

From: David Sloan
Sent: Fri, 1 May 2015 14:46:34 +0000
To: Craig Stowell
Cc: Joel Klumpp; Vera Poe; Marlo Berg; Russell Schreiber (Wichita Falls); Daniel Nix (Wichita Falls); Mark Southard (mark.southard@wichitafallstx.gov); Jack Schulze
Subject: RE: Wichita Falls DPR UV Alarm & Shutdown Triggers
Attachments: UV Monitoring and Reporting SOP_2.pdf

Craig: Mark has clarified language in the SOP to eliminate any uncertainty on the off-spec calculation. Please let me know if you need anything else.

DAVID SLOAN / FREESE AND NICHOLS, INC.

From: Craig Stowell [mailto:Craig.Stowell@tceq.texas.gov]
Sent: Wednesday, April 29, 2015 3:40 PM
To: David Sloan
Cc: Joel Klumpp; Vera Poe; Marlo Berg; Russell Schreiber (Wichita Falls); Daniel Nix (Wichita Falls); Mark Southard (mark.southard@wichitafallstx.gov); Jack Schulze
Subject: RE: Wichita Falls DPR UV Alarm & Shutdown Triggers

David, We only have one comment on the new SOP:
On page 2 it states:

Each day, the number of hours the UV reactor produced off-spec water (due to any of the above conditions) must be calculated by using FSO Locational Report to verify the number of minutes the UV produced off-spec water and dividing that total by sixty (60). This value is reported on the SWMOR-Alt.

The SWMOR-Alt calculates the total amount of water produced by the UV reactor by totaling the daily flows. The total amount of off-spec water is also calculated by the SWMOR-Alt by totaling the number of hours in the off-spec water columns.

I believe that the underlined portion is calculated by the SWMOR-Alt but the daily amount of off-spec water needs to be calculated by hand and placed into the SWMOR-Alt for it to total. Please verify and revise the wording of SOP as necessary. I copied Jack Schulze on this email to confirm our phone conversation on this matter.

Thanks,

Craig A. Stowell, P.E.

Texas Commission on Environmental Quality
Water Supply Division
Utilities Technical Review Team, MC-159
P.O. Box 13087
Austin, Texas 78711-3087
Tel. 512-239-4633

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From: David Sloan [<mailto:DWS@freese.com>]

Sent: Thursday, April 23, 2015 4:38 PM

To: Craig Stowell

Cc: Joel Klumpp; Vera Poe; Marlo Berg; Russell Schreiber (Wichita Falls); Daniel Nix (Wichita Falls); Mark Southard (mark.southard@wichitafallstx.gov)

Subject: RE: Wichita Falls DPR UV Alarm & Shutdown Triggers

Craig: The City has prepared an additional SOP document to address monitoring provisions, consistent with the SWMOR-Alt documentation they are providing. I am attaching a copy of this document. They have also updated the Alarm & Shutdown Triggers document as attached to reference the monitoring SOP. If there are still any missing points, please give me a call so I can be sure I understand what is needed. Thanks.

Best regards,

DAVID SLOAN / FREESE AND NICHOLS, INC.

From: Craig Stowell [<mailto:Craig.Stowell@tceq.texas.gov>]

Sent: Thursday, April 23, 2015 9:56 AM

To: David Sloan

Cc: Joel Klumpp; Vera Poe; Marlo Berg; Russell Schreiber (Wichita Falls); Daniel Nix (Wichita Falls); Mark Southard (mark.southard@wichitafallstx.gov)

Subject: RE: Wichita Falls DPR UV Alarm & Shutdown Triggers

David, I am not seeing the following in any of the SOPs and the alarm and shutdown conditions. Please incorporate as appropriate:

- a. The City must provide at least a 3.0-log inactivation of *Cryptosporidium* through the use of UV. If the City produces off-spec water for more than four (4) consecutive hours during a day or for more than 5% of the water produced during a month, the reactor must be taken off line and the reactors must be inspected and, if necessary, repaired. The UV unit is considered to be operating off-spec when:
 - (1) The validated dose falls below the dose needed to achieve 3.0-log inactivation of *Cryptosporidium*,
 - (2) the reactor operates at a flow rate that exceeds 25.6 MGD
 - (3) the UV transmittance of the water falls below 70%, or
 - (4) one or more of the lamps is inoperable.

Reporting conditions for WF

- a. The UV intensity as measured by a UV sensor, lamp status, flow rate through the unit, UV transmittance, and lamp power continuously and record the results every 15 minutes in accordance with 30 TAC §290.111(d)(2)(A).
 1. If the reactor is operated at flow below 1.0 MGD, the calculated validated dose (D_{val}) value must be based on 1.0 MGD
 2. If the UVT of the water being treated by the UV reactor exceeds 98%, the D_{val} value must be based on 98%.
- b. The total amount of water treated by each UV unit each month
- c. The total amount of water produced each month when the UV unit is not operating within validated conditions (off-spec) in accordance with 30 TAC §290.111(d)(3)(B).
- d. The continuous time each day that the UV unit is not operating with validated conditions (off-spec).

Thanks,

Craig A. Stowell, P.E.

Texas Commission on Environmental Quality
Water Supply Division
Utilities Technical Review Team, MC-159
P.O. Box 13087
Austin, Texas 78711-3087
Tel. 512-239-4633

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From: David Sloan [<mailto:DWS@freese.com>]

Sent: Wednesday, April 22, 2015 1:37 PM

To: Craig Stowell

Cc: Joel Klumpp; Vera Poe; Marlo Berg; Russell Schreiber (Wichita Falls); Daniel Nix (Wichita Falls); Mark Southard (mark.southard@wichitafallstx.gov)

Subject: Wichita Falls DPR UV Alarm & Shutdown Triggers

Craig: I am attaching Draft Version 5.4 of the Wichita Falls *DPR Alarm and Shutdown Triggers* document.

Please note the additions for the UV system on pages 35-38. The following items have been added:

1. Low permeate (UV) flow (<1 MGD)
2. Low UVT value (<70%)
3. Low UV Lamp Ballast Power (<30%)
4. Low Validated Dose (<12) [in lieu of RED value]

Please let me know if you have any questions or need additional information.

Best regards,

DAVID W. SLOAN, P.E., BCEE
SENIOR PROCESS ENGINEER
BOARD CERTIFIED ENVIRONMENTAL ENGINEER



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Direct Potable Water Reuse Standard Operating Procedure

Wichita Falls, Texas

UV Monitoring and Reporting

This SOP supersedes any previous SOP on this topic.

INTRODUCTION

In order to maintain a multiple barrier approach to disinfection through the Direct Potable Reuse Plant, the UV systems must be properly operated, and data logged for reporting purposes. Proper operation of the UV reactors will provide a minimum of 3.0 log removal for *Cryptosporidium*.

OBJECTIVE

To ensure that the UV reactors are started in the proper sequence to maintain a minimum disinfection credit of 3.0 log removal for *Cryptosporidium*. This procedure will explain monitoring and reporting requirements on the Trojan UV system.

PROCEDURE

Monitoring and Reporting:

The SCADA system monitors data points within the Trojan UV system for reporting and alarm and shut down conditions. That data is logged in 15-minute intervals and stored in daily files on SCADA Server 6. The file name is *log_uv*, and can be found by navigating folders on Server 6 in the following sequence:

- XXXX (Year) on Server 6
 - XXX (Month)
 - XX (Day)
 - log_uv

Each daily file contains 15-minute data for each Trojan UV reactor for the validated dose (Dval), UVT, sensor correction factor, sensor 1 intensity, sensor 2 intensity, flow rate, ballast 1 power (%), ballast 2 power (%) and RED dose.

This data is transferred to the FSO Locational Report to calculate the minimum Dval, UVT and Flow for reporting purposes in the SWMOR-Alt.

RO permeate flow is totalized on a daily basis and recorded on the Cypress Water Treatment Plant Flow Records form.

Each daily file is used by the Water Purification Superintendent and the Operations and Maintenance Supervisor for data reporting in the SWMOR-Alt for the DPR plant.

In order to maintain a minimum of 3.0 log credit for *Cryptosporidium*, the UV must provide a minimum validated dose of 12.0, the UVT must be 70% - 98% and the flow must be 1 MGD – 25.6 MGD.

- A UVT less than 70% will produce an alarm, discussed in Alarms and Shutdowns.
- The UVT analyzer may show a transmittance greater than 98%, however a UVT greater than 98% is calculated in the Trojan programming as a maximum of 98%.
- The flow may be less than 1 MGD, however the Trojan programming will only use a minimum flow of 1 MGD. Flow less than 1 MGD also produces a low flow alarm, discussed in Alarms and Shutdowns.
- Although the maximum approved flow rate for the Trojan UV system is 25.6 MGD, the design and operational maximum RO permeate flow is only 10 MGD.

Any time the UV reactor is not providing a minimum of 3.0 log credit removal for *Cryptosporidium*, the water passing through the UV reactor is considered to be *off-spec*.

Off-spec water can be related to any of the following conditions:

- The validated dose (Dval) falls below 12.0.
- One or more UV lamps is inoperable.
- The UVT falls below 70%.
- The reactor operates at a flow rate exceeding 25.6 (this situation is unlikely due to design and operational conditions limiting the maximum flow rate to 10 MGD).

