PROJECT:

QUEENSLAND URBAN UTILITIES
GATTON STP DISINFECTION UPGRADE

QUU PROJECT CONTRACT NO. C1011-045QUU061

OPERATION & MAINTENANCE MANUAL

PREPARED BY

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TABLE OF CONTENTS

1 DOCUMENT HISTORY

Revision History

Version	Author	Issue Purpose	Signature	Date
Draft	B. McAlister	Review		28/06/2013
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Draft	M. Meynard	Manager		28/06/2013
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2 INTRODUCTION

This operation and maintenance manual presents information required for the operation and maintenance of the upgraded disinfection system for the Gatton Sewage Treatment Plant.

This document can be used as a guide to assist operators in understanding and operating the disinfection system. This document contains information regarding only the disinfection system and associated equipment within the scope of supply by Meyjor Industries Pty Ltd.

Individual equipment manuals are also included to assist the operators. These are found in the appendices section and should be used in conjunction with this operation and maintenance manual. It is recommended the operators familiarise themselves with the information contained within this document before operating the disinfection system.

Emphasis should be placed on the following:

- Plant and Equipment Operating Hazards.
- Operating Parameters/Limits.
- Operating Requirements.
- Maintenance Requirements.
- Location of Emergency Stops.
- Familiar with Plant Facilities Management Program.
- Plant Controls.
- Equipment operation, calibration, maintenance, cleaning etc.

3 PLANT OVERVIEW

The Gatton Sewage Treatment Plant Disinfection System's purpose is to do a final disinfection of the treated effluent before it gets discharged to the local waterways or distributed to the end use customers. The treated effluent is discharged from the Gatton STP and held in settling lagoons before being gravity fed into the disinfection race. The effluent is dosed with Sodium Hypochlorite as it enters the disinfection race where it is held for sufficient retention time to achieve disinfection. The system has several analytical systems to monitor and control the quality of the effluent to provide warnings should the required chlorine concentrations stray outside the set parameters.

Further details can be found in the following plant functional description.

4 FUNCTIONAL DESCRIPTION

4.1 PROCESS DESCRIPTION

The process upgrade seeks to provide more stable disinfection for the recycled water customers by re-locating the suction for the recycled water pumps from the inlet box to the end of the chlorine contact race. This will provide improved disinfection by providing contact between the chlorine and the wastewater in the disinfection race itself.

A high ammonia concentration is generally present in the effluent from the sewage treatment plant's lagoons. As such, due to the high ammonia present, the system will primarily utilise chloramination (via monochloramine generation) for disinfection as opposed to breakpoint chlorination to provide a free chorine residual. In the case of low ammonia concentration the system will be capable of switching to a breakpoint based system to ensure sufficient disinfection occurs when there is insufficient ammonia present to ensure the formation of sufficient monochloramine.

When ammonia levels are high chlorine will be dosed into the chlorine contact tank on a flow-paced basis to provide sufficient monochloramine to achieve disinfection. The proportional setting will be an operator adjustable setting, which may be tuned using the readouts of the free and total chlorine sensors installed in the process. The sensors will provide alarm points to help prevent over and under dosing, and provide chlorine levels for operator adjustment of the proportional dosing set point. When ammonia levels are low chlorine will be dosed into the chlorine contact tank to achieve breakpoint and sufficient residual free chlorine to achieve adequate disinfection. Breakpoint dosing into the chlorine contact tank will be controlled via a PID loop to achieve a free chlorine residual in the detention tank. An ammonia sensor will control the switching between the monochloramine and breakpoint based system. The chlorine contact dose is to be delivered into a turbulent zone to ensure adequate mixing.

A secondary dose will be applied to the recycled water pipeline to provide a top-up dose to ensure that the recycled water customers receive disinfected water. This will be applied using a second set of dosing pumps, dosing into the recycled water pipe prior to the suction of the recycled water supply pumps. Secondary dosing can utilise either a flow-paced proportional dose from the recycled water flow meter or a PID loop control from a set chlorine concentration regardless of the ammonia concentration. If ammonia is high the recycled water dosing will utilise monochloramine disinfection based on total chlorine residuals and when ammonia is low the recycled water dosing will utilise breakpoint chlorination based on free chlorine residuals. Flow paced set points and chlorine concentration set points will be operator adjustable. The chlorine dose will be delivered down-stream of the recycled water flow meter. Due to the length of pipework and the number of fittings an in-line mixer is not required to achieve adequate mixing.

4.2 SYSTEM FLOWCHART

System Flowchart

4.3 CHLORINE DOSING

Two separate dosing modes have been designed to achieve disinfection, these are the monochloramine mode, which takes advantage of the fact that high concentrations of ammonia are generally present in the effluent from the Gatton plant, and the breakpoint mode, which has been included to account for the instances when ammonia concentrations drop below a threshold amount, resulting in insufficient chloramine production.

Chloramine Dosing

The system will normally run under the Chloramine protocol. This involves the creation of chloramines from the reaction of Sodium Hypochlorite with the Ammonia present in the effluent. Chloramines result from the replacement of one of the hydrogen ions of the ammonia molecule (NH3) with a chlorine ion. As such there are three primary types of inorganic chloramines: Monochloramine (*NH2Cl*), Dichloramine, (*NHCl2*) and Nitrogen tri-chloride, (*NCl3*) (sometimes referred to as trichloramine).

Monochloramine (NH2Cl) is the most useful of the inorganic chloramine compounds, and generally chloramine based systems will be optimised to form mostly monochloramine. This is because Monochloramine formation is the easiest to control and the dosages used tend to produce the lowest amount of organic disinfection by-products.

The form of Chloramine generated is generally dependent upon both the chlorine concentration and the pH of the effluent. The higher the chlorine concentration, the more dichloramine and nitrogen trichloride will be formed by the reaction. Additionally, at a pH of below 7 the formation of dichloramine will generally be

favoured over that of monochloramine, assuming sufficient chlorine is available to support the reaction.

Breakpoint Dosing

If chlorine is added beyond the 'monochloramine hump' (the 5:1 chlorine:ammonia point) the total chlorine residual will begin to fall, and will reach a minimum value, referred to as the 'breakpoint'. This phenomena is caused by the chlorine molecules bound in the chloramines being be stripped away, with the resulting nitrogen outgassing. At the 'breakpoint' essentially everything in the sample that can be oxidised by chlorine has been, and any additional chlorine added contributes directly to the free chlorine residual.

Breakpoint chlorination results in a free chlorine residual, with free chlorine being a more powerful oxidant than the various species of chloramine. As all of the ammonia in the sample is required to be consumed (in addition to any chlorine demand from other sources), breakpoint chlorination requires the addition of significant volumes of chlorine if there is any significant concentration of ammonia present, and as such, is best applied when the ammonia residual is too low to support chloramine disinfection.

Breakpoint chlorination generally occurs at a mass ratio of 7.6-8:1 of Cl_2:NH_3, and often small municipalities practicing breakpoint chlorination for water supplies will add concentrations of up to 10mg/L in order to achieve breakpoint. The actual addition is variable and is likely to change based upon source water characteristics and will be altered based upon final field testing.

4.4 CONTROL SYSTEM OVERVIEW

The following section provides an overview of the control system and a description of its components and functions.

The automatic control system is to run under two modes; Monochloramine (primary) disinfection mode and Breakpoint (secondary) disinfection mode.

Primary mode utilises flow proportional chlorine dosing into the chlorine contact tank which is flow paced off the total plant flow and either flow paced or PID loop controlled dosing into the recycled water line. Primary mode is based on achieving total chlorine residuals.

Secondary mode is utilised when there is insufficient ammonia available to ensure sufficient chloramine production to allow for effective disinfection. When secondary mode is engaged the system will attempt to breakpoint chlorinate the water. The chlorine contact tank dosing will switch from flow-paced dosing to a PID loop controlled system based on a free chlorine residual set point which is operator adjustable but should be set to a nominal set point of between 0.3 and 0.7mg/L. The recycled water dosing can be selected to run either flow paced from the recycled water flow meter or be controlled by a PID loop based on a free chlorine residual set point.

Switching between the primary and secondary mode is governed by inlet ammonia concentration, as indicated by an ammonia sensor situated in the inlet box.

The system may be run in fixed flow mode, with operators simply setting a dose rate via the HMI. During fixed flow mode all interlocks will be bypassed. As this increases the risk of noncompliance the system should not be run in this manner for an elongated period of time.

The control system will isolate the recycled water supply from the customers automatically if the chlorine concentrations in the recycled water do not comply with the specified requirements. In order to protect the pumps from being run dry, the system will also shut down recycled water delivery if the level in the detention basin becomes too low to maintain flooded pump suctions and a minimum 45min residence time.

The control system will activate an alarm and suspend chlorine contact tank dosing if the free chlorine residual in the chlorine detention tank increases above 0.7mg/L. There is no total chlorine residual limit for the environmental license, and as such, there is no automated shutdown for this parameter.

The system also features flow throttling control, which restricts the ‘on’ time for the recycled water supply pumps based upon the level in the chlorine detention tank. This aims to prevent the complete interruption of recycled water supply for customers during periods of high demand or low supply volumes.

4.5 CCT PRIMARY FLOW PACED MONOCHLORAMINE DOSING CONTROL SUMMARY

Switching between disinfection modes is controlled by the inlet box ammonia sensor with the system switching to primary mode if the ammonia is above the pre-set set point.

The dosing pumps are controlled proportional to the flow through the detention race, as calculated by the PLC from the sum of the flows registered by the creek outfall and the recycled water flow meters.

The proportional dosing rate is an operator controlled variable that may be manually adjusted via the dose rate controller on the HMI. The primary mode set point controls the dose rate during flow paced mode.

Operators may use the readout from the chlorine detention tank total chlorine sensor to adjust the proportional dosing set point. This is a manual adjustment.

