Section 32 - Electrical and Instrumentation

A. Introduction – The HRSD Operations Department has an Electrical and Instrumentation Division that provides electrical and instrumentation support for all of HRSD. The Engineering Department is responsible for coordinating the electrical review of plans and specifications and coordinating with the Operations Department on design and start-up issues. Based upon HRSD’s history with various products and manufacturers, we have developed requirements and needs for certain specific products. Manufacturers of equipment and products are listed in the tables that follow.

B. General – Unless otherwise agreed upon, the FIRM shall design facilities and specify equipment around the names listed in this Section. In all cases NEMA is preferred over IEC rated components. IEC and NEMA/IEC components are not acceptable. Place all electric/electronic equipment indoors whenever possible. The following sections provide independent tables of products and manufacturers for pump stations, interceptor system controls and treatment plants in order to accommodate the different requirements of the various operating departments within HRSD.

C. Pump Station and Interceptor Systems – Refer to following Table “Pump Station.”

D. Treatment Plant – Refer to following Table “Treatment Plant.” Equipment Numbering Sequences shall be in accordance with the Treatment Plant Section of this document.
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I. Item No. 1

A. Switchgear and MCCs

1. Manufacturers
   a. Eaton
   b. Square D
   c. Allen Bradley

2. Specific Criteria
   a. Design to meet arc flash standard; Reduce incident energy to 12 Cal/Cm2 or lower (MCC and VFD’s incident energy should be designed to meet 1.2 Cal/Cm2 if attainable); Reference HRSD Arc Flash Mitigation Document Dated July 9-10, 2013 (refer to Exhibit A)
   b. MCCs must be placed indoors in NEMA 12 enclosures (gasketed)
   c. Switchgear must be placed indoors in NEMA 1A enclosure (gasketed)
   d. MCC’s providing rear access is not acceptable
   e. All horizontal / vertical bus must be accessible
   f. Everything to be face-mounted, motor controls in the MCC are to be marked, lead, 1st lag, 2nd lag selectable, (any combination) with automatic failover (This may be part of the bubbler panel.)
   g. Bottom entry versus Top entry routing must be evaluated for application.
   h. Provide with tin-plated copper bus.
   i. Provide feeder breakers with digital trip units.
   j. Provide extra fasteners for door cover.
   k. Provide phenolic labels with black backgrounds and white lettering.
   l. Provide spare terminals for intermediate terminal blocks for controls.
   m. Provide grounding for Switchgear (Ball type)

B. Breakers / Solid State Breakers

1. Manufacturers
   a. Eaton
   b. Square D

2. Specific Criteria
   a. Provide 20 amp minimum
   b. Provide remote open/close operator to protect personnel from Arc Flash Incident; operator should be outside of arc flash boundary where possible.
   c. Provide ARMS “Arc Reduction Maintenance Switch” or equal; when activating downstream breakers incident energy levels will be reduced. Also, add separate pilot light to indicate when maintenance mode is enabled or disabled.
   d. Provide LSIG digital trip unit if \( \geq 1000 \) amps and LSI if \(< 1000 \) amps
   e. Provide trip units with fault indication to determine status (i.e. overloads or fault conditions)
C. Metering Package
   1. Manufacturers
      a. Schweitzer Eneigneering Laboratories (SEL)
      b. Eaton
      c. Schneider Electric (Square D)
      d. GE
      e. Basler
   2. Specific Criteria
      a. Volt Meter 3 phase & off
      b. Ammeter 3 phase & off
      c. kW
      d. Provide 3 phase undervoltage & overcurrent protection

D. CT Cabinet
   1. Manufacturers
      a. Provided by Utility
   2. Specific Criteria
      a. Locate meter base and CT cabinet on outside of pumping station

E. Selector Switches, Push Buttons, Lighted Push Buttons (NEMA 30mm)
   1. Manufacturers
      a. Square D
      b. Eaton
      c. Allen Bradley
   2. Specific Criteria
      a. Expandable contact blocks on operator
      b. IEC and NEMA/IEC rated switches are not acceptable.

F. Contactors
   1. Manufacturers
      a. Eaton
      b. Square D (Contactor must be able to reclose after short power blips)
      c. Allen Bradley
   2. Specific Criteria
      a. Provide with expandable auxiliary contacts for 120 volt control circuits
      b. IEC and NEMA/IEC rated contractors are not acceptable.

G. Fuses & Fuse Holders
   1. Manufacturers
      a. Bussmann
      b. Shawmut
   2. Specific Criteria
      a. Shall be locally available
H. Transformers

1. Manufacturers
   a. Square D
   b. Eaton
   c. ACME

2. Specific Criteria
   a. Copper coils
   b. Aluminum coils are unacceptable

I. Terminal Strips

1. Manufacturers
   a. Phoenix Contact
   b. Square D
   c. Weidmuller
   d. Panduit Panduct DIN Rail Wiring Duct

2. Specific Criteria
   a. DIN Rail mount if possible
   b. Industrial rated

J. Combination Starters (buckets)

1. Manufacturers
   a. Square D
   b. Eaton
   c. Allen Bradley

2. Specific Criteria
   a. Provide standalone combination starters in the proper enclosures (see junction/pull boxes and miscellaneous enclosures).
   b. 120 volt control voltage
   c. Run light – red
   d. Stop light – green
   e. Fault light – Amber
   f. Power available light – white
   g. Provide push to test indicator lights
   h. Elapsed time meters (Crompton, ENB)–pump motors graduated in 1/10 hours, non-resettable
   i. Externally mounted resets, operational from the front
   j. Provide with adjustable thermo-magnetic breakers
   k. Fused control transformer
   l. MCC mounted lighting panels shall be provided with 25% spare breakers
   m. Provide spare buckets (minimum 2)
   n. Provide connections for motor leads directly from the motors to the starters. Do not use intermediate terminal blocks.
   o. No IEC or NEMA/IEC rating (NEMA only).

K. Rubber Mats (in front of gear)
1. Manufacturers
   a. Grainger
   b. Chesapeake Bay Rubber

2. Specific Criteria
   a. Contractor will provide and install at substantial completion (OSHA approved electric safety rubber matting: Type II ASTM D178)

L. Pilot Lights
1. Manufacturers
   a. Square D
   b. Eaton
2. Specific Criteria
   a. Provide LED type pilot lights
   b. Provide push to test lamp
   c. LED color and light cover color will be specified by HRSD
   d. No IEC or NEMA/IEC Rating (NEMA Only)

M. Voltage Test Points
1. Manufacturer
   a. Safeside- Grace Engineered Products (Load side of Main Breaker)

II. Item No. 2

A. Emergency Generators
1. Manufacturers
   a. Caterpillar
   b. Cummins Onan
   c. Kohler
2. Specific Criteria
   a. Diesel generators
   b. Propane or natural gas powered engine generators are site specific
   c. Engines to be of domestic manufacture whenever possible
   d. Standby rated
   e. 4-stroke
   f. Parts must be available in 48 hours or less
   g. Must meet current U.S. EPA and Virginia DEQ air standards
   h. Low emission units
   i. 48 hours of runtime/Fuel at full load
   j. Remote Emergency stop pushbuttons at doorways (Pilla Model GS120 w/clear, hinged plastic cover)

B. Generator
1. Manufacturers
   a. Stamford Newage
   b. Caterpillar
   c. KATO
   d. LIMA
   e. Marathon
   f. Cummins

2. Specific Criteria
   a. Provide permanent magnet exciters
   b. The rectifier shall be a brushless, full-wave bridge
   c. All stator winding leads are to be brought out to the terminal box
   d. Neutrals shall be sized to full rating
   e. Temperature rise shall not exceed Class B rating with 105° C ambient rise
   f. Alternator shall have a space heater that switches off when running
   g. Provide for 2/3 winding pitch; 5/6 pitch is not acceptable
   h. Minimum Class H insulation (epoxy) with tropicalization (anti-fungus) temperature requirements as specified by NEMA
   i. Provide voltage regulation less than +/- 1%
   j. Provide 150% minimum overspeed capability
   k. Provide amortisseur winding
   l. Provide less than 5% THD (Total Harmonic Distortion)
   m. Provide less than 50 TIF (Telephone influence factor)
   n. Provide Square D/Eaton main breaker of domestic manufacture
   o. Provide elapsed time meter graduated in 1/10 hours (analog or digital), nonresettable
   p. Voltage regulators shall be 3 phase.
   q. Provide 12 leads to switch voltages
   r. Provide flap at the end of exhaust to keep rain, birds, etc. out.
   s. The type of bird screen is site specific.
   t. Sound attenuation is site specific

C. Diesel Engine

1. Manufacturers
   a. Caterpillar
   b. Cummins
   c. John Deere
   d. MTU

2. Specific Criteria
   a. Heavy-duty, direct-injected, 4-stroke diesel engine.
   b. Provide electronically controlled engines with an electronic control system to meet current EPA emissions regulations
   c. State the control system
   d. Provide isochronous frequency regulation (no load to full load)
   e. Provide +/- .25% steady state frequency regulation (minimum)
   f. Size air, fuel and oil filters to provide a minimum of 250 hours of operation before servicing
g. Provide a Racor fuel-water separator
h. The heavy duty air filter is to be a dry type with a restriction indicator
i. Provide a Nelson (or Racor) heavy duty crankcase vapor coalescer
j. Provide a battery charging alternator 12V/65 amp, 24v/35amp minimum – negative ground)
k. Skid-mounted radiator sized to prevent overheating in the most severe conditions (122°F ambient)
l. Provide residential grade super critical type exhaust system (lowest possible DB available: indicator lights for all shutdowns and alarms) and muffler. All insulation must be blanket type (non-asbestos), removable for servicing of exhaust system
m. Provide 12/24 volt DC starting system
n. Provide all diagnostic equipment for complete trouble shooting and training; operational training must be included (software/technical manuals/hardware etc.)
o. Provide speed sensing to protect against accidental starter engagement into a moving flywheel. (Battery charging alternator voltage output will not be accepted for this purpose)
p. Provide an adjustable (0-15 minutes) cool down time
q. Provide a large red emergency stop push button
r. Generator Alarms and shutdowns
   1) Low oil pressure
   2) Not in auto
   3) High coolant temperature
   4) Overspeed
   5) Low fuel (Pre shutdown)
   6) Generator running and over-crank shall shut down the engine and provide indicator lights.
   7) All generator alarms/shut downs provide indicator lights
   8) Separate alarms and shutdowns based on HRSD recommendation and not tie everything to common alarm
s. Provide analog or digital displays for coolant temperature, oil pressure, service hours, engine RPM, system DC volts and system diagnostic code
t. Provide Kim Hot-Start engine block heater (thermostatically controlled); isolation valves must be included.
u. Provide vibration isolators between generator set base and floor
v. Provide lifting eyes bolt
w. Provide break mean effective pressure (BMEP) calculations
x. Provide SCADA interface/data monitoring for HRSD generators

D. Battery Chargers
   1. Manufacturers
      a. LaMarche
      b. Cummins
      c. SENS
   2. Specific Criteria
      a. 12 / 24 volt chargers or equal
      b. Automatic, solid state, provide continuous taper charging
c. UL listed, provide with under/over voltage, current failure and loss of power acknowledgment

d. Evaluate full float charge versus trickle charge

E. Starting Batteries

1. Manufacturers
   a. Exide

2. Specific Criteria
   a. Use 8D series lead acid batteries (4D is not acceptable)
   b. Provide 2 minimum
   c. Each battery shall provide 1200 CCA each
   d. Provide with insulated battery rack
   e. Provide with 2 year full replacement guarantee
   f. Provide as a minimum 2 cranking cycles at a minimum of 30 seconds each
   g. Consult engine manufacturer for sizing

F. Day Tanks

1. Manufacturers
   a. Pryco
   b. Tramont

2. Specific Criteria
   a. UL Listed – double wall
   b. Provide with Oberndorfer bronze gear type pump. All pumps must be mounted on Day Tank. Pumps with rubber or nitrile impellers will not be accepted
   c. Provide with a low level alarm and light
   d. Size for 2 hour minimum running time
   e. Provide a fuel level indicator on the day tank
   f. Provide a 2 pump system. Each pump shall be capable of pumping 100% fuel oil throughout the entire system.
   g. Provide “Not in Auto” lamp or other warning device
   h. Use momentary switch for tank fill/test

G. Transfer Switches

1. Manufacturers
   a. Eaton
   b. ASCO

2. Specific Criteria
   a. Provide with a metering package
   b. Provide with an exercise cycle of 4 hours, field adjustable from 10 minutes to 4 hours
   c. Provide with a utility power available light normal/emergency, phase indicator lights
   d. Zenith transfer switches are not acceptable.
   e. VFD compatible
   f. Time delay normal to emergency
g. Time delay engine start  
h. Time delay emergency to normal  
i. Time delay engine cool down  
j. Three phase over voltage (Source 1 & 2)  
k. Phase reversal (normal)  
l. Three phase under frequency (Source 2)  
m. 4 NO / NC form C contacts for (Source 1 & 2)  
n. Manual Push to test button which automatically returns to utility & adjustable run timer (0-600 minutes) (**Note: This is not an exercise function**)  
o. Time delay neutral position  
p. Three phase UV protection (Source 1 & 2)  
q. Normal position light  
r. Emergency position light  
s. Normal source available light  
t. Emergency source available light  

H. Underground Storage Tanks (UST) Leak Detection  

1. Manufacturers  
a. Veeder Root TLS 300/350 (printer option is available)  
b. Xerxes  

2. Specific Criteria  
a. Provide with leak detection system  
b. Provide in accordance with EPA and all applicable state and local standards  
c. Provide tank monitoring system  
d. Provide a graduated stick for level measuring  
e. Provide for refueling and stick access  
f. Provide with electronic tank level indicating system  
g. Provide with 48-hour fuel tank capacity  
h. Provide AMI Model 8CH-DAC 8 channel digital/analog converter (4-20ma)  

I. Louvers and Dampers  

1. Manufacturers  
a. Greenheck  
b. Ruskin  

2. Specific Criteria  
a. Provide gravity damper  
b. Provide anodized aluminum louvers and dampers with nylon bushings or ball bearings  
c. Provide with bird screens readily removable without removing louvers or dampers  
d. Designed to limit rainwater in the building  
e. All hardware & components must be the same material and non-corrosive.  
f. Where louvers and dampers are required provide (inside) recessed damper and (outside) flange mounted louvers  

J. Meter or monitoring package
1. Specific Criteria
   
a. Provide standard metering package
   
b. Frequency
   
c. Provide a voltage adjust rheostat
   
d. Provide 3 phase undervoltage and over-current protection
   
e. Provide automatic and manual start and stop

K. Start Up and Testing - Diesel Generator Tests

1. Specific Criteria
   
a. Provide factory test data
   
b. Contractors shall verify and provide fuel prior to start up and testing
   
c. Simulate and test all safety equipment. Using a reactive load bank > 500kW or a resistive load bank <500kW (0.8PF) run the generator:
      1) 15 minutes at idle speed
      2) 30 minutes at 25% load
      3) 30 minutes at 50% load
      4) 60 minutes at 75% load
      5) 120 minutes at 100% load
      6) 15 minutes at 25% load
      7) 15 minutes at 0% load
      8) off-Record stator, bearing, oil, ambient, and water temperatures every 15 minutes
   
d. Provide load bank receptacle boxes (site specific – Refer to Exhibit B)
   
e. Design in such that the station load is not included during load bank test.
   
f. Take power factor (pF) into consideration for resistive load bank test to ensure generator is not overloaded.
   
g. Demonstrate all warnings and shutdown alarms (simulation with laptop).
   
h. Record speed, voltage and amperage at 15 minute intervals as well as just prior to and after the load change
   
i. Hook up the generator and cycle through the light loading cycles as well as heavy loading cycles (3 each). Record same parameters every 15 minutes and before and after changing load. Tests to be witnessed by HRSD Automotive Superintendent and HRSD Electrical Engineer/Superintendent or designee
   
j. Create and attach to the switchgear detailed instructions. The instructions shall be laminated. The instructions shall be simple enough for anyone to pick them up and operate the diesel generator set.
   
k. Group A, B, and C phase cable together to cancel out EMF (Electromagnetic Field)

III. Item No. 3

   A. Energy Efficient Motors

      1. Specific Criteria
         
a. HRSD Electric Motor Specifications in Exhibit E “HRSD Electric Motor Specifications”.
         
b. Emergency stop pushbuttons

IV. Item No. 4

   Section 32 32-11 January 2020
A. **Sump Pumps**

1. Manufacturers
   a. Zoeller Co.

2. Specific Criteria
   a. 120 volt
   b. Plug into receptacle
   c. Float controlled

V. **Item No. 5 - Level Sensing Systems**

A. Bubbler Type, Ultrasonic (Rosemount), and Submersible

1. Specific Criteria
   a. Complete purged air bubbler system for sensing wetwell liquid level which generates and transmits level signals to a separate PLC which controls pump operations
   b. Provide UPS for power failure
   c. Power light – white
   d. Provide with low pressure switch with normally closed dry contacts downstream of the regulator
   e. Provide externally mounted duplex air compressors mounted on 30 gallon horizontal receiving tank (Model 3HBB-10-M300 AX) with lead/lag rotation control
   f. Provide oil-less compressors with 120 volt 60 cycle, single phase motors with integral thermal overload protection
   g. Provide manual purging of bubbler piping
   h. Provide manual alternation of air compressors
   i. Mount air compressors outside of the panel whenever possible
   j. Provide high level alarm in wetwells. Provide with micro (non-mercury) switch backup (float ball)
   k. Provide high wet well light and pressure switch
   l. Provide overflow light and pressure switch
   m. Provide high wet well and overflow push to test lights
   n. All alarm contacts are closed in a normal operating state (Closed loop system)
   o. Provide high level Floatball for alarms

B. Ultrasonic (site specific)

1. Manufacturers
   a. Siemens

2. Specific Criteria
   a. Microprocessor
   b. FM approved (frequency modulation)

C. Level Transducer (site specific)

1. [Refer to Exhibit F - Stilling Well Detail](#)
D. Pressure Sensing Systems

1. Manufacturers
   a. Foxboro
   b. Rosemont

2. Specific Criteria
   a. Provide series 40 Red Valve pressure seals with Viton boot
   b. Provide 0-100psi gauge (Ashcroft)
   c. Provide a Foxboro IDPT 10 absolute pressure electronic transmitter
   d. See Standard Detail “Pressure Reducing Station Pressure Sensor Detail”
   e. Suction and discharge transmitters to be mounted in dry well area

