

# APPENDIX H

## KEY LARGO WASTEWATER TREATMENT DISTRICT

### TECHNICAL SPECIFICATONS FOR EMERGENCY VACUUM TRAILER EQUIPMENT

THIS IS TO CERTIFY THAT THE ENCLOSED ENGINEERING SPECIFICATIONS  
WERE PREPARED BY ME OR UNDER MY RESPONSIBLE CHARGE.

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Date

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## **DIVISION II - EQUIPMENT**

### **SECTION 11307 - SPECIFICATION FOR FACTORY ASSEMBLED VACUUM PUMP SKID**

#### **PART 1 - GENERAL**

The following specification is a guideline for pre-fabricated Vacuum Collection Equipment. It is organized by major components with sizing indicated. Following the mechanical equipment specification is a detailed electrical specification.

##### **1.1 DESCRIPTION OF WORK**

The extent of work under this section includes furnishing, pre-fabrication and factory testing of a complete, four unit vacuum pump assembly mounted on a structural steel skid

##### **1.2 RELATED WORK SPECIFIED ELSEWHERE**

Furnishing and installation of pre-fabricated trailer mounted vacuum pump equipment, including but not limited to a pump control panel, conduit and wiring and other associated equipment and vacuum pumps skid assembly.

##### **1.3 MANUFACTURER'S EXPERIENCE**

The manufacturer of pre-fabricated station equipment and controls shall have a minimum of five (5) years of experience in the design, manufacture and start-up of vacuum stations, and have at least five (5) installations in service. Provide verification upon request.

##### **1.4 SUBMITTALS**

**SHOP DRAWINGS AND LITERATURE:** Provide a submittal including complete plan and elevation view drawings of assembled unit (s), and structural steel base. Indicate any field installed connection piping required on site by others. Provide manufacturer's literature on all equipment provided with the station. Indicate materials of construction, physical properties, controls, operational requirements, details and other data.

##### **1.5 OPERATION AND MAINTENANCE MANUALS**

Submit O & M Manuals for all components indicating recommended spares, start-up data and maintenance procedures. Submit a listing of suppliers who may provide repair parts.

##### **1.6 WARRANTY**

Provide a one-year manufacturer's warranty covering all materials and workmanship of all products supplied. Warranty shall commence from the date of station start-up. (i.e. when controls are turned to auto).

## **DIVISION II - EQUIPMENT**

### **SECTION 11307 - SPECIFICATION FOR FACTORY ASSEMBLED VACUUM STATIONS**

#### **PART 2 - PRODUCTS**

##### **2.1 VACUUM PUMPS**

- A. Vacuum pump shall be a Busch (RC0630.C4Z6.11XX) as modified for vacuum sewage collection system use (P14000). Pumps shall be rotary vane and shall have a nominal pumping speed of 1200 RPM and produce 455 ACFM. Four (4) pumps of this size to be supplied.
- B. The vacuum pump shall be driven by a 25 horsepower standard C-face, F2 assembly, TEFC NEMA inverter duty electric motor through a shaft coupling. No belt drives shall be used. At no time does motor horsepower exceed nameplate ratings. Pump shall have an end (ultimate) vacuum of 29.3" Hg. (15 Torr) minimum at sea level (29.92" Hg barometer). Pump shall be capable of continuous operation.
- C. The vacuum pump shall be air-cooled with absolutely no water requirements.
- D. Lubrication shall be provided by an integral, fully recirculating oil supply which is filtered by an automotive-type spin-on filter. Once through (non-recirculating) or partial recirculating oil lubrication systems shall not be permitted. Oil separation system shall be integral and shall consist of no less than four stages of internally mounted oil and smoke elimination from the exhaust gas stream. This includes bulk separation, mist elimination, smoke elimination and baffle.
- E. Pump shall have a built-in anti-suck-back valve mounted at the pump inlet.
- F. Entire pump, motor, and exhaust box shall be shipped as one factory assembled and tested unit mounted on vibration isolators and shall be mounted on the vacuum station skid as shown on the drawings.
- G. Each pump shall be fitted with a name plate indicating Type, Serial number and Air displacement.
- H. Each pump motor shall be fitted with a name plate indicating model, serial number, horsepower, voltages, amperages, speed, efficiency, insulation type, frame number, locked rotor current, and enclosure type.
- I. Each pump will be equipped with an internal crank case heater. The heater shall be properly sized to maintain uniform crank case temperatures without damage to the oil. These units are to be self

contained including an operating thermostat. Power for these heaters to be supplied by the main vacuum skid control panel.

- J. Each Vacuum pump shall include a moisture separator. It shall be adequately sized for the CFM air displacement of the pump. It shall have a clear housing and be provided with flanges, air inlet and drain valves.
- K. The vacuum system manufacturer shall provide a Sch 80 PVC manual condensate collection system to collect condensate from the vacuum pump moisture separator, exhaust piping when needed, and the vacuum header assembly when needed. The system operator will be required to drain this system once a day during routine inspections and maintenance.

## 2.2 COLLECTION STATION PIPING

- A. This item includes piping, valves, fittings, pipe supports, fixtures, drains and other work involved in providing a complete installation.
- B. Vacuum pumps skid piping shall include all piping within the vacuum pumps skid, connecting piping to vacuum pumps, vacuum header and exhaust header.
- C. Inlet vacuum lines shall be Schedule 80 PVC, 304 Stainless Steel, Galvanized, or Schedule 40 black iron . Vacuum Pump exhaust piping to be stainless steel, galvanized or black iron.
- D. One eighth inch (1/8") thick E.P.D.M. gaskets shall be used on all flanges.
- E. Piping shall be adequately supported to prevent sagging and vibration and to permit expansion, venting and drainage. Supports shall be situated to prevent the weight of piping and valves from bearing on the pumps.
- F. When these lines are inter-connected there shall be a check valve installed on each pump's exhaust.
- G. Check valves for incoming lines on the vacuum pumps shall be Henry pratt rubber flapper swing type, or approved equal.
- H. Butterfly valve for incoming lines on the vacuum pumps will be provided. Valve to be epoxy coated, ductile iron, semi-lug body with nylon coated 316 SS disc, suitable for continuous contact with domestic sewage.  
Acceptable manufacturers : Bray or equal.
- I. A manually operated condensation collection system will be provided as shown on the Station plans, the purpose of which is to prevent exhaust moisture and odors from escaping into the Station ambient air. All valves

for the condensation collection system shall be provided. The final 1" piping and supports shall be contractor furnished as shown on plans.

### 2.3 STRUCTURAL STEEL SKID

A. The entire vacuum pump assembly shall be rigidly mounted to a raised structural steel platform by means of bolting or welding.

B. All structural steel shall conform to ASTM A-36/A-36M with minimum tensile strength 58,000 PSI.

C. The platform shall be so designed to support the assembly with main support members adequately sized to bear loads applied by lifting the unit (s) at four (4) points on its perimeter. Cross members will be located to bear the loads applied by various components. All structural members to be joined by a minimum 1/4" fillet weld.

D. The entire top surface of the platform will be covered with steel deck plates. Where access to components is required, non-slip type safety floor plate are to be used. Lifting cleats will be attached at four (4) points along the platform perimeter to allow lifting by cable and spreader bars. Each cleat will be adequately sized to bear the load of the entire assembly. They will be fastened by bolts and are to be removed.

E. Painting: The entire platform will be prepared for painting by use of a phosphatizing process. Sandblasting shall not be required. One (1) primer coat of a Rust-oleum Product compatible with 9100 Series Epoxy will be applied immediately after phosphatizing at 3 mils D.F.T. minimum.

### 2.4 FACTORY TESTING

A. The assembled unit(s) will be vacuum tested to 24" Hg. for a period of not less than two (2) hours. Maximum leak rate to be one (1%) percent per hour. The assembly will be tested at as near field conditions as can be factory simulated. Vacuum pumps controls will be preset and tested.

B. All alarm functions will be normally open to close on alarm condition and will be pre-tested..

C. A factory test report with a chart indicating the vacuum test will be provided with the O & M Manual.

### 2.5 FINAL PAINTING

After all testing is complete, the entire assembly will be tooled, cleaned, pressure washed and/or solvent washed in accordance with SSPC-SPI, SP2 and SP3. Then coated with Rust-oleum Epoxy Paint #9186 (Navy Gray) to a minimum of 3 mils D.F.T. Final coating for all surfaces shall be 6 mils minimum.

## 2.6 SPARE PARTS

The following is a listing of recommended spares which shall be considered minimum. Any spare part supplied in addition shall be listed with submittals and O & M Manuals:

### A. Vacuum Pumps:

Four (4) complete set of filters  
Twenty (20) gallons of vacuum pump oil

SECTION 11308  
ELECTRICAL SPECIFICATION FOR EMERGENCY VACUUM TRAILER  
KEY LARGO, FL

**PART 1 - GENERAL**

The following specification is a general guideline for a trailer-mounted, prewired control panel and electrical components provided for a trailer-mounted vacuum pump skid with four (4) new vacuum pumps. The control panel and electrical components will also be used to control existing station equipment including level controls and two (2) or three (3) sewage pumps.

Provide (1) control panel to operate four (4) vacuum pumps and two (2) or three (3) sewage pumps for this phase of construction.

1.1 DESCRIPTION OF WORK

The extent of work under this section includes furnishing, pre-wiring and factory testing of a complete and self-contained control unit for monitoring of vacuum and fluid levels and cycling of vacuum pumps on an emergency vacuum trailer and sewage pumps in skid mounted vacuum stations. The electrical equipment includes, but is not limited to: a control panel, level controls, and a vacuum transmitter.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Interconnection of sections of the split skid design. Routing of conduit and wires, termination at the MCP terminal strip, and at the field junction box on the vacuum skid or tank skid. Interconnection includes motor leads, switch leads, and probe connections.

1.3 QUALITY ASSURANCE

Wiring and workmanship for the control components on the Vacuum Collection Skids will comply with the following regulations, standards, and publications:

N.E.C. - National Electric Code  
U.L. Underwriters Laboratories

All control components shall bear a U.L. Listing label in applicable categories. Some exceptions may be made where components become difficult to use, implement, or obtain in order to be listed. Control vendor shall use UL guidelines if installing a non-UL component to allow for entire assembly to still bear the UL label.

The control panel shall be inspected and listed as a UL 508 assembly.

1.4 QUALITY CONTROL

All control panel components shall be of the most current and proven design. Specifications and Drawings call attention to certain features but do not purport to cover all details entering into the design of the control system. The components provided by the manufacturer shall be compatible with the functions required and shall form a complete working system.



## **PART 1 – GENERAL**

### **1.5 MANUFACTURER'S EXPERIENCE**

The manufacturer of prefabricated control panel shall have a minimum of five (5) years of experience in the design, manufacture and start-up of vacuum stations, and have at least five (5) installations in service. Provide verification upon request.

### **1.6 SUBMITTALS - ELECTRICAL DRAWINGS**

Provide a submittal including complete electrical prints. These include but are not limited to panel layout and material list, power distribution, P & ID, and I/O layout.

### **1.7 OPERATION AND MAINTENANCE MANUALS**

*Submit O & M Manuals: Manuals to include description of control switches, system operation, and theory of operation, warranty information, the above drawings, and manufacturer's published literature on control components.*

Part numbers of components used on the drawings to be highlighted.

### **1.8 ON SITE START UP**

- A. Provide on-site start up services. Typically 1 working day per station for each of 7 vacuum stations.
  - 1. The vacuum system manufacturer shall provide a copy of its start-up report during the submittal review. It shall be reviewed and approved by the engineer. The start-up personnel shall follow the guidelines defined in the report.
  - 2. Provide in writing to the Owner/Engineer that the equipment has been properly installed and has passed the manufacturers start up requirements. (1) wk. after final start-up has occurred.
  - 3. Subsequent on-site visits for start-up related issues will require additional compensation.

### **1.9 FACTORY TRAINING**

- A. Provide training at its manufacturing facility on mechanical and electrical equipment provided.
  - 1. The Owner may send its operators to the vacuum systems manufacturing facility in the United States. The owner will pay for their expenses.
  - 2. The vacuum system manufactures training course shall be 5 days at no cost to the Owner.
  - 3. The vacuum system manufacture shall hold training sessions (1) one week per month.

**PART 1 – GENERAL**

4. The vacuum system manufacture shall provide a copy of the course outline during the submittal review. It shall be reviewed and approved by the engineer.

## **PART 2 – PRODUCTS**

### **GENERAL**

- A. Provide NEMA-4X enclosure panel with all PLC, Panelview screen, relays, starters, disconnects, instruments, switches, indicating lights, terminal boards, and wiring to perform the following functions. Panel to be free standing and sized to allow proper installation of the equipment.
1. Provide power distribution for 480V, 3Ph, 60Hz power from a generator.
  2. Provide control logic for operation of four (4) vacuum pumps in the automatic and manual modes.
  3. Provide control logic for operation of the two (2) or three (3) sewage pumps in the automatic and manual modes.
  4. Provide control logic to assure delay of lag (2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup>) Vacuum and/or lag (2<sup>nd</sup> or 3<sup>rd</sup>) Sewage pump operation on initial power turn up.
  5. Provide control logic for operation of a High-Level cutoff isolation valve.
  6. Provide local alarm, audible and visual, for low vacuum pressure, for high wastewater level in sewage collection tank, and for high level lockout conditions. Provide for capability to silence the audible alarm and test for Pilot light operation.
  7. Provide trending of Vacuum Tank pressure through Operator interface.
  8. Provide Phase Fail and Surge Protection.
  9. Provide alarm output signals.
  10. Provide logic to indicate if a pump fails to run when called.

