CONTROL PANEL No.1 (CP-1):
Reference: Schematic Diagrams EC1 through EC17

CONTROL PANEL No.1 (CP-1) SCOPE
The following functional description is a detailed technical description of normal operation of the electrical controls. This description is intended to be used with the system schematic drawings. Reference to line numbers applies to the schematic line number to assist in locating the parts on the schematic. The line numbers are on the left-hand side of the schematic drawing vertically arranged and in consecutive order. Other numbers used on the schematic include wire numbers (which are based on line numbers with suffixes A, B, C, etc. added to differentiate between different electrical logic points and are usually located directly beneath the line representing the number) and device terminal numbers (usually located above the line representing the number and adjacent to the connection point).

This description does not include any details on abnormal or unusual conditions. Isolated functions that are independent will be described separately to simplify and clarify this functional description.

The operating instructions for this system are more general and intended to give an overall picture of the operation without technical details. A review of the operating instruction may be helpful before starting study of the following functional description.

1.0 CP-1 GENERAL
It is assumed that the start-up procedure in the operating instruction has been followed. Control power is assumed to be available and all essential circuit breakers have been closed. The output functions of this control are the operation of electric motors operating two Septic Tank Pumps SETP-01 and STEP-
02, two Aeration Basin Blowers B-01 and B-02, Digester Blower DB-01 and DB-02, one Secondary Clarifier Motor SCO-01, one Digested Sludge Pump DSP-01, two RAS Pumps RAS-01 and RAS-02 and one WAS Pump WAS-01. In addition, the controls for one Unit Heater UH-01, one Heat Tape HT-01, one Site Lighting control, one Plant Lighting control, one remote Annunciator Panel and one Ultra Violet Controller are provided.

Each motor is operated by a starter (M1-M11) or by a variable speed drive (VFD-01 and VFD-02) as shown on schematic drawings EC1 and EC2. When power is supplied, the started coils and/or variable frequency drives are energized, operating their respective components to energize the selected motor. For example, starter coil M1 (line 1139) when energized will close M1 contacts (lines 14, 15 and 16) to energize and run Septic Tank pump No. STEP-01. Additional M1 contacts may be used for auxiliary purposes such as M1A contact at line 1136 to operate the O.C. (operation counter), RTM (Run Time Meter) and the green running light. In the following detailed description of the control functions, additional details of the starter and motor operation will be eliminated to simplify the detailed discussion.

2.0 SEPTIC TANK PUMP STEP-01

The “Hand-Off-Auto” selector switch controls the pump motor and is interlocked to a level controller, level switch, faults and Septic Tank Pump STEP-02. Indicating lights show operational status and alarm panel shows abnormal conditions. Normal operation is “Auto”.

2.1 Septic Tank Pump Step-01 Off Operation

With selector switch SS12 (Line 1139) in OFF power is denied to starter coil M1. The starter coil will be de-energized and the pump motor will stop. In addition, when in the OFF position, SS12 switch
contacts at line 1141 will be closed to enable Step-02 pump to run should the alternator relay RA3 be in the position to run Step-01 (contacts at lines 1146/1147 closed).

2.2 Septic Tank Pump Step-01 Manual Operation
With R28A contact closed and Selector Switch SS12 in HAND (line 1139), power is supplied to M1 running the motor. R28A contact is normally open but closes when relay R28 coil (line 1134) is energized by the motor circuit protector MCP-1 contact and the overload relay OL1 contact. If MCP-1 and/or OL1 trip (line 1132), R28 coil de-energizes, opening contact R28A and locking out the pump (line 1139) until MCP-1 and/or OL1 are reset.

2.3 Septic Tank Pump Step-01 Automatic Operation
With R28A contact closed, selector switch SS12 in AUTO, R25C (line 1148) not open, R24A (line 1146) or R23D (line 1148) or TS17A (line 1150) closed and TD37A (line 1148) closed, RA3B/RA3C (line 1146/1147), and through the jumper around R75B (line 1144) power is supplied to starter coil M1, running the motor. Note: this jumper is used to allow both pumps to run in a one pump low flow condition. Contact R25C will be closed if SPC-1 and SPC-2 (lines 1092/1095) do not detect a low Septic Tank level. Contact R24A will be closed if SPC-2 contact at line 1063 is closed. Contact R23D (line 1148) will be closed is SPC-1 contact at line 1048 is closed. TD17A contact (line 1150) will be closed if TD17 (line 1074) is timed out and R23B at line 1074 is not open. TD37A (line 1148) will be closed if TD37 is time out (line 840). Contacts RA3B/RA3C (lines 1146/1147) will be closed if the alternator relay RA3 at line 1148 is in the proper cycle. In addition, M1 will energize if contact R24D (line 1147) closes and Step-01 is the lag pump.
If there is a breaker MCP-1 or overload relay OL-1 trip, R27/28 (lines 1132/1134) will de-energize causing R27B (line 1131) to close and turning on the overload light IL13. R27C (line 1758) and R28C (line 1863) will close to energize the general alarm and to send an alarm signal back to Scada.

Auxiliary contact M1A (line 1136) will close when the coil of motor starter M1 is energized. This will operate the Run Time Meter 1, Operation Counter 2 and the Pump Run light IL14 (lines 1136, 1137 & 1138) M1B Line 1915 will close when the coil of motor starter M1 is energized to send a run signal back to Scada. Auxiliary contact M1C (line 1125) will also close to partially enable the Two Pumps Fail alarm.

If the Step-01 Low Flow relay R75 (line 1525) energizes, contact R75A (line 1145) closes to turn on the Step-02 starter M2 (line 1155) if SS13 is in the AUTO position. Also, if MCP-1 or OL-1 trips de-energizing R28 (line 1134), R28A contact (line 1139) will open to turn off M1 and R28E (line 1143) will close to energize Step-02 motor starter, M2, if SS13 is in auto.

3.0 SEPTIC TANK PUMP STEP-02

Pump is controlled by a “Hand-Off-Auto” selector switch and interlocked to a level controller, level switch, faults and Septic Tank Pump STEP-01. Indicating lights show operational status and alarm panel shows abnormal conditions. Normal operation is “Auto”.

3.1 Septic Tank Pump Step-02 Off Operation

With selector switch SS13 (line 1155) in OF power is denied to started coil M2. The starter coil will be de-energized and the pump motor will stop. In addition, when in the OFF position, SS13 switch contact
at line 1157 will be closed to enable Step-01 pump to run should the alternator relay RA3 be in the position to run Step-02 (contacts RA3A/RA3D at lines 1149/1150 closed).

3.2 Septic Tank Pump Step-02 Manual Operation
With R30A contact closed and Selector Switch SS13 in HAND (line 1155), power is supplied to M1 running the motor. R30A contact is normally open but closes when relay R30 coil (line 1162) is energized by the motor circuit protector MCP-2 contact and the overload relay OL2 contact (line 1160). If MCP and/or OL2 trip, R30 coil de-energizes, opening contact R30A and locking out the pump (line 1155) until MCP-2 and/or OL2 are reset.

3.3 Septic Tank Pump Step-02 Automatic Operation
With R30A contact closed, selector switch SS13 in AUTO, R25C (line 1148) not open, R24A (line 1146) or R23D (line 1148) or TD17A (line 1150) closed and TD37A (line 1148), and RA3A/RA3D (line 1149/1150) closed, power is supplied through the R78B jumper (line 1152) to starter coil M2, running the motor. Note: this jumper is used to operate both pumps to run in a one pump low flow condition.

Contact R25C will be closed if SPC-1 and SPC-2 (lines 1092/1095) do not detect a low Septic Tank level. Contact R24A will be closed if SPC-2 contact at line 1063 is closed. Contact R23D will be closed if SPC-1 contact at line 1048 is closed. TD17A contact will be closed if TD17 is time out and R23B at line 1074 is not open. TD37A will be closed if TD37 is timed out (line 840). Contacts RA3A/RA3D will be closed if the alternator relay at line 1148 is in the proper cycle. In addition, M2 will energize if contact R24D (line 1147) closes and Step-02 is the lag pump.
If there is a breaker MCP-2 or overload relay OL-2 trip, R29/30 (line 1160/1162) will de-energize causing R29B (line 1159) to close and turning on the overload light IL15. R29C (line 1760) and R30C (line 1864) will close to energize the general alarm and to send an alarm signal back to Scada.

Auxiliary contact M2A (line 1164) will close when the coil of motor starter M2 is energized. This will operate the Run Time Meter 2, Operation Counter 2 and the Pump Run light IL16 (lines 1164, 1165, 1166). Auxiliary contact M2B (line 1916) will close when the coil of motor starter M1 is energized to send a run signal back to Scada. Auxiliary contact (M2C (line 1125) will also close to partially enable the Two Pumps Fail alarm.

If the Step-02 Low Flow relay coil R78 (line 1535) energizes, contact R78A (line 1151) closes to turn on the Step-01 starter M1 (line 1139) if SS12 is in the AUTO position. Also, if MCP-2 or OL-2 trips de-energizing R30 (line 1162), R30A contact (line 1155) will open to turn off M2 and R30E (line 1153) will close to energize Step-01 motor starter, M1.

### 3.4 Septic Tank Level Transducer Selector Switch

Selector switch SS-20 (line 478) allows either level transmitter LT-1 (line 457) or LT-2 (line 501) to be used for either setpoint controllers SPC-1 or SPC-2 if one transmitter has faulted. If turned to the LT-1 position, the LT-1 analog signal will go to both SPC-1 and SPC-2 controllers. If turned to the LT-2 position, the LT-2 analog signal will go to both controllers. When SS-20 is placed in the Auto position, each transducer will be connected and provide its analog signal to its respective controller. In a failure mode of one transducer, turn selector switch SS-20 to the good transducer position to enable the faulted transducer to be removed and repaired.
4.0 INFLUENT FLOW SYSTEM

The system measures Influent Flow and generates a 4-20ma analog signal to enable instantaneous flow readings at setpoint controller SCP-7, Flow Recorder No.1, Auto Dialer No. 2 (line 648) and for the Flow Samplers (lines 638 and 755). Total flow is provided by the Integrator and Flow Totalizer operation counter. The major components of the Influent Flow system consists of a flow meter FM-1 (line 638), an Integrator (line 644), a system Flow Recorder No.1 (line 649), an I/I signal isolator, a recorder bypass switch SS4 (line 647) and a Flow Totalizer Counter (OC13).

4.1 Influent Flow Meter

The Influent Flow Meter FM-1 measures incoming sewage flow to the facility and is located next to the northeast wall of the equipment room in the maintenance building. It is connected to 120 VAC through CB-21 at line 638 for its internal power requirements and generates a 4-20ma signal at line 639 that is proportional to the rate of influent flow. This 4-20ma analog signal is used for various functions as described in detail in the following narratives.

The influent flow meter FM-1, in the display head in the equipment room, contains instantaneous flow readout in GPM and also toggles to indicate total gallons. This should, periodically be compared to the OC-13 flow totalizer operation counter located on the front panel of CP-1. This will allow a rough check on the calibration of the integrator.

4.2 I/I Signal Isolator

The I/I (current to current) signal isolator is the first device in the Influent Flow analog loop at line 642. The isolator increases the strength of the 4-20ma signal to the Flow Samplers (line 638) and also electrically isolates the signal from the main flow loop to the sampler loop. The isolator does not
change the value of the 4-20ma signal but generates the exact same analog value to the Samplers that is generated by the Influent Flow Meter. DSP-3 (line 639) is a data signal protector that is used to absorb any harmful voltage surges that may be induced into the Sampler 4-20ma loop thus protecting equipment connected to the loop conductors.

4.3 Auto Telephone Dialer
The next component in the Influent Flow 4-20ma analog loop is the Auto Telephone Dialer No. 2 at line 648. The connection of the loop to the dialer allows remote monitoring of the instantaneous flow value.

4.4 System Flow Recorder
The third component in the loop is System Flow Recorder No.1 at line 649. This recorder monitors the 4-20ma Influent Flow rate and uses a paper chart to record the flow values. The recorder is physically located on the upper left-hand corner of CP-1 bay C door. To enable continuing flow loop operation should the recorder require maintenance, Chart Recorder selector switch SS4 (line 647) is connected such that if placed in the Bypass position, the analog loop will be shorted around the chart recorder which enables the removal of the recorder while maintaining operation of the 4-20ma flow loop. Care must be used to ensure that the selector switch is returned to the Run position after the recorder is returned to service.

4.5 Influent Flow Transducer
The fourth component in the Influent Flow loop is the Influent Flow Transducer Set Point Controller, SPC-7 at line 627 and 646. This setpoint controller measures the flow value in the 4-20ma loop and displays the amount of flow in gpm (gallons per minute) on the digital readout on the face of the instrument.
SPC-7 Controller also turns on two alarms. The first is the One Pump Low Flow alarm shown on lines 631 and 1106 and the other alarm is the Two Pumps Low Flow alarm shown on lines 630 and 1125.

The One Pump Low Flow alarm occurs when Influent Flow decreases to the setpoint of the minimum flow rate of one STEP pump. Relay R31 (line 1106) energizes when the setpoint is reached and SPC-7 contacts AL-1 (line 1106) close. Relay contacts R31A (line 1110) and R31D (line 1118) then close and if TS25 and TS26 are in the Auto position, time delay relays TD18 and/or TD19 will energize depending on which STEP pump motors are currently running.

If STEP-01 motor is running, power is available at line 1110 (reference no. 5) and time delay relay TD18 energizes after a short time delay. When TD18 turns on, TD18A (line 1527) contact closes and relays R75 and R76 energize enabling General, Annunciator, Dialer No. 2 and Scada alarms. In addition, relay R75 enables STEP-02 pump motor to run by closing its contact R75A (line 1145).

If STEP-02 motor is running, power is available at line 1118 (reference no. 6) and time delay relay TD19 energizes after a short time delay. When TD19 turns on, TD19A (line 1537) contact closes and relays R78 and R79 energize enabling General, Annunciator, Dialer and Scada alarms. In addition, relay R78 enables STEP-01 pump motor to run by closing its contact R78A (line 1151).

If flow in the Influent Flow loop reaches the setpoint for minimum flow for both STEP-01 and STEP-02 pumps, SPC-7 closes contact AL-2 (line 1125) and if both STEP pumps are running, contacts M1C (STEP-01 motor starter) and M2C (STEP-02 motor starter) are closed (line 1125) and time delay relay TD20 energizes after a short time delay. When TD20 energizes contactTD20A (line 1547) closes energizing relays R81 and R82 enabling General, Scada and Telephone Dialer alarms.
4.6 Integrator

The fifth component in the Influent Flow analog loop is the Integrator at line 644. This component monitors the 4-20ma instantaneous flow rate and internally, mathematically modifies the signal to represent total flow in the loop. When flow is present in the loop, the component will momentarily close its contact (line 644) periodically and counter OC13 will be incremented one count. Each count represents a preset amount of flow that has been programmed into the Integrator. Currently, each count on OC13 represents 100 gallons so the simple calculation of multiplying the total number of counts on OC13 times 100 will give the total flow in gallons that has occurred in the Influent Flow loop.

To determine how many gallons has occurred over a period of time, record the number of counts at the beginning of the time period and subtract from the number of counts at the end of the period and multiply by 100.

4.7 Influent and Effluent Samplers

The last components to operate from the Influent Flow analog loop are the Influent (line 752) and Effluent (line 758) Samplers. Each component is connected to the loop through the I/I Signal Isolator (lines 638 and 756) and monitors the amount of flow represented by the 4-20ma signal. According to preset values, each sampler will periodically and automatically open valves that remove samples of the Influent and Effluent flows. The samples are then chemically analyzed to determine the operating efficiency of treatment plant operation.

4-20 mA Input for Flow Proportional Sampling

An optional interface unit is available (P.N. 2021) which converts a 4-20 mA flow meter output into 12 VDC pulses. At 20 mA (100% flow rate), the interface sends ten pulses per minute; at 4 mA (0% flow rate), the interface sends zero pulses.
Multnomah Falls WWTP Functional Descriptions – Continued:

The interface has a 1.5 ft. cable with a connector on one end, and a 10 ft. cable with two open wire leads on the other. After all field wiring has been connected and completely tested, insert the connector into the sampler receptacle labeled AUXILIARY, located on the left side of the control housing. With respect to the 10 ft. cable, the wire with clear insulation is POSITIVE (+) and the wire with black insulation is NEGATIVE (-).

**Note:** Part # 2021 interface works with either wire connected to positive (+) input wire.

Older model 4-20 mA interface (#2020) requires current loop polarity to work properly.

**Required Calculations:**

1. **Calculate “Q”**: “Q” is \( \frac{\text{Average Flow Rate}}{\text{Maximum Flow Rate}} \) (20 mA. value).

