

**Solicitation: F1700-120203**  
**Hatchery Section Intake Screen Modification**

The following changes in the tender documents are effective immediately. This addendum will form part of the Contract Documents.

**Addendum No. 2**

1. There are no specifications for the VFD or the output filter for the VFD.

**See attached specification section 26 29 23 Variable Frequency Drives: Low Voltage.**

2. Provide more detail for the surge protectors called out on drawing number 17.

**Provide a surge protective device (SPD) for both the 600-volt panel and the 208-volt panel located in the new Mechanical Equipment Building. The SPD for the 600-volt panel shall include a NEMA 3R enclosure, indicator lights for each phase, UL 1449 Type 2 and shall include a 10 year product warranty. The SPD on the 600-volt panel shall be suitable for a 600-volt, DELTA connected, 3-phase, 3-wire + ground service, and shall be rated for a peak surge current per phase of 120-kA. The SPD connected to the 208-volt panel shall be nipple mounted, suitable for a 208Y/120-volt, 3-phase, 4-wire + ground service and be rated for a peak surge current per phase of 50-kA. SPD's by Square D, Cutler Hammer, Siemens, or approved equivalent.**

3. PVC Conduits

**Per specification section 26 05 34 - 3.2, rigid PVC conduit may only be used underground. Use rigid steel for all other conduit, except above 2.4 m, EMT may be used if not subject to mechanical injury.**

4. Could you please clarify the prepackage power supply.

**It is UL listed, 600v primary, 208/120 secondary, 3 phase, 15KVA transformer, in a NEMA 3R enclosure, with a minimum of 12 circuit breaker spaces, and branch breakers as shown.**

5. Do you have any information on the 600V distribution located at the River Intake Pump House, drawing 15?

**Westinghouse Switchboard, 600-volt, 3-phase, 3-wire, minimum equipment rating of 25,000 amps RMS symmetric. Further information shall be site verified by contractors.**

**End of Addendum No. 2**

**Part 1 General**

**1.1 SUMMARY**

- .1 Section Includes:
  - .1 Variable frequency drives (VFDs) for operation of inverter duty motors.

**1.2 RELATED SECTIONS**

- .1 Not Used.

**1.3 QUALITY ASSURANCE**

- .1 Referenced Standards:
  - .1 American National Standards Institute (ANSI).
  - .2 ETL Testing Laboratories (ETL).
  - .3 Institute of Electrical and Electronics Engineers, Inc. (IEEE):
    - .1 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.
    - .2 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
    - .3 C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
  - .4 National Electrical Manufacturer's Association (NEMA):
    - .1 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
    - .2 MG 1, Motors and Generators.
  - .5 National Fire Protection Association (NFPA):
    - .1 70, National Electrical Code (NEC):
      - .1 Article 430, Motors Motor Circuits, and Controllers.
  - .6 Occupational Safeties and Health Administration (OSHA).
  - .7 Underwriters Laboratory, Inc. (UL):
    - .1 508, Standard for Industrial Control Equipment.
    - .2 508A, Standard for Industrial Control Panels.
- .2 Qualifications:
  - .1 Provide drives that are listed and labeled by UL, ETL, or other Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA regulations, or that have been inspected and subsequent field-labeled by such NRTL.
  - .2 Where listed drives and other components are installed in a common enclosure, the assembly shall be listed and labeled per UL 508 and UL 508A or equivalent NRTL standard.
    - .1 Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" or equivalent NRTL label prior to shipment to the jobsite.

- .3 Coordination:
  - .1 VFD shall be supplied complete with all required control components.
    - .1 Provide control as indicated:
      - .1 On the electrical drawings.
      - .2 As specified in this Specification Section.
    - .2 VFD provider shall review the application and provide, at no additional cost to the Owner, the hardware and software necessary to allow the VFD to control the driven equipment motor over its required operating range.
      - .1 These may include, but are not limited to, analog and digital interface modules, communication interface modules, switches, lights and other devices.
  - .2 Verify plan dimensions with equipment space requirements as indicated on the Drawings.
    - .1 Equipment which exceeds the allotted maximum dimensions may not be acceptable.
    - .2 Equipment which reduces clear work space below the minimums established by the NFPA 70 will not be acceptable.