### 2.1 **ENCLOSURE**

- A. Provide a NEMA 4X rated flange-mounted disconnect enclosure for the electrical controls. The vacuum system manufacturer shall size the enclosure to fit the electrical equipment for this project. The enclosure shall be mounted on the emergency vacuum trailer.
1. The enclosure shall be made from 12-gauge stainless steel.
  2. The body seams shall be continuously welded and ground smooth, the enclosure body shall include body stiffeners in larger enclosures for extra rigidity, the body flange trough shall include liquids and contaminants, a heavy-duty lifting eye shall be anchored into the top of the enclosure, and the center post shall be removable for easy panel installation.

## **PART 2 – PRODUCTS**

3. The doors on the enclosure shall include heavy gauge continuous hinges; they shall include heavy-duty 3-point latching mechanisms operated by patented padlocking handles on all doors. Each of the latching rods shall have rollers for easier door closing. The door shall include a high-impact thermoplastic pocket for data and have an oil-resistant gasket. The master door shall be the far-right side and include a defeater. The defeater must require a screwdriver to be used to allow the door to open. The master door shall include mechanical interlocks to keep the slave door from being opened first. The doors shall be able to close in any order. Each door shall include a padlocking handle.
4. A universal cutout shall be provided on the right flange for the disconnect operator.
5. The enclosure shall be provided with a 11 gauge back panel which mounts to the back of the enclosure on collar studs.
6. The enclosure shall be unpainted SS 304. Finish shall be Brushed #4.
7. The enclosure manufacture shall provide the operator adapters for the universal cutouts for the disconnect. The operator adapter shall interlock the master door with the disconnect operating mechanism.
8. Provide an activated door switch. The switch shall turn a light on when the enclosure door is opened.
9. The enclosure shall meet UL 508A standards.
10. Enclosure package shall be: Hoffman, or equal.
11. Provide a 20 watt, LED, 1200 Lumens, Kelvin Temp 4000K lighting package. Lithonia or equal
12. Provide an exhaust fan sized appropriately for the enclosure. Include an inlet grill as well. Hoffman, or equal.

### **2.2 VOLTAGE TEST STATION**

- A. Provide a safe way for the system operator to verify the presence or absence of voltage. Provides a connection for ethernet cable. This device shall be mounted on the outside the electrical enclosure.
- B. This device shall be non-flashing with a safe-test port, installed in a UL Type 4 housing with horizontal mount rated IP65. The housing shall include a 304 stainless steel latch and a UV rated polycarbonate cover. Voltage indicator shall be conveniently viewed from the enclosure. Operating range 4-600VAC, 50/60Hz/400Hz or 30-600VDC.

## **PART 2 – PRODUCTS**

### **2.3 DISCONNECTS**

- A. Provide main disconnect for incoming power with a 25 kIAC rating. Disconnect shall have adjustable breaking capacity to provide power to each station with varying sewage pump horsepower.
- B. Provide operating handle for disconnect switch mechanism providing indication and control of switch position with enclosure door open or closed, and capable of being locked in the OFF position with three (3) padlocks.
- C. One (1) power feed shall be provided to the enclosure and distributed to the pump disconnects via a distribution block.
- C. Provide separate disconnects for each Sewage Pump utilized. Disconnects are to have adjustable breaking capacity and sized to provide power to each station with varying sewage pump horsepower. Construct and mount disconnect switches in main NEMA Type 4X enclosure.

### **2.4 VACUUM PUMPS -- COMBINATION STARTERS**

- A. General - except as otherwise indicated, provide motor starters and auxiliary components, which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation. Where more than one type of equipment meets indicated requirements, selection is Installers' option.
- B. VACUUM PUMPS: **Full voltage non-reversing starters** - provide full voltage alternating current non-reversing starters. These are IEC rated integral (modular) self-protected units sized for indicated loads. They provide padlockable disconnect, short circuit protection, contactor and overload protection, all located inside the panel. Equip starters with electrical interlocks where indicated. Construct and mount starters in enclosure.

### **2.5 SEWAGE PUMPS --VARIABLE FREQUENCY DRIVES**

- A. **Variable frequency drives are to be provided for the vacuum pumps and the sewage pumps.** VFD's should be a microprocessor-based unit with menu-oriented keypad programming of setup parameters.
- B. Manufacturer's specifications must be submitted for approval as "state of the art" in motor control. The most important of these features will be:
  - Adjustable frequency range translated to 900-3600 rpm.
  - 4-20ma (or 0-10vdc) input capability
  - Rated at 150% output for 60 sec.
  - Remote start/stop.
  - Programmable accell/decel times.
  - Wide range of internal fault protection.
  - Ethernet Connectivity

**PART 2 – PRODUCTS**

- C. The Sewage pump VFD's shall be controlled by the Flow meter and the Pressure Transmitter on the force main. Logic for control will reside in PLC.
- D. Allen-Bradley, Model 525 or 755 or equal.

2.6 **PROGRAMMABLE LOGIC CONTROLLER (PLC) BASED SYSTEM**

- A. Conceptual system control scheme is as follows:
  - 1. PLC-CPU shall be Allen Bradley Compact Logix or ControlLogix, n equal.
  - 2. See Paragraphs, PLC Hardware, PLC Software and Local Control Panels (LCP) for additional requirements.
- B. PLC Hardware
  - 1. Provide programmable logic controllers (PLC) and input/output modules in sufficient quantities specified herein and as required to meet functional requirements of the Specification. PLC hardware and power supplies shall be provided in completely wired local control panels as specified herein and as shown. Manufacturer shall include cables, mounting hardware, racks and connectors as required for fully operational PLC systems.
  - 2. PLC system hardware shall be as manufactured by Allen Bradley or equal.
  - 3. I/O modules shall be removable without disturbing field wiring.
  - 4. Provide minimum of 20% spare slot capacity in the card rack for future expansion.
  - 5. For PLC digital output, provide 115-volt output cards. Install isolation relays for all outputs.
  - 6. PLC shall have Ethernet Communication.
- C. PLC-CPU
  - 1. Each process module PLC-CPU shall be Allen Bradley Compact Logix or equal.
  - 2. 25% spare memory shall be available after PLC has been programmed for full operation.
- D. Digital Input (DI) Modules
  - 1. Provide Allen Bradley or equal 120V DI modules as required.

## **PART 2 – PRODUCTS**

### E. Digital Output (DO) Modules

1. Provide Allen Bradley or equal 120V DO modules as required.

## 2.7 OPERATOR INTERFACE

- A. An operator interface shall be provided that gives the operator controlling and monitoring options. A 6-inch display screen shall be included. Graphics are to be displayed in an 18-bit color. Operator input is to be available through touch screen. Included shall be a RS232 and USB port and an Ethernet port. Operator Interface shall be accessible through the panel face without opening the control enclosure door. Allen-Bradley PanelView Plus 7 or equal.

## 2.8 TRANSFORMER

- A. Provide a transformer to take the line power and provide control power. Step it down from 480V to 120V. Sized to carry the load as needed.
- B. Non-ventilated automation transformer type, single phase, encapsulated. Group 1, 240 x 480 Primary, 120/240 Secondary, 60hz.
- C. Rated for hazardous locations, UL listed/NEMA type 4X enclosure.
- D. Provide touch proof cover for terminals.
- E. Complies with latest addition of the National Electrical Code
- F. Sola or equal.

## 2.9 24V POWER SUPPLY MODULE

- A. Provide a 120VAC input – 24VDC output power supply module for the PLC and the vacuum transmitter. Level transmitter, Force Main Pressure, HMI shall have a separate 24VDC power supply.
1. The module shall have auto select input voltage, 24V DC, and have an adjustable voltage feature. The module shall have an indefinite short circuit, overvoltage and overtemperature protection and operate @ -10 C to 60 C without derating. The module shall withstand high inrush loads without shutdown or foldback. The module shall be narrow in width and enclosed with a rugged metal case. The mounting terminations shall be large, rugged, accessible and have multiple connections. The module shall be DIN rail mountable type.
- B. Power supply module shall be by Allen Bradley 1606XLP60EQ, or equal.





## **PART 2 – PRODUCTS**

### **2.10 REMOTE ACCESSSS ROUTER**

- A. Provide wireless access to PLC. The device shall include an integrated WiFi, firewall friendly outbound connection, Ethernet configurable, field interface with USB – female connector, VPN Security. EWON or equivalent.

### **2.11 ETHERNET SWITCH**

- A. Provide an Unmanaged Industrial Ethernet Switch to allow communication to VFDs and SCADA equipment.
- B. The switch shall have an IP30 rated housing. The switch shall have (8) 10/100Base-TX, RJ-45 ports. It shall meet IEEE 802.3, 802.3u, 802.3x, Din Rail mounted, 12V – 48 VDC power input
- C. Ethernet switch shall be: ADVANTECH, EKI-2528 or equal.

### **2.12 SURGE SUPPRESSION – INCOMING POWER**

- A. Surge suppression shall be provided on main power (480 v) and control power (120 v). Control power surge suppression shall include compliance with UL 1449 Fourth Edition Listed. SCCR rating—200kA.
- B. Control Power – ASCO Power Technologies 400 series, Model 420 SPDee Series or equal.
- C. Main power surge suppression shall include protection against lightning or power surges in the main power supply, typically 460-volt, 3 phase.
- D. Main Power – AB4983-DS, or equal.

### **2.13 SURGE SUPPRESSION – CONTROL POWER**

- A. Provide surge protection on for the control power after the step down transformer.
  - 1. 50kA 8x20us Per Mode, I nominal 20kA, Large-Block, 34mm square, 50kA MOVs, Individually fused & thermally Protected MOVs, Repetitive Impulse: 5000 – 3kA-8x20us; 10kA-8x20us, Response time less than 1 nanosecond, solid state Bi-directional Operation, Pre-wired 3 ft. of #10 AWG conductor, Typical Type 2 Connection: #10AWG to 30A breaker.
  - 2. Surge suppression device shall be UL 1449 3<sup>rd</sup> Edition listed.
  - 3. Surge Suppression shall be: ASCO, 400 Series Model 420 (SPDee Series)

## **PART 2 – PRODUCTS**

### **2.14 PHASE FAIL**

- A. Phase Loss, Under Voltage shall be monitored. Operating voltage shall be 380-500 Adj. with automatic reset.
- B. Macromatic PMD series, Model PMDU, or equal.

### **2.15 ALARM HORN**

- A. An alarm horn shall be provided. 100dB sound level. 22MM
- B. Allen Bradley 855P or equal

### **2.16 PILOT DEVICES**

- A. Selector switches shall be heavy duty, oil tight/watertight, 22mm units. Switches shall have double-break silver contacts. Devices shall be installed using gaskets to maintain their NEMA 4X rating.
- B. Push buttons shall be heavy duty, oil tight/watertight, 22mm units. Contacts should be double break silver.
- C. Pilot lights and illuminated selector switches should be 22mm, heavy duty, transformer type. Where contacts are used they should be of double break silver type style.
- D. Allen-Bradly, or equal

### **2.17 RELAYS**

- A. Relays shall be heavy duty, general purpose type with 10-amp contacts. Relays shall have octal type terminals which plug-in to a socket.
- B. Relays shall be Idec RR relays, or equal.

### **2.18 ELAPSED TIME METERS**

- A. Display ETM's on operator interface screen.

### **2.19 MINATURE CIRBUIT BREAKERS**

- A. Provide supplementary protectors for all devices that require them. Transformer (primary and secondary sides) 24V power supply, input and output modules, ventilation fan, isolation valve, power switch, field potential distributor.
- B. Do this in leu of fuses. UL/CSA listed
- C. Allen Bradley or equal

## **PART 2 – PRODUCTS**

### **2.20 TERMINAL BLOCKS**

- A. Terminal blocks shall be provided in the control panel for field wiring connections. All terminal blocks should be labeled in accordance with the prints, bearing the wire number connected. IEC style, 600V terminals are required.

### **2.21 WIRING**

- A. All wiring shall be copper. Control wire shall be 16-gauge, 600-volt, type MTW, with the exception of low-level DC wires. Power wiring shall be 600-volt, type MTW, THHN, or suitable grade.
- B. All wire on the skids which extends outside the enclosure shall be protected by rigid galvanized conduit.

### **2.22 POWER RECEPTACLES AND PLUGS**

- A. Supply female receptacle and male plug for the incoming 480V AC power and for the outgoing 480V power supply to the sewage pumps. Provide plug handle and associated connections required to attach power cable. Cable supplied by others. Rated for outdoor use.
- B. Meltric or equal.

### **2.23 VACUUM CHART RECORDER**

- A. Supply 1 hr., 4 hr., 12 hr. and 24 hr. trending screens on the operator interface screen.
- B. Historically collect vacuum levels within the collection tank.

### **2.24 ALARM SYSTEM**

- A. Provide alarm output signals. The vacuum system suppliers' alarms shall be:
  - 1. Low vacuum alarm: via pressure transmitter and PLC time running program.
  - 2. Sewage high level condition: via level controls.
  - 3. Sewage high level lock out condition: via level controls.