If the system overdoses, as detected by the chlorine detention tank total and free chlorine sensors, the system will activate an alarm and shut down the chemical dosing pumps if free chlorine is above 0.7mg/L. Once the free chlorine concentration falls below the high free chlorine set point, the dosing pumps will start automatically at the proportional dose rate. The total and free chlorine alarms will remain in the alarm history for reference prior to being cleared.

If the chlorine detention tank total chlorine concentration is too low the low level alarm will be activated.

Conductivity in the chlorine detention tank is monitored by the chlorine detention tank conductivity sensor. If high conductivity is detected an alarm will be activated but no action will be taken by the system.

4.6 CCT SECONDARY CONCENTRATION TRIM BREAKPOINT DOSING CONTROL SUMMARY

Switching between disinfection modes is controlled by the inlet box ammonia sensor with the system switching to secondary mode if the ammonia is below the pre-set set point.

The chlorine contact tank dosing pumps are controlled via a PID loop based on free chlorine residuals in the chlorine detention tank.

The free chlorine set point is an operator controlled variable that may be manually adjusted, but should nominally be set to between 0.3 – 0.7mg/L.

If the system overdoses, as detected by the chlorine detention tank free chlorine sensor, the system will activate an alarm and shut down the chemical dosing pumps. Once the free chlorine concentration falls below the high free chlorine set point, the dosing pumps will start automatically at the proportional dose rate calculated by the PID loop. The alarm will remain in the alarm history for reference prior to being cleared.

If the free chlorine concentration is too low the low level alarm will be activated.
The recycled water pumps will also be inhibited if free chlorine in the chlorine detention tank is too low. Once the free chlorine is above the low free chlorine set point the recycled water pumps will automatically become available.

Conductivity in the chlorine detention tank is monitored by the chlorine detention tank conductivity sensor. If high conductivity is detected an alarm will be activated, but no action will be taken by the system.

4.7 RCW PRIMARY MODE FLOW PACED BOOSTER DOSING CONTROL SUMMARY

The recycled water booster dosing can be operated in flow paced mode or concentration trim via a PID loop control. This is operator selectable and is not reliant on the system being in either primary (monochloramine) or secondary (breakpoint) dosing modes.

In primary flow paced mode the dosing pumps are flow paced to the recycled water flow as detected by the recycled water flow meter.

While the system is in primary mode the recycled water chlorine monitoring will be done by the recycled water total chlorine analyser.

The proportional dosing rate is an operator controlled variable that may be manually adjusted via the dose rate controller on the HMI. The primary mode dose rate set point controls the dose rate during flow paced mode.

Operators may use the readout from the recycled water total chlorine sensor to adjust the proportional dosing set point. This is a manual adjustment.

If the system overdoses, as detected by the recycled water total chlorine sensor, the control system will activate an alarm, shut down the recycled water chlorine dosing pumps and inhibit the recycled water supply pumps. Once the recycled water total chlorine concentration falls below the high total chlorine set point, the recycled water pumps will automatically become available and the dosing pumps will start automatically if there is a demand for recycled water. The alarm will remain in the alarm history for reference prior to being cleared.

If the recycled water total chlorine concentration is too low the low level alarm will be activated and the recycled water pumps will be inhibited until the recycled water total chlorine is above the low level set point.

As a safeguard to the recycled water customers the recycled water free chlorine will also be monitored in primary mode and the recycled water pumps will be inhibited while ever the recycled water free chlorine is above the high level set point.

To assist in starting the recycled water pumps when the recycled water total chlorine is low and to avoid nuisance stoppages of the recycled water pumps, there is an operator adjustable time delay to allow the recycled water pumps to start / run on low total chlorine for a pre-set time before being inhibited. This allows the recycled water pumps to be started while total chlorine residuals in the pipe is low giving time for adequately chlorinated water from the chlorine detention tank to be drawn through the pipe.

4.8 RCW PRIMARY MODE CONCENTRATION TRIM BOOSTER DOSING CONTROL SUMMARY

The recycled water booster dosing can be operated in flow paced mode or concentration trim via a PID loop control. This is operator selectable and is not reliant on the system being in either primary (monochloramine) or secondary (breakpoint) dosing modes.

In primary concentration trim mode the dosing pumps are flow controlled via a PID loop using flow through the recycled water flow meter, as well as feedback from the recycled water total chlorine analyser to achieve a pre-set set point for total chlorine concentration in the recycled water line.

While the system is in primary mode the recycled water chlorine monitoring will be done by the recycled water total chlorine analyser.

The primary mode total chlorine concentration trim is an operator adjustable set point that can be manually adjusted on the HMI. While the total chlorine concentration trim PID loop is functioning correctly, there should be no need for further operator intervention other than alarm monitoring.

If the system overdoses, as detected by the recycled water total chlorine sensor, the system will activate an alarm, shut down the recycled water chlorine dosing pumps and inhibit the recycled water pumps. Once the recycled water total chlorine concentration falls below the high total chlorine set point, the recycled water pumps will automatically become available and the dosing pumps will start automatically if there is a demand for recycled water. The alarm will remain in the alarm history for reference prior to being cleared.

If the recycled water total chlorine concentration is too low the low level alarm will be activated and the recycled water pumps will be inhibited until the recycled water total chlorine is above the low level set point.

As a safeguard to the recycled water customers the recycled water free chlorine will also be monitored in primary mode and the recycled water pumps will be inhibited while ever the recycled water free chlorine is above the high level set point.

To assist in starting the recycled water pumps when the recycled water total chlorine is low and to avoid nuisance stoppages of the recycled water pumps, there is an operator adjustable time delay to allow the recycled water pumps to start / run on low total chlorine for a pre-set time before being inhibited. This allows the recycled water pumps to be started while total chlorine residuals in the pipe is low giving time for adequately chlorinated water from the chlorine detention tank to be drawn through the pipe.

4.9 RCW SECONDARY MODE FLOW PACED BOOSTER DOSING CONTROL SUMMARY

The recycled water booster dosing can be operated in flow paced mode or concentration trim via a PID loop control. This is operator selectable and is not reliant on the system being in either primary (monochloramine) or secondary (breakpoint) dosing modes.

In secondary flow paced mode the dosing pumps are flow paced to the recycled water flow as detected by the recycled water flow meter.

While the system is in secondary mode the recycled water chlorine monitoring will be done by the recycled water free chlorine analyser.

The proportional dosing rate is an operator controlled variable that may be manually adjusted via the dose rate controller on the HMI. The secondary mode dose rate set point controls the dose rate during flow paced mode.

Operators may use the readout from the recycled water free chlorine sensor to adjust the proportional dosing set point. This is a manual adjustment.

If the system overdoses, as detected by the recycled water free chlorine sensor, the control system will activate an alarm, shut down the recycled water chlorine dosing pumps and inhibit the recycled water supply pumps. Once the recycled water free chlorine concentration falls below the high free chlorine set point, the recycled water pumps will automatically become available and the dosing pumps will start automatically if there is a demand for recycled water. The alarm will remain in the alarm history for reference prior to being cleared.

If the recycled water free chlorine concentration is too low the low level alarm will be activated and the recycled water pumps will be inhibited until the recycled water free chlorine is above the low level set point.

To assist in starting the recycled water pumps when the recycled water free chlorine is low and to avoid nuisance stoppages of the recycled water pumps, there is an operator adjustable time delay to allow the recycled water pumps to start / run on low free chlorine for a pre-set time before being inhibited. This allows the recycled water pumps to be started while free chlorine residuals in the pipe is low giving time for adequately chlorinated water from the chlorine detention tank to be drawn through the pipe.

4.10 RCW SECONDARY MODE CONCENTRATION TRIM BOOSTER DOSING CONTROL SUMMARY

The recycled water booster dosing can be operated in flow paced mode or concentration trim via a PID loop control. This is operator selectable and is not reliant on the system being in either primary (monochloramine) or secondary (breakpoint) dosing modes.

In secondary concentration trim mode the dosing pumps are flow controlled via a PID loop using flow through the recycled water flow meter, as well as feedback from the recycled water free chlorine analyser to achieve a pre-set set point for free chlorine concentration in the recycled water line.

While the system is in secondary mode the recycled water chlorine monitoring will be done by the recycled water free chlorine analyser.

The secondary mode free chlorine concentration trim is an operator adjustable set point that can be manually adjusted on the HMI. While the free chlorine concentration trim PID loop is functioning correctly, there should be no need for further operator intervention other than alarm monitoring.

If the system overdoses, as detected by the recycled water free chlorine sensor, the system will activate an alarm, shut down the recycled water chlorine dosing pumps and inhibit the recycled water pumps. Once the recycled water free chlorine concentration falls below the high free chlorine set point, the recycled water pumps will automatically become available and the dosing pumps will start automatically if there is a demand for recycled water. The alarm will remain in the alarm history for reference prior to being cleared.

If the recycled water free chlorine concentration is too low the low level alarm will be activated and the recycled water pumps will be inhibited until the recycled water free chlorine is above the low level set point.

To assist in starting the recycled water pumps when the recycled water free chlorine is low and to avoid nuisance stoppages of the recycled water pumps, there is an operator adjustable time delay to allow the recycled water pumps to start / run on low free chlorine for a pre-set time before being inhibited. This allows the recycled water pumps to be started while free chlorine residuals in the pipe is low giving time for adequately chlorinated water from the chlorine detention tank to be drawn through the pipe.

4.11 RECYCLED WATER PUMP CONTROL SUMMARY

The recycled water supply runs on a demand based system upon remote start/stop functions. A number of conditions within the system will result in the isolation or supply restriction of the recycled water pumps.

While in primary mode, if the recycled water total chlorine concentration reaches the high alarm level, the system will shut down and isolate the recycled water pumps and will not allow the pumps to re-start until the total chlorine concentration has decreased below the alarm set point.