E. Float Balls

1. Manufacturers
   a. Flygt
   b. Opti Float (Intrinsically Safe – Fiber Optic)
   c. CSI Controls

2. Specific Criteria
   a. Locate near sump pump in dry well and wet well
   b. Alarm on high level
   c. Support float ball cable to bottom of well; must be rigid and removable from top

VI. Item No. 6 – Variable Frequency Drives (VFDs)

A. Variable Frequency Drives (VFDs)

1. Manufacturers
   a. YASKAWA (A1000) – P1000 is acceptable for certain applications; must be approved by owner.
   b. Allen Bradley (Powerflex 400/700)

2. Specific Criteria
   a. Provide thermal/mag breakers for the drive input power
   b. Install equipment with the idea of keeping it clean and the temperature regulated
   c. Provide thumbscrews for removable/washable filters or thumb screws replaced by snap in grills that are removable from the front of the cabinet (reusable)
   d. Provide a programmable ramp time
   e. Provide input reactors (MTE Corp) or TCI
   f. Pulse Width Modulated (PWM)
   g. IGBTs
   h. Automatic restart on power disruption
   i. Tune out a minimum of 3 frequencies
   j. Hand/Off/Automatic (HOA) selector switch
   k. Manual speed pot door mounted (in addition to keypad control)
   l. Mount the resets and appropriate indicator lighting on the front of the drive or outside of the box
   m. Tune drive to motor with a harmonics meter
n. Provide an input circuit breaker for short circuit protection (Fuses are not acceptable).
o. The controller electronics shall contain indicators of the following conditions:
   1) Undervoltage
   2) Overvoltage
   3) Over temperature
   4) Memory failure
   5) Emergency Stop
   6) Ground fault
   7) Instantaneous overcurrent
o. Provide auxiliary run contacts wired to run command for ventilation fan
p. Provide a NEMA 12 flanged disconnect free standing enclosure
q. Mount the resets and the appropriate indicator lighting on the front of the drive or the outside of the box
r. Provide four contact outputs for run status, power failure, VFD failure, not in auto status
s. The following are site specific options:
   1) VFD must be able to be isolated and bypassed (auto/manual operation) allowing the motor to operate across the line at full load speed and current
   2) Provide manual isolation and bypass capability
   3) Provide three contactors for bypass operation
   4) 6 Pulse Drive
   5) Bypass contactors are site specific; consult with Interceptor Systems & Electrical Shop
3. Additional Design Considerations
a. All electrical components must be NEMA only. IEC or NEMS/IEC is not acceptable.
b. Filters to HVAC units must be maintained and free from dust during construction phase.
c. VFD parameters must be included on as built prints (i.e. momentary power loss ride thru, energy savings, and fault reset)
d. Specify coil locks (Power Quality Solutions) on control relays for power dip ride thru capabilities.
e. Provide Bypass mode for critical VFD’s. Soft start or across the line depending on application.
f. Specify main circuit breaker cable operators for breaker operation instead of standard door operating mechanisms.
g. Provide One reset button to reset VFD and control circuit faults.
h. Provide finger safe barriers for main side line breaker lugs.
i. Provide enough fans to replace each fan within a VFD (spare parts) where several VFD’s of the same size and model are specified.
j. Provide paper copies of VFD manuals.
k. To support large and heavy VFD’s 60 HP and above, provide a pedestal with a flat plate mounted inside the enclosure for VFD to rest for easy removal. Also provide a lift table to remove VFD.
l. Provide external air filter for easy access on cabinets.
m. Contractor to perform static tuning for optimal performance during startup. Contractor to supply panel shop with motor data sheets including the number of poles per motor. Also, include number of motor poles on motor nameplate.

n. Provide extended warranty by VFD manufacturer where replacement cost is justified.

o. Need all switches to indicate when not in auto

p. Need indication when control power is loss in addition to VFD fault.

q. Evaluate best routing method for bottom versus top entry of wire.

r. VFD shall be sized to provide current necessary for motor to produce continuous rated horsepower and service factor horsepower at highest carrier frequency.

Refer to Exhibit C “Variable Frequency Drive” Specs

B. Eddy Current Brake Systems/DC Drives – UNACCEPTABLE

VII. Item No. 7

A. Watt Hour Meter (for MCCs or individual motors) – Meter base and meter

1. Specific Criteria
   a. Provided by utility. Locate outside of pump station.

VIII. Item No. 8

A. PLC/RTU

1. Manufacturers
   a. Emerson / Control Wave
   b. Allen Bradley

2. Specific Criteria
   a. Provide functional descriptions, the application program, the job-specific program data and a copy of the as-built software documentation
   b. Include control & alarms
   c. Controls accommodate automatic purge and latch output to current state during bubbler purge
   d. Program must be provided using Function Block Programming
   e. Control Wave Micro
   f. PLC’s and RTU’s shall be equipped with isolation relays for all digital inputs. Example: (Idec 5-blade – 24 VDC coils- with a form C configuration contactor) relays mounted on DIN rail for the purpose isolating relay inputs. Whether a junction box is used or control panel a 24 VDC power supply with sufficient capacity to energize all of the 24 VDC relay coils simultaneously when necessary for all PLC or RTU inputs.

IX. Item No. 9

A. Exhaust Fans
1. Manufacturers  
   a. ILG  
   b. Dayton  
   c. Greenheck  
   d. Airovent  
   e. MK Plastics

2. Specific Criteria  
   a. Corrosion resistant including hardware  
   b. Must be explosion proof in wet wells and metering vaults  
   c. Direct drive  
   d. Belt drive not acceptable unless approved by Owner

X. Item No. 10

A. Lighting

1. Manufacturers  
   a. Holophane  
   b. Hubbell  
   c. Thomas  
   d. Crouse Hinds

2. Specific Criteria  
   a. Provide proper levels of lighting over major equipment including switchgear, generators, pump motors, and controls. Lighting levels should conform to the IES lighting handbook as a minimum.  
   b. Provide exterior lighting at doorways and yard lighting required by building configuration.  
   c. Consider operation by photo electric cell.  
   d. ALTO or equivalent lighting shall be used to limit the mercury content of the lighting.  
   e. Non-fluorescent fixtures shall be LEDs Remove.f.

   f. Consider LED technology for design and replacement of existing.  
   
   Refer to Exhibit D - Lighting Policy

B. Incandescent

1. Manufacturers  
   a. Crouse Hinds  
   b. Holophane  
   c. Appleton

2. Specific Criteria  
   a. Provide explosion proof lighting in pump station wet wells  
   b. Provide 10 ft. candles minimum in wet well areas  
   c. Provide corrosion resistant or rubber coated lights in wet wells  
   d. LEDs
C. Fluorescent Light

1. Manufacturers
   a. Holophane

2. Specific Criteria
   a. Provide with low temp ballasts
   b. Provide with lens and gaskets in chemical rooms
   c. Do not provide fluorescent lighting and controls on the same circuit
   d. Provide electronic ballasts with T-8 bulbs
   e. Provide fluorescent lighting in control cabinets (i.e. PLCs, bubbler control panels) with door switches

D. Metal Halide

1. Manufacturers
   a. Holophane

2. Specific Criteria
   a. Suitable in high bay areas
   b. Provide quick strike fixtures in appropriate areas
   c. Wall-paks are suitable inside or outside
   d. Purchase Type “O” lamps for open fixtures.

E. HPS, LPS, and Mercury Vapor – NOT ACCEPTABLE FOR ANY APPLICATION

F. Emergency Lighting

1. Specific Criteria
   a. Dual Lite GMM-EL-W2 in admin areas
   b. Emerg Lite PRO-2 in corrosive areas
   c. Wall-paks are provided by HRSD
   Note: Install dual input inverters if applicable

G. Exit Lighting

1. Specific Criteria
   a. Highly visible 24 hours/day for life of material

H. LED

1. Specific Criteria
   a. To reduce maintenance
   b. Perform payback analysis

XI. Item No. 11

A. Concrete Housekeeping Pads
1. Specific Criteria
   a. Provide a minimum of 4 inch thickness under MCCs, generators, transformers, and other general electrical equipment and around conduits at floor penetration.
   b. Chamfer all edges

XII. Item No. 12

A. Conduit and Conduit Systems
   1. Specific Criteria
      a. Ream and chamfer all edges
      b. EMT or IMC are not allowed
      c. All flexible conduit shall be metallic liquidtite or equal
      d. Flexible conduit must not be installed to complete one small run between RGS.
      e. Provide ¾ inch minimum size. (Where specifically approved or when the instrumentation restricts this size, ½ inch can be used)
      f. Do not use plastic anchors
      g. Seal conduits with a silicone product as necessary
      h. See Miscellaneous section of these standards for markings and coatings
      i. Seal conduits with OZ Gedney conduit and cable seals or with silicone where seals are not available
      j. Cable trays are not acceptable unless approved by Owner
      k. Label all conduits inside of building (Engineer must provide conduit schedule)
      l. Circuit # must be brought back to the panel/breaker.
      m. Paint RGS conduits red if requested by owner.

B. Spare Conduit Feeder
   1. Specific Criteria
      a. Provide with service entrance
      b. Add appropriate spares with pull wire

C. PVC Coated Rigid Steel (inside and out)
   1. Manufacturers
      a. Robroy
      b. OCAL
      c. Perma-Cote
      d. Gafco Industries
      e. Plastibond
      f. KorKap
   2. Specific Criteria
      a. Provide in wet wells, underground (not encased), chemical areas, outside, and damp areas. Provide with PVC coated fittings, boxes and touch-up material
      b. Provide 8” of PVC coated conduit where stubbed up through concrete (washdown areas)

D. Galvanized Rigid Steel
1. Specific Criteria
   a. Provide with applications other than PVC coated above.

E. PVC
   1. Specific Criteria
      a. Underground/encased reinforced concrete, Schedule 40 can be substituted for galvanized conduit in duct banks where EMI is not a threat.

F. Tools Used
   1. Specific Criteria
      a. Use suitable tools with conduit.

G. Patching/Repair
   1. Specific Criteria
      a. Use appropriate material to patch and repair.

H. Flex – Liquidtite & Fittings
   1. Manufacturers
      a. Crouse Hinds
   2. Specific Criteria
      a. Use fittings to suit installed conduit.

I. Fixtures & Fittings (pull boxes)
   1. Specific Criteria
      a. Use appropriate fittings and materials.

J. Struts and Straps
   1. Specific Criteria
      a. To suit conduit materials
      b. Use matching fasteners
      c. In outside, wet or damp areas use stainless steel fasteners
      d. PVC coated channel or unistrut are not acceptable

K. Pull Boxes (wire pulled through) and Junction Boxes (wires terminated inside)
   1. Specific Criteria
      a. In outside, wet or damp areas, use stainless steel fasteners
      b. Over 6 inch x 6 inch are to be hinged
      c. Gasketed
      d. Use stainless steel or aluminum in outside or damp areas

L. Red Dye (Ductbank)
   1. Specific Criteria
      a. Provide red dye in concrete duct banks
XIII. Item No. 13

A. Wire

1. Specific Criteria
   a. Provide separation of power, signal and telephone services
   b. Use compression type lugs only
   c. Do not splice wire
   d. Telephone
      1) Provide conduit and wiring for telephone
   e. Welding cable (DLO) – Design based on intermittent duty vs. continuous duty
   f. THHN, THWN, XHHW (for ductbanks)
      1) Follow NEC color coding
      2) All wire shall be stranded wire, rated for 600 volts
      3) #12 minimum wire size for typical applications
   g. Instrumentation
      1) All wire (MTW) or signal wire shall be rated at 600 volts
      2) DC wire shall be color-coded blue #16 AWG minimum
      3) AC wire shall be color-coded red #16 AWG minimum
      4) Analog signals shall be #18-2 with a shield (minimum), tinned

Note: Cabinets with multiple sources must be clearly marked as such

XIV. Item No. 14 - Relays

A. Industrial

1. Manufacturers
   a. Allen Bradley
   b. Eaton

2. Specific Criteria
   a. Fixed base

B. Electronic

1. Manufacturers
   a. IDEC
   b. Potter-Brumfield
   c. Agastat

2. Specific Criteria
   a. Plug in ice cube type with pilot lights
XV. Item No. 15 - **Lockout / Tagout (Safety)** Refer to Section 21 – HRSD Safety Program in this manual for specifics.

XVI. Item No. 16

A. **Switches / Receptacles / Plugs**

1. Manufacturers
   a. Pass & Seymour
   b. Hubbell
   c. Crouse Hinds

2. Specific Criteria
   a. Provide compression type screw terminals on receptacles. Wire binding receptacles or switches are not acceptable
   b. Provide for dedicated circuits for sump pumps
   c. Provide one weatherproof (WP)/watertight receptacle with lockable cover on exterior wall of the pump station on a separate circuit; separately switches and should not be hot at all times.
   d. Provide a receptacle on each wall of the PS, upper & lower levels.
   e. Lower levels shall be mounted at 48 inches above finished floor - Provide one weatherproof/water tight receptacle on exterior walls on a single circuit, separately switched (Should be “hot” all the time)
   f. Provide ground fault receptacles and breakers where required
g. Provide power receptacles in control cabinets
h. Provide “in use” covers for indoor sump applications

XVII. Item No. 17 - **Electric Unit Heaters**

*Not used, do not supply unless a condition requires it.*

XVIII. Item No. 18

A. **Electrical Drawings**

1. Specific Criteria
   a. Process and Instrumentation Diagrams (P&IDs) are to conform to ISA modified standards (Consulting engineer to provide).
   b. Provide functional descriptions with the P&IDs (Consulting engineer to provide)
c. Provide Point-to-Point connection drawings. Contractor shall develop
d. Review and approval by the engineer shall be prior to installation
e. Label all conduits inside building
f. Place metal tags on cables in manholes.
g. Provide final conduit & cable schedule on disk (AutoCAD, PDF or VISIO)

XIX. Item No. 19

A. Safety Switches (fused or unfused)
   1. Manufacturers
      a. Square D
      b. Eaton
      c. Allen Bradley
   2. Specific Criteria
      a. Light duty safety switches are unacceptable
      b. Must be pad lockable

XX. Item No. 20

A. Transformers (Dry)
   1. Manufacturers
      a. Square D
      b. Eaton
      c. GE
   2. Specific Criteria
      a. No aluminum wire
      b. Provide 220°C insulation system for 15 kVA and larger
      c. Provide 180°C insulation system for transformers less than 15 kVA
      d. Transformers shall handle a 15% overload without exceeding the insulation rating

XXI. Item No. 21 – Metering Vaults / Pits

A. Dehumidifiers
   1. Specific Criteria
      a. Provide receptacle and location for HRSD installation

B. Power Requirements
   1. Specific Requirements
      a. Provide two receptacles with weatherproof covers

C. Exhaust Fans
   1. See Exhaust Fans (item#9)

D. Sump Pumps
1. Provide “in use” receptacle with a remote GFCI breaker located in station power panel

E. Lighting

XXII. Item No. 22

A. Pressure Sustaining/Regulating Valves

1. Manufacturers
   a. KTM
   b. Foxboro
   c. Clow

2. Specific Criteria
   a. No butterfly valves or pinch valves with controls
   b. Provide 4-20 mA operated valves. Do not use pulsed control valves
   c. Automatic Controls of Virginia or Valve Automation for actuator applications

B. Valve Actuators

1. Manufacturers
   a. EIM/Bettis

2. Specific Criteria
   a. Auma and Rototorque are not acceptable

XXIII. Item No. 23

A. Alarm Systems

1. Specific Criteria
   a. HRSD will provide and install the alarm system. Contractor shall provide sensors and wiring to a junction box and terminate on a terminal strip adjacent to the alarm panel location
   b. HRSD will provide alarm points

B. Station Bypass Alarm Systems (Refer to Exhibit G)

1. Specific Criteria
   a. A minimum of two (2) weeks notice is required to set up temporary alarms for a scheduled station bypass operation
   b. HRSD will provide and install the temporary alarm system. Contractor shall provide sensors and wiring to a junction box and terminate on a terminal strip adjacent to the alarm panel location.
   c. HRSD will provide alarm points
   d. Contractors to provide contact names and numbers for alarming purposes

XXIV. Item No. 24 – Flow Meters (Size for average flows)
A. Magnetic
   1. Manufacturers
      a. Rosemount
      b. Foxboro
   2. Specific Criteria
      a. Use for control or billing applications
      b. Ensure vendor is clear on application
      c. Provide with remote head, display and keyboard

B. Insertable Doppler
   1. Manufacturers
      a. ISCO

C. Ultrasonics (strap on)
   1. Manufacturers
      a. FUJI
   2. Specific Criteria
      a. Do not use for control
      b. Locate inside station

D. Venturi
   1. Specific Criteria
      a. Generally, not used in most applications

XXV. Item No. 25 – RTUs

A. Antenna
B. Junction box

XXVI. Item No. 26

A. Louvers/Dampers
   1. Specific Criteria
      a. See Emergency Diesel Generator Louvers and Dampers (Item #2)

XXVII. Item No. 27

A. Cathodic Protection (Test Stations)
   1. Specific Criteria
      a. Use Flush Fink Test Stations
XXVIII. Item No. 28

A. **Junction Boxes and Misc. Enclosures**

1. Manufacturers
   a. Hoffman
   b. Saginaw
   c. Hammond

2. Specific Criteria
   a. Provide PVC coated boxes and/or fittings when using with PVC coated conduit. Use “like” materials.