### **2.25 FACTORY TESTING**

- A. The vacuum pump assembly will be vacuum tested to 24" Hg. for a period of not less than two (2) hours. Maximum leak rate to be one (1%) percent per hour. The station will be test run at as near field conditions as can be factory simulated. Vacuum pumps controls will be preset and tested. Sewage pump level control inputs will be preset and tested.

**PART 2 – PRODUCTS**

- B. All alarm functions will be normally open to close on alarm condition and will be pre-tested.

A factory test report with a chart indicating the vacuum test will be provided with the O & M Manual.

2.26 **SPARE PARTS**

- A. The following is a listing of recommended spares which shall be considered minimum. Any spare part supplied in addition shall be listed with submittals and O & M Manuals:

- 1. One - 3 position non illuminated selector switch.

## **PART 3 – FUNCTIONS**

Control configurations, System Operations and Theory of Operations are shown for a four (4) vacuum pump and two (2) or three (3) sewage pump control system.

### **2.30 CONTROL SWITCHES**

#### **A. Control Power:**

1. DSC0 - DISCONNECT - Provides 480V distribution power.
2. C1-4 and DSC1-5 - CONTROL KNOBS - Provides 480V lockable disconnect for vacuum pump motors, and sewage pump motor VFDs and contactors.
3. SS1 - CONTROL POWER - Provides 120V control power to the PLC field potential distributor, the level controls, 24 VDC power supply, and PLC I/O.
4. PL-SS1 - POWER ON - Indicates that control power has been applied to the PLC field potential distributor, the level controls, 24 VDC power supply, and PLC I/O.

#### **B. Vacuum Pump Controls:**

1. SS2 - VACUUM PUMP DUTY SELECT - determines the mode of operation for all vacuum pumps.
  - a. LEAD - The vacuum pump selected by the Vacuum Pump Lead Select Switch, SS3, will remain the lead pump.
  - b. ALTERNATE - Vacuum Pumps #1-4 will alternate as the Duty Pump whenever the system requires more vacuum.
2. SS3 - VACUUM PUMP LEAD SELECT - determines which vacuum pump will be the lead pump and which pumps will be the standby pumps when LEAD is selected by SS2.
  - a. 1 - Vacuum Pump #1 will be the Lead Pump each time the system calls for more vacuum. Vacuum Pump #2 will be the Standby Pump. Vacuum Pump #3 will be the second Standby Pump. Vacuum Pump #4 will be the third Standby Pump.
  - b. 2 - Vacuum Pump #2 will be the Lead Pump each time the system calls for more vacuum. Vacuum Pump #3 will be the Standby Pump. Vacuum Pump #4 will be the second Standby Pump. Vacuum Pump #1 will be the third Standby Pump.
  - c. 3 - Vacuum Pump #3 will be the Lead Pump each time the system calls for more vacuum. Vacuum Pump #4 will be the Standby Pump. Vacuum Pump #1 will be the second Standby Pump. Vacuum Pump #2 will be the third Standby Pump.

**PART 3 – FUNCTIONS**

- d. 4 - Vacuum Pump #4 will be the Lead Pump each time the system calls for more vacuum. Vacuum Pump #1 will be the Standby Pump. Vacuum Pump #2 will be the second Standby Pump. Vacuum Pump #3 will be the third Standby Pump.
- 3. SS4 - VACUUM PUMP #1 - determines the operation of Vacuum Pump #1.
  - a. HAND - Manual - power is applied directly to Vacuum Pump #1.
  - b. OFF - Off - power is removed from Vacuum Pump #1.
  - c. AUTO - Automatic - Vacuum Pump #1 is controlled by the circuitry as selected by the Vacuum Pump Duty Switch, SS2, and the Vacuum Pump Lead Switch, SS3.
- 4. SS4\_PL - indicates that power has been applied to Vacuum Pump #1.
- 5. SS5 - VACUUM PUMP #2 - determines the operation of Vacuum Pump #2.
  - a. HAND - Manual - power is applied directly to Vacuum Pump #2.
  - b. OFF - Off - power is removed from Vacuum Pump #2.
  - c. AUTO - Automatic - Vacuum Pump #2 is controlled by the circuitry as selected by the Vacuum Pump Duty Switch, SS2, and the Vacuum Pump Lead Switch, SS3.
- 6. SS5\_PL - indicates that power has been applied to Vacuum Pump #2.
- 7. SS6 - VACUUM PUMP #3 - determines the operation of Vacuum Pump #3.
  - a. HAND - Manual - power is applied directly to Vacuum Pump #3.
  - b. OFF - Off - power is removed from Vacuum Pump #3.
  - c. AUTO - Automatic - Vacuum Pump #3 is controlled by the circuitry as selected by the Vacuum Pump Duty Switch, SS2, and the Vacuum Pump Lead Switch, SS3.
- 8. SS6\_PL - indicates that power has been applied to Vacuum Pump #2.
- 9. SS7 - VACUUM PUMP #4 - determines the operation of Vacuum Pump #4.
  - a. HAND - Manual - power is applied directly to Vacuum Pump #4.
  - b. OFF - Off - power is removed from Vacuum Pump #4.

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- c. AUTO - Automatic - Vacuum Pump #4 is controlled by the circuitry as selected by the Vacuum Pump Duty Switch, SS2, and the Vacuum Pump Lead Switch, SS3.
  - 10. SS7\_PL - indicates that power has been applied to Vacuum Pump #4.
  - 11. ETM1 - indicates the total elapsed time that Vacuum Pump #1 has been on. Integrated into Operator Interface screen.
  - 12. ETM2 - indicates the total elapsed time that Vacuum Pump #2 has been on. Integrated into Operator Interface screen.
  - 13. ETM3 - indicates the total elapsed time that Vacuum Pump #3 has been on. Integrated into Operator Interface screen.
  - 14. ETM4 - indicates the total elapsed time that Vacuum Pump #4 has been on. Integrated into Operator Interface screen.
  - 15. ETM5 - indicates the total elapsed time that all Vacuum Pumps have operated simultaneously. Integrated into Operator Interface screen.
- C. Sewage Pump Controls:
- 1. SS8 - SEWAGE PUMP SELECT - Determines the mode of operation for both sewage pumps.
    - a. Duty "1" - Sewage pump #1 will be the Duty Pump each time the system requests the sewage pumps to operate. Sewage Pump #2 will be the Standby Pump.
    - b. Duty "2" - Sewage pump #2 will be the Duty Pump whenever the system requests the sewage pumps to operate. Sewage Pump #1 will be the Standby Pump.
    - c. Duty "3" - Sewage pump #2 will be the Duty Pump whenever the system requests the sewage pumps to operate. Sewage Pump #1 will be the Standby Pump.
    - d. Duty "Alt" - Sewage Pump #1 and Sewage Pump #2 will alternate as being the Duty Pump whenever the system requests to be pumped.
  - 2. SS9 - SEWAGE PUMP #1 - determines the operation of Sewage Pump #1.
    - a. HAND-Manual - Power is applied directly to Sewage Pump #1.
    - b. OFF-Off - Power is removed from Sewage Pump #1.

**PART 3 – FUNCTIONS**

- c. AUTO -Automatic - Sewage Pump #1 is controlled by the circuitry as selected by the Sewage Pump Select Switch, SS8.
  - 3. PL-SS9 - Indicates that power has been applied to Sewage Pump #1.
  - 4. SS10 - SEWAGE PUMP #2 - Determines the operation of Sewage Pump #2.
    - a. HAND-Manual - Power is applied directly to Sewage Pump #2.
    - b. OFF-Off - Power is removed from Sewage Pump #2.
    - c. AUTO-Automatic - Sewage Pump #2 is controlled by the circuitry as selected by the Sewage Pump Select Switch, SS8.
  - 5. PL-SS10 - Indicates that power has been applied to Sewage Pump #2.
  - 6. SS11 - SEWAGE PUMP #3 - Determines the operation of Sewage Pump #3.
    - a. HAND-Manual - Power is applied directly to Sewage Pump #3.
    - b. OFF-Off - Power is removed from Sewage Pump #3.
    - c. AUTO-Automatic - Sewage Pump #3 is controlled by the circuitry as selected by the Sewage Pump Select Switch, SS8.
  - 7. PL-SS11 - Indicates that power has been applied to Sewage Pump #3.
  - 8. ETM6 - Indicates the total elapsed time that Sewage Pump #1 has been on.
  - 9. ETM7 - Indicates the total elapsed time that Sewage Pump #2 has been on.
  - 10. ETM8 - Indicates the total elapsed time that Sewage Pump #3 has been on.
  - 11. ETM9 - Indicates the total elapsed time that Sewage Pump #1 and #2 and #3 have been on simultaneously.
- D. Alarms
  - 1. PL1 - LOW VACUUM ALARM - indicates that system vacuum has dropped below 13 inches of mercury, or that vacuum pump operation has been requested for "X" amount of time.
  - 2. PL2 - SEWAGE HIGH LEVEL ALARM - indicates that the sewage in the Main Holding Tank has reached a high-level condition.



**PART 3 – FUNCTIONS**

3. PL3 - SEWAGE AND VACUUM PUMP LOCKOUT ALARM - indicates that the sewage level in the Main Holding Tank is high enough that there is risk of the sewage occupying areas not designed for its presence and damaging pumps.
4. PL4 - VACUUM PUMP #1 TEMPERATURE FAIL ALARM - Indicates that the temperature switch in Vacuum Pump #1 has been tripped. The pump will become inoperable and will remain inoperable until the oil chamber temperature is reduced.
5. PL5 - VACUUM PUMP #2 TEMPERATURE FAIL ALARM - Indicates that the temperature switch in Vacuum Pump #2 has been tripped. The pump will become inoperable and will remain inoperable until the oil chamber temperature is reduced.
6. PL6 - VACUUM PUMP #3 TEMPERATURE FAIL ALARM - Indicates that the temperature switch in Vacuum Pump #3 has been tripped. The pump will become inoperable and will remain inoperable until the oil chamber temperature is reduced.
7. PL7 - VACUUM PUMP #4 TEMPERATURE FAIL ALARM - Indicates that the temperature switch in Vacuum Pump #4 has been tripped. The pump will become inoperable and will remain inoperable until the oil chamber temperature is reduced.
8. PL8 - SEWAGE PUMP #1 MOTOR FAIL - The presence of a motor failure for Sewage Pump #1 will be indicated by the Sewage Pump #1 Motor Fail Pilot Light, PL8, and the Alarm Horn. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button. When the alarm is acknowledged, the Alarm Horn will go off, but PL8 will remain on until the motor failure condition is corrected.
9. PL9 - SEWAGE PUMP #2 MOTOR FAIL - The presence of a motor failure for Sewage Pump #2 will be indicated by the Sewage Pump #2 Motor Fail Pilot Light, PL9, and the Alarm Horn. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button. When the alarm is acknowledged, the Alarm Horn will go off, but PL9 will remain on until the motor failure condition is corrected.
10. PL10 - SEWAGE PUMP #3 MOTOR FAIL - The presence of a motor failure for Sewage Pump #3 will be indicated by the Sewage Pump #3 Motor Fail Pilot Light, PL10, and the Alarm Horn. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button. When the alarm is acknowledged, the Alarm Horn will go off, but PL10 will remain on until the motor failure condition is corrected.
11. ALARM HORN - indicates that a Low Vacuum Alarm, a High-Level Alarm, or a Sewage and Vacuum Pump Lockout Alarm condition is present.

**PART 3 – FUNCTIONS**

12. PB1 - ALARM ACKNOWLEDGE - silences the Alarm Horn when a Low Vacuum Alarm, a High-Level Alarm, or a Sewage and Vacuum Pump Lockout Alarm is present.
13. PB2 - ALARM TEST - Turns on all Alarm Lights and activates the Alarm Horn to assure proper working condition.
14. SS12 - ALARM HORN ON/OFF - Enables/disables the Alarm Horn.
15. SS13 - ISOLATION VALVE MODE AUTO/CLOSE - Automatically closes the isolation valve during High Level Lockout Alarm. Allows manual close.

## **PART 3 – FUNCTIONS**

### **2.31 SYSTEM OPERATION**

#### **A. Turning the System On**

NOTE: Start with all pump mode switches, SS4-7, SS9-11, in the "Off" position.

1. Place main disconnect, DSC0, in the "On" position.
2. Place the Control Knobs of load switches, C1-4 and DSC1-5, in the "On" position.
3. Place the Control Power On Switch, SS1, to the "On" position. Note the presence of Control Power On Light, PL-SS1.

#### **B. Turning the Vacuum Pump Controls On**

1. Place the Vacuum Pump Duty Select Switch, SS2, into the desired mode of operation.
2. Place the Vacuum Pump Lead Select Switch, SS3, into the desired mode of operation.
3. Place the Vacuum Pump #1 Switch, SS4, into the desired position.
4. Place the Vacuum Pump #2 Switch, SS5, into the desired position.
5. Place the Vacuum Pump #3 Switch, SS6, into the desired position.
6. Place the Vacuum Pump #4 Switch, SS7, into the desired position.

#### **C. Turning the Sewage Pump Controls On**

1. Place the Sewage Pump Select Switch, SS8, into the desired mode of operation.
2. Place the Sewage Pump #1 Switch, SS9, into the desired position.
3. Place the Sewage Pump #2 Switch, SS10, into the desired position.
4. Place the Sewage Pump #3 Switch, SS11, into the desired position.