2. **Calculate “t”**: “t” = a/n. “a” = time in minutes for sampling program “n” = number of desired samples

3. **Multiply “Q” by “t”**: Resulting product is number of counts to be entered into program. This number must be a whole number, such as 10, 13 or 20.

*These calculations may have to be completed a number of times to compensate for seasonal variations in flow, or to accommodate specific plant operating conditions.*

**Multnomah Falls Calcs:**

- **Minimum - 0.010 MGD**  
  \[
  \frac{0.010}{0.144} = 0.069444 \\
  1440/20 \text{ samples} = 72 \times 0.069444 = 5.0 
  \]

- **Average - 0.024 MGD**  
  \[
  \frac{0.024}{0.144} = 0.16666 \\
  1440/48 \text{ samples} = 30 \times 0.16666 = 5.0 
  \]

- **Maximum - 0.040 MGD**  
  \[
  \frac{0.040}{0.144} = 0.27777 \\
  1440/80 \text{ samples} = 18 \times 0.27777 = 5.0 
  \]

Further technical assistance regarding external device control and flow-paced sampling is available via American Sigma’s toll-free number – (800) 635-1230.

Influent and Effluent Samplers provide a method of automatically removing samples for analysis from influent/effluent flows to/from the treatment plant. The samplers are connected to the flow loop of FM-1 (drawing EC4,
line 638) through the I/I (current to current) repeater shown at line 643. The 4-20ma flow signal connected to the samplers (line 756) from the I/I repeater is analyzed by the samplers and integrated to provide a signal for energizing various electrical valves that remove samples from the system.

5.0 AERATION BASIN BLOWER B-01
Blower is controlled by the “Hand-Of-Auto” selector and interlocked to a pressure controller, faults and Aeration Basin Blower B-02. Blower includes a variable frequency drive to maintain a preset pressure. Indicating lights show operational status and alarm panel show abnormal conditions. Normal operation is “Auto” mode.

5.1 Aeration Blower B-01 SPC -3 Auto/ Manual Operation
The Aeration Blower motor B-01 controls are designed to operate such that the SPC-3 controller adjusts motor speed via a pressure transducer, PT-1, mounted in the discharge of the blower and connected to SPC-3. If a change in output pressure is sensed by PT-1, SPC-3 measures the amount of change and adjusts the analog output to VFD-1 to vary its speed thus keeping the output of the blower at a constant pressure. For example, should the output of B-01 drop, PT-1 will measure the amount of decrease and send this value to SPC-3. The setpoint controller then determines how much to increase the speed of the variable frequency drive connected to the blower motor so that the output pressure will then increase back to its former value previously entered into the setpoint controller. This function occurs automatically when the setpoint controller, SPC-3 is placed in the Auto mode and all other B-01 controls are also configured in Auto mode as per sec. 5.4 below.

It is also possible to operate the blower motor VFD in a Manual (Hand) mode via setpoint controller SPC-3. With all other controls in the Auto mode as described in sec. 5.4 below, placing SPC-3 in
Manual by pushing the Auto/Manual button to Manual on the face of the controller will disable the Auto function as described in the paragraph directly above. The controller will then require the operator to manually adjust the output of the setpoint controller by pushing the up and down arrow buttons on the face of the controller because the pressure transducer PT-1 is no longer read by the setpoint controller. Operating in this mode requires constant monitoring by the operator to ensure that the correct output pressure is maintained.

5.2 Aeration Blower B-01 Off Operation

With selector switch SS7 in OFF (line 883), power is denied to VFD start relay coil R21 (line 883). The relay coil will be de-energized and open VFD call input relay contact R21A (line 886) and the pump motor will stop. In addition, when in the OFF position, SS7 switch contacts at line 885 will be closed to enable B-02 pump to run should the alternator relay RA1 (line 892) be in the position to run B-01 (contacts RA1B/RA1C at line 890/891 closed).

5.3 Aeration Blower B-01 Manual Operation

With R12A contact closed and Selector Switch SS7 in HAND (line 883), power is supplied to R21 energizing VFD-01 call input (line 37) running the motor. R12A contact is normally open but closes when relay R12 coil (line 877) is energized by the circuit breaker CB-4 contact and the VFD-01 FLT contact (line 876). If CB-4 and/or VFD-01 FLT trip, R12 coil de-energizes, opening contact R12A and locking out the pump (line 883) until CB-4 and/or VFD-01 FLT are reset.

5.4 Aeration Blower B-01 Automatic Operation

With R12A contact closed, selector switch SS7 in AUTO (line 884) R8A (line 892 closed, TD35A (line 892) timed out and closed, RA1B/RA1C (line 890/891), and R53B (line 888) closed power is supplied to relay coil R21, energizing VFD-01 call input (line 37) to run the motor.
Relay coil R8 (line 800) will be energized if SS5 is not turned off and the selected position has a completed circuit (e.g., SS5 in TIME CLOCK position, TC1B closed and SS6 in the MED. Position). TD35A will be closed if Power Fail Restart TD35 (line 836) is timed out, Alternator RA1 (line 892) relay contacts RA1A/RA1D (lines 893/894) will be closed if the relay is in the correct sequence and contact R53B is not open (Aeration Blower Fail relay R53 at line 1442 not energized).

If there is a breaker CB-4 or VFD-01 FLT trip, R11/12 (lines 876/877) will de-energize causing R11B (line 875) to close and turning on the overload light IL5. R11C (line 1762) and R12C (line 1859) will close to energize the general alarm and to send an alarm signal back to Scada.

VFD-01 Running contact (line 880) will close when VFD-01 is energized to run the motor. This will operate the Run Time Meter 3, Operation Counter 3, and the Pump Run light IL6 (lines 880, 881, and 882). Relay contact R117A (line 1911) will close when the VFD-01 Running contact is closed to send a running signal back to Scada.

If the Aeration Blower B-01 Fail relay coil R53 (line 1442) energizes, contact R53B (line 888) opens to turn off R21 and contact R53A (line 889) closes to turn on the Aeration Basin Blower B-02 Call relay R22 (line 899) if SS8 is in the AUTO position (line 900). Also, if CB-4 or VFD-01 FLT trips de-energizing R12 (line 877), R12A contact (line 883) will open to turn off R21 and R12E (line 887) will close to energize Aeration Blower B-02 VFD Call relay R22 (line 899).

**5.5 Aeration Blower B-01 Modified Overload Operation**

The motor overload feature of the VFD has been modified to filter out nuisance overload trips. On drawing ACH501, A time delay relay TDO has been added with the relay coil connected to the
hardwired overload device MOL1. The contacts of TDO are shown connected to the Enable input to the VFD drive at terminal board TBRD, terminal strip TB1A, terminal 15. After the overload device has detected a motor overloaded condition and opened thus de-energizing the coil of TDO, a very short time later the contacts of TDO will open to turn the voltage off to terminal 15 thus shutting down the drive. The time delay relay coil will automatically reset and be energized once again when the overload fault has cleared and the overload device has been reset by an operator.

Note: It is essential that the time delay value on the TDO relay be set as low as possible to prevent subjecting the motor to excessive current during an overload condition.

6.0 AERATION BASIN BLOWER B-02

Blower is controlled by the “Hand-Off-Auto” selector switch and interlocked to a pressure controller, faults and Aeration Basin Blower B-01. Blower includes a variable frequency drive to maintenance a preset pressure. Indicating lights show operational status and alarm panel show abnormal conditions. Normal operation is “Auto” mode.

6.1 Aeration Blower B-02 SPC -4 Auto/ Manual Operation

The Aeration Blower motor B-02 controls are designed to operate such that the SPC-4 controller adjusts motor speed via a pressure transducer, PT-2, mounted in the discharge of the blower and connected to SPC-4. If a change in output pressure is sensed by PT-2, SPC-4 measures the amount of change and adjusts the analog output to VFD-2 to vary its speed thus keeping the output of the blower at a constant pressure. For example, should the output of B-02 drop, PT-2 will measure the amount of decrease and send this value to SPC-4. The setpoint controller then determines how much to increase the speed of the variable frequency drive connected to the blower motor so that the output pressure will then increase back to its former value previously entered into the setpoint controller. This
function occurs automatically when the setpoint controller, SPC-4 is placed in the Auto mode and all other B-02 controls are also configured in Auto mode as per sec. 6.4 below.

It is also possible to operate the blower motor VFD in a Manual (Hand) mode via setpoint controller SPC-4. With all other controls in the Auto mode as described in sec. 6.4 below, placing SPC-4 in Manual by pushing the Auto/ Manual button to Manual on the face of the controller will disable the Auto function as described in the paragraph directly above. The controller will then require the operator to manually adjust the output of the setpoint controller by pushing the up and down arrow buttons on the face of the controller because the pressure transducer PT-2 is no longer read by the setpoint controller. Operating in this mode requires constant monitoring by the operator to ensure that the correct output pressure is maintained.

6.2 Aeration Blower B-02 Off Operation
With selector switch SS8 in OFF (line 901) power is denied to VFD start relay coil R22. The relay coil will be de-energized and open VFD call input and the pump motor will stop. In addition, when in the OFF position, SS8 switch contacts at line 901 will be closed to enable B-01 pump to run should the alternator relay RA1 be in the position to run B-02 (contact at lines 893/894 closed).

6.3 Aeration Blower B0-02 Manual Operation
With R14A contact closed and Selector Switch SS8 in HAND (line 899), power is supplied to R22 closing R22A (line 901) energizing VFD-02 call input (line 54) running the motor. R14A contact is normally open but closes when relay R14 coil (line 906) is energized by the circuit breaker CB-5 contact and the VFD-02 FLT contact (line 904) and/or VFD-02 FLT trip, R14 coil de-energizes, opening contact R14A and locking out the pump (line 899) until CB-5 and/or VFD-02 FLT are reset.
6.4 Aeration Blower B-02 Automatic Operation

With R14A contact closed, selector switch SS8 in AUTO, R8A (line 892) closed, TD35A (line 892) timed out and closed, RA1A/RA1D (line 893/894), and R58B (line 896) closed power is supplied to relay coil R22 closing R22A, energizing VFD-02 call input (line 54) to run the motor.

Relay coil R8 (line 800) will be closed if SS5 is not turned off and the selected position has a competed circuit (e.g., SS5 in TIME CLOCK position, TC1B closed and SS6 in the MED. Position). TD35A will be closed if Power Fail Restart TD35 (line 836) is timed out, Alternator RA1 relay contacts RA1A/RA1D will be closed if the relay is in the correct sequence and contact R58B is not open (Aeration Blower Fail relay R58 at line 1462 not energized).

If there is a breaker CB-5 or VFD-02 FLT trip, R13/14 (lines 904/906) will de-energize causing R13B (Line 903) to close and turning on the overload light IL7. R13C (line 1764) and R14C (line 1860) will close to energize the general alarm and to send an alarm signal back to Scada.

VFD-02 Running contact (line 908) will close when VFD-02 is energized to run the motor. This will operate the Run Time Meter 4, Operation Counter 4, and the Pump Run light IL8 (lines 908, 909 and 910). Relay contact R118A (line 1912) will close when the VFD-02 Running contact closes to send a running signal back to Scada.

If the Aeration Blower B-02 Fail relay R58 (line 1462) energizes, contact R58B (line 896) opens to turn off R22 and contact R58A (line 895) closes to turn on the Aeration Basin Blower B-01 Call relay R21 (line 883) if SS7 is in the AUTO position. Also, if CB-5 or VFD-02 FLT trips de-energizing R14 (line 906), R14A contact (line 899) will open to turn off R22 and R14E (line 897) will close to energize Aeration Blower B-01 VFD Call relay R21 (line 883).
6.4 Aeration Blower B-02 Modified Overload Operation

The motor overload feature of the VFD has been modified to filter out nuisance overload trips. On drawing ACH501, a time delay relay TDO has been added with the relay coil connected to the hardwired overload device MOL1. The contacts of TDO are shown connected to the Enable input to the VFD drive at terminal board TBRD, terminal strip TB1A, terminal 15. After the overload device has detected a motor overloaded condition and opened thus de-energizing the coil of TDO, a very short time later the contacts of TDO will open to turn the voltage off to terminal 15 thus shutting down the drive. The time delay relay coil will automatically reset and be energized once again when the overload fault has cleared and the overload device has been reset by an operator.

Note: It is essential that the time delay value on the TDO relay be set as low as possible to prevent subjecting the motor to excessive current during an overload condition.

7.0 DIGESTER BLOWER DB-01

Blower is controlled by the Hand-Off-Auto” selector switch and interlocked to a pressure controller, faults and Digester Blower DB-02. Indicating lights show operational status and alarm panel show abnormal operation conditions. Normal operation is “Auto” mode.

7.1 Digester Blower DB-01 Off Operation

With selector switch SS9 in OFF (line 1011) power is denied to starter coil M5. The starter coil will be de-energized and the pump motor will stop. In addition, when in the OFF position, SS9 switch contacts at line 1013 will be closed to enable DB-02 pump to run should the alternator relay RA2 be in the position to run DB-01 (contacts RA2B/RA2C at lines 1018/1019 closed).
7.2 Digester Blower DB-01 Manual Operation

With R18A contact closed and Selector Switch SS9 in HAND (line 1011), power is supplied to M5 running the motor. R18A contact is normally open but closes when relay R18 coil (line 1006) is energized by the motor circuit protector MCP-5 contact and the overload relay OL5 contact (line 1004). If MCP-5 and/or OL5 trip, R18 coil de-energizes, opening contact R18A and locking out the pump (line 1011) until MCP-5 and/or OL5 are reset.

7.3 Digester Blower DB-01 Automatic Operation

With R18A contact closed, selector switch SS9 in AUTO (line 1012) TD36A (line 1016) timed out and closed, a Time Clock contact (TC1D, TC1E or TC1F lines 1020-1022) that corresponds with the appropriate SS10 setting closed, RA2B/RA2C (line 1018/1019) closed and R63B (line 1016) closed, power is supplied to starter coil M5, running the motor.

TD36A will be closed if TD36 is timed out (line 838). Contact TC1D, TC1E and TC1F will close as per settings of Time Clock (line 211). Contacts RA2B/RA2C will be closed if the alternator relay at line 1020 is in the proper cycle. Contact R63B (line 1016) will close if the coil of R63 (line 1484) is not energized due to a blower failure alarm.

If there is a breaker MCP-5 or overload relay OL-5 or overload relay Ol-5 trip, R17/18 (lines 1004/1006) will de-energize causing R17B (line 1003) to close and turning on the overload light IL9. R17C (line 1768) and R18C (line 1861) will close to energize the general alarm and to send an alarm signal to Scada.

Auxiliary contact M5A (line 1008) will close when the coil of motor starter M5 is energized. This will operate the Run Time Meter 5, Operation Counter 5, and the Pump Run light IL10 (lines 1008, 1009,
1010) M5B (line 1913) will close when the coil of motor starter M5 is energized to send a run signal back to Scada.

If the Digester Blower DB-01 Fail relay R63 (line 1484) energizes, contact R63B (line 1016) opens to turn off M5 and contact R63A (line 1017) closes to turn on the Digester Blower DB-02 starter M6 (line 1027) if SS11 is in the AUTO position. Also, if MCP-5 or OL-5 trips de-energizing R18 (line 1005), R18A contact (line 1011) will open to turn off M5 and R18E (line 1015) will close to energize Digester Blower DB-02 motor starter, M6.

8.0 DIGESTER BLOWER DB-02
Blower is controlled by the "Hand-Off-Auto" selector switch, and interlocked with pressure controller, faults and Digester Blower DB-01. Indicating lights show operational status and alarm panel show abnormal conditions. Normal operation is "Auto" mode.

8.1 Digester Blower DB-02 Off Operation
With selector switch SS11 (line 1027) in OFF power is denied to starter coil M6. The starter will be de-energized and the pump motor will stop. In addition, when in the OFF position, SS11 switch contacts at line 1029 will be closed to enable DB-01 pump to run should the alternator relay RA2 be in the position to run DB-02 (contact at lines 1021/1022 closed).

8.2 Digester Blower DB-02 Manual Operation
With R20A contact closed and Selector Switch SS11 in HAND (line 1027), power is supplied to M6 running the motor. R20A contact is normally open but closes when relay R20 coil (line 1034) is energized by the motor circuit protector MCP-6 contact and the overload relay OL6 contact (line 1032).
If MCP-6 and/or OL6 trip, R20 coil de-energizes, opening contact R20A and locking out the pump (line 1027) until MCP-6 and/or OL6 are reset.

8.3 Digester Blower DB-02 Automatic Operation

With R20A contact closed, selector switch SS11 in AUTO, TD36A (line 1016) timed out and closed, a Time Clock contact (TC1D, TC1E or TC1F lines 1020-1022) that corresponds with the appropriate SS10 setting closed, RA2A/RA2D (line 1021/1022) closed and R68B (line 1024) closed, power is supplied to starter coil M6, running the motor.