While in primary mode, if the recycled water total chlorine concentration reaches the low alarm level, the system will shut down and isolate the recycled water pumps and will not allow the pumps to re-start until the total chlorine concentration has increased above the alarm set point. There is a programmed time delay to allow the recycled water pumps to start on low chlorine concentration however if the low level set point is not achieved within this time delay the recycled water pumps will stop again. This time delay is operator adjustable on the HMI.

While in secondary mode, if the recycled water free chlorine concentration reaches the high alarm level, the system will shut down and isolate the recycled water pumps and will not allow the pumps to re-start until the free chlorine concentration has decreased below the alarm set point.

While in secondary mode, if the recycled water free chlorine concentration reaches the low alarm level, the system will shut down and isolate the recycled water pumps and will not allow the pumps to re-start until the free chlorine concentration has increased above the alarm set point. There is a programmed time delay to allow the recycled water pumps to start on low chlorine concentration however if the low level set point is not achieved within this time delay the recycled water pumps will stop again. This time delay is operator adjustable on the HMI.

Level in the chlorine detention tank is monitored by the chlorine detention tank ultrasonic level sensor. If the level in the chlorine detention tank falls below the operator adjustable low level alarm point, the pumps will be shut down and isolated to prevent them running dry. In addition this will close the penstock valve and activate an alarm for operator attention. This is to prevent a large flow of unmetered (and hence un-dosed) water into the chlorine detention tank while the tank re-fills when the recycled water pumps are not running (and hence there is no flow signal to initiate chlorine dosing). The pumps will remain isolated until the level rises above the low alarm level and the operator re-sets the alarm state manually. The penstock will also need to be re-set by turning its local control from automatic to manual then back to automatic. It's recommended that before the recycled water pumps and the penstock are re-set, that the settling lagoon be allowed to fill then the chlorine detention tank is filled and manually dosed to the required chlorine concentration by the operator. The system can now be re-instated in the appropriate automatic mode.

In order to prevent the chlorine detention tank being drained, the system utilises three (3) phases of time based supply restrictions. As the level in the chlorine detention tank falls to the first restriction set point, the system will automatically scale back the period of time each of the recycled water pumps are allowed to operate. As the system reaches each subsequent restriction set point, the relevant time based restriction will be engaged to manage supply volumes to the recycled water customers. This demand management system has adjustable level and on/off timer set points which can be adjusted by the operator via the HMI.

4.12 PENSTOCK VALVE CONTROL SUMMARY

The penstock valve is controlled by the chlorine detention tank ultrasonic level sensor and its purpose is to provide additional flow into the chlorine detention tank when the level in the settling lagoon draws below the weir level of the inlet box.

When the level in the chlorine detention tank draws below the open set point, the control system will open the penstock valve to allow effluent to continue flowing into the chlorine detention tank.

When the level in the chlorine detention tank draws above the close set point, the control system will close the penstock valve. The penstock will cycle to maintain lagoon level unless the recycle water pump demand is higher than the influent flow rate in which case the penstock will remain open to continue supply to the recycled water pumps.

The penstock position status is monitored by the control system using feedback from the position indicator in the penstock actuator.

If the penstock valve fails to open or close on command within the pre-set time, the system will raise an alarm.

In the instance where the recycled water pumps drain the chlorine detention tank to the low level set point, the penstock valve will be closed and will not re-open without operator intervention. To re-set the penstock its local control needs to be switched from automatic to manual, then back to automatic operation and the alarms cleared.

4.13 DOSING FLOW SWITCHES CONTROL SUMMARY

Dosing flow is monitored by simple on / off flow switches. There is a single flow switch in the chlorine contact tank dosing common discharge line and a single flow switch in the recycled water dosing common discharge line.

The flow switches are simple presence/absence of flow and are not adjustable nor do they measure flow. Should either flow switch register an absence of flow while the associated dosing pumps are running, a dosing pump no flow alarm will be activated.

Prior to a dosing pump no flow alarm being activated, if either of the duty dosing pumps go into fault mode the control system will activate a dosing pump #1 fault alarm while switching dosing over to the standby dosing pump. If the standby dosing pump fails or goes into fault mode the control system will generate a further dosing pump #2 fault alarm.

5 OPERATOR SAFETY PRECAUTIONS

- Always wear appropriate PPE when operating or undertaking any maintenance on chemical systems. i.e. eye protection, gloves, protective clothing.
- Always ensure you isolate the power to the equipment you are about to work on to avoid the risk of the equipment starting up without warning.
- Always ensure you isolate the suction and discharge of each pump before attempting to carry out any service work or repairs.
- Always relieve the back pressure in the discharge line between the loading / injection valves and the pump prior to removing any fittings, unions or connections.

Note: These procedures do not address all of the safety concerns associated with operating this system and do not replace a properly designed and implemented facility safety program. It is the responsibility of the user to establish appropriate safety and health practices and ensure that they are implemented.

Operators should be familiar with the chemicals being utilised, please refer to Material Safety Data Sheets as supplied by the chemical manufacturer.

Warning: All electrical work must be carried out by a qualified electrician.

Eye protection should be worn at all times when operating, or adjusting any equipment on the dosing system, whilst systems are operational, or stationary, due to pressure and possible corrosive nature of fluids contained within the pipe work and fittings.

These measures should be outlined in facility manuals, and addressed in personnel training.
It is the responsibility of the end-user to establish safe work-practices for plant operation.

6 OPERATING INSTRUCTIONS

6.1 PRE-START CHECKS

The Gatton Sewage Treatment Plant Disinfection System is a continuously operating plant. It can only be shut down when the settling lagoon that feeds the disinfection system is low enough to allow a shut down without the chlorine detention tank spilling into the local creek via the discharge weir. While a start-up might be a rare event, there are a number of procedures and checks that need to be carried out prior to the plant being started.

1. If the chlorine detention tank is empty check the drain valve is closed and the detention tank will need to be filled while being manually dosed to achieve the correct chlorine levels.
2. Ensure the recycled water line isolation valve VV-2710-021 is in the open position.
3. Ensure the penstock valve PK-0710-001 is in the closed position.
4. Prime the inlet box sample pump PUS-0710-101 and start pump.
5. Check all filters on the ammonia analyser sample panel are clean and effluent is passing through the collection vessel on the analyser and returning back to the inlet box.
6. Prime the detention tank sample pump PUS-0710-102 and start pump.
7. Check all filters on the detention tank analyser sample panel are clean and effluent is passing through the sensor housings on the analyser panel and returning back to the inlet box.
8. Prime the recycle line sample pump PUS-2710-101 and start pump.
9. Check all filters on the recycle line analyser sample panel are clean and effluent is passing through the sensor housings on the analyser panel and returning back to the inlet box.
10. Ensure the recycle line flow meter transmitter is powered and working.
11. Check the Sodium Hypochlorite storage tank has sufficient chemical.
12. Check the dosing system suction strainers are clean.
13. Check the dosing system process valves are open and drain valves are closed.
14. Check the dosing pumps are primed and powered.
15. Check the main control panel HMI screen for the following:
    a. Check all system and alarm set points are correct.
    b. Ensure dosing pumps are set to automatic operation.
    c. Select flow paced or trim dosing for the recycle line.
    d. Clear all alarms from the alarm history screen.
16. If any alarms are unable to be cleared then rectify the cause of the alarm before starting the plant.

The plant is now ready to be started.

6.2 DURING OPERATION

During operation either the flow paced proportional dose rates or chlorine concentration trim set points will need to be operator set to achieve the desired chlorine residuals. Once the plant has been successfully started and is operating normally the plant should be briefly monitored to ensure the chlorine levels have stabilised to system set points. The retention time in the detention tank is approximately 1 hour so the system may take this amount of time or longer to stabilise. Once the system has stabilised check the HMI alarm history page and clear any alarms. If any alarms are unable to be cleared then identify and rectify the cause of the alarm before leaving the plant unattended. Once the plant is running unattended the alarm notification service through the SCADA system should be monitored continuously. Should any chlorine level or instrument fault alarms be generated they should be attended to and rectified immediately.

During normal operation the effluent level in the contact and detention tank may vary due to recycle water demand, this is normal. The control system consists of a recycle water demand management system which limits the times that customers can draw recycled water based on effluent levels in the contact and detention tank. As the demand for recycled water increases and the tank levels fall, the control system will introduce more restrictions on a progressive basis. This is to prevent the recycled water demand exceeding the incoming flows and subsequently emptying the detention tank.

Should the detention tank be emptied due to recycled water demand, the recycled water pumps will be inhibited and the penstock held in the closed position which will require operator intervention to re-instate the system back to normal operation. The following procedures will need to be carried out to re-instate the system.