#### **D. Enabling the Alarm Horn**

1. Place the Alarm Horn Switch, SS12, into the desired mode of operation.

#### **E. Acknowledging Alarms**

1. **LOW VACUUM ALARM** - The presence of low vacuum will be indicated by the Low Vacuum Pilot Light, PL1, and the Alarm Horn. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button. When

**PART 3 – FUNCTIONS**

the alarm is acknowledged, the Alarm Horn will go off, but PL1 will remain on until the low vacuum condition is corrected.

2. SEWAGE HIGH LEVEL ALARM - The presence of a sewage high level will be indicated by the Sewage High Level Pilot Light, PL2, and the Alarm Horn. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button. When the alarm is acknowledged, the Alarm Horn will go off, but PL2 will remain on until the high sewage level condition is corrected.
3. SEWAGE HIGH LEVEL LOCKOUT ALARM - The presence of a sewage high level lockout will be indicated by the Sewage High Level Lockout Pilot Light, PL3, and the Alarm Horn. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button. When the alarm is acknowledged, the Alarm Horn will go off, but PL3 will remain on until the high sewage level lockout condition is corrected.
4. VACUUM PUMPS #1-4 TEMPERATURE FAIL ALARMS - The presence of a vacuum pump temperature fail alarm for Vacuum Pumps #1-4 will be indicated by Vacuum Pump Temperature Fail Pilot Lights, PL4-7, respectively. The Alarm Horn will also sound. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button, PB1. When the alarm is acknowledged, the Alarm Horn will go off, but the associated pilot light will remain on until the over temperature condition is corrected.
5. SEWAGE PUMP #1-3 MOTOR FAIL - The presence of a motor failure for Sewage Pump #1-3 will be indicated by the Sewage Pump #1-3 Motor Fail Pilot Light, PL8-10, respectively and the Alarm Horn. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button. When the alarm is acknowledged, the Alarm Horn will go off, but the associated pilot light will remain on until the motor failure condition is corrected.

F. TESTING ALARMS

1. Push the Alarm Test Push-button, PB2. The Alarm Horn will sound.

## **PART 3 – FUNCTIONS**

### 2.32 THEORY OF OPERATION

#### A. Control Power:

The Disconnect Switch, DSC0, applies 480V power to the Vacuum Pump motor starters, C1-4, and Sewage Pump Disconnects, DSC1-5, and to the Control Transformer, TRN1. TRN1 steps down the 480V to 120V for control power. The secondary side of the transformer protected by CB3. The load side of CB3 feeds the Control Power On Switch, SS1.

When SS1 is switched on, the PLC Field Potential Distributor (FPD), the Level Control Relay (LC1), the 24VDC Power Supply, and the PLC I/O are powered. Each of the I/O modules is protected by a fused source. Presence of control power to the I/O is indicated by the Power On Pilot Light, PL-SS1.

The Programmable Controller (PLC), the HMI, EWON Remote Access Module (WIFI), Ethernet Switch (HUB), Pressure Transmitter (PT1), and Level Transmitter (LT1) are powered through the 24VDC Power Supply and protected by CB8.

#### B. Vacuum Pump Controls - Automatic Operation:

In automatic operation, the vacuum pumps are controlled by the Vacuum Level Pressure Transducer, PT1. Vacuum is requested and the duty vacuum pump starts when PT1 registers 16 inches of mercury. When PT1 registers 20 inches of mercury all vacuum pumps are shut off.

When the Duty switch in the "ALT" position, the lead vacuum pump is determined by the Vacuum Pump Alternator, a four position bit shift register. One high bit is constantly rotating through the register, shifting as the vacuum request is satisfied. Its position dictates which pump has priority to lead. If the bit advances past the #4 position, it is reloaded into the #1 position, hence the constant rotation of one bit.

The Sequencing shift register loads a bit in the priority position and shifts the bit through the register as triggered by the Standby Pump Timer. The priority bit is constantly held high so the Sequencing register fills as the timer, explained below, expires. If a bit is shifted off the end of the register it is reloaded in the #1 position. When the vacuum request is satisfied the register is cleared for the next cycle.

In automatic operation, the lag vacuum pump is controlled by Standby Vacuum Pump Timer. TMR2 starts when PT1 registers below 16 inches of mercury. At the end of "X" minutes of delay as determined by the setting on TMR2, power is applied to the second vacuum pump in the active Vacuum Sequence.

In automatic operation, the second lag vacuum pump is controlled by Standby Vacuum Pump Timer. TMR3 starts when PT1 registers below 16 inches of mercury. At the end of "X" minutes of delay as determined by the setting on

**PART 3 – FUNCTIONS**

TMR3, power is applied to the third vacuum pump in the active Vacuum Sequence.

In automatic operation, the third lag vacuum pump is controlled by Standby Vacuum Pump Timer. TMR4 starts when PT1 registers below 16 inches of mercury. At the end of "X" minutes of delay as determined by the setting on TMR4, power is applied to the fourth vacuum pump in the active Vacuum Sequence.

With the duty register in Positions 1-4 the combination of shift registers and timers allows for the following operational sequences:

Sequence #1	1, 2, 3, 4
#2	2, 3, 4, 1
#3	3, 4, 1, 2
#4	4, 1, 2, 3

With the Duty Switch in the "ALT" Position the Sequence # is advanced by one each time the vacuum cycle completes.

When power is applied to the Vacuum Pump #1 motor starter, an auxiliary bit applies power to the Vacuum Pump #1 Run Indicator pilot light and Elapsed Time Meter, ETM1. The same action occurs when power is applied to Vacuum Pump #2-4, Vacuum Pump #2-4 Run Indicator pilot light and ETM #2-4. When Vacuum Pumps #1-4 are on simultaneously, associated auxiliary bits apply power to ETM5 which records the total elapsed time that all vacuum pumps are on simultaneously.

All vacuum pumps are disabled from operation with the presence of a Sewage and Vacuum Pump High Level Lockout Alarm.

C. Vacuum Pump - "Off":

In the "Off" position, operation of that associated vacuum pump is disabled.

D. Vacuum Pump - "Hand":

In the "Hand" position, power is applied directly to the associated vacuum pump. However, the presence of a Sewage and Vacuum Pump Lockout Alarm or the engagement of the Emergency Stop will disable the vacuum pump operation.

E. Sewage Pump Controls - "Automatic" Operation:

The level of sewage in the collection tank is monitored by Level Transmitter, LT1, and resolved in the PLC. In "Automatic" operation, the sewage pumps are controlled by a bit labeled LP1 and the mode of operation as selected by the Sewage Pump Select Switch, SS8. The LP1 bit becomes active when the level in the collection tank reaches the Lead Pump Level.

**PART 3 – FUNCTIONS**

When the Sewage Pump Select Switch, SS8, is in the Duty "1" position, power is applied directly to Sewage Pump #1. If Sewage Pump #1 cannot handle the incoming flow, the level of sewage will continue to rise until it reaches the Standby Pump level. Power will then be applied to Sewage Pump #2. The Duty Pump and, if required, the Standby Pump will remain on until the level of sewage in the Main Holding Tank drops below the Pump Off level. For Station E, Sewage Pump #3 will run if Sewage Pumps #1 and #2 cannot handle the incoming flow and the level of sewage rises to the Second Standby Pump level.

With the Sewage Pump Select Switch, SS8, in the Duty "2" position, Sewage Pump #2 becomes the Duty Pump and will be energized when the level of sewage reaches the Duty Pump On level. Sewage Pump #3 will become the Standby Pump and will be energized if the sewage level in the Main Holding Tank continues to rise and reaches the Standby Pump level. The Duty Pump and, if required, the Standby Pump will remain on until the sewage level in the Main Holding Tank drops below the Pump Off level. For Station E, Sewage Pump #1 will run if Sewage Pumps #2 and #3 cannot handle the incoming flow and the level of sewage rises to the Second Standby Pump level.

For Station E, with the Sewage Pump Select Switch, SS8, in the Duty "3" position, Sewage Pump #3 becomes the Duty Pump and will be energized when the level of sewage reaches the Duty Pump On level. Sewage Pump #1 will become the Standby Pump and will be energized if the sewage level in the Main Holding Tank continues to rise and reaches the Standby Pump level. The Duty Pump and, if required, the Standby Pump will remain on until the sewage level in the Main Holding Tank drops below the Pump Off level. Sewage Pump #2 will run if Sewage Pumps #3 and #1 cannot handle the incoming flow and the level of sewage rises to the Second Standby Pump level.

With Sewage Pump Select Switch, SS8, in the "Alternate" position, power is applied to the Sewage Pump Alternator logic. This software alternator determines which sewage pump will be the Duty Pump and the Standby Pump. The end result is the switching of Duty Pump duty between Sewage Pump #1 and Sewage Pump #2 (and Sewage Pump #3 for Station E).

When power is applied to Sewage Pump #1 variable frequency drive, VFD1, an auxiliary switch applies power to the Sewage Pump #1 Run Indicator and to Elapsed Time Meter, ETM6. The same method of operation applies to Sewage Pump #2 and #3 Run Indicators and Elapsed Time Meters, ETM6-7. When Sewage Pump #1 and Sewage Pump #2 are on simultaneously (or Sewage Pumps #1, #2, and #3 for Station E), auxiliary bits apply power to ETM8, which records the total elapsed time that all sewage pumps are on together.

All sewage pumps are disabled from operation in the "Automatic" mode via LT1 or LC1 and the PLC bit labeled HLL Relay, that trigger the presence of a Sewage High Level Lockout Alarm. Additionally, pumps are not allowed to run in the presence of a Phase Failure.

### **PART 3 – FUNCTIONS**

A Sewage Pump moisture or temperature fail will also latch out its respective pump until the pump is inspected. Once it has determined that it is okay for the pump to run again, push the Alarm Acknowledge button, PB1, to reset the latch.

F. Sewage Pump - "Off":

In the "Off" position, operation of that associated sewage pump is disabled.

G. Sewage Pump - "Hand Operation":

In the "Hand" position, power is applied directly to the associated sewage pump.

H. Alarms - Low Vacuum:

The Low Vacuum Alarm bit, VS2, closes at 13 inches of mercury or the Vacuum Standby Pump Timer, TMR7, times out indicating a low vacuum condition. The activation of VS2 or TMR7 energizes the Low Vacuum Alarm bit.

The energizing of the Low Vacuum Alarm bit applies power to the Alarm Horn. When the Alarm Horn is acknowledged by pressing the Alarm Acknowledge Pushbutton, PB1, power is applied to the Low Vacuum Latch bit, which then latches in and holds the Alarm Horn off until the Low Vacuum Alarm condition is corrected.

I. Alarm - Sewage High Level:

When the sewage level in the Main Holding Tank reaches the High-Level setting, power is applied to the Sewage High Level Alarm bit.

The energizing of the Sewage High Level Alarm bit applies power to the Alarm Horn. When the Alarm Horn is acknowledged by pressing the Alarm Acknowledge Pushbutton, PB1, power is applied to the Sewage High Level Latch bit, which then latches in and holds the Alarm Horn off until the Sewage High Level condition is corrected.

J. Alarms - Sewage and Vacuum Pump Lockout (High Level Lockout):

When the sewage level in the Main Holding Tank reaches the High-Level Lockout setting, power is applied to the High-Level Lockout Delay On Timer, TMR8. After "X" seconds of delay, as determined by the setting on TMR8, power is applied to the High-Level Lockout Control bit. When it is energized, Vacuum Pumps #1 and #2 are disabled in both "Auto", "Hand", and "Bypass" operation and Sewage Pumps #1 and #2 are disabled in "Auto" operation only.

The energizing of the High-Level Lockout Control bit applies power to the Alarm Horn. When the Alarm Horn is acknowledged by pressing the Alarm Acknowledge Pushbutton, PB1, power is applied to the Sewage High Level Lockout Latch bit, which then latches in and holds the Alarm Horn off until the Sewage High Level Lockout condition is corrected.



**PART 3 – FUNCTIONS**

K. Alarms - Vacuum Pumps #1-4 Temperature Fail:

When the oil chamber of a particular vacuum pump overheats, the temperature switch mounted to that particular vacuum pump disengages. When the signal from the temperature switch is discontinued, operation of that particular vacuum pump is disabled and the Temperature Fail bit for that particular vacuum pump is energized.

The energizing of the Temperature Fail bit for a particular vacuum pump applies power to the Alarm Horn and to the respective Vacuum Pump Temperature Fail Pilot Light, PL4-7. When the Alarm Horn is acknowledged by pressing the Alarm Acknowledge Pushbutton, PB1, power is applied to the Temperature Fail Latch bit for that particular vacuum pump. This latch bit then latches in and holds the Alarm Horn off. The particular Temperature Fail Alarm Pilot Light will remain on and the particular vacuum pump will remain disabled until the Temperature Fail condition is corrected.

L. Alarms – Sewage Pump #1 or #2 Fail:

In the event a temperature switch, TS6 or 7, opens due to an overheat condition, that Sewage Pump will be latched out by its “Fail” bit and the Sewage Pump “FAIL” will indicate on the HMI.

The pump must be inspected for cause of the failure. Once corrected, the Sewage Pump fail latch may be reset by pressing the Alarm Acknowledge button, PB1.