3. Inside
   a. Specific Criteria
      1) Stainless steel, fiberglass reinforced plastic (FRP), NEMA 4x

4. Outside
   b. Specific Criteria
      1) Stainless steel, NEMA 4x with Myers hubs

5. Wet
   a. Use with PVC coated conduit and PVC coated hubs
      1) Stainless steel, fiberglass reinforced plastic, NEMA 4x with watertight fittings (Myers)

XXIX. Item No. 29

A. **Panel Boards/Control Panels**

1. Manufacturers
   a. Eaton
   b. Square D
   c. GE

2. Specific Criteria
   a. Provide with tin-plated copper bus
   b. Provide 25% spares (minimum)
   c. Provide bolt-in breakers
   d. Do not provide cans with pre-stamped knockouts
   e. Provide with hinged panel cover with a latching door
   f. Provide heavy duty industrial grade panel boards
   g. Breaker operator should be outside of panel
   h. Breaker should be located inside of panel
i. HOA switches should be on the outside of panel
j. Dead front Hinge panel cover if available.
k. Provide LED work light, if warranted
l. Provide phenolic labels with black backgrounds and white lettering

XXX. Item No. 30 – Miscellaneous Electrical

A. Electrical Equipment Testing
   1. Specific Criteria
      a. Provide testing in off-peak hours or switch off an equivalent amount of load prior to testing.

B. One Line Diagram
   1. Specific Criteria
      a. Provide an update to the one line diagram with significant changes in the electrical system.

C. Thermographic Inspection
   1. Specific Criteria
      a. Provide a thermographic inspection of the new systems upon completion.

D. Short Circuit / Coordination Study / Arc Flash
   1. Specific Criteria
      a. Provide a coordination study short circuit, coordination, and arc flash analysis for new systems or systems with significant changes.
      b. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable. Include Arc flash analysis results for generator protective device.
      c. Contractor must adhere to NFPA 70E Electrical Safety requirements when working on electrical equipment in HRSD facilities.
      d. Engineer must design electrical systems in accordance with NFPA 70E.

Refer to Exhibit A
XXXI. **Item No. 31 - Lightning Protection** Refer to NFPA 820 and NFPA 780. - Lightning Protection applications will be site specific (Discuss with HRSD Electrical Staff).

XXXII. **Item No 32 - SCADA Site Drawing (Refer to Exhibit H)**
I. Item No. 1

A. Switchgear

1. Manufacturers
   a. Eaton
   b. Square D

2. Specific Criteria
   a. Design to meet arc flash standard; Reduce hazard category rating to 2 or lower (MCC and VFD’s should be designed to meet incident energy of 1.2 Cal/Cm2 or below if attainable); Reference HRSD Arc Flash Mitigation Document Dated July 9-10, 2013
   b. Provide two 48 VDC control voltage. 48 VDC redundant battery systems for control voltage per incoming primary voltage source. Use 1 Best Battery Selector to switch between each set of batteries (per primary source side) for control voltage
   c. Stored charge breaker systems are unacceptable
   d. Sealed Lead acid (VRLA)
   e. NiCAD are not acceptable unless approved by Owner
   f. Provide tin-plated copper bus
   g. Provide switchgear indoors in a NEMA 1A (gasketed) enclosure
   h. Switchgear to be located indoors
   i. Provide with push to test lights
   j. Bottom entry versus top entry must be evaluated for application
   k. Provide in a room strictly for switchgear
   l. Install 3 or 4 inch windows on switchgear for IR testing for new installations (consult with Electrical Manager)
   m. Equipment should be designed to be double end fed with tie breakers
   n. Rack out breakers must be racked in and out remotely without opening doors
   o. Provide remote open/close operator to protect personnel from Arc Flash Incident; operator should be outside of arc flash boundary where possible.
   p. Provide ARMS “Arc Reduction Maintenance Switch” or equal; when activating downstream breakers incident energy levels will be reduced. Also, add separate pilot light to indicate when maintenance mode is enabled or disabled.
   q. Provide hinged doors if available
   r. Design electrical gear/equipment to achieve an arc flash rating of Cat 2 or less
   s. Provide trip units with fault indication to determine status (i.e. overloads or fault conditions)
   t. Provide LSIG digital trip unit if =/> 1000 amps and LSI if < 1000 amps
   u. Provide extra fasteners for door cover
   v. Provide phenolic labels with black backgrounds and white lettering

Note: 1. For reliability and the ability to safely troubleshoot and perform maintenance on switchgear and MCC’s, the main switchgear should be double ended with a Bus tie. The main gear shall provide each piece of major electrical equipment with an A and B feeder (from each
end). Each MCC shall have a double ended configuration with Bus ties and Kirk Key interlocks to allow isolation of ½ the electrical gear at the MCC level.

2. When this is not possible, alternatives shall be investigated for critical electrical equipment for critical processes. *(Return to MCCs)*

Refer to Exhibit A

B. Breakers/Solid State Breakers

1. Manufacturers
   a. Eaton
   b. Square D

2. Specific Criteria
   a. Provide appropriate spares and spaces

C. Metering or Monitoring Package (Utility Grade Metering)

1. Manufacturers
   a. Schweitzer Eneigneering Laboratories (SEL)
   b. Eaton
   c. Schneider Electric (Square D)
   d. GE
   e. Basler

2. Specific Criteria
   a. Provide utility grade metering
   b. Volt Meter 3 phase & off
   c. Ammeter 3 phase & off
   d. kW
   e. PF
   f. kVA
   g. kVAR
   h. Utility grade CTs & PTs
   i. Metering packages (See Item No. 8)
   j. Provide 3 phase undervoltage & overcurrent protection (open Delta PTs are unacceptable)
   k. Provide testing that trips the main with a loss of any of the three legs.
   l. Generator must be designed to be manually initiated to return to utility.

D. Selector Switches, Push Buttons, Lighted Push Buttons

1. Manufacturers
   a. Square D
   b. Eaton
   c. Allen Bradley
2. Specific Criteria
   a. Expandable contact blocks on operators
   b. NEMA/IEC rated switches are not acceptable.

E. Contactors
   1. Manufacturers
      a. Eaton
      b. Square D
      c. Allen Bradley
   2. Specific Criteria
      a. Provide with expandable auxiliary contacts for 120 volt control circuits
      b. NEMA/IEC rated contactors are not acceptable

F. Fuses & Fuse Holders
   1. Specific Criteria
      a. Must be locally available

G. Switchgear Control Transformers
   1. Specific Criteria
      a. Provide copper coils
      b. Aluminum coils are unacceptable

H. Terminal Strips / DIN Rail (Space Saver)
   1. Manufacturers
      a. Phoenix
      b. Contact
      c. ILSCO
      d. Square D
      e. Weidmuller
      f. Panduit Panduct
   2. Specific Criteria
      a. Rail mount if possible
      b. Industrial rated
      c. Finger safe

I. Rubber Mats
   1. Specific Criteria
      a. Contractor will provide and install at substantial completion (OSHA Approved: Type II ASTM D178)
      b. Add matting in front of gear

J. Pilot Lighting
   1. Specific Criteria
      a. Provide LED type pilot lights
K. Protective Relays
   1. Manufacturers
      a. Schweitzer Engineering Laboratories
      b. GE
      c. Basler

   2. Specific Criteria
      a. Provide 10 year warranty
      b. Solid State

II. Item No. 2

A. MCCs
   1. Manufacturers
      a. Eaton
      b. Square D
      c. Allen Bradley

   2. Specific Criteria
      a. Provide with tin-plated copper bus
      b. MCCs to be placed indoors in a NEMA 12 (gasketed) enclosure.
      c. Provide redundant feeders to either end of the MCCs with a bus tie in the middle whenever possible.
      d. Provide with Kirk key interlocks door (mounted)
      e. Do not provide in the same room with chemical tanks or pumps
      f. Provide with “push to test” lights
      g. Bottom entry vs. top entry must be evaluated based on application
      h. Provide with face mounted operators and resets
      i. Design to meet arc flash standard
      j. Provide extra fasteners for door cover.
      k. Provide phenolic labels with black backgrounds and white lettering
      l. Provide spare terminals for intermediate terminal blocks for controls.

   Notes: See General Notes, Item 1 – Switchgear

A. Breakers/Solid State Breakers
   1. Manufacturers
      a. Eaton
      b. Square D

B. Metering/Monitoring Package (For applications other than utility grade metering)
   1. Manufacturers
      a. Eaton IQ SEL
      b. Square D
      c. Power Logic
      d. Schweitzer Engineering Laboratories (SEL)
2. Specific Criteria
   a. Volt Meter 3 phase & off
   b. Ammeter 3 phase & off
   c. kW
   d. PF
   e. kVA
   f. kVAR
   g. CTs & PTs
   h. Metering packages (See Item No. 8)

C. Selector Switches, Push Buttons, Lighted Push Buttons

1. Manufacturers
   a. Square D
   b. Eaton
   c. Allen Bradley

2. Specific Criteria
   a. Expandable contact blocks on operators

D. Contactors

1. Manufacturers
   a. Eaton
   b. Square D (Contactor must be able to reclose after short power blips)
   c. Allen Bradley

2. Specific Criteria
   a. Provide with expandable auxiliary contacts for 120 volt control circuits

E. Fuses & Fuse Holders

1. Manufacturers
   a. Bussmann
   b. Shawmut

2. Specific Criteria
   a. Must be locally available

F. MCC CTs and PTs

1. Manufacturers
   a. Square D
   b. Eaton
   c. Allen Bradley

2. Specific Criteria
   a. Metering
   b. Provide copper coils
   c. Aluminum coils are unacceptable

G. Terminal Strips
1. Manufacturers
   a. Phoenix
   b. Contract
   c. ILSCO
   d. Square D
   e. Weidmuller

2. Specific Criteria
   a. Rail mount instrumentation if possible
   b. Industrial rated

H. Combination Starters (Buckets)

1. Manufacturers
   a. Square D
   b. Eaton
   c. Allen Bradley

2. Specific Criteria
   a. 120 volt control voltage
   b. Run light – red
   c. Stop light – green
   d. Fault light – amber
   e. Power available light – white
   f. Provide push to test indicator lights
   g. Elapsed time meters–graduated in 1/10 hours Resetable or Non-resetable (plant/site specific; incorporate time meters on DCS if available)
   h. Provide over load resets operational from the front (external)
   i. Provide with adjustable thermo-mag breakers
   j. Fused control transformer
   k. 25% spares and/or spaces for all sizes of buckets or expandable option
   l. MCC mounted lighting panels shall be provided with 25% spare breakers
   m. Provide connections for motor leads directly from the motors to the starter. Do not use intermediate terminal blocks (50 HP and smaller)
   n. Provide standalone combination starters in the proper enclosures (See Junction/Pull Boxes and Miscellaneous Enclosures)

I. Rubber Mats (to be placed in front of gear)

1. Manufacturers
   a. Grainger
   b. Chesapeake Bay Rubber

2. Specific Criteria
   a. Contractor will provide and install at substantial completion (OSHA approved: Type II ASTM D178)

J. Voltage Test Points

1. Manufacturer
a. Safeside-Grace Engineered Products (Load side of Main Breaker)

III. Item No. 3

A. Emergency Generators

1. Manufacturers
   a. Caterpillar
   b. Cummins

2. Specific Criteria
   a. Diesel generators
   b. Turbine generators are not acceptable unless approved by Owner.
   c. Engines to be of domestic manufacture whenever possible
   d. 4-stroke diesels **ONLY**
   e. Parts must be available in 48 hours or less
   f. Must meet current U.S. EPA and Virginia DEQ air standards
   g. Low emission units
   h. All units shall be Standby Rated
   i. Remote Emergency stop pushbuttons at doorways (Pilla Model GS120 w/clear, hinged, plastic cover)

B. Generator

1. Manufacturers
   a. Stamford
   b. Newage
   c. Caterpillar
   d. KATO
   e. LIMA
   f. Marathon
   g. Cummins

2. Specific Criteria
   a. Generators 1 MWatt and larger require a two bearing generator unless the manufacturer has engineered the engine main bearing to reliably withstand the dynamic rotor loads and weights
   b. The rectifier shall be a brushless, full-wave bridge
   c. <400 kW and below at 480 volts bring all leads out to the terminal box
   d. 400 kW and above – bring out 3 leads and a neutral (minimum) to the terminal box
   e. Neutrals shall be sized to full rating (brought out to the terminal box)
   f. Temperature rise on generator voltages 4160 & higher shall not exceed Class B rating with 80° C ambient rise. All others shall not exceed 105° C rating
   g. Alternator shall have a space heater that switches off when running
   h. Provide for 2/3 winding pitch
   i. Minimum Class H insulation (operating temperature class 180° C) with topicalization (anti-fungus)
   j. Provide voltage regulation less than +/- 1%

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k. Provide 150% minimum overspeed capability
l. Provide amortisseur winding
m. Provide less than 5% THD (Total Harmonic Distortion)
n. Provide less than 50 TIF (Telephone influence factor)
o. Voltage regulator shall be 3 phase

C. Diesel Engine

1. Manufacturers
   a. Caterpillar
   b. Cummins

2. Specific Criteria
   a. Heavy-duty, direct-injected, 4-stroke diesel engine
   b. Provide electronically controlled engines
   c. Provide electronically controlled engines with an electronic control system
   d. Require vendor to identify the control system to be provided
   e. Provide system software and training to fully troubleshoot and operate the engine
   f. Provide isochronous frequency regulation (no load to full load)
   g. Provide +/- 0.25% steady state frequency regulation (minimum)
   h. Air, fuel and oil filters shall be sized to provide a minimum of 250 hours of operation before servicing
   i. Provide a Racor fuel-water separator
   j. The air filter is to be a dry type with a restriction indicator
   k. Provide RTD’s for monitoring bearing and winding temperatures
   l. Add vibration monitoring if > 1000 KW
   m. Provide a Nelson (or Racor) heavy duty crankcase vapor coalesce
   n. All radiators and supporting appurtenances are to be galvanized steel
   o. The radiator core shall have solder coated fins to prevent corrosion by hydrogen sulfide gas
   p. Size radiator to prevent overheating in the most severe conditions (122°F ambient)
   q. Exhaust system and muffler shall be lowest DB appropriate for the surrounding area.
   r. The starting system shall be 24 volt DC
   s. Provide all diagnostic equipment for complete trouble shooting (software/technical manuals/hardware etc.)
   t. Speed sensing shall be provided to protect against accidental starter engagement into a moving flywheel.
   u. Battery charging alternation output voltage will not be acceptable for this purpose
   v. Provide an adjustable (0-15 minutes) cool down time
   w. Provide a large red emergency stop push button
   x. Low oil pressure, high coolant temperature, overspeed, and over-crank shall shut down the engine and provide indicator lights
   y. Analog or digital displays shall be provided for coolant temperature, oil pressure, service hours, engine RPM, system DC volts and system diagnostic code
   z. Provide Kim Hot-Start engine block heater (thermostatically controlled) set in accordance with manufacturer’s recommendation (120°F – 140°F)
   aa. Provide vibration isolators between generator set base and floor
   bb. Provide lifting eyes
   cc. Provide brake mean effective pressure (BMEP) calculations
dd. Provide means of quantifying flows from the day tank to the diesel and from the diesel back to the main tank.

D. Battery Chargers
   1. Manufacturers
      a. LaMarche
      b. Cummins
      c. SENS
   2. Specific Criteria
      a. 24 volt chargers or LaMarche equal
      b. Automatic, solid state, provide continuous taper charging
      c. UL listed, provide with under/over voltage, current failure and loss of power acknowledgment
      d. Full Float Charge versus trickle charge must be evaluated for application.

E. Starting Batteries
   1. Manufacturers
      a. Delco -DEKA
      b. Exide Switch locations
   2. Specific Criteria
      a. Use 8D lead-acid batteries (4D is not acceptable)
      b. Provide a minimum of 2. The batteries shall provide 1200 CCA each
      c. Provide with insulated battery rack
      d. Provide a 2 year full replacement guarantee
      e. Provide as a minimum 2 cranking cycles at a minimum of 30 seconds each

F. Air Starter
   1. Manufacturers
      a. Ingersoll Rand
   2. Specific Criteria
      a. Site Specific

G. Day Tanks
   1. Manufacturers
      a. Pryco
      b. Simplex
      c. Tramont
   2. Specific Criteria
      a. UL Listed – double wall
      b. Provide with Oberndorfer bronze gear type pump. Pumps with rubber or nitrile impellers will not be accepted
      c. Provide with a low level alarm
      d. Size for 2 hour minimum running time
e. Provide a fuel level indicator on the day tank
f. Provide a two pump system. Each pump shall be capable of pumping 100% of the fuel oil for all generators
g. Fuel shall be returned to the day tank
h. Provide Not in Auto lamp or other warning device.
i. Meet all VDEQ requirements

H. Underground Storage Tanks (UST)

1. Manufacturers
   a. Controls by Veeder-Root TLS 300/350 (printer available as option)
   b. Xerxes

2. Specific Criteria
   a. Provide in accordance with EPA and all applicable state and local standards
   b. Provide with leak detection system
   c. Provide a graduated stick for level measuring
   d. Provide for stick access and refueling
   e. Provide with 7 days of fuel tank capacity
   f. Provide an electronic tank level indicating system with a 4-20 mA output calibrated to the tank or Ethernet connection (TCP/IP)
   g. Provide AMI Model 8CH-DAC 8 channel digital/analog converter (4-20ma)

I. Louvers and Dampers

1. Manufacturers
   a. Greenheck
   b. Ruskin

2. Specific Criteria
   a. Aluminum or PVC with hardware
   b. Provide for gravity dampers on emergency generator systems (For motor operated applications, must fail to open position if power loss)
   c. Provide anodized aluminum dampers with nylon bushings or ball bearings
   d. Steel and/or steel shafts are not acceptable
   e. Provide with bird screens readily removable without removing louvers or dampers
   f. Designed to limit rainwater in building
   g. Where louvers and dampers are required, provide recessed dampers (inside) and flange mounted louvers (outside)
   h. Manufacturer shall set and balance the system

J. Metering/Monitoring Package

1. Specific Criteria
   a. Volt meter 3 phase & off
   b. Ammeter 3 phase & off
   c. Frequency
   d. kW
   e. PF
   f. kVA
   g. kVAR
h. kWh
i. Utility grade CTs & PTs
j. Metering packages (See Item No. 8)
k. Provide 3 phase undervoltage & overcurrent protection
l. Synchroscope
m. Sync lights
n. Supply a TCP/IP modbus link with an HRSD supplied IP address, subnet mask, and gateway to allow the Emerson DCS (or other monitoring system) to read the all data registers from the generators and the associated MCC hardware. This includes run statuses, breaker statuses, voltage, current, diesel generator engine data, etc.