#### **1.4 DEFINITIONS**

- .1 Variable Torque (VT):
  - .1 Defines a load characteristic in which the torque delivered from the motor to the load is reduced as speed is reduced below full rated.
  - .2 This type of load permits the VFD and the motor to operate at reduced output current at reduced speed.
- .2 Constant Torque (CT):
  - .1 Defines a load characteristic in which the torque delivered from the motor to the load remains constant as speed is varied.
  - .2 This type of load requires the VFD to be able to continuously deliver rated output current over the entire speed range.
- .3 Constant Horsepower:
  - .1 Defines a load characteristic in which the torque delivered from the motor to the load is reduced as the speed is increased.
  - .2 This characteristic is required for operation of the VFD and motor above rated frequency to maintain output current within the rated value.
- .4 Low Voltage: 600 Vac or less.

#### **1.5 SUBMITTALS**

- .1 Shop Drawings:
  - .1 See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

- .2 Provide a schedule for each VFD including the following information:
  - .1 Equipment Tag Number.
  - .2 VFD Complete Catalog Number.
  - .3 VFD Amp Frame Size.
  - .4 Variable or Constant Torque Rating Basis.
  - .5 Rated Input Current.
  - .6 Rated Continuous Output Current.
  - .7 Rated Short Circuit Current.
  - .8 VFD cable type specified (shielded or non-shielded).
  - .9 VFD Maximum Motor Lead Length for the type of cable used.
  - .10 As installed motor Lead Length.
- .3 Submit VFD Shop Drawings concurrently with driven equipment and motor Shop Drawings.
- .4 Product technical data:
  - .1 Complete electrical ratings and performance specifications confirming compliance with specified ratings and performance.
  - .2 Maximum rate of heat rejection from VFD and all related components and associated cooling requirements.
  - .3 Manufacturer's installation instructions.
  - .4 Manufacturer's programming and operating instructions.
- .5 Fabrication and/or layout drawings:
  - .1 Top, front, and side exterior views, with details showing maximum overall dimensions of enclosure, mounting provisions and conduit/cable entry provisions.
  - .2 Identify minimum clearances from other VFDs or electrical equipment required for proper cooling at top, bottom, side and back of enclosure.
  - .3 Three-line diagrams showing AC schematic of VFD, input, output and bypass devices including device ratings.
  - .4 Interior layout drawings showing location of all components within enclosure, field wiring terminal boards, and power and grounding connections.
  - .5 Field wiring diagrams showing locations and sizes of all electrical connections, ground terminations, and requirements for shielded wire usage or any other special installation considerations.
- .6 Certifications:
  - .1 Submit with Shop Drawings:
    - .1 Identification and location of closest authorized service organization.
  - .2 Submit after installation:
    - .1 Certified field service reports showing:
      - .1 Each VFD is operational.
      - .2 Each VFD and its driven equipment motor are compatible.

- .3 Each VFD responds correctly to the input control signals.
- .4 Critical frequencies of the drive system and that the VFD has been set to lockout these frequencies.
- .5 Measured harmonic levels per Harmonic Protection Requirements Article.
- .6 Measured motor terminal peak voltages per Motor Protection Requirements Article.
- .2 Operations and Maintenance Manuals:
  - .1 See Specification Section 01 33 00 for requirements for:
    - .1 The mechanics and administration of the submittal process.
    - .2 The content of Operation and Maintenance Manuals.
  - .1 Approved copy of VFD schedule per Submittals Article.
  - .2 Manufacturer's instruction manuals.
  - .3 Troubleshooting procedures with a cross-reference between symptoms and corrective recommendations.
  - .4 Connection data to permit removal and installation of recommended smallest field-replaceable parts.
  - .5 Recommended spare parts list.
  - .6 Commissioning sheets showing "as-left" values of all user-programmable or adjustable drive parameters.

## **Part 2 Products**

### **2.1 MANUFACTURERS**

- .1 Acceptable Manufacturers
  - .1 Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    - .1 Allen Bradley.
    - .2 ASEA Brown Bovari (ABB).
    - .3 Cutler-Hammer.
    - .4 Danfoss.
    - .5 General Electric Company.
    - .6 Siemens.
    - .7 Square D Company.
    - .8 Toshiba.
    - .9 Yaskawa.
    - .10 Or Approved Equivalent

### **2.2 GENERAL**

- .1 VFDs shall consist of a rectifier-DC bus-inverter combination producing a sine-coded pulse-width-modulated (PWM) output voltage waveform.