Each day, the number of hours the UV reactor produced off-spec water (due to any of the above conditions) must be calculated by using FSO Locational Report to verify the number of minutes the UV produced off-spec water and dividing that total by sixty (60). This value is reported on the SWMOR-Alt.

For the entire month, the SWMOR-Alt calculates the total amount of water produced by the UV reactor by totaling the daily flows. The total amount of *off-spec* water is also calculated for the entire month in the SWMOR-Alt by totaling the number of hours in the *off-spec* water columns for every day of that month.

If a UV reactor produces off-spec water for more than four consecutive hours during a day, or if the reactor produces off spec water for more than 5% of the total water produced for the month, the UV reactor must be taken off line and inspected. If repairs are deemed necessary after inspection, they must be made prior to putting the reactor back in use.

Alarms and Shutdowns:

The Trojan UV Controls Philosophy provides detailed descriptions of alarm and shutdown conditions with the UV reactor, panel and UVT system.

PART

D

CONTROLS PHILOSOPHY

CONTROLS PHILOSOPHY – Wichita Falls IPR, TX

Project# 112368

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1.0 UV Swift 24 System

The objective of this document is to provide details regarding the control strategy for the UV Swift 24 System. The control philosophy outlines the major hardware components, system status, alarm conditions, and modes of operation of the UV System.

1.1 Hardware Details

The following is the list of hardware that is included in the System Controller located in a CPP.

Type	Details
PLC	Allen Bradley, L35
Discrete Input Module	Allen Bradley, IQ16
Discrete Input Module	Allen Bradley, IQ32
Analog Input Module	Allen Bradley, IF4
Analog Input Module	Allen Bradley, IF8
Discrete Output Module	Allen Bradley, OB32
Network Type	Modbus TCP/IP
HMI	Allen Bradley, PV700+, ENET and Touch Screen

An integrated modem for remote access to permit offsite personnel to monitor system performance and assist in diagnosing failures:

- Installed in first CPP



The PLC is configured to include the following reserved I/O points:

Discrete Inputs

Channel	Discrete Input to Trojan PLC	State/Action
1	Wiper Pressure Switch	ON = Pressure Sensed
2	Wiper Home Limit Switch	ON = when HOME
3	Spare	
4	Cover On	ON = no alarm
5	Reactor High Temperature	ON = no alarm
6	Cabinet High Temperature	ON = no alarm
7	Emergency Stop	OFF = emergency
8	Reactor Water Level	ON = no alarm
9	Door Open Indicator	ON = doors are Closed
10	Ballast Panel 1 Cooling Fan	ON = no alarm
11	Reserved	
12	Spare	
13	Spare	
14	Spare	
15	Remote On/Off	ON = command to start
16	UV Transmittance Alarm	OFF = UVT monitor on-line

Channel	Discrete Input to Trojan PLC	State/Action
1	Reserved	
2	Reserved	
3	Reserved	
4	Reserved	
5	Reserved	
6	Reserved	
7	Reserved	
8	Reserved	
9	Ballast #1 Contactor Feedback	ON = Contactor Closed
10	Ballast #2 Contactor Feedback	ON = Contactor Closed
11	Reserved	
12	Reserved	

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13	Reserved	
14	Reserved	
15	Reserved	
16	Reserved	
17	Reserved	
18	Reserved	
19	Reserved	
20	Reserved	
21	Reserved	
22	Reserved	
23	Reserved	
24	Reserved	
25	Reserved	
26	Reserved	
27	Reserved	
28	Reserved	
29	Reserved	
30	Reserved	
31	Spare	
32	Spare	

Analog Inputs

Channel	Analog Input to Trojan PLC	State/Action
1	Reserved	
2	UV Transmittance	70 – 100%
3	Spare	
4	Spare	

Channel	Analog Input to Trojan PLC	State/Action
1	UV Intensity Sensor Lamp 1	0 – 85.9 mW/cm ²
2	UV Intensity Sensor Lamp 2	0 – 85.9 mW/cm ²
3	Reserved	
4	Reserved	

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5	Reserved	
6	Reserved	
7	Reserved	
8	Reserved	

Discrete Outputs

Channel	Discrete Output from Trojan PLC	State/Action
1	Reactor Running Status	ON = system is on and disinfection warm-up is complete. The target dose is being achieved.
2	Common Critical Alarm	ON = no alarm
3	Common Major Alarm	ON = no alarm
4	Common Minor Alarm	ON = no alarm
5	UV Lamps ON	ON = UV lamps request enabled
6	Wiper Motor ON	ON = wiper motor run
7	Wiper Extend	ON = extend
8	Wiper Retract	ON = retract
9	Reserved	
10	System Ready	ON = system is ready to be turned on, is in Auto Reactor mode and is in Remote control mode.
11	Reserved	
12	Reserved	
13	Reserved	
14	Panel Cooling Fans	ON = panel fans run
15	Reserved	
16	Reserved	
17	Ballast 1 Main Contactor On	ON = close contactor
18	Ballast 2 Main Contactor On	ON = close contactor
19	Reserved	
20	Reserved	
21	Reserved	
22	Reserved	
23	Reserved	

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24	Reserved	
25	Spare	
26	Spare	
27	Spare	
28	Spare	
29	Spare	
30	Spare	
31	Spare	
32	Spare	

Site Specific Design Data

The following parameters were used to configure the UV system and are specific for this site:

No of Reactors	2
No. of Lamps per Reactor	2
Reactor Model number	8L24-2
Design Target Log Inactivation:	3 Log
Design Target Organism:	T1
Design Target Pathogen:	Crypto
Design Dose Target:	14.8 mJ/cm ²
Reactor Flow Rate	10 MGD
Total Site Flow	10 MGD
Flow Type	Manual
Design UVT	>95%
UVT Type	Analog
Automatic Cleaning	Mech-Chem
UPS Present	No
Inlet Valve Control	No
Outlet Valve Control	No
Cooling Valve Control	No
Remote Control Input	Hardwired/SCADA
Status and Alarm Outputs	Hardwired/SCADA
SCADA Network Protocol	Modbus TCP/IP
Dose Output	SCADA
Intensity Output	SCADA

1.2 Site Specific Control Strategy

The following items are non-standard control features for this system which deviates from the Trojan's UVSwift24 control strategy.

- None required

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1.3 Safety Features

The UVSwift24 control strategy employs a number of alarm conditions that will result in control action designed to maintain the delivered dose.

A number critical interlock conditions will disable a UV reactor include low water level alarm, high reactor temperature alarm, high ballast temperature, wiper failure alarms, dust cap removed and multiple lamp or ballast alarms. Certain other alarm conditions will trigger a control action that may result in a reactor running at full power. Examples of this type of alarm would be a single lamp or ballast failure, or a sensor signal fault. These alarm conditions are more fully described later in this document.

2.0 Control System Overview

2.1 General Description

The control system for an UVSwift24 system consists of a PLC controller with associated I/O in a local rack, a HMI for operator interface and system configuration, and a DeviceNet communication network for the UV ballasts. Additionally the PLC and HMI will optionally be accessible through a remote dial-up modem for the purpose of monitoring logic and making online changes. A plant SCADA network may optionally be connected to the PLC through available network protocols and will be able to access designated read and write integer arrays.

Alarms are grouped together with Common Critical, Common Major and Common Minor alarm bits that are set if any of the assigned conditions are active. These alarms are described further in subsequent sections.

Common Critical Alarms - In the event that a critical alarm condition should occur, the controller will immediately initiate a reactor shut down (all lamps off). The alarm condition would have to be cleared before another start-up sequence could be initialized. Critical alarm conditions include:

Reactor Low Water Level, Reactor High Temperature, Cabinet High Temperature, Wiper Home Position Fault, Wiper Home Switch Failed, Wiper Jam at Retract Travel, Wiper Service Mode Active, Multiple Lamp and/or Ballast, Reactor Cover is Off, E-Stop Pressed1, Flow Meter Signal Out of Range, Low Flow RateBallast Output Ground Fault (1 per ballast), Main Power Outage, LCP Ballast Panel Door is Open, SCADA Communications Alarm (severity option).

Common Major Alarms - In the event that a major alarm condition should occur, the controller will display the alarm message on the operator interface and automatically ramp up the power level of all lamps in the affected reactor to 100% power. Once the alarm condition has been cleared, the reactor will resume automatic dose pacing (If Auto Reactor is selected as mode of control). Major alarms include:

Low UV Dose Major, Log Inactivation Target Not Possible, Major Lamp Power Regulation Failure (1 per lamp), Lamp Failure (1 per lamp), Lamp Rectification Failure (1 per lamp), Ballast Mains Contactor Failure (1 per ballast), Ballast DeviceNet Comms Failure (1 per ballast), Ballast Output Short Failure (1 per ballast), Ballast Fan 1 Failure (1 per ballast), Ballast Multiple Fan Failures (1 per ballast), Ballast Internal Failure (1 per ballast), Ballast Hi Temp Shutdown (1 per ballast),



Ballast Input Voltage Range Failure (1 per ballast), Sensor Signal Lost (1 per sensor), Off Specification.

