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PROCESS CONTROL SPECIFICATION FOR THE SEEP WELL FIELD, LS-1, AND THE ION EXCHANGE TREATMENT SYSTEM

Envirogen Document
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Rev B

Lift Station #1 System Improvements
Perchlorate Removal Water Treatment Equipment
Henderson, NV

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Contents

REVSION LOG

Rev	Description of Change	Date	Initials
A	Review Draft	10/13/2015	GF
B	Integrated the Seep Well Field and Ion Exchange System	7/20/2016	DW

1 INTRODUCTION

This document provides a description of the process control logic for the ENVIROGEN Perchlorate Removal System. Additional specific details, which are referenced herein, are contained in the Piping and Instrumentation Diagram 1373-134-P010, P011, P012, P013, P014, P401, and P402.

2 CONTROL PANEL DESCRIPTION:

2.1 PANEL DESCRIPTION

2.1.1 MAIN PLC CONTROL ENCLOSURE

A. E-Stop to de-energize all PLC outputs and remove the permissive signal provided to the customer feed.

B. Power conditioner for 120 VAC control power

C. Main Disconnect with fuses rated for 240 VAC 3 phase power feed.

D. Circuit breaker protection for all branch circuits

E. Convenience GFI receptacle w/ dedicated 15 amp circuit breaker

F. Color Touch Screen HMI/OIT, Simatic TP1200 12" Industrial Computer

G. Programmable Logic Controller (PLC), S7-300 CPU

H. Ethernet switch, 5 port, Phoenix or equal

I. Radio transmitter/receiver, Xetawave

J. Wiring requirements: Fail-safe wiring configuration (i.e. a failure of the PLC cannot cause a cross connection condition).

K. Panel mounted Devices: Touch-screen monitor.

L. UPS power supply for PLC and HMI

M. All required power supplies and other ancillary components shall be included for a complete functioning system.

2.1.2 BED VALVE ENCLOSURE

A. Dead front wall mount NEMA 12 enclosure

B. Drop/Remote I/O Card with Profibus Communication to Main PLC

C. Interposing relays for all PLC outputs.

D. Power distributions for 120 VAC control power

E. Fuses or Circuit breaker protection for any branch circuits

F. Power light to indicated panel is powered

G. Terminal Strip for Field wiring.

2.2 ELECTRICAL DOCUMENTATION

A. Schematic wiring diagram including detailed wiring diagrams for all instruments and logical tagging of all devices. Labels shall be affixed to all wire termination points, terminals, relays, power supplies, circuit breakers

B. Panel layout drawings – internal and external

C. All Drawings shall be in AUTOCAD 2009 and shall be in drawing borders and title blocks supplied by ENVIROGEN with ENVIROGEN supplied drawing numbers.

D. PLC code with full annotation (Native File for record and PDF for reviews)

E. Human Machine Interface (HMI) code with full annotation (Native Files for records, PDF of screen shots for Reviews)

2.3 SYSTEM DISPLAY INFORMATION

The following information shall be displayed on the HMI:

A. All analog input signals

B. All analog output signals

C. Status of all discrete inputs

D. Status of all discrete outputs

E. Status of all operating modes

F. Status of all alarms

G. All operator adjustable control parameter and alarm values shall be displayed

All displayed items shall be appropriately scaled, tagged and named.

The following colors shall be used for shading icons or display items

Red – Energized and Running/Open
Green – Energized and Stopped/Closed
Grey – Not Energized
White – Standby
Amber – All permissive meet

See Section 3.9.2 for IX Vessel color codes.

2.4 TRENDING DATA RECORDING REQUIREMENTS

The system shall be capable of recording analog and discrete signal for display of real-time and historical trending information and alarm history.

The system will need to store up at least 30 days of information.

3 CONTROLS

The following sections contain control logic and descriptions for the various systems and equipment that comprise the ion exchange system. Where possible, the process is designed to be able to recover from shut down conditions.

3.1 TIME DELAY BETWEEN SWITCH AND ALARM ACTIVATION

All configured or discreet switch must be maintained for an operator adjustable time delay. The process switch must be maintained for the entire time delay before activating its associated alarm.

3.2 SEEP WELL FIELD PUMP LOGIC

Each Seep well pump logic must be verified before placing the well pump in operation.

The Seep Well Field includes 9 groundwater recovery wells. Each well is equipped with a submersible well pump. The well pump can be operated locally at the pump or PLC controls.

LS-1 PANEL – HOA SELECTOR SWITCH: A Hand – Off – Auto (HOA) selector switch turns the well pump on or off at each well. The local PLC, located at Lift Station 1, is used to control the pump when the LS-1 panel mounted HOA switch is operated in the Auto position. The well pump will not operate when the selector switch is placed in the Off position. When the panel mounted selector switch is placed in Hand, the pump will run without PLC control.

NOTE: When the LS-1 panel located HOA switch is operated in Hand, the well pump energizes. The PLC also has a configured HOA switch, which can operate in Hand. When the PLC operates in Hand, the local HOA selector switch needs to be in the Auto position.

LS-1 PANEL - WELL PUMP RUN STATUS LIGHT: When the Off position of the HOA switch is selected, the well pump and the pump run status light will be off. The pump run status light is driven by the well pump motor starter's control relay. When the selector switch changed to either Hand or Auto, the well pump will become energized, and the run status indicating light will illuminate.

WELL PUMP FLOW RATE: A flow meter positioned on the well pump discharge line monitors the pump discharge flow rate of the operating pump. The flow meters are located near the LS-1 wet well. An operator adjustable low-low flow switch (FSLL) is configured from the Seep well's flow signal.

VALVE POSITION SWITCHES: The process operator has a choice of treatment system for each Seep Well Pump. The well pump discharge stream can discharge into an equalization tank for IX treatment or to the lift station wet well for treatment by the main Ground Water Treatment System. The HMI station will display the position status of both manually operated header valves.

WELL PUMP LOGIC – BEFORE PUMP START:

If the position of one (or both) well pump discharge valve pair is partially open or if the valve position is not known, the well pump run permissive signal is withdrawn (neither position switch is active). The partially open valve state must be maintained for 15 seconds before the associated well pump run permissive signal is withdrawn (Interlock 1503).

LIMIT SWITCH TERMINOLOGY

YIO(Well ID-A) = wet well feed valve (A) is open (O)
YIC(Well ID-A) = wet well feed valve (A) is closed (C)
YIO(Well ID-B) = IX EQ Tank feed valve (B) is open (O)
YIC(Well ID-B) = IX EQ Tank feed valve (B) is closed (C)

Note: The "Well ID" designation in a limit switch tag represents the numerical portion of the well ID Tag.
99 for well 99R3, 115 for well 115R, 116 for well 116, 118 for well 118, 119 for well 119, 120 for well 120, 121 for well 121, 117 for well 117, or 133 for well 133

SEEP WELL LEVEL: A submersible level transmitter is located near the bottom of each Seep Well. The well level signal is displayed on the HMI screen. Four operator adjustable level switches are configured from the Seep well's level signal, LSLL, LSL, LSH, and LSHH.

When a Seep well is in operation, the operator will try to throttle the position of the manual pump discharge valve to match the Seep well pump flow rate with the groundwater well recharge rate to minimize the frequency of pump start / stop cycles. The frequency of the pump start / stop cycle rate is easily viewed with the pump's flow signal on the HMI trend display.

Well Level Control:

As each Seep well, the well level will rise as ground water flows into the well. Ground water continues to enter the well until the well level matches the ground water table elevation, or to the position of the high level switch. To maintain the well level between the high and low level switch set points, the well pump is used to lower the well level by pumping ground water out of the well. Each Seep well pump operates at two pump speeds, 100% or 0% (on / off).

The "pump down" logic is designed to turn the well pump on and off. When the well level rises to the level of the level switch high (LSH), the well pump is energized. The pump remains in operation until the water level falls to the level of the level switch low (LSL). When the low level switch is activated, the well pump is turned off. The well pump restarts when the well level reaches the position of high level switch, and the pump on / off cycle continues.

Pump Cavitation Protection

When the well level falls to the level of the low-low level switch, the well pump is de-energized (See Interlock 1501 below). As groundwater recharges the well, the well level will rise. The "pump-down" control cycle resumes as the water level rises and remains at or above the level of the high level switch (LSH) for 10 minutes, the low-low level alarm is cleared, and the well pump restarts.

If the well level rises to the position of the LSHH switch, an alarm is activated to make sure that the operator is aware of the high-high level, and that the needs to investigate the well condition that is triggering the alarm.

See Section 4.6 for the full list of process interlocks.

3.3 CURRENT INFLUENT WATER QUALITY & FLOW RATES

Table 3.3 - Expected Flow Rates and Concentrations - Seep Wells

Well	Flow (gpm)	ClO_4 (mg/L)	ClO_3 (mg/L)	NO_3 as N (mg/L)	Treatment System Selection
PC 116R	130	13.30	20.22	3.46	GWTP
PC 99R2/3	60	14.94	22.71	3.88	GWTP
PC 115R	100	7.84	11.92	2.04	GWPT
PC 117	90	8.39	12.75	2.18	GWPT
PC 118	70	2.57	3.91	0.67	IX
PC 119	65	0.58	0.88	0.15	IX
PC 120	1	0.58	0.88	0.15	IX
PC 121	0	1.10	1.67	0.29	IX
PC 133	4	4.20	6.38	1.09	IX

3.4 LS-1 WET WELL CONTROL LOGIC

Water from the Seep wells is pumped to the wet well at Lift Station 1 or to T-100 Equalization Tank. The operator manually sets valve positions to direct the Seep well water to the wet well at LS-1 or to T-100.
Process control logic for the Equalization Tank T-100 and the IX treatment system is presented in the next section.

The vertical turbine pumps at LS-1 are used to pump water from the wet well to Lift Station 2. Water from LS-2 is then pumped to the GW-11 pond. LS-2 sends a run permissive signal to the LS-1 wet well pumps. When the LS-2 High-High level alarm signal is activated, the run permissive signal is withheld from the LS-1 wet well pumps. The LS-1 wet well pumps will return to operation when the run permissive signal is restored.

LOCAL PANEL HOA SWITCH AND STATUS LIGHTS: The two LS-1 wet well pumps each have a HOA selector switch and a pump run status light. The pump run status light uses the motor starter control relay for status indication. When the Off position of the panel mounted HOA switch is selected, the wet well pump and the wet well pump run status light will be off. When the selector switch changed to either the Hand or Auto position, the well pump will become energized, and the run status indicating light will illuminate.