- .2 VFDs shall constitute a complete combination motor controller per NFPA 70, Article 430 and shall provide the following per the requirements of that article without the addition of any external components or devices.
  - .1 Motor control.
  - .2 Motor overload protection.
  - .3 Motor and motor branch circuit short circuit and ground fault protection.
  - .4 Motor and controller disconnecting means.
- .3 It is the intent of this Specification that VFDs shall be an “engineered” or “configured” drive package in which the VFD chassis, all input, output and bypass power devices, VFD accessories, ancillary switches, contactors, relays, and related control devices are selected, furnished, factory-assembled and -tested by the supplier in a single enclosure requiring only connection of the power supply circuit, motor branch circuit, and external control wiring in the field.

## **2.3 PERFORMANCE AND DESIGN REQUIREMENTS**

- .1 Application:
  - .1 VFD(s) shall be of sufficient capacity and shall provide a quality of output waveform for stepless motor control from 10 to 100 percent of base speed of the driven equipment.
  - .2 VFDs shall be compatible with:
    - .1 Inverter duty induction motors.
  - .3 VFDs shall be suitable for Variable Torque (VT) applications.
  - .4 VFDs shall be designed to operate successfully under the following site conditions:
    - .1 Ambient:
      - .1 Temperature extremes: +10 Deg C to +35 Deg C.
      - .2 95 percent non-condensing relative humidity.
    - .2 Elevation: 300 FT above MSL.
    - .3 Power supply characteristics:
      - .1 600Vac, 3 PH, 60 Hz, 3 wire, (+/- 10 percent).
      - .2 Resistive grounded.
- .2 Ratings and Performance Specifications:
  - .1 Voltage rating:
    - .1 Nominal: 575Vac, 3 PH, 60 Hz.
    - .2 Range for continuous full load operation: +/-10 percent of nominal.
    - .3 Voltage imbalance tolerance for full load operation: 3 percent minimum.
  - .2 Current ratings:
    - .1 Continuous:
      - .1 Equal to or greater than the motor nameplate full load.
    - .2 Short-term overload:
      - .1 110 percent for 1 minute.
    - .3 Permissible for 1 minute every 10 minutes continuously.

- .3 Efficiency:
  - .1 97 percent, minimum, at full speed and full load.
  - .2 93 percent, minimum at 1/2 speed and full load.
- .4 Displacement power factor:
  - .1 95 percent, minimum from 50 percent to 100 percent speed and load.
- .5 Control type:
  - .1 Volts/Hertz ratio; constant over the entire operating range of the VFD except:
    - .1 When operating under voltage boost.
    - .2 At frequencies over 60 Hz.
  - .2 Open Loop Sensorless vector.
- .3 The VFD shall be provided with the following minimum user-programmable parameters:
  - .1 Carrier frequency.
  - .2 Independent maximum and minimum speeds for forward and reverse operation.
  - .3 Start frequency and hold time.
  - .4 Independent linear acceleration and deceleration time.
  - .5 Preset "jog" speed.
  - .6 Three (3) critical frequency bands.
  - .7 One (1) preset speed selectable by logic input.
  - .8 Volts/Hertz ratio.
  - .9 Voltage boost, magnitude, and frequency range.
  - .10 Process controller gain, offset and bias.
  - .11 Current limit.
  - .12 Overcurrent pickup.
  - .13 Overcurrent delay.
  - .14 Ground fault pickup.
  - .15 DC injection level and time.
- .4 The VFD shall be designed such that the power circuit components are fully protected from line side disturbances and load side faults:
  - .1 General:
    - .1 Shutdown conditions associated with supply circuit conditions which can be corrected external to the VFD-motor system shall be provided with automatic reset, with shutdown cause logged in memory:
      - .1 Input under voltage.
      - .2 Input over voltage.
      - .3 Input under frequency.
      - .4 Input over frequency.
      - .5 Input Phase loss.
      - .6 DC Bus under voltage.