TD36A will be closed if TD36 is timed out (line 838). Contacts TC1D, TC1E and TC1F will close as per settings of Time Clock TC1 (line 211). Contacts RA3A/RA3D will be closed if the alternator relay at line 1020 is in the proper cycle. Contact R68B (line 1024) will close if the coil of R68 (line 1499) is not energized due to a blower failure alarm.

If there is a breaker MCP-6 or overload relay OL-6 trip, R19/20 will de-energize causing R19B (line 1031) to close and turn on the overload light IL11. R19C (line 1774) and R20C (line 1862) will close to energize the general alarm and to send an alarm signal back to Scada.

Auxiliary contact M6A (line 1036) will close when the coil of motor started M6 is energized. This will operate the Run Time Meter 6, Operation Counter 6, and the Pump Run light IL12 (lines 1036, 1037, 1038). Auxiliary contact M6B (line 1914) will close when the coil of motor starter M6 is energized to send a run signal back to Scada.

If the Digester Blower DB-02 Fail relay R68 (line 1499) energizes, contact R68B (line 1024) opens to turn off M6 and contact R68A (line 1023) closes to turn on the Digester Blower DB-01 starter M5 (line 1011) if SS9 is in the AUTO position. Also, if MCP-6 or OL-6 trips de-energizing R20 (line 1034), R20A
contact (line 1027) will open to turn off M6 and R20E (line 1025) will close to energize Digester Blower DB-01 motor starter, M5.

9.0 SECONDARY CLARIFIER DRIVE SCO-01
Clarifier is controlled by the “Off-On” selector switch and interlocked with over torque switch, and faults. Indicating lights show operational status and alarm panel show abnormal conditions. Normal operation is “On” mode.

9.1 Secondary Clarifier SCO-01 Off Operation
With selector switch SS18 in OFF power is denied to starter coil M7. The started coil will be de-energized and the pump motor will stop.

9.2 Secondary Clarifier SCO-01 On Operation
With R44A contact closed, TD37D contact closed, Selector Switch SS18 in ON and the over torque limit switch in normal position (line 1361), power is supplied to M7 running the motor. R44A contact is normally open but closes when relay R44 coil (line 1353) is energized by the motor circuit protector MCP-7 contact and the overload relay OL7 contact. If MCP-7 and/or OL7 trip, R44 coil de-energizes, opening contact R44A and locking out the pump (line 1361) until MCP-7 and/or OL7 are reset. TD37D will be closed when TD37 (line 840) is energized and time out.

The over torque limit switch will be in the normal (motor running) position unless an over torque condition in the Clarifier motor causes the switch to change position. If the motor over-torques, the switch de-energizes M7 and energizes TD29 (line 1359). After TD29 times out contact TD29A (line 1592) enables the SCO-01 over torque alarm relays R93/R94 (lines 1590/1592).
If there is a breaker MCP-7 or overload relay OL-7 trip, R44 will de-energize causing contact R44B (line 1351) to close and turning on the overload light IL29. Contact R44C (line 1776) and R44E (line 1868) will also close to energize the general alarm and to send an alarm signal back to Scada.

Auxiliary contact M7A (line 1355) will close when the coil of motor starter M7 is energized. This will operate the Run Time Meter 7, Operation Counter 7, and the Pump Run light IL 30 (lines 1355, 1356, 1357). Auxiliary contact M7B (line 1907) will close when the coil of motor starter M7 is energized to send a run signal back to Scada.

10.0 DIGESTED SLUDGE PUMP DSP-01

Pump is controlled by the Hand-Off-Remote selector, “Start-Stop” pushbutton, interlocked and fault relays. Indicating lights show operational status and alarm panel show abnormal conditions. The pump controls have a Cutout/Restore feature that allows the pump to be restarted after a low level alarm condition has been cleared.

10.1 Digested Sludge Pump DSP-01 Off Operation

With selector switch SS17 in OFF, power is denied to starter coil M8 (line 1335). The starter coil will be de-energized and the pump motor will stop.

10.2 Digested Sludge Pump DSP-01 Hand Operation

With R41A (line 1335) contact closed, Selector Switch SS17 in HAND (line 1339) and TD28A closed (line 1335), power is supplied to M8 running the motor. R41A contact is normally open but closes when relay R41 coil (line 1326) is energized by the motor circuit protector MCP-8 contact and the overload
relay OL-8 contact. If MCP-8 and/or OL-8 trip, R41 coil de-energizes, opening contact R41A and locking out the pump (line 1335) until MCP-8 and/or OL-8 are reset. TD28A will be closed after LS13 (line 1346) closes and TD28, R43 and IL28 also are energized. After TD28 times out, indicating an adequate DSP level (line 1344), its contacts TD28A (line 1335) and TD28A (line 1646) operate enabling pump operation and turning off the Wetwell Low Level alarm.

If there is a breaker MCP-8 or overload relay OL-8 trip, R41 will de-energize causing contact R41B (line 1324) to close and turning on the overload light IL26. Contact R41C (line 1778) and R41E (line 1870) will also close to energize the general alarm and to send and alarm signal back to Scada.

Auxiliary contact M8A (line 1328) will close when the coil of motor starter M8 is energized. This will operate the Run Time Meter 11, Operation counter 11, Pump Run light IL27 and the one-shot timer, TD27 (line 1331). Auxiliary contact M8B (line 1920) will close when the coil of motor starter M8 is energized to send a run signal back to Scada.

**10.3 Digested Sludge Pump DSP-01 Remote Operation**

In addition to the conditions given in section 9.2 above concerning R41A and TD28A contacts, with TD36D contacts (line 1335) closed (after TD36 has time out at line 838), Selector Switch SS17 in REMOTE and the remote START Pushbutton pushed, power is supplied to motor starter M8, running the motor. Auxiliary contact M8A closes energizing TD27 (line 1331). TD27A (line 1337) closes allowing the start button to be released. After the preset time of TD27 has expired TD27A drops out and if the remote start pushbutton has been released, M8 will de-energize and stop the motor. If the motor is required to stop before TD27A times out, the remote STOP pushbutton (line 1335) can be pushed to stop the motor and de-energize TD27.
10.4 Digested Sludge Pump DSP-01 Cutout/ Restore Control

The Digested Sludge Pump has a Cutout/ Restore feature that allows the pump to be restarted after a low level alarm condition has stopped the pump. Time delay relay TD28 (line 1344) and relay R43 (line 1346) are both de-energized when the level float switch LS-13 drops out due to a low level. When TD28 drops out, contact TD28A (line 1335) opens and de-energizes the pump motor starter M8 (line 1335) stopping the pump motor. Contact R43B (line 1348) also de-energizes turning on indicating light IL28 (line 1348). When the correct operating level is restored, LS-13 (line 1346) closes re-energizing TD28 and R43 which turns off IL28 notifying the operator that it is possible to re-start the Digested Sludge Pump motor. If selector switch SS17 (line 1335) in the Hand position when TD28A closes, the pump motor will start automatically when the level is restored. If SS17 is in the Remote position, the Start pushbutton (line 1335) will have to be pushed in order to restart the pump motor.

11.0 RAS PUMP RAS-01

Pump is controlled by the “Hand-Off-Auto” selector switch and interlocked to RAS Pump RAS-02, and faults. Indicating lights show operational status and alarm panel show abnormal conditions. Normal operation is “Auto” mode.

11.1 Ras Pump Ras-01 Off Operation

With selector switch SS15 (line 1267) in OFF power is denied to starter coil M9. The starter coil will be de-energized and the pump motor will stop. In addition, when in the OFF position, SS15 switch contacts at line 1269 will be closed to enable Ras-02 pump to run should the alternator relay RA4 be in the position to run RAS-01 (contacts RA4B/RA4C at lines 1274/1275 closed).
11.2 Ras Pump Ras-01 Manual Operation

With R36A contact closed and Selector Switch SS15 in HAND (line 1267), power is supplied to M9 running the motor. R36A contact is normally open but closes when relay R36 coil (line 1261) is energized by the motor circuit protector MCP-9 contact and the overload relay OL-9 contact (line 1260). If MCP-9 and/or OL-9 trip, R36 coil de-energizes, opening contact R36A locking out the pump (line 1267) until MCP-9 and/or OL-9 are reset.

11.3 Ras Pump Ras-01 Automatic Operation

With R36A contact closed, selector switch SS15 in AUTO (line 1268), TC2A (line 1180) closed with SS14 (line 1180) in TIME CLOCK position or R122A (line 1182) closed and SS14 in COMP position, TS38A (line 1276), RA4B/RA4C (line 1274/1275), R84B (line 1272) closed and R33B (line 1268) is closed, power is supplied to starter coil M9, running the motor.

Contact TC2A will be closed per settings on Time Clock TC2 (line 213), R122A is closed if computer contact COMP (line 1177) is closed and TS42 is in the A position, or if TS42 is in the C position and relay coil R122 is energized. TD38A will be closed if TD38 is timed out (line 842). Contacts RA4B/RA4C will be closed if the alternator relay at line 1276 is in the proper cycle. Contact R84B (line 1272) will be closed if the coil of R84 (line 1559) is not energized due to a flow fail alarm. Contact R33B (line 1268) will be closed if the level for Ras-01 pump is not low (R33 at line 1220).

If there is a breaker MCP-9 or overload relay OL-9 trip, R35/36 (lines 1260/1261) will de-energize causing R35B (line 1259) to close and turning on the overload light IL19. R35C (line 1780) and R36C (line 1865) will close to energize the general alarm and to send an alarm signal back to Scada.
Auxiliary contact M9A (line 1263) will close when the coil of motor starter M9 is energized. This will operate the Run Time Meter 8, Operation Counter 8, Pump Run light IL20 (lines 1263, 1264, 1265) and also provide power for Ras-01 Flow Fail alarm relay TD21 (line 1198). Auxiliary contact M9B (line 1917) will close when the coil of motor starter M9 is energized to send a run signal back to Scada.

If the Ras-01 Flow Fail alarm relay R84 (line 1559) energizes, contact R84B (line 1272) opens to turn off M9 and contact R84A (line 1273) closes to turn on the Ras-02 starter M10 (line 1283) if SS16 is in the AUTO position. Also, if MCP-9 or OL-9 trips de-energizing R36 (line 1261), R36A contact (line 1267) will open to turn off M9 and R36E (line 1271) will close to energize Ras-02 motor starter, M10.

12.0 RAS PUMP RAS-02
Pump is controlled by the “Hand-Off-Auto” selector switch and interlocked to RAS Pump RAS-01, and faults. Indicating lights show operational status and alarm panel show abnormal conditions. Normal operation is “Auto” mode.

12.1 Ras Pump Ras-02 Off Operation
With selector switch SS16 in OFF, power is denied to starter coil M10. The starter coil will be de-energized and the pump motor will stop. In addition, when in the OFF position, SS16 switch contacts at line 1285 will be closed to enable Ras-01 pump to run should the alternator relay RA4 be in the position to run RAS-02 (contacts RA4A/RA4D at lines 1277/1278 closed).

12.2 Ras Pump Ras-02 Manual Operation
With R38A contact closed and Selector Switch SS16 in HAND (line 1283), power is supplied to M10 running the motor. R38A contact is normally open but closes when relay R38 coil (line 1289) is
energized by the motor circuit protector MCP-10 contact and the overload relay OL-10 contact. If MCP-10 and/or OL-10 trip, R38 coil de-energizes, opening contact R38A and locking out the pump (line 1283) until MCP-10 and/or OL-10 are reset.

12.3 Ras Pump Ras-02 Automatic Operation
With R38A contact closed, selector switch SS16 in AUTO (line 1284), TC2A (line 1180) closed with SS14 in TIME CLOCK position or R122A (line 1182) closed and SS14 in COMP position, TD38A (line 842), RA4A/RA4D (line 1277/1278), R87B (line 1280) closed and R34B (line 1284) is closed, power is supplied to starter coil M10, running the motor.

Contact TC2A will be closed per settings on Time Clock TC2 (line 213), R122A is closed if computer contact COMP (line 1177) is closed and TS42 (line 1177) is in the A position or if TS42 is in the C position and relay coil R122 is energized. TD38A will be closed if TD38 is timed out (line 842). Contacts RA4A/RA4D will be closed if the alternator relay at line 1276 is in the proper cycle. Contact R87B (line 1280) will be closed if the coil of R87 (line 1568) is not energized due to a flow fail alarm. Contact R34B (line 1284) will be closed if the level for Ras-02 pump is not low (R34 at line 1227).

If there is a breaker MCP-10 or overload relay OL-10 trip, R37/38 (lines 1288/1289) will de-energize causing R37B (line 1287) to close and turning on the overload light IL21. R37C (line 1782) and R38C (line 1866) will close to energize the general alarm and to send an alarm signal back to Scada.

Auxiliary contact M10A (line 1292) will close when the coil of motor starter M10 is energized. This will operate the Run Time Meter 9, Operation Counter 9, Pump Run light IL22 (lines 1292, 1293, 1294) and also provide power for Ras-02 Flow Fail alarm relay TD22 (line 1204). Auxiliary contact M10B (line 1918) will close when the coil of motor starter M10 is energized to send a run signal back to Scada.
If the Ras-02 Flow Fail alarm relay R87 (line 1568) energizes, contact R87B (lines 1280) opens to turn off M10 and contact R87A (line 1279) closes to turn on the Ras-01 starter M9 (lines 1267) if SS15 is in the AUTO position. Also, if MCP-10 or OL-10 trips de-energizing R38 (line 1289), R38A contact (line 1283) will open to turn off M10 and R38E (line 1281) will close to energize Ras-01 motor starter, M9.

13.0 WAS PUMP WAS-01

Pump is controlled by Start and Stop pushbutton switches and interlocked with a high-level float switch and faults. Indicating lights show operational status and abnormal conditions are alarmed.

13.1 WAS Pump WAS-01 Start/Stop Operation

With motor circuit protector MCP-11 (line 167) turned on, no restart cycle running (TD38D, line 1313 closed), no low water level alarm (TD26A, line 1313 closed) and no overloads extant (R39A, line 1313 closed), pushing the Start pushbutton (PB3, line 1313) will energize motor contactor M11 (line 1313) starting the WAS-01 pump motor. When M11 energizes, M11 contact M11A (line 1307) closes and power is applied to the run time meter (RTM10), operation counter (OC10), running indicating light (IL24) and time delay relay TD25 at lines 1307 through 1311 respectively. When TD25 energizes, contact TD25A (line 1315) closes enabling M11 to remain energized when the Start push button is released.

Stopping the WAS-01 motor is accomplished manually by depressing the Stop pushbutton (PB2, line 1313). Automatic stopping of the motor is provided by either the single-shot TD relay TD25 timing out and opening its contacts (TD25A, line 1315) or by a low water alarm which will cause TD 26A contacts (line 1313) to open. Notice that TD relay TD25 is adjustable from 1-1023 seconds.
13.2 WAS Pump WAS-01 Alarms

The WAS-01 pump motor alarm features consist of 2 alarms, WAS-01 Overload/ Breaker Trip and WAS-01 Pump Cutout/ Restore (low level) alarm.

The overload/breaker trip alarm occurs when either the motor circuit protector MCP-11 (line 167) trips, due to a short circuit or locked rotor or motor overload relay OL-11 senses a motor overload (contact OL-11 opens at line 171 and 1305) or the MCP-11 is physically turned off (contact MCP-11 opens at line 171 and 1305). Either action causes relay R39 (line 1305) to de-energize opening its contact R39A at line 1313 which in turn will turn off the M11 contactor (line 1313) causing the motor to stop. In addition, when relay R39 de-energizes, a General alarm is turned on (line 1784) and an alarm is sent to Scada (line 1867). Lastly, a red indicating light IL23 (line 1303) located on CP-1, is turned on to indicate the overload/breaker trip alarm condition.

The WAS-01 Pump Cutout/ Restore (low level) alarm occurs when float switch LS-12 (line 1320) opens due to a falling water level. If TS33 is in the Auto position, time delay relay TD26 (line 1318) and relay R40 (line 1320) will both de-energize signaling an alarm condition. TD26A contact (line 1313) will open to de-energize contactor M11 turning off the WAS-01 pump motor. In addition, TD26C contact (line 1634) closes to initiate a General alarm (line 1750), an alarm to Scada (line 1906) and an alarm to the Telephone Dialer No. 2 via relay R113 (line 1632) contact 113A (line 2139). Lastly, a red indicating light IL25 (line 1322) located on CP-1, is turned on to indicate the WAS-01 Pump Cutout/ Restore (low level) alarm condition.
14.0 HEAT TAPE HT-1

The Off-On selector switch SS19 at line 1390 controls heat Tape contactor (C2). When the selector switch is on, the Heat Tape contactor will energize when ambient air temperature drops and either a thermostat or outside ambient air temperature controller close their respective contacts. Indicating lights show operational status and abnormal conditions are alarmed. Normal operation of SS1 is in On mode.