END OF SECTION

## DIVISION II - EQUIPMENT

### SECTION 11307 - SPECIFICATION FOR FACTORY ASSEMBLED VACUUM PUMP SKID

#### PART 1 - GENERAL

The following specification is a guideline for pre-fabricated Vacuum Collection Equipment. It is organized by major components with sizing indicated. Following the mechanical equipment specification is a detailed electrical specification.

##### 1.1 DESCRIPTION OF WORK

The extent of work under this section includes furnishing, pre-fabrication and factory testing of a complete, four unit vacuum pump assembly mounted on a structural steel skid

##### 1.2 RELATED WORK SPECIFIED ELSEWHERE

Furnishing and installation of pre-fabricated trailer mounted vacuum pump equipment, including but not limited to a pump control panel, conduit and wiring and other associated equipment and vacuum pumps skid assembly.

##### 1.3 MANUFACTURER'S EXPERIENCE

The manufacturer of pre-fabricated station equipment and controls shall have a minimum of five (5) years of experience in the design, manufacture and start-up of vacuum stations, and have at least five (5) installations in service. Provide verification upon request.

##### 1.4 SUBMITTALS

SHOP DRAWINGS AND LITERATURE: Provide a submittal including complete plan and elevation view drawings of assembled unit (s), and structural steel base. Indicate any field installed connection piping required on site by others. Provide manufacturer's literature on all equipment provided with the station. Indicate materials of construction, physical properties, controls, operational requirements, details and other data.

##### 1.5 OPERATION AND MAINTENANCE MANUALS

Submit O & M Manuals for all components indicating recommended spares, start-up data and maintenance procedures. Submit a listing of suppliers who may provide repair parts.

##### 1.6 WARRANTY

Provide a one-year manufacturer's warranty covering all materials and workmanship of all products supplied. Warranty shall commence from the date of station start-up. (i.e. when controls are turned to auto).

## **DIVISION II - EQUIPMENT**

### **SECTION 11307 - SPECIFICATION FOR FACTORY ASSEMBLED VACUUM STATIONS**

#### **PART 2 - PRODUCTS**

##### **2.1 VACUUM PUMPS**

- A. Vacuum pump shall be a Busch (RC0630.C4Z6.11XX) as modified for vacuum sewage collection system use (P14000). Pumps shall be rotary vane and shall have a nominal pumping speed of 1200 RPM and produce 455 ACFM. Four (4) pumps of this size to be supplied.
- B. The vacuum pump shall be driven by a 25 horsepower standard C-face, F2 assembly, TEFC NEMA inverter duty electric motor through a shaft coupling. No belt drives shall be used. At no time does motor horsepower exceed nameplate ratings. Pump shall have an end (ultimate) vacuum of 29.3" Hg. (15 Torr) minimum at sea level (29.92" Hg barometer). Pump shall be capable of continuous operation.
- C. The vacuum pump shall be air-cooled with absolutely no water requirements.
- D. Lubrication shall be provided by an integral, fully recirculating oil supply which is filtered by an automotive-type spin-on filter. Once through (non-recirculating) or partial recirculating oil lubrication systems shall not be permitted. Oil separation system shall be integral and shall consist of no less than four stages of internally mounted oil and smoke elimination from the exhaust gas stream. This includes bulk separation, mist elimination, smoke elimination and baffle.
- E. Pump shall have a built-in anti-suck-back valve mounted at the pump inlet.
- F. Entire pump, motor, and exhaust box shall be shipped as one factory assembled and tested unit mounted on vibration isolators and shall be mounted on the vacuum station skid as shown on the drawings.
- G. Each pump shall be fitted with a name plate indicating Type, Serial number and Air displacement.
- H. Each pump motor shall be fitted with a name plate indicating model, serial number, horsepower, voltages, amperages, speed, efficiency, insulation type, frame number, locked rotor current, and enclosure type.
- I. Each pump will be equipped with an internal crank case heater. The heater shall be properly sized to maintain uniform crank case temperatures without damage to the oil. These units are to be self

contained including an operating thermostat. Power for these heaters to be supplied by the main vacuum skid control panel.

- J. Each Vacuum pump shall include a moisture separator. It shall be adequately sized for the CFM air displacement of the pump. It shall have a clear housing and be provided with flanges, air inlet and drain valves.
- K. The vacuum system manufacturer shall provide a Sch 80 PVC manual condensate collection system to collect condensate from the vacuum pump moisture separator, exhaust piping when needed, and the vacuum header assembly when needed. The system operator will be required to drain this system once a day during routine inspections and maintenance.

## 2.2 COLLECTION STATION PIPING

- A. This item includes piping, valves, fittings, pipe supports, fixtures, drains and other work involved in providing a complete installation.
- B. Vacuum pumps skid piping shall include all piping within the vacuum pumps skid, connecting piping to vacuum pumps, vacuum header and exhaust header.
- C. Inlet vacuum lines shall be Schedule 80 PVC, 304 Stainless Steel, Galvanized, or Schedule 40 black iron . Vacuum Pump exhaust piping to be stainless steel, galvanized or black iron.
- D. One eighth inch (1/8") thick E.P.D.M. gaskets shall be used on all flanges.
- E. Piping shall be adequately supported to prevent sagging and vibration and to permit expansion, venting and drainage. Supports shall be situated to prevent the weight of piping and valves from bearing on the pumps.
- F. When these lines are inter-connected there shall be a check valve installed on each pump's exhaust.
- G. Check valves for incoming lines on the vacuum pumps shall be Henry pratt rubber flapper swing type, or approved equal.
- H. Butterfly valve for incoming lines on the vacuum pumps will be provided. Valve to be epoxy coated, ductile iron, semi-lug body with nylon coated 316 SS disc, suitable for continuous contact with domestic sewage.  
Acceptable manufacturers : Bray or equal.
- I. A manually operated condensation collection system will be provided as shown on the Station plans, the purpose of which is to prevent exhaust moisture and odors from escaping into the Station ambient air. All valves

for the condensation collection system shall be provided. The final 1" piping and supports shall be contractor furnished as shown on plans.

### 2.3 STRUCTURAL STEEL SKID

A. The entire vacuum pump assembly shall be rigidly mounted to a raised structural steel platform by means of bolting or welding.

B. All structural steel shall conform to ASTM A-36/A-36M with minimum tensile strength 58,000 PSI.

C. The platform shall be so designed to support the assembly with main support members adequately sized to bear loads applied by lifting the unit (s) at four (4) points on its perimeter. Cross members will be located to bear the loads applied by various components. All structural members to be joined by a minimum 1/4" fillet weld.

D. The entire top surface of the platform will be covered with steel deck plates. Where access to components is required, non-slip type safety floor plate are to be used. Lifting cleats will be attached at four (4) points along the platform perimeter to allow lifting by cable and spreader bars. Each cleat will be adequately sized to bear the load of the entire assembly. They will be fastened by bolts and are to be removed.

E. Painting: The entire platform will be prepared for painting by use of a phosphatizing process. Sandblasting shall not be required. One (1) primer coat of a Rust-oleum Product compatible with 9100 Series Epoxy will be applied immediately after phosphatizing at 3 mils D.F.T. minimum.

### 2.4 FACTORY TESTING

A. The assembled unit(s) will be vacuum tested to 24" Hg. for a period of not less than two (2) hours. Maximum leak rate to be one (1%) percent per hour. The assembly will be tested at as near field conditions as can be factory simulated. Vacuum pumps controls will be preset and tested.

B. All alarm functions will be normally open to close on alarm condition and will be pre-tested..

C. A factory test report with a chart indicating the vacuum test will be provided with the O & M Manual.

### 2.5 FINAL PAINTING

After all testing is complete, the entire assembly will be tooled, cleaned, pressure washed and/or solvent washed in accordance with SSPC-SPI, SP2 and SP3. Then coated with Rust-oleum Epoxy Paint #9186 (Navy Gray) to a minimum of 3 mils D.F.T. Final coating for all surfaces shall be 6 mils minimum.

## 2.6 SPARE PARTS

The following is a listing of recommended spares which shall be considered minimum. Any spare part supplied in addition shall be listed with submittals and O & M Manuals:

### A. Vacuum Pumps:

Four (4) complete set of filters  
Twenty (20) gallons of vacuum pump oil

SECTION 11308  
ELECTRICAL SPECIFICATION FOR EMERGENCY VACUUM TRAILER  
KEY LARGO, FL

**PART 1 - GENERAL**

The following specification is a general guideline for a trailer-mounted, prewired control panel and electrical components provided for a trailer-mounted AIRVAC vacuum pump skid with four (4) new vacuum pumps. The control panel and electrical components will also be used to control existing station equipment including level controls and two (2) or three (3) sewage pumps.

Provide (1) control panel to operate four (4) vacuum pumps and two (2) or three (3) sewage pumps for this phase of construction.

1.1 DESCRIPTION OF WORK

The extent of work under this section includes furnishing, pre-wiring and factory testing of a complete and self-contained control unit for monitoring of vacuum and fluid levels and cycling of vacuum pumps on an emergency vacuum trailer and sewage pumps in skid mounted vacuum stations. The electrical equipment includes, but is not limited to: a control panel, level controls, and a vacuum transmitter.

1.2 RELATED WORK SPECIFIED ELSEWHERE

Interconnection of sections of the split skid design. Routing of conduit and wires, termination at the MCP terminal strip, and at the field junction box on the vacuum skid or tank skid. Interconnection includes motor leads, switch leads, and probe connections.

1.3 QUALITY ASSURANCE

Wiring and workmanship for the control components on the Vacuum Collection Skids will comply with the following regulations, standards, and publications:

N.E.C. - National Electric Code  
U.L. Underwriters Laboratories

All control components shall bear a U.L. Listing label in applicable categories. Some exceptions may be made where components become difficult to use, implement, or obtain in order to be listed. Control vendor shall use UL guidelines if installing a non-UL component to allow for entire assembly to still bear the UL label.

The control panel shall be inspected and listed as a UL 508 assembly.

1.4 QUALITY CONTROL

All control panel components shall be of the most current and proven design. Specifications and Drawings call attention to certain features but do not purport to cover all details entering into the design of the control system. The components provided by Aqseptence Group - Airvac shall be compatible with the functions required and shall form a complete working system.

**PART 1 – GENERAL**

**1.5 MANUFACTURER'S EXPERIENCE**

The manufacturer of prefabricated control panel shall have a minimum of five (5) years of experience in the design, manufacture and start-up of vacuum stations, and have at least five (5) installations in service. Provide verification upon request. Aqseptence Group – Airvac – No equal

**1.6 SUBMITTALS - ELECTRICAL DRAWINGS**

Provide a submittal including complete electrical prints. These include but are not limited to panel layout and material list, power distribution, P & ID, and I/O layout.

**1.7 OPERATION AND MAINTENANCE MANUALS**

*Submit O & M Manuals: Manuals to include description of control switches, system operation, and theory of operation, warranty information, the above drawings, and manufacturer's published literature on control components.*

Part numbers of components used on the drawings to be highlighted.

**1.8 ON SITE START UP**

A. Provide on-site start up services. Typically 3-5 working days per station.

1. The vacuum system manufacturer shall provide a copy of its start-up report during the submittal review. It shall be reviewed and approved by the engineer. The start-up personnel shall follow the guidelines defined in the report.
2. Provide in writing to the Owner/Engineer that the equipment has been properly installed and has passed the manufacturers start up requirements. (1) wk. after final start-up has occurred.
3. Subsequent on-site visits for start-up related issues will require additional compensation.

**1.9 FACTORY TRAINING**

A. Provide training at its manufacturing facility on mechanical and electrical equipment provided.

1. The Owner shall send its operators to the vacuum systems manufacturing facility in Rochester, IN. The owner will pay for their expenses.
2. The vacuum system manufactures training course shall be 5 days at no cost to the Owner.
3. The vacuum system manufacture shall hold training sessions (1) one week per month.



**PART 1 – GENERAL**

4. The vacuum system manufacture shall provide a copy of the course outline during the submittal review. It shall be reviewed and approved by the engineer.

## **PART 2 – PRODUCTS**

### **GENERAL**

- A. Provide NEMA-4X enclosure panel with all PLC, Panelview screen, relays, starters, disconnects, instruments, switches, indicating lights, terminal boards, and wiring to perform the following functions. Panel to be free standing and sized to allow proper installation of the equipment.
1. Provide power distribution for 480V, 3Ph, 60Hz power from a generator.
  2. Provide control logic for operation of four (4) vacuum pumps in the automatic and manual modes.
  3. Provide control logic for operation of the two (2) or three (3) sewage pumps in the automatic and manual modes.
  4. Provide control logic to assure delay of lag (2<sup>nd</sup>, 3<sup>rd</sup>, and 4<sup>th</sup>) Vacuum and/or lag (2<sup>nd</sup> or 3<sup>rd</sup>) Sewage pump operation on initial power turn up.
  5. Provide control logic for operation of a High-Level cutoff isolation valve.
  6. Provide local alarm, audible and visual, for low vacuum pressure, for high wastewater level in sewage collection tank, and for high level lockout conditions. Provide for capability to silence the audible alarm and test for Pilot light operation.
  7. Provide trending of Vacuum Tank pressure through Operator interface.
  8. Provide Phase Fail and Surge Protection.
  9. Provide alarm output signals.
  10. Provide logic to indicate if a pump fails to run when called.