Common Minor Alarms – A minor alarm indicates maintenance is required and includes the following alarms:

Optiview Signal Out of Range, Optiview Device Fault – Manual Value, Wiper Jam at Extend Travel, Wiper Hydraulic Failure, Wiper Extend Travel Time Exceeded, Wiper Retract Travel Time Exceeded, Ballast Panel Cooling Fan Failure, Ballast Fan 2 Failure (1 per ballast), Ballast Internal Warning (1 per ballast), Ballast Hi Temp Warning (1 per ballast), Ballast Input Voltage Range Warning (1 per ballast), Ballast Incorrect Lamp Type Dip Switch Setting, Lamp Rectification Warning (1 per lamp), Lamp Voltage Out of Range Warning (1 per lamp), Lamp End of Life Warning (1 per lamp), Sensor Saturated (1 per sensor), Sensor Reference Check (1 per sensor), Reference Sensor Procedure Active, PLC Battery Low

2.2 System Fault Conditions

The UV system is subject to a number of fault conditions which may be a minor, major, or critical in nature. All alarms are subject to a minor, major, critical or individually configured alarm delay timers. The following table summarizes all of the available general system alarms:

Alarm	Description	Alarm Severity	Delay	Control Action
Dosimeter Communication Timeout	PLC is not communicating with the Dosimeter board	Critical	10 comm. cycles	Shut down reactor
PLC Battery Low	PLC battery has a low output voltage	Minor	None	None
SCADA Communication Alarm (severity option)	Failed to detect watchdog bit from SCADA system toggling	Critical	3.5 sec	If SCADA instruments (flow, UVT, valves) selected, reactor shuts down
Cabinet High Temperature	Cabinet temperature exceeds the maximum limit	Critical		Reactor shut down
LCP Ballast Panel Door Open	Ballast panel Door is opened	Critical		Reactor shut down

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3.0 Reactor Control

3.1 Control Architecture

Each Control Power Panel (CPP) controls the function of its associated reactor.

When a start-up sequence is initiated, the controller will operate the valves in their respective sequence and verify that the valves are operating correctly (if system is equipped with valves) and perform a wipe sequence to verify that the wiping system is operational. Lamps are initially energized to the high power setting for a warm-up period regardless of mode (i.e. either manual or auto). After the warm-up period has expired, the lamps are automatically switched to the requested power level. The "lamp warm-up" timer (factory set at 3 minutes) dictates this time period.

When power is restored after an electrical service interruption, and the Auto Restart option is selected at the CPP, the entire start-up sequence will be re-initialized upon the power being restored. Once the "lamp cool-down" timer has expired (factory set at 5 minutes) all lamps that were in operation will be re-fired to their previous power setting. Lamps cannot be turned on 'hot'; they must be given time to cool down before they are re-fired.

3.1.1 Reactor General Fault Conditions

UV reactors are subject to a number of fault conditions which may be a minor priority and identify service requirement, may be major in nature and result in a reactor either being shut down when in Auto or run at full power as required, or may be critical and prevent the reactor from running in either Auto or Manual modes. All alarms are subject to a minor, major, critical or individually configured alarm delay timers. The following table summarizes all of the available general faults:

Alarm	Description	Alarm Severity	Delay	Control Action
Reactor Low Water Level	UV reactor does not contain enough water to activate the level switch	Critical	5 sec	Shut down reactor
High Reactor Temperature	UV reactor high temperature switch tripped	Critical	500 mSec	Shut down reactor
Reactor Cover Off	Protective cover over on reactor removed	Critical	500 mSec	Shut down reactor
E-stop pressed	E-stop switch pushed – will mask out High Reactor Temperature and Dust Cap alarms	Critical	500 mSec	Shut down reactor

3.2 Lamp Control and Monitoring

The PLC controller automatically adjusts ballast power levels. For power settings, the PLC controller will control the electronic ballasts power levels by communicating with each of the ballasts over a DeviceNet communications protocol.

Each lamp is controlled by single ballast, each with seventy-one available power levels (30 to 100%).

The electronic ballast detects lamp on/off status. The status of each individual lamp is displayed via the Reactor Overview Screen at the Operator Interface. Faulted lamps are indicated by specific lamp address on the Alarm Screen.

3.2.1 Lamp and Ballast Fault Conditions

The following alarm conditions are monitored for UV lamps and ballasts:

Alarm	Description	Alarm Severity	Delay	Control Action
Multiple Lamp and/or Ballast Failure	The number of lamps and/or Ballasts that are failed in the reactor is greater than or equal to the configured multiple lamp and/or Ballast failure set point	Critical	None	Shut down reactor
Ballast Output Ground Fault	Ground is not properly connected to Ballast	Critical	None	Shut down Reactor
Lamp Power Regulation Failure	Percentage Power regulation function failed	Major	None	Run at full power
Lamp Failure	A lamp that is required to operate is not running after warm-up time	Major	None	Run at full power
Lamp Rectification Failure	Lamp control indicates that lamp has reached end of life	Major	None	Run at full Power
Ballast Mains Contactor Failure (1 per ballast)	Mains contactor failed to connect the supply to Ballast	Major	None	None
Ballast DeviceNet Comms Failure (1 per ballast)	Ballast communication failed	Major	None	None
Ballast Output Short Failure (1 per ballast)	Output side of ballast is shorted	Major	None	Run at full Power
Ballast Fan 1 Failure (1 per ballast)	Ballast Fan 1 turned On but failed to Run	Major	None	None
Ballast Multiple Fan Failures (1 per ballast)	More than one Ballast fans failed to Run when commanded	Major	None	Run at full Power
Ballast Internal Failure (1 per ballast)	Ballast failed to operate	Major	None	Run at full Power
Ballast Hi Temp Shutdown (1 per ballast)	Ballast Temperature exceeds the maximum limit so ballast has been shut down	Major	None	Reactor shut down
Ballast Input Voltage Range Failure (1 per ballast)	Input voltage to ballast is outside of required range for normal operation; ballast has shut down	Major	None	Run at full Power

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Ballast Panel Cooling Fan Failure	Cooling fan fail to run when commanded	Minor	None	None
Ballast Fan 2 Failure (1 per ballast)	Ballast Fan 2 fail to run when commanded	Minor	None	None
Ballast Internal Warning (1 per ballast)	Ballast Temperature exceeds the maximum limit	Minor	None	None
Ballast Hi Temp Warning (1 per ballast)	Ballast is experiencing a high temperature condition	Minor	None	None
Ballast Input Voltage Range Warning (1 per ballast)	Input voltage to ballast is outside of required range for normal operation	Minor	None	None
Ballast Incorrect Lamp Type Dip Switch Setting	Lamp type installed does not match ballast DIP switch setting	Minor	None	None
Lamp Rectification Warning (1 per lamp)	Lamp control indicates that lamp is reaching end of life	Minor	None	None
Lamp Voltage Out of Range Warning (1 per lamp)	Input voltage to lamp is outside of required range for normal operation	Minor	None	None
Lamp End of Life Warning (1 per lamp)	A lamp has exceeded it rated end of life operating hours	Minor	None	None

3.3 Operating Modes

3.3.1 Reactor Control - Local/Remote

The CPP for each UV reactor is placed in either local or remote on/off control mode via a Remote Mode enable selection at the Operator Settings screens.

When the CPP is in Local mode, the operator will have available a reactor Start/Stop pushbutton available on the System Overview screen. Selecting a reactor Start will request the start-up sequence for the reactor to be initiated if the reactor is ready for a start-up to occur. A reactor will be ready for start-up if there are no critical alarm conditions and the lamps are not in a cool-down mode. Selecting a reactor Stop will request the shut-down sequence for the reactor to be initiated.

When the CPP is placed in Remote mode the CPP responds to a discrete input signal to initiate a start-up or shut down sequence in any operating mode (manually-set power level or dose paced automatic mode) from the plant PLC. This signal may be configured to be a hardwired input or a networked input that is transmitted over the SCADA interface connection.



Note: The remote PLC is unable to change the operation mode or adjust a manual power level setting (must be undertaken in person at the CPP). When Remote mode is not enabled the system can only be started and stopped by the operator via the Control screen at the CPP (this is Local mode).

3.3.2 Manual Operation through the Controller

The reactor can be turned on or off, and ballast power levels can be set in Manual Mode from the Reactor Overview Screen on the operator interface.

In the event of a Major Alarm condition, all lamp power levels will be increased to 100% power.

3.3.3 Automatic (Dose Pacing)

Dose pacing is applied to the reactor while in "Auto Reactor" mode only. In Auto mode the ballast power levels are controlled automatically to meet the target dose while conserving power.

In Auto mode the reactor initially energizes at maximum power level. Once the lamp warm-up timer expires, the reactor stages down to its required power level ensuring that the target dose is maintained.

As UV demand increases, by either an increase in flow, a decrease in UV Transmittance, or a decrease in lamp intensity, the power level of the lamps is increased accordingly.

Equipment power levels are controlled so that the minimum power setting is selected to maintain the target dose. The Operator sets the target dose via the Operator Settings screens.

In the event of a Major Alarm condition, all lamp power levels will be increased to 100% power.

3.4 Dose Calculation

The Trojan UV Dosimeter™ that predicts dose on-line is based on the hydraulic footprint of the reactor and current operating parameters of the system.

Based on an input flow signal (or keyed in value), an input %T (transmittance) signal (or keyed in value), and AccUVSensor™ measurements the Trojan UV Dosimeter™ calculates dose and displays the dose delivered by the system on the operator interface in mJ/cm^2 . This dose prediction is then used in the Dose Pacing strategy to modulate lamp power.