The primarily controller for the Heat Tape is by setpoint controller SPC-10 from the outside temperature transmitter TT-3, line 721. The thermostat is a backup controller. The setpoint of the thermostat is such that SPC-10 will turn the Heat Tape contactor on first on falling ambient air temperatures. If SPC-10 fails to turn the Heat Tape contactor on, the thermostat at line 1390 will energize the contactor after the temperature decreases past the setpoint of SPC-10.

14.1 Heat Tape HT-1 Off Operation

With selector switch SS19 (line 1390) in OFF, power is denied to contactor coil C2. The contactor coil will be de-energized and the Heat Tape will shut off.

14.2 Heat Tape HT-1 On Operation

With R45A contact closed, selector switch SS19 in ON (line 1390) and either the Heat Tape Thermostat (line 1390) closed and/or contact R42A (line 1392) closed, power is supplied to contactor coil C2 turning on the Heat Tape (lines 176, 178). When Heat Tape contactor C2 energizes, it closes contacts at line 1396 to turn on light IL32 on CP-1 indicating that the Heat Tape is on. In addition, a signal is also sent to Scada (line 1908).
As noted above in the Heat Tape system description, setpoint controller SPC-10 (line 708) via R42 is the primary control from outside temperature sensor TT-3. SPC-10 will energize Heat Tape contactor C2 during falling ambient temperatures before the mechanical room thermostat contacts close. The thermostat in the mechanical room in parallel with R42A contact is a backup controller that has a setpoint that turns the Heat Tape contactor on at a lower temperature than does SPC-10 through relay R42.

Contact R45A will close if the coil of R45 (line 1388) is energized through contact R121A (line 1388), which indicates that CB-9 is closed (line 176) supplying power to the heat tape. If there is a breaker trip, R45 will de-energize causing R45A (line 1390) to open and de-energize C2 and R45B (line 1387) to close and turn on the breaker trip light IL31. R45C (line 1766) will close turning on the general alarm and R45E (line 1869) will close to send an alarm signal back to Scada, line 1908.

### 14.3 Heat Tape GFI Circuit Breaker and Heat Tape Testing

To test the Heat Tape ground fault circuit breaker (CB-9 line 176, located in CP-1), push the amber test push button located on the face of the breaker on the lower left corner and continue to hold to allow for any time delay provided in the breaker trip function. After the button is pushed and after the required time delay occurs, the breaker will trip to the mid-position if it is functioning correctly. After the circuit breaker trips, it can be reset by releasing the test button and turning it completely off and then back on.

Faulty heat tapes will most likely be detected by a tripped (handle at mid-position) CB-9 circuit breaker. To test the heat tape and confirm a faulted condition, first turn off the Heat Tape GFI circuit breaker (CB-9). After the breaker is verified off and with Heat Tape contactor C2 (line 1390) turned off (SS9 in the Off position), use a voltage tester to ensure no electrical power is still being applied to the heat tape by placing one test probe on terminal 2H9C at line 176 and the other probe on a ground connection in

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CP-1. Test the other circuit terminal with a probe on 2H9D at line 178 and the other probe to ground. The normal circuit voltage is 208 vac with approx. 110 vac to ground. With circuit breaker CB-9 and switch SS9 open, the both voltage tester readings should read 0 vac to ground.

If the circuit voltage is 0 vac and with disconnect switches at lines 176 and 182 closed, use a test meter with a resistance reading capability and read the amount of resistance in the tape. First, test for a shorted tape by placing the test probes across terminals 2H9C and 2H9D. If the meter has a reading of 0 ohms or very close to 0 ohms, the tape is shorted and will need to be repaired. Second, to test for a grounded tape, connect one probe to one of the two terminals (2H9C and 2H9D) and the other probe on a ground connection in panel CP-1. The meter should have a high resistance reading of 1 Meg-ohm or greater. If the reader is considerably less than 1 Meg-ohm, the tape is grounded and will have to be repaired.

15.0 EXTERIOR LIGHTING CONTROLS

Exterior Site and Plant lighting has both hand and automatic controls connected to operator switches SS1 and SS2 located on CO-1. Site lighting consists of 2 pole-mounted luminaries located to the west and south of the treatment plant and is automatically controlled by a photocell. Plant lighting consists of lighting fixtures mounted in the clarifier area that also operate in auto from the photocell and in addition, from a motion sensor located in the clarifier area.

15.1 Site Lighting

When operator switch SS1 on CP-1 is in the Hand position (line 228), lighting contactor LC1 (line 229) turns on energizing Site lighting by closing contact LC1A at line 233. If SS1 is placed in the Auto position, contactor LC1 will turn on when the photo cell (line 226) located outside closes its contacts.
(line 229), which occurs when ambient light decreases in the evening. In addition, when Site Lighting contactor LC1 energizes, it also closes a contact LC1B at line 240 that enables Plant Lighting as described below.

Site lighting also has a manual bypass switch (line 231), which when closed will bypass all controls described above and turn on the Site lighting contactor LC1 at line 229. The Bypass switch is mounted on the outside southwest corner wall of the maintenance building.

15.2 Plant Lighting

When operator switch SS2 mounted on CP-1 is in the Hand position (line 235), lighting contactor LC2 (line 236) turns on energizing Plant Lighting. If SS2 is placed in the Auto position, contactor LC2 will turn on when the motion detector (line 243), located on the east wall of the maintenance building, detects movement and closes its contact (line 236). However, Plant Lighting will not turn on unless contactor LC1 (line 229) is also on closing its contact LC1B at line 240. This function operates Plant Lighting in auto from the photocell as well as the motion detector.

Plant Lighting also has a manual bypass switch (line 231) which, when closed, will bypass all controls described above and turn on the Plant Lighting contactor LC2 at line 236 and in turn Plant Lighting at line 240 provided that the Site Lighting contactor is also energized. The Bypass switch is mounted outside on the east wall of the maintenance building.

16.0 CONTROL FUSES WITH PIN BLOWN FUSE INDICATORS

Each remote 4-20ma analog instrument loop circuit is provided with fuses that visibly indicate a blown fuse condition to aid in troubleshooting and quickly locating faulty circuits. The fuse, when blown, will cause a mechanical pin to extend from one end of the fuse to indicate the blown condition. Fuses with
extended pins must be discarded and replaced with new fuses as the fuse cannot be “reset” by pushing
the pin back into the fuse. The fuses are set for .5A (1/2 amp or 500ma) and must be replaced with the
same amperage and type of fuse.

Examples of locations for these fuses can be found in the Outside Air Temp. analog loop at line 721
(F27 & F28), UV Intensity loop at line 765 (F31 & F32) and Septic Tank level loop at line 513 (F11 &
F12).

17.0 ELECTRICAL POWER SURGE PROTECTION

17.1 Surge Protection Overview - Transient Voltage Surge Suppressors and Lightning Arrestors are
connected to the electrical distribution system to provide protection for connected equipment against
power surges and spikes that can occur in the power supply system. At lines 4 & 8 and at line 136, two
Lightning Arresters (LA) and one transient voltage surge suppressor (TVSS) are shown. When high
voltage spikes and surges due to lightning strikes or other equipment connected elsewhere in the
electrical distribution system occur, components mounted within the Lightning Arrestors and TVSS
absorb the high energy levels of the spike or surge and reduce the voltage to a level that will not
damage connected equipment.

Surge protection equipment is located in CP-1 in D bay in the upper left hand corner and mounted next
to Lighting Panel LP-1 in the Equipment Room.

17.1 Surge Protection Operation – The surge protection equipment requires no maintenance or
operational adjustments, etc. under normal conditions. However, there are green LED indicating lights
located on the equipment that show the state of internal components. If any of these internal
components are damaged due to spikes or surges, the equipment must be replaced to ensure continued protection for connected equipment. If the LED lights on the front of the surge protector enclosure are lit, the internal components are working properly. If one or more of the lights are not lit and power is available to the surge protector, the unit is faulty and must be replaced. For additional information, reference the Maintenance Manual, 16900 sec 2.16 and 2.17.

18.0 ULTRA-VIOLET DISINFECTION SYSTEM

The Ultra-Violet Disinfection System runs continuously when its power supply circuit breaker (CB-12, Line 191) is closed and the UV unit is turned on at the unit. The system is monitored for UV equipment failure, for failure of its power supply circuit breaker, CB-12 and also for a high water level condition in the UV channel. If an UV Major alarm occurs (UV System Fail alarm, line 1410), the run time meter TRM14 (line 1406) records the amount of time the alarm was active. Also, the number of times the UV major alarm occurs is recorded on operation counter OC14 (line 1407). Reference additional discussion of UV High Level and UV System Fail alarms found in the Alarm Narrative section that follows.

18.1 UV Intensity Analog Loop - The UV Intensity level is also monitored by the Autodialer No. 2, a chart recorder and the UV Setpoint Controller SPC-11. The UV Controller (line 772) outputs a 4-20ma analog signal that measures the intensity of the UV level from 0 to 100%. The 4-20ma signal is connected to a chart recorder REC-2 (line 773) to provide a record of the level of intensity. The signal is also connected to the Autodialer No. 2 (line 765) for remote monitoring purposes, to the UV Intensity setpoint controller SPC-11 (line 732) for local display purposes and to DSP-4 to protect against electrical surges caused by lightning. In addition, a selector switch SS21 (line 765) is connected in parallel with the chart recorder input to allow removal of the chart recorder from the analog loop leaving the loop in operation. Placing the switch in the Bypass position shorts out the chart recorder and allows...
the loop to function while the recorder is being serviced. After the recorder is back in service, the selector switch must be returned to the Run position.

At lines 1406 and 1407, run time meter RTM14 and operation counter OC14 record how long the UV controller has been in a fault condition (RTM14) and how many times the condition has occurred (OC14).

19.0 THREE PHASE MONITORING SYSTEM

CP-1 has an installed Phase Monitoring System. This consists of two phase monitoring relays mounted on the upper left hand corner of Bay C back panel in CP-1. PMR-1 (line 40) monitors the 3Ø phase 480 VAC power bus and PMR-2 (line 140) monitors the 120/208 3Ø power bus. Each relay monitors the integrity of the electrical power supplied to the bus. Power fault conditions monitored by the relays include a low voltage on one or more of the 480 or 208 VAC conductors connected to each relay, a complete loss of voltage on one or more of each connected power conductors or the connection of two power wires is reversed creating a phase reversal fault.

19.1 Phase Monitor Relay Fault Description - If a fault condition occurs, the relay monitoring the fault condition will de-energize and open its contact connected at line 791 (contacts PMR-1 or PMR-2). This action in turn de-energizes Phase Monitor Contactor C1 (line 791), which then opens its contacts C1E (line 191), C1D (line 403), C1A (line 789), C1C (line 791) and C1B (line 793). Opening these contacts turns power off to the UV System Controller (line 191), UPS (line 407), DC power supplies PS-1 (line 411) and PS-2 (line 425) and 24 VAC control power buses B/C (line 792), B1/C1 (line 789), B2/ C2 (line 793). The result of these actions is to effectively shut down the treatment plant due to the loss of power to all control components. One exception to this loss of power exists in that the UPS power conditioner
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will continue to provide 120 VAC control power to bus A3/ N3 (line 407 & 444). UPS connected loads (all Setpoint Controllers and power supply PS-3) will remain operating to provide a monitoring capability of the treatment plant instrumentation components such as LT-1, LT-2, FM-1, etc. These instruments will continue to operate and display plant parameters until either the correct power is restored or the UPS power conditioner battery discharges and the unit shuts down.

19.1 Phase Monitor Relay Bypass Switch Function - A feature built into the system provides a convenient method of adjusting the settings on the power monitor relays without shutting the system off. At line 792, By-Pass Switches SW1 and SW2 are connected such that if SW1 is closed, power monitor contact PMR1 is effectively shorted out of the system and power monitor relay PWM-1 can then be adjusted without de-energizing phase monitor contactor C1. If SW2 is closed, the contacts for PWM-2 are then shorted and power monitor PWM-2 can also be adjusted without de-energizing contactor C1.

Please note, care must be used when using SW1 and SW2 since leaving the switches closed after use will leave the treatment plant system unprotected from supply power voltage problems, which could result in the damage of equipment such as the 480 and 208 3Ø motors.

19.2 Phase Monitor Relay Adjustment - To adjust the power monitor relays for correct operating voltage and time delay functions, first close SW1 or SW2 switches at line 792 depending on whether power monitor relay PWM-1 or PWM-2 is to be adjusted. Operate these switches as per the narrative directly above. A good practice would be to perform adjustments on one relay at a time leaving the other power monitor relay to operate in the system. This would provide partial coverage should a fault occur while performing calibration on one relay.
After the switch is closed that shorts out the contacts belonging to the phase monitor relay to be adjusted, turn the voltage dial on the face of the selected power monitor relay completely counterclockwise until it can no longer turn. Next slowly turn the dial clockwise until the PWM relay trips and normal indicator reads “OFF” with the trip indicator reading “ON” (relay contacts opened). As soon as the relay trips, stop turning the dial and reverse the turn so that the dial is rotated counterclockwise once again. Stop turning when the dial is just past the point at which the relay tripped. Observe to see if this adjustment is stable and the relay does not sporadically turn off/on. If the relay does trip and cycle off/on, turn the dial once again a small amount counterclockwise. Repeat this procedure as necessary until the relay does not cycle under normal operating conditions.

For the time delay functions of Trip Delay and Reset Delay, turning both counterclockwise will adjust the time delay value of each to the maximum value. Turning clockwise will decrease the amount of Trip and Reset Delay time. The correct settings for the time delay functions are determined by actual use. If the relays have nuisance trips (relays occasionally trip with no apparent problems with the electrical power other than momentary surges), adjust the Trip Delay by turning counterclockwise until the nuisance trips stop. If, after the relays trip, it is desirable to have a greater amount of time before the relay resets after normal power returns, turn the Reset Delay time setting counterclockwise a small amount. A larger Reset Delay time can be desirable to protect some equipment and particularly to prevent frequent cycling from damaging air conditioning compressors in HVAC equipment. As was noted in the narrative above, after adjusting the settings ensure that the closed SW1 or SW2 (line 792) switch is left in an open position to enable Phase Monitor contactor C1 to de-energize on power faults.
20.0 GROUND FAULT PROTECTION SYSTEM

20.1 Ground Fault Relay System – A ground fault system is installed in CP-1 and consists of a
Ground fault relay GFR, System Ground Fault indicating light IL90 and two relays, R129 and R130 as
shown on drawing EC5, lines 777 through 784. The relay GFR is connected to a Ground Fault Sensor
as shown on drawing EC1 at line 2. It must be noted that the GFR relay is configured to alarm only
and not to de-energize any equipment due to a ground fault condition.

The ground fault sensor detects current flowing though the 480 VAC 3 phase bus at L1, L2 and L3.
Any imbalance variation between each of the 3 phases and the neutral bus beyond the setting of the
relay will cause the relay to energize turning on the connected System Ground Fault indicating light and
the two alarm relays.

If the relay should energize due to a ground fault condition, relays R129 and R130 send Ground Fault
alarms to the General Alarm system at line 1800, to SCADA at line 1925, to the Remote Annunciator at
line 1841 and to Telephone Dialer No.2 at line 2185.

The GFR relay has two adjustments available from the front of the relay. A Current Threshold pot
adjusts the level of imbalance current required to trip the relay and a Time Delay pot adjusts the
amount of time after the current threshold is reached before the relay actually trips. The time delay
feature is used to filter out nuisance and unwanted trips.

The GFR relay has two pushbuttons located on the face of the relay. One button, “Push to Test” will
simulate an alarm condition and cause the relay to trip thus testing the connected relays and light. The
other button, “Shunt Trip Bypass” will not be used in this application as the relay does not trip the main
breaker in CP-1.

The GFR relay also has one indicating LED mounted on the face of the relay that indicates “Power On”.
Another indicator, the “Trip Indicator” shows if the relay has tripped due to a fault condition. The Trip
Indicator must be manually reset.
21.0 CONTROL POWER MONITORING SYSTEM

21.1 24VAC Power Loss Monitor – The 24vac power loss monitor consists of 3 relays, R7 (line 796), R115 (line 998) and R116 (line 1173). R7 monitors the B/C bus, R115 monitors the B1/C1 bus and R116 monitors the B2/C2 bus. Because relays R115 and R116 have contacts (R115A and R116A, line 796) in series with the R7 relay coil, a power loss on any 24vac bus will de-energize R7 and send alarms to the Annunciator (R7E, line 1838) and Scada (R7C, line 1856) in addition to directly turning on the site strobe and audible alarms (R7B, line 423). In order to determine quickly which 24vac bus has failed, indicating lights mounted on the door of CP-1 will be turned off to indicate the failed bus. Indicating light IL4 monitors bus B/C, indicating light IL74 monitors bus B1/C1 and indicating light IL79 monitors bus B2/C2.