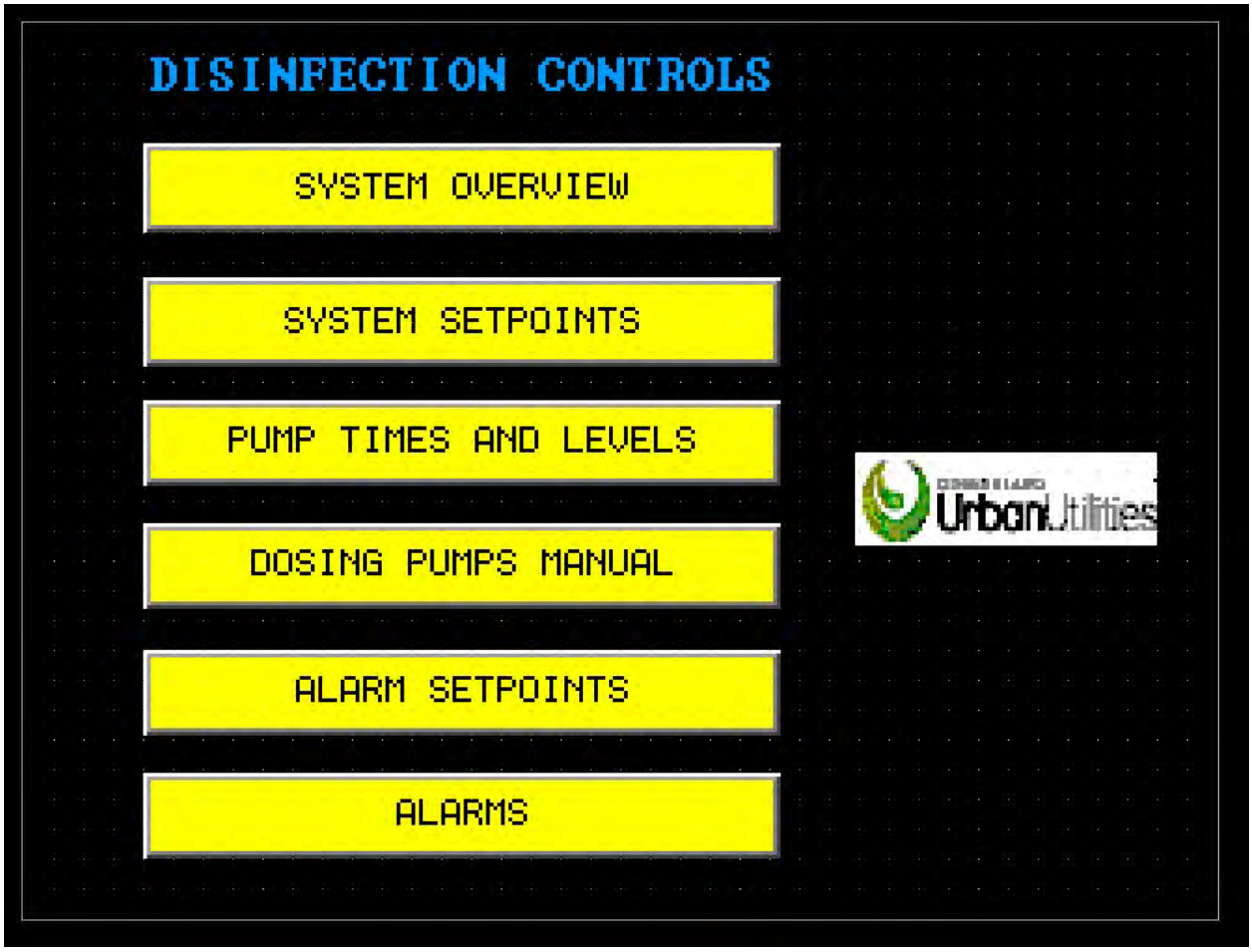
1. Disable the recycle water pumps and leave the penstock closed and allow the lagoon to fill with effluent from the treatment plant until it is just below the inlet box weir.
2. While the lagoon is filling, manually operate the penstock to allow the detention tank to fill while manually dosing using fixed flow dosing. Monitor chlorine levels with a hand held instrument while manually dosing to achieve the desired chlorine residuals. Once the detention tank is full, close the penstock and switch the penstock local control into automatic mode.
3. Once the detention tank is full and the chlorine residuals are correct ensure the analyser sample systems are operating correctly.
4. Clear all alarms on the HMI and rectify the cause of any alarms that are unable to be cleared.
5. Once the lagoon level reaches the inlet box weir and starts to flow into the contact tank the chlorine dosing can be switched to automatic dosing when there is flow over the detention tank outfall weir.
6. Monitor the system for several hours to ensure chlorine residuals are stable and within specifications.
7. Recycle water pumps can then be enabled for supply to customers.

Note: The recycled water demand management system was designed to prevent the detention tank from being emptied by the demand for recycled water exceeding incoming flows through the disinfection system. If this situation does occur it is strongly

recommended that the parameters of the demand management system are reviewed and adjusted to prevent the detention tank being emptied again due to customer demand. Time and level parameters of the demand management system are fully operator adjustable and some trial and error may be required to achieve the optimum restrictions.

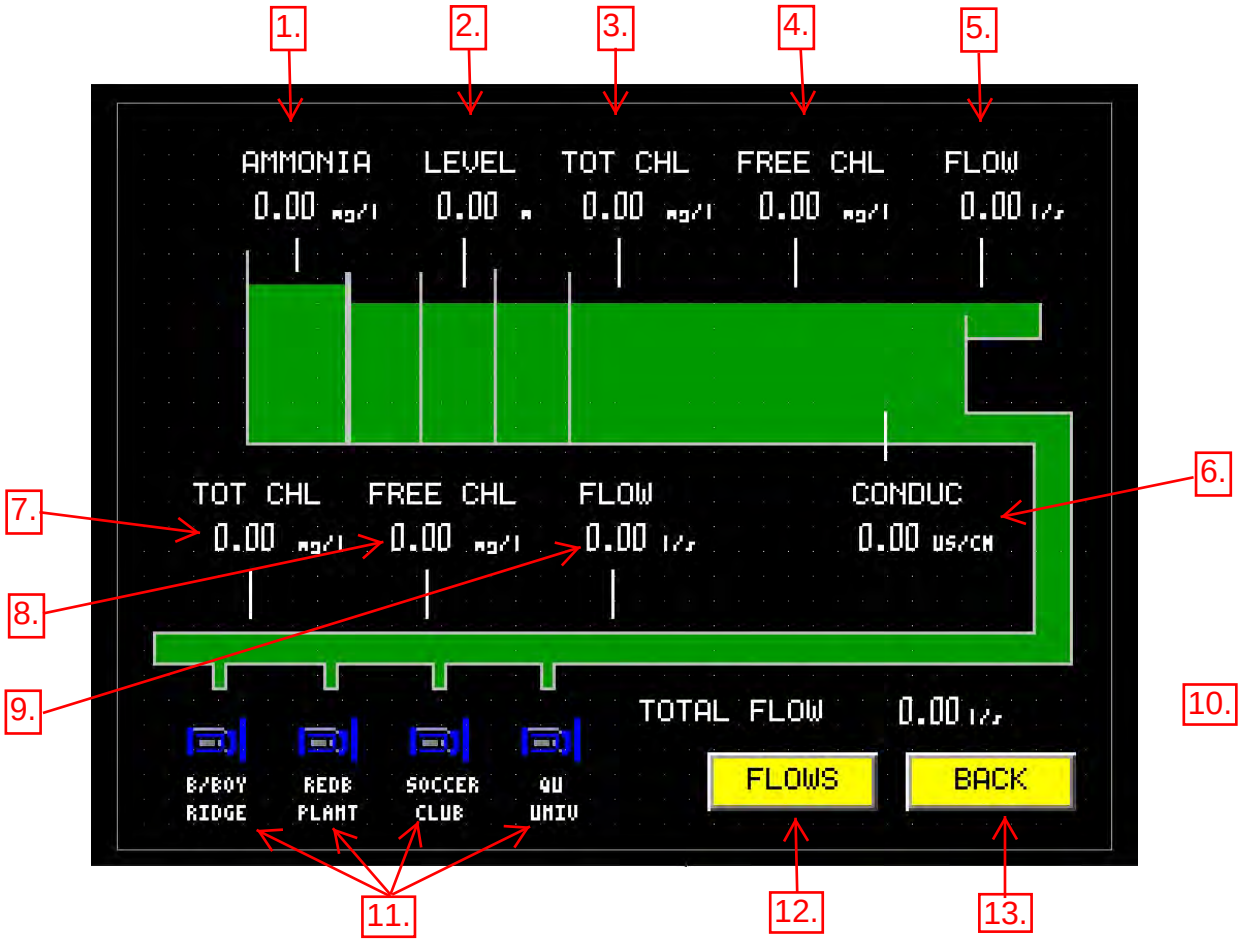
6.3 HMI SCREEN FUNCTIONS

Main Menu Page



The Main Menu screen displays the sub-menu screens used to operate the disinfection system. Sub-menu pages can be selected using the touch screen.

