A), 1 digital output transistorized (30 V DC, 0,5 A), 2 switchable analog inputs for 0 – 10 V or 0/4 – 20 mA and parameterizable in addition as digital inputs, 2 analog outputs for 0 – 10 V or 0/4 – 20 mA, 1 permanently assigned input for the thermal motor protection with PTC, KTY84, Pt1000 or bimetal, operating voltage 24 V DC external or via the power module.
  - c. The drive shall be capable of sensing reference loss conditions.
  - d. In the event of loss of the reference signal, the drive shall be user programmable to the following:
    - i. Fault the drive and coast to stop.
    - ii. Issue a minor fault - allows the drive to continue running while some types of faults are present.
    - iii. Alarm and maintain last reference.
8. EMC Filters and Line Reactor: Each VFD shall be provided with EMC filters and line reactors matched to the drive and provided by the drive manufacturer.
9. Acceleration / Deceleration
  - a. Accel/Decel settings shall provide separate adjustments to allow either setting to be adjusted from 0 to 3600 seconds.
  - b. A second set of remotely selectable accel/decel settings shall be accessible through digital inputs.

10. Speed Profiles

- a. Programming capability shall allow the user to produce speed profiles with linear acceleration/deceleration or "S Curve" profiles that provide changing accel/decel rates.
- b. S Curve profiles shall be adjustable.

11. Process PID Control

- a. The drive shall incorporate an internal process PI regulator with proportional and integral gain adjustments as well as error inversion and output clamping functions.
- b. The feedback shall be configurable for normal or square root functions. If the feedback indicates that the process is moving away from the set-point, the regulator shall adjust the drive output until the feedback equals the reference.
- c. Process control shall be capable of being enabled or disabled with a hardwire input. Transitioning in and out of process control shall be capable of being tuned for faster response by preloading the integrator.
- d. Protection shall be provided for a loss of feedback or reference signal.

12. Skip Frequencies

- a. Three adjustable set points that lock out continuous operation at frequencies which may produce mechanical resonance shall be provided.
- b. The set points shall have an adjustable bandwidth up to Maximum Forward Speed.

13. Faults

- a. At a minimum, the following faults shall be accessible through the Human Interface Module:
  - i. Power Loss
  - ii. Undervoltage
  - iii. Overvoltage
  - iv. Motor Overload
  - v. Heat Sink Over-temperature
  - vi. Maximum Retries
  - vii. Phase to Phase and Phase to Ground Faults

14. Fault Memory

- a. The last 10 (or more) fault codes shall be stored and time stamped in a fault buffer.
- b. Information about the drive's condition at the time of the last fault such as operating frequency, output current, dc bus voltage and other status conditions shall be stored.
- c. A power-up marker shall be provided at each power-up time to aid in analyzing fault data.
- d. The last 10 alarm codes shall be stored and time stamped for additional troubleshooting reference.



15. Fault Reset / Run
  - a. The drive shall provide multiple automatic fault reset and restarts following a fault condition before locking out and requiring manual restart.
  - b. The automatic mode shall not be applicable to a ground fault, shorted output faults and other internal microprocessor faults.
  - c. The time between restarts shall be adjustable from 0.5 seconds to 30 seconds.
16. Run on Power Up
  - a. A user programmable restart function shall be provided to allow restart of the equipment after restoration of power after long duration power outages. Restart time dependent on presence of incoming signal.
17. Overload Protection
  - a. The drive shall provide internal class 10 adjustable overload protection.
  - b. Overload protection shall be speed sensitive and adjustable.
  - c. A viewable parameter shall store the overload usage.
18. Auto Economizer
  - a. An auto economizer feature shall be available to automatically reduce the output voltage when the drive is operating in an idle mode (drive output current less than programmed motor FLA). The voltage shall be reduced to minimize flux current in a lightly loaded motor thus reducing kW usage.
  - b. When the load increases, the drive shall automatically return to normal operation.
19. Terminal Blocks
  - a. Separate terminal blocks shall be provided for control and power wiring.
20. Flying Start
  - a. The drive shall be capable of determining the speed and direction of a spinning motor and adjust its output to "pick-up" the motor at the rotating speed. This feature is disabled by default.
21. Real-Time Clock
  - a. Shall be capable of providing time stamped events.
  - b. Shall have the ability to be set locally or via a remote controller.
  - c. Shall provide the ability to be programmable for month, day, year and local time zones in HH:MM:SS.