The B/C bus (lines 800 to 995) provides 24vac control power to the Aeration Blower motors/alarms B-01 and B-02 and Digester Blower motors/alarms DB-01 and DB-02. The B1/C1 (lines 997 to 1166) bus provides 24vac control power to the Digester Blower motors/alarms DB-01 and DB-02, and to the Septic Tank Pump motors/alarms STEP-01 and STEP-02. The B2/C2 bus (from line 1307 to 1420) supplies 24vac control power to the Waste Activated Sludge Pump motors/alarms WAS-01 and WAS-02, Aeration Basin No.1 and No.2 High level alarms, Digested Sludge Pump motor/alarm DSP-01, Secondary Clarifier Drive motor/alarm SCO-01, Secondary Clarifier and Aerobic Digester level alarms, Heat Tape alarms, UV System alarms, Generator alarms and the controls for the General Alarm System starting at line 1426.

21.2 24VDC Power Loss Monitor – The 24vdc control power buses are monitored by relays R1 (line 416), R2 (line 430), R5 (line 451) and R6 (line 453). R1 monitors the +1/-1 bus, R2 monitors the +2/-2 bus and R5 and R6 monitor the +3/-3 DC control power bus. Because relays R1 and R2 have contacts (R1A and R2A, line 451) in series with R5 and R6 relay coils, a power loss on any 24vdc bus will de-
energize R5 and R6 and send alarms to the General Alarm system (R5B, line 1685), Annunciator (R6C, line 1838), Scada (R5C, line 1857) and the Telephone Dialer No. 1 (R6B, line 2102). In order to determine quickly which 24vdc bus has failed, indicating lights mounted on the door of CP-1 will be turned off to indicate the failed bus. Indicating light IL1 monitors bus +1/-1, indicating light IL2 monitors bus +2/-2 and indicating light IL3 monitors bus +3/-3.

The +1/-1 bus (lines 413 to 423) provides 24vdc control power to the Site Strobe and Audible alarm system and to the Gel Cell backup batteries. The +2/-2 bus (lines 426 to 443) provides 24vdc control power to the analog loops for the Septic Tank Effluent pump seal alarms. The +3/-3 bus (lines 448 to 744) provides 24vdc control power to all 4-20ma analog loops, Septic Tank Level LT-1 and LT-2, Aeration Blower Pressure PT-1 and PT-2, Digester Blower Pressure PT-3 and PT-4, Influent Flow Rate FM-1, Lab Room Temperature TT-1, Equipment Room Temperature TT-2 and Outside Air Temperature TT-3.

22.0 UPS SYSTEM

22.1 UPS Overview

The installed UPS system provides 120vac conditioned power to all Set Point Controllers (SPC-1 through SPC-11, lines 455 through 775) and connected components. In addition, in the event of a power loss to CP-1, the UPS system will keep its connected load energized until power is restored or the UPS battery runs down.

22.2 UPS Power Source and Connected Loads - At line 407, the UPS is shown plugged in to a receptacle mounted within CP-1. The receptacle in turn is powered through GF1 from transformer CPT-1 at line 104. Shown plugged into the UPS unit are 3 plugs, one for 120vac bus A3/N3 (lines 407
and 444), another for PS3 (lines 408 and 447) and the last for the Auto Dialer No. 2 (lines 409, 2068 and 21321). The plug system is provided here for quick and easy UPS replacement should the unit fault and require repair.

22.3 UPS Operation – The UPS has three modes of operation: Normal, Bypass and Battery. When in normal mode, the UPS is connected to and receiving power from its 120vac source voltage. The backup battery is being charged and the unit is providing filtered, regulated power to its connected load.

If placed in Bypass mode, the unit is still connected to and receiving power from its 120vac source. The backup battery is being charged and the UPS unit is still providing filtered, but unregulated power to its connected load, since the internal rectifier and inverter is bypassed.

When the 120vac source of power fails or is disconnected from the UPS, the unit now switches to its backup battery, which in turn provides power to the connected load through the unit's internal rectifier and inverter.

22.4 Front Panel Controls and Indicator Lights – The UPS has two pushbuttons and seven indicator lights on its front panel. The top pushbutton turns the UPS on and puts the load online when pressed. The 2nd pushbutton turns the UPS off disconnecting power to the load when depressed. Under normal UPS operation, the top indicator light (Sine Wave Indicator) indicates that source power is being supplied to the UPS unit with the next 5 indicator lights showing the amount of power being provided to the connected load. The bottom light is off to show that the battery is not providing power to the connected load.
During a fault condition, the 1st light will turn off if the connected 120vac power source is lost. The 2nd light (Overload Indicator) will illuminate if the connected load draws more than the rated output current for the UPS unit. The 3rd light (Site Fault) illuminates to show an overall fault with the system. The 4th light (Overtemp) turns on to indicate that the unit temperature is higher than acceptable. The 5th light (Battery Fault) turns on to indicate a fault with the backup battery. The 6th light (Self-Test) turns on to indicate that the unit is in a self-test mode. The last light turns on to indicate that the battery is providing power to the load.

For additional detailed information concerning UPS operation and indicator light use, reference the owner’s manual found in section 16900 2.20 (Vol. 1) of the maintenance manual.

23.0 AUTO TELEPHONE DIALER SYSTEM

23.1 Auto Telephone Dialer Overview (See section 1.22.40 Telephone Dialer Setup and Calibration)

Panel CP-1 has an automated Telephone Dialer connected to the alarm system. The Dialer system consists of two units, no.1 and no.2, both of which are physically mounted inside B bay on the right side panel with Dialer No.1 mounted just above Dialer No.2. The Dialers are connected to the various alarms and status circuits as described in the preceding and following narrative and as shown on the schematic drawings starting at line 2068 and continuing through to line 2193. If an alarm occurs on any of the connected circuits, the Dialer automatically begins calling personnel to be notified as per a pre-programmed telephone list. The majority of alarms are connected to Dialer No.1. Reference the appropriate system description as described in this narrative for an explanation of each individually connected circuit.
23.2 Auto Telephone Dialer Operation

The Telephone Dialer, once configured and placed in operation, requires little care. However, there are some procedures that an operator may need to perform as explained in the Operations Manual under the Telephone Dialer Setup and Calibration section. Note in particular the explanation for the procedures to change phone numbers, turn the system on from a “Halt” condition and call in for status. For additional information, reference the manufacturer’s Installation and Operation Manual found in section 16900 2.47 of the O&M Manuals.

24.0 CP-1 ENCLOSURE HEATING and COOLING SYSTEM

24.1 Heating and Cooling Overview

Panel CP-1 has an installed heating and cooling system to maintain internal enclosure temperature within a predetermined range to keep temperatures from either decreasing too low or increasing too high.

24.2 Heating System - Two strip heaters (line 196) are installed that are controlled by a thermostat mounted on the left side panel in Bay C. The heating circuit is connected to circuit breaker CB-13. The thermostat is set to turn the heaters on at temperatures lower than approx. 50°F.

24.3 Cooling System - A ventilation fan (line 202) is installed that is controlled by a thermostat mounted on the left side panel in Bay C. The cooling circuit is connected to circuit breaker CB-14. The thermostat is set to turn the fan on at temperatures higher than approx. 90°F.
25.0 MOTOR OVERLOADS

25.1 Motor Overload Overview

The motor starters mounted in Bays C and D use a protection device called a motor overload. The motor overload device senses motor running current in a motor circuit and activates to turn the motor off if the current value increases to an amount that can damage the motor windings. Motor overload devices are located internally within each motor starter enclosure and have "reset" pushbuttons extruding through the front of the enclosure.

25.1 Motor Overload Reset – If a motor overload device senses an out of range motor current, the unit will “trip” and disconnect the motor starter from its control circuit thus de-energizing the motor and stopping the motor from overheating before it is damaged. Once the overload “trips”, it will remain in the tripped condition preventing the motor from starting until the overload unit is “reset” by pushing the reset button mounted in the face of each motor starter enclosure within CP-1. A tripped condition will be noticed when depressing the reset button in that when pushing on the button, some resistance will be noticed. On a unit that has not tripped, no resistance will be noticed when the button is depressed.

After an overload unit has tripped due to a motor overload condition and before depressing the reset button, the motor needs to be checked to ensure that it hasn’t been damaged.

Using the Digester Blower motor DB-01 (line 58) as an example, after opening the supply circuit breaker MCP-5 use the high voltage range (500 volts or more) on a multimeter and ensure that power has been disconnected from each motor supply conductor by reading the potential difference between each conductor (5M1, 5M2 and 5M3) and between each conductor and ground. After ensuring no power is present on the supply conductors, use the lowest scale resistance setting on the meter and
measure the resistance of each motor lead at terminals 5T1, 5T2 and 5T3. The amount of resistance will vary from approx. 10 ohms or higher for small motors to 5 ohms or less for larger motors. If the resistance reads 0 ohms, the motor is most likely shorted and will have to be replaced. If the resistance reads extremely high the motor has an open wire that will have to be repaired. Also read from each of the motor leads to a ground connection using a high resistance scale of 10,000 ohms or more. If the reading is 50,000 ohms or less, the insulation on the motor windings are most likely damaged and the motor will have to be replaced.

After taking the readings as described directly above, visually inspect the motor if possible. If the motor is extremely hot and especially if a noxious burnt smell is observed the motor is most likely damaged and must be replaced.

If the motor passes all inspections and readings, ensure that the multimeter is removed from any connection to the power circuit and re-energize the circuit by closing circuit breaker MCP-5. On the face of the motor starter, depress the reset button and if tripped, a small click will be felt in the button and also possibly heard. This click will indicate that the overload device was tripped and has been reset. It is possible that if the overload device has just tripped, depressing the reset button will not reset the device as not enough time has elapsed to cause the device to cool and reset. If this condition is observed, wait a short period of time (5 to 10 minutes) and depress the reset button once again. The 2nd attempt should reset the overload device.

After the overload device is reset, the motor starter will once again energize and run the motor if the motor is required to run by the control circuit connected to it.
26.0 ALARMS

26.1 Alarm Overview

The Multnomah Falls WWTP control system provides for a variety of alarm systems. One category of alarms consist of power loss on the 120 VAC control power bus (A1 & N1), any 24 VAC control power bus (B/C, B1/C1 and B2/C2) and any 24 VDC control power bus (+1/-1, +2/-2 and +3/-3). These alarms are connected to a relay activated alarm system as described below under section CP-1 Connected Alarms.

The great majority of alarms are generated by level switches, flow sensors, etc., connected to a relay activated alarm system located in the treatment plant control panel CP-1. Devices connected to the Annunciator Panel located in the Multnomah Falls Lodge generate remaining alarms. The CP-1 and Annunciator alarm relays are in turn connected to indicating lights located on the doors of CP-1, the remote Annunciator panel and Light Box panel, an Autodialer system and a Scada system. Audible alarms (Sonalerts) are provided on the doors of CP-1, the Annunciator panel, and the Remote Light Box. Additionally, a site alarm strobe and horn are mounted on the exterior face of the equipment room’s east wall.

26.2 Alarm System Operation

When alarms are received by the relay activated alarm system, each alarm is “latched” in by a separate relay belonging to the alarm system (relays R50 through R124, lines 1428 through 1672). The “latching” of the relay means that the alarm will remain extant regardless of the state (energized or de-energized) of the alarming relay. Each alarm will then continue to alarm until reset by an operator at the CP-1 panel or remotely by Scada.
For example, if an Aeration Blower High Pressure alarm is received by the system at line 1434, TD3 closes its contact TD3D and relay R51 is energized (along with alarm light IL35) closing its R51A contacts (line 1436) and turning on the alarms it is connected to through its remaining contacts (lines 1689 and 1872). This alarm condition remains true even if the initiating relay TD3 de-energizes and opens its contact TD3D because the R51A closed contact keeps relay R51 energized irregardless of the open or close state of TD3D because R51A is connected in parallel across the TD3D contact. The alarm can only be reset when both TD3D contact opens and 24 VAC power is removed from wire R by either an operator pushing the Alarm Reset pushbutton (PB4) mounted on CP-1 or remotely by Scada energizing R49 (line 1420) and thereby opening contact R49B (line 1428).

It should be noted that when resetting alarms by pushing PB4 or by Scada action (R49B), if the initiating contact closure (TD3D in this case) remains closed, the alarm will momentarily be turned off only as long as PB4 is depressed or R49 is energized and before time delay relay TD34 (line 1432) closes its contact TD34A (line 1428). Once PB4 is released or R49 is de-energized and TD34 times out, the alarm will once again be active as the initiating contact (TD3D) is still closed.

26.3 Battery Backup External Site Alarms

A Battery Backup External Site alarm system is provided for with a Strobe Light and Alarm Horn mounted on the east exterior wall of the maintenance building. The system annunciates General and Bus Failure alarms to personnel working outside the maintenance building. The controls to operate this system are shown at lines 417 through 423.

Under normal conditions, power supply PS-1 (line 411) supplies 24 VDC power to wires +1 and –1 charging the Gel Cell batteries (line 417) and energizing relay R1 (line 416). Relay R1 in turn holds its contact R1C (line 419) open and closes contact R1D (line 421). This action by relay R1 prevents the
external Strobe Light (line 419) and the external Alarm Horn (line 421) from turning on in the absence of fault conditions and also enables General and Bus Power Loss alarms to be announced on the External Site alarm system.

When a General Alarm occurs in the alarm system, relay R111 (line 1799) is energized. Relay R111 contacts R111A (line 421) will close and because relay contact R1D (line 421) is closed during normal PS-1 operation, the External Site Strobe Light and Alarm Horn will be energized announcing the alarm condition to the treatment plant site. Also, if any 24 VAC bus alarm occurs, relay R7 (line 796) will de-energize closing its contact R7B (line 421) which, as was true with the General alarm, will cause the External Site alarm system to actuate.

If 120 VAC power is lost to power supply PS-1 (line 411), if PS-1 internally faults and no longer provides 24 VDC power or if a fault occurs in the wiring to relay R1, the relay will de-energize. Because diode D1 (line 417) prevents a reverse electrical current from the Gel Cell batteries from flowing through the diode to relay R1, the relay remains de-energized. Because R1 is de-energized, relay contact R1C is closed applying 24 VDC power from the batteries to the External Site alarm system Strobe Light and Alarm Horn annunciating the loss of power to wires +1 and -1. In addition, contact R1D opens to prevent relay R1 from being energized by the batteries should a General alarm (R111A) or 24 VAC Bus Failure alarm (R7B) be current.

The External Site alarm system will continue to alarm until either 24 VDC power is restored to the +1 and −1 wires, the batteries lose their charge (approx. 30 hours), CB19 (line 417) is opened, or, for the Alarm Horn only, Horn selector switch SS3 (line 421) is turned to the Off position.
After 24 VDC power is restored to the +1 and –1 wires, relay R1 automatically energizes to restore the system to normal operation.

26.4 CP-1 Connected Alarms

Individual alarms are listed below in alphabetical order with a description of the activating device and a description of the alarm systems energized by each alarm relay.

26.4.1 AC (24VAC) Power Failure Alarm – Relay R7 (line 796) is turned off by the opening contact R115A (BUS B1/C1, R115 at line 998) or R116A (Bus B2/C2, R116 at line 1175) or by the loss of 24VAC power from CPT-2 (Bus B/C line 788). R7B enables the external plant strobe, horn, and CP-1 Sonalert (lines 419, 421, 423), the Remote Annunciator Panel R7E (line 1838) and at Scada R7C (line 1856).

26.4.2 Aeration Basin No. 1 High Level Alarm – R89/R90 (lines 1576/1578) are energized by TD23A which is activated by the coil of TD23 at line 1235 after the delay period times out when LS-1 (line 1235) closes due to a high level condition. This alarm is annunciated by R90D at the CP-1 General Alarm (line 1738) by R89D at the remote Annunciator Panel (line 1832) and by R90F for Scada (line 1897) & R89A for the Autodialer No. 1.

26.4.3 Aeration Basin No. 2 High Level Alarm – R91/R92 (lines 1583/1585) are energized by TD24A which is activated by the coil of TD24 at line 1242 after the delay period times out when LS-2 (line 1242) closes due to a high level condition. This alarm is annunciated by R92D at the CP-1 General Alarm (line 1740) by R91D remote Annunciator Panel (line 1833) and by R92F for Scada (line 1898) & R91A for the Autodialer No. 1.

26.4.4 Aeration Blower B-01 High Pressure Alarm – R51 (line 1434) is energized by TD3D which is activated by the coil of TD3 at line 820 after the delay period times out when SPC-3 alarm
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contact AL-2 (line 820) closes due to a high pressure condition, when blower is running (879). This alarm is annunciated by R51D at the CP-1 General Alarm (line 1689) and by R51F for Scada (line 1872).