If the UV Dosimeter predicted dose falls below the target dose value, a Low UV Dose alarm condition is set.

3.5 Off-Specification Monitoring

The PLC monitors the UVT, flow, AccUVSensor™ measurements, target and calculated RED, calculated validated dose, and lamp, ballast, and sensor status signals to ensure that the reactor is operating within its validated limits. The reactor is considered off-specification if it is operating outside of its validated limits.

On-Spec/Off-Spec status will be displayed on the operator interface.

The following is a table of alarms that can occur, indicating that the reactor is operating Off-Spec:

Alarm	Description	Alarm Severity	Delay (default)
Off Specification – Low Validated Dose	Indicates that the validated dose is below the required dose.	Major	10 sec
Off Specification – Low S/SO	Indicates that S/S ₀ (Relative Lamp Output) is below the validated limit.	Major	10 sec
Off Specification – Low UVT	Indicates that the UV transmittance is below the validated limit.	Major	10 sec
Off Specification – High Flow	Indicates that the Flow rate is above the validated limit.	Major	10 sec
Off Specification – Low RED	Indicates that the Actual RED is below the Target RED.	Major	10 sec
Off Specification – Reactor Off and Valves Open	Indicates that the reactor is off and the valves do not have a closed status.	Major	10 sec
Log Inactivation Not Possible Major	Indicates that the reactor cannot treat the required log inactivation target	Major	10 sec
Sensor Correction Factor Applied	Indicates a value greater than 1 is being used as a sensor correction factor	Minor	10 sec
Off Specification – Invalid BRED	Indicates that a valid RED bias term cannot be determined at the current operating conditions.	Major	10 sec
Off Specification – Invalid RED Target	Indicates that the Target RED is greater than the validated limit at the current operating conditions.	Major	10 sec
Off Specification – Lamp Failed	Indicates that at least one lamp has failed	Major	10 sec
Off Specification – Sensor Failed	Indicates that at least one sensor has failed	Major	10 sec

Some of the above alarms may trigger a Low UV Dose Major Alarm or a Log Inactivation Not Possible Major Alarm, which will result in the reactor operating at full power until the fault is cleared.

3.6 Reactor HMI Interface

3.6.1 Operator Interface for Reactor and Dose Control

The operator interface provides two screens that summarize the reactor and lamp operational information. The Reactor Overview screen provides a summary of the current operational status of the reactor and all of the lamps within the reactor, as well as provides buttons to allow the operator to perform a reactor startup or shutdown, or control the lamp power when in manual mode. This screen also provides a summary of the UV Dose control for the reactor and displays all of the variables that effect dose. The Reactor Overview contains the following information:

- Reactor Power Control Mode –
 - Auto, Manual, Manual Lamp
- Reactor Status – Off, On, Warming, Cooling
- Reactor Start Control Mode – Local, Remote
- Auto Restart – Enabled, Disabled
- Wiper Status – Idle, Wiping, Faulted, Not Present
- Flow Rate
- Log Inactivation
- Off Specification Status
- UVT
- Delivered Dose
- Target Dose
- Reactor Power Level
- Individual Lamp Status – On, Off, Cooling, Warming, Faulted
- Reactor operational status messages
- Validated Dose
- Validation Factor

Control buttons are provided to allow an operator to:

- Initiate a reactor startup (when in Local Control Mode)
- Initiate a reactor shutdown (when in Local Control Mode)
- Reset all reactor faults
- Enter a reactor power level (when in Manual Power Control Mode)

The Lamp Overview screen provides detailed information about each lamp in the reactor. This screen also provides buttons to allow an operator to reset the lamp cycles and lamp hours values for each lamp. The Lamp Overview contains the following information for each lamp:

- Current Lamp Power
- Current Lamp Runtime Hours
- Current Lamp Cycles

Control buttons are provided to allow an operator to:

- Reset lamp hours for each lamp
- Enter lamp runtime hours for each lamp

3.6.2 Plant Configuration Interface for Reactor and Dose Control

Some of the options and settings used for selecting reactor and dose control configuration will be available in a selection of Protected Settings screens that are accessed with a password used by plant maintenance personnel.

The following items will be available on these screens:

- | | |
|-------------------------------------|--------------------------------------|
| • Target Log Inactivation Set Point | • Reactor Power Control Mode |
| • Target Mode Pathogen | • Reactor Start Control Mode |
| • Target Organism | • Auto Restart Mode |
| • Dose Analog Output Scaling | • SCADA Communication Failure Action |
| • UPS Control Option | • |
| • Minor Alarm Delay | • |

4.0 ActiClean™ Cleaning System Control and Monitoring

4.1 Control Architecture

Automatic lamp cleaning is accomplished using the ActiClean™ Physical/Chemical wiper system. A motor powers a hydraulic cylinder that extends the wiper to the end of the sleeves and then, after a short delay, retracts the wiper to its home position. A pressure switch has been incorporated into the wiper system's design and is used to determine when the extend stroke end-of-travel position has been reached. A limit switch has also been included to sense when the wiper reaches or is at its home position inside the reactor. A cleaning sequence may be initiated manually at the Operator Interface, or operated automatically on fixed time interval. A wipe is also initiated any time a reactor is initially started up.

4.2 Wiper control modes

The wiper can be operated in four modes as listed below

- In Manual wiping mode, each wiping sequence can only be individually initiated by the operator via the Wiper Overview screen.
- In Fixed Interval mode, the operator at the Operator Settings screens keys in the interval between wiping sequences. The operator may still manually initiate individual wiping sequences.
- In Off mode, the wiper is disabled.

- In Service mode, the operator gains access the Wiper Service Fill Mode screen.

4.3 Wiper General Fault Conditions

Wipers are subject to a number of fault conditions which are critical in nature. The following table summarizes all of the available wiping alarms.

Alarm	Description	Alarm Severity	Delay	Control Action
Wiper Home Position Fault	Wiper not commanded to move but not in home position or commanded to move but still in home position	Critical	None	Shut down reactor
Wiper Home Switch Failed	Wiper home switch does not indicate home position or out of home position	Critical	None	Shut down reactor
Wiper Jam at Retract Travel	Wiper is requested to retract and pressure switch input is set before minimum travel time	Critical	Travel Time	Shut down reactor
Wiper Service Mode Active	Wiper is under maintenance	Minor	None	None
Wiper Jam at Extend Travel	Wiper is requested to extend and pressure switch input is set before minimum travel time	Minor	Travel Time	Request Home
Wiper Pressure Switch Clogged	Wiper pressure switch input is set but wiper not activated	Minor	None	Switched to manual
Wiper Extend Travel Time Exceeded	Wiper has not reached end of travel before configured travel time	Minor	None	Maintenance Required
Wiper Retract Travel Time Exceeded	Wiper has not reached end of travel before configured travel time	Minor	None	Maintenance Required

4.4 Wiping HMI Interface

4.4.1 Operator Interface for Wiper Control

The operator interface will have a single dedicated screen (Wiper Overview Screen) that will be used to display wiper status information and be used to control the wiper actions.

The Wiper Overview screen will contain the following information:

- Wiper Status – Idle, Wiping, Faulted, Not Present
- Wiper Mode – Off, Fixed Interval, Manual
- Wiper Position – At Home, Extending, Retracting, Undefined, Advanced, Critical Alarm, Major Alarm
- Time Since Last Wipe
- Time to Next Wipe
- Wiper Interval Time

- Wiper Progress %
- Wiper Progress Revs
- Number of Wiper Cycles
- Wiper Status Banners

Control buttons are provided to allow an operator to:

- Initiate a manual wipe
- Initiate a wiper return to home
- Enter a new value for wiper cycles

4.4.2 Plant Configuration Interface for Wiper Control

Some of the options and settings used for selecting wiper control configuration will be available in a Protected Setting screen that is accessed with a password used by plant maintenance personnel. The following items will be available on this screen:

- Wiper Cycle Interval Time
- Wiper Control Mode

5.0 Flow Input Signal

5.1 Control Architecture

A flow signal is required in order to provide Dose Pacing functionality for the system. The flow can be transmitted to the UV PLC in two different ways. Most commonly, the flow is received as a 4-20 mA signal. In this mode, the input signal is scaled to a configurable engineering units range. Flow can be displayed in US MGD, GPM, L/S, M3/Hour or MLD units as standard options. The input signal is passed through a smoothing algorithm that reduces the effect of temporary spikes and drops in flow. Alternately, a flow signal may be passed from a Plant network through a configured SCADA system to a designated address in the UV PLC. The signal must be passed as 16-bit integer value that represents an engineering unit's signal multiplied by 10. The UV PLC will divide this value by 10 to get a scaled flow with 1 decimal place accuracy. In either of these modes, a manually entered flow value may be used to replace the measured flow value. This value will be used upon operator demand, or if a flow fault condition occurs.

5.2 Flow Fault Conditions

The following table summarizes all of the available flow alarms:

Alarm	Description	Alarm Severity	Delay	Control Action
Low Flow Rate	Flow is below preset setpoint for configured time	Critical	Configurable	Shut down reactor
Flow Meter Signal Out of Range	4-20 mA flow signal input is below 3.5 mA or above 20.5 mA	Critical	Major Delay	Shut down reactor

5.3 Flow Signal HMI Interface

5.3.1 Operator Interface for Flow Control

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The operator interface will display the scaled flow value in the selected Engineering Units on a Reactor Overview screen. The displayed value will represent the total system flow currently being used by the Dose Calculation routine and will be based on the current mode of operation for flow. If the system is using a manual flow value, the operator must enter the current flow value on the Flow Settings screen.