### 2.1 **ENCLOSURE**

- A. Provide a NEMA 4X rated flange-mounted disconnect enclosure for the electrical controls. The vacuum system manufacturer shall size the enclosure to fit the electrical equipment for this project. The enclosure shall be mounted on the emergency vacuum trailer.
1. The enclosure shall be made from 12-gauge stainless steel.
  2. The body seams shall be continuously welded and ground smooth, the enclosure body shall include body stiffeners in larger enclosures for extra rigidity, the body flange trough shall include liquids and contaminants, a heavy-duty lifting eye shall be anchored into the top of the enclosure, and the center post shall be removable for easy panel installation.

## **PART 2 – PRODUCTS**

3. The doors on the enclosure shall include heavy gauge continuous hinges; they shall include heavy-duty 3-point latching mechanisms operated by patented padlocking handles on all doors. Each of the latching rods shall have rollers for easier door closing. The door shall include a high-impact thermoplastic pocket for data and have an oil-resistant gasket. The master door shall be the far-right side and include a defeater. The defeater must require a screwdriver to be used to allow the door to open. The master door shall include mechanical interlocks to keep the slave door from being opened first. The doors shall be able to close in any order. Each door shall include a padlocking handle.
4. A universal cutout shall be provided on the right flange for the disconnect operator.
5. The enclosure shall be provided with a 11 gauge back panel which mounts to the back of the enclosure on collar studs.
6. The enclosure shall be unpainted SS 304. Finish shall be Brushed #4.
7. The enclosure manufacture shall provide the operator adapters for the universal cutouts for the disconnect. The operator adapter shall interlock the master door with the disconnect operating mechanism.
8. Provide an activated door switch. The switch shall turn a light on when the enclosure door is opened.
9. The enclosure shall meet UL 508A standards.
10. Enclosure package shall be: Hoffman, or equal.
11. Provide a 20 watt, LED, 1200 Lumens, Kelvin Temp 4000K lighting package. Lithonia or equal
12. Provide an exhaust fan sized appropriately for the enclosure. Include an inlet grill as well. Hoffman, or equal.

### **2.2 VOLTAGE TEST STATION**

- A. Provide a safe way for the system operator to verify the presence or absence of voltage. Provides a connection for ethernet cable. This device shall be mounted on the outside the electrical enclosure.
- B. This device shall be non-flashing with a safe-test port, installed in a UL Type 4 housing with horizontal mount rated IP65. The housing shall include a 304 stainless steel latch and a UV rated polycarbonate cover. Voltage indicator shall be conveniently viewed from the enclosure. Operating range 4-600VAC, 50/60Hz/400Hz or 30-600VDC.
- C. Grace Engineering Products, Inc. or equal

## **PART 2 – PRODUCTS**

### **2.3 DISCONNECTS**

- A. Provide main disconnect for incoming power with a 25 kIAC rating. Disconnect shall have adjustable breaking capacity to provide power to each station with varying sewage pump horsepower.
- B. Provide operating handle for disconnect switch mechanism providing indication and control of switch position with enclosure door open or closed, and capable of being locked in the OFF position with three (3) padlocks.
- C. One (1) power feed shall be provided to the enclosure and distributed to the pump disconnects via a distribution block.
- D. Provide separate disconnects for each Sewage Pump utilized. Disconnects are to have adjustable breaking capacity and sized to provide power to each station with varying sewage pump horsepower. Construct and mount disconnect switches in main NEMA Type 4X enclosure.

### **2.4 VACUUM PUMPS -- COMBINATION STARTERS**

- A. General - except as otherwise indicated, provide motor starters and auxiliary components, which comply with manufacturer's standard materials, design and construction in accordance with published product information, and as required for complete installation. Where more than one type of equipment meets indicated requirements, selection is Installers' option.
- B. VACUUM PUMPS: Full voltage non-reversing starters - provide full voltage alternating current non-reversing starters. These are IEC rated integral (modular) self-protected units sized for indicated loads. They provide padlockable disconnect, short circuit protection, contactor and overload protection, all located inside the panel. Equip starters with electrical interlocks where indicated. Construct and mount starters in enclosure.

### **2.5 SEWAGE PUMPS --VARIABLE FREQUENCY DRIVES**

- A. Variable frequency drives are to be provided for the vacuum pumps and the sewage pumps. VFD's should be a microprocessor-based unit with menu-oriented keypad programming of setup parameters.
- B. Manufacturer's specifications must be submitted for approval as "state of the art" in motor control. The most important of these features will be:
  - Adjustable frequency range translated to 900-3600 rpm.
  - 4-20ma (or 0-10vdc) input capability
  - Rated at 150% output for 60 sec.
  - Remote start/stop.
  - Programmable accell/decel times.
  - Wide range of internal fault protection.
  - Ethernet Connectivity

**PART 2 – PRODUCTS**

- C. The Sewage pump VFD's shall be controlled by the Flow meter and the Pressure Transmitter on the force main. Logic for control will reside in PLC.
- D. Allen-Bradley, Model 525 or 755 no equal.

2.6 **PROGRAMMABLE LOGIC CONTROLLER (PLC) BASED SYSTEM**

- A. Conceptual system control scheme is as follows:
  - 1. PLC-CPU shall be Allen Bradley Compact Logix or ControlLogix, no equal.
  - 2. See Paragraphs, PLC Hardware, PLC Software and Local Control Panels (LCP) for additional requirements.
- B. PLC Hardware
  - 1. Provide programmable logic controllers (PLC) and input/output modules in sufficient quantities specified herein and as required to meet functional requirements of the Specification. PLC hardware and power supplies shall be provided in completely wired local control panels as specified herein and as shown. Manufacturer shall include cables, mounting hardware, racks and connectors as required for fully operational PLC systems.
  - 2. PLC system hardware shall be as manufactured by Allen Bradley or equal.
  - 3. I/O modules shall be removable without disturbing field wiring.
  - 4. Provide minimum of 20% spare slot capacity in the card rack for future expansion.
  - 5. For PLC digital output, provide 115-volt output cards. Install isolation relays for all outputs.
  - 6. PLC shall have Ethernet Communication.
- C. PLC-CPU
  - 1. Each process module PLC-CPU shall be Allen Bradley Compact Logix or equal.
  - 2. 25% spare memory shall be available after PLC has been programmed for full operation.
- D. Digital Input (DI) Modules
  - 1. Provide Allen Bradley or equal 120V DI modules as required.

## **PART 2 – PRODUCTS**

### E. Digital Output (DO) Modules

1. Provide Allen Bradley or equal 120V DO modules as required.

## 2.7 OPERATOR INTERFACE

- A. An operator interface shall be provided that gives the operator controlling and monitoring options. A 6-inch display screen shall be included. Graphics are to be displayed in an 18-bit color. Operator input is to be available through touch screen. Included shall be a RS232 and USB port and an Ethernet port. Operator Interface shall be accessible through the panel face without opening the control enclosure door. Allen-Bradley PanelView Plus 7 or equal.

## 2.8 TRANSFORMER

- A. Provide a transformer to take the line power and provide control power. Step it down from 480V to 120V. Sized to carry the load as needed.
- B. Non-ventilated automation transformer type, single phase, encapsulated. Group 1, 240 x 480 Primary, 120/240 Secondary, 60hz.
- C. Rated for hazardous locations, UL listed/NEMA type 4X enclosure.
- D. Provide touch proof cover for terminals.
- E. Complies with latest addition of the National Electrical Code
- F. Sola or equal.

## 2.9 24V POWER SUPPLY MODULE

- A. Provide a 120VAC input – 24VDC output power supply module for the PLC and the vacuum transmitter. Level transmitter, Force Main Pressure, HMI shall have a separate 24VDC power supply.
1. The module shall have auto select input voltage, 24V DC, and have an adjustable voltage feature. The module shall have an indefinite short circuit, overvoltage and overtemperature protection and operate @ -10 C to 60 C without derating. The module shall withstand high inrush loads without shutdown or foldback. The module shall be narrow in width and enclosed with a rugged metal case. The mounting terminations shall be large, rugged, accessible and have multiple connections. The module shall be DIN rail mountable type.
- B. Power supply module shall be by Allen Bradley 1606XLP60EQ, or equal.

## **PART 2 – PRODUCTS**

### **2.10 REMOTE ACCESSS ROUTER**

- A. Provide wireless access to PLC. The device shall include an integrated WiFi, firewall friendly outbound connection, Ethernet configurable, field interface with USB – female connector, VPN Security. EWON or equivalent.

### **2.11 ETHERNET SWITCH**

- A. Provide an Unmanaged Industrial Ethernet Switch to allow communication to VFDs and SCADA equipment.
- B. The switch shall have an IP30 rated housing. The switch shall have (8) 10/100Base-TX, RJ-45 ports. It shall meet IEEE 802.3, 802.3u, 802.3x, Din Rail mounted, 12V – 48 VDC power input
- C. Ethernet switch shall be: ADVANTECH, EKI-2528 or equal.

### **2.12 SURGE SUPPRESSION – INCOMING POWER**

- A. Surge suppression shall be provided on main power (480 v) and control power (120 v). Control power surge suppression shall include compliance with UL 1449 Fourth Edition Listed. SCCR rating—200kA.
- B. Control Power – ASCO Power Technologies 400 series, Model 420 SPDee Series or equal.
- C. Main power surge suppression shall include protection against lightning or power surges in the main power supply, typically 460-volt, 3 phase.
- D. Main Power – AB4983-DS, or equal.

### **2.13 SURGE SUPPRESSION – CONTROL POWER**

- A. Provide surge protection on for the control power after the step down transformer.
  - 1. 50kA 8x20us Per Mode, I nominal 20kA, Large-Block, 34mm square, 50kA MOVs, Individually fused & thermally Protected MOVs, Repetitive Impulse: 5000 – 3kA-8x20us; 10kA-8x20us, Response time less than 1 nanosecond, solid state Bi-directional Operation, Pre-wired 3 ft. of #10 AWG conductor, Typical Type 2 Connection: #10AWG to 30A breaker.
  - 2. Surge suppression device shall be UL 1449 3<sup>rd</sup> Edition listed.
  - 3. Surge Suppression shall be: ASCO, 400 Series Model 420 (SPDee Series)

## **PART 2 – PRODUCTS**

### **2.14 PHASE FAIL**

- A. Phase Loss, Under Voltage shall be monitored. Operating voltage shall be 380-500 Adj. with automatic reset.
- B. Macromatic PMD series, Model PMDU, or equal.

### **2.15 ALARM HORN**

- A. An alarm horn shall be provided. 100dB sound level. 22MM
- B. Allen Bradley 855P or equal

### **2.16 PILOT DEVICES**

- A. Selector switches shall be heavy duty, oil tight/watertight, 22mm units. Switches shall have double-break silver contacts. Devices shall be installed using gaskets to maintain their NEMA 4X rating.
- B. Push buttons shall be heavy duty, oil tight/watertight, 22mm units. Contacts should be double break silver.
- C. Pilot lights and illuminated selector switches should be 22mm, heavy duty, transformer type. Where contacts are used they should be of double break silver type style.
- D. Allen-Bradly, or equal

### **2.17 RELAYS**

- A. Relays shall be heavy duty, general purpose type with 10-amp contacts. Relays shall have octal type terminals which plug-in to a socket.
- B. Relays shall be Idec RR relays, or equal.

### **2.18 ELAPSED TIME METERS**

- A. Display ETM's on operator interface screen.

### **2.19 MINATURE CIRBUIT BREAKERS**

- A. Provide supplementary protectors for all devices that require them. Transformer (primary and secondary sides) 24V power supply, input and output modules, ventilation fan, isolation valve, power switch, field potential distributor.
- B. Do this in leu of fuses. UL/CSA listed
- C. Allen Bradley or equal



## **PART 2 – PRODUCTS**

### **2.20 TERMINAL BLOCKS**

- A. Terminal blocks shall be provided in the control panel for field wiring connections. All terminal blocks should be labeled in accordance with the prints, bearing the wire number connected. IEC style, 600V terminals are required.

### **2.21 WIRING**

- A. All wiring shall be copper. Control wire shall be 16-gauge, 600-volt, type MTW, with the exception of low-level DC wires. Power wiring shall be 600-volt, type MTW, THHN, or suitable grade.
- B. All wire on the skids which extends outside the enclosure shall be protected by rigid galvanized conduit.

### **2.22 POWER RECEPTACLES AND PLUGS**

- A. Supply female receptacle and male plug for the incoming 480V AC power and for the outgoing 480V power supply to the sewage pumps. Provide plug handle and associated connections required to attach power cable. Cable supplied by others. Rated for outdoor use.
- B. Meltric or equal.

### **2.23 VACUUM CHART RECORDER**

- A. Supply 1 hr., 4 hr., 12 hr. and 24 hr. trending screens on the operator interface screen.
- B. Historically collect vacuum levels within the collection tank.

### **2.24 ALARM SYSTEM**

- A. Provide alarm output signals to a cellular radio transmitter.
- B. Cellular transmitter shall have 8 digital inputs and 2 analog inputs (4-20 mA or 0-5 VDC). Transmitter shall also include a 120 VAC to 12 VAC power supply and a backup battery.
- C. Mission Communications or equal.
- D. The vacuum system suppliers' alarms shall be:
  - 1. Low vacuum alarm: via pressure transmitter and PLC time running program.
  - 2. Sewage high level condition: via level controls.
  - 3. Sewage high level lock out condition: via level controls.