26.4.5 Aeration Blower B-02 High Pressure Alarm – R56 (line 1454) is energized by TD7D which is activated by the coil of TD7 at line 853 after the delay period times out when SPC-4 alarm contact AL-2 (line 853) closes due to a high pressure condition, when blower is running (907). This alarm is annunciated by R56D at the CP-1 General Alarm (line 1695) and by R56F for Scada (line 1876).

26.4.6 Aeration Blower B-01 High Temperature Alarm – R52 (line 1438) is energized by TD4D which is activated by the coil of TD4 at line 826 after the delay period times out when TS1 closes due to a high temperature condition. This alarm is annunciated by R52D at the CP-1 General Alarm (line 1691) and by R52F for Scada (line 1873).

26.4.7 Aeration Blower B-02 High Temperature Alarm – R57 (line 1458) is energized by TD8D which is activated by the coil of TD8 at line 860 after the delay period times out when TS-2 closes due to a high temperature condition. This alarm is annunciated by R57D at the CP-1 General Alarm (line 1697) and by R57F for Scada (line 1877).

26.4.8 Aeration Blower B-01 Low Flow Alarm – R50 (line 1428) is energized by TD1D which is activated by the coil of TD1 at line 811 after the delay period times out when FS1 closes due to a low flow condition when blower is running (line 879). This alarm is annunciated by R50D at the CP-1 General Alarm (line 1687) and by R50F for Scada (line 1871).

26.4.9 Aeration Blower B-02 Low Flow Alarm – R55 (line 1450) is energized by TD5D which is activated by the coil of TD5 at line 844 after the delay period times out when FS2 closes due to a low flow condition when blower is running (line 907). This alarm is annunciated by R55D at the CP-1 General Alarm (line 1693) and by R55F for Scada (line 1875).
26.4.10 Aeration Blower B-01 Low Pressure Alarm – R54 (line 1446) is energized by TD2D which is activated by the coil of TD2 at line 815 after the delay period times out when SPC-3 alarm contact AL-1 (line 815) closes due to a low pressure condition when blower is running (line 879). This alarm is annunciated by R54D at the CP-1 General Alarm (line 1786) and by R54F for Scada (line 1874).

26.4.11 Aeration Blower B-02 Low Pressure Alarm – R59 (line 1466) is energized by TD6D which is activated by the coil of TD6 at line 848 after the delay period times out when SPC-4 alarm contact AL-1 (line 848) closes due to a low pressure condition when blower is running (line 907). This alarm is annunciated by R59D at the CP-1 General Alarm (line 1788) and by R59F for Scada (line 1878).

26.4.12 Aerobic Digester No. 1 High Level Alarm – R97/R98 (lines 1606/1609) are energized by TD31A which is activated by the coil of TD31 at line 1373 after the delay period times out after LS-5 closes due to a digester high level condition. This alarm is annunciated by R98D at the CP-1 General Alarm (line 1746) by R97A for the Autodialer No. 1 (liner 2127) and by R98F for Scada (line 1902).

26.4.13 Aerobic Digester No. 2 High Level Alarm – R99/R100 (lines 1613/1615) are energized by TD32A which is activated by the coil of TD32 at line 1380 after the delay period times out after LS-6 closes due to a digester high level condition. This alarm is annunciated by R100D at the CP-1 General Alarm (line 1748) by R99A for the Autodialer No. 1 (line 2135) and by R100F for Scada (line 1903).

26.4.14 ATS Transferred Alarm – R109/R110 (lines 1658/1660) and IL71 (line 1662) are energized by an ATS Auxiliary contact at line 1660 after the transfer switch shifts. This alarm is annunciated by R110D at the CP-1 General Alarm (line 1790), by R109A for the remote Annunciator Panel (line 1837), by R109D for the Autodialer No. 1 (line 2100) and by R110F for Scada (line 1910).
26.4.15 Blower Fail Alarm – R70 (line 1507) is energized by any one of the individual blower failed alarms, Aeration Blower No. 1 (R53F, line 1505), Aeration Blower No. 2 (R58F, line 1507), Digester Blower DB-01 (R63F, line 1509) or Digester Blower DB-02 (R68F, line 1511). This alarm is annunciated by R70A at the remote Annunciator Panel (line 1831) and by R70D at the Autodialer No. 1 (line 2092).

Relay R53 (line 1442) is energized by contact R9A (line 1442) which is closed when relay R9 (line 833) energizes due to the contact closure of either TD3A (line 831), TD1A (line 833), TD4A (line 835), R11E (line 837) or TD2A (line 839). These contacts are in turn closed when any of the various Aeration Blower B-01 faults occur, TD1 (line 811) Blower B-01 Low Flow, TD2 (line 815) Blower B-01 Low Pressure, TD3 (line 830) Blower B-01 High Pressure, TD4 (line 826) Blower B-01 High Temperature and R11 (line 876) Blower B-01 VFD Fault. The functional description for time delay relays TD 1 through TD4 and relay R11 was given in the Aeration Blower B-01 functional description in the above narrative. Also, relay R53 contacts R53A and R53B (lines 888 & 889) were discussed at the same location.

Relay R58 (line 1462) is energized by contact R10A (line 1462), which is closed when relay R10 (line 865) energizes due to the contact closure of either TD7A (line 863), TD5A (line 844), TD8A (line 860), R13E (line 904) or TD6A (line 848). These contacts are in turn closed when any of the various Aeration Blower B-02 faults occur, TD5 (line 844) Blower B-02 Low Flow, TD6 (line 848) Blower B-02 Low Pressure, TD7 (line 853) Blower B-02 High Pressure, TD8 (line 860) Blower B-02 High Temperature and R13 (line 904) Blower B-02 VFD Fault. The functional description for time delay relays TD5 through TD8 and relay R13 was given in the Aeration Blower B-02 functional description in the above narrative. Also, relay R58 contacts R53A and R53B (lines 895 & 896) were discussed at the same location.
Relay R63 (line 1484) is energized by contact R15A (line 1484), which is closed when relay R15 (line 918) energizes due to the contact closure of either TD9A (line 916), TD10A (line 937), TD12A (line 951), R17E (line 1004) or TD11A (line 944). These contacts are in turn closed when any of the various Digester Blower B-01 faults occur, TD9 (line 930) Blower DB-01 Low Pressure, TD10 (line 937) Blower DB-01 High Pressure, TD11 (line 944) Blower DB-01 Low Flow, TD12 (line 951) Blower DB-01 High Temperature and R17 (line 1004) Blower DB-01 Overload. The functional description for time delay relays TD9 through TD12 and relay R17 was given in the Digester Blower DB-01 functional description in the above narrative. Also, relay R63 contacts R63A and R63B (lines 1017 & 1016) were discussed at the same location.

Relay R68 (line 1499) is energized by contact R16A (line 1499), which is closed when relay R16 (line 962) energizes due to the contact closure of either TD13A (line 960), TD14A (line 981), TD16A (line 995), R19E (line 1032) or TD15A (line 988). These contacts are in turn closed when any of the various Digester Blower B-02 faults occur, TD13 (line 974) Blower DB-02 Low Pressure, TD14 (line 981) Blower DB-02 High Pressure, TD15 (line 988) Blower DB-02 Low Flow, TD16 (line 995) Blower DB-02 High Temperature and R19 (line 1032) Blower DB-02 Overload. The functional description for time delay relays TD13 through TD16 and relay R19 was given in the Digester Blower DB-02 functional description in the above narrative. Also, relay R68 contacts R68A and R68B (lines 1023 & 1024) were discussed at the same location.

26.4.16 B-01 OL/BT Alarm – Aeration Blower B-01 VFD Fault/Breaker Tripped alarm is turned on by R11/R12 (line 876/877) if CB-4 opens or if VFD-01 fault trips. This alarm is annunciated by R11C at the CP-1 General Alarm (line 1762) and by R12C at Scada (line 1859).

26.4.17 B-02 OL/BT Alarm – Aeration Blower B-02 VFD Fault/Breaker Tripped alarm is turned on by R13/R14 (line 904/905) if CB-5 opens or if VFD-02 Fault trips. This alarm is annunciated by R13C at the CP-1 General Alarm (line 1764) and by R14C at Scada (line 1860).
26.4.18 Clarifier High Level Alarm – R95/R96 (lines 1600/1602) are energized by TD30A which is activated by the coil of TD30 at line 1366 after the delay period times out when LS-3 closes due to a Clarifier high level condition. This alarm is annunciated by R96D at the CP-1 General Alarm (line 1744) by R96F at Scada (line 1901) and by R95A at the Autodialer No. 1 (line 2096).

26.4.19 DC (24VDC) Power Failure Alarm – Relays R5/R6 (lines 451/453) are turned off by the opening of contacts R2A or R1A (line 451) or by the loss of DC power supply PS-3 (line 450). This alarm is annunciated by R5B at the CP-1 General Alarm (line 1685), by R6C at the Remote Annunciator Panel (line 1838), by R5C at Scada (line 1857) and by R6B at the Autodialer No. 1 (line 2102).

26.4.20 DB-01 OL/BT Alarm – Digester blower DB-01 Overload/Breaker Tripped alarm is turned on by R17/R18 (lines 1004/1006) if MCP-5 opens or if OL-5 overload trips. This alarm is annunciated by R17C at the CP-1 General Alarm (line 1768) and by R18C at Scada (line 1861).

26.4.21 DB-02 OL/BT Alarm – Digester Blower DB-02 Overload/Breaker Tripped alarm is turned on by R19/R20 (lines 1032/1034) if MCP-6 opens or if OL-6 overload trips. This alarm is annunciated by R19C at the CP-1 General Alarm (line 1774) and by R20C at Scada (line 1862).

26.4.22 DSP-01 OL/BT Alarm – Digester Sludge Pump DSP-01 Overload/Breaker Tripped alarm is turned on by R41 (line 1326) if MCP-8 opens or if OL-8 overload trips. This alarm is annunciated by R41C at the CP-1 General Alarm (line 1778) and by R41E at Scada (line 1870).

26.4.23 DSP-01 Wetwell Low Level Alarm – Digested Sludge Wetwell low level alarm relays R106/R107 (lines 1644/1646) are energized by TD28A which is activated by the coil of TD28 at line 1344 after the delay period times out after LS-13 (line 1346) closes due to a digested sludge wetwell high level condition. This alarm is annunciated by R107D at the CP-1 General Alarm (line 1752) by R106D at the Autodialer No. 2 (line 2141) and by R106F at Scada (line 1896).
26.4.24 Digester Blower DB-01 High Alarm – R61 (line 1475) is energized by TD10D which is activated by the coil of TD10 at line 937 after the delay period times out when SPC-5 alarm contact AL-2 (line 937) closes due to a high pressure condition, when blower is running (line 1007). This alarm is annunciated by R61D at the CP-1 General Alarm (line 1699) and by R61F at Scada (line 1880).

26.4.25 Digester Blower DB-02 High Pressure Alarm – R66 (line 1490) is energized by TD14D which is activated by the coil of TD14 at line 981 after the delay period times out when SPC-6 alarm contact AL-2 (line 981) closes due to a high pressure condition, when blower is running (line 1035). This alarm is annunciated by R66D at the CP-1 General Alarm (line 1703) and by R66F at Scada (line 1883).

26.4.26 Digester Blower DB-01 High Temperature Alarm – R62 (line 1478) is energized by TD12D which is activated by the coil of TD12 at line 951 after the delay period times out when TS-3 closes due to a high temperature condition. This alarm is annunciated by R62D at the CP-1 General Alarm (line 1701) and by R62F at Scada (line 1881).

26.4.27 Digester Blower DB-02 High Temperature Alarm – R67 (line 1493) is energized by TD16D which is activated by the coil of TD16 at line 995 after the delay period times out when TS-4 closes due to a high temperature condition. This alarm is annunciated by R67D at the CP-1 General Alarm (line 1706) and by R67F at Scada (line 1884).

26.4.28 Digester Blower DB-01 Low Flow Alarm – R64 (line 1481) is energized by TD11D which is activated by the coil of TD11 at line 944 after the delay period times out when FS-3 closes due to a low flow condition, when blower is running (line 1007). This alarm is annunciated by R64D at the CP-1 General Alarm (line 1792) and by R64F at Scada (line 1921).
26.4.29 **Digester Blower DB-02 Low Flow Alarm** – R69 (line 1496) is energized by TD15D which is activated by the coil of TD15 at line 988 after the delay period times out when FS-4 closes due to a low flow condition, when blower is running (line 1035). This alarm is annunciated by R69D at the CP-1 General Alarm (line 1794) and by R69F at Scada (line 1922).

26.4.30 **Digester Blower DB-01 Low Pressure Alarm** – R60 (line 1472) is energized by TD9D which is activated by the coil of TD9 at line 930 after the delay period times out when SPC-5 alarm contact AL-1 (line 930) closes due to a low pressure condition, when blower is running (line 1008). This alarm is annunciated by R60D at the CP-1 General Alarm (line 1718) and by R60F at Scada (line 1879).

26.4.31 **Digester Blower DB-02 Low Pressure Alarm** – R65 (line 1487) is energized by TD13D which is activated by the coil of TD13 at line 974 after the delay period times out when SPC-6 alarm contact AL-1 (line 974) closes due to a low pressure condition, when blower is running (line 1008). This alarm is annunciated by R65D at the CP-1 General Alarm (line 1720) and by R65F at Scada (line 1882).

26.4.32 **Equipment Room High Temperature Alarm** – R124 (line 1654) is energized by SPC-9 alarm contact AL-2 (line 1653) due to a high temperature condition in the Equipment Room. This alarm is annunciated by R124A at the CP-1 General alarm (line 1798) by R124D at Scada (line 1924) and by R124F at the Autodialer No. 2 (line 2150).

26.4.33 **General Alarm CP-1** – Relay R111 (line 1799) is energized by contacts as indicated from line 1685 through line 1798. This alarm is annunciated by R111A at the CP-1 Panel (line 421) by R111D at the remote Annunciator Panel (line 1841) and by R111F at the Autodialer No. 2 (line 2115).
26.4.34 Heat Tape HT-01 BT Alarm - HT-01 Breaker Tripped alarm is turned on by R121 (line 177) if CB-9 opens, R121A de-energizes relay coil R45 (line 1388). This alarm is annunciated by R45C at the CP-1 General Alarm (line 1766) and by R45E at Scada (line 1869).

26.4.35 Generator Running – When the Emergency Generator is running, generator controls close a contact (line 1415) shown as relay RR1 line 2031 and 2034 located in the control panel mounted on the generator set. If toggle switch TS 40 is in the A position, relay R48 (line 1415) will energize along with Generator Running indicating light IL33 (line 1417). Contact R48D (line 1830) or Contact R109A line 1837 ATS Transfer, closes to provide an alarm to the Annunciator Panel, contact R48F line 1909 & R110F line 1910 closes to annunciate to Scada and contact R48A (line 2090) closes to annunciate the alarm to the Auto Dialer No.1. It should be noted that the Generator Running alarm is not included with the General Alarms. It should also be noted that this is not an alarm in the truest sense of the word as the Generator may be running only because of a test or for maintenance purposes.

26.4.36 Generator Failed – The Generator Failed alarm is unique from other alarms connected to the alarm system. The contacts for this alarm are controlled by relay RA1 found in the Generator control panel as indicated on lines 2029, 2033, 2183 and 2177. However, the only remote method of annunciation for the alarm is through the Autodialer No. 1 as shown on lines 2183 and 2177. The alarm is on only as long as it is generated by the Generator control panel.

26.4.35 Lab Building Fire Alarm – R125 (line 1675) is energized by a smoke detector in the Lab Building. This alarm is annunciated by R125A at the remote Annunciator (line 1840) and by R125D at the Autodialer No. 1 (line 2113).
26.4.36 Lab Building High Temperature Alarm – R123 (line 1651) is energized by SPC-8 alarm contact AL-2 (line 1650) or SPC-8 alarm contact AL-1 (line 1652), due to a high temperature condition in the Lab Building. This alarm is annunciated by R123A at the CP-1 General Alarm (line 1796), by R123D at Scada (line 1923) and by R123F at the Autodialer No. 2 (line 2143).

26.4.37 Lab Building Intrusion Alarm – TD40 (line 1677) is energized by an intruder at either door switch No. 1 (line 1677) or by door switch No. 2 (line 1678) (Plan sheet EC12, line 1678, should read Door Switch No. 2) in the Lab Building. This alarm is annunciated by TD40D at the remote Annunciator Panel (line 1839) and by TD40A at the Autodialer No. 1 (line 2104). The Key Switch shown on line 1680 is used to prevent a false Intrusion alarm from being sent when authorized personnel enter the administration building. The switch is located in a box mounted to the right of the main entry door on the south side of the building. The switch must be turned to the Off position before TD40 (line 1677) times out once Door Switches No.1 and No.2 located at each entry door have closed due to an opened door.