K. System Operation

1. Specific Criteria
a. Provide protection such that the two sources (utility & emergency generator) can never be closed out of phase
b. Provide approvals by Dominion Virginia Power on the paralleling protection scheme
c. Provide a selector switch to allow the operator to choose “curtailment” or “loss of power” (typically set to “loss of power”)
d. In the loss of power setting, the system shall have automatic and manual operation. The manual operation would be provided in the event the automatic functions failed
 e. If the operator switches to curtailment:
   1) Depressing a single push button in the automatic mode will start the engine, parallel with the utility, ramp the plant load onto the generator and open the utility breaker
   2) Depressing a second push button will ramp the load back to the utility and shut down the generators
f. Provide a detailed sequence of operation for generator and switchgear operation

L. Start Up and Testing

1. Specific Criteria
a. Provide factory test data.
b. Simulate and test all safety equipment. Using a reactive load bank (0.8PF) run the generator:
   1) 15 minutes at idle speed
   2) 30 minutes at 25% load
   3) 30 minutes at 50% load
   4) 60 minutes at 75% load
   5) 120 minutes at 100% load
   6) 15 minutes at 25% load
   7) 15 minutes at 0% load (cool down) off
      Record stator, bearing, oil, ambient, and water temperatures every 15 minutes.
c. Record speed, voltage and amperage at 15 minute intervals as well as just prior to and after a load change.
d. Demonstrate all warnings and shutdowns with laptop.
e. Hook up the generator to the main switchgear. Perform all automatic and manual functions a minimum of three times each. The plant will load the generators as much as possible. Particular attention should be observed to the larger starting loads. Record same parameters every 15 minutes and before and after changing load. Tests to be witnessed by HRSD Automotive Superintendent and HRSD Electrical Engineer or designee.
f. Create and attach to the switchgear detailed instructions. The instructions shall be laminated. The instructions shall be simple enough for anybody to pick them up and operate the diesel generator set.
g. Group A, B, and C phase cable together to cancel out EMF (Electromagnetic Field)

IV. Item No. 4

A. Energy Efficient Motors
   1. Specific Criteria
      a. See HRSD Electric Motor Specifications in Exhibit E “HRSD Electric Motor Specifications”.
      b. Provide ammeters on motors 50 HP & larger.
      c. Local stop pushbuttons for VFDs, Use HOA for constant speed applications.
      d. Add momentary push button at Motor

V. Item No. 5

A. Sump Pumps
   1. Specific Criteria
      1) Provide with 120 volt plug and receptacle. See Treatment Plant/Miscellaneous Items.

VI. Item No. 6

A. Level Sensing Systems
   1. Specific Criteria
      a. Provide 4-20 mA signal
      2) See Treatment Plant No. 24
      3) See Chemical Systems Plants

B. Bubbler Type – Level Sensing Systems
   1. Specific Criteria
a. Complete purged air bubbler system with time delay for sensing wet well liquid level which generates and transmits level signals to control pump operations
b. Provide UPS backup for controls
c. Provide power light – white
d. Provide a pressure sensing device (Foxboro or equal)
e. Provide externally mounted duplex air compressors mounted on 30 gallon horizontal receiving tank
f. Provide push button for manual purging of bubbler piping
g. Provide manual alternation of air compressors
h. Provide lead/lag switch – no off
i. Provide panel mounted 4 ½ inch 0 level gauge/Analog gauge
j. Mount air compressors outside of panel whenever possible
k. Provide pressure activated switches for point applications (Barksdale)

C. Ultrasonic – Level Sensing Systems
   1. Manufacturers
      a. Rosemont
      b. Siemens
   2. Specific Criteria
      a. Microprocessor
      b. FM approved (frequency modulation)

D. Capacitance – Level Sensing Systems (Not Acceptable)
   1. Manufacturers
      a. Warrick
      b. Drexelbrook
   2. Specific Criteria
      a. Provide with point applications only
      b. Not for 4-20 ma applications

E. Pressure Transmitters – Level Sensing Systems
   1. Manufacturers
      a. Foxboro
      b. Rosemount
      c. Air Monitor – Incinerator draft
   2. Specific Criteria
      a. All other locations

F. FloatBalls
   1. Manufacturers
      a. Flygt
      b. Optifloat
   2. Specific Criteria
      a. Non mercury
b. Fiber Optic

G. Pressure Sensing System – Level Sensing Systems

1. Specific Criteria
   a. Provide series 40 Red Valve Pressure seal with Viton boot
   b. Provide Ashcroft Gauges 100 psi
   c. Provide Foxboro IDPT 10 absolute pressure electronic transmitter
   d. See Standard Detail “Pressure Reducing Station Pressure Sensor Detail”

H. Diaphragm – Level Sensing Systems

1. Manufacturers
   a. Foxboro
   b. Rosemont

2. Specific Criteria
   a. Pressure Transmitter (Diaphragm Type)

I. Radar – Level Sensing Systems

1. Manufacturers
   a. Rosemont

2. Specific Criteria
   a. Non-Contacting and Guided Wave types will be application dependent

VII. Item No. 7

A. Variable Frequency Drives (VFDs)

1. Manufacturers
   a. Yaskawa (A1000)
   b. Allen Bradley (Powerflex 400/700)

2. Specific Criteria
   a. Install the equipment with the idea of keeping it clean and temperature regulated
   b. Provide thumbscrews for removable/washable filters or thumb screws replaced by snap in grills that are removable from the front of the cabinet (reusable)
   c. Provide a programmable ramp time
   d. Provide input reactors (MTE Corp) or TCI
   e. Pulse Width Modulated (PWM)
   f. Use IGBTs
   g. Automatic restart on power disruption
   h. Tune out a minimum of 3 frequencies
   i. Hand/Off/Automatic (HOA) selector switch
   j. Manual speed control by potentiometer (door mounted) in addition to keypad control.
   k. Tune drive to motor with a harmonics meter
   l. Provide an input circuit breaker for short circuit protection (Fuses are not acceptable)
   m. The controller electronics shall contain indicators of the following conditions:
      1) Undervoltage
2) Overvoltage
3) Over temperature
4) Memory failure
5) Emergency Stop
6) Ground fault
7) Instantaneous overcurrent

n. Provide a NEMA 12 flanged disconnect free standing enclosure
o. Provide auxiliary run contactor wired to run command for ventilation fan
p. Mount the resets & appropriate indicator lighting on the front of the drive or the outside of the box
q. Provide four contact outputs for run status, power failure, VFD failure, not in auto status
r. The following are site specific options:
   1) VFD must be able to be isolated and bypassed (auto/manual operation) allowing the motor to operate across the line at full-load speed and current. Site specific
   2) Provide manual isolation and bypass capability
   3) Provide three contactors for bypass operation
s. VFD “T” leads in free air shall be run in RGS or PVC coated RGS
t. “T” leads can be run in PVC if in a duct bank
u. Do not run “T” leads in conduit with any other conductors
v. “T” leads shall be run in a separate conduit per each drive
w. 6 pulse drive or Matrix drive or AB 755T

3. Additional Design Considerations
   a. All electrical components must be NEMA only. IEC or NEMS/IEC is not acceptable.
   b. Filters to HVAC units must be maintained and free from dust during construction phase.
   c. VFD paramters must be included on as built prints (i.e. momentary power loss ride thru, energy savings, and fault reset)
   d. Specify coil locks (Power Quality Solutions) on control relays for power dip ride thru capabilities.
   e. Specify Baker SKF EP 1000 Dynamic motor link on all motor/VFD system 100HP and above or designated as critical equipment.
   f. Provide Bypass mode for critical VFD’s. Soft start or across the line depending on application.
   g. Specify main circuit breaker cable operators for breaker operation instead of standard door operating mechanisms.
   h. Provide One reset button to reset VFD and control circuit faults.
   i. Provide finger safe barriers for main side line breaker lugs.
   j. Provide enough fans to replace each fan within a VFD (spare parts) where several VFD’s of the same size and model are specified.
   k. Provide paper copies of VFD manuals.
   l. To support large and heavy VFD’s 60 HP and above, provide a pedestal with a flat plate mounted inside the enclosure for VFD to rest for easy removal. Also provide a lift table to remove VFD.
   m. Provide external air filter for easy access on cabinets.
   n. VFD shall be sized to provide current necessary for motor to produce continuous rated horsepower and service factor horsepower at highest carrier frequency.
o. Contractor to perform static tuning for optimal performance during startup. Contractor to supply panel shop with motor data sheets including the number of poles per motor. Also, include number of motor poles on motor nameplate.
p. Provide extended warranty by VFD manufacturer where replacement cost is justified.
q. Need all switches to indicate when not in auto
r. Need indication when control power is loss in addition to VFD fault.
s. Evaluate best routing method for bottom versus top entry of wire.

B. DC Drives
   1. Specific Criteria
      a. Unacceptable

C. Eddy Current Brake Systems
   1. Specific Criteria
      a. Unacceptable

VIII. Item No. 8

A. **Metering Packages for Switchgear**
   1. Manufacturers
      a. Schweitzer Engineering Lab (SEL)
      b. Xpert (Eaton)
      c. Power Logic (Square D)
      d. Multilin (GE)
   2. Specific Criteria
      a. Provide cumulative watt-hour meters on each MCC, or specific motor
      b. Provide a meter on each MCC to indicate 3 phase parameters on the MCC; i.e., volts, amps, kW, PF, kVA, kWh, etc.
      c. Provide with motors 200 HP and above

IX. Item No. 9

A. **PLCs**
   1. Manufacturers
      a. Allen Bradley (i.e. – SLC 500, Compact Logix 5000, Micro Logix 5000)
   2. Specific Criteria
      a. Provide functional descriptions, the application program, the job-specific program data and a copy of the as-built software documentation
      b. Include PLC fail indicator
      c. Provide license, software, programmed files with labels (as Built)
      d. PLC’s and RTU’s shall be equipped with isolation relays for all digital inputs. Example: (Idec 5-blade – 24 VDC coils- with a form C configuration contactor) relays mounted on DIN rail for the purpose isolating relay inputs. Whether a junction box is
used or control panel a 24 VDC power supply with sufficient capacity to energize all of the 24 VDC relay coils simultaneously when necessary for all PLC or RTU inputs.

Item No. 10

A. **Exhaust Fans**

1. Manufacturers
   a. ILG
   b. Dayton
   c. Greenheck
   d. Airovent
   e. Mk Plastics

2. Specific Criteria
   a. Corrosion resistant including hardware
   b. Must be explosion proof in hazardous areas

XI. Item No. 11

A. **Lighting**

1. Manufacturers
   a. Holophane
   b. Hubbell
   c. Thomas
   d. Crouse-Hinds

2. Specific Criteria
   a. LEDs
   b. Provide proper levels of lighting over major equipment including switchgear, generators, pump motors, and controls. Minimum lighting levels should conform to the IES lighting handbook.
   c. ALTO or equivalent lighting shall be used to limit the mercury content of the lighting.
   d. Non fluorescent fixtures shall be metal halide
   e. Exterior lights shall be placed on a single photo cell (within reason)

Refer to Exhibit D - Lighting Policy

B. Incandescent – Light Bulbs

1. Manufacturers
   a. Crouse Hinds
   b. Holophane
   c. Appleton

2. Specific Criteria
   a. Explosion proof in hazardous areas
   b. Industrial areas
C. Florescent – Light Bulbs

1. Manufacturers
   a. Holophane

2. Specific Criteria
   a. Provide with low temp ballasts
   b. Provide with lens and gaskets in chemical rooms
   c. Do not provide florescent lighting and controls on the same circuit
   d. Provide electronic ballasts with
   e. T-8 bulbs

D. Metal Halide – Light Bulbs

1. Manufacturers
   a. Holophane

2. Specific Criteria
   a. Suitable in high bay areas
   b. Provide quick strike fixtures in appropriate areas
   c. Wall-paks are suitable inside or outside

3. Other
   a. HPS
      1) Specific Criteria
         i. Not acceptable for any application
   b. LPS
      1) Specific Criteria
         i. Not acceptable for any application
   c. Mercury Vapor
      1) Specific Criteria
         i. Not acceptable for any application
   d. Emergency Lighting
      1) Manufacturers
         i. Dual Lite
         ii. Emergency Lite

         Note: Install dual input inverters if applicable

      2) Specific Criteria
         i. Dual Lite GMM-EL-W2 in admin areas
         ii. Emerg Lite PRO-2 in corrosive areas
   e. Exit Lighting
      1) Manufacturers
         i. Dual Lite
         ii. Lithonia
2) Specific Criteria
   i. Highly visible 24 hours/day for life (self-illuminating)
   ii. Provide lighted only if required

f. High-Mast Lighting
   1) Manufacturers
      i. Holophane

2) Specific Criteria
   i. Site specific

g. LED
   1) Specific Criteria
      i. To reduce maintenance
      ii. Perform payback analysis

XII. Item No. 12

A. **Concrete Housekeeping Pads**

   1. Specific Criteria
      a. Provide a minimum of 4 inch thickness under Switchgear, MCCs, transformers, general electrical equipment, and around conduits at floor penetrations
      b. Chamfer all edges

XIII. Item No. 13

A. **Conduit and Conduit Systems**

   1. Specific Criteria
      a. Provide three separate conduit systems. One for power circuits >600 volts, one for power circuits less than 600 volts, and one for communication circuits
      b. Instrumentation (<25v) can be placed in the communication duct bank
      c. Use compression type lugs only; when splicing is specifically approved
      d. Ream and chamfer all edges
      e. EMT or IMC are not acceptable unless approved by Owner
      f. All flexible conduit shall be heavy duty metallic liquidtight or equal
      g. Provide ¾ inch minimum size (when specifically approved or when instrumentation restricts this size, ½ inch can be used)
      h. Do not use plastic anchors
      i. Seal conduits with a silicone product as necessary (in the manholes to the buildings)
      j. Administrative areas (plenum) can use EMT down to ½ inch (lighting only)
      k. Label all conduits inside of building (Engineer must provide conduit schedule)
      l. Circuit # must be brought back to the panel/breaker.
      m. Place metal tags on cables in manholes
      n. See the Miscellaneous section of these standards for markings and coatings
      o. Provide Oz Gedney conduit and cable seals or silicone where seals are not available
p. Cable trays are not acceptable unless approved by Owner
q. Evaluate cost of stainless steel or aluminum conduit vs. PVC coated rigid steel conduit (where applicable)

B. Spare Conduits
   1. Specific Criteria
      a. Provide with service entrance
      b. Add appropriate spares with pull wires

C. Future Conduits
   1. Specific Criteria
      a. Some future conduits may become trip hazards, they must be cut flush and grouted at the finish floor in some cases.

D. PVC Coated Rigid Steel (inside and out)
   1. Manufacturers
      a. Robroy
      b. Plasti-Bond
      c. Perma-cote
      d. Korkap
      e. Ocal
      f. Gafco Industries
   2. Specific Criteria
      a. Provide in corrosive areas, underground (not encased), chemical areas, chemical containment areas, outside and damp areas
      b. Provide with PVC coated fittings, boxes and touch-up material
      c. Provide 8” of PVC coated conduit where stubbed up through concrete (wash-down areas)

E. PVC
   1. Specific Criteria
      a. Underground/encased reinforced concrete
      b. Can replace RGS in duct banks where EMI is not a threat

F. Rigid Galvanized Steel
   1. Specific Criteria
      a. Provide in all other areas not covered by PVC and PVC coated

G. Tools Used
   1. Specific Criteria
      a. Use suitable tools with conduit

H. Patching/Repair
   1. Specific Criteria
      a. Use appropriate material to patch and repair
I. Flex – Liquidtite & Fittings
   1. Specific Criteria
      a. Use Myers hubs where suitable
      b. Use coated fittings where appropriate
      c. Heavy duty metallic fittings require

J. Explosion Proof Fittings
   1. Manufacturers
      a. Crouse Hinds
      b. Appleton
   2. Specific Criteria
      a. Use fittings to match installed conduit

K. Fixtures & Fittings
   1. Specific Criteria
      a. Use appropriate fittings and materials

L. Struts and Straps
   1. Specific Criteria
      a. To suit conduit materials
      b. Use matching fasteners
      c. In outside, wet or damp areas use stainless steel fasteners

M. Pull Boxes (wire pulled through) and Junction Boxes (wires terminated inside)
   1. Specific Criteria
      a. Over 6 inch x 6 inch are to be hinged
      b. Gasketed
      c. Use stainless steel/aluminum in outside/wet areas
      d. Use PVC coated reinforced fiberglass in hazardous and chemical areas

N. Wire Hangers
   1. Specific Criteria
      a. Appropriately locate above dropped ceilings

O. Red Dye
   1. Specific Criteria
      a. Provide red dye in concrete duct bank
      b. 4000 psi

XIV. Item No. 14
A. **Wire**

1. Specific Criteria
   a. Provide for separation of power, signal and telephone services
   b. Do not splice wire
   c. Use compression type lugs only
   d. Place metal tags on cables in manholes
   e. Welding cable (DLO) – Design based on intermittent duty vs. continuous duty

B. Telephone – Wire

1. Specific Criteria
   a. Minimum wire gauge #22-24 AWG
   b. Provide plenum rated cable in return air plenums

C. THHN, THWN, XHHW – Wire

1. Specific Criteria
   a. Follow NEC color coding
   b. All shall be stranded wire, rated for 600 volt
   c. #12 minimum wire size for typical applications

D. Instrumentation – Wire

1. Specific Criteria
   a. All wire MTW or signal wire shall be rated at 600 volt
   b. Do not combine analog circuits (twisted shielded pair-TSP) with other circuits in the same conduit
   c. Instrumentation control wires should be sized accordingly (#16 stranded wire recommended)
   d. DC wire shall be color-coded blue #16 AWG minimum
   e. AC wire shall be color-coded red #16 AWG minimum
   f. Unless otherwise specified by the manufacturer, provide analog signals with #18-2 AWG with a shield, tinned