WET WELL CONTROL PANEL – HOA SELECTOR SWITCH: When the operator selects the Hand position of the LS-1 panel, the well pump will operate without PLC pump controls.

When the HOA in the wet well control panel is in the Auto position, PLC pump control logic will become active. The PLC pump control logic evaluates the following process data:

- The HOA switch position: The Auto position of the HOA switch are monitored by the PLC, enabling the PLC to know the selected pump operating state.
- A water level transmitter is used to monitor the water level in the wet well.
- A flow meter positioned on the well pump discharge line to monitor the pump discharge flow rate.

- A pressure sensor/transmitter positioned on the well pump discharge line monitors the pump discharge pressure rate from the operating pumps.

PUMP SELECTION: The HMI and the local panel allow for one or both wet well pumps to operate at the same time.

AUTOMATIC WELL LEVEL CONTROL: A PLC configured PID control loop uses the level signal as the measured variable. The operator inputs the well level set point through the HMI screen. The level controller output signal is then transmitted (two separate output signals) to P-40011 and to P-40012 Variable Frequency Drive (VFD) and is used as its set point.

PUMP FREQUENCY SET POINT: It is not desired to start both turbine pumps at the same time. The lead wet well pump is to operate at its minimum pump speed at 4 mA, and ramp up to 100% speed (60 Hz) at 20 mA. The lag wet well pump will operate at its minimum pump speed at 7 mA and ramp up to 100% speed (60 Hz) at 20 mA. Both wet well pumps will receive LC-42020 output signal as their speed set point.

LEAD – LAG PUMP SELECTION: HS-40013, the “Pump 1” “Pump 2” lead pump selector switch is used to select the lead wet well pump.

MANUAL WELL LEVEL CONTROL: The operator places the PLC configured HOA switch of the selected pump in the Hand position. In Hand, the PLC over-rides the Well Level Controller, and sets the pump speed at 100%.

NOTE: The PLC configured HOA switches and the panel mounted HOA switches are not the same and operate differently. When the panel mounted HOA switch is operated in Hand, the wet well pump energizes at the current frequency setting. When the PLC configured HOA switch is operated in Hand, the pump will operate at 100% speed (Interlock 1507).

LT-40020 is a level transmitter measuring the level in the wet well. The transmitter will send a 4-20 mA signal representative of the level. The PLC shall use this signal as the measured variable in a PLC configured PID control loop.
A pop-up display of the level control loop is used for the operator to input control loop data.

The level controller output signal will be used as the speed set point for SC-40021 and SC-40022, the variable frequency drives for the wet well pumps.

The HMI shall display

Level Measurement as LI-40020, in feet

HMI shall allow operator input of set point values for:

Level Control Set Point LIC-40020
Low-Low Level LCLL-40020
Low Level LCL-40020 (no associated alarm)
High Level LCH-40020 (no associated alarm)
High-High Level LCHH-40020
Controller tuning parameters for proportional, integral, and derivative control inputs
Controller selector switch for Auto / Manual controller operation
Controller displays for the measured variable and controller output.

The wet well at LS-1 also includes four level float switches, which are configured as LSLL-40021, LSH-40021, LSH-40021, and LSHH-40021.

The LS-1 configured wet well Low-Low level switch LCLL-40020 provides the input to activate LALL-40020.
The LS-1 configured wet well High-High level switch LCHH-40020 both provides the input to activate LAHH-40020.

LS-1 WET WELL LEVEL CONTROL USING FLOAT SWITCHES: In the event that the analog signal from LIC-40020 is lost, or if the PLC at LS-! is not available, the four level float switches enter service to control the wet well pumps P-40011 and P-40012.
The pump wet well pumps are started and stopped at the existing LS-1 control panel.
The wet well pumps run in a lead/lag system. If both pumps are in AUTO at the LS-1 panel, then the pumps will automatically alternate which pump is the lead pump.
If one of the pumps is not in AUTO mode and is not running, or if one of the pumps is faulted, the other pump will become the lead pump.

The lead pump will energize when the wet well level rises to the LSH-40021 elevation. The lag pump will energize when the wet well level rises to the LSHH-40021 position. The lead pump will de-energize when the wet well level falls to the position of the LSL-40021 level, and the lag pump will de-energize at the LSLL-40021 elevation.
When the PLC at LS-1 returns to service, the operator will press the level control reset button.

The variable frequency drive controller will be similar to the level controller set-up.
SC-40021 and SC-40022 do not include controller configured switches. SC-40021 and SC-40022 will include local / remote selection to select between a local speed set point (local) or use the Level controller's output signal (remote) as the speed set point.

Pump Cavitation Protection

When the wet well level falls to the position of the low-low level switch, the wet well low-low level alarm is activated. On activation of the low-low alarm, the run permissive for wet well pumps is withdrawn. When the wet well level rises above the low level set point, the low-low level alarm is cleared, the run permissive for the wet well pumps is restored, and the well pump restarts.

Wet Well Overflow Protection

Seep Well Pump Run Permissive: When the level in the wet well at LS-1 reaches the high-high level set point, the run permissive signal is withdrawn from the Seep well pumps that feed the LS-1 wet well. The YIO-xxA limit switches are used to identify the wells that feed the wet well. When the run permissive signal is restored, the Seep well pumps feeding the wet well will return to operation.

Lift Station 1 also includes a pressure and flow sensor/transmitters, which are installed on the common pump discharge line. Two flow switches are configured from the FI-40025 signal, FSLL-40021 and FSHH-40025.

3.5 EQ TANK T-100 CONTROL LOGIC

Equalization Tank T-100 is a transportable 21,000 gallon tank. T-100 instruments include a level sensor / transmitter, and a discrete high-high level float switch. T-100 provides water to the suction lines pf the IX Feed Pump T-100A/B. A pressure transmitter and a flow transmitter are included on the P-100A/B pump discharge line.

T-100 LEVEL CONTROL: LT-100 is a level transmitter measuring the level in the equalization tank. The transmitter sends a 4-20 mA signal representative of the tank level to the PLC. Four level switches are configured from the LT-100 analog signal: LSLL, LSL, LSH, and LSHH.

The PLC shall use this signal as the measured variable in a PLC configured PID control loop. A pop-up display of the level control loop is used for the operator to input control loop tuning inputs and the controller's operating modes. The level controller output signal is used as the speed set point for SC-100 and SC-105, the variable frequency drives for P-100A / B.

The HMI shall display

Level Measurement as LI-100, in feet

HMI shall allow operator input of set point values for:

Level Control Set Point LIC-100
Low-Low Level LSLL-100
Low Level LSL-100 (no associated alarm)
High Level LSH-100 (no associated alarm)
High-High Level LSHH-100
Controller tuning parameters for proportional, integral, and derivative control inputs
Controller selector switch for Auto / Manual controller operation
Controller displays for the measured variable and controller output.

The variable frequency drive controller will be similar to the level controller set-up.

SC-100 and SC-105 do not include controller configured switches. SC-100 and SC-105 will include local / remote selection to select between a local set point (local) or use the Level controller's output signal (remote) as the speed set point.

Pump Cavitation Protection

When the wet well level falls to the position of the low-low level switch, the Equalization Tank low-low level alarm is activated. On activation of the low-low alarm, the run permissive for P-100 A/B is withdrawn. When the Equalization Tank level rises above the low level set point, the low-low level alarm is cleared, the run permissive for P-100A / B is restored, and the well pump restarts.

T-100 Overflow Protection

The discrete level float switch is set-up for use as a high-high level switch. This float level switch, along with the configured LSHH switch, provides inputs to activate the LAHH high-high level alarm. When the high-high level alarm activates, the run permissive signal is withdrawn from the Seep wells that feed T-100. The YIO-xxB limit switches are used to identify the wells that feed the Equalization Tank. When the Equalization Tank level falls to the high level set point, the high-high level alarm is cleared, the run permissive signal is restored for the Seep wells that feed T-100.

Please review Interlocks 1504, 1506, and 1507 in Section 4.6. These interlocks are used in the operation of T-100.

FIT-101 is a flow indicating transmitter measuring the influent flow. The transmitter will send a 4-20 mA signal representative of the flow. The PLC shall monitor and compare the flow to system alarm set points.

The HMI shall display

Flow Measurement as FI-101, in gpm

Resettable Influent Flow Totalizer, in gallons

HMI shall allow operator input of set point values for:

Low-Low Feed Flow Alarm FALL-101

Low Feed Flow Alarm FAL-101

High Feed Flow Alarm FAH-101

In the event that:

FALL-101 shall turn the run permissive for the feed water OFF.

FAL-101 shall trigger LOW FEED FLOW alarm.

FAH-101 shall initiate SYSTEM PAUSE mode.

3.6 LOAD & COMPOSITION CALCULATIONS

NOTE: In Section 3, the following variables are operator adjustable: Ideal IX Vessel Flow Rate, Maximum IX Vessel Flow Rate, Minimum IX Vessel Flow Rate, Resin Capacity, Published Data Resin Safety Factor, and the volume of resin per IX vessel.

On-line process analyzers are not used to evaluate the composition of the recovered groundwater. Water samples are collected from the well pump discharge line and analyzed by the on-site or off-site laboratories.

The process operator enters the composition of each Seep Well into the HMI stations upon receipt of current well water analyses. The composition of each well feed initially will use the composition data from Table 3.0.

The LS-1 composition, LS-1 Load, and the T-100 composition will be displayed on an HMI screen.

Variable definitions that are used in the load equation:

NO_3-N = Influent (i.e. feed to system) Nitrate-nitrogen concentration, measured in mg/L as N;

$Cl0_3$ = Influent (i.e. feed to system) Chlorate concentration, measured in mg/L;

$Cl0_4$ = Influent (i.e. feed to system) perchlorate concentration, measured in mg/L;

Flow = Seep well flow rate, in gpm.

LIMIT SWITCH NUMERICAL VALUES USED IN THE LOAD CALCULATIONS
(Only the numeric portion of the Well ID is used)

YIO(Well ID-A) = wet well feed valve is open = 1

YIC(Well ID-A) = wet well feed valve is closed = 0

YIO(Well ID-B) = IX EQ Tank feed valve is open = 1

YIC(Well ID-B) = IX EQ Tank feed valve is closed = 0

Notes: whenever a valve position is not reported, the associated well pump run permissive signal is withdrawn (flow rate = 0 gpm)

3.6.1 LS-1 WET WELL LOAD CALCULATION

The valve to the LS-1 wet well header must be open, YIO(Well ID-A) = 1.