- .2 Shutdown conditions which indicate overload or fault within the VFD, the output circuit, or the motor shall require local manual reset at the VFD, requiring operator intervention.
  - .1 Over temperature.
  - .2 Blown fuse.
  - .3 Component failure.
  - .4 Overload.
  - .5 Short circuit.
  - .6 Ground fault.
  - .7 DC Bus over voltage.
  - .8 External safety input (e.g., motor thermal protection).
  - .9 Logic fault.
- .3 When automatic shutdown occurs, VFD shall restart immediately upon reset, whether automatic or manual.
- .4 VFD shall hold cause of trip data for a minimum of four (4) shutdowns in memory.
  - .1 Data to be accessible through the keypad, local communication link and remotely.
- .2 Input protection:
  - .1 Input circuit breaker or current-limiting fuses with externally operable disconnect.
    - .1 Fault current interrupting rating equal to or greater than the specified withstand rating of the VFD.
    - .2 Handle padlockable in the OFF position.
  - .2 Provide full protection for semiconductors integral to the VFD; units requiring current-limiting fuses or circuit breakers in the supply circuit are not acceptable.
  - .3 Incoming line transient suppression.
    - .1 6000V peak per IEEE C62.41.
    - .2 Phase-to-phase and phase-to-ground protection.
  - .4 Sustained over voltage trip.
- .3 Internal protection:
  - .1 Surge suppression and power device snubbers.
  - .2 Power devices rated at 2.5 times line voltage.
  - .3 Instantaneous over current trip.
  - .4 DC bus over voltage trip.
  - .5 Power device over temperature trip.
  - .6 Control logic circuit malfunction trip.
- .4 Output protection:
  - .1 Inverse-time overload trip:
    - .1 UL Class 10 characteristic.
  - .2 Over voltage trip.
  - .3 Over frequency trip.



- .4 Short circuit trip.
  - .1 Line to line and line to ground.
- .5 Ground fault trip.

## **2.4 MOTOR PROTECTION REQUIREMENTS**

- .1 The VFD shall produce a quality of output waveform adequate to allow the motor to produce rated torque at rated RPM continuously without exceeding the temperature rise given in NEMA MG 1 Table 31-2.
- .2 Provide motor overload, short circuit and ground fault protection integral to drive electronics.

## **2.5 EQUIPMENT CONSTRUCTION**

- .1 Fabrication and Assembly:
  - .1 Each VFD system shall be factory-assembled in an enclosure for remote mounting, and shall utilize interchangeable plug-in printed circuit boards and power conversion components wherever possible.
  - .2 Reactors and/or filters, where required, shall be mounted within or in an ancillary enclosure adjacent to the drive enclosure, or with the Engineer's permission may be mounted in a separate enclosure.
  - .3 Cooling fans, as required, shall be provided to run when drive is running.
  - .4 Enclosures for separately mounted VFD's:
    - .1 NEMA Type 12
- .2 Wiring:
  - .1 The wiring in the VFD shall be neatly installed in wire ways or with wire ties where wire ways are not practical.
    - .1 Where wire ties are used, the wire bundles are to be held at the back panel with a screw-mounted wire tie mounting base.
    - .2 Bases with a self-sticking back will not be allowed.
  - .2 Provide terminal boards for all field wiring and inter-unit connections, including analog signals.
    - .1 Provide terminals for shield continuity where required.
  - .3 Terminal blocks shall be complete with marking strip, covers and pressure connectors.
    - .1 A terminal for each conductor of external circuits plus one (1) ground for each shielded cable.
    - .2 Terminals shall be labeled to agree with identification indicated on the supplier's submittal drawings.
    - .3 Individually fuse each control loop or system and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.
  - .4 All grounding wires shall be attached to the enclosure sheet metal with a ring tongue terminal.
  - .5 Wiring shall not be kinked or spliced and shall have markings on both ends or be color coded.

- .3 Nameplates:
  - .1 All devices mounted on the face of the drive shall be provided with a suitable nameplate.
  - .2 Push buttons, selector switches, and pilot lights shall have the device legend plate.
  - .3 Relays, terminals, and special devices inside the control enclosure shall have permanent markings to match identification used on manufacturer's wiring diagrams.
- .4 Painting: Enclosure, after being phosphate washed, shall be thoroughly cleaned and given at least one (1) coat of rust-inhibiting primer on all inner surfaces prior to fabrication.