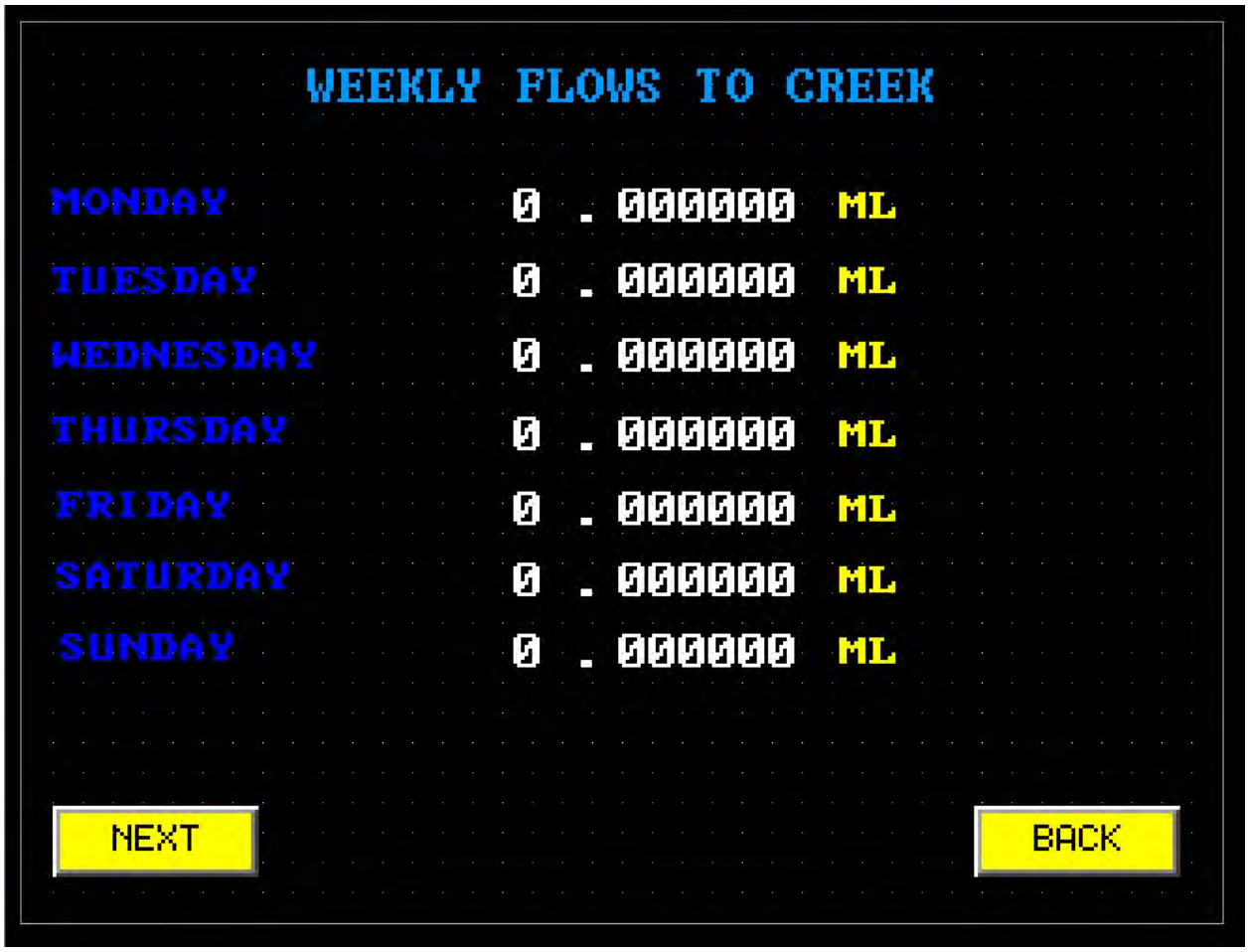
System Overview



The System Overview Page is a display only screen that displays the current system readings important for operation of the plant.

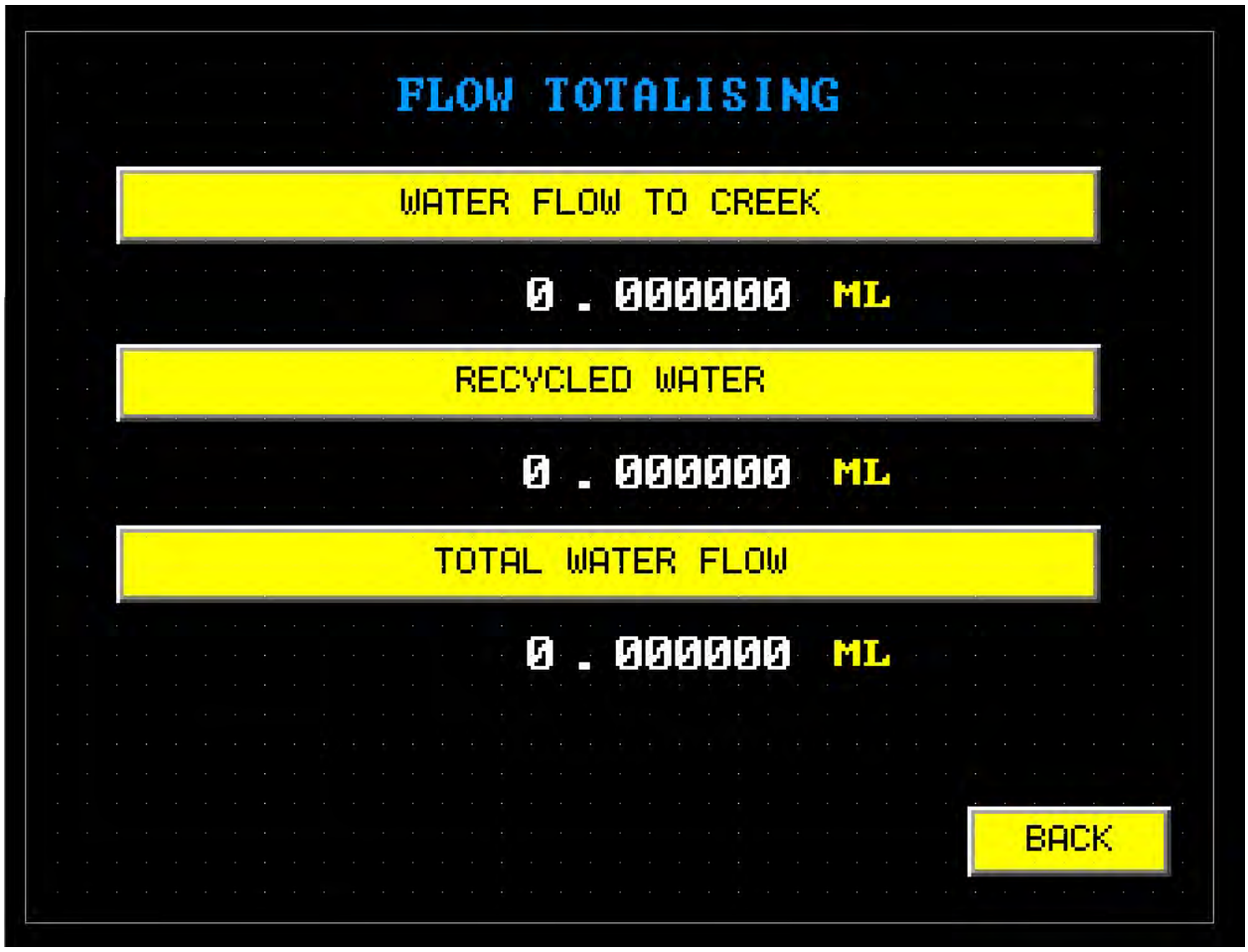
1. AMMONIA – refers to the current Ammonia level in the Inlet Box in mg/L.
2. LEVEL – refers to the current effluent level in the contact tank in m. above sea level.
3. TOT CHL – refers to the current total chlorine in the detention tank in mg/L.
4. FREE CHL – refers to the current free chlorine in the detention tank in mg/L.
5. FLOW – refers to the current flow over the detention tank weir in litres / second.
6. CONDUC – refers to the current conductivity in the detention tank.
7. TOT CHL – refers to the current total chlorine in the recycled water in mg/L.
8. FREE CHL – refers to the current free chlorine in the recycled water in mg/L.
9. FLOW – refers to the current recycled water flow in litres / second.
10. TOTAL FLOW – refers to the current weir and recycled effluent flows combined.
11. PUMPS – Displays RCW pump status. Blue = available Red = unavailable
12. FLOWS – touch this button to progress to the Weekly Flows Page.
13. BACK – touch this button to return back to the Main Menu Page.

Weekly Flows



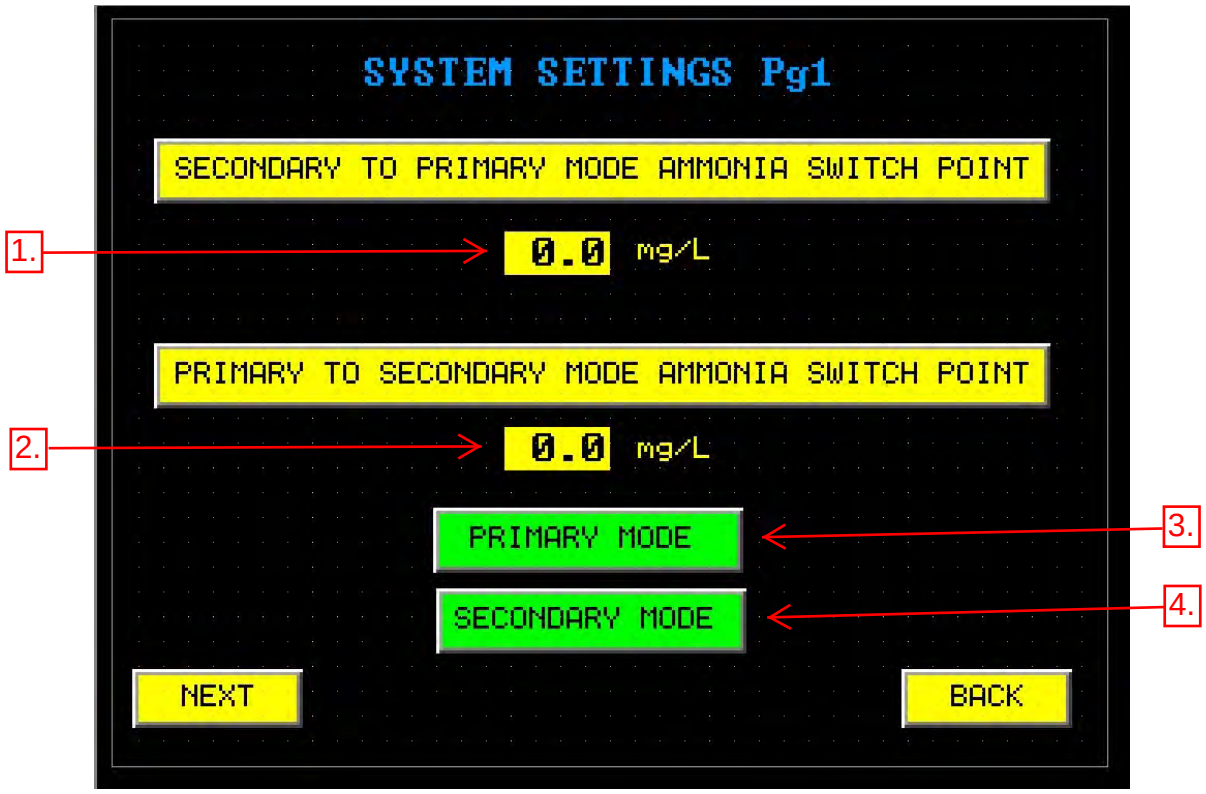
The Weekly Flows Page is a display only screen that displays historical data for daily effluent flows to the creek in megalitres. It shows historical flows for the previous 7 days and is automatically updated each day.

Flow Totalising



The Flow Totalising Page is a display only screen that displays totalised flow of effluent to the Lockyer Creek, recycled water to customers and total combined flow in megalitres.