If the valve to the LS-1 wet well header is closed, YIO(Well ID-A) = 0

If the position of the valve to the LS-1 wet well header is not known, the associated well pump will be off-line (well flow rate is 0 gpm)

(Well ID) Load =

[(0.90 x NO_3-N) + (0.17 x $Cl0_3$) + (0.18 x $Cl0_4$)] x YIO(Well ID-A) x flow /1,000,000 x 8.34

This equation is applied to each of the nine Seep Wells. The total load entering the wet well is then calculated by adding the results of the nine Seep well load calculations.

Total Load entering the LS-1 Wet Well:

Load A(121) + Load A(120) + Load A(119) + Load A(118) + Load A(115) + Load A(99) + Load A(116) + Load A(117) + Load A(133) = Total Load A(lbs./min)

3.6.2 LS-1 WET WELL COMPOSITION

Units:

Concentration: mg / Liter

Flow: gallons / minute

8.34 pounds of water / gallon

1,000,000 mg / Liter or 1 million

Nitrate-N:

The amount of nitrate-N entering the wet well is calculated.

NO_3-N (pounds / minute) =

{NO_3-N(121) x flow(121) x YIO(121A) + NO_3-N(120) x flow(120) x YIO(120 A) +

NO_3-N(119) x flow(119) x YIO(119A) + NO_3-N(118) x flow(118) x YIO(118A)

NO_3-N(115) x flow(115) x YIO(115A) + NO_3-N(99) x flow(99) x YIO(99A)

NO_3-N(116) x flow(116) x YIO(116A) + NO_3-N(117) x flow(117) x YIO(117A)

NO_3-N(133) x flow(133) x YIO(133A)} x 8.34 / 1,000,000 = Total NO_3-N pounds / minute

The total flow rate of the nine wells entering the wet well is then calculated.

Flow (121) x YIO(121A) + Flow (120) x YIO(120A) + Flow (119) x YIO(119A) +

Flow (118) x YIO(118A) + Flow (115) x YIO(115A) + Flow (99) x YIO(99A) +

Flow (116) x YIO(116A)+ Flow (117) x YIO(117A) + Flow (133) x YIO(133A) = Total Flow entering the wet well (gpm)

The nitrate-N total is then divided by the total flow rate from the nine wells to evaluate the wet well concentration of nitrate-N.

{(Total NO_3-N pounds / minute) / (Total Flow(gal / min)} x 1,000,000 / 8.34 = NO_3-N (ppm)

Chlorate:

The amount of chlorate entering the wet well is calculated.

{ CLO_3(121) x flow(121) x YIO(121A) + CLO_3(120) x flow(120) x YIO(120A) +

CLO_3(119) x flow(119) x YIO(119A) + CLO_3(118) x flow(118) x YIO(118A)

CLO_3(115) x flow(115) x YIO(115A) + CLO_3(99) x flow(99) x YIO(99A)

CLO_3(116) x flow(116) x YIO(116A) + CLO_3(117) x flow(117) x YIO(117A) +

CLO_3(133) x flow(133) x YIO(133A)} x 8.34 / 1,OOO,OOO = Total CLO_3 lb/min

The total flow rate of the nine wells entering the wet well is then calculated.

Flow (121) x YIO(121A) + Flow (120) x YIO(120A) + Flow (119) x YIO(119A) +

Flow (118) x YIO(118A) + Flow (115) x YIO(115A) + Flow (99) x YIO(99A) +

Flow (116) x YIO(116A) + Flow (117) x YIO(117A) + Flow (133) x YIO(133A) = Total Flow

entering the wet well (gpm)

The chlorate total is then divided by the total flow rate from the nine wells to evaluate the wet well concentration of chlorate.

{(Total CLO3- pounds / minute) / (Total Flow (gal / min)} x 1,000,000 / 8.34 = CLO3(ppm)

Perchlorate:

The amount of chlorate entering the wet well is calculated.

{ CLO_4(121) x flow(121) x YIO(121A) + CLO_4(120) x flow(120) x YIO(120A) +

CLO_4(119) x flow(119) x YIO(119A) + CLO_4(118) x flow(118) x YIO(118A)

CLO_4(115) x flow(115) x YIO(115A) + CLO_4(99) x flow(99) x YIO(99A)

CLO_4(116) x flow(116) x YIO(116A) + CLO_4(117) x flow(117) x YIO(117A) +

CLO_4(133) x flow(133) x YIO(133A)} x 8.34 / 1,OOO,OOO = Total CLO_4 lb/min

The total flow rate of the nine wells entering the wet well is then calculated.

Flow (121) x YIO(121A) + Flow (120) x YIO(120A) + Flow (119) x YIO(119A) +

Flow (118) x YIO(118A) + Flow (115) x YIO(115A) + Flow (99) x YIO(99A) +

Flow (116) x YIO(116A) + Flow (117) x YIO(117A) + Flow (133) x YIO(133A) = Total Flow entering the wet well (gpm)

The chlorate total is then divided by the total flow rate from the nine wells to evaluate the wet well concentration of chlorate.

{(Total CLO_4- pounds / minute) / (Total Flow (gal / min)} x 1,000,000 / 8.34 = CLO_4(ppm)

3.6.3 IX EQ TANK COMPOSITION

Nitrate-N:

The amount of nitrate-N entering the EQ Tank T-100 is calculated.

NO_3-N (pounds / minute) =

{NO_3-N(121) x flow(121) x YIO(121B) + NO_3-N(120) x flow(120) x YIO(120 B) +

NO_3-N(119) x flow(119) x YIO(119B) + NO_3-N(118) x flow(118) x YIO(118B)

NO_3-N(115) x flow(115) x YIO(115B) + NO_3-N(99) x flow(99) x YIO(99B)

NO_3-N(116) x flow(116) x YIO(116B) + NO_3-N(117) x flow(117) x YIO(117B)

NO_3-N(133) x flow(133) x YIO(133B)} x 8.34 / 1,000,000 = Total NO_3-N pounds / minute

The total flow rate of the nine wells entering the EQ Tank T-100 is then calculated.

Flow (121) x YIO(121B) + Flow (120) x YIO(120B) + Flow (119) x YIO(119B) +

Flow (118) x YIO(118B) + Flow (115) x YIO(115B) + Flow (99) x YIO(99B) +

Flow (116) x YIO(116B)+ Flow (117) x YIO(117B) + Flow (133) x YIO(133B) = Total Flow

entering the wet well (gpm)

The nitrate-N total is then divided by the total flow rate from the nine wells to evaluate the EQ Tank T-100 concentration of nitrate-N.

{(Total NO_3-N pounds / minute) / (Total Flow(gal / min)} x 1,000,000 / 8.34 = NO_3-N (ppm)

Chlorate:

The amount of chlorate entering the EQ Tank T-100 is calculated.

{ CLO_3(121) x flow(121) x YIO(121B) + CLO_3(120) x flow(120) x YIO(120B) +

CLO_3(119) x flow(119) x YIO(119B) + CLO_3(118) x flow(118) x YIO(118B)

CLO_3(115) x flow(115) x YIO(115B) + CLO_3(99) x flow(99) x YIO(99B)

CLO_3(116) x flow(116) x YIO(116B) + CLO_3(117) x flow(117) x YIO(117B) +

CLO_3(133) x flow(133) x YIO(133B)} x 8.34 / 1,OOO,OOO = Total CLO_3 lb/min

The total flow rate of the nine wells entering the EQ Tank T-100 is then calculated.

Flow (121) x YIO(121B) + Flow (120) x YIO(120B) + Flow (119) x YIO(119B) +

Flow (118) x YIO(118B) + Flow (115) x YIO(115B) + Flow (99) x YIO(99B) +

Flow (116) x YIO(116B) + Flow (117) x YIO(117B) + Flow (133) x YIO(133B) = Total Flow

entering the wet well (gpm)

The chlorate total is then divided by the total flow rate from the nine wells to evaluate the EQ Tank T-100 concentration of chlorate.

{(Total CLO3- pounds / minute) / (Total Flow (gal / min)} x 1,000,000 / 8.34 = CLO3(ppm)

Perchlorate:

The amount of chlorate entering the EQ Tank is calculated.

{ CLO_4(121) x flow(121) x YIO(121B) + CLO_4(120) x flow(120) x YIO(120B) +

CLO_4(119) x flow(119) x YIO(119B) + CLO_4(118) x flow(118) x YIO(118B)

CLO_4(115) x flow(115) x YIO(115B) + CLO_4(99) x flow(99) x YIO(99B)

CLO_4(116) x flow(116) x YIO(116B) + CLO_4(117) x flow(117) x YIO(117B) +

CLO_4(133) x flow(133) x YIO(133B)} x 8.34 / 1,OOO,OOO = Total CLO_4 lb/min

The total flow rate of the nine wells entering the EQ Tank is then calculated.

Flow (121) x YIO(121B) + Flow (120) x YIO(120B) + Flow (119) x YIO(119B) +

Flow (118) x YIO(118B) + Flow (115) x YIO(115B) + Flow (99) x YIO(99B) +

Flow (116) x YIO(116B) + Flow (117) x YIO(117B) + Flow (133) x YIO(133B) = Total Flow

entering the EQ Tank (gpm)

The perchlorate total is then divided by the total flow rate from the nine wells to evaluate the EQ Tank T-100 concentration of perchlorate.

{(Total CLO_4- pounds / minute) / (Total Flow (gal / min)} x 1,000,000 / 8.34 = CLO_4(ppm)

The influent specification function is based on daily flow-proportioned composite samples, which will be monitored individually or averaged over a thirty-day period. In addition, the following values are not to be exceeded individually at any time (instantaneously):

NO_3-N limit = 50 mg/l

$Cl0_3$ limit = 500 mg/l

$Cl0_4$ limit = 400 mg/l

3.6.4 IX TREATMENT SYSTEM

The IX System for perchlorate treatment is designed to operate with minimal operator attention. Most of the work associated with the IX process will relate to changing out of spent media with fresh media.