   **Note:** Cabinets with multiple sources must be clearly marked as such

E. High Voltage Cable – Wire

1. Specific Criteria
   a. Follow appropriate code

F. Heat Tracing – Wire

1. Manufacturers
   a. Letco-Dual Controls
   b. Chromolox

2. Specific Criteria
   a. Provide terminations and splices above the insulation
   b. Provide thermostatically controlled constant watt tracing
c. Provide with insulation

d. Provide with protective outer coating

e. Provide a metal strip on PVC pipe to distribute heat

f. Provide with indicator light

g. Provide with stainless steel leads in corrosive areas

h. Provide coating for chemically corrosive areas

XV. Item No. 15 - Relays

A. Industrial

1. Manufacturers
   a. Allen Bradley
   b. Eaton

2. Specific Criteria
   a. Fixed base

B. Electronic

1. Manufacturers
   a. IDEC
   b. Potter-Brumfield
   c. Agastat

2. Specific Criteria
   a. Plug-in/ice cube type with pilot lights

XVI. Item No. 16

A. Lockout / Tagout → Safety

1. Specific Criteria

XVII. Item No. 17

A. Switches / Receptacles / Plugs

1. Manufacturers
   a. Pass & Seymour
   b. Hubbell
   c. Crouse Hinds

2. Specific Criteria
   a. Provide compression type screw terminals on receptacles. Wire binding receptacles or switches are not acceptable.
   b. Provide for dedicated circuits for sump pumps
   c. Provide power receptacle in control cabinets
d. Provide a neutral for each circuit, multi wire circuits are not allowed without special approval and then with a two-pole breaker
e. Provide “in use” covers for indoor sump area applications

XVIII. Item No. 18 – Unit Heaters

A. Unit Heaters - Electric
   1. Manufacturers
      a. QMark
      b. Dayton
   2. Unit Heaters – Gas
      a. Space Ray
      b. Dayton

XIX. Item No. 19

A. Electrical Drawings
   1. Specific Criteria
      a. Process and Instrumentation Diagrams (P&IDs) are to conform to ISA modified standards (Consulting engineer to provide)
      b. Provide functional descriptions with the P&IDs (Consulting engineer to provide)
      c. Provide Point-to-Point connection drawings. Contractor shall develop.
      d. Review and approval by the engineer shall be prior to installation
      e. Label all conduits inside building
      f. Place metal tags on cables in manholes
      g. Provide final conduit & cable schedule on disk (AutoCAD, PDF & VISIO)

XX. Item No. 20

A. Safety Switches (fused or unfused)
   1. Manufacturers
      a. Square D
      b. Eaton
      c. Westinghouse
      d. Allen Bradley
   2. Specific Criteria
      a. Light duty safety switches are unacceptable
      b. Must be pad lockable

XXI. Item No. 21 - Transformers
A. Dry Transformers
   1. Manufacturers
      a. Square D
      b. Eaton
      c. GE
      d. ACME
   2. Specific Criteria
      a. No Aluminum Wire
      b. Provide 220° C insulation system for 15kVA and larger
      c. Provide 180° C insulation system for transformers less than 15kVA
      d. Transformers shall handle a 15% overload without exceeding the insulation rating
      e. Place on 4” housekeeping pads

B. Oil Filled Transformers
   1. Manufacturers
      a. Square D
      b. Eaton
      c. GE
   2. Specific Criteria
      a. No PCBs allowed
      b. Provide with FR3 oil
      c. Provide housekeeping pad – elevate pad in places prone for flooding.
      d. Require external sample ports

XXII. Item No. 22

A. Metering Vaults/Pits
   1. Specific Criteria
      a. Provide receptacle and receptacle location per HRSD direction
      b. Provide sump pumps as needed with remote GFCI circuit breaker protection

B. Other Metering Vaults/Pits
   1. Power Requirements
      a. Specific Criteria
         1) Provide two receptacles with weatherproof covers with remote GFCI circuit breaker protection
   2. Exhaust Fans
      a. See Exhaust Fans
      b. Size for 12 air changes per hour (minimum)
      c. Bring exhaust duct to within 6 inches above finished floor
   3. Lighting
      a. Provide incandescent lighting with a vapor tight glove and guard
b. Provide light switch at access

XXIII. Item No. 23

A. Pressure Sustaining/Regulating Valves

1. Manufacturers
   a. KTM
   b. Foxboro
   c. Clow

2. Specific Criteria
   a. Provide 4-20 mA operated valves. Do not use pulsed control valves
   b. Automatic Controls of Virginia or Valve Automation for actuator applications
   c. Use EIM/Bettis actuators

B. Other

1. Butterfly Valves
2. V Notch Plug Valves
3. V Notch Ball Valves

XXIV. Item No. 24

A. Flow Meters – Size for average flows

1. Parshall flume
   a. Specific Criteria
      1) Use ultrasonic level indicator (Siemens)

2. Magnetic
   a. Manufacturers
      1) Rosemont
      2) Foxboro
   b. Specific Criteria
      1) Use for control or billing applications
      2) Ensure vendor is clear on application
      3) Provide with remote head, display and keyboard

3. Ultrasonics (strap on)
   a. Manufacturers
      1) Fuji
   b. Specific Criteria
2) Do not use for control

4. Ultrasonics level
   a. Manufacturers
      1) Siemens
      2) Rosemount

5. Insertion (mass flow)
   a. Manufacturers
      1) Magnetrol
      2) Sierra
      3) Kurz
   b. Specific Criteria
      1) Air

6. Venturi
   a. Specific Criteria
      1) Generally, not used in most applications

XXV. Item No. 25

A. RTUs (Remote Terminal Unit)
   1. Manufacturers
      a. Allen Bradley

   2. Specific Criteria
      a. HRSD shall provide
      b. Physical size 24”x24”x8” in a NEMA 4x enclosure
      c. Physical size 12”x12”x8” in a NEMA 4x enclosure

XXVI. Item No. 26

A. Louvers/Dampers
   1. Manufacturers
      a. Greenheck
      b. Ruskin

   2. Specific Criteria
      a. Provide gravity dampers for all applications
      b. See Emergency Generators

XXVII. Item No. 27
A. **Transfer Switches**

1. Manufacturers
   a. Eaton
   b. Square D
   c. ASCO

2. Specific Criteria
   a. Nema 12 Enclosure unless required otherwise
   b. IQ Plus Monitoring Device
   c. Provide BUS status (A or B) to the DCS
   d. *Zenith transfer switches are not acceptable*

XXVIII. **Item No. 28**

A. **On-Line Vibration Monitors**

1. Manufacturers
   a. Bentley-Nevada

2. Specific Criteria
   a. Application specific

XXIX. **Item No. 29**

A. **Panel Meters**

1. Analog
   a. Manufacturers
      1) GE/Yokogawa
      2) Simpson

2. Digital
   a. Manufacturers
      1) Yokogawa
      2) Red Lion
      3) Simpson

3. Elapsed Time
   a. Manufacturers
      1) Crompton
      2) ENB
      3) Yokogawa
      b. Specific Criteria
         1) Non resettable / resettable (plant site specific)

4. Pulse Counters
   a. Manufacturers
      1) Acromag
      2) Omron
5. Isolators
   a. Manufacturers
      1) Action Pack
      2) AGM
      3) Yokogawa
   b. Specific Criteria
      1) Isolate 4-20 MA and 1-5 volt signals

6. Signal Converters
   a. Manufacturers
      1) AGM
      2) RIS
      3) Acromag
   b. Specific Criteria
      1) Isolate 4-20 MA and digital

7. Surge Protectors
   a. Manufacturers
      1) Phoenix
      2) MTL-Crouse Hinds
   b. Specific Criteria
      1) Provide 4-20mA DC signal surge protectors
      2) Surge protectors are to be Din Rail mounted
      3) Provide 120v AC power supply surge protectors

XXX. Item No. 30

A. Analyzers/Monitors: Safety / Gas
   1. Combustible LEL
      a. Manufacturers
         1) Detronics
         2) MSA
   2. O₂
      a. Manufacturers
         1) Detronics
         2) MSA
   3. SO₂
      a. Manufacturers
         1) Detronics
   4. Bisulfite
   5. H₂S
      a. Manufacturers
         1) Detronics
b. Specific Criteria
   1) ATI is not used for Safety

B. Analyzers/Monitors: Process

1. pH
   a. Manufacturers
      1) Foxboro
      2) E&H Memosens CPS16D pH probe (Incinerator scrubber water process)
         (Site Specific/Specific applications)

2. ORP
   a. Manufacturers
      1) Foxboro
   a. Specific Criteria
      1) Provide only
      2) Stanco not acceptable

3. O₂ (Incinerator)
   a. Manufacturers
      1) COSA
   b. Specific Criteria
      1) Provide only
      2) Operating temperature >1500°F

4. DO
   a. Manufacturers
      1) Hach
      2) Insite
   b. Specific Criteria
      1) Optica

5. CL₂
   a. Manufacturers
      1) Rosemount
      2) Prominent
      3) Chemtrac

6. H₂S
   a. Manufacturers
      1) ATI

XXXI. Item No. 31

A. Miscellaneous Instrumentation

1. PID Controllers
   a. Manufacturers
      1) Emerson Ovation
2. Electric Actuators
   a. Manufacturers
      1) EIM/Bettis
         Note: Verify hazardous classification for small 120V actuators.
   b. Specific Criteria
      1) 120 volts and 480 volts AC

3. Burner Actuators
   a. Manufacturers
      1) Honeywell
      2) Barber Coleman

4. Alarm Panel
   a. Manufacturers
      1) Ronan

5. Temperature Controllers
   a. Manufacturers
      1) Yokogawa

XXXII. Item No. 32

A. Miscellaneous Electrical

1. Electrical Equipment Testing
   a. Specific Criteria
      1) Provide testing in off-peak hours or switch off an equivalent amount of load prior to testing.

2. One Line Diagram
   a. Specific Criteria
      1) Provide an update to the one line diagram with significant changes in the electrical system.

3. Thermographic Inspection
   a. Specific Criteria
      1) Provide a thermographic inspection of the new systems upon completion.

4. Coordination Study/Short Circuit/Arc Flash
   a. Specific Criteria
      1) Provide a coordination study short circuit, coordination, and arc flash analysis for new systems or systems with significant changes.
      2) The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum
amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable. Include Arc flash analysis results for generator protective device.
Contractor must adhere to NFPA 70E Electrical Safety requirements when working on electrical equipment in HRSD facilities.
3) Engineer must design electrical systems in accordance with NFPA 70E

Refer to Exhibit A

XXXIII. Item No. 33

A. Heating and Cooling

1. Manufacturers
   a. Honeywell
   b. Barber Coleman

2. Specific Criteria
   a. Louver actuators to be used with building heating/ventilation systems.

XXXIV. Item No. 34 – Junction/Pull Boxes and Miscellaneous Enclosures

A. Junction/Pull Boxes and Miscellaneous Enclosures

1. Manufacturers
   a. Hoffman
   b. Saginaw
   c. Hammond

2. Specific Criteria
   a. Provide PVC coated boxes and/or fittings when using with PVC coated conduit.

B. Administrative Areas

1. Manufacturers
   a. Hoffman
   b. Saginaw
   c. Hammond

2. Specific Criteria
   a. NEMA 4

C. Inside

1. Specific Criteria
   a. Stainless steel, fiberglass reinforced plastic (FRP), steel, NEMA 4

D. Outside
XXXV. Item No. 35

A. Panel Boards/Control Panels

1. Manufacturers
   a. Eaton
   b. Square D
   c. Siemens
   d. GE

2. Specific Criteria
   a. Provide PVC coated boxes and/or fittings when using with PVC coated conduit.
   b. Provide with tin-plated copper bus
   c. Provide 25% spares minimum
   d. Provide bolt in breakers
   e. Do not provide cans with pre-stamped knockouts
   f. Provide with hinged panel cover with a latching door
   g. Provide heavy duty, industrial grade panel boards
   h. Breaker operator should be outside of panel
   i. Breaker should be located inside of panel
   j. HOA switches should be on the outside of panel
   k. Provide dead front hinged panel.
   l. Provide LED work light, if warranted

XXXVI. Item No. 36

A. Distributed Control System (DCS)

1. Manufacturers
   a. Emerson

2. Specific Criteria
   a. Provide fail safe condition within the DCS located in the marshalling cabinet terminal strips
      1) Contact in the field must be wired to a normally closed contact in the energized position. When fault occurs, the contact will open and be displayed as a system failure. This prevents contacts which do not close properly to indicate a fault to
the system. A digital status that equals 1 (one) indicates a closed contact and a 0 (zero) indicates an open contact. An open contact occurs when a fault occurs (fail open).

2) DCS DCU’s and RIO’s shall be equipped with isolation relay junction box(s) (interposing relays) adjacent to all of the DCU’s and RIO’s. The junction box shall contain ample room to house relays; Example: (Idec 5-blade – 24 VDC coils-with a form C configuration contactor) relays mounted on DIN rail for the purpose isolating relay junction box. This junction shall be equipped with a 24 VDC power supply with sufficient capacity to energize all of the 24 VDC relay coils simultaneously when necessary for all DCS inputs.

**Note:** The following HRSD design standards shall be adhered to: colors for graphical screens, graphics design, and control functionality. The current HRSD DCS standards are maintained by Industrial Automation within the E&I division. These standards are available upon request.

XXXVII. Item No. 37- **Lightning Protection** Refer to NFPA 820 and NFPA 780. - Lightning Protection applications will be site specific (Discuss with HRSD Electrical Staff).

XXXVIII. Item No. 38 - **SWIFT (Refer to Exhibit I)**
Meeting Notes

Subject: Arc Flash Mitigation Planning Workshop

Client: HRSD

Project: Arc Flash Mitigation Workshops

Project No: 214032

Meeting Date: July 9-10, 2013
Meeting Location: HRSD South Shore Operations Center, Atlantic Conference Room

Notes by: B. M'Coy

Attendees:

HRSD

Sherman Pressey
Carolyn Cagle
John Haymore
Jennifer See
Tim Marsh
Stephanie Laughinghouse
Ryan Duke
Mardane McLemore
Stan Saunders
Lee Inman
Kelly Lamp
Rick Raike

HDR

Gary Useldinger
Bill M'Coy
Natalie Wieszek
Kevin Thernes

Notes:

Primary HRSD Arc Flash Hazards:
1. Mechanical lock out/tag out by non-qualified personnel – treatment plants and pump stations (unattended).
2. Work on Greater Than Category 4 equipment by qualified electrical personnel.
3. Energized work in emergencies.
4. Hand-Off-Auto (HOA) selector switches located on motor control centers (MCCs) and variable frequency drive (VFD) panels – treatment plants and pump stations.

HRSD Arc Flash Program Goals:
1. Reduce arc flash hazard/risk category to Category 2 or lower (MCC and VFD panels should be reduced to Category 0).
2. Resolve issues with lock out/tag out by non-qualified personnel.
3. Determine method to manage changes to equipment and standard procedures:
   a. Standards & Preferences
   b. Software (SKM model updates) and hardcopy documentation.
      i. Who will manage; where stored.
      ii. How will changes be tracked.
   c. Manage through construction.
4. Electrical Safety Program in compliance with standards.
   a. Training and qualifying personnel.

HRSD Mitigation Actions to Date:
1. Prepared Draft Electrical Safety Program (held up on lock out/tag out issue).
2. Initiated pilot program at Virginia Initiative Plant (VIP) - mechanical lock out/tag out:
   a. Local shared PPE at equipment (Category 2) - Grit MCC.
   b. Remote Switching Operator (RSO) device - RAS MCC.
3. Purchased Eaton remote racking device for switchgear breakers (located at VIP Blower Building).
4. Developed form for tracking equipment changes.
5. Conducted re-training for all qualified electrical personnel on NFPA 70E.
6. Installed permanent remote operating panel for opening/closing existing 2SB1 main circuit breakers at VIP.
7. Retrofitted circuit breakers with AC-PRO with QUICK-TRIP trip units to provide adjustable long time, short time, and instantaneous settings (LSI) at VIP.
8. Installing Arc Reduction Maintenance Switch (ARMS) and maintenance bypass transfer switches at Army Base Treatment Plant (ABTP).
9. VIP NRI design will include separate enclosures for the Main Switchgear main circuit breakers at VIP.
10. Compiled spreadsheet of electrical equipment with respective arc flash hazard/risk categories.