System Settings Page 1



The System Settings Page 1 screen controls the set points for automatic switching between Primary Mode and Secondary Mode dosing.

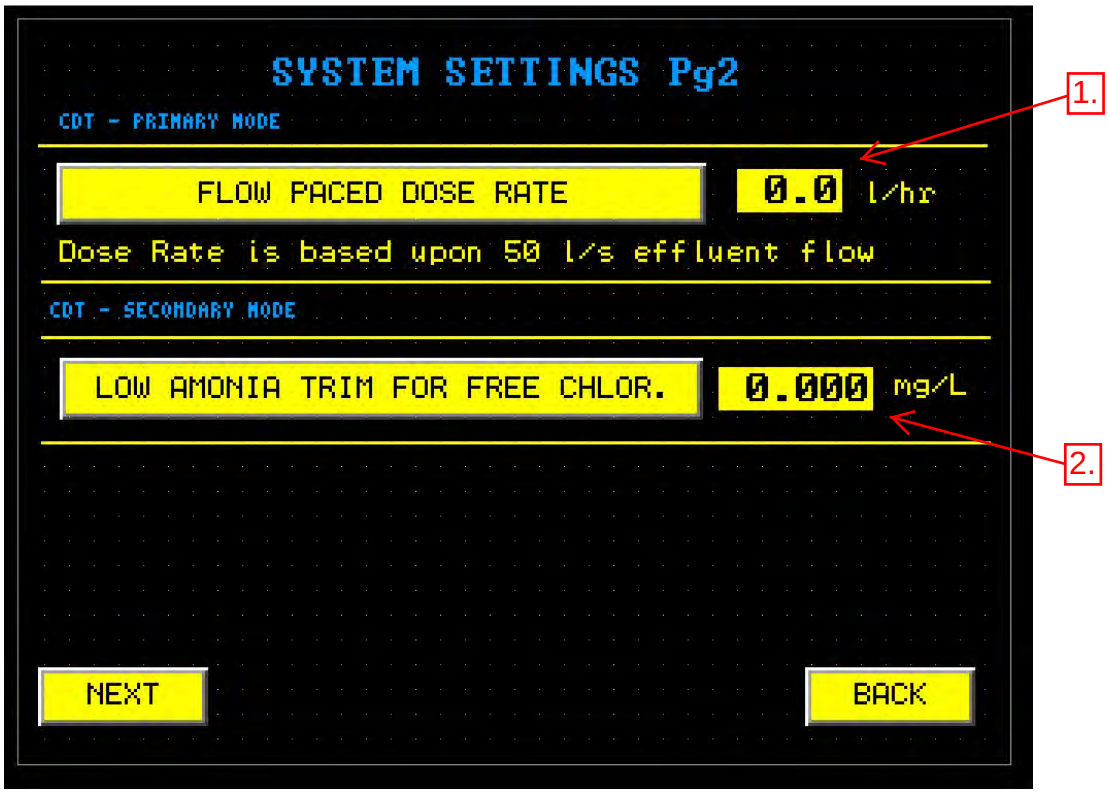
1. This set point refers to the concentration that the Inlet Box Ammonia needs to rise above to switch from Secondary Mode dosing to Primary Mode dosing. ie. Primary Mode dosing requires high Ammonia. Touch the set point to adjust.

2. This set point refers to the concentration that the Inlet Box Ammonia needs to fall below to switch from Primary Mode dosing to Secondary Mode dosing. ie. Secondary Mode dosing requires low Ammonia. Touch the set point to adjust.

3. When "PRIMARY MODE" is illuminated it signifies the system is currently dosing in "Primary" mode. This is display only and not a button.

4. When "SECONDARY MODE" is illuminated it signifies the system is currently dosing in "Secondary" mode. This is display only and not a button.

System Settings Page 2

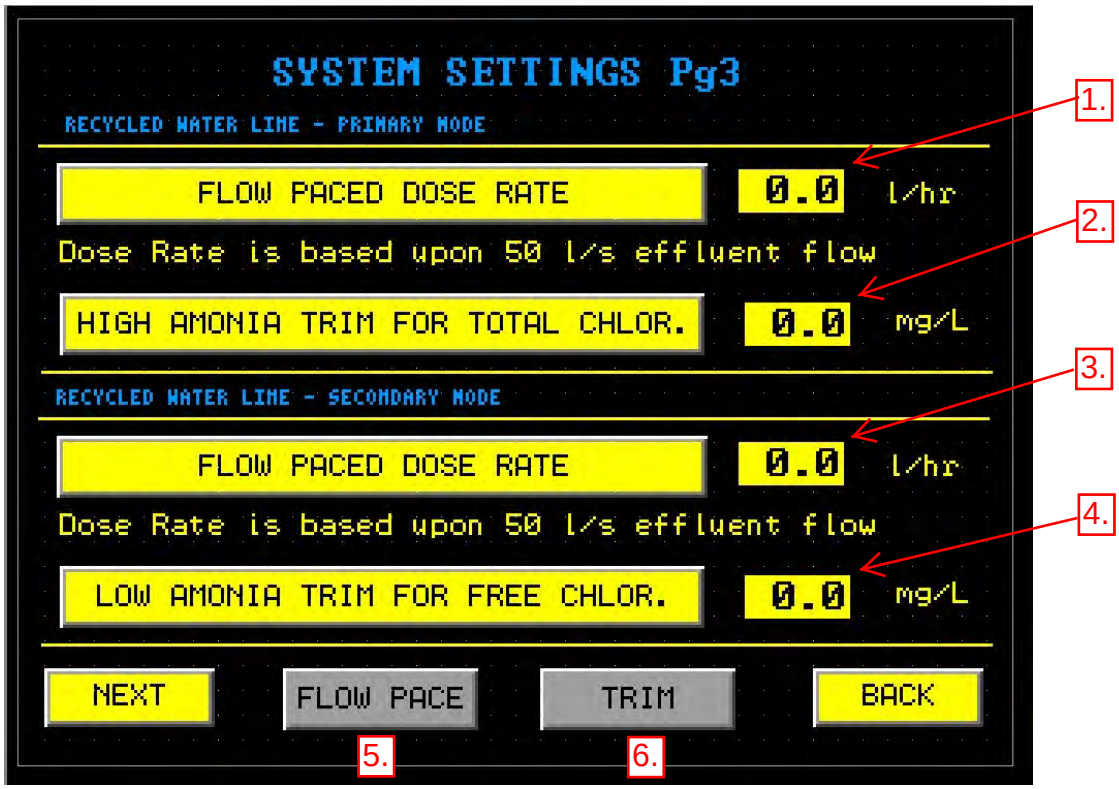


The System Settings Page 2 screen controls the dose rate into the Detention Tank.

1. This displays the current Primary Mode flow paced dose rate into the Detention Tank in litres / hour based upon 50 litres / second of total plant flow.
   eg. 10.0l/hr based upon 50 litres / second plant flow would equate to 5.0l/hr at 25 litres / second plant flow. Touch the set point button to adjust.
   Note: This setting only applies when in Primary Mode!

2. This displays the current Secondary Mode concentration trim set point for Free Chlorine in the Detention Tank. The desired set point for Free Chlorine is entered in mg/L and the control system will automatically vary the Detention Tank dose rate to maintain the Chlorine at the desired set point. Touch the set point button to adjust.
   Note: This setting only applies when in Secondary Mode!

System Settings Page 3



The System Settings Page 3 screen controls the dose rate into the Recycled Water Pipe that supplies recycled water to the customer supply pumps.

1. This displays the current Primary Mode flow paced dose rate into the Recycled Water in litres / hour based upon 50 litres / second of recycled water flow. eg. 10.0l/hr based upon 50 litres / second recycled water flow would equate to 5.0l/hr at 25 litres / second recycled water flow. Touch the set point button to adjust.
   Note: This setting only applies when in Primary Mode Flow Paced Dosing!

2. This displays the current Primary Mode concentration trim set point for Total Chlorine in the Recycled Water. The desired set point for Total Chlorine is entered in mg/L and the control system will automatically vary the Recycled Water dose rate to maintain the Chlorine at the desired set point. Touch the set point button to adjust.
   Note: This setting only applies when in Primary Mode Trim Dosing!