The process examines the process flow rate to match it with the optimal number of on-line treatment vessels. The process responds to changing flow rates by adding or removing treatment vessels. The IX treatment process also adjust the maximum treatment capacity of the IX media in response to changes in the perchlorate concentration of the influent water.

3.7 CURRENT EFFLUENT WATER QUALITY REQUIREMENTS

The treated effluent from the Perchlorate Treatment System must meet the following criteria as per NPDES permit NV0023060 issued December 2011.

Table 3.6 Effluent Water Quality Requirements

Effluent	30 Day Average
Perchlorate Concentration, ug/L	< 18[a]
Ammonia-N, lb/day	< 40
Total P, lb/d	< 20
TSS, mg/l	< 135
BOD, mg/l	< 25
pH	6.5-9 SU

Note[a] or less than the minimum reporting level “MRL”, as measured by the current EPA Method 314.0, Revision 1, November, 1999, whichever is greater. For non-detect samples, daily composite values will be assigned a value of zero for calculating 30 day average. Maximum perchlorate concentration is based on maximum flow of 1000 gpm.

Values are based on discrete samples, which are averaged over a thirty-day period.

3.8 ION EXCHANGE TREATMENT SYSTEM

Water that enters the IX Equalization Tank will be treated by the Ion Exchange System at LS-1. The IX Treatment System evaluates a number of operating parameters to successfully treat the ground water from the Seep Wells.

- The composition of the IX feed water. On process start-up, the IX feed composition will be set to the values as entered into the HMI composition input screen. Initially, the composition as noted in Table 3.3 is entered into the HMI input screen. The composition of each well will be updated after the analysis of the well water samples is complete. The PLC addresses the impact of changes in the perchlorate concentration on the IX vessel maximum treatment capacity.
- The flow rate of each Seep will be used by the PLC in real time. The IX System Feed to identify the number of vessels to be placed on-line.
- The totalized amount of perchlorate that is retained in each IX treatment vessel is monitored to evaluate the current amount of perchlorate adsorbed by the
- IX vessel. The current amount of perchlorate adsorbed by each IX vessel will be displayed in several ways:
  - The current amount of perchlorate adsorbed by the IX vessel
  - The current amount of perchlorate as a percentage of the IX vessel's operational treatment capacity and
  - The current amount of perchlorate as a percentage of the IX vessel's theoretical treatment capacity

The composition and load of the water in the Lift Station #1 wet well will be monitored for use by the Perchlorate Treatment System.

3.9 OPERATING MODES

This IX system has sixteen (16) units operating in parallel; eight units on-line (initially) and eight units in regeneration/standby capable of treating up to 600 gpm. The IX system has the following operating conditions or modes:

3.9.1 SYSTEM MODES

1. SYSTEM OFF: Pump P-100A/B is OFF; motorized valves are in their shelf state (closed). Motorized valves include MOV-1C, MOV-1D, MOV-2C, MOV-2D, MOV-3C, MOV-3D, MOV-4C, MOV-4D, MOV-5C, MOV-5D, MOV-6C, MOV-6D, MOV-7C, MOV-7D, MOV-8C, MOV-8D, MOV-9C, MOV-9D, MOV-10C, MOV-10D, MOV-11C, MOV-11D, MOV-12C, MOV-12D, MOV-13C, MOV-13D, MOV-14C, MOV-14D, MOV-15C, MOV-15D, MOV-16C, MOV-16D. The run permissive signal is withdrawn to the well pumps that flow into T-100.

2. AUTO SYSTEM OPERATIONS: Pump P-100A/B and all motorized valves (MOV-1A through MOV-16D) referenced above are in AUTOMATIC mode and will operate as specified in the automated valve sequencing algorithm. Run permissive to well pumps that flow to T-100 is granted.

3. MANUAL SYSTEM OPERATIONS: HMI switches HS-100A and HS-100B can be operated manually to start and stop Pump P-100A/B. HMI switches HS-210 through HS-581 are used to operate motorized valves MOV-1C, MOV-1D, MOV-2C, MOV-2D, MOV-3C, MOV-3D, MOV-4C, MOV-4D, MOV-5C, MOV-5D, MOV-6C, MOV-6D, MOV-7C, MOV-7D, MOV-8C, MOV-8D, MOV-9C, MOV-9D, MOV-10C, MOV-10D, MOV-11C, MOV-11D, MOV-12C, MOV-12D, MOV-13C, MOV-13D, MOV-14C, MOV-14D, MOV-15C, MOV-15D, MOV-16C, MOV-16D. The run permissive signal to the well pumps that flow to T-100 is withdrawn.

4. SYSTEM PAUSED: Each IX vessel in in Auto, and remains in their last operating mode: IX-210, IX-220, IX-230, IX-240, IX-350, IX-360, IX-370, IX-380, IX-410, IX-420, IX-430, IX-440, IX-550, IX-560, IX-570, IX-580; Pump P-100A/B; all MOV valves (MOV-1A through MOV-16D) are in AUTO mode and remain in their last position prior to pausing; run permissive to feed water remains ON; all alarms are bypassed.

3.9.2 IX VESSEL MODES:

The vessel states noted below can apply to any one of the IX vessel in the system. The "x" in the notations below represents anyone of the sixteen (16) IX vessels. For example IX Vessel 220 would relate to MOV-2C or MOV-2D.

NOTE: The operator is able to collect a water sample for analysis from the IX vessel's sample point that is located on the IX vessel discharge line operating in any vessel mode. The analysis point collects the water sample by opening V-xx7, where xx is the Vessel Tag name without the zero). The sample can be used to check for bed exhaustion.

ADSORB: The vessel is online and actively treating water. Vessel valves MOV-*x*C and MOV-*x*D are in the OPEN position.

IN-USE: When the PLC takes a vessel off-line before reaching its maximum treatment capacity, the PLC will tag the vessel as In-Use. When the PLC needs to place another bed on-line as a result of higher system flow rate, In-Use vessels will return to the Adsorb mode. The ClO4 totalizer resumes to count.

STANDBY: The vessel is ready for service and shall be placed into service automatically when one of the other beds is depleted. Vessel valves MOV-*x*C and MOV-*x*D are in the CLOSED position.

SPENT: The vessel has adsorbed its limit of contaminants and is ready for resin media change-out, A vessel in the Spent state cannot return to service. After the media of the Spent vessel has been changed out, the operator presses a switch acknowledging the media has been changed-out. The HMI will then challenge the operator to confirm that he is intentionally returning the IX vessel to the Standby mode.

OFFLINE: During automatic operation, the operator can remove a vessel from service by switching the vessel off-line. The C&D valves for an off-line vessel are closed. The valve state of an off-line vessel cannot be changed by the PLC.

For each vessel in the system the PLC/HMI should allow the operator to select a vessel Mode for the IX vessel pair prior to entering Auto operation:

ADSORB – Forced into service for treatment

STANDBY – After the media change-out of a spent vessel is complete, the operator is able to change the vessel status from Spent to Standby.

OFFLINE – Not available for service. Upon return to the Standby mode, the PLC assumes that the media is fresh, and the perchlorate totalizer is reset to 0.

The operator will find this feature useful when a block of vessels is intentionally to be kept out of service until a later date.

While the process operates in Auto, changes in vessel operating mode are made by using the Advanced Features. These features are accessed on a pop-up screen by mouse clicking on IX vessel.

When manually changing the vessel operating state, the operator mouse-clicks on the screen image of one vessel of the pair (either one). This will activate a pop-up window showing the vessel pair and the list of selectable vessel pair operating states. If the operator selects to many vessels in the Adsorb mode, the PLC program will change the vessel operating mode from Adsorb to On-line. (See the next section). The operator will then push a switch on the pop-up display to close the pop-up window. Also see Section 5 for advanced features of IX vessel operations.

The HMI shall display

- The HMI screen will display the operating mode of each bed (Adsorb, Standby, In-Use, Spent, or Offline) will appear in text under each bed.
- HMI screen display the operating mode of the IX bed as a color.
    - Lead Beds in the Adsorb will be shown with a red outline.
    - Lag Beds in the Adsorb will be shown with a yellow outline.
    - In-use beds will be green.
    - Beds in Standby will be white.
    - Spent beds will be dark red.
    - Off-Line beds will be grey.

- The percent of maximum treatment capacity of each IX Bed.
- See section 2.3 for the colors used for other equipment states.

3.10 ON-LINE BED SELECTION

The number of on-line IX vessel pairs is evaluated by the PLC. The PLC divides the IX feed rate (FIT-101) by the ideal vessel flow rate. When calculating the number if on-line bed pairs: (FI-101 gpm) / 75 = X.yy The PLC will increase the fractional portion to the next integer.)

Example: 140 gpm / 75 gpm/vessel = 1.86 which is increased to 2.
80 gpm / 75 gpm/vessel = 1.06 which increases to 2.

When the number of calculated treatment vessels exceeds the number of available vessel pairs, the PLC divides the feed flow rate by the number of available vessel pairs to identify the individual vessel flow rate.

If the flow rate per vessel is above the minimum and below the maximum vessel flow limits, the IX System permissive is granted. When the calculated flow rate per vessel is outside of the acceptable range, the IX treatment system remains off-line, and the total Seep Well flow is routed to the wet well at LS-1.

The IX system operates with preset IX vessel pairs:

IX-210 (9)	IX-220 (10)	IX-230 (11)	IX-240 (12)	IX-350 (13)	IX-360 (14)	IX-370 (15)	IX-380 (16)
↕	↕	↕	↕	↕	↕	↕	↕
IX-410 (1)	IX-420 (2)	IX-430 (3)	IX-440 (4)	IX-550 (5)	IX-560 (6)	IX-570 (7)	IX-580 (8)

3.11 VESSEL SELECTION SEQUENCE

The preferred selection of well pair that will be placed on-line will start with the first vessel pair, IX-210 (lead) (from Vessel Bank A) – IX-410 (lag) (from Vessel Bank B), and sequentially select the next vessel pair based on vessel location within the IX Process Container. The number in parenthesis is the vessel location number. The last vessel pair in the Forward flow mode will be IX-380 – IX-580.

After the eight lead vessels are spent, the process is configured to use the former lag vessels (Vessel Bank B) as the new set of lead vessels. In this mode, IX-410 becomes the lead IX vessel, and IX-210 becomes the lag vessel. Media in the former lead position (Vessel Bank A) is replaced with fresh resin.