**PART 2 – PRODUCTS**

**2.25 FACTORY TESTING**

- A. The vacuum pump assembly will be vacuum tested to 24" Hg. for a period of not less than two (2) hours. Maximum leak rate to be one (1%) percent per hour. The station will be test run at as near field conditions as can be factory simulated. Vacuum pumps controls will be preset and tested. Sewage pump level control inputs will be preset and tested.
  
- B. All alarm functions will be normally open to close on alarm condition and will be pre-tested.

A factory test report with a chart indicating the vacuum test will be provided with the O & M Manual.

**2.26 SPARE PARTS**

- A. The following is a listing of recommended spares which shall be considered minimum. Any spare part supplied in addition shall be listed with submittals and O & M Manuals:
  - 1. One - 3 position non illuminated selector switch.

## **PART 3 – FUNCTIONS**

Control configurations, System Operations and Theory of Operations are shown for a four (4) vacuum pump and two (2) or three (3) sewage pump control system.

### **3.1 CONTROL SWITCHES**

#### **A. Control Power:**

1. DSC0 - DISCONNECT - Provides 480V distribution power.
2. C1-4 and DSC1-5 - CONTROL KNOBS - Provides 480V lockable disconnect for vacuum pump motors, and sewage pump motor VFDs and contactors.
3. SS1 - CONTROL POWER - Provides 120V control power to the PLC field potential distributor, the level controls, 24 VDC power supply, and PLC I/O.
4. PL-SS1 - POWER ON - Indicates that control power has been applied to the PLC field potential distributor, the level controls, 24 VDC power supply, and PLC I/O.

#### **B. Vacuum Pump Controls:**

1. SS2 - VACUUM PUMP DUTY SELECT - determines the mode of operation for all vacuum pumps.
  - a. LEAD - The vacuum pump selected by the Vacuum Pump Lead Select Switch, SS3, will remain the lead pump.
  - b. ALTERNATE - Vacuum Pumps #1-4 will alternate as the Duty Pump whenever the system requires more vacuum.
2. SS3 - VACUUM PUMP LEAD SELECT - determines which vacuum pump will be the lead pump and which pumps will be the standby pumps when LEAD is selected by SS2.
  - a. 1 - Vacuum Pump #1 will be the Lead Pump each time the system calls for more vacuum. Vacuum Pump #2 will be the Standby Pump. Vacuum Pump #3 will be the second Standby Pump. Vacuum Pump #4 will be the third Standby Pump.
  - b. 2 - Vacuum Pump #2 will be the Lead Pump each time the system calls for more vacuum. Vacuum Pump #3 will be the Standby Pump. Vacuum Pump #4 will be the second Standby Pump. Vacuum Pump #1 will be the third Standby Pump.
  - c. 3 - Vacuum Pump #3 will be the Lead Pump each time the system calls for more vacuum. Vacuum Pump #4 will be the Standby Pump. Vacuum Pump #1 will be the second Standby Pump. Vacuum Pump #2 will be the third Standby Pump.

**PART 3 – FUNCTIONS**

- d. 4 - Vacuum Pump #4 will be the Lead Pump each time the system calls for more vacuum. Vacuum Pump #1 will be the Standby Pump. Vacuum Pump #2 will be the second Standby Pump. Vacuum Pump #3 will be the third Standby Pump.
3. SS4 - VACUUM PUMP #1 - determines the operation of Vacuum Pump #1.
  - a. HAND - Manual - power is applied directly to Vacuum Pump #1.
  - b. OFF - Off - power is removed from Vacuum Pump #1.
  - c. AUTO - Automatic - Vacuum Pump #1 is controlled by the circuitry as selected by the Vacuum Pump Duty Switch, SS2, and the Vacuum Pump Lead Switch, SS3.
4. SS4\_PL - indicates that power has been applied to Vacuum Pump #1.
5. SS5 - VACUUM PUMP #2 - determines the operation of Vacuum Pump #2.
  - a. HAND - Manual - power is applied directly to Vacuum Pump #2.
  - b. OFF - Off - power is removed from Vacuum Pump #2.
  - c. AUTO - Automatic - Vacuum Pump #2 is controlled by the circuitry as selected by the Vacuum Pump Duty Switch, SS2, and the Vacuum Pump Lead Switch, SS3.
6. SS5\_PL - indicates that power has been applied to Vacuum Pump #2.
7. SS6 - VACUUM PUMP #3 - determines the operation of Vacuum Pump #3.
  - a. HAND - Manual - power is applied directly to Vacuum Pump #3.
  - b. OFF - Off - power is removed from Vacuum Pump #3.
  - c. AUTO - Automatic - Vacuum Pump #3 is controlled by the circuitry as selected by the Vacuum Pump Duty Switch, SS2, and the Vacuum Pump Lead Switch, SS3.
8. SS6\_PL - indicates that power has been applied to Vacuum Pump #2.
9. SS7 - VACUUM PUMP #4 - determines the operation of Vacuum Pump #4.
  - a. HAND - Manual - power is applied directly to Vacuum Pump #4.
  - b. OFF - Off - power is removed from Vacuum Pump #4.

**PART 3 – FUNCTIONS**

- c. AUTO - Automatic - Vacuum Pump #4 is controlled by the circuitry as selected by the Vacuum Pump Duty Switch, SS2, and the Vacuum Pump Lead Switch, SS3.
  - 10. SS7\_PL - indicates that power has been applied to Vacuum Pump #4.
  - 11. ETM1 - indicates the total elapsed time that Vacuum Pump #1 has been on. Integrated into Operator Interface screen.
  - 12. ETM2 - indicates the total elapsed time that Vacuum Pump #2 has been on. Integrated into Operator Interface screen.
  - 13. ETM3 - indicates the total elapsed time that Vacuum Pump #3 has been on. Integrated into Operator Interface screen.
  - 14. ETM4 - indicates the total elapsed time that Vacuum Pump #4 has been on. Integrated into Operator Interface screen.
  - 15. ETM5 - indicates the total elapsed time that all Vacuum Pumps have operated simultaneously. Integrated into Operator Interface screen.
- C. Sewage Pump Controls:
- 1. SS8 - SEWAGE PUMP SELECT - Determines the mode of operation for both sewage pumps.
    - a. Duty "1" - Sewage pump #1 will be the Duty Pump each time the system requests the sewage pumps to operate. Sewage Pump #2 will be the Standby Pump.
    - b. Duty "2" - Sewage pump #2 will be the Duty Pump whenever the system requests the sewage pumps to operate. Sewage Pump #1 will be the Standby Pump.
    - c. Duty "3" - Sewage pump #2 will be the Duty Pump whenever the system requests the sewage pumps to operate. Sewage Pump #1 will be the Standby Pump.
    - d. Duty "Alt" - Sewage Pump #1 and Sewage Pump #2 will alternate as being the Duty Pump whenever the system requests to be pumped.
  - 2. SS9 - SEWAGE PUMP #1 - determines the operation of Sewage Pump #1.
    - a. HAND-Manual - Power is applied directly to Sewage Pump #1.
    - b. OFF-Off - Power is removed from Sewage Pump #1.

**PART 3 – FUNCTIONS**

- c. AUTO -Automatic - Sewage Pump #1 is controlled by the circuitry as selected by the Sewage Pump Select Switch, SS8.
  - 3. PL-SS9 - Indicates that power has been applied to Sewage Pump #1.
  - 4. SS10 - SEWAGE PUMP #2 - Determines the operation of Sewage Pump #2.
    - a. HAND-Manual - Power is applied directly to Sewage Pump #2.
    - b. OFF-Off - Power is removed from Sewage Pump #2.
    - c. AUTO-Automatic - Sewage Pump #2 is controlled by the circuitry as selected by the Sewage Pump Select Switch, SS8.
  - 5. PL-SS10 - Indicates that power has been applied to Sewage Pump #2.
  - 6. SS11 - SEWAGE PUMP #3 - Determines the operation of Sewage Pump #3.
    - a. HAND-Manual - Power is applied directly to Sewage Pump #3.
    - b. OFF-Off - Power is removed from Sewage Pump #3.
    - c. AUTO-Automatic - Sewage Pump #3 is controlled by the circuitry as selected by the Sewage Pump Select Switch, SS8.
  - 7. PL-SS11 - Indicates that power has been applied to Sewage Pump #3.
  - 8. ETM6 - Indicates the total elapsed time that Sewage Pump #1 has been on.
  - 9. ETM7 - Indicates the total elapsed time that Sewage Pump #2 has been on.
  - 10. ETM8 - Indicates the total elapsed time that Sewage Pump #2 has been on.
  - 11. ETM9 - Indicates the total elapsed time that Sewage Pump #1 and #2 have been on simultaneously.
- D. Alarms
  - 1. PL1 - LOW VACUUM ALARM - indicates that system vacuum has dropped below 13 inches of mercury, or that vacuum pump operation has been requested for "X" amount of time.
  - 2. PL2 - SEWAGE HIGH LEVEL ALARM - indicates that the sewage in the Main Holding Tank has reached a high-level condition.

**PART 3 – FUNCTIONS**

3. PL3 - SEWAGE AND VACUUM PUMP LOCKOUT ALARM - indicates that the sewage level in the Main Holding Tank is high enough that there is risk of the sewage occupying areas not designed for its presence and damaging pumps.
4. PL4 - VACUUM PUMP #1 TEMPERATURE FAIL ALARM - Indicates that the temperature switch in Vacuum Pump #1 has been tripped. The pump will become inoperable and will remain inoperable until the oil chamber temperature is reduced.
5. PL5 - VACUUM PUMP #2 TEMPERATURE FAIL ALARM - Indicates that the temperature switch in Vacuum Pump #2 has been tripped. The pump will become inoperable and will remain inoperable until the oil chamber temperature is reduced.
6. PL6 - VACUUM PUMP #3 TEMPERATURE FAIL ALARM - Indicates that the temperature switch in Vacuum Pump #3 has been tripped. The pump will become inoperable and will remain inoperable until the oil chamber temperature is reduced.
7. PL7 - VACUUM PUMP #4 TEMPERATURE FAIL ALARM - Indicates that the temperature switch in Vacuum Pump #4 has been tripped. The pump will become inoperable and will remain inoperable until the oil chamber temperature is reduced.
8. PL8 - SEWAGE PUMP #1 MOTOR FAIL - The presence of a motor failure for Sewage Pump #1 will be indicated by the Sewage Pump #1 Motor Fail Pilot Light, PL8, and the Alarm Horn. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button. When the alarm is acknowledged, the Alarm Horn will go off, but PL8 will remain on until the motor failure condition is corrected.
9. PL9 - SEWAGE PUMP #2 MOTOR FAIL - The presence of a motor failure for Sewage Pump #2 will be indicated by the Sewage Pump #2 Motor Fail Pilot Light, PL9, and the Alarm Horn. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button. When the alarm is acknowledged, the Alarm Horn will go off, but PL9 will remain on until the motor failure condition is corrected.
10. PL10 - SEWAGE PUMP #3 MOTOR FAIL - The presence of a motor failure for Sewage Pump #3 will be indicated by the Sewage Pump #3 Motor Fail Pilot Light, PL10, and the Alarm Horn. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button. When the alarm is acknowledged, the Alarm Horn will go off, but PL10 will remain on until the motor failure condition is corrected.
11. ALARM HORN - indicates that a Low Vacuum Alarm, a High-Level Alarm, or a Sewage and Vacuum Pump Lockout Alarm condition is present.

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12. PB1 - ALARM ACKNOWLEDGE - silences the Alarm Horn when a Low Vacuum Alarm, a High-Level Alarm, or a Sewage and Vacuum Pump Lockout Alarm is present.
13. PB2 - ALARM TEST - Turns on all Alarm Lights and activates the Alarm Horn to assure proper working condition.
14. SS12 - ALARM HORN ON/OFF - Enables/disables the Alarm Horn.
15. SS13 - ISOLATION VALVE MODE AUTO/CLOSE - Automatically closes the isolation valve during High Level Lockout Alarm. Allows manual close.



## **PART 3 – FUNCTIONS**

### **3.2 SYSTEM OPERATION**

#### **A. Turning the System On**

NOTE: Start with all pump mode switches, SS4-7, SS9-11, in the "Off" position.

1. Place main disconnect, DSC0, in the "On" position.
2. Place the Control Knobs of load switches, C1-4 and DSC1-5, in the "On" position.
3. Place the Control Power On Switch, SS1, to the "On" position. Note the presence of Control Power On Light, PL-SS1.

#### **B. Turning the Vacuum Pump Controls On**

1. Place the Vacuum Pump Duty Select Switch, SS2, into the desired mode of operation.
2. Place the Vacuum Pump Lead Select Switch, SS3, into the desired mode of operation.
3. Place the Vacuum Pump #1 Switch, SS4, into the desired position.
4. Place the Vacuum Pump #2 Switch, SS5, into the desired position.
5. Place the Vacuum Pump #3 Switch, SS6, into the desired position.
6. Place the Vacuum Pump #4 Switch, SS7, into the desired position.

#### **C. Turning the Sewage Pump Controls On**

1. Place the Sewage Pump Select Switch, SS8, into the desired mode of operation.
2. Place the Sewage Pump #1 Switch, SS9, into the desired position.
3. Place the Sewage Pump #2 Switch, SS10, into the desired position.
4. Place the Sewage Pump #3 Switch, SS11, into the desired position.