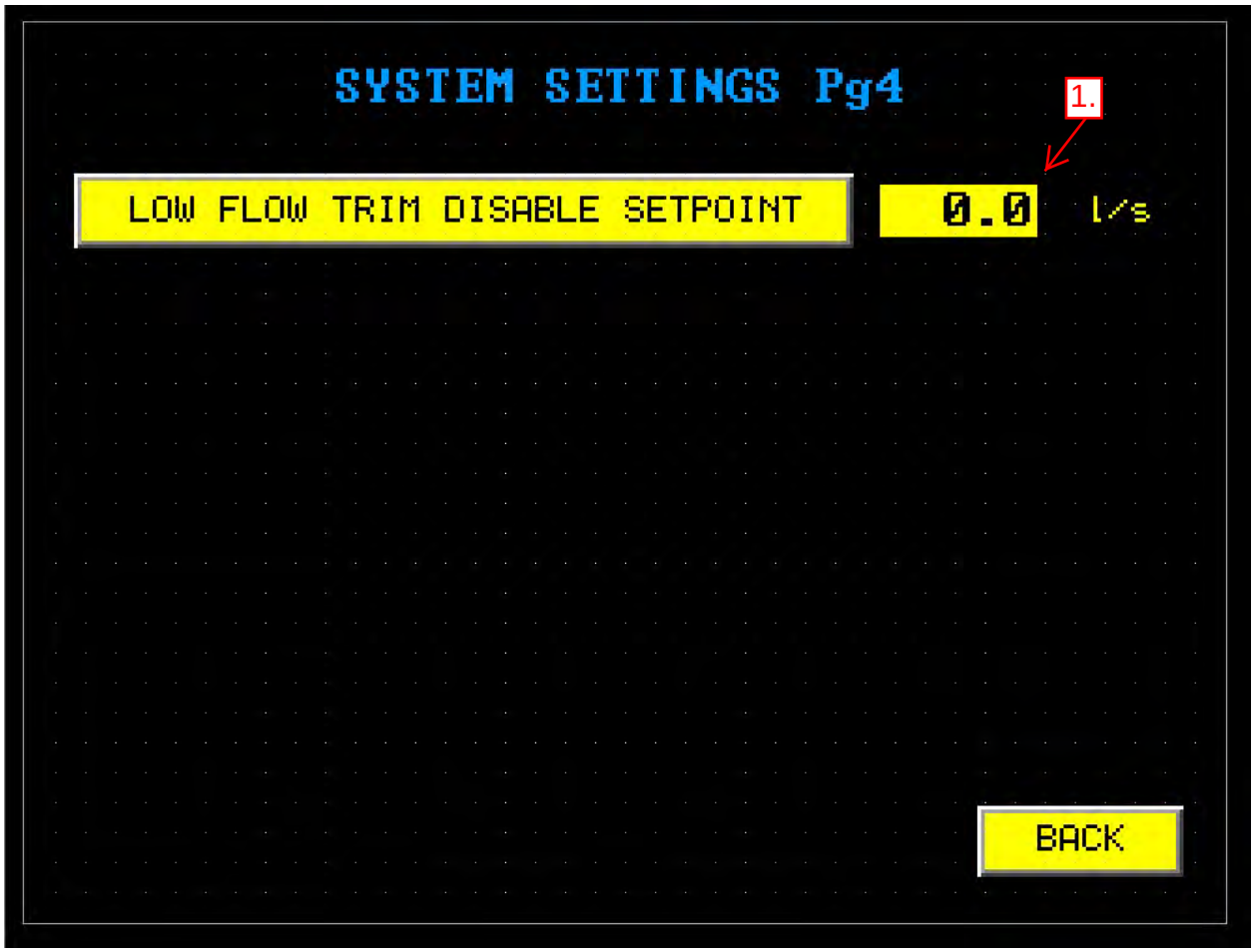
3. This displays the current Secondary Mode flow paced dose rate into the Recycled Water in litres / hour based upon 50 litres / second of recycled water flow. eg. 10.0l/hr based upon 50 litres / second recycled water flow would equate to 5.0l/hr at 25 litres / second recycled water flow. Touch the set point button to adjust.
   Note: This setting only applies when in Secondary Mode Flow Paced Dosing!

4. This displays the current Secondary Mode concentration trim set point for Free Chlorine in the Recycled Water. The desired set point for Free Chlorine is entered in mg/L and the control system will automatically vary the Recycled Water dose rate to maintain the Chlorine at the desired set point. Touch the set point button to adjust.
   Note: This setting only applies when in Secondary Mode Trim Dosing!

5. "FLOW PACE" is a button used to select flow paced dosing for the Recycled Water. When the button is illuminated GREEN it signifies that flow paced dosing has been selected.

6. "TRIM" is a button used to select concentration trim dosing for the Recycled Water. When the button is illuminated GREEN it signifies that concentration trim dosing has been selected.

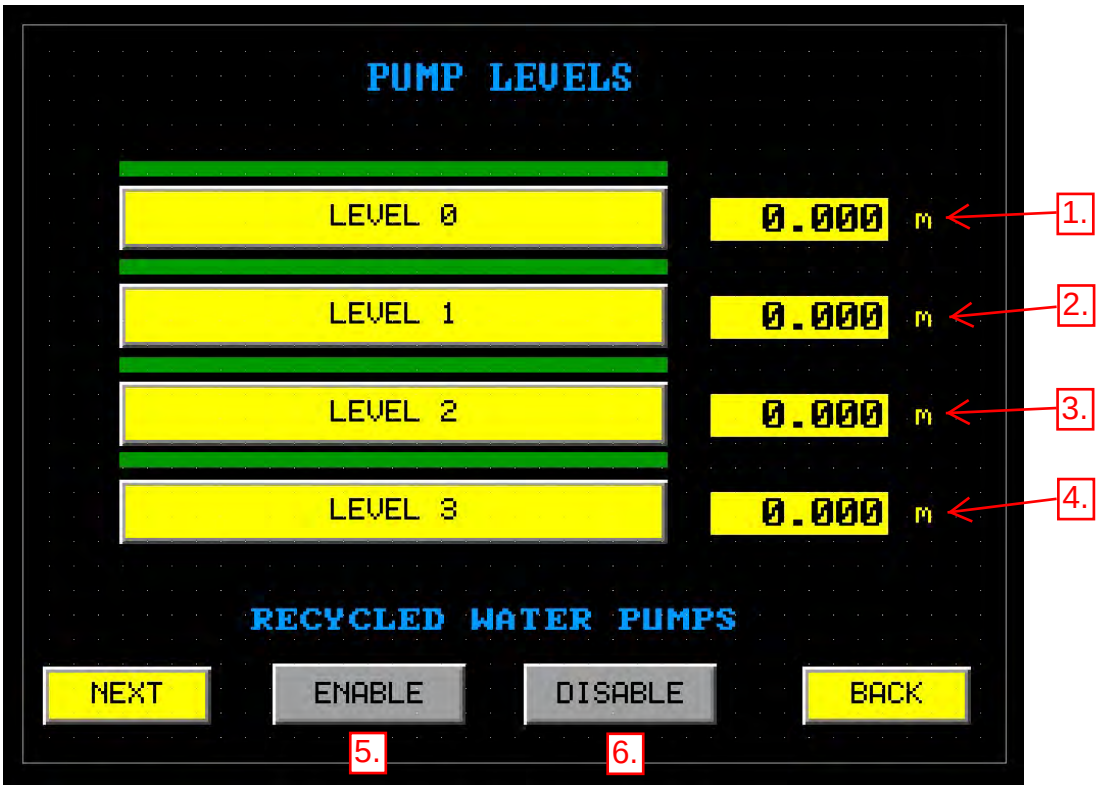
System Settings Page 4



The System Settings Page 4 screen controls the "Low Flow Trim Disable Set Point" which prevents the control system dosing under Trim Dosing if water flow is below the set point.

1. This button displays the Trim Dose Low Flow Disable Set Point in litres / second. Touch the button to adjust.

Recycle Water Pump Restriction Levels

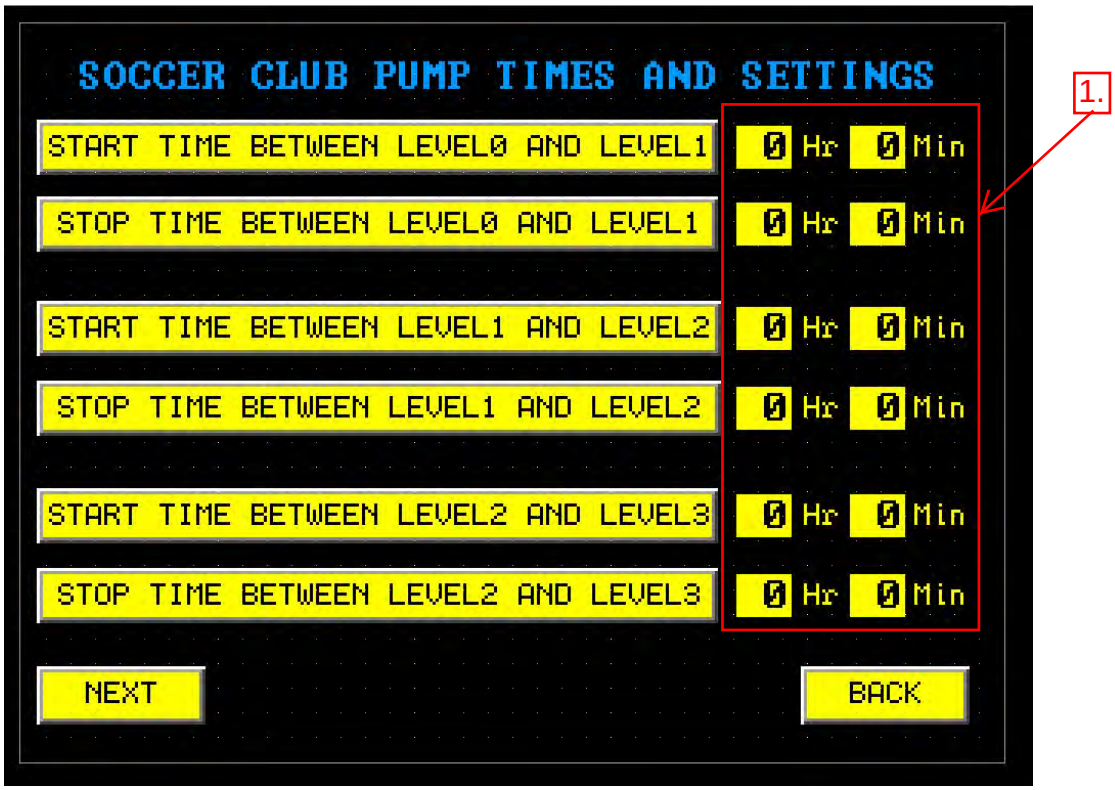


The Recycled Water Pump Restriction Levels screen displays the Chlorine Detention Tank levels for each time based restriction applied to the Recycled Water supply pumps. There are four (4) level set points that are displayed in m. above sea level. The lower the level in the Detention Tank the more time based restrictions are applied to the Recycled Water supply pumps.

1. Displays the level "0" set point for restrictions. Touch the button to adjust.
2. Displays the level "1" set point for restrictions. Touch the button to adjust.
3. Displays the level "2" set point for restrictions. Touch the button to adjust.
4. Displays the level "3" set point for restrictions. Touch the button to adjust.
5. "ENABLE" is a button used to enable the Recycled Water supply pumps. When the button is illuminated GREEN it signifies the Recycled Water supply pumps are available. If the button is not illuminated GREEN the pumps will not operate.
6. "DISABLE" is a button used to disable the Recycled Water supply pumps. When the button is illuminated GREEN it signifies the Recycled Water supply pumps are not available. If the button is illuminated GREEN the pumps will not operate.