When the process is operating in the Forward flow configuration, the Forward valves, V-F1, V-F2, and V-F3 are open and V-R1, V-R2, and V-R3 are closed. When the process is operating in the Reverse flow configuration, the Reverse valves V-R1, V-R2, and V-R3 are open and V-F1, V-F2, and V-F3 are closed.

Each of the forward and reverse valves, V-R1, V-R2, and V-R3 & V-R1, V-R2, and V-R3, are fitted with position switches so that the PLC will know the valve position. The IX treatment system will not operate unless each valve position is either full open or full closed.

When the position of any one or more of the Forward and Reverse valves is not known, and that condition is maintained for 15 seconds, a FOR / REV position alarm is generated and the IX treatment process is placed into the System Off mode.

Treating perchlorate with vessel pairs allows the lead vessel to treat perchlorate until the resin is fully spent. When the lead vessel is treating perchlorate near the maximum treatment capacity, some perchlorate is able to pass to the lag vessel for treatment. After a Forward / Reverse change is made, the lag vessel become the new lead treatment vessels. To account for the vessels initial use, an operator adjustable input is used to estimate the perchlorate load on the lag vessel based on the perchlorate totalized for the lead vessel (see the operator input table in Section 7.2).

3.12 TRACKING THE TOTALIZED AMOUNT OF PERCHLORATE

From the moment an IX vessel pair is placed on-line, the totalized amount of perchlorate treated by the resin (media) is tracked, and displayed on the HMI screen.

In response to treatment system flow rate changes, an IX vessel can be taken off-line before the media is spent. The vessel mode will change from Adsorb to On-Line, and will be assigned the highest priority for its return to operation. The perchlorate accumulation will resume at the value it had when it came off stream.

The perchlorate totalizers will use the formula (see Section 3.12 for calculating the feed ClO4 concentration):

Totalized ClO4 mass = (the IX feed flow FI-101, gallons/minute) * (3.785 liters/gallon) / (# on-line vessel pairs) * (ClO4 concentration mg/liter) / (1000 mg/liter) / (60 seconds/min)

This equation is executed once per second for each on-line vessel, and the results are added to the previous calculated ClO4 total.

During operations, the totalized amount of perchlorate treated is calculated and display on the HMI screen for the lead IX treatment vessel. Calculations for the Theoretical and Maximum Vessel treatment capacity applies to the lead IX treatment vessels. The lead treatment vessels in the Adsorb and In-use modes will display the totalized amount of perchlorate treated.

3.12.1 THEORETICAL AND OPERATIONAL MAXIMUM TREATMENT CAPACITY

The resin adsorption capacity of perchlorate is a function of the perchlorate concentration.

Table 3.7, Perchlorate Concentration Factor

Perchlorate Concentration Factor		
Concentration Range, Low mg/L	Concentration Range, High mg/L	Factor
0	0.015	0.16
0.016	0.05	0.18
0.0501	0.1	0.20
0.101	0.25	0.22
0.251	0.4	0.24
0.401	0.55	0.27
0.551	0.7	0.30
0.701	0.85	0.35
0.851	1	0.40
1.001	1.15	0.47
1.151	1.3	0.55
1.301	1.5	0.65
1.501	1.75	0.72
1.751	2	0.77
2.01	2.5	0.83
2.501	3	0.89
3.001	3.5	0.96
3.501	4	0.99
4.001	5	1.00
5.001	99	1.01

THEORETICAL MAXIMUM TREATMENT CAPACITY: The theoretical maximum total treatment capacity is equal to the published resin capacity or tested resin capacity (operator input) expressed as meq/ml or eq/L multiplied by the molecular weight of perchlorate (99.4 g/mole). 0.77 eq/L X 99.4 g/mole = 76.54 grams/l resin.

OPERATIONAL TREATMENT CAPACITY: The operational capacity of the resins is a function of the concentration of perchlorate in the feed stream. The theoretical total capacity is multiplied by the concentration factor from table 3.7 above.

Using data from Table 3.3, the average perchlorate concentration in the IX Feed water is 2.7 mg/L. Using Table 3.7, the perchlorate concentration factor is 0.89. The perchlorate molecular weight is 99.4 grams / gram-mole. The Operational ClO4 Capacity can be expressed from a resin basis, or from the IX Vessel basis:

Operational ClO4 Capacity = (0.77 mole equivalents/liter-Resin) * (Conc. Factor) * (MW-ClO4)
= 68.53 grams ClO4 / liter-Resin

Operational ClO4 Vessel Capacity = (0.77 mole equivalents/liter-Resin) * (Conc. Factor) * (99.4 grams-ClO4/gram-mole) * (25 cu.ft. resin /vessel) * (28.32 liters/cu.ft.)
= 48228. grams-ClO4 / vessel.

When the IX system is operated with vessel pairs, the primary IX vessel can remain on-line until the theoretical ClO4 vessel Capacity is reached.

3.12.2 MAXIMUM OPERATIONAL VESSEL TREATMENT CAPACITY

The maximum operational vessel treatment capacity is reduced in lead-lag (series) operational systems. The leakage from the lead vessel as it exhausted is adsorbed by the lag vessel. Consequently, a safety factor (estimated load on lag vessel) will need to be applied to all vessel operations after the first run of the system. Based on the computer modeling projections, the amount of perchlorate mass that is projected to be loaded onto the lag vessel is up to 15% of the total load on the lead vessel. The maximum operating capacity will be set as the operating capacity times this safety factor. This safety factor is initially set to 0.85 (unit-less), and will be adjusted based on operational experience.

Maximum ClO4 Capacity = (0.77 mole equivalents/liter-Resin) * (Conc. Factor) * (MW-ClO4)
(Safety Factor)
= 57.90 grams ClO4 / liter-Resin

Maximum ClO4 Vessel Capacity = (0.77 mole equivalents/liter-Resin) * (99.4 grams-ClO4/gram-mole) * (25 cu.ft. resin /vessel) * (28.32 liters/cu.ft.) * (Conc. Factor)
= 40994. grams-ClO4 / vessel.

or this could be the operational ClO4 vessel capacity X Safety factor (48228 X 0.85 = 40,993.8)

When the IX vessel resin bed reaches the Maximum ClO4 Vessel Capacity, the PLC changes the vessel mode from Adsorb to Spent.

3.12.3 RESERVE TREATMENT CAPACITY

From the time that an IX pair enters the Spent mode until the primary vessel resin change-out, it is possible that the Spent vessel pair could return to the Absorb mode. The PLC program will check for this possibility.

When the IX system treats water with a low perchlorate concentration, the concentration factor has a great effect on the vessel's treatment capacity (Section 3.7.6). As the perchlorate concentration increases, the treatment capacity of the resin also increases.

This scenario can occur when a new well pump begins to feed the IX system and the perchlorate concentration increases.

When the updated treatment capacity increases by 5% or more, the PLC will change the operating mode of the vessel pair from Spent to Adsorb.

IF (Totalized vessel ClO4 mass) / (Operational ClO4 Vessel Capacity [grams-ClO4 / vessel] < 95%, then place the vessel pair back into the into the Adsorb mode.

When the PLC performs its calculation to identify the number of beds in the Adsorb mode, and needs to take a vessel off-line, the vessel in Adsorb with the lowest Tag ID will have its mode change from Adsorb to On-Line.

4 PROCESS ELEMENTS:

4.1 LIMIT SWITCHES IDENTIFY TREATMENT HEADER SELECTION

LIMIT SWITCH TERMINOLOGY

YIO(Well ID-A) = wet well feed valve (A) is open (O)

YIC(Well ID-A) = wet well feed valve (A) is closed (C)

YIO(Well ID-B) = IX EQ Tank feed valve (B) is open (O)

YIC(Well ID-B) = IX EQ Tank feed valve (B) is closed (C)

Note: The “Well ID” designation in a limit switch tag represents the numerical portion of the well ID Tag. 99 for well 99R3, 115 for well 115R, 116 for well 116, 118 for well 118, 119 for well 119, 120 for well 120, 121 for well 121, 117 for well 117, or 133 for well 133

The HMI shall display

Valve position for each well

These are digital outputs on manual valves therefore there are no HMI set point values: See Section 3.2 for a description of the position switch control logic.

4.2 WELL PUMP FLOW TRANSMITTER, FIT-40XXX

FIT-40XXX is a flow indicating transmitter measuring the well pump discharge flow from each well where ‘XXX’ is a 99, 115, 116, 118, 119, 120, 121, 117, or 133 dependent of which wells are in operation. The Lift Station 1 PLC, supplied as part of the Metrics project, will send a 4-20 mA signal representative of the flow via Profibus cables.

Additionally, the PLC shall display the total flow rate of all wells feeding the wet well at LS-1 and the total flow rate of all wells feeding the Equalization Tank T-100.

Each well pump flow meter will be configured with the configured low flow set point, which will activate a low flow alarm.

The HMI shall display

Flow Measurement as FI-40XXX, in gpm

Resettable Flow Totalizer for each well, in gallons

HMI shall allow operator input of set point values for:

Low Feed Flow Switch FSL-40XXX

In the event that:

FSL-1XX shall trigger FAL-1XX, LOW FLOW alarm, after its time delay times out.

4.3 PRESSURE TRANSMITERS, PIT-101 /PIT111 /PIT-580 /PIT-590

PIT-101 measures the gage pressure at the discharge of the booster pump station. PIT-102 measures the gage pressure at the discharge of the bag filters. PIT-580 measures the gage pressure at the IX Vessel Bank A discharge header. PIT-590 measures the gage pressure at the IX Vessel Bank A discharge header All four transmitters will supply a 4-20 mA signal to the PLC that represents the measured pressure reading.

The HMI shall display PI-101, PI-111, PI-580, and PIT-590.

HMI shall allow operator input of set point values for:

Feed Pump Discharge Pressure LOW Alarm – PAL-101

IX Header Discharge Pressure LOW Alarm – PAL-590

Pressure indications and alarms for PI-101 and PI-590 are for information only and do not control any system function.

4.4 PRESSURE DIFFERENTIALS, PDI-101 /PDI-580 /PDI-590

PIT-101 and PIT-111 are used to calculate the differential pressure across the influent bag filter.

PIT-111 and PIT-580 are used to calculate the differential pressure across the IX vessel bank A header, and

PIT-111 and PIT-590 are used to calculate the differential pressure across the IX vessel bank B discharge header.