**Potential Arc Flash Mitigation Alternatives for Medium Voltage Switchgear:**

<table>
<thead>
<tr>
<th>New</th>
<th>Retrofit Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus differential relays installed in switchgear</td>
<td>Bus differential relays installed in switchgear</td>
</tr>
<tr>
<td>• Approximately $5k</td>
<td>• Approximately $5k</td>
</tr>
<tr>
<td>• There is a concern with nuisance tripping</td>
<td>• There is a concern with nuisance tripping</td>
</tr>
<tr>
<td>Maintenance bypass switch on main and feeder circuit breakers</td>
<td>Maintenance bypass switch on main and feeder circuit breakers</td>
</tr>
<tr>
<td>Separate main circuit breaker</td>
<td>Clean air/filtration/climate control (applies to all equipment)</td>
</tr>
<tr>
<td>• Partitions in switchgear</td>
<td></td>
</tr>
<tr>
<td>• Separate rooms</td>
<td></td>
</tr>
<tr>
<td>• Separate space in room</td>
<td></td>
</tr>
<tr>
<td>Permanent remote operator</td>
<td>Permanent remote operator</td>
</tr>
<tr>
<td>Arc flash sensing relay</td>
<td>Arc flash sensing relay</td>
</tr>
<tr>
<td>Main-tie-tie-main configuration (doubled ended switchgear)</td>
<td>Upgrade induction disc relays to microprocessor relays</td>
</tr>
<tr>
<td>5-cycle breakers</td>
<td></td>
</tr>
</tbody>
</table>

**Potential Arc Flash Mitigation Alternatives for Medium Voltage MCC:**

<table>
<thead>
<tr>
<th>New</th>
<th>Retrofit Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove HOA from MCC</td>
<td>Remove HOA from MCC</td>
</tr>
<tr>
<td>Bus differential installed in switchgear</td>
<td>Bus differential installed in switchgear</td>
</tr>
<tr>
<td>• Approximately $5k</td>
<td>• Approximately $5k</td>
</tr>
<tr>
<td>• There is a concern with nuisance tripping</td>
<td>• There is a concern with nuisance tripping</td>
</tr>
<tr>
<td>Maintenance bypass switch</td>
<td>Maintenance bypass switch</td>
</tr>
<tr>
<td>Separate main circuit breaker</td>
<td>Clean air/filtration/climate control (applies to all equipment)</td>
</tr>
<tr>
<td>• Partitions in switchgear</td>
<td></td>
</tr>
<tr>
<td>• Separate rooms</td>
<td></td>
</tr>
<tr>
<td>• Separate space in room</td>
<td></td>
</tr>
<tr>
<td>Permanent remote operator</td>
<td>Permanent remote operator</td>
</tr>
<tr>
<td>Arc flash sensing relay</td>
<td>Arc flash sensing relay</td>
</tr>
<tr>
<td>Main-tie-tie-main configuration (double ended switchgear)</td>
<td>Upgrade induction disc relays to microprocessor relays</td>
</tr>
<tr>
<td>5-cycle breakers</td>
<td></td>
</tr>
</tbody>
</table>
### Potential Arc Flash Mitigation Alternatives for Low Voltage Switchgear:

<table>
<thead>
<tr>
<th>New</th>
<th>Retrofit Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance bypass at upstream medium voltage feeder and/or at main circuit breaker</td>
<td>Retrofit unit substations (3.F. in Attachment A)</td>
</tr>
<tr>
<td>Remote open/close and remote racking</td>
<td>Remote open/close and remote racking</td>
</tr>
<tr>
<td>Separate main circuit breaker from switchgear</td>
<td>Remove main circuit breaker and install in separate location (if possible)</td>
</tr>
<tr>
<td>Arc flash sensing relay</td>
<td>Arc flash sensing relay</td>
</tr>
<tr>
<td>Arc Vault</td>
<td>Arc Vault</td>
</tr>
<tr>
<td>Zone selective interlocking (ZSI)</td>
<td>ZSI</td>
</tr>
</tbody>
</table>

### Potential Arc Flash Mitigation Alternatives for Low Voltage Switchboards:

<table>
<thead>
<tr>
<th>New</th>
<th>Retrofit Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not preferred for new equipment</td>
<td>Replace with switchgear</td>
</tr>
<tr>
<td>Separate main circuit breaker from switchboard</td>
<td>Remove main circuit breaker and install in separate location</td>
</tr>
<tr>
<td>Arc Vault</td>
<td>Arc vault</td>
</tr>
<tr>
<td>Maintenance bypass switch at upstream feeder circuit breaker and/or at main circuit breaker</td>
<td>Maintenance bypass switch at upstream feeder circuit breaker and/or at main circuit breaker</td>
</tr>
<tr>
<td></td>
<td>Remote open/close of insulated case circuit breakers</td>
</tr>
</tbody>
</table>

### Potential Arc Flash Mitigation Alternatives for Low Voltage MCC:

<table>
<thead>
<tr>
<th>New</th>
<th>Retrofit Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Separate main circuit breaker from MCC</td>
<td>Remove main circuit breaker and install in separate location (if possible)</td>
</tr>
<tr>
<td>Solid state trip unit on upstream feeder circuit breaker and/or main circuit breaker</td>
<td>Solid state trip unit on upstream feeder circuit breaker and/or main circuit breaker</td>
</tr>
<tr>
<td>Remote racking</td>
<td>Remote switch operator (RSO)</td>
</tr>
<tr>
<td>Arc Vault</td>
<td>Arc Vault</td>
</tr>
</tbody>
</table>

### Potential Arc Flash Mitigation Alternatives for Low Voltage VFD and Control Panels:

<table>
<thead>
<tr>
<th>New</th>
<th>Retrofit Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote mount HOAs (Category 1 or higher)</td>
<td>Remote mount HOAs (Category 1 or higher)</td>
</tr>
<tr>
<td>Solid state trip unit (LSI) on upstream feeder circuit breakers to VFDs and main circuit breakers</td>
<td></td>
</tr>
</tbody>
</table>

### Potential Arc Flash Mitigation Alternatives for Low Voltage Power Panels and Transfer Switches:

<table>
<thead>
<tr>
<th>New</th>
<th>Retrofit Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Addressed by upstream protective device</td>
<td>Addressed by upstream protective device</td>
</tr>
<tr>
<td>Address construction quality in Standards &amp; Preferences</td>
<td>Address construction quality in Standards &amp; Preferences</td>
</tr>
</tbody>
</table>

### Alternatives to be Evaluated for Lowering Arc Flash Hazard Category in Pump Stations:

<table>
<thead>
<tr>
<th>New</th>
<th>Retrofit Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Main circuit breaker mounted outside</td>
<td>Main circuit breaker mounted outside</td>
</tr>
<tr>
<td>Install upstream separately-mounted circuit breaker</td>
<td>Install upstream separately-mounted circuit breaker</td>
</tr>
<tr>
<td>Smart MCC with networking</td>
<td>Remote switching</td>
</tr>
</tbody>
</table>
Alternatives to be Evaluated to Address Pump Station Equipment Lock Out/Tag Out:

<table>
<thead>
<tr>
<th>New</th>
<th>Retrofit Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local disconnect with remote start/stop</td>
<td>Local disconnect with remote start/stop</td>
</tr>
<tr>
<td>Remote switching</td>
<td>Remote switching</td>
</tr>
<tr>
<td>Personal protective equipment (PPE)</td>
<td>PPE</td>
</tr>
<tr>
<td>Achieve Category 0 at pump station</td>
<td>Achieve Category 0 at pump station</td>
</tr>
</tbody>
</table>

Alternatives to be Evaluated to Address Plant HOAs:

<table>
<thead>
<tr>
<th>New</th>
<th>Retrofit Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>HOA located at process equipment without VFD</td>
<td>Achieve Category 0 at MCC/VFD panel</td>
</tr>
<tr>
<td>HOA on VFD with DCS shutdown</td>
<td>Relocate HOA to motor/equipment</td>
</tr>
<tr>
<td>Local disconnect at all equipment with DCS shutdown</td>
<td>Connect to DCS</td>
</tr>
<tr>
<td>HOA located at HVAC equipment</td>
<td></td>
</tr>
</tbody>
</table>

Alternatives to be Evaluated to Address Plant Equipment Lock Out/Tag Out:

<table>
<thead>
<tr>
<th>New and Retrofit</th>
<th>Retrofit Existing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local disconnect switch at all equipment with DCS shutdown</td>
<td>RSO devices (all categories)</td>
</tr>
<tr>
<td>Design for Category 0 at applicable panels (MCCs, VFD panels, control panels, etc.)</td>
<td>PPE (Category 2 or lower)</td>
</tr>
<tr>
<td></td>
<td>Modify circuit breakers</td>
</tr>
<tr>
<td></td>
<td>Change protective schemes</td>
</tr>
</tbody>
</table>

Criteria that will be used to evaluate alternatives:
- Initial cost
- Safety – achieve low arc flash hazard/risk
- Risk – loss of operation
- Ease of operation
- Reliability – of implemented equipment
- Versatility - addresses lock out/tag out and electrical work
- Annual cost
- Feasibility/Maintaining operation

Preliminary Decisions:
1. Existing pump stations and new pump stations (< 400A service):
   a. Use portable remote switching operator (RSO) devices.
   b. Relocate HOAs off of MCC.
   c. For new pump stations, separately-mount main circuit breaker inside the pump station.
2. New pump stations (≥ 400A service):
   a. Install main circuit breaker with adjustable LSI trip unit and remote switching.
   b. Separately-mount main circuit breaker inside the pump station.
   c. For Greater Than Category 4 areas, workers need to have utility shut down power at their end to work on main circuit breaker.
   d. HOAs mounted off of MCC.
   e. Consider using SCADA to shutdown equipment and install local disconnect switches.

Miscellaneous Notes:
1. 5 year audit - does it require upgrade to current code?
2. Arc flash labels - equipment based or task based?
3. Who tracks/maintains software?
4. Testing should include circuit breaker trip time.
5. Work on electrical equipment with a Greater Than Category 4 rating at plants by qualified electrical personnel requires equipment to be de-energized prior to work.
Action Items:
1. HDR to draft Standard & Preferences language for new pump station electrical service configuration.
2. HRSD to procure RSO devices for existing pump stations.
3. HRSD to contract relocation of HOAs in existing pump stations.
4. HDR to evaluate actions to achieve Category 0 at MCCs, VFD panels, and other applicable panels requiring lock out/tag out at VIP, one larger pump station, and one smaller pump station. Also, evaluate relocation of HOAs to motors at VIP. Consider risk reduction (Category 2 or lower) for electrical work at distribution equipment.
5. HRSD complete pilot testing of RSO devices and PPE at VIP.
6. HDR draft Standard & Preferences language for MCCs, VFD panels, and other applicable panels in new plant designs to address lock out/tag out (goal to achieve Category 0, with adding local disconnects as alternative). Also, installing motorized circuit breakers that feed large VFD panels.
7. HRSD to develop cost for installation of local disconnect switches at two pump stations.
8. HDR draft Standard & Preferences language to address HOAs on new plant designs.
9. HDR draft Standard & Preferences language on managing construction process relative to arc flash (equipment shop drawings, etc.).
10. HRSD and HDR will schedule a follow-up one-day workshop upon completion of the evaluations listed in Action Items 4 and 7.
Attachment A
Typical Approaches to Limiting Arc Flash Exposure

Limiting Arc Exposure
1. Avoiding arc flash accidents
2. Reducing the level of arc energy released
3. Proper use of personal protective equipment (PPE)

Avoiding Arc Flash Accidents
1. Preventive maintenance
   a. Keep equipment clean.
   b. Keep rodents and birds out of equipment.
   c. Control and repair corrosion of enclosure and electric components.
   d. Check for loose connections.
   e. Test insulation integrity.
   f. Test and repair relays/trip units and breakers.
   g. Test and repair moving parts (breaker racking, switch operation, etc.)
2. Working on Live Equipment
   a. If possible, always work on de-energized equipment.
   b. Use insulated tools.
   c. When excessive force is needed (loosening bolts), it is not uncommon to lose control.
   d. Do not use paint, cleaning chemicals, spray lubrication, etc. on live parts.

Reducing Incident Energy on Worker
1. Reduce the level of Fault
   a. Use smaller KVA transformers.
   b. Double ended switchgear:
      i. Keep tie breaker open in Main-Tie-Main configurations.
      ii. Use only one source of a Main-Main configuration.
      iii. Utilize two line-ups in a Main-Tie-Main configuration instead of one line-up in a Main-Tie-Main.
   c. Current limiting fuses or breakers.
   d. Current limiting reactors.
2. Reduce arcing time
   a. Reduce breaker response time safety margin.
      i. Replace electro-mechanical relays with microprocessor relays allows time margin between relays to be reduced from 0.4 second to 0.2 – 0.25 seconds.
      ii. Utilized 5 cycle breakers rather than 8 cycle breakers.
   b. Bus differential protection.
   c. Zone selective interlocking (ZSI).
   d. Temporary instantaneous settings:
      i. Arc maintenance settings on trip units.
      ii. Maintenance group setting on microprocessor relays.
      iii. Add instantaneous trip devices to breakers with no instantaneous that can be turned on and off.
   e. Arc flash sensing relays via fiber optical cable.
   f. Adjust fuse size and speed.
   g. General Electric Arc Vault.
   h. High/Low resistance grounding.
3. Equipment features
   a. Remote breaker operation (open/close).
   b. Remote breaker racking.
   c. Arc flash resistant MCC and switchgear. (not effective with doors open)
   d. MCC that can rack bucket out with door closed.
   e. Locate main breaker section remote (separate room) from distribution section.
   f. Retrofit unit substations (primary fuse switch with secondary feeder breakers) with secondary CT and relay and primary switch over breaker with trip unit to provide both primary and secondary protection.
   g. Remote switching operator (RSO) device.
Exhibit B

North and South Shore Pump Stations
Load Bank Connection's
5560 C/S FY12 Rev 04

PART I – GENERAL

1.01 Scope of Work – Rolling Hills and Colonial Williamsburg Pump Stations

The work to be performed under this Section shall include furnishing all labor, materials, tools and equipment necessary to install and test all load bank connections.

A. Work includes providing labor and materials to build and install a Deep Hinged Window Kit with locking wing knobs and an aluminum inner plate for mounting the necessary panel receptacles.

The Deep Hinged Window Kit shall be sized and configured to insure proper safe distances between all energized components to grounding surfaces with the hinged cover closed and locked while the panel receptacles are energized.

- Special Notation
  - The amount of panel receptacles and Deep Hinged Window Kit shall be sized to meet the minimum of 100% rating of the generator load with additional room to add 50% more panel receptacles.

B. Work includes installing properly sized aluminum plate and Deep Hinged Window Kit to meet 150% of the capacity of the generator.

C. Work includes providing and installing all necessary lugs in transfer switch to accept cable for panel receptacles.

- Special Notation
  - Lugs shall be sized to accept conductors being used for panel receptacles and conductors from generator.

D. Work includes making all necessary terminations in a workmanship like manner.

E. Work includes removing a portion of the steel side door of the transfer switch and mounting an aluminum plate of adequate size to cover area removed and to accept panel receptacles to meet 150% of the capacity of the generator.

F. Work includes mounting Aluminum Plate, Panel Receptacles, and Deep Hinged Window Kit with machine screws and nuts of adequate size.

G. Work includes coordination with HRSD to perform an operational test to validate product quality and installation.

H. Work must be performed onsite between hours of 7am-3pm Mon-Fri. The time schedule may be altered if approved by owner.
1.02 Scope of Work – Rodman, Quail, and Suffolk Pump Stations

The work to be performed under this Section shall include furnishing all labor, materials, tools and equipment necessary to install and test all load bank connections.

A. Work includes providing labor and materials to install conduit, wire, and deep hinged NEMA 4X junction box with an aluminum dead front panel for mounting the necessary panel receptacles.

The junction box shall be sized and configured to insure proper safe distances between all energized components to grounding surfaces with the hinged cover closed and locked while the panel receptacles are energized.

- Special Notation
  - The amount of panel receptacles and junction box shall be sized to meet the minimum of 100% rating of the generator load with additional room to add 50% more panel receptacles.

B. Work includes installing properly sized aluminum plate and junction box to meet 150% of the capacity of the generator.

C. Work includes providing and installing all necessary lugs in transfer switch to accept cable for panel receptacles.

- Special Notation
  - Lugs shall be sized to accept conductors being used for panel receptacles and conductors from generator.

D. Work includes making all necessary terminations in a workmanship like manner.

E. Work includes installing properly sized conduit and fittings necessary from the existing transfer switch to the receptacle junction box.

F. Work includes mounting aluminum dead front plate and Panel Receptacles in junction box.

G. Work includes coordination with HRSD to perform an operational test to validate product quality and installation.

H. Work must be performed onsite between hours of 7am-3pm Mon-Fri. The time schedule may be altered if approved by owner.
1.03 Submittals
   B. The contractor shall submit a minimum of four copies of all submittals in a three
      ring binder. Any CAD drawings or other relevant information must be submitted
      in electronic format on a CD (Compact Disc). The Owner will review and
      approve before any material is purchased or any work has commenced. The
      submittals shall be delivered or mailed to the North Shore Electrical Shop, 2391
      G Avenue Newport News, VA 23602 Attn: Dean Lowery or the South Shore
      Electrical Shop, 1424 Air rail Ave, VA Beach VA 23455 Attn: Donnie Ward.
   C. The following submittals will be provided:
      a. Manufacture Product Specification's of cables, connectors, enclosure,
         and associated hardware.

Part 2 Products

2.01 Panel Receptacles shall be Leviton 18 series female panel receptacle, Cam type 400
   amp 600v 1/0 – 4/0 AWG. (18R24-(B,O,Y,G))
   A. Panel Receptacles shall be Leviton® 18series female receptacle Cam type
      400amp 600v, 1/0 – 4/0 AWG (part No.18R24).
   B. Panel Receptacles shall be colored to match corresponding phase and
      grounding conductor (grounded conductor Not Applicable )
      i.e.: 480V or 240V
         A phase – Brown/Black
         B phase – Orange/Red
         C phase – Yellow/Blue
         Ground - Green
         Neutral – NA

2.02 Deep Hinged Window Kit with locking wing knobs (Rolling Hills, Colonial Williamsburg)
   A. Deep Hinged Window Kit with locking wing knobs may be Hoffman® (i.e. CAT
      No. AWDH2420N4) or equivalent quality.
   B. Window Kit shall be capable of being locked.
   C. Shall be mounted with machine screws and nuts.

2.03 Deep Junction Box with Aluminum dead front panel (Rodman, Quail,
   Suffolk)
   A. Shall be lockable, hinged, and NEMA 4X
   B. Shall have an aluminum dead front panel

2.04 Lugs
   A. Shall be that of a manufacture with conductor size and temperature rating
      stamped into side of lug.
   B. Shall be capable of accepting the correct number of conductors coming from the
      generator and panel receptacles (a minimum of 100% rating of the generator).

2.05 Aluminum Plate
   A. Shall be a minimum of 1/4" thick.
   B. Shall be adequate size to accept the panel receptacles capable of 150% of the
      generator rating.
   C. Shall be mounted with machine screws and nuts.

2.06 Conductor
   A. Shall be that of DLO type (Diesel Locomotive Cable)
   B. Shall be a minimum of 4/0 and 600v rated.
   C. Shall be supported so as not to cause stress on the insulation of the conductor or
      the lugs where being terminated.
   D. Stranded, Copper

2.07 Conduit and Fittings
A. Shall be sized appropriately for conductors.
B. Conduit shall be galvanized ridged steel.
C. Conduit fittings shall be malleable iron.

Part 3 Execution

3.01 General and Schedule of work
A. A schedule of work shall be prepared by the Contractor and submitted to the
   Owner within 10 days of the project award. **The project must be completed**
   **and invoiced by Friday June 15th, 2012** to receive payment.