NOTE: Recycled Water supply pumps must be selected as "enabled" or "disabled".

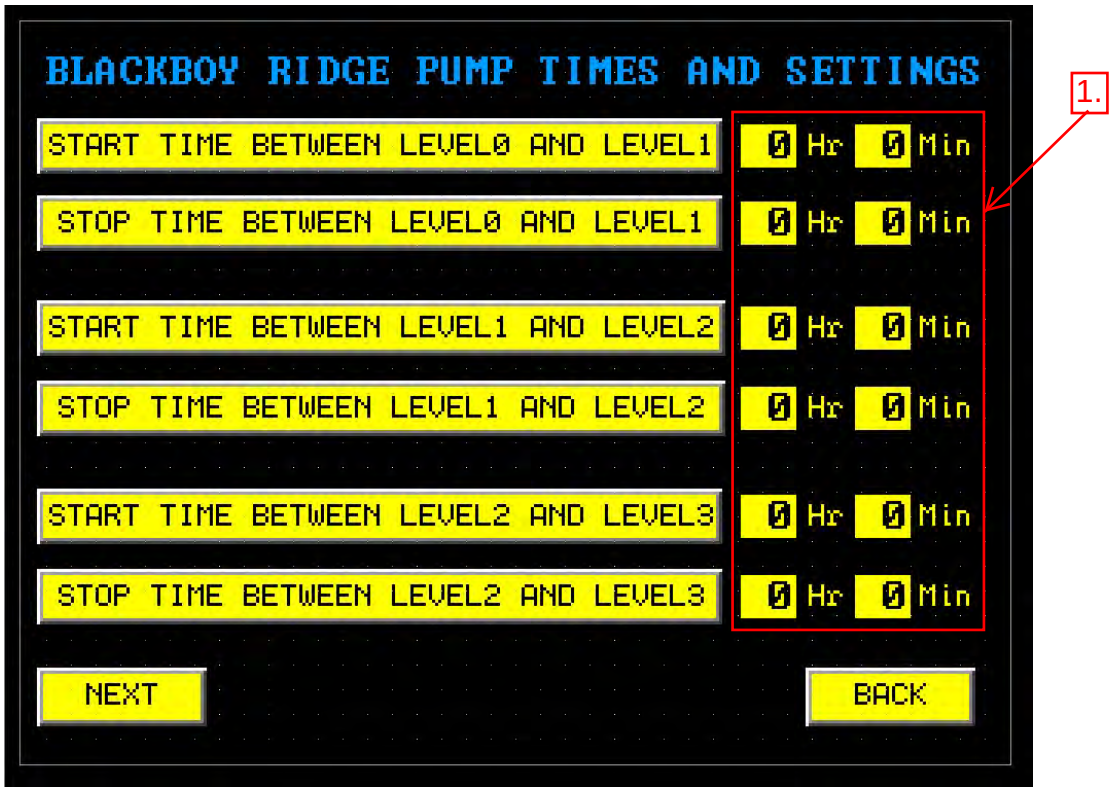
Soccer Club Pump Times



The Soccer Club Pump Times screen displays the restriction times applied to the Soccer Club Pump for each Detention Tank level.

1. These buttons are used to adjust the start and stop times of the pump for each level and are entered as the actual time required in 24 – hour time format.
   eg. A start time of "6 hr 30 Min" = 6.30am
   eg. A stop time of "18hr 30Min" = 6.30pm
   Touch the buttons to adjust.

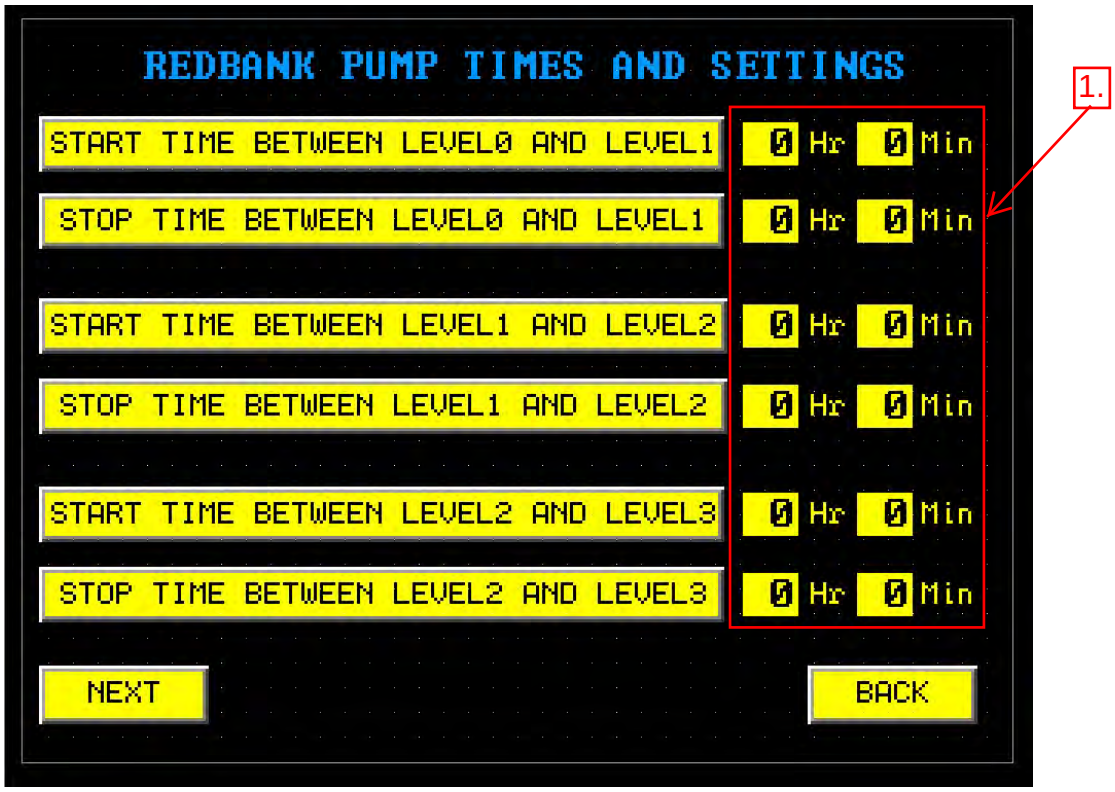
Blackboy Ridge Pump Times



The Blackboy Ridge Pump Times screen displays the restriction times applied to the Blackboy Ridge Pump for each Detention Tank level.

1. These buttons are used to adjust the start and stop times of the pump for each level and are entered as the actual time required in 24 – hour time format.
   eg. A start time of "6 hr 30 Min" = 6.30am
   eg. A stop time of "18hr 30Min" = 6.30pm
   Touch the buttons to adjust.

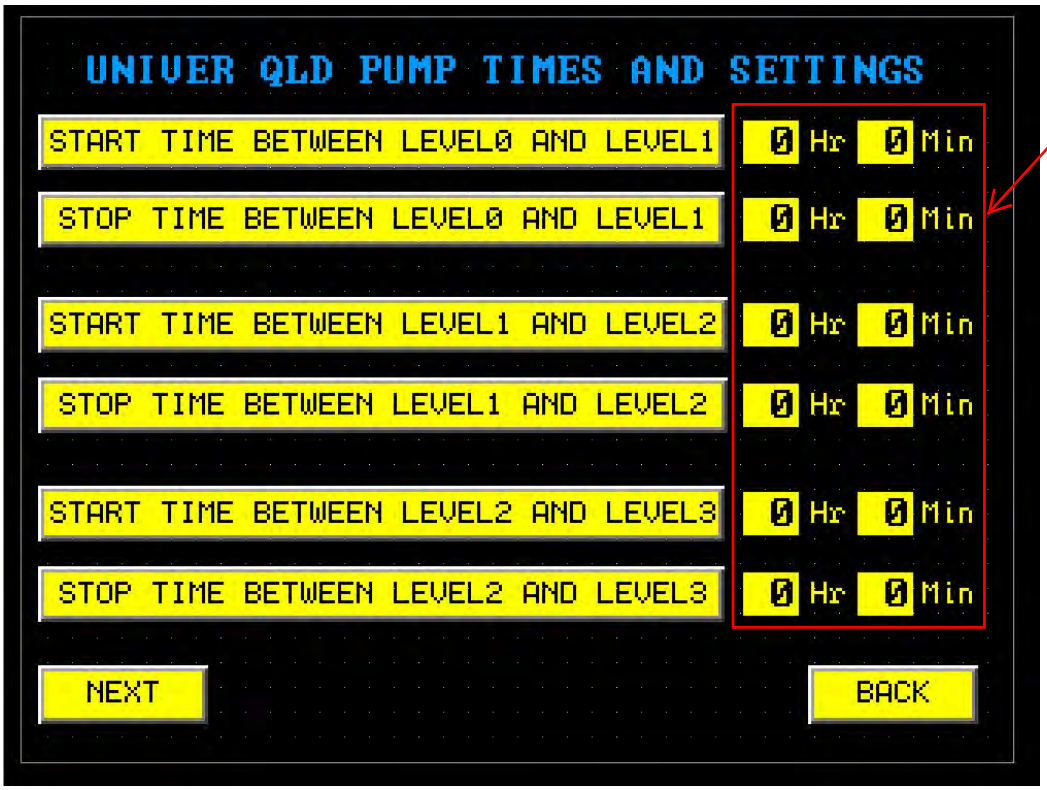
Redbank Pump Times



The Redbank Pump Times screen displays the restriction times applied to the Redbank Pump for each Detention Tank level.