The HMI shall display the differential pressure and high differential pressure alarms.

HMI shall allow operator input of set point values for:

Bag Filter Pressure Differential HIGH Alarm - PDAH-101
IX Vessel Bank A Pressure Differential HIGH Alarm - PDAH-580
IX Vessel Bank B Pressure Differential HIGH Alarm - PDAH-590

4.5 MOTOR OPERATED VALVES (MOV)

IX VESSEL FEED AND DISCHARGE VALVES (MOV-xC & xD)

Valves MOV-xC and MOV-xD where 'x' is a 1 through 16 for the respective IX vessel, are electric actuated ball valves for controlling flows in and out of the IX vessels.

The valves have Auto and Manual modes of operations.

A. **Auto Mode:**

When the IX process is operated in the Auto Mode of process operations, the valve position is set by the PLC based on the vessel mode: ABSORB, IN-USE, STANDBY, SPENT, OR IN-USE,

Only the operator can change the status of a SPENT vessel to STANDBY after a complete resin change-out.

The HMI will display the valve position.

B. **Manual Mode:**

When an IX system is in its Manual Mode, the motor operated valves can be operated from the HMI screens when the valve Manual / Auto selector switch is in the Auto position. The MOV can be operated locally at the valve when the valve Auto / Manual selector is set to manual.

CAUTION: *The PLC power passes through an uninterruptable power supply which is designed to maintain the PLC memory, including motor operated valve positions. If the PLC is intentionally taken off-line, the two-way motor operated valves will cycle to their closed state while the PLC program boots. All MOVs will return to their previous operating state after the PLC program restarts.*

4.6 PROCESS INTERLOCKS

PROCESS INTERLOCKS			
INTERLOCK	DESCRIPTION	TESTED BY:	DATE
1501	Well pump shuts down on low level or low discharge flow. When the well exceeds the reset level for 10 minutes, pump restarts.		
1502	When the wet well level rises, the wells will shut off in four stages: PC-99R3, PC-115R, PC-116R, all other wells. The wells will be restarted when the wet well level falls. This is hard wired through the wet well level transmitter.		
1503	If the position of one (or both) well pump discharge valve is partially open , or if the valve position is not known (neither position switch is active), and if the partially open valve state is maintained for 15 seconds, the associated well pump run permissive signal is withdrawn.		
1504	On low wet well level, the wet well pumps will be shut down until the well level rises to a reset level.		
1505	If the valve position of any one or more of the six forward / reverse valves V-F1, V-F2, V-F3, V-R1, V-R2, OR V-R3, the IX process is placed in the Off mode, and a common valve position alarm is activated.		

PROCESS INTERLOCKS			
1506	On wet well or tank high-high level, the well pumps feeding the wet well or tank are shut down (Either or both the mechanical level switch or the switch configured from the level controller will activate this interlock))		
1507	When a well pump runs in hand, the pump will operate at 100% speed.		
1508	High-High at LS-2, detected by either the level transmitter or LSHH-42021, shuts down the wet well pumps at LS-1 and LS-3.		

5 ADVANCED PROCESS FEATURES

5.1 PLACING AN IX VESSEL OFFLINE

Operator Selection

Any one of the eight IX Vessel pairs can be manually taken Off-line. To do this, the Operator inputs the vessel ID Tag of the vessel to be taken off-line. The PLC will store the totalized amount of perchlorate treated by the primary vessel coming off line has treated since its last resin replacements.

On the same pop-up window, the next available well pair that will replace the vessel pair being withdrawn from the process is displayed. The last step in this procedure will require the operator to confirm that the vessel pair swap is intended. Once confirmed, the vessel swap will occur. The operator will then push a switch on the pop-up display to close the pop-up window.

5.2 RESTORING AN IX VESSEL BACK INTO OPERATION

To restore an offline IX Vessel back into operation, the process operator removes its Off-line selection.

When all resin replacement steps completed by the vessel taken off-line, the operator will change the bed status to Stand-by. The PLC will challenge the operator to repeat the change in status to prevent accidental changes of status. The PLC will reset the bed volume counter to zero.

5.3 SELECTING THE NEXT ON-LINE VESSEL

The PLC will first restore any In-Use IX vessel back into the Adsorb mode of operation. If there are no In-Use vessels, the PLC will select the Standby IX Vessel with the next highest Tag ID to be the next IX vessel to be placed on-line. The PLC will never select a vessel pair that has a vessel in the Spent or Offline status for returning to the adsorb status.

5.4 RESETTING THE PERCHLORATE TOTALIZER

The process Operator has the capability to increase or decrease the totalizer value tracking the amount of perchlorate adsorbed by the IX vessel. This feature provides the Operator with limited control to adjust the change-out frequency of on-line IX beds.

The ability to reduce the totalizer value is password protected. The password protection is required to ensure that the operator makes this change is occurring to achieve a thought-out goal, because it is used in rare situations (i.e. start-up or testing).

6 SYSTEM START UP

CAUTION! Ensure that all process parameters are set in the HMI input screens, all process controllers have been tuned and have a set point, and all manual valves are set for operation (see Chapter 6 for details).

When power is initially turned ON, the system shall be in SYSTEM OFF mode.
The HMI shall include a SYSTEM ON button and a SYSTEM AUTO/MANUAL button.

When the operator selects the SYSTEM ON button, the system shall change from the SYSTEM OFF to SYSTEM PAUSED.

6.1 AUTOMATIC MODE OPERATIONS

In preparation of starting the IX treatment process, the Operator must confirm that the Seep well field is ready for operation, that the manually operated valves in the appropriate open / closed state, and that the Seep wells are set to flow to either the wet well at LS-1 or to the Equalization Tank T-100. The operator also needs to verify the local Seep well pump selector switch is set to the Auto position, that the wet well pumps are set to the Auto position, and the IX feed pump is set to Auto. The operator will then check to ensure that the wet well and Equalization Tank are ready for operation. The operator will need to check to see if the IX system is ready and all equipment internal to the IX container is ready to operate.

Once the process equipment is checked for operation, the operator must review that all data input fields have been entered into the HMI.

When the operator chooses to run the IX treatment system in Auto, the operator will place the Man / Auto selector switch in the Auto position. The process then opens the C and D automated valves of the first two vessel pairs.

The HMI Seep well pump selector switch is then placed into Auto, starting the Seep well pumps. The wet well and EQ Tanks controls will then initiate the Wet Well and the IX Feed Pumps under automatic control.

When FIT-101 measures the feed flow rate, and it exceeds the set point of the low flow switch, the system will leave the SYSTEM PAUSED mode and will enter into the SYSTEM RUNNING mode. An on-delay time function shall be included in the PLC logic to allow temporary bypass of feed alarm FAL-101 on system start.

Initially, two IX vessel pairs will enter service to treat the feed water. When the feed pump P-100A or B energizes, FIT-101 will begin monitoring the IX feed flow rate. The PLC will take auto control over the IX system. After an operator adjusted time delay, the PLC will examine the IX feed rate (FIT-101), and divide the flow rate by the optimal flow rate for the IX vessel (the optimal IX Vessel flow rate is addressed in Chapter 5). This result will revise the number of beds in Adsorb mode.

6.2 MANUAL MODE OPERATIONS

When the operator chooses to manually run the IX treatment system in manual, the operator will place the Man / Auto selector switch in the Man position. The process operator now is responsible for opening and closing all automated valves. The PLC will allow the process controllers to function.

To prepare the process for operations in Man, the operator needs to open the C and D automated valves of the selected IX vessel pairs. In manual operation, the operator is responsible for opening and closing valves, starting and stopping pumps, and monitoring the process to prevent over-flowing tanks.

7 PROCESS PARAMETERS

7.1 SECURE PROCESS INPUT PARAMETERS

The following password protected Process Parameters are available. These parameters are adjustable only by qualified members of Envirogen's Staff. The initial value will be the value of the current totalized adsorbed perchlorate, initially set at zero.

Process Parameter	Parameter Description	Range	Initial Value
$ClO4TOTAL_{IX01}$	Total ClO4 treated – Bed IX01,	0 – 54,189 grams	0
$ClO4TOTAL_{IX02}$	Total ClO4 treated – Bed IX02,	0 – 54,189 grams	0
$ClO4TOTAL_{IX03}$	Total ClO4 treated – Bed IX03,	0 – 54,189 grams	0
$ClO4TOTAL_{IX04}$	Total ClO4 treated – Bed IX04,	0 – 54,189 grams	0
$ClO4TOTAL_{IX05}$	Total ClO4 treated – Bed IX05,	0 – 54,189 grams	0
$ClO4TOTAL_{IX06}$	Total ClO4 treated – Bed IX06,	0 – 54,189 grams	0
$ClO4TOTAL_{IX07}$	Total ClO4 treated – Bed IX07,	0 – 54,189 grams	0
$ClO4TOTAL_{IX08}$	Total ClO4 treated – Bed IX08,	0 – 54,189 grams	0
$ClO4TOTAL_{IX09}$	Total ClO4 treated – Bed IX09,	0 – 54,189 grams	0
$ClO4TOTAL_{IX10}$	Total ClO4 treated – Bed IX10,	0 – 54,189 grams	0
$ClO4TOTAL_{IX11}$	Total ClO4 treated – Bed IX11,	0 – 54,189 grams	0
$ClO4TOTAL_{IX12}$	Total ClO4 treated – Bed IX12,	0 – 54,189 grams	0
$ClO4TOTAL_{IX13}$	Total ClO4 treated – Bed IX13,	0 – 54,189 grams	0
$ClO4TOTAL_{IX14}$	Total ClO4 treated – Bed IX14,	0 – 54,189 grams	0
$ClO4TOTAL_{IX15}$	Total ClO4 treated – Bed IX15,	0 – 54,189 grams	0
$ClO4TOTAL_{IX16}$	Total ClO4 treated – Bed IX16,	0 – 54,189 grams	0

7.2 PROCESS INPUT PARAMETERS

The following Process Parameters are available without password protection. These parameters are adjustable by the Process Operator.