26.4.38 Return Activated Sludge Pump RAS-01 Flow Failed Alarm – Relay R83/84 (lines 1557/1559) are energized by TD21A when pump RAS-01 is in the run condition, M9A (line 1263) closed providing power to contact R32A (line 1198), level switch LS-7 closes energizing relay R32 (line 1189) which closes R32A energizing time delay relay TD21 (line 1198) closing contact TD21A (line 1559) after the delay period times out. This alarm is annunciated by R83A at the CP-a General Alarm (line 1730), by R83F at Scada (line 1892), and by R84F at the Autodialer No. 1 (line 2119).

26.4.39 Return Activated Sludge Pump RAS-01 Wetwell Low Level Alarm – Relay R85 (line 1563) is energized by R33D which is activated by the coil of R33 at line 1220 if LS-9 closes due to a low level condition. This alarm is annunciated by R85D at the CP-1 General Alarm (line 1732) and by R85F at Scada (line 1893).
26.4.40 Return Activated Sludge Pump RAS-02 Flow Failed Alarm – Relays R86/87 (lines 1566/1568) are energized by TD22A when pump RAS-02 is in the run condition, M10A (line 1292) closed providing power to contact R32D (line 1204), level switch LS-7 closes energizing relay R32 (line 1189) which closes R32D energizing time delay relay TD22 (line 1204) closing contact TD22A (line 1568) after the delay period times out. When relay R86 is energized, it closes contact R86D (line 1734) to turn on a General alarm and contact R86F (line 1894) to send an alarm to Scada. When relay R87 energizes, contact R87F (line 2121) closes to annunciate to the Autodialer No. 1.

26.4.41 Return Activated Sludge Pump RAS-02 Wetwell Low Level Alarm – Relay R88 (line 1572) is energized by R34D which is activated by the coil of R34 at line 1227 if LS-10 closes due to a low level condition. This alarm is annunciated by R88D at the CP-1 General Alarm (line 1736) and by R88F at Scada (line 1895).

26.4.42 Return Activated Sludge Pumps RAS-01 & RAS-02 Failed Alarm. – Relay R112 (line 1666) is energized by R83D (line 1664, Ras Pump Ras-01 Low Flow Alarm), R86D (line 1666, Ras Pump Ras-02 Low Flow Alarm), R35E (line 1668, Ras Pump Ras-01 OL/BT alarm) and R37E (line 1672, Ras Pump Ras-02 OL/BT Alarm). This alarm is annunciated by R112D at the remote Annunciator Panel (line 1835).

26.4.43 Secondary Clarifier SCO-01 Over Torque Alarm – Relays R93/94 (lines 1590/1592) are energized by TD29A which is activated by the coil of TD29 (line 1359) after the delay period times out if the over torque limit switch (line 1361) closes due to an over torque condition. This alarm is annunciated by R94D at the CP-1 General Alarm (line 1742) by R93A at the remote Annunciator (line 1834) by R94F at Scada (line 1900) and by R93D at the Autodialer No. 1 (line 2094).

26.4.44 SCO-01 OL/BT Alarm – Secondary Clarifier SCO-01 Overload/Breaker Tripped alarm is enabled by relay R44 (line 1353) if MCP-7 opens or if OL-7 overload trips. This alarm is annunciated by R44C at the CP-1 General alarm (line 1776) and by R44E at Scada (line 1868).
26.4.45 **Septic Tank High Level Alarm** – Relays R73/74 (lines 1519/1521) are energized by R26A which is activated by the coil of R26 (line 1099) if the high level contact AL-2 on SPC-1 (line 1099) or high level contact AL-2 on SPC-2 (line 1102) closes due to a high level condition. This alarm is annunciated by R74D at the CP-1 General Alarm (line 1710) by R73A at the remote Annunciator (line 1828) by R74F at Scada (line 1886) and by R73D at the Autodialer No. 1 (line 2083).

26.4.46 **Septic Tank Low Level Alarm** – Relays R71/72 (lines 1515/1516) are energized by R25A which is activated by the coil of R25 (line 1092) if the high level contact AL-1 on SPC-1 (line 1092) or low level contact AL-1 on SPC-2 (line 1095) closes due to a low-level condition. This alarm is annunciated by R72D at the CP-1 General Alarm (line 1708) by R71A at the remote Annunciator (line 1829) by R72F at Scada (line 1885) and by R71D at the Autodialer No. 1 (line 2085).

26.4.47 **Septic Tank Effluent Pump STEP-01 Flow Failed Alarm** – Relays R75/76 (lines 1525/1527) are energized by TD18A when pump STEP-01 is in the run condition, M1A (line 1136) is closed providing power to contact R31A (line 1110), SPC-7 alarm contact AL-1 closes energizing relay R31 (line 1106) which closes R31A energizing time delay relay TD18 (line 1110) closing contact TD18A (line 1527) after the delay period times out. This alarm is annunciated by R76D at the CP-1 General Alarm (line 1712) by R75F at the remote Annunciator Panel (line 1826) by R76F at Scada (line 1887) and by R75D at the Autodialer No. 1 (line 2079).

26.4.48 **Septic Tank Effluent Pump STEP-02 Flow Failed Alarm** – Relays R78/79 (lines 1535/1537) are energized by TD19A when pump STEP-02 is in the run condition, M2A (line 1164) is closed providing power to contact R31D (line 1118), SPC-7 alarm contact AL-1 closes energizing relay R31 (line 1106) which closes R31D energizing time delay relay TD19 (line 1118) closing contact TD19A (line 1537) after the delay period times out. This alarm is annunciated by R79D at the CP-1 General Alarm (line 1716) by R78F at the remote Annunciator Panel (line 1827) by R79F at Scada (line 1889) and by R78D at the Autodialer No. 1 (line 2081).
26.4.49 Septic Tank Effluent Pumps STEP-01 & STEP-02 Flow Failed Alarm – Relays R81/82 (lines 1545/1547) are energized by TD20A which is activated by the coil of TD20 (line 1125) when auxiliary motor starter contacts M1C and M2C (line 1125) are closed (both pumps running) and if the flow failed contact AL-2 on SPC-7 (line 1125) closes due a flow failed condition. This alarm is annunciated by R82D at the CP-1 General Alarm (line 1724) by R82F at Scada (line 1891) and by R81D at the Autodialer No. 1 (line 2117).

26.4.50 Septic Tank Effluent Pump STEP-01 Seal Failed Alarm – Relay R77 (line 1531) is energized by R3A which is activated by the coil of R3 (line 433) if the moisture probe for pump STEP-01 senses moisture in the motor due to a failed motor seal. This alarm is annunciated by R77D at the CP-1 General Alarm (line 1714) and by R77F at Scada (line 1888).

26.4.51 Septic Tank Effluent Pump STEP-02 Seal Failed Alarm – Relay R80 (line 1541) is energized by R4A which is activated by the coil of R4 (line 439) if the moisture probe for pump STEP-02 senses moisture in the motor due to a failed motor seal. This alarm is annunciated by R80D at the CP-1 General Alarm (line 1722) and by R80F at Scada (line 1890).

26.4.52 STEP-01 OL/BT Alarm – Septic Tank Effluent Pump STEP-01 Overload/Breaker Tripped alarm is turned on by R27/28 (lines 1132/1134) if MCP-1 opens or if OL-1 overload trips. This alarm is annunciated by R27C at the CP-1 General Alarm (line 1758) and by R28C at Scada (line 1863).

26.4.53 STEP-02 OL/BT Alarm – Septic Tank Effluent Pump STEP-02 Overload/Breaker Tripped alarm is turned on by R29/30 (lines 1160/1162) if MCP-2 opens or if OL-2 overload trips. This alarm is annunciated by R29C at the CP-1 General Alarm (line 1760) and by R30C at Scada (line 1864).
Multnomah Falls WWTP Functional Descriptions – Continued:

26.4.54 Waste Activated Sludge Wetwell Level Low Alarm – When low level switch LS-12 (line 1320) opens time delay relay TD26 (line 1318) de-energizes closing contact TD26C (line 1634) which energizes relays R105/113 (lines 1634/1632) enabling the WAS wetwell low level alarm. This alarm is annunciated by R105D at the CP-1 General Alarm (line 1750) by R105F at Scada (line 1906) and by R113A at the Autodialer No. 2 (line 2139).

26.4.55 WAS-01 OL/BT Alarm – Waste Activated Sludge Pump WAS-01 Overload/ Breaker Tripped alarm is turned on by R39 (line 1305) if MCP-11 opens or OL-11 overload trips. This alarm is annunciated by R39C at the CP-1 General Alarm (line 1784) and by R39E at Scada (line 1867).

26.4.56 Ultra Violet High Level Alarm – Relays R101/102 (lines 1620/1622) are energized by TD33A which, is activated by the coil of TD33 (line 1404) if the level switch LS-4 closes due to a high level condition. This alarm is annunciated by R102D at the CP-1 General Alarm (line 1756), by R102F at Scada (line 1904) and by R101A at the Autodialer No. 2 (line 2137).

26.4.57 Ultra Violet System Fail Alarm – Relays R103/104 (lines 1626/1628) are energized by TD39B which is activated by the coil of TD39 (line 1400) if CB-12 or if contact R47B opens due to an Ultra-Violet Major alarm (UV System Fail alarm at UV cabinet) contact closure (line 1410). This alarm is annunciated by R104D at the CP-1 General Alarm (line 1754), by R104F at Scada (line 1905), by R103D at the Autodialer No. 1 (line 2098) and by R103A at the annunciator (line 1836).
ANNUNCIATOR PANEL FUNCTIONAL DESCRIPTIONS:

Reference: Schematic Diagrams ANE1 through ANE3

ANNUNCIATOR SCOPE

The following functional description is a detailed technical description of normal operation of the electrical controls in the Annunciator and connected Remote Light Box.

Annunciator Location = MF Lodge/Service Entrance/Dry Food Storage Area.

Remote Light Box Location = MF Lodge/2nd Floor/Behind Cash Register in Stairway.

This description is intended to be used with the system schematic drawings. Reference to line numbers applies to the schematic line number to assist in locating the parts on the schematic. The line numbers are on the left-hand side of the schematic drawing vertically arranged and in consecutive order. Other numbers used on the schematic include wire numbers (which are based on line numbers with suffixes A, B, C, etc. added to differentiate between different electrical logic points and are usually located directly beneath the line representing the number) and device terminal numbers (usually located above the line representing the number and adjacent to the connection point).

This description does not include any details on abnormal or unusual conditions. Isolated functions that are independent will be described separately to simplify and clarify this functional description.

The operating instructions for this system are more general and intended to give an overall picture of the operation without technical details. A review of the operating instruction may be helpful before starting study of the following functional description.
1.0 ANNUNCIATOR GENERAL

It is assumed that the start-up procedure in the operating instruction has been followed. Control power is assumed to be available and all essential circuit breakers have been closed. The output functions of this control are primarily for the remote monitoring, (from MF Lodge), of alarm signals and equipment status in the treatment plant (CP-1 generated alarms and status indications as discussed in the above narrative). In addition, this panel contains components used to monitor and control the Well House pump motor and Well House Water Tank Level LT-3.

2.0 ANNUNCIATOR POWER MONITORING RELAY

2.1 Power Monitor Relay – The Annunciator panel has a power monitor relay MR1 (line 4016) that measures the level of power supplied to the panel. If the level of power varies either higher or lower than preset levels, the relay will trip, open its contact MR1-A (line 4014) and turn on the under or over voltage LED indicator lights mounted in the relay. When contact MR1-A opens, power is disconnected from bus A2/N2 effectively shutting down the Annunciator panel. When power returns to normal values, MR1 will automatically reset and close its MR1-A contact thus restoring power to connected components. The LED indicators will also turn off. The power monitor relay does not directly alarm to a remote alarm site but when a power loss of any source occurs, relay R11 (line 4306) will alarm loss of power including the opening of MR1-A contacts.

2.1 Power Monitor Relay Bypass Switch – A Bypass switch SW1 (line 4016) has been installed to allow continued operation of the Annunciator panel should the Power Monitor relay fault or should it be determined that operation of the panel is required in a low or high voltage condition. Moving the switch to the Off Bypass position will effectively short out the MR1-A contacts (line 4014) and allow power to be applied to connected components regardless of the state of the contacts (open or closed). Care
must be used to ensure that when the Bypass feature is no longer required, Sw1 must be returned to
the Normal On position to enable MR1 to protect connected components from voltage fault conditions.

2.2 Power Monitor Relay Adjustment – The Power Monitor relay can be adjusted if required as
follows:

➢ Before doing any adjusting, turn Bypass Switch SW1 to the Off Bypass position to avoid loosing
power during the adjustment procedure.

➢ Turn the under voltage adjustment pot clockwise until the relay trips and the under voltage LED
turns on. Stop turning the pot and reverse turning direction counterclockwise. Rotate slowly
just until the relay turns back on and the LED turns off. Stop at this point.

➢ Next rotate the over voltage adjustment pot counterclockwise until the relay trips and the over
voltage LED turns on. Stop turning the pot and reverse turning clockwise direction. Rotate
slowly just until the relay turns back on and the LED turns off. Stop at this point.

➢ Ensure that the Bypass Switch SW1 is returned to the Normal On position before leaving the
Annunciator panel.

For other methods of adjusting the relay, reference the Maintenance Manual section 16900, 2.28I for
additional instructions.

3.0 ANNUNCIATOR POWER SURGE PROTECTION

3.1 Surge Protector– The Annunciator panel has a power surge protector (or Transient Voltage Surge
Suppressor, TVSS, line 4001) connected to its supply transformer CPT-1 to provide protection for
connected equipment against power surges and spikes that can occur in the power supply system.

When high voltage spikes and surges due to lightning strikes or other equipment connected elsewhere
in the electrical distribution system occur, components mounted within the TVSS absorb the high energy
levels of the spike or surge and reduce the voltage to a level that will not damage connected equipment.

Surge protection equipment is located in the Annunciator panel in approximately the middle of the back panel and is labeled GFI receptacle.

3.2 Surge Protection Operation– The surge protection equipment requires no maintenance or operational adjustments, etc. under normal conditions. If any internal device fails due to a voltage surge, the entire unit must be replaced. For additional maintenance details, reference the Maintenance Manual section 16900, 2.18.

4.0 ANNUNCIATOR ALARMS

4.1 Annunciator Alarm Overview

The Multnomah Falls WWTP Annunciator Panel provides remote annunciation for a variety of alarms. One category of alarms consists of power loss on the 120 VAC control power bus (A2 & N2) and on the 24 VAC control power bus (B & C). These alarms are connected to a relay activated alarm system as described below under section Annunciator Connected Alarms.

The great majority of alarms are generated by level switches, flow sensors, etc., connected to a relay activated alarm system located in the treatment plant control panel CP-1 also as described below and in the preceding narrative on CP-1 panel. Devices directly connected to the Annunciator Panel generate the remaining alarms. The CP-1 and Annunciator alarm relays are in turn connected to indicating lights located on the doors of the Annunciator panel and Remote Light Box panel. Audible
alarms (Sonalert) are also provided for on the doors of the Annunciator panel and the Remote Light Box.

4.2 Annunciator Alarm System Operation

When alarms are received by the relay activated alarm system, each alarm energizes two relays belonging to the alarm system (relays R6 & R7, lines 4253 and 4254). Relay R6 closes its contact R6A (line 4031) and energizes the local and remote audible alarms SA (lines 4031 & 4034), local indicating light IL26 (line 4032), remote LED 26 (line 4036, in the Remote Light Box) and remote indicating light IL81 (line 4038, in CP-1). Relay R7 closes its contact R7A (line 4334) to alarm Scada and contact R7D (line 4354) to alarm the Telephone Dialers in panel CP-1. These relays remain energized as long as the initiating alarm or any subsequent alarm remains active through the common wire no. 4052A. Because of the use of blocking diodes D2 through D24 (lines 4051 through 4245), unalarmed circuits are not energized when the common wire no. 4052A is energized. These diodes prevent false alarms in connected circuits that are not in an alarm state. Once the initiating alarm or subsequent alarms are cleared and are no longer alarming, power is lost to wire no. 4052A and relays R6 and R7 de-energize turning off the General alarm without operator action required to reset them.