22. Power Loss

- a. Ride-Through: The VFD system shall attempt to ride through power dips up to 20% of nominal. The duration of ride-through shall be inversely proportional to load. For outages greater than 20%, the drive shall stop the motor and issue a power loss alarm signal to a process controller, which may be forwarded to an external alarm signaling device.
- b. Run on Power Up: The VFD system shall provide circuitry to allow for remote restart of equipment after a power outage. Unless indicated in the contact drawings, faults due to power outages shall be remotely resettable. The VFD system shall indicate a loss of power to a process controller, which may be forwarded to an external alarm signaling device. Upon indication of power restoration, the process controller will attempt to clear any faults and issue a run command, if desired.

23. Human Machine Interface Module (HMI)

- a. Each VFD shall provide a HMI with integral LCD display. The HMI shall be door-mounted on the MCC
- b. The HMI shall have the following features:
  - i. A two-line by twenty-one (21) character backlit LCD display with graphics capability.
  - ii. The HMI shall indicate drive operating conditions, adjustments and fault indications.
  - iii. Shall provide digital speed control.
- c. The keypad shall include programming keys, drive operating keys (Start, Stop, Direction, Jog and Speed Control), and numeric keys for direct entry.
- d. HMI module shall be *Siemens Sinamics BOP* panel, or equal.

24. The drive system nameplate shall be marked with system Short Circuit Current Rating (SCCR).

25. Control Power Transformer

- a. Provide a 24 VDC control power transformer with fused primary/secondary, and mounted and wired inside of the drive system enclosure.
- b. The transformer shall be rated for the VFD control requirements. Control power transformer shall be of adequate capacity and impedance to source 24 vdc control circuits and I/Os shown and specified.

26. Harmonic Mitigation Requirements

- a. Each drive system shall be compliant with IEEE519-2014 standards at the input power connection terminals based upon the input power phase imbalance within 0.5% of nominal line voltage and under full VFD output current ratings.

- b. Passive harmonics filters shall be mounted within the drive enclosure.
- c. All harmonics filters shall meet the following requirements:
  - i. Filters shall treat all characteristic low frequency harmonics generated by a single-phase full wave inverter load. Characteristic harmonics shall be suppressed without need for individual tuning or the requirement to phase shaft against other harmonic sources.
  - ii. Units shall be an adaptive passive series connected low pass filter consisting of an inductor capacitor network. Filter shall meet the harmonic performance specification with a 3 percent phase voltage unbalance as defined in ANSI C-84, 1-1995.
  - iii. Filters shall have all copper wiring. An integrated series and shunt reactor shall be used in the construction of the harmonics filter.
  - iv. Full load efficiency of the harmonics filter shall be greater than 97 percent.
  - v. When fed from a power distribution system operating at the normal distribution voltage, the harmonic filter output voltage at full load shall not be less than the nominal RMS utilization voltage. At no load, the output voltage shall not be more than 4.6 percent of nominal RMS and peak distribution voltage.
  - vi. Total Harmonic Input Current Distortion shall be less than 5% at full local.
  - vii. Harmonic filters shall have a high-temperature alarm contacts (wired to VFD shutdown and alarm on the Pumphouse PLC); and an isolation contactor to disconnect the harmonic filter capacitor bank when the VFD is not operating (to avoid filter over-heating).
  - viii. Harmonics filters shall be *Matrix AP* three-phase filters, as manufactured by MTE Corporation, or equal. Filters shall be UL and cUL listed to UL508 Type Mx and CSA-C22.2 No. 14-95 and shall be rated by the manufacturer for use with the associated variable frequency drive equipment.
- d. All harmonics filters in combination with the associated variable frequency drives shall be provided with unit responsibility by the drive manufacturer for performance and harmonics mitigation.