7.2.1 INITIAL SEEP WELL COMPOSITION INPUTS

Well	Concentration Range ClO4 (mg/L)	ClO_4 (mg/L) Input		Concentration Range ClO3 (mg/L)	ClO_3 (mg/L) Input		Concentration Range NO_3 as N (mg/L)	NO_3 as N (mg/L) Input
PC 116R	0 - 25.00	13.30		0 - 25.00	20.22		0 - 25.00	3.46
PC 99R2/3	0 – 25.00	14.94		0 – 25.00	22.71		0 – 25.00	3.88
PC 115R	0 – 15.00	7.84		0 – 15.00	11.92		0 – 15.00	2.04
PC 117	0 – 15.00	8.39		0 – 15.00	12.75		0 – 15.00	2.18
PC 118	0 – 15.00	2.57		0 – 15.00	3.91		0 – 15.00	0.67
PC 119	0 – 15.00	0.58		0 – 15.00	0.88		0 – 15.00	0.15
PC 120	0 – 15.00	0.58		0 – 15.00	0.88		0 – 15.00	0.15
PC 121	0 – 15.00	1.10		0 – 15.00	1.67		0 – 15.00	0.29
PC 133	0 – 15.00	4.20		0 – 15.00	6.38		0 – 15.00	1.09

7.2.2 INITIAL SEEP WELL PUMP DISCHARGE HEADER VALVE POSITIONS

The PLC will monitor the position of the pump discharge header valves. The normal state is defined as (Either YIO-xxA or YIC-xxA contact state is active) AND (Either YIO-xxB or YIC-xxB contact state is active) Provide a 15 second on-delay to allow time for manually changing the valve state before activating the valve position alarm. When the position alarm is active, the associated well pump rum permissive is withdrawn.

Well	YIO-xxA	YIC-xxA		YIO-xxB	YIC-xxB	VALVE POSITION ALARM TEST
PC 116R	Open	No Signal		No Signal	Closed	
PC 99R2/3	Open	No Signal		No Signal	Closed	
PC 115R	Open	No Signal		No Signal	Closed	
PC 117	Open	No Signal		No Signal	Closed	
PC 118	No Signal	Closed		Open	No Signal	
PC 119	No Signal	Closed		Open	No Signal	
PC 120	No Signal	Closed		Open	No Signal	
PC 121	No Signal	Closed		Open	No Signal	
PC 133	No Signal	Closed		Open	No Signal	

7.2.3 SEEP WELL PUMP LOW-LOW FLOW RATE SET POINTS

7.2.4 INITIAL LEAD – LSG VESSEL ASSIGNMENTS

WELL	WELL PUMP FLOW SWITCH LOW-LOW SET POINT	FSLL-401xx		INITIAL LEAD – LAG VESSEL ASSIGNMENTS	VALVE STATE
PC 116R	0 – 200 GPM	15		Forward – Reverse Valves	
PC 99R2/3	0 – 100 GPM	15		V-F1 Vessels 9-16 Lead	Open
PC 115R	0 – 200 GPM	15		V-F2 Vessels 9-16 Lead	Open
PC 117	0 – 200 GPM	15		V-F3 Vessels 9-16 Lead	Open
PC 118	0 – 100 GPM	5		V-R1 Vessels 1-8 Lead	Closed
PC 119	0 – 100 GPM	5		V- Vessels 1-8 Lead R2	Closed
PC 120	0.0 – 10.0 GPM	0.0		V- Vessels 1-8 Lead R3	Closed
PC 121	0.0 – 10.0 GPM	0.0			
PC 133	0.0 – 50.0 GPM	0.0			

7.2.5 LEVEL AND SPEED CONTROLLER INPUTS

When the operator selects the instrument tag for

- LIC-40020 LS-1 Wet Well Level
- SC-40021 P-40021 VFD Speed Set Point
- SC-40022 P-40022 VFD Speed Set Point
- LIC-100 T-100 Equalization Tank Level
- SC-100 P-100 VFD Speed Set Point
- SC-105 P-105 VFD Speed Set Point

a pop-up screen on the HMI page will appear.

For each control loop, the following input fields will be available:

Controller Local / Remote mode selection	to determine if an internal / external controller set point signal is used. This input is needed only for the four speed controllers. SC-40021 and SC-40022 will always look to LIC-40020 as the source of the remote set point. SC-100 and SC-105 will always look to LIC-100 as the source of the remote set point.
Auto / Manual	Controller output control: When in Auto, the controller provides output control. In manual, the operator sets the controller output signal.

Local Set Point
Proportional Input
Integral Input
Derivative Input

Each controller will have a graphical display for the range, and displays for the set point and measured variable.
Each controller will have a graphical display for the controller output signal.

7.2.6 SEEP WELL LEVEL SWITCH SETPOINTS

WELL	INSTRUMENT TAG	WELL LEVEL SET POINTS		WELL	INSTRUMENT TAG	WELL LEVEL SET POINTS
PC-121	LIC-40121 0 – 100%			PC-120	LIC-40120 0 – 100%	
	LSLL	20%			LSLL	20%
	LALL TIME DELAY	5 SEC			LALL TIME DELAY	5 SEC
	LSL	25%			LSL	25%
	LSH	90%			LSH	90%
	LSHH	95%			LSHH	95%
	LAHH TIME DELAY	5 SEC			LAHH TIME DELAY	5 SEC

WELL	INSTRUMENT TAG	WELL LEVEL SET POINTS		WELL	INSTRUMENT TAG	WELL LEVEL SET POINTS
PC-119	LIC-40119 0 – 100%			PC-118	LIC-40118 0 – 100%	
	LSLL	20%			LSLL	20%
	LALL TIME DELAY	5 SEC			LALL TIME DELAY	5 SEC
	LSL	25%			LSL	25%
	LSH	90%			LSH	90%
	LSHH	95%			LSHH	95%
	LAHH TIME DELAY	5 SEC			LAHH TIME DELAY	5 SEC

WELL	INSTRUMENT TAG	WELL LEVEL SET POINTS		WELL	INSTRUMENT TAG	WELL LEVEL SET POINTS
PC-115R	LIC-40115 0 – 100%			PC-99R	LIC-40099 0 – 100%	
	LSLL	20%			LSLL	20%
	LALL TIME DELAY	5 SEC			LALL TIME DELAY	5 SEC
	LSL	25%			LSL	25%
	LSH	90%			LSH	90%
	LSHH	95%			LSHH	95%
	LAHH TIME DELAY	5 SEC			LAHH TIME DELAY	5 SEC

WELL	INSTRUMENT TAG	WELL LEVEL SET POINTS		WELL	INSTRUMENT TAG	WELL LEVEL SET POINTS
PC-116R	LIC-40119 0 – 100%			PC-117	LIC-40118 0 – 100%	
	LSLL	20%			LSLL	20%
	LALL TIME DELAY	5 SEC			LALL TIME DELAY	5 SEC
	LSL	25%			LSL	25%
	LSH	90%			LSH	90%
	LSHH	95%			LSHH	95%
	LAHH TIME DELAY	5 SEC			LAHH TIME DELAY	5 SEC

WELL	INSTRUMENT TAG	WELL LEVEL SET POINTS		WELL	INSTRUMENT TAG	WELL LEVEL SET POINTS
PC-133	LIC-40119 0 – 100%			PC-118	LIC-40118 0 – 100%	
	LSLL	20%			LSLL	20%
	LALL TIME DELAY	5 SEC			LALL TIME DELAY	5 SEC
	LSL	25%			LSL	25%
	LSH	90%			LSH	90%
	LSHH	95%			LSHH	95%
	LAHH TIME DELAY	5 SEC			LAHH TIME DELAY	5 SEC

7.2.7 LS-1 WET WELL SET POINTS

LS-1 WET WELL OPERATOR INPUTS		
Parameter	Configured Set Point	Default Value
LIC-40020		
	LCLL	20%
	LALL	5 second on-delay
	LCL	25%
	LCH	85%
	LCHH	90%
	LAHH	5 second on-delay
FI-40025		
	FSLL	85
	FALL	5 second on-delay
	FSHH	600 pm
	FAHH	5 second on-delay

7.2.8 IX SYSTEM OPERATOR INPUTS

IX System Operator Inputs		
LIC-100 0 – 11 feet		
	LSLL	2.2 feet
	LALL	5 second on-delay
	LSL	3.0 ft.
	LSH	9.5 feet
	LSHH	10 feet
	LAHH	5 second on-delay
FI-101 80 – 1000 gpm		
	FSLL	85
	FALL	5 second on-delay
	FSHH	600 pm
	FAHH	5 second on-delay
PSL-101 0 – 100 psi	PSL	20 psi
PSL-590	PSL	20 psi
PDSH-101 Configured from PI-101 – PI-111, 0 – 20 psid	PDSH	12 psid
PDSH-590 0 – 100 psi	PDSH	20 psi

IX System Operator Inputs		
Parameter	Range	Default Value
Ideal IX Vessel Flow Rate	60 – 90 gpm	75
Maximum IX Vessel Flow Rate	gpm	90
Minimum IX Vessel Flow Rate	30 – 70 gpm	35
Resin Capacity, Published Data	0.77 mole equivalents/liter	0.77
Resin Safety Factor	0.50 – 1.00 Unit-less	0.85
Resin per IX vessel	0 - 999 cu. ft.	25
Molecular Weight, Perchlorate	99.4 grams / gram-mole	99.4
Perchlorate totalizer amount to account for treatment as the second vessel in the vessel pair	0 – 10000 grams ClO4	6300.
PAL-101 IX Feed Pump discharge pressure low	0 – 100 psi	20 psi
PAH-111 Filtered water pressure, High	0 – 100 psi	30 psi
PAL-590 Treated Water discharge to the LA Wash low	0 – 100 psi	8 psi
PDAH-101 Bag Filter DP Alarm, high	0 – 100 psid	15 psid
PDAH-580 IX Vessel Bank A DP Alarm High	0 – 100 psi	5 psi
PDAH-590 IX Vessel Bank B DP Alarm High	0 – 100 psi	5 psi

See Section 3.9 for vessel color codes
See Section 3.10 for vessel pair assignments.