5.3.2 Plant Interface for Flow Configuration

Some of the options and settings used for selecting flow signal configuration will be available in Protected Settings screens that are accessed with a password used by plant maintenance personnel. The following items will be available on these screens:

- Default Manual Flow
- Flow Scale Max Value
- Low Flow Alarm Value
- Low Flow Alarm Delay
- Low Flow Cooling Set Point
- Extra Cooling Time
- Flow Signal Debounce
- Flow Measurement Mode
- Flow Units

6.0 UVT Input Signal

6.1 Control Architecture

A UVT signal may be used in order to provide accurate Dose calculation functionality for an UVSwift system. A 4-20mA analog UVT signal option is available on all systems. Alternately, a UVT signal may be passed from a Plant network through a configured SCADA system to a designated address in the UV PLC. The signal must be passed as 16-bit integer value that represents a percentage UVT signal multiplied by 10. The UV PLC will divide this value by 10 to get a scaled flow with 1 decimal place accuracy. A manually entered UVT value is available and may be selected if an online value is not available.

6.2 UVT Measurement Modes

If the UVT is received as a 4-20 mA signal, the input signal is scaled to a fixed 70 to 100% engineering units range. In all input modes, the input signal is passed through a smoothing algorithm that reduces the effect of temporary spikes and drops in UVT. A manually entered UVT value will be used when selected by the operator, or when some UVT fault conditions occur.

6.3 UVT Fault Conditions

The following table summarizes all of the available UVT alarms:

Alarm	Description	Alarm Severity	Delay	Control Action
Optiview Signal Out of Range	4-20 mA UVT signal input is below 3.5 mA or above 20.5 mA	Minor	10 sec	Use Manual UVT
Optiview Device Fault – Manual Value	Optiview meter failure mode signaled by discrete output	Minor	Configurable	Use Manual UVT

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6.4 UVT Signal HMI Interface

6.4.1 Operator Interface for UVT Control

The operator interface will display the scaled UVT value in % on a Reactor Overview screen. The displayed value will represent the UVT value currently being used by the Dose calculation and will be based on the current mode of operation for UVT. If the system is using a manual UVT value, the operator must enter the current UVT value on the UVT Settings screen.

6.4.2 Plant Interface for UVT Configuration

The Manual UVT setpoint will be available without requiring an operator to login, on System Overview screen. Some of the options and settings used for selecting UVT signal configuration will be available in Protected Settings screens that are accessed with a password used by plant maintenance personnel. The following items will be available on these screens:

- Default Manual UVT
- Optiview Fault Alarm Delay
- UVT Debounce %
- UVT Maximum
- UVT Minimum
- UVT Measurement Mode

7.0 AccUVSensors™

One AccUVSensor™ is provided for each lamp to monitor the UV intensity. The signal for each sensor is amplified to 4-20mA and is sent to the controller for use in the UVDosimeter dose calculation routine. UV intensity measurement is displayed on the Sensor Overview Screen for each AccUVSensor™. The UV intensity measurement is displayed in mW/cm². A reference sensor procedure may be initiated by the UV controller that will step the operator through the process of checking the output of each UV sensor against a calibrated sensor.

7.1 AccUVSensor Fault Conditions

The following table summarizes all of the available AccUVSensor alarms:

Alarm	Description	Alarm Severity	Delay	Control Action
Sensor Signal Lost (1 per sensor)	4-20 mA sensor signal input is below 3.5 mA	Major	Major Delay	Run at full power
Sensor Saturated (1 per sensor)	4-20 mA sensor signal input is above 20.5 mA	Minor	Minor Delay	None
Sensor Reference Check (1 per sensor)		Minor	Minor Delay	None
Reference Sensor Procedure Active		Minor		None

7.2 AccUVSensor HMI Interface

7.2.1 Operator Interface for AccUVSensor

The operator interface will display the scaled intensity value for each AccUVSensor in mW/cm^2 on a Sensor Overview screen. The following information will be available for each sensor:

- Intensity value mW/cm^2
- Sensor runtime since calibration
- Sensor current mA
- Sensor check interval

Control buttons are provided to allow an operator to:

- Reset runtime days for each sensor since calibration occurred
- Enter the Reference Sensor Calibration screens

7.2.2 Plant Interface for AccUVSensor Configuration

Some of the options and settings used for selecting AccUVSensor signal configuration will be available in Protected Settings screens that are accessed with a password used by plant maintenance personnel. The following items will be available on these screens:

- Sensor Check Interval
- Sensor Debounce Time
- Sensor Full Scale Intensity
- Sensor Debounce Value

8.0 SCADA Communication Requirements

The PLC will interface to the Plant SCADA system via Ethernet I/P communication protocol. This will allow the SCADA to monitor the UV disinfection process and other additional I/O. A list of available UV system status addresses will be supplied upon completion of programming.

Note: Not all points shown below will be required by every system.

8.1 SCADA Write

The following table resides in the Trojan PLC. The SCADA PLC writes data to the following table.

Array Element	Modbus Address	Comment	Data Type	Units	Scale
PSS_Write[0].0	41001/0	Sync Date and Time	Bit	1=Sync	
PSS_Write[0].1	41001/1	Spare	Bit		
PSS_Write[0].2	41001/2	Spare	Bit		
PSS_Write[0].3	41001/3	Spare	Bit		
PSS_Write[0].4	41001/4	Spare	Bit		
PSS_Write[0].5	41001/5	Spare	Bit		
PSS_Write[0].6	41001/6	Spare	Bit		
PSS_Write[0].7	41001/7	Spare	Bit		
PSS_Write[0].8	41001/8	Spare	Bit		
PSS_Write[0].9	41001/9	Spare	Bit		
PSS_Write[0].10	41001/10	Spare	Bit		
PSS_Write[0].11	41001/11	Spare	Bit		
PSS_Write[0].12	41001/12	Spare	Bit		
PSS_Write[0].13	41001/13	Spare	Bit		
PSS_Write[0].14	41001/14	Spare	Bit		
PSS_Write[0].15	41001/15	Spare	Bit		
PSS_Write[1]	41002	LinkWord	Integer	Value Increases by One Every Second	
PSS_Write[2]	41003	Date and Time - Year	Integer	Year	
PSS_Write[3]	41004	Date and Time - Month	Integer	Month	
PSS_Write[4]	41005	Date and Time - Day	Integer	Day	
PSS_Write[5]	41006	Date and Time - Hour	Integer	Hour	
PSS_Write[6]	41007	Date and Time - Minute	Integer	Minute	

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Array Element	Modbus Address	Comment	Data Type	Units	Scale
PSS_Write[7]	41008	Date and Time - Second	Integer	Second	
PSS_Write[8]	41009	Spare	Integer		
PSS_Write[9]	41010	Spare	Integer		
PSS_Write[10].0	41011/0	UV Start Request	Bit	1=Start	
PSS_Write[10].1	41011/1	UV Stop Request	Bit	1=Stop	
PSS_Write[10].2	41011/2	Ack All Alarms	Bit	1=Ack Alarms	
PSS_Write[10].3	41011/3	Request Minimum Power	Bit	1=Minimum Power	
PSS_Write[10].4	41011/4	Request Maximum Power	Bit	1=Maximum Power	
PSS_Write[10].5	41011/5	Hot Standby Request	Bit	1=Minimum Power and Cooling Valves Open	
PSS_Write[10].6	41011/6	Spare	Bit		
PSS_Write[10].7	41011/7	Spare	Bit		
PSS_Write[10].8	41011/8	Spare	Bit		
PSS_Write[10].9	41011/9	Spare	Bit		
PSS_Write[10].10	41011/10	Spare	Bit		
PSS_Write[10].11	41011/11	Spare	Bit		
PSS_Write[10].12	41011/12	Spare	Bit		
PSS_Write[10].13	41011/13	Spare	Bit		
PSS_Write[10].14	41011/14	Spare	Bit		
PSS_Write[10].15	41011/15	Spare	Bit		
PSS_Write[11]	41012	Target Log Inactivation	Integer	0.5 - 4.0 Log	x10
PSS_Write[12]	41013	Target Pathogen	Integer	0=Cryptosporidium, 1=Giardia	
PSS_Write[13]	41014	Challenge Organism	Integer	0=MS2, 1=T1	
PSS_Write[14]	41015	Target RED	Integer	mJ/cm ²	x10
PSS_Write[15]	41016	Spare	Integer		
PSS_Write[16]	41017	Spare	Integer		
PSS_Write[17]	41018	Spare	Integer		
PSS_Write[18]	41019	Spare	Integer		
PSS_Write[19]	41020	Spare	Integer		
PSS_Write[20]	41021	UVT	Integer	70-100%	x10
PSS_Write[21]	41022	Flow	Integer	MGD	x10
PSS_Write[22].0	41023/0	Manual Wipe	Bit	1=Wipe Request	

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Array Element	Modbus Address	Comment	Data Type	Units	Scale
		Request			
PSS_Write[22].1	41023/1	Spare	Bit		
PSS_Write[22].2	41023/2	Spare	Bit		
PSS_Write[22].3	41023/3	Spare	Bit		
PSS_Write[22].4	41023/4	Spare	Bit		
PSS_Write[22].5	41023/5	Spare	Bit		
PSS_Write[22].6	41023/6	Spare	Bit		
PSS_Write[22].7	41023/7	Spare	Bit		
PSS_Write[22].8	41023/8	Spare	Bit		
PSS_Write[22].9	41023/9	Spare	Bit		
PSS_Write[22].10	41023/10	Spare	Bit		
PSS_Write[22].11	41023/11	Spare	Bit		
PSS_Write[22].12	41023/12	Spare	Bit		
PSS_Write[22].13	41023/13	Spare	Bit		
PSS_Write[22].14	41023/14	Spare	Bit		
PSS_Write[22].15	41023/15	Spare	Bit		
PSS_Write[24]	41025	Spare	Integer		
PSS_Write[25]	41026	Spare	Integer		
PSS_Write[26]	41027	Spare	Integer		
PSS_Write[27]	41028	Spare	Integer		
PSS_Write[28]	41029	Spare	Integer		
PSS_Write[29]	41030	Spare	Integer		
PSS_Write[30]	41031	Spare	Integer		
PSS_Write[31]	41032	Spare	Integer		

8.2 SCADA Read Only

The following table resides in the Trojan PLC. The SCADA PLC reads the following table.