4.3 Annunciator Battery Backup General Alarm System

A Battery Backup alarm system is provided for with a red indicating light IL26 (line 4032) and SonAlert audible alarm SA (line 4031) mounted on the door of the Annunciator panel. In addition, remote alarms are provided at CP-1 in the Treatment Plant through the energizing of the remote red indicating light IL81 (line 4038, mounted on CP-1 D bay door) and at the remote SonAlert SA (line 4034) and red led 26 (line 4036) mounted in the Light Box panel. The system annunciates General and Bus Failure alarms within the vicinity of the Annunciator panel, at panel CP-1 and at the Light Box. The controls to operate this system are shown at lines 4024 through 4038.
Under normal conditions, power supply PS-1 (line 4019) supplies 24 VDC power to wires +1 and –1 charging the Gel Cell batteries (line 4027 and 4029) and energizing relay R1 (line 4025). Relay R1 in turn holds its contact R1B (line 4029) open and closes contact R1A (line 4031). This action by relay R1 prevents IL26 (line 4032), the two audible alarms SA (lines 4031 & 4034) and the red led 26 from turning on in the absence of fault conditions and also enables General and Bus Power Loss alarms to be announced on the alarm system.

When a General Alarm occurs in the alarm system, relay R6 (line 4252) is energized. Relay R6 contacts R6A (line 4031) will close and because relay contact R1A (line 4031) is closed during normal PS-1 operation, IL26 (line 4032), the two audible alarms SA (lines 4031 & 4034) and the red led 26 will be energized annunciating the alarm condition at the Annunciator panel. Also, if the 24 VAC bus alarm occurs, relay R11 (line 4306) will de-energize closing its contact R11B (line 4034) which, as was true with the General alarm, will cause the alarm components IL26, two SAs and LED 26 to annunciate.

If 120 VAC power is lost to power supply PS-1 (line 4019), if PS-1 internally faults and no longer provides 24 VDC power or if a fault occurs in the wiring to relay R1, the relay will de-energize. Because diode D1 (line 4027) prevents a reverse electrical current from the Gel Cell batteries from flowing through the diode to relay R1, the relay remains de-energized. Because R1 is de-energized, relay contact R1B is closed applying 24 VDC power from the batteries to alarm components IL26, two SAs and LED 26 which annunciates the loss of power to wires +1 and -1. In addition, contact R1A opens to prevent relay R1 from being energized by the batteries should contacts R11B (line 4034) be closed.
The Annunciator alarm system will continue to alarm until either 24 VDC power is restored to the +1 and –1 wires, the batteries loose their charge, CB5 (line 4027) is opened, or; for the audible alarms only, selector switch SS1 (line 4031) or SS2 (line 4034) is turned to the Off position.
After 24 VDC power is restored to the +1 and –1 wires, relay R1 automatically energizes to restore the system to normal operation.

4.4 Annunciator Alarms

Individual alarms are listed below in alphabetical order with a description of the activating device and a description of the alarm systems energized by each alarm relay.

4.4.1 24VAC Power Failure Alarm – This alarm occurs when relay R11 (line 4306) is turned off by the loss of 24VAC power from CPT-2 (Bus B/C). This alarm is annunciated by R11B at the Annunciator Panel/Remote Light Box (line 4034) as an audible alarm and as a visual alarm (lines 4031 through 4036), at CP-1 (line 4038) as a visual alarm only and by R11E at the Autodialer No. 2 (lines 2148/4378).

4.4.2 24VDC Power Failure Alarm – This alarm occurs when relay R1 (line 4025) is turned off by the loss of 24VDC power from PS1 (Bus +1/-1). This alarm is annunciated by R1B (line 4029) at the Annunciator Panel/Remote Light Box as an audible alarm and as a visual alarm (lines 4031 through 4036), at CP-1 (line 4038) as a visual alarm only and by R1C at the Autodialer No. 1 (lines 2146/4374).

4.4.3 Aeration Basin No.1 High Level Alarm – This alarm occurs when relay contact R89D (line 1576/4134) in CP-1 panel closes due a high water condition in the basin. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL12 (line 4134) and a Remote Light Box light, LED12 (line 4136).
4.4.4 **Aeration Basin No.2 High Level Alarm** – This alarm occurs when relay contact R91D (line 1583/4141) in CP-1 panel closes due a high water condition in the basin. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL13 (line 4141) and a Remote Light Box light, LED13 (line 4143).

4.4.5 **ATS Transferred Alarm** – This alarm occurs when relay contact R109A (line 1658/4179) in CP-1 panel closes due the ATS (Automatic Transfer Switch) in the Treatment Plant building shifting position from the normal source of power to the backup emergency generator. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL17 (line 4179) and a Remote Light Box light, LED17 (line 4181).

4.4.6 **Blower Failed Alarm** – This alarm occurs when relay contact R70A (line 1507/4115) in CP-1 panel closes due a low pressure condition in the discharge of any of the Aeration No.1 & 2 and Digester Blower No.1 & 2 Fans in the Treatment Plant. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL11 (line 4115) and a Remote Light Box light, LED11 (line 4117).

4.4.7 **CP-1 General Alarm** – This alarm occurs when relay contact R111D (line 1799/4207) in CP-1 panel closes due a General alarm condition in CP-1 in the Treatment Plant. This alarm is annunciated as a General alarm for the Annunciator as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL21 (line 4207) and a Remote Light Box light, LED21 (line 4209).
4.4.8 Fire Alarm – This alarm occurs when relay contact R125D (line 1675/4200) in CP-1 panel closes due a Fire alarm condition in the Treatment Plant Lab room. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL21 (line 4207) and a Remote Light Box light, LED21 (line 4209).

4.4.9 Generator Running Alarm – This alarm occurs when relay contact R48D (line 1415/4108) in CP-1 panel closes due the Emergency Generator running in the Treatment Plant Equipment room. This occurs whenever the generator is running in either test mode or if the normal source of power has been lost to the Treatment Plant. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL10 (line 4108) and a Remote Light Box light, LED10 (line 4110).

4.4.10 Intrusion Alarm – This alarm occurs when time delay relay contact TD40D (line 1677/4193) in CP-1 panel closes due an unauthorized entry into the Treatment Plant building at one of the two entry doors into the Lab room. This alarm can also occur if an authorized entry was made but the detection system was not turned off in time to prevent an alarm. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL19 (line 4193) and a Remote Light Box light, LED19 (line 4195).

4.4.11 RAS Pumps Failed Alarm – This alarm occurs when relay contact R112D (line 1666/4155) in CP-1 panel closes due to a failure of one of the two RAS pumps in the Treatment Plant. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL15 (line 4155) and a Remote Light Box light, LED15 (line 4157).
4.4.12 SCO-01 Clarifier Drive Over Torque Alarm – This alarm occurs when relay contact R93A (line 1590/4148) in CP-1 panel closes because of an over torque condition in the clarifier arm located in the Treatment Plant. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL14 (line 4148) and a Remote Light Box light, LED14 (line 4150).

4.4.13 Septic Tank High Level Alarm – This alarm occurs when relay contact R73A (line 1519/4094) in CP-1 panel closes because of a high level condition the site septic tank. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL8 (line 4094) and a Remote Light Box light, LED8 (line 4096).

4.4.14 Septic Tank Low Level Alarm – This alarm occurs when relay contact R71A (line 1515/4101) in CP-1 panel closes because of a low level condition the site septic tank. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL9 (line 4101) and a Remote Light Box light, LED9 (line 4103).

4.4.15 Septic Tank Pump STEP-01 Failed Alarm – This alarm occurs when relay contact R75F (line 1525/4075) in CP-1 panel closes because of a low flow condition when the pump was running. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL6 (line 4075) and a Remote Light Box light, LED6 (line 4077).
4.4.16 Septic Tank Pump STEP-02 Failed Alarm – This alarm occurs when relay contact R78F (line 1535/4081) in CP-1 panel closes because of a low flow condition when the pump was running. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL7 (line 4081) and a Remote Light Box light, LED7 (line 4083).

4.4.17 Ultra-Violet (UV) System Failed Alarm – This alarm occurs when relay contact R103A (line 1626/4162) in CP-1 panel closes because of a controller failed contact closure in the UV system controller. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL16 (line 4162) and a Remote Light Box light, LED16 (line 4164).

4.4.18 Water Tank High Level Alarm – This alarm occurs when contact AL-2 in setpoint controller SPC-11 (line 4267) or a float switch (line 4062) in the water tank closes because of a high water level condition in the Well House Water Tank. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL4 (line 4058) and a Remote Light Box light, Red LED 4 (line 4060). In addition, relay R4 (line 4056) is energized closing its R4A contact (line 4313) which in turn energizes relay R8 (line 4313). Relay contact R8A opens to turn off the Well Pump Call signal, contact R8D (line 4338) closes to send a high level alarm signal to Scada and contact R8F (line 4358) closes to send a high level signal to the Dialer No. 1 in CP-1.

4.4.19 Water Tank Low Level Alarm – This alarm occurs when contact AL-1 in setpoint controller SPC-11 (line 4267) or a float switch (line 4069) in the water tank closes because of a low water level condition in the Well House Water Tank. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL5 (line 4066) and a Remote Light Box light, LED5.
Multnomah Falls WWTP Functional Descriptions – Continued:

(line 4068). In addition, relay R5 (line 4064) is energized closing its R5A contact (line 4315) which in turn energizes relay R9 (line 4315). Relay contact R9A closes to turn on the Well Pump Call signal, contact R9D (line 4342) closes to send a low level alarm signal to Scada and contact R9F (line 4362) closes to send a low level signal to the Dialer No. 1 in CP-1.

4.4.20 Well House General Alarm – This alarm occurs when an alarm contact in the Pump House (line 4053) closes because of a General alarm condition in the Well House. This alarm is annunciated as a General alarm as described above under section Annunciator Alarm System Operation (relays R6 and R7 energize). It also turns on an Annunciator indicating light, IL3 (line 4050) and a Remote Light Box light, Red LED3 (line 4052). In addition, relay R3 (line 4048) is energized closing its R3A contact (line 4331), which sends an alarm signal to Scada and contact R3C also closes to send an alarm signal to the Dialer No. 1 in CP-1.

4.4.21 Spare Alarm Circuits – The Annunciator Panel has spare alarm circuits installed that can be used for additional alarms should the need arise. Starting at line 4223 and continuing through line 4246, 4 spare alarm circuits are available for use with each circuit being complete with all components required to operate the Annunciator General Alarm system.

However, to enable a Scada or Dialer alarm, additional relays would need to be installed. As an example, relay R3 (line 4048) was added to the Well House General alarm to enable an alarm signal to Scada at line 4331 with its R3A contact.

USFS will add narrative for well house general alarms in CP-1. This required adding 3 additional relays in CP-1.
5.0 WELL HOUSE WELL PUMP CONTROL

5.1 Well Pump Running – Well Pump running indication is provided when the contacts from the Well House (line 4053) close to energize relay R2 (line 4040), turn on the indicating light IL2 (line 4040), turn on the remote indicating light LED2 (line 4053) at the Remote Light Box. In addition, relay contacts R2A (line 4310) close to turn on the running time meter RTM1 (line 4310) and increment operation counter OC1 (line 4311) by one count. A signal is also sent to Scada by the closure of contacts R2D (line 4327).

5.2 Well Pump Running Control – Well Pump running control is provided by one of three methods:

5.2.1 Hand control - By placing selector switch SS3 (line 4317) in the “Hand” position thereby directly energizing relay R10.

5.2.2 SPC control - Setpoint controller through placing selector switch SS3 (line 4319) in the “SPC” position. In this position, a closure from contact SPC-11 (line 4319) operated by setpoint controller SPC-11 (line 4264) starts the pump by energizing relay R10.

5.2.3 Level Switch control - Level float switch control by placing selector switch SS3 (line 4322) in the “Level Switch” position thereby operating relay R10 through control provided by relay contact closure R8A (line 4322), R9A (line 4322) and R10A (line 4324). As briefly explained in the above narrative under Water Tank High and Low Level alarms, relay R10 is energized when a low tank level is reached and contact R9A closes. When relay R10 energizes, its contact R10A (line 4324) closes to maintain the electrical circuit around the R9A contact because R9A will open once the level begins to rise in the water tank which would turn relay R10 off if it was not “shorted” out by the closed R10A contact. Relay R10 remains energized by its own R10A contact until the water tank level reaches the high level and relay R8 opens its contact R8A (line 4322) and thus de-energizing R10 and turning off the command to run the pump.
When relay R10 is energized, it also closes its R10D contact (line 4328) which in turn is connected to the motor controls for the Well Pump motor in the Well House. This contact closure enables the motor to run.

5.3 Water Tank Level Control Analog Loop — Water tank level analog loop is a 4-20ma loop that provides local and remote indication of the amount of water in the fresh water tank. At line 4289, the water tank level transmitter is shown connected to the 24vdc positive voltage source +1 though fuse F55 (line 4279), lighting protectors LP & LPE1-5 and surge protectors DSP & DSP-1. The loop is next connected to Signal Repeater SR-1 (line 4279) where the signal is copied exactly and reproduced by the repeater to provide a separate 4-20ma signal to the Scada input at line 4291 through DSP-2 and fuses F59 & F60. From the signal repeater, the 4-20ma signal next is connected to a remote level indicator for display in the Remote Light Box through fuses F57 & F58. After the remote display, the signal is connected to setpoint controller SPC-11 at lines 4263 and 4265. The setpoint controller displays the water level locally at the Annunciator panel and also uses the signal to turn the call signal for the Well Pump on and off through relay R10 as described in the narrative directly above. SPC-11 also provides a contact closure AL-2 (line 4058) for a Water Tank High Level alarm as described in the alarm narratives above and another contact closure AL-1 (line 4065) for a Water Tank Low Level alarm also as described above.

6.0 TEST POINTS

The Annunciator Panel has test points built into the controls to provide a means to easily test the quality of the Water Tank Level analog loop 4-20ma signal. At line 4279, test points TP1, TP2 and TP3 are shown. Reference the Operating Instructions in this Operation and Maintenance manual for instructions on how to use these points.
7.0 TEST SWITCHES

The Annunciator Panel has test switches built into the test switch box mounted on the inside of the panel door. Test switches TS1 through TS24 are shown from lines 4041 through line 4244. Using test switch TS5 (line 4075) as an example, placing the switch in the C (closed) position initiates a test of the Septic Tank Pump STEP-01 Failed Alarm and consequently the Annunciator General Alarm system by bypassing the initiating contact R75F (line 4076) operated by relay R75 in panel CP-1. Closing this switch also bypasses fuse F13 (line 4075). When closed, indicating light IL6 (line 4075) will illuminate as well as relays R6 and R7 (lines 4252 & 4255) which in turn initiates an Annunciator General Alarm as well as the Septic Tank Pump STEP-01 Failed Alarm. The benefit of performing this procedure is to test the Annunciator General Alarm and Septic Tank Pump STEP-01 Failed Alarm circuits in the event that the alarm circuits are suspected of being faulty. If an alarm should have occurred but did not, this test will prove that the alarm circuits connected in the Annunciator Panel are working and the fault would then be found in either the initiating device in the field portion of the circuit or in the fuse.

If test switch TS5 is placed in the O (Off) position, the test described above is turned off and the alarm circuit for the Septic Tank Pump STEP-01 Failed alarm will not annunciate the Annunciator General Alarm.

If test switch TS5 is placed in the A (Auto) position, the Septic Tank Pump STEP-01 Failed alarm circuit is then connected to the initiating field device (relay contact, float switch, etc.) and will alarm if an alarm condition is detected by the initiating device.
Note: The normal position for test switches TS1 through TS24 is to be in the A position. After testing any circuit in the C position or if an active alarm was silenced by placing the test switch in the O position, ensure all test switches are returned to the A position before leaving the Annunciator Panel to ensure that all alarms will be displayed and annunciated.

8.0 CONTROL FUSES WITH PIN BLOWN FUSE INDICATORS

The Water Tank Level 4-20ma analog circuit is provided with fuses that visibly indicate a blown fuse condition to aid in troubleshooting and quickly locating faulty circuits. The fuse, when blown, will cause a mechanical pin to extend from one end of the fuse to indicate the blown condition. Fuses with extended pins must be discarded and replace with new fuses as the fuse cannot be “reset” by pushing the pin back into the fuse. The fuses are set for .5A (1/2 amp or 500ma) and must be replace with the same amperage and type of fuse. These fuses are F55 & F56 (line 4279), F57 & F58 (line 4282) and F59 & F60 (line 4288).

9.0 POWER AVAILABLE INDICATING LIGHTS

The Annunciator Panel has been provided with indicating lights that show the status of power on the 24vdc and 24vac power buses. Local indicating light IL1 (line 4025) and remote LED1 (line4022) shows that power is available on bus +1/-1 and local indicating light IL27 (line 4308) and remote LED11A (line 4120) through contact closure of R11D shows that power is available on bus B/C. Bus +1/-1 provides 24vdc power to all alarm circuits and to the Water Tank Level 4-20ma analog loop. Bus B/C provides 24vac power to operate the Water Tank and Well Pump Call circuits and control. If any of these lights are not illuminated, either the light is burned out or power is no being applied to the bus they are connected to.