B. This project is located on the North Shore as well as the South Shore at total of five
   separate HRSD owned waste water pumping stations.
   - The North Shore Stations are:
     1. Rolling Hills – 402 Rolling Hills Dr. Williamsburg VA 23185
     2. Colonial Williamsburg – 1000 RT. 132 Williamsburg VA 23185
   - The South Shore Stations are:
     1. Rodman – 2412 Rodman Ave., Portsmouth VA 23707
     2. Suffolk – 1136 Sanders Dr., Suffolk VA 23434
     3. Quail PRS – 822 Quail Ave. Chesapeake VA 23324

C. The installation of the aluminum plate with the appropriate amount of panel
   receptacles and Deep Hinged Window Kit with locking wing knobs shall be
   determined at each location.

D. The location of where the junction boxes, panel receptacles, aluminum plate and
   Deep Hinged Window Kit with locking wing knobs will be determined at each location
   depending on equipment layout.
   - Special Notation
     o The preferred location will be as low to the finished floor as possible
       and towards the hinged side of the door or on a side of the transfer
       switch.
     o Where junction boxes are installed the preferred location is top of
       box at 6 feet from finished grade outside.

E. The successful contractor shall perform work in a safe and workmanship manner and
   adhere to all applicable codes.

F. The contractor must attend safety orientation training prior to starting construction,
   which will be facilitated by HRSD Safety Department. Call Jennifer See at (757) 460
   - 7060 to schedule an appointment.

G. The successful contractor shall contact HRSD personnel when entering and exiting
   into the pump station. On North Shore call (757) 833-1720 and (757) 460-7072 on
   the South Shore. HRSD access Badges and keys will be issued by HRSD. The
   contractor must make a log entry in the stations log book upon arrival and departure
   of the station.

H. The contractor shall coordinate all shutdowns with the contact personnel. Certain
   weather events may dictate rescheduling a shutdown at the last minute and is up to
   the discretion of the owner.

I. This work will require qualified personnel to work in proximity of energized parts; a
   energized work permit is required to perform work “hot”.

Part 4 HRSD Contacts

4.01 Contact personnel
A. North Shore Electrical Supervisor

Load Bank Rec.
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<thead>
<tr>
<th>Name</th>
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<tr>
<td>Dean Lowery</td>
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<td></td>
<td>757-833-1702 desk</td>
<td></td>
</tr>
<tr>
<td>B. South Shore Electrical Supervisor</td>
<td>757-376-2721 cell</td>
<td></td>
</tr>
<tr>
<td>Donnie Ward</td>
<td>757460-7348 desk</td>
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<tr>
<td>D. Electrical Manager</td>
<td>Sherman Pressey – 757-274-8753 cell</td>
<td>757-833-1715 desk</td>
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</table>

**Other**
- Meetings (pre-bid, pre-construction, and other coordination meetings).
- Cost estimate breakdown (includes labor, material, and other associated cost).

**Attachments**
- A – Hoffman Window Kits
- B – Leviton Connectors
- C – Photos
Hinged Hoffman Type NEMA 4X
18" Tall x 12" Wide x 14" Deep
Cont. Hinge with Padlock Hasp,
Stainless Steel

Enlargement

400 Amp, 2" Thick Aluminum Backplate
14" x 8" *

Notes:
1. Typical dimensions shown for various service sizes. Box must be field verified prior to fabrication and installation.

Hampton Roads Sanitation District
Standard Design Detail
Load Test Hinged Bank Box

Date: 1/2015
HAMPTON ROADS SANITATION DISTRICT  
Electrical Department  
2391 G Avenue  
Newport News, VA 23602  
Phone: 757-833-1702  
Fax: 757-875-0273

Drive Specifications:
Date: 09-10-15

**Variable Frequency Drive w/ Waste Water Package**

1.) Horsepower: _______
2.) Full Load Amps: _______
3.) _______ VAC, Three Phase, 60 Hertz, with internal DC Link Choke and Line Reactor.
4.) NEMA 12 free standing enclosure, 90” x 36” x 20” with viewing window and positive pressure blower & filter. Viewing window shall be made by Tegam (www.tegam.com- Item# AWXXXX). Also note, width may vary depending on air exchanges needed for correct cooling factor and/ or dimension of the VFD. **Tegam windows are not required if the VFD’s are installed in a controlled environment.**
5.) Door mounted digital keypad operator
6.) Fully NEMA rated door interlocking circuit breaker approved for thermal & magnetic trips. **IEC or DUAL RATED NOT ACCEPTED.**
7.) Fully NEMA rated three contactor by-pass configuration fully rated for continuous drive operation. Also, shall operate automatically when in the by-pass position. **IEC or DUAL RATED NOT ACCEPTED.**
8.) NEMA rated – “Drive/ Off/ By-Pass” and “Test/Off/Run” selector switches.
9.) NEMA Rated- “Manual/Auto” selector switch programmed for a voltage (manual) and current (auto) input. Additional contact on “Auto” side of switch to provide closure in auto mode and wired to terminal on drive.

10.) Door mounted Yokogawa elapsed time meter Model # 240311AAAB7-120 VAC non-resettable. **Crompton elapsed time meter is UL listed**

11.) 4-20 MADC speed reference for input and output signals.

12.) NEMA rated speed potentiometer mounted on door for manual speed control.

13.) Isolation form “C” relay **TPDT** for each “Run”, “Fault” and “Man/Auto” status.

14.) Enclosure shall be manufactured by Hoffman.

15.) Control transformer should be 1,000 VA or larger based on control needs in cabinet.

16.) Auxiliary contact for cabinet cooling fans to be form “C” relay **TPDT** and controlled from Run Status contacts of VFD.

17.) Cooling air fans shall be sized to provide correct air exchanges in cabinet to maintain temperature in cabinet below VFD rating.

18.) Extended 5 year warranty must be included.

19.) **The assembly shall be listed per UL508 and 508A or equivalent NRTL standard.** The entire assembly shall be affixed with UL508A label prior to shipment.

20.) Application specific - evaluate need for soft start for bypass for 100 HP motors or greater.

21.) Door mounted cradle for controller that could be removed and connected via (3m or 9ft) cable so that drive can be operated outside of the arc flash boundary.

**Note for Vendor:**

1.) Must visit the site to verify that equipment ordered is correct for operation.

2.) Drawings for approval are required to be submitted to HRSD Electrical Department.

3.) Items 6 & 7 shall be approved NEMA rated Cutler-Hammer, Allen-Bradley or Square D. **Or other manufacture NEMA rated with written approval by the HRSD site.**
4.) All switches and lights shall be heavy duty NEMA Rated Cutler-Hammer or Allen-Bradley 30mm.

5.) All switches, lights and keypad shall be mounted inside of viewing window on door. If applicable

6.) All spare relay contacts should be wired to terminal blocks.

7.) Fault relay should be controlled from Normally Closed (N.C.) contacts of VFD MB & MC Terminals and to be wired after Overload (O/L) contacts on drawing.

8.) All VFD’s will be shipped attached Horizontally on pallets and with sufficient protection for the switches, lights and On/Off breaker.

9.) **THERE SHALL BE NO IEC OR DUAL RATED NEMA DEVICES ACCEPTED.**

Examples: Lights, position switches, circuit breakers, contactors and speed potentiometer.

Mount Thermostat above or close to the VFD. Not at the bottom of the cabinet
The purpose of these guidelines is to provide direction for sustainable lighting solutions to meet the needs of facilities and help accomplish the Mission and Vision of HRSD.

Sustainable lighting meets the qualitative needs of the visual environment with the least impact on the physical environment.

- **Sustainable lighting elements**
  - Optimize use of daylight
  - Minimize use of energy
  - Reduce light pollution and light trespass
  - Minimize embodied environmental effects
  - Specify environmentally preferable materials and equipment
  - Ensure system quality, flexibility, adaptability, maintainability and durability
  - Provide staff orientation and training

- **Qualitative needs**
  - Support work
    - Productivity, safety, security
  - Regulatory
    - Minimum required light levels maintained
  - Human Centric
    - The psychological wellbeing, interest, and enthusiasm of people.

- **Optimize use of daylight**
  - Daylight can provide potential benefits in terms of health, performance, or general well being
  - Minimize electric lighting, turn off (or down) in response to daylight
    - Simple solution: Photo-sensor, controller, step-dimming ballast (bi-level option) for fixture retrofit
    - Optional feature for occupancy/vacancy sensors- Built in photo-sensor- Inhibits room lights from turning on when there is sufficient daylight present
• **Minimize use of energy**
  o Integrated design
    ▪ Optimize integration with daylighting
  o Appropriate, high quality design
    ▪ Appropriate light levels, noticeable improvement
  o Effective controls
    ▪ To reduce kWh by turning off lighting
      • Switching controls
    ▪ To reduce kW by turning down lighting
      • Dimming controls

• **Reduce light pollution and light trespass**
  o Light pollution is:
    ▪ Unnecessary, unwanted or wasted light
    ▪ Light that damages or degrades the nighttime luminous environment
    ▪ Light that negatively impacts humans, animals or plants
  o Sustainability issue because:
    ▪ Affects use of energy & enjoyment of natural nighttime sky
  o Light Trespass
    ▪ Obtrusive light that crosses a property line
    ▪ Difficult to quantify
      • When, where & how much light is unwanted
  o Can be avoided by:
    ▪ Aiming lights down
    ▪ Choosing fixtures with hoods or visors
    ▪ Installing motion sensors to turn off lights when not needed
    ▪ Use lowest wattage lamp to do the job
    ▪ Lighting should not be overly bright in relation to the surrounding area.
    ▪ B.U.G. rating of fixture, Back, Up, Glare.

• **Minimize embodied environmental effects**
  o Total energy required to produce a product, service or material including all life cycle phases from raw extraction to end of life
    ▪ Includes manufacturing, packaging, transportation, installation, recycling
  o Buy American (locally)
    ▪ Minimize transportation
  o Retrofit vs. Re-lighting (w/new fixtures)
    ▪ Retrofit uses less material (often w/ lamps & ballasts or LED retrofit kits only)
• Specify environmentally preferable materials and equipment
  o Lighting equipment manufacturers demonstrating their commitment to environmental responsibility with improvements to manufacturing
  o RoHS COMPLIANCE
    ▪ Reduction of Hazardous Substances Directive
    ▪ Aims to restrict certain dangerous substances commonly used in electronic equipment

• Ensure system quality, flexibility, adaptability, maintainability and durability
  o Quality
    ▪ Lighting that positively addresses human needs, architecture, economics, energy and the environment.
  o Flexibility
    ▪ To extend useful life of facility & better serve user’s changing needs
      • Ex: Flexible lighting controls, such as wireless
      • Ex: Flexible wiring systems
  o Adaptability
    ▪ Should anticipate change to allow system reconfiguration and reuse in future remodeling
      • LED’s improving Lumens Per Watt at 20% a year
      • Ex: Lighting controls – reprogram for new space uses
      • Ex: Lighting controls – wireless
  o Maintainability & Durability
    ▪ Lighting systems that perform the longest with the least maintenance effort have best economic and environmental value
      • SSL equipment & LED bulbs – lowest life-cycle cost
      • Long-life lamps have great value
      • Ex: Standardizing and minimizing the number of different lamp types reduces inventory and maintenance labor

• Provide staff orientation and training
  o Ensures operation and maintenance

• Lighting Metrics
  o Provides a means to make comparisons between various lighting sources
    ▪ Lumens-Total amount of light emitted by a source in all directions
    ▪ Lumens Per Watt-Measure of light source energy efficiency
    ▪ CRI- Color Rendering Index is the measurement of how colors look under a light source when compared with sunlight. The index is measured from 0-
100, with a perfect 100 indicating that colors under the light source appear the same as they would under natural sunlight.

- CCT- Correlated Color Temperature, measured in degrees Kelvin, refers to the amount of orange vs blue hue to the white light. "Warm" Light has a more orange hue vs. "Cool" light, which has a more bluish tint to it.
- Foot Candles- Measurement of total quantity of light falling on a square foot of a surface. This measurement is useful because working conditions are often specified in foot candles.

• Warranties
  o Unfortunately there are still a number of unproven products and manufacturers out there that are causing challenges for both consumers and the industry.
  o Half of new businesses last less than 5yrs

• Reference Resources
  o Department Of Energy (DOE)
    ▪ Caliper Reports
  o DesignLights Consortium (DLC)
    The DesignLights Consortium® (DLC) is a non-profit organization dedicated to accelerating the widespread adoption of high-performing commercial lighting solutions. The DLC promotes high-quality, energy-efficient lighting products in collaboration with utilities and energy efficiency program members, manufacturers, lighting designers, and federal, state, and local entities. Through these partnerships, the DLC establishes product quality specifications, facilitates thought leadership, and provides information, education, tools and technical expertise.
  o Illuminating Engineering Society (IES)
  o Occupational Safety and Health Administration (OSHA)
  o International Dark Sky Association (IDA)
    IDA is non-profit, tax-exempt, membership-based organization to help preserve & restore dark skies while maximizing the quality and efficiency of nighttime outdoor lighting
A Practical Guide for Choosing the Appropriate LED Lighting

There’s More To It Than Just Lumens Per Watt

General

- Deplete existing parts inventory
- Plan for future network connectivity
- Use motion activating controls with overrides
- Color Rendering (CRI) Index of 80 or greater
- Correlated Color Temperature (CCT) 3500-4000K, Exterior
- Correlated Color Temperature (CCT) 4000K and above, Interior
- Consider glare use diffuser and or indirect fixture
- Consider vertical and up-light levels of illumination
- Consider light trespass and pollution, Exterior
- Ask for photo metrics of fixtures

Recommendations

- LED replacement tubes and cob lamps (plug and play) are not recommended due to safety and efficiency concerns.
- New fixtures designed around the LED light source are recommended.
- LED fixture retrofits are an option if more feasible than new fixture.
- Buy a few or ask vendor to supply fixtures for a temporary trial
- Use a light meter and record foot-candle readings horizontal and vertical before and after changes

Difficult Access Areas

- Replace with LED fixture

Outside / Exterior Lighting

- High Mast Lighting
  - No new installations, Install LED street lighting
  - Replace with LED fixture
  - Consider light trespass and pollution
• Street Lighting/Building Exterior
  – LED replacement cob lamps not recommended due to safety and efficiency concerns
  – Low and High Pressure Sodium- replace with LED
  – Metal Halide- replace with LED
  – Incandescent/Halogen- replace with LED
  – Consider light trespass and pollution

**Fluorescent Lighting**

• LED replacement tubes not recommended due to safety and efficiency concerns

• Existing T-12, Fixtures 8’0
  – Retrofit with LED kit or replace with new LED fixture preferred
  – Consider vertical levels of illumination
  – Consider glare, use indirect or diffuser

• Existing T-12, Fixtures 4’0
  – Retrofit with LED kit or replace with new LED fixture preferred
  – Consider vertical levels of illumination
  – Consider glare, use indirect or diffuser

**Hazardous ( Classified) Areas, PTF, Wet Well, Digester etc.**

• Replace with LED fixture rated for specific conditions, Class and Division
  – Correlated Color Temperature (CCT) 4000K and above
  – Color Rendering (CRI) Index of 90 or greater
  – Consider vertical and uplight levels of illumination
  – Consider glare, use diffuser
The following specifications shall be used for the purchase of new motors.

A. The motor shall meet or exceed the efficiency levels from NEMA MG1 Table 12-11 which comply with levels set by The Energy Policy Act and Conservation Act (EPCA), as amended by the Emergency and Security Act of 2007 (EISA). See NEMA MG1 Table 12-11.

B. The motor efficiency shall be determined using the test standards found in IEEE Standard 112-2004, Standard Test Procedure for Polyphase Induction Motors and Generators, or by other internationally accepted methods.

C. The motor shall be properly sized for the given load.

D. The motor shall be Totally-Enclosed, Fan-Cooled (TEFC), unless noted. Open Drip Proof (ODP) is acceptable in cases where TEFC is not available.

E. The motor shall have a minimum service factor of 1.15.

F. The motor shall have a minimum insulation class of F.

G. Motors used with variable frequency drives shall be examined for inverter duty motor applicability.

H. The following parameters shall be specified for the motor:

1. Motor horsepower
2. Voltage
3. Full load amps
4. Speed
5. Frequency
6. Phase
7. Shaft size
8. Environmental conditions (ambient operating temperature range, humidity level, etc.)
9. Starting torque (loaded or unloaded)
10. Classification of hazard (explosion proof, non-explosion proof, etc.)
11. Special equipment requirements (thermal protection, space heaters for outside, wet or high humidity area, standard or nonstandard conduit boxes, etc.)
12. Maximum number of starts per day/per hour
13. High temperature grease (for special cases, if required)
I. Where a Contractor is required to coat a motor, the motor shall be coated with an industrial enamel at a thickness of 5 mil D.F.T. The coating color shall be gray, U.S. Government Federal Register 595 Paint Color Number 16473.
## NEMA MG1 Table 12-11
Motor Efficiencies

### OPEN MOTORS

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### NEMA MG1 Table 12-11
#### Motor Efficiencies

**ENCLOSED MOTORS**

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<tr>
<th>HP</th>
<th>FULL-LOAD EFFICIENCIES OF ENERGY EFFICIENT MOTORS</th>
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<td>Minimum Efficiency 2 POLE</td>
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NOTES:
1. COORDINATE LOCATION OF STILLING WEL WITH PM PRIOR TO INSTALLATION.
2. CENTER ACCESS FOR TRANSDUCER REMOVAL OVER STILLING WELL.
Temporary Portable Pump Alarms and Setup Standards

When a project requires a temporary portable pump to be alarmed, the following guidelines need to be followed.

- **When work is performed at station:** If power is available, all alarms are to be routed through existing HRSD’s scada system. Portable pump manufacture call box is not acceptable unless otherwise approved for site specific situations. If power is not available then, HRSD solar Scada panel will be provided. A portable generator may be required depending on site specific situations.

- **When work is performed at a manhole:** If power is available, all alarms are to be routed through existing HRSD’s scada system. Portable pump manufacture call box is not acceptable unless otherwise approved for site specific situations. If power is not available then, HRSD solar Scada panel will be provided. A portable generator may be required depending on site specific situations. Naming of the alarms from a manhole should indicate the location of the manhole (i.e. Pearl and Ligon)

- The name of the site is to be used followed by temporary lead, lag or second lag, depending on the number of pumps. (Example: Arctic Temporary Lead, Arctic Temporary Lag and Arctic Second Lag.)