Array Element	Modbus Address	Comment	Data Type	Units	Scale
PSS_Read[0].0	40001/0	LinkBit	Bit	Flashing Bit	
PSS_Read[0].1	40001/1	Main Power Present	Bit	1=Power Present	
PSS_Read[0].2	40001/2	OEM Logged In	Bit	1=Logged In	
PSS_Read[0].3	40001/3	OP1 Logged In	Bit	1=Logged In	
PSS_Read[0].4	40001/4	Operator Logged In	Bit	1=Logged In	
PSS_Read[0].5	40001/5	Spare	Bit		
PSS_Read[0].6	40001/6	Spare	Bit		
PSS_Read[0].7	40001/7	Spare	Bit		
PSS_Read[0].8	40001/8	Spare	Bit		
PSS_Read[0].9	40001/9	Spare	Bit		
PSS_Read[0].10	40001/10	Spare	Bit		
PSS_Read[0].11	40001/11	Spare	Bit		
PSS_Read[0].12	40001/12	Spare	Bit		
PSS_Read[0].13	40001/13	Spare	Bit		
PSS_Read[0].14	40001/14	Spare	Bit		
PSS_Read[0].15	40001/15	Spare	Bit		
PSS_Read[1]	40002	LinkWord	Integer	Value Increases by One Every Second (0-32000)	
PSS_Read[2]	40003	Date and Time - Year	Integer	Year	
PSS_Read[3]	40004	Date and Time - Month	Integer	Month	
PSS_Read[4]	40005	Date and Time - Day	Integer	Day	
PSS_Read[5]	40006	Date and Time - Hour	Integer	Hour	
PSS_Read[6]	40007	Date and Time - Minute	Integer	Minute	
PSS_Read[7]	40008	Date and Time - Second	Integer	Second	
PSS_Read[8]	40009	Spare	Integer		
PSS_Read[9]	40010	Spare	Integer		
PSS_Read[10].0	40011/0	Common Critical Alarm	Bit	1=Alarm Active	

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Array Element	Modbus Address	Comment	Data Type	Units	Scale
PSS_Read[10].1	40011/1	Common Major Alarm	Bit	1=Alarm Active	
PSS_Read[10].2	40011/2	Common Minor Alarm	Bit	1=Alarm Active	
PSS_Read[10].3	40011/3	Ready	Bit	1=Ready to Run	
PSS_Read[10].4	40011/4	Startup Initiated	Bit	1=Startup Initiated	
PSS_Read[10].5	40011/5	Reactor On	Bit	1=On and Able to Treat Water	
PSS_Read[10].6	40011/6	Startup Completed	Bit	1=Startup Complete	
PSS_Read[10].7	40011/7	Shutdown Initiated	Bit	1=Shutdown Initiated	
PSS_Read[10].8	40011/8	Auto Restart Active	Bit	1=Active	
PSS_Read[10].9	40011/9	Sensor Reference Check Active	Bit	1=Active	
PSS_Read[10].10	40011/10	Spare	Bit		
PSS_Read[10].11	40011/11	Spare	Bit		
PSS_Read[10].12	40011/12	Spare	Bit		
PSS_Read[10].13	40011/13	Spare	Bit		
PSS_Read[10].14	40011/14	Spare	Bit		
PSS_Read[10].15	40011/15	Spare	Bit		
PSS_Read[11]	40012	Remote Control Mode	Integer	0=Local, 1=Remote Hardwired, 2=Remote Networked	
PSS_Read[12]	40013	Operating Mode	Integer	0=Auto, 1=Manual	
PSS_Read[13]	40014	Status	Integer	0=Off, 1=Cooling, 2=Warming, 3=On, 5=Hot Standby, 6=Unknown	
PSS_Read[14]	40015	Theoretical Power Consumption	Integer	kWatts	x10
PSS_Read[15]	40016	Flow Units	Integer	0=MGD, 1=GPM, 2=MLD, 3=L/s, 4=m ³ /Hr	
PSS_Read[16]	40017	Reactor Runtime Hours	Integer	Hours (0-23)	
PSS_Read[17]	40018	Reactor Runtime Days	Integer	Days	
PSS_Read[18]	40019	Disinfection Warmup Time Remaining	Integer	Seconds	
PSS_Read[19]	40020	Operation Warmup Time Remaining	Integer	Seconds	
PSS_Read[20]	40021	Cooling Time Remaining	Integer	Seconds	

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Array Element	Modbus Address	Comment	Data Type	Units	Scale
PSS_Read[21]	40022	Spare	Integer		
PSS_Read[22]	40023	Spare	Integer		
PSS_Read[23]	40024	Spare	Integer		
PSS_Read[24]	40025	Spare	Integer		
PSS_Read[25]	40026	Spare	Integer		
PSS_Read[26]	40027	Spare	Integer		
PSS_Read[27]	40028	Spare	Integer		
PSS_Read[28]	40029	Spare	Integer		
PSS_Read[29]	40030	Spare	Integer		
PSS_Read[30].0	40031/0	Off-Spec	Bit	1=Off Specification	
PSS_Read[30].1	40031/1	Spare	Bit		
PSS_Read[30].2	40031/2	Spare	Bit		
PSS_Read[30].3	40031/3	Spare	Bit		
PSS_Read[30].4	40031/4	Spare	Bit		
PSS_Read[30].5	40031/5	Spare	Bit		
PSS_Read[30].6	40031/6	Spare	Bit		
PSS_Read[30].7	40031/7	Spare	Bit		
PSS_Read[30].8	40031/8	Spare	Bit		
PSS_Read[30].9	40031/9	Spare	Bit		
PSS_Read[30].1	40031/10	Spare	Bit		
PSS_Read[30].11	40031/11	Spare	Bit		
PSS_Read[30].12	40031/12	Spare	Bit		
PSS_Read[30].13	40031/13	Spare	Bit		
PSS_Read[30].14	40031/14	Spare	Bit		
PSS_Read[30].15	40031/15	Spare	Bit		
PSS_Read[31]	40032	Target Log Inactivation	Integer	0.5 - 4.0 Log	x10
PSS_Read[32]	40033	Theoretical Log Inactivation	Integer	0.5 - 4.0 Log	x10
PSS_Read[33]	40034	Target Pathogen	Integer	0=Cryptosporidium, 1=Giardia	
PSS_Read[34]	40035	Challenge Organism	Integer	0=MS2, 1=T1	
PSS_Read[35]	40036	Dose Required	Integer	mJ/cm ²	x10
PSS_Read[36]	40037	Validated Dose	Integer	mJ/cm ²	x10
PSS_Read[37]	40038	Target RED	Integer	mJ/cm ²	x100
PSS_Read[38]	40039	Calculated RED	Integer	mJ/cm ²	x100
PSS_Read[39]	40040	Validation Factor	Integer		x10
PSS_Read[40].0	40041/0	UVT Analyzer Faulted	Bit	1=Faulted	

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Array Element	Modbus Address	Comment	Data Type	Units	Scale
PSS_Read[40].1	40041/1	Measured UVT Used	Bit	1=Measured	
PSS_Read[40].2	40041/2	Manual UVT Used	Bit	1=Manual	
PSS_Read[40].3	40041/3	Default UVT Used	Bit	1=Default	
PSS_Read[40].4	40041/4	Spare	Bit		
PSS_Read[40].5	40041/5	Spare	Bit		
PSS_Read[40].6	40041/6	Spare	Bit		
PSS_Read[40].7	40041/7	Spare	Bit		
PSS_Read[40].8	40041/8	Spare	Bit		
PSS_Read[40].9	40041/9	Spare	Bit		
PSS_Read[40].1	40041/10	Spare	Bit		
PSS_Read[40].11	40041/11	Spare	Bit		
PSS_Read[40].12	40041/12	Spare	Bit		
PSS_Read[40].13	40041/13	Spare	Bit		
PSS_Read[40].14	40041/14	Spare	Bit		
PSS_Read[40].15	40041/15	Spare	Bit		
PSS_Read[41]	40042	Measured UVT Value	Integer	0-100%	x10
PSS_Read[42]	40043	Active UVT Value	Integer	0-100%	x10
PSS_Read[43]	40044	Spare	Integer		
PSS_Read[44]	40045	Spare	Integer		
PSS_Read[45].0	40046/0	Flow Meter Faulted	Bit	1=Faulted	
PSS_Read[45].1	40046/1	Measured Flow Used	Bit	1=Measured	
PSS_Read[45].2	40046/2	Manual Flow Used	Bit	1=Manual	
PSS_Read[45].3	40046/3	Default Flow Used	Bit	1=Default	
PSS_Read[45].4	40046/4	Spare	Bit		
PSS_Read[45].5	40046/5	Spare	Bit		
PSS_Read[45].6	40046/6	Spare	Bit		
PSS_Read[45].7	40046/7	Spare	Bit		
PSS_Read[45].8	40046/8	Spare	Bit		
PSS_Read[45].9	40046/9	Spare	Bit		
PSS_Read[45].1	40046/10	Spare	Bit		
PSS_Read[45].11	40046/11	Spare	Bit		
PSS_Read[45].12	40046/12	Spare	Bit		
PSS_Read[45].13	40046/13	Spare	Bit		