Initial IX Vessel Operating Modes				
Vessel	**Mode**		**Vessel**	**Mode**
IX-410 (1)	Adsorb		IX-210 (9)	Adsorb
IX-420 (2)	Adsorb		IX-220 (10)	Adsorb
IX-430 (3)	Standby		IX-230 (11)	Standby
IX-440 (4)	Standby		IX-240 (12)	Standby
IX-550 (5)	Standby		IX-350 (13)	Standby
IX-560 (6)	Standby		IX-360 (14)	Standby
IX-570 (7)	Standby		IX-370 (15)	Standby
IX-580 (8)	Standby		IX-380 (16)	Standby

Process Parameter	Parameter Description	Range	Default Value
IX Operating Mode	IX Operating Mode	Auto – Off - Manual	Auto
Max Bed Flow	Maximum IX Bed Flow Rate, which is used in the number of beds online.	48.00 – 144.00 gpm	75.00
LIC-100	Eq Tank Level Control Set point	0-12 feet	7

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7.3 PLC ALARMS

Following is a list of PLC alarms:

ALARM NAME	DEFAULT VALUE	RESULT OF ALARM	TIME DELAY
JAL-40030 UPS Power Health Monitors the electrical power at LS-1. Alarm activates upon power loss.	N/A	Notification	5 min
Communication Loss Monitors the wireless network radio for loss of communication.	N/A	Notification	5 min
HMI Fault	N/A	SYSTEM SHUTDOWN	5 min
Instrument Fault	N/A	SYSTEM SHUTDOWN	3 min
PDAH-101 Bag Filter DP Alarm, High	15 psid	Withdraw P-100A/B Run Permissive Signal	3 min

ALARM TABLE NOTES:

1. A SYSTEM SHUTDOWN condition shall cause the system to cease treatment and remove the run permissive signal for the Seep Well Pumps that feed the IX treatment system, and the P-100A/B Feed Pumps, An IX system shutdown has no association with the run permissive signal from the Seep well pumps feeding the LS-1 wet well.

2. The control panel provides the external signal to provide or remove run permissive signal to feed.

3. The low flow alarm FAL-101A is not monitored when P-100A/B is not running. FAL-101A becomes monitored when an on-delay timer times out after the start of P-100A/B.

4. All alarms are displayed on the HMI.

7.4 I/O LIST

Process Parameter	Parameter Description	Range	Default Value
7.4.1 DIGITAL INPUTS			
HS-40121 in Auto	Well Pump HOA selector switch in Auto mode		
YI-40121	Well Pump Run Status		
HS-40120 in Auto	Well Pump HOA selector switch in Auto mode		
YI-40120	Well Pump Run Status		
HS-40119 in Auto	Well Pump HOA selector switch in Auto mode		
YI-40119	Well Pump Run Status		
HS-40118 in Auto	Well Pump HOA selector switch in Auto mode		
YI-40118	Well Pump Run Status		
HS-40115R in Auto	Well Pump HOA selector switch in Auto mode		
YI-40115R	Well Pump Run Status		
HS-40099R3 in Auto	Well Pump HOA selector switch in Auto mode		
YI-40099R3	Well Pump Run Status		
HS-40116R in Auto	Well Pump HOA selector switch in Auto mode		
YI-40116R	Well Pump Run Status		
HS-40117 in Auto	Well Pump HOA selector switch in Auto mode		
YI-40117	Well Pump Run Status		
HS-40133 in Auto	Well Pump HOA selector switch in Auto mode		
YI-40133	Well Pump Run Status		
YIO-21A	LS-1 wet well header Open		
YIC-21A	LS-1 wet well header Closed		
YIO-21B	IX EQ Tank header Open		
YIO-21B	IX EQ Tank header Closed		
YIO-20A	LS-1 wet well header Open		
YIC-20A	LS-1 wet well header Closed		
YIO-20B	IX EQ Tank header Open		
YIC-20B	IX EQ Tank header Closed		

YIO-19A	LS-1 wet well header Open		
YIC-19A	LS-1 wet well header Closed		
YIO-19B	IX EQ Tank header Open		
YIC-19B	IX EQ Tank header Closed		
YIO-18A	LS-1 wet well header Open		
YIC-18A	LS-1 wet well header Closed		
YIO-18B	IX EQ Tank header Open		
YIC-18B	IX EQ Tank header Closed		
YIO-15A	LS-1 wet well header Open		
YIC-15A	LS-1 wet well header Closed		
YIO-15B	IX EQ Tank header Open		
YIC-15B	IX EQ Tank header Closed		
YIO-99A	LS-1 wet well header Open		
YIC-99A	LS-1 wet well header Closed		
YIO-99B	IX EQ Tank header Open		
YIC-99B	IX EQ Tank header Closed		
YIO-16A	LS-1 wet well header Open		
YIC-16A	LS-1 wet well header Closed		
YIO-16B	IX EQ Tank header Open		
YIC-16B	IX EQ Tank header Closed		
YIO-17A	LS-1 wet well header Open		
YIC-17A	LS-1 wet well header Closed		
YIO-17B	IX EQ Tank header Open		
YIC-17B	IX EQ Tank header Closed		
YIO-99A	LS-1 wet well header Open		
YIC-99A	LS-1 wet well header Closed		
YIO-99B	IX EQ Tank header Open		
YIC-99B	IX EQ Tank header Closed		
LSHH-40021	LS-1 wet well level, high-high		
LSLL-40021	LS-1 wet well level, low-low		
HS-40011 in Auto	P-40011 local HOA selector switch is in Auto		
HS-40012 in Auto	P-40012 local HOA selector switch is in Auto		
YI-40011	P-40011 run status		
YI-40012	P-40012 run status		
LSHH-101	T-100 level High-High		

YIO-F1	Forward Valve Open		
YIC-F1	Forward Valve Closed		
YIO-F2	Forward Valve Open		
YIC-F2	Forward Valve Closed		
YIO-F3	Forward Valve Open		
YIC-F3	Forward Valve Closed		
YIO-R1	Reverse Valve Open		
YIC-R1	Reverse Valve Closed		
YIO-R2	Reverse Valve Open		
YIC-R2	Reverse Valve Closed		
YIO-R3	Reverse Valve Open		
YIC-R3	Reverse Valve Closed		
7.4.2 DIGITAL OUTPUTS			
PC-121 Well Pump Run Permissive	Well Pump Run Permissive		
HS-40121 Run	Well Pump Run Command		
PC-120 Well Pump Run Permissive	Well Pump Run Permissive		
HS-40120 Run	Well Pump Run Command		
PC-119 Well Pump Run Permissive	Well Pump Run Permissive		
HS-40119 Run	Well Pump Run Command		
PC-121 Well Pump Run Permissive	Well Pump Run Permissive		
HS-40118 Run	Well Pump Run Command		
PC-118 Well Pump Run Permissive	Well Pump Run Permissive		
HS-40115 Run	Well Pump Run Command		
PC-115 Well Pump Run Permissive	Well Pump Run Permissive		
HS-40099 Run	Well Pump Run Command		
PC-099 Well Pump Run Permissive	Well Pump Run Permissive		
HS-40116 Run	Well Pump Run Command		
PC-121 Well Pump Run Permissive	Well Pump Run Permissive		

HS-40116 Run	Well Pump Run Command		
PC-117 Well Pump Run Permissive	Well Pump Run Permissive		
HS-40117 Run	Well Pump Run Command		
PC-133 Well Pump Run Permissive	Well Pump Run Permissive		
HS-40133 Run	Well Pump Run Command		
HS-40011	P-40011 in Auto		
HS-40011	P-40011 in manual (to SC-40011)		
HS-40012	P-40012 in Auto		
HS-40012	P-40012 in manual (to SC-40012)		
HS-100	P-100A Run		
HS-105	P-105 Run		
HS-210	IX Vessel C valve open		
HS-211	IX Vessel D valve open		
HS-220	IX Vessel C valve open		
HS-221	IX Vessel D valve open		
HS-230	IX Vessel C valve open		
HS-231	IX Vessel D valve open		
HS-240	IX Vessel C valve open		
HS-241	IX Vessel D valve open		
HS-350	IX Vessel C valve open		
HS-351	IX Vessel D valve open		
HS-360	IX Vessel C valve open		
HS-361	IX Vessel D valve open		
HS-370	IX Vessel C valve open		
HS-371	IX Vessel D valve open		
HS-380	IX Vessel C valve open		
HS-381	IX Vessel D valve open		
HS-410	IX Vessel C valve open		
HS-411	IX Vessel D valve open		
HS-420	IX Vessel C valve open		
HS-421	IX Vessel D valve open		
HS-430	IX Vessel C valve open		
HS-431	IX Vessel D valve open		
HS-440	IX Vessel C valve open		
HS-441	IX Vessel D valve open		
HS-550	IX Vessel C valve open		
HS-551	IX Vessel D valve open		
HS-560	IX Vessel C valve open		

HS-561	IX Vessel D valve open		
HS-570	IX Vessel C valve open		
HS-571	IX Vessel D valve open		
HS-580	IX Vessel C valve open		
HS-581	IX Vessel D valve open		
7.4.3 ANALOG INPUTS			
LT-40121	Seep Well Level	0 – 100%	50
FT-40121	Seep Well Pump discharge flow rate		
LT-40120	Seep Well Level	0 – 100%	50
FT-40120	Seep Well Pump discharge flow rate		
LT-40119	Seep Well Level	0 – 100%	50
FT-40119	Seep Well Pump discharge flow rate		
LT-40118	Seep Well Level	0 – 100%	50
FT-40118	Seep Well Pump discharge flow rate		
LT-40115	Seep Well Level	0 – 100%	50
FT-40115	Seep Well Pump discharge flow rate		
LT-40099	Seep Well Level	0 – 100%	50
FT-40099	Seep Well Pump discharge flow rate		
LT-40116	Seep Well Level	0 – 100%	50
FT-40116	Seep Well Pump discharge flow rate		
LT-40117	Seep Well Level	0 – 100%	50
FT-40117	Seep Well Pump discharge flow rate		
LT-40133	Seep Well Level	0 – 100%	50
FT-40133	Seep Well Pump discharge flow rate		
LT-40021	Wet Well Level	0 – 100%	
PIT-40025	LS-1 wet well pump discharge pressure	0 – 50 psi?	
FT-40025	LS-1 wet well pump discharge flow rate		
LT-100	LS-1 wet well level	0 – 11 ft.	60%
PIT-101	LS-1 pump discharge pressure	0 – 100 psi	
PIT-111	Filtered Water Pressure	0 – 100 psi	

PI-590	Treated water discharge pressure	0 – 100 psi	
7.4.4 ANALOG OUTPUTS			
SC-40021	Speed set point, P-40011		
SC-40022	Speed set point, P-40012		
SC-100	Speed set point, P-100		
SC-105	Speed set point, P-105		