#### **D. Enabling the Alarm Horn**

1. Place the Alarm Horn Switch, SS12, into the desired mode of operation.

#### **E. Acknowledging Alarms**

1. **LOW VACUUM ALARM** - The presence of low vacuum will be indicated by the Low Vacuum Pilot Light, PL1, and the Alarm Horn. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button. When

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the alarm is acknowledged, the Alarm Horn will go off, but PL1 will remain on until the low vacuum condition is corrected.

2. SEWAGE HIGH LEVEL ALARM - The presence of a sewage high level will be indicated by the Sewage High Level Pilot Light, PL2, and the Alarm Horn. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button. When the alarm is acknowledged, the Alarm Horn will go off, but PL2 will remain on until the high sewage level condition is corrected.
3. SEWAGE HIGH LEVEL LOCKOUT ALARM - The presence of a sewage high level lockout will be indicated by the Sewage High Level Lockout Pilot Light, PL3, and the Alarm Horn. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button. When the alarm is acknowledged, the Alarm Horn will go off, but PL3 will remain on until the high sewage level lockout condition is corrected.
4. VACUUM PUMPS #1-4 TEMPERATURE FAIL ALARMS - The presence of a vacuum pump temperature fail alarm for Vacuum Pumps #1-4 will be indicated by Vacuum Pump Temperature Fail Pilot Lights, PL4-7, respectively. The Alarm Horn will also sound. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button, PB1. When the alarm is acknowledged, the Alarm Horn will go off, but the associated pilot light will remain on until the over temperature condition is corrected.
5. SEWAGE PUMP #1-3 MOTOR FAIL - The presence of a motor failure for Sewage Pump #1-3 will be indicated by the Sewage Pump #1-3 Motor Fail Pilot Light, PL8-10, respectively and the Alarm Horn. The Alarm Horn can be silenced by pushing the Alarm Acknowledge Push-button. When the alarm is acknowledged, the Alarm Horn will go off, but the associated pilot light will remain on until the motor failure condition is corrected.

F. TESTING ALARMS

1. Push the Alarm Test Push-button, PB2. The Alarm Horn will sound.

## **PART 3 – FUNCTIONS**

### **3.3 THEORY OF OPERATION**

#### **A. Control Power:**

The Disconnect Switch, DSC0, applies 480V power to the Vacuum Pump motor starters, C1-4, and Sewage Pump Disconnects, DSC1-5, and to the Control Transformer, TRN1. TRN1 steps down the 480V to 120V for control power. The secondary side of the transformer protected by CB3. The load side of CB3 feeds the Control Power On Switch, SS1.

When SS1 is switched on, the PLC Field Potential Distributor (FPD), the Level Control Relay (LC1), the 24VDC Power Supply, and the PLC I/O are powered. Each of the I/O modules is protected by a fused source. Presence of control power to the I/O is indicated by the Power On Pilot Light, PL-SS1.

The Programmable Controller (PLC), the HMI, EWON Remote Access Module (WIFI), Ethernet Switch (HUB), Pressure Transmitter (PT1), and Level Transmitter (LT1) are powered through the 24VDC Power Supply and protected by CB8.

#### **B. Vacuum Pump Controls - Automatic Operation:**

In automatic operation, the vacuum pumps are controlled by the Vacuum Level Pressure Transducer, PT1. Vacuum is requested and the duty vacuum pump starts when PT1 registers 16 inches of mercury. When PT1 registers 20 inches of mercury all vacuum pumps are shut off.

When the Duty switch in the "ALT" position, the lead vacuum pump is determined by the Vacuum Pump Alternator, a four position bit shift register. One high bit is constantly rotating through the register, shifting as the vacuum request is satisfied. Its position dictates which pump has priority to lead. If the bit advances past the #4 position, it is reloaded into the #1 position, hence the constant rotation of one bit.

The Sequencing shift register loads a bit in the priority position and shifts the bit through the register as triggered by the Standby Pump Timer. The priority bit is constantly held high so the Sequencing register fills as the timer, explained below, expires. If a bit is shifted off the end of the register it is reloaded in the #1 position. When the vacuum request is satisfied the register is cleared for the next cycle.

In automatic operation, the lag vacuum pump is controlled by Standby Vacuum Pump Timer. TMR2 starts when PT1 registers below 16 inches of mercury. At the end of "X" minutes of delay as determined by the setting on TMR2, power is applied to the second vacuum pump in the active Vacuum Sequence.

In automatic operation, the second lag vacuum pump is controlled by Standby Vacuum Pump Timer. TMR3 starts when PT1 registers below 16 inches of mercury. At the end of "X" minutes of delay as determined by the setting on

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TMR3, power is applied to the third vacuum pump in the active Vacuum Sequence.

In automatic operation, the third lag vacuum pump is controlled by Standby Vacuum Pump Timer. TMR4 starts when PT1 registers below 16 inches of mercury. At the end of "X" minutes of delay as determined by the setting on TMR4, power is applied to the fourth vacuum pump in the active Vacuum Sequence.

With the duty register in Positions 1-4 the combination of shift registers and timers allows for the following operational sequences:

Sequence #1	1, 2, 3, 4
#2	2, 3, 4, 1
#3	3, 4, 1, 2
#4	4, 1, 2, 3

With the Duty Switch in the "ALT" Position the Sequence # is advanced by one each time the vacuum cycle completes.

When power is applied to the Vacuum Pump #1 motor starter, an auxiliary bit applies power to the Vacuum Pump #1 Run Indicator pilot light and Elapsed Time Meter, ETM1. The same action occurs when power is applied to Vacuum Pump #2-4, Vacuum Pump #2-4 Run Indicator pilot light and ETM #2-4. When Vacuum Pumps #1-4 are on simultaneously, associated auxiliary bits apply power to ETM5 which records the total elapsed time that all vacuum pumps are on simultaneously.

All vacuum pumps are disabled from operation with the presence of a Sewage and Vacuum Pump High Level Lockout Alarm.

C. Vacuum Pump - "Off":

In the "Off" position, operation of that associated vacuum pump is disabled.

D. Vacuum Pump - "Hand":

In the "Hand" position, power is applied directly to the associated vacuum pump. However, the presence of a Sewage and Vacuum Pump Lockout Alarm or the engagement of the Emergency Stop will disable the vacuum pump operation.

E. Sewage Pump Controls - "Automatic" Operation:

The level of sewage in the collection tank is monitored by Level Transmitter, LT1, and resolved in the PLC. In "Automatic" operation, the sewage pumps are controlled by a bit labeled LP1 and the mode of operation as selected by the Sewage Pump Select Switch, SS8. The LP1 bit becomes active when the level in the collection tank reaches the Lead Pump Level.

### **PART 3 – FUNCTIONS**

When the Sewage Pump Select Switch, SS8, is in the Duty "1" position, power is applied directly to Sewage Pump #1. If Sewage Pump #1 cannot handle the incoming flow, the level of sewage will continue to rise until it reaches the Standby Pump level. Power will then be applied to Sewage Pump #2. The Duty Pump and, if required, the Standby Pump will remain on until the level of sewage in the Main Holding Tank drops below the Pump Off level. For Station E, Sewage Pump #3 will run if Sewage Pumps #1 and #2 cannot handle the incoming flow and the level of sewage rises to the Second Standby Pump level.

With the Sewage Pump Select Switch, SS8, in the Duty "2" position, Sewage Pump #2 becomes the Duty Pump and will be energized when the level of sewage reaches the Duty Pump On level. Sewage Pump #3 will become the Standby Pump and will be energized if the sewage level in the Main Holding Tank continues to rise and reaches the Standby Pump level. The Duty Pump and, if required, the Standby Pump will remain on until the sewage level in the Main Holding Tank drops below the Pump Off level. For Station E, Sewage Pump #1 will run if Sewage Pumps #2 and #3 cannot handle the incoming flow and the level of sewage rises to the Second Standby Pump level.

For Station E, with the Sewage Pump Select Switch, SS8, in the Duty "3" position, Sewage Pump #3 becomes the Duty Pump and will be energized when the level of sewage reaches the Duty Pump On level. Sewage Pump #1 will become the Standby Pump and will be energized if the sewage level in the Main Holding Tank continues to rise and reaches the Standby Pump level. The Duty Pump and, if required, the Standby Pump will remain on until the sewage level in the Main Holding Tank drops below the Pump Off level. Sewage Pump #2 will run if Sewage Pumps #3 and #1 cannot handle the incoming flow and the level of sewage rises to the Second Standby Pump level.

With Sewage Pump Select Switch, SS8, in the "Alternate" position, power is applied to the Sewage Pump Alternator logic. This software alternator determines which sewage pump will be the Duty Pump and the Standby Pump. The end result is the switching of Duty Pump duty between Sewage Pump #1 and Sewage Pump #2 (and Sewage Pump #3 for Station E).

When power is applied to Sewage Pump #1 variable frequency drive, VFD1, an auxiliary switch applies power to the Sewage Pump #1 Run Indicator and to Elapsed Time Meter, ETM6. The same method of operation applies to Sewage Pump #2 and #3 Run Indicators and Elapsed Time Meters, ETM6-7. When Sewage Pump #1 and Sewage Pump #2 are on simultaneously (or Sewage Pumps #1, #2, and #3 for Station E), auxiliary bits apply power to ETM8, which records the total elapsed time that all sewage pumps are on together.

All sewage pumps are disabled from operation in the "Automatic" mode via LT1 or LC1 and the PLC bit labeled HLL Relay, that trigger the presence of a Sewage High Level Lockout Alarm. Additionally, pumps are not allowed to run in the presence of a Phase Failure.

### **PART 3 – FUNCTIONS**

A Sewage Pump moisture or temperature fail will also latch out its respective pump until the pump is inspected. Once it has determined that it is okay for the pump to run again, push the Alarm Acknowledge button, PB1, to reset the latch.

F. Sewage Pump - "Off":

In the "Off" position, operation of that associated sewage pump is disabled.

G. Sewage Pump - "Hand Operation":

In the "Hand" position, power is applied directly to the associated sewage pump.

H. Alarms - Low Vacuum:

The Low Vacuum Alarm bit, VS2, closes at 13 inches of mercury or the Vacuum Standby Pump Timer, TMR7, times out indicating a low vacuum condition. The activation of VS2 or TMR7 energizes the Low Vacuum Alarm bit.

The energizing of the Low Vacuum Alarm bit applies power to the Alarm Horn. When the Alarm Horn is acknowledged by pressing the Alarm Acknowledge Pushbutton, PB1, power is applied to the Low Vacuum Latch bit, which then latches in and holds the Alarm Horn off until the Low Vacuum Alarm condition is corrected.

I. Alarm - Sewage High Level:

When the sewage level in the Main Holding Tank reaches the High-Level setting, power is applied to the Sewage High Level Alarm bit.

The energizing of the Sewage High Level Alarm bit applies power to the Alarm Horn. When the Alarm Horn is acknowledged by pressing the Alarm Acknowledge Pushbutton, PB1, power is applied to the Sewage High Level Latch bit, which then latches in and holds the Alarm Horn off until the Sewage High Level condition is corrected.

J. Alarms - Sewage and Vacuum Pump Lockout (High Level Lockout):

When the sewage level in the Main Holding Tank reaches the High-Level Lockout setting, power is applied to the High-Level Lockout Delay On Timer, TMR8. After "X" seconds of delay, as determined by the setting on TMR8, power is applied to the High-Level Lockout Control bit. When it is energized, Vacuum Pumps #1 and #2 are disabled in both "Auto", "Hand", and "Bypass" operation and Sewage Pumps #1 and #2 are disabled in "Auto" operation only.

The energizing of the High-Level Lockout Control bit applies power to the Alarm Horn. When the Alarm Horn is acknowledged by pressing the Alarm Acknowledge Pushbutton, PB1, power is applied to the Sewage High Level Lockout Latch bit, which then latches in and holds the Alarm Horn off until the Sewage High Level Lockout condition is corrected.

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K. Alarms - Vacuum Pumps #1-4 Temperature Fail:

When the oil chamber of a particular vacuum pump overheats, the temperature switch mounted to that particular vacuum pump disengages. When the signal from the temperature switch is discontinued, operation of that particular vacuum pump is disabled and the Temperature Fail bit for that particular vacuum pump is energized.

The energizing of the Temperature Fail bit for a particular vacuum pump applies power to the Alarm Horn and to the respective Vacuum Pump Temperature Fail Pilot Light, PL4-7. When the Alarm Horn is acknowledged by pressing the Alarm Acknowledge Pushbutton, PB1, power is applied to the Temperature Fail Latch bit for that particular vacuum pump. This latch bit then latches in and holds the Alarm Horn off. The particular Temperature Fail Alarm Pilot Light will remain on and the particular vacuum pump will remain disabled until the Temperature Fail condition is corrected.

L. Alarms – Sewage Pump #1 or #2 Fail:

In the event a temperature switch, TS6 or 7, opens due to an overheat condition, that Sewage Pump will be latched out by its “Fail” bit and the Sewage Pump “FAIL” will indicate on the HMI.

The pump must be inspected for cause of the failure. Once corrected, the Sewage Pump fail latch may be reset by pressing the Alarm Acknowledge button, PB1.

END OF SECTION