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Array Element	Modbus Address	Comment	Data Type	Units	Scale
PSS_Read[45].14	40046/14	Spare	Bit		
PSS_Read[45].15	40046/15	Spare	Bit		
PSS_Read[46]	40047	Measured Flow Value	Integer	MGD	x10
PSS_Read[47]	40048	Active Flow Value	Integer	MGD	x10
PSS_Read[48]	40049	Spare	Integer		
PSS_Read[49]	40050	Spare	Integer		
PSS_Read[50].0	40051/0	Wiper Faulted	Bit	1=Faulted	
PSS_Read[50].1	40051/1	Wiper Fill Mode Active	Bit	1=Active	
PSS_Read[50].2	40051/2	Spare	Bit		
PSS_Read[50].3	40051/3	Spare	Bit		
PSS_Read[50].4	40051/4	Spare	Bit		
PSS_Read[50].5	40051/5	Spare	Bit		
PSS_Read[50].6	40051/6	Spare	Bit		
PSS_Read[50].7	40051/7	Spare	Bit		
PSS_Read[50].8	40051/8	Spare	Bit		
PSS_Read[50].9	40051/9	Spare	Bit		
PSS_Read[50].1	40051/10	Spare	Bit		
PSS_Read[50].11	40051/11	Spare	Bit		
PSS_Read[50].12	40051/12	Spare	Bit		
PSS_Read[50].13	40051/13	Spare	Bit		
PSS_Read[50].14	40051/14	Spare	Bit		
PSS_Read[50].15	40051/15	Spare	Bit		
PSS_Read[51]	40052	Wiper Mode	Integer	0=Off, 1=Fixed Interval, 2=Manual, 3=Service	
PSS_Read[52]	40053	Wiper Position	Integer	0=At Home, 1=Extending, 2=Retracting, 3=Unknown, 4=Advanced, 5=Faulted	
PSS_Read[53]	40054	Wiper Runtime Cycles	Integer	Cycles	
PSS_Read[54]	40055	Wiper Percentage Complete	Integer	0-100%	
PSS_Read[55]	40056	Time Until Next Wipe (Hours)	Integer	Hours	
PSS_Read[56]	40057	Time Until Next Wipe (Minutes)	Integer	Minutes	
PSS_Read[57]	40058	Spare	Integer		
PSS_Read[58]	40059	Spare	Integer		
PSS_Read[59]	40060	Spare	Integer		
PSS_Read[75]	40076	Spare	Integer		

Array Element	Modbus Address	Comment	Data Type	Units	Scale
PSS_Read[76]	40077	Spare	Integer		
PSS_Read[77]	40078	Spare	Integer		
PSS_Read[78]	40079	Spare	Integer		
PSS_Read[79]	40080	Spare	Integer		
PSS_Read[80].0	40081/0	Ballast 1 Faulted	Bit	1=Faulted	
PSS_Read[80].1	40081/1	Lamp 1 Faulted	Bit	1=Faulted	
PSS_Read[80].2	40081/2	Lamp 1 On Status	Bit	1=On	
PSS_Read[80].3	40081/3	Sensor 1 Faulted	Bit	1=Faulted	
PSS_Read[80].4	40081/4	Sensor 1 Reference Check Required	Bit	1=Required	
PSS_Read[80].5	40081/5	Spare	Bit		
PSS_Read[80].6	40081/6	Spare	Bit		
PSS_Read[80].7	40081/7	Spare	Bit		
PSS_Read[80].8	40081/8	Spare	Bit		
PSS_Read[80].9	40081/9	Spare	Bit		
PSS_Read[80].1	40081/10	Spare	Bit		
PSS_Read[80].11	40081/11	Spare	Bit		
PSS_Read[80].12	40081/12	Spare	Bit		
PSS_Read[80].13	40081/13	Spare	Bit		
PSS_Read[80].14	40081/14	Spare	Bit		
PSS_Read[80].15	40081/15	Spare	Bit		
PSS_Read[81]	40082	Ballast 1 Ballast Power Level	Integer	%	
PSS_Read[82]	40083	Lamp 1 Status	Integer	0=Off, 2=Warming, 3=Cooling, 4=On, 5=Faulted	
PSS_Read[83]	40084	Lamp 1 Runtime Hours Remaining Until EOL	Integer	Hours	
PSS_Read[84]	40085	Lamp 1 Runtime Cycles	Integer	Cycles	
PSS_Read[85]	40086	Sensor 1 UV Intensity	Integer	mW/cm ²	x10
PSS_Read[86]	40087	Sensor 1 Days Until Reference Check Required	Integer	Days	
PSS_Read[87]	40088	Spare	Integer		
PSS_Read[88]	40089	Spare	Integer		
PSS_Read[89]	40090	Spare	Integer		
PSS_Read[90].0	40091/0	Ballast 2 Faulted	Bit	1=Faulted	
PSS_Read[90].1	40091/1	Lamp 2 Faulted	Bit	1=Faulted	

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Array Element	Modbus Address	Comment	Data Type	Units	Scale
PSS_Read[90].2	40091/2	Lamp 2 On Status	Bit	1=On	
PSS_Read[90].3	40091/3	Sensor 2 Faulted	Bit	1=Faulted	
PSS_Read[90].4	40091/4	Sensor 2 Reference Check Required	Bit	1=Required	
PSS_Read[90].5	40091/5	Spare	Bit		
PSS_Read[90].6	40091/6	Spare	Bit		
PSS_Read[90].7	40091/7	Spare	Bit		
PSS_Read[90].8	40091/8	Spare	Bit		
PSS_Read[90].9	40091/9	Spare	Bit		
PSS_Read[90].1	40091/10	Spare	Bit		
PSS_Read[90].11	40091/11	Spare	Bit		
PSS_Read[90].12	40091/12	Spare	Bit		
PSS_Read[90].13	40091/13	Spare	Bit		
PSS_Read[90].14	40091/14	Spare	Bit		
PSS_Read[90].15	40091/15	Spare	Bit		
PSS_Read[91]	40092	Ballast 2 Ballast Power Level	Integer	%	
PSS_Read[92]	40093	Lamp 2 Status	Integer	0=Off, 2=Warming, 3=Cooling, 4=On, 5=Faulted	
PSS_Read[93]	40094	Lamp 2 Runtime Hours Remaining Until EOL	Integer	Hours	
PSS_Read[94]	40095	Lamp 2 Runtime Cycles	Integer	Cycles	
PSS_Read[95]	40096	Sensor 2 UV Intensity	Integer	mW/cm ²	x10
PSS_Read[96]	40097	Sensor 2 Days Until Reference Check Required	Integer	Days	
PSS_Read[97]	40098	Spare	Integer		
PSS_Read[98]	40099	Spare	Integer		
PSS_Read[99]	40100	Spare	Integer		

8.3 SCADA Alarms

The following table resides in the Trojan PLC. The SCADA PLC reads data from the following table if required.