## **2.6 COMPONENTS AND ACCESSORIES**

- .1 Input Line Reactors:
  - .1 Impedance: 3 percent.
  - .2 Continuous current: Not less than drive rating.
  - .3 Current overload: 150 percent for 1 minute.
  - .4 Insulation temperature rating: 180 Deg C.
  - .5 Copper windings.
  - .6 Saturation current rating: 3.5 to 5 times rated current.
  - .7 Hi-potential rating: 2500 Vac line to ground and line to line, for 1 minute.
  - .8 Noise reduction features:
    - .1 Epoxy over cast coil.
    - .2 Extra dips and bakes of varnish over continuous wound coil.
- .2 Output Filter
  - .1 3 phase, 600V Class.
  - .2 UL and CUL listed.
  - .3 NEMA 1 enclosure.
  - .4 40°C ambient temperature.
  - .5 180°C inductor insulation rating.
  - .6 Suitable for operation at the rated motor current.
  - .7 Trans-Coil, Inc. model KLCUL or approved equal.

## **2.7 SOURCE QUALITY CONTROL**

- .1 Factory Tests:
  - .1 Conduct all standard tests in accordance with NEMA and ANSI standards to ensure conformance to Specification requirements.
  - .2 Prior to final assembly:
    - .1 Inspect incoming components.
    - .2 Test and inspect power devices.
    - .3 Circuit cards:
      - .1 Component and functional tests:

- .2 Burn-in chamber or temperature cycling test.
    - .3 System test after burn-in or temperature cycling.
  - .3 After final assembly:
    - .1 Continuity and insulation test of 480 power control circuits.
    - .2 Drive tests:
      - .1 Burn-in complete drive at full load for 24 HRS.
      - .2 Verify all auxiliary circuits operation.
      - .3 Monitor output variables.
    - .3 Systems test:
      - .1 Provide inputs to field connections and simulate on-site operation.
      - .2 Test all auxiliary equipment.

## **2.8 MAINTENANCE MATERIALS**

- .1 Provide manufacturer's recommended renewable spare parts (e.g., power and control fuses).
- .2 Spare parts utilized during pre-start-up or start-up and demonstration testing shall be immediately restocked, at no cost to the Owner.

## **Part 3 Execution**

### **3.1 INSTALLATION**

- .1 Install products in accordance with manufacturer's instructions and as indicated on the Drawings.
- .2 Verify the installed motor nameplate electrical requirements do not exceed the VFD capacity.
- .3 Provide services of manufacturer's representative to perform start-up services.
- .4 The selection of input and output harmonic and voltage spike protection shall also be made on the available physical space.

### **3.2 START UP**

- .1 Pre-start-up Services:
  - .1 Shall be completed a minimum of 10 days prior to the start-up and demonstration period described in Specification Section 01 79 00.
  - .2 Shall consist of:
    - .1 Physical and electrical installation check.
    - .2 Final adjustments and calibration of drive parameters.
    - .3 VFD operation from simulated input signals.
  - .3 Shall be complete when VFD(s) are fully operational.
  - .4 Record all data necessary for the preparation of required test reports.

- .2 Start-up and Demonstration Services:
  - .1 Supervise start-up of all units including recheck of settings made during the pre-start-up tests.
    - .1 Perform all work in the presence of the Owner's designated representatives.
  - .2 Setup all VFDs with carrier frequency at minimum value consistent with proper operation; inform Engineer of carrier frequencies set in excess of 5 kHz and reason for setting.
  - .3 Simulate operation of the VFD and its associated controls.
    - .1 Ensure compatibility of VFD with associated control and instrumentation signals.
    - .2 By testing the pump flow rates in operation at the hatchery, program each drive with a minimum speed setting. This setting shall insure that with the pump operating at it's minimum speed setting, the pump is still moving water.
  - .4 Simulate VFD failures and demonstrate troubleshooting aids. Demonstrate the alarms are properly annunciated to the hatchery central alarm system.
- .3 Instruct Owner's designated personnel:
  - .1 Minimum of two (2) hours at the jobsite.
  - .2 Include both field and classroom instruction.
  - .3 Instructions shall include proper operation and maintenance procedures including, but not limited to:
    - .1 Lubrication.
    - .2 Troubleshooting.
    - .3 Repair and replacement.
    - .4 Parts inventory.
    - .5 Maintenance records.

**END OF SECTION**