## 27. Auxiliary Relays

- a. VFDs shall include one NO auxiliary output relay, and one NC auxiliary output relay.
- b. Relay contacts shall be rated for 115V AC/30V DC, 5.0 amp resistive, 2.5 amp inductive.

## 28. Hand/Off/Auto Selector Switch

- a. Each VFD shall be controlled by a "Hand/Off/Auto" selector switch mounted on the MCC door.
- b. The "Hand/Off/Auto" selector switch shall start the drive in the "Hand" mode and stop the drive in the "Off" mode.

- c. In the “Auto” mode the drive shall be started and stopped from a remote “RUN” circuit from the Pumphouse PLC.
- d. The drive speed reference shall be controlled by a remote 4-20 mA input when in “Auto” mode.
- e. The device shall be a 22 or 30mm, NEMA Type 4/13, mounted on the drive system enclosure door.

29. Pilot Lights

- a. Each VFD shall operate remote pilot lights, mounted on the MCC door, for indication of the following status:
  - i. Drive Tripped (yellow)
  - ii. Drive Running (green)
  - iii. Drive Start (green illuminated push-button)
  - iv. Drive Stop (red illuminated push-button)
- b. Devices shall be 22 or 30 mm, NEMA Type 4/13, mounted on the MCC door. [See Motor Control Specification for MCC and MCC Drawings.]

**PART 3 EXECUTION**

3.1 Installation

- A. Installation shall be in compliance with manufacturer’s instructions, drawings and recommendations.
- B. Provide individual ground circuits for each VFD in full accordance with N.E.C. and the drive manufacturer’s requirements.

3.2 Start-up

- A. Certified factory start-up shall be provided for each VFD provided.
  - 1. At a minimum, the start-up service shall include:
    - a. Perform pre-Power Check
    - b. Megger Motor Resistances: Phase-to-Phase and Phase-to-Ground
    - c. Verify system grounding per manufacturer’s specifications
    - d. Verify power and signal grounds
    - e. Check connections
    - f. Check environment
  - 2. Drive Power-up and Commissioning:
    - a. Measure Incoming Power Phase-to-Phase and Phase-to-Ground
    - b. Measure DC Bus Voltage
    - c. Measure AC Current Unloaded and Loaded
    - d. Measure Output Voltage Phase-to-Phase and Phase-to-Ground
    - e. Verify input reference signal

3. All measurements shall be recorded.
  4. Drive shall be tuned for system operation.
  5. A written record of drive parameter listing shall be provided.
- B. Service engineers shall be employed by the manufacturer or a manufacturer-certified distributor and provide start-up services including physical inspection of drive and connected wiring and final adjustments to meet specified performance requirements.
- C. Field Services
1. In addition to Manufacturer's Services specified for the new MCC in Section 16480 – Motor Controls, a manufacturer's representative for the VFD equipment specified herein shall be present at the jobsite and/or classroom designated by the Owner for the minimum hours listed for the services as follows, travel time excluded. The startup/training representative's qualifications shall be provided for approval in accordance with the requirements for equipment Submittal Review:
    - a. (8) hours for installation and startup assistance to the Contractor, inspection, functional and performance testing, and certification of the installation.
    - b. (6) hours for operator training to the Owner, to include the following:
      - i. The basis of the training shall be the variable frequency drive, the engineered drawings and the user manual. At a minimum, the training shall:
      - ii. Review the engineered drawings identifying the components shown on the drawings.
      - iii. Review starting / stopping and speed control options for the controller.
      - iv. Review operation of the Human Interface Module for programming and monitoring of the variable frequency drive.
      - v. Review the maintenance requirements of the variable frequency drive.
      - vi. Review safety concerns with operating the variable frequency drive.
  2. Startup services and training of Owner's personnel shall be at such times as requested by the Owner and may be at a later date than equipment installation and startup. The manufacturer's representative may be expected to make two separate trips to the jobsite without additional compensation.

D. Product Support

1. Factory-trained application engineering and service personnel that are familiar with the VFD products offered shall be available within 400 road miles of the project site.
2. A 24-hour, 365-day technical support line shall be available.

**END OF SECTION 16483**