- Both contractor and HRSD will be alerted in the event of a pump alarm. The contractor is responsible to be primary responder with the support of HRSD staff.

- All pump maintenance and fuel requirement are the contractors responsibility.

- Pump maintenance records are to be provided monthly through the duration of the project by contractor, depending on length of project.

- Battery chargers are required with all pumps. In situations where power is not available a portable generator may be required.

- All discharge piping is to be pressure rated flanged or fused pipe. Isolations valves are required at each pump along with an additional external swing check valve. A means to bleed air off the discharge piping is required.

- Float balls, level transducers and pressure transducers are acceptable. In a Lift station or manhole application, level transducers are used. If float balls are used for control, a two float setup is required per pump. All floats are to be secured in manhole or wet well so as not to become tangled, hindering pump operation. In a temporary PRS setup, owner furnished sensor valve will be provided to allow contractor to connect pressure transducers for control. An isolation valve is required to be furnished by contractor at this location.

- If work is to be performed during cold weather, the contractor is responsible for providing freeze protection on pumps and controls, specifically transducers.

- Depending on location and duration of job, concrete protective barrier wall may be required.

- All manholes and wet wells where temporary pumps are being used must be secured to prevent trip hazards, fall risks and odor issues.

The following standard alarms are required. Site specific alarms will be evaluated on a as need basis.
<table>
<thead>
<tr>
<th>Two Pump Lift station Or Manhole (Diesel Pumps)</th>
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<tbody>
<tr>
<td>Lead</td>
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<td>Lag</td>
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<td>High well</td>
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<td>Overflow</td>
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<table>
<thead>
<tr>
<th>Three Pump Lift station Or Manhole (Diesel Pumps)</th>
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<tbody>
<tr>
<td>Lead</td>
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<tr>
<td>Lag</td>
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<tr>
<td>Second Lag</td>
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<td>High well</td>
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<td>Overflow</td>
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<table>
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<tr>
<th>Two Pump Lift Station or Manhole (Diesel Pumps) New Prime Guard Controller</th>
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<tbody>
<tr>
<td>Lead</td>
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<tr>
<td>Lag</td>
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<td>High well</td>
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<td>Overflow</td>
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<tr>
<th>Two Pump Lift Station or Manhole (One electric one diesel pump) New Prime Guard Controller</th>
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<tr>
<td>Dominion Power</td>
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<tr>
<td>Lead</td>
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<tr>
<td>Lag</td>
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<tr>
<td>High well</td>
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<td>Overflow</td>
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</table>

(For HRSD monitoring purposes only, provide well level.)
Three Pump Lift Station or Manhole (One electric two diesel pump) New Prime Guard Controller

Dominion Power   On / OFF

Lead            Fail / Normal  (Electric)
Lag             On / off and Fail / Normal
Second Lag      On / off and Fail / Normal
High well       Alarm / Normal  (HRSD furnished float ball if station alarms cannot be used)
Overflow        Alarm / Normal  (Determined necessary according to length of Job. HRSD furnished float ball if station alarms cannot be used.)

(For HRSD monitoring purposes only, provide well level.)

Two Pump PRS (Diesel Pumps) New Prime Guard Controller

Lead            Fail / Normal
Lag             On / off and Fail / Normal

(For HRSD monitoring purposes only, provide Suction and Discharge pressures.)

Three Pump PRS (Diesel Pumps) New Prime Guard Controller

Lead            Fail / Normal
Lag             On / off and Fail / Normal
Second Lag      On / off and Fail / Normal

(For HRSD monitoring purposes only, provide Suction and Discharge pressures.)

Two Pump PRS (One electric one diesel pump) New Prime Guard Controller

Dominion Power   On / OFF
Lead            Fail / Normal  (Electric)
Lag             On / off and Fail / Normal

(For HRSD monitoring purposes only, provide Suction and Discharge pressures.)
Three Pump PRS (One electric two diesel pump) New Prime Guard Controller

- Dominion Power: On / OFF
- Lead: Fail / Normal (Electric)
- Lag: On / off and Fail / Normal
- Second Lag: On / off and Fail / Normal

(For HRSD monitoring purposes only, provide Suction and Discharge pressures.)

### Required Contractor Supplied Bypass Pumping Alarm Outputs for HRSD SCADA System interface

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<th>Pump Alarms</th>
<th>Level Alarms</th>
<th>Analogs</th>
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<td>LEAD PUMP RUNNING/OFF</td>
<td>FLOODBALL HIGH LEVEL</td>
<td>4-20 mA Isolated Output</td>
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<td>Alarm (OPEN) on LEAD PUMP OFF</td>
<td>Alarm (OPEN) on FLOODBALL OVERFLOW</td>
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<tr>
<td>LEAD PUMP NORMAL/FAIL</td>
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<td>1st LAG PUMP ON/OFF</td>
<td>Alarm (OPEN) on LEVEL TRANSMITTER</td>
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<tr>
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<tr>
<td>Alarm (OPEN) on 2nd LAG PUMP FAIL</td>
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A normally CLOSED contact state is required during normal operation.

Any OPEN contact will generate an Alarm Condition.
Exhibit H

SCADA/WMP SITE MATERIALS

CABINET = Hoffman A60H3612ALD/SP1 w/Back Plane (Special Order HRSD WMP for 60x28x18)
Teleg 3307A or 3314 w/Modem & Antenna

FLOW METER =

BATTERY CHARGER =

BATTERIES (4x) = 100Ah Gel Cell Batteries (12VDC)

CABINET LIGHT = Various (12VAC)

PANDUIT = Various

DIN RAIL = Various

TERMINAL STRIPS = Weidmuller # WU2.5 1020000000 (Beige)
Weidmuller # WU2.5 1020050000 (Green)
Weidmuller # (Black) ?
Weidmuller # (Red) ?
Weidmuller #05-Simpler 9015x9000 (30VAC)

OUTLET = Square D #GOU125 (25A DIN Rail Mount)

CIRCUIT BREAKER = Various 4 x 5 x 8

POST = Various

ANTENNA MAST 27' = Various

MISC WIRING = Various

RTU = MOSCAD Ace (Optional)

POWER SUPPLY = IDEC 24 VDC #PSR-5024 (Optional)

POWER SUPPLY = IDEC 14 VDC #PSR-5012 (Optional)

External Devices are not included in material list.
RECOMMENDED ADDITIONS/CHANGES TO SPECIFICATIONS FOR FUTURE SWIFT DESIGN

PREPARED BY HRSD EEM STAFF

SECTION 1  ELECTRICAL
  1.1 ELECTRICAL CONDUIT / ROUGH IN / METHODS
  1.2 LIGHTING
  1.3 DESIGN / LAYOUT

SECTION 2  INSTRUMENTATION ELECTRICAL
  2.1 MOLEX CONNECTORS
  2.2 WIRING TERMINATIONS
  2.3 VFD CABINET CONSTRUCTION
  2.4 INSTRUMENT GENERAL

SECTION 3  INSTRUMENTATION PIPING METHODS
  3.1 SAMPLE PIPING
  3.2 DRAIN PIPING
  3.3 GENERAL

SECTION 4  DCS
  4.1 INTERPOSING RELAY CABINET
  4.2 OPCON
  4.3 CONTROL NETWORK
1.1 ELECTRICAL CONDUIT/ROUGH IN METHODS

A. ALL EXTERIOR POWER AND CONTROL CONDUCTORS MUST BE FULLY ENCASED IN CONDUIT. CABLE TRAY MAY NOT BE USED ON AREAS DEFINED AS “WET LOCATION” BY THE NEC. CONDUIT STUB UPS SHALL EXTEND COMPLETELY UP TO ALL ENCLOSURES, DISCONNECTS OR WIREWAYS. NO EXTERIOR CABLE WILL BE ALLOWED TO BE RAN “FREE AIR”. EXPANSION JOINTS TO BE USED WHERE REQUIRED.

B. ALL OUTLET BOX ROUGH-INS OF GWB CONSTRUCTION SHALL USE A BRACKET TO MOUNT TO AT LEAST TWO WALL STUDS. SCREW EAR BOXES ARE NOT ACCEPTABLE. USE OF THESE BRACKETS WILL ALSO INSURE THAT BOXES MOUNTED NEXT TO EACH OTHER WILL BE LEVEL.

C. ALL CONDUIT/RACEWAYS SHALL BE RAN CONCEALED IN AREAS OF GWB CONSTRUCTION.

D. ALLOW ½" TRADE SIZE EMT TO BE RAN ON RECEPTACLE AND LIGHTING CIRCUITS CONCEALED IN GWB CONSTRUCTION, OR ABOVE CEILING TILES.

1.2 LIGHTING

A. CONTROL ROOM LIGHTING SHALL BE OF A LOW GLARE DESIGN IN RELATION TO THE VIDEO DISPLAYS, WITH DIMMABLE SWITCHING AND OCCUPANCY SENSOR OVERRIDE.
B. ELECTRICAL AND MECHANICAL SPACES SHALL HAVE A MINIMUM LIGHTING LEVEL OF 30 VERTICAL AND HORIZONTAL FOOT CANDLES PER IES STANDARDS. 75% OF EACH ELECTRICAL AND MECHANICAL ROOM SPACE LIGHTING FIXTURES SHALL BE ON DUAL TECHNOLOGY OCCUPANCY SENSORS WITH ADEQUATE COVERAGE OF ENTIRE SPACE. THE 25% REMAINDER OF LIGHTING SHALL BE CONNECTED TO TRADITIONAL MANUAL SWITCHING.

C. NO STAIRWAY LIGHTING SHALL BE MOUNTED IN A LOCATION THAT IS NOT ACCESSIBLE VIA A STANDARD 8’ A-FRAME LADDER SET ON STAIR LANDINGS.

D. NO LIGHTING ABOVE FANS DUE TO STROBING EFFECT.
1.3 DESIGN / LAYOUT

A. LAB COUNTER TOP RECEPTACLES SHALL BE ONE DUPLEX EVERY FIVE FEET OF COUNTER WITH A MINIMUM OF TWO DUPLEX RECEPTACLES FOR ANY SIZE COUNTER SPACE.
B. CONTROL ROOM DESIGN SHALL INCLUDE RACEWAYS FOR VIDEO AND DATA CABLES, AND A DUPLEX RECEPTACLE BEHIND EACH WALL MOUNTED VIDEO MONITOR OR COMPUTER DISPLAY.
2.1 MOLEX CONNECTORS

A. FIELD POWERED TRANSMITTERS SHALL USE MOLEX CONNECTOR CAT. 
#WH1R3005A20M0568 MOUNTED ON THE BOTTOM OF THE TRANSMITTER. THE MATING PLUG/CABLE IS CAT. #WH103000A45M0208 (2 METER CABLE LENGTH) FOR 120 VOLT POWER CONNECTIONS. THIS CONNECTOR WILL SERVE AS A MEANS OF DISCONNECT FOR INDIVIDUAL UNITS.

B. TRANSMITTERS AND SENSORS WILL USE A MOLEX CONNECTOR CAT. # WH8R4005A18M0058 MOUNTED ON THE BOTTOM OF TRANSMITTER/SENSOR WHEN POSSIBLE. THE MATING PLUG/CABLE IS CAT. # WH80400D01M0208 THIS IS A TWO PAIR CONFIGURATION THAT WILL ALLOW FOR TWO ANALOG 4-20MA CURRENT LOOPS OR TWO DIGITAL SIGNALS. IF THE EQUIPMENT REQUIRES MORE THAN TWO PAIR SHIELDED CONDUCTORS HARD WIRING IS ACCEPTABLE.
2.2 WIRING TERMINATIONS

A. ALL CONTROL WIRING TERMINATIONS WILL USE A CRIMP ON TYPE CONNECTOR OF EITHER A FORK TYPE OR A PIN TYPE APPROPRIATE FOR TERMINAL BLOCK STYLE.
B. UPON OWNER REVIEW AND APPROVAL THE MINIMUM CONTROL WIRE SIZE MAY BE REDUCED TO ACCOMODATE EQUIPMENT WITH SMALL/CONGESTED TERMINATION SPACES. EXAMPLE: METERING PUMPS WITH 12-16 CONTROL CONDUCTORS.

2.3 VFD CABINET CONSTRUCTION

A. THE MOUNTING LOCATION OF COOLING FAN THERMOSTAT INSIDE THE CABINET SHALL BE PARALLEL OR HIGHER THAN THE TOP OF THE ACTUAL VFD UNIT WHERE THE HEAT ORIGINATES.
B. COOLING FAN POWER SHALL BE RAN THROUGH THE RUN RELAY SO THAT THE FAN DOES NOT RUN IF VFD IS NOT IN RUN MODE.
C. COOLING FAN EXHAUST OUTLETS INSIDE CONDITIONED SPACES SHALL NOT HAVE FILTERS, AND SHALL EXHAUST OUT THE SIDE OR TOP OF THE CABINET CONSISTANT WITH U.L. STANDARDS.

D. INCLUDE A BULKHEAD MOUNT WITH DUST COVER USB CONNECTOR ON THE CONTROL SURFACE OF THE VFD CABINET WHICH IS CONNECTED TO THE DATA PORT ON THE VFD UNIT. THIS IS TO ALLOW A LAPTOP CONNECTION TO THE VFD TO MODIFY PARAMETERS, ETC. WITHOUT NEEDING TO OPEN THE CABINET.
2.4 INSTRUMENT GENERAL

A. WHERE POSSIBLE MOUNT ALL TRANSMITTERS AT APPROX 5’ AFF OR WALKWAY FOR EASE OF ACCESS AND VISUAL INSPECTION.

B. PROVIDE LOCAL AUDIBLE AND VISUAL ALARMS IN CHEMICAL ROOMS FOR CHLORINE AND SULPHER DIOXIDE GAS DETECTORS. CURRENTLY INSTALLED GAS DETECTORS ONLY HAVE A BLINKING DISPLAY WHEN ALARM CONDITION EXISTS.

C. PROVIDE A UPS TO POWER SHIMADZU TOC ANALYZER SIZED TO CARRY IT THROUGH GENERATOR STARTUP/SWITCHING.

INSTRUMENTATION PIPING METHODS

3.1 SAMPLE PIPING

A. FIRST SAMPLE INSTRUMENT IN A LINE UP SHALL NOT BE AFFECTED BY AIR BUBBLES. FOR EXAMPLE A PH PROBE FIRST IN LINE WILL ALLOW AIR TO ESCAPE BEFORE REACHING TURBIDITY METERS.

B. ALTERNATIVE METHODS SHOULD BE INVESTIGATED TO CONTROL FLOW TO INSTRUMENT LINE UPS ON INFLUENT AND FLOC/SED INSTRUMENTATION. ROTAMETERS AND REGULATORS ARE CLOGGING CAUSING LOW OR NO FLOW CONDITIONS.

C. PROVIDE A MEANS TO FLUSH BIOFILTER HEADLOSS TRANSUDER SAMPLE LINES.

D. INCORPORATE A FULL DIAMETER FLUSH VALVE AT LOW POINT OF INSTRUMENT LINEUP SAMPLE LINES.

3.2 DRAIN PIPING

A. FLOOR DRAINS AT EACH INTERIOR INSTRUMENT LINEUP.
B. INSTRUMENT DRAIN LINES ON FRONT OF INSTRUMENT LINEUP WITH AIR GAP TO ALLOW
VISUAL FLOW CONFIRMATION.

3.3 GENERAL

C. METERING PUMPS ON TURBIDITY INSTRUMENTS.

D. SELF-CLEANING DEVICES ON INFLUENT AND FLOC/SED TURBIDITY INSTRUMENTS.

E. HEAT TRACING AND INSULATION ON ALL EXTERIOR SAMPLE AND DRAIN LINES INCLUDING
PRESSURE TRANSMITTERS AND SWITCHES.

DCS

4.1 INTERPOSING RELAY CABINET

A. PROVIDE A POWER MONITORING OUTPUT POINT TO DCS THAT WILL INDICATE POWER LOSS
TO ANY INTERPOSING RELAY CABINET CONTROL CIRCUITS.

4.2 OPCON

A. AT LEAST ONE ADDITIONAL OPERATORS CONSOLE FOR DCS THAT IS NOT LOCATED IN THE
MAIN CONTROL ROOM.

4.3 NETWORK

A. SPEC FIBER OPTIC CAPABLE CISCO NETWORK SWITCHES IN ALL VENDOR PROVIDED
EQUIPMENT THAT WILL CONNECTED THIRD PARTY TO THE DCS.

B. ENCOURAGE THE USE OF FIBER OPTIC CABLE IN LEIU OF TYPE TC CAT-6 CABLE.

C. IF CAT-6 TYPE TC IS USED IT MUST BE TERMINATED TO A PATCH PANEL AND NOT DIRECTLY
CONNECTED TO NETWORK EQUIPMENT. THIS IS TO PREVENT DAMAGE TO NETWORK JACKS FROM THE
RELATIVELY LARGE HEAVY CABLE.

D. INVESTIGATE THE USE OF VENDOR NETWORKS TO ALLOW THIRD PARTY COMMUNICATION
TO THE DCS. SUCH AS HACH INSTRUMENTS, YASKAWA VFD AND CHEMICAL METERING PUMPS. THIS
WOULD ALLOW MORE DETAILED INFORMATION TO BE AVAILABLE TO THE DCS. IT WOULD ALSO ALLOW
ALL CONTROL WIRING TO REMOTE AREAS SUCH AS RECHARGE WELL HOUSES TO BE FIBER OPTIC. THIS
NEEDS TO BE FURTHER DISCUSSED WITHIN HRSD TO DETERMINE IF WE WILL GET ALL NEEDED ALARMS
WE DESIRE FROM THE VFD CABINET. IE: POWER LOSS INDICATION

E. PROVIDE A HRSD CORPORATE NETWORK HARDWIRE CONNECTION OR WI-FI AT REMOTE
LOCATIONS SUCH AS PUMP HOUSES TO ALLOW TROUBLESHOOTING VIA EDS, ETC.

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