Array Element	Modbus Address	Comment
Alarms[0].0	42001/0	1. PLANT SCADA COMMUNICATIONS FAILURE
Alarms[0].1	42001/1	2. COMMUNICATIONS BOARD TIMEOUT
Alarms[0].2	42001/2	3. PLC FAULTED
Alarms[0].3	42001/3	4. E-STOP PRESSED
Alarms[0].4	42001/4	5. LCP PANEL DOOR IS OPEN
Alarms[0].5	42001/5	6. PLC BATTERY LOW
Alarms[0].6	42001/6	7. UPS LOW BATTERY OR UPS FAULT
Alarms[0].7	42001/7	8. MAIN POWER IS DISCONNECTED
Alarms[0].8	42001/8	9. MAIN POWER IS RESTORED
Alarms[0].9	42001/9	10. DEVICENET 24VDC POWER FAILURE
Alarms[0].10	42001/10	11. BALLAST PANEL 1 COOLING FAN FAILURE
Alarms[0].11	42001/11	12. BALLAST PANEL 2 COOLING FAN FAILURE
Alarms[0].12	42001/12	13. BALLAST PANEL 3 COOLING FAN FAILURE
Alarms[0].13	42001/13	14. Spare Alarm
Alarms[0].14	42001/14	15. Spare Alarm
Alarms[0].15	42001/15	16. IO SIMULATION ENABLED
Alarms[1].0	42002/0	17. REACTOR LOW WATER LEVEL
Alarms[1].1	42002/1	18. REACTOR HIGH TEMPERATURE
Alarms[1].2	42002/2	19. CABINET HIGH TEMPERATURE
Alarms[1].3	42002/3	20. REACTOR COVER IS OFF
Alarms[1].4	42002/4	21. MULTIPLE BALLAST ALARM
Alarms[1].5	42002/5	22. MULTIPLE LAMP ALARM
Alarms[1].6	42002/6	23. START UP SEQUENCE FAILED
Alarms[1].7	42002/7	24. LOW UV DOSE MAJOR
Alarms[1].8	42002/8	25. UV REFERENCE SENSOR PROCEDURE ACTIVE
Alarms[1].9	42002/9	26. Spare Alarm
Alarms[1].10	42002/10	27. Spare Alarm
Alarms[1].11	42002/11	28. Spare Alarm
Alarms[1].12	42002/12	29. Spare Alarm
Alarms[1].13	42002/13	30. Spare Alarm
Alarms[1].14	42002/14	31. Spare Alarm
Alarms[1].15	42002/15	32. Spare Alarm
Alarms[2].0	42003/0	33. OFF SPECIFICATION - LOW VALIDATED DOSE

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Array Element	Modbus Address	Comment
Alarms[2].1	42003/1	34. OFF SPECIFICATION - LOW S/SO
Alarms[2].2	42003/2	35. OFF SPECIFICATION - LOW UVT
Alarms[2].3	42003/3	36. OFF SPECIFICATION - HIGH FLOW
Alarms[2].4	42003/4	37. OFF SPECIFICATION - LOW RED
Alarms[2].5	42003/5	38. OFF SPECIFICATION - REACTOR OFF WITH VALVES OPEN
Alarms[2].6	42003/6	39. LOG INACTIVATION NOT POSSIBLE
Alarms[2].7	42003/7	40. SENSOR CORRECTION FACTOR APPLIED
Alarms[2].8	42003/8	41. OFF SPECIFICATION - INVALID BRED
Alarms[2].9	42003/9	42. OFF SPECIFICATION - INVALID MINIMUM RED
Alarms[2].10	42003/10	43. OFF SPECIFICATION - LAMP FAILED
Alarms[2].11	42003/11	44. OFF SPECIFICATION - SENSOR FAILED
Alarms[2].12	42003/12	45. Spare Alarm
Alarms[2].13	42003/13	46. Spare Alarm
Alarms[2].14	42003/14	47. Spare Alarm
Alarms[2].15	42003/15	48. Spare Alarm
Alarms[3].0	42004/0	49. UVT ANALYZER FAULT
Alarms[3].1	42004/1	50. UVT ANALYZER SIGNAL OUT OF RANGE
Alarms[3].2	42004/2	51. UVT ANALYZER MANUAL VALUE USED
Alarms[3].3	42004/3	52. UVT LESS THAN DESIGN
Alarms[3].4	42004/4	53. Spare Alarm
Alarms[3].5	42004/5	54. Spare Alarm
Alarms[3].6	42004/6	55. Spare Alarm
Alarms[3].7	42004/7	56. Spare Alarm
Alarms[3].8	42004/8	57. LOW FLOW RATE
Alarms[3].9	42004/9	58. HIGH FLOW RATE
Alarms[3].10	42004/10	59. FLOW METER SIGNAL OUT OF RANGE
Alarms[3].11	42004/11	60. FLOW METER MANUAL VALUE USED
Alarms[3].12	42004/12	61. MAXIMUM HYDRAULIC CAPACITY EXCEEDED
Alarms[3].13	42004/13	62. FLOW GREATER THAN DESIGN
Alarms[3].14	42004/14	63. Spare Alarm
Alarms[3].15	42004/15	64. Spare Alarm
Alarms[4].0	42005/0	65. WIPER REVOLUTION SENSOR FAULT
Alarms[4].1	42005/1	66. WIPER HOME LIMIT SWITCH FAULT
Alarms[4].2	42005/2	67. WIPER EXTEND TRAVEL TIME EXCEEDED
Alarms[4].3	42005/3	68. WIPER RETRACT TRAVEL TIME EXCEEDED
Alarms[4].4	42005/4	69. WIPER POSITION UNKNOWN
Alarms[4].5	42005/5	70. WIPER JAM AT EXTEND TRAVEL

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Array Element	Modbus Address	Comment
Alarms[4].6	42005/6	71. WIPER JAM AT RETRACT TRAVEL
Alarms[4].7	42005/7	72. WIPER HOME POSITION FAULT
Alarms[4].8	42005/8	73. WIPER HYDRAULIC FAILURE
Alarms[4].9	42005/9	72. WIPER SERVICE MODE ACTIVE
Alarms[4].10	42005/10	75. Spare Alarm
Alarms[4].11	42005/11	76. Spare Alarm
Alarms[4].12	42005/12	77. Spare Alarm
Alarms[4].13	42005/13	78. Spare Alarm
Alarms[4].14	42005/14	79. Spare Alarm
Alarms[4].15	42005/15	80. Spare Alarm
Alarms[5].8	42006/8	89. COOLING VALVE NOT READY
Alarms[5].9	42006/9	90. COOLING VALVE FAIL TO OPEN
Alarms[5].10	42006/10	91. COOLING VALVE FAIL TO CLOSE
Alarms[5].11	42006/11	92. COOLING VALVE IN MANUAL
Alarms[5].12	42006/12	93. Spare Alarm
Alarms[5].13	42006/13	94. Spare Alarm
Alarms[5].14	42006/14	95. Spare Alarm
Alarms[5].15	42006/15	96. Spare Alarm
Alarms[6].8	42007/8	105. Spare Alarm
Alarms[6].9	42007/9	106. Spare Alarm
Alarms[6].10	42007/10	107. Spare Alarm
Alarms[6].11	42007/11	108. Spare Alarm
Alarms[6].12	42007/12	109. Spare Alarm
Alarms[6].13	42007/13	110. Spare Alarm
Alarms[6].14	42007/14	111. Spare Alarm
Alarms[6].15	42007/15	112. Spare Alarm
Alarms[7].0	42008/0	113. BALLAST 1 MAJOR ALARM
Alarms[7].1	42008/1	114. BALLAST 1 MINOR ALARM
Alarms[7].2	42008/2	115. BALLAST 1 HIGH TEMPERATURE
Alarms[7].3	42008/3	116. BALLAST 1 MULTIPLE FAN FAILURES
Alarms[7].4	42008/4	117. BALLAST 1 OUTPUT GROUND FAULT
Alarms[7].5	42008/5	118. LAMP 1 MAJOR ALARM
Alarms[7].6	42008/6	119. LAMP 1 MINOR ALARM
Alarms[7].7	42008/7	120. LAMP 1 RUNTIME HOURS EXCEED DESIGN
Alarms[7].8	42008/8	121. SENSOR 1 SIGNAL LOST
Alarms[7].9	42008/9	122. SENSOR 1 SATURATED
Alarms[7].10	42008/10	123. SENSOR 1 UV INTENSITY DEVIATION

Array Element	Modbus Address	Comment
Alarms[7].11	42008/11	124. SENSOR 1 REFERENCE CHECK REQUIRED
Alarms[7].12	42008/12	125. Spare Alarm
Alarms[7].13	42008/13	126. Spare Alarm
Alarms[7].14	42008/14	127. Spare Alarm
Alarms[7].15	42008/15	128. Spare Alarm
Alarms[8].0	42009/0	129. BALLAST 2 MAJOR ALARM
Alarms[8].1	42009/1	130. BALLAST 2 MINOR ALARM
Alarms[8].2	42009/2	131. BALLAST 2 HIGH TEMPERATURE
Alarms[8].3	42009/3	132. BALLAST 2 MULTIPLE FAN FAILURES
Alarms[8].4	42009/4	133. BALLAST 2 OUTPUT GROUND FAULT
Alarms[8].5	42009/5	134. LAMP 2 MAJOR ALARM
Alarms[8].6	42009/6	135. LAMP 2 MINOR ALARM
Alarms[8].7	42009/7	136. LAMP 2 RUNTIME HOURS EXCEED DESIGN
Alarms[8].8	42009/8	137. SENSOR 2 SIGNAL LOST
Alarms[8].9	42009/9	138. SENSOR 2 SATURATED
Alarms[8].10	42009/10	139. SENSOR 2 UV INTENSITY DEVIATION
Alarms[8].11	42009/11	140. SENSOR 2 REFERENCE CHECK REQUIRED
Alarms[8].12	42009/12	141. Spare Alarm
Alarms[8].13	42009/13	142. Spare Alarm
Alarms[8].14	42009/14	143. Spare Alarm
Alarms[8].15	42009/15	144. Spare Alarm

See associated SOPs:

UVT Start-up SOP

UV Reactor Start up SOP

UV Reactor Shutdown SOP

Prepared by: _____ Date: _____

Approved by: _____ Date: _____

*This SOP is considered effective on the date it is approved. SOP's are to be reviewed and/or updated annually or any time this process has changed.

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Sign below and date that you have read this SOP. By signing you are stating that you understand and will defer to this SOP when applicable.

Printed Name	Signature	Date	Printed Name	Signature	Date
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____
_____	_____	_____	_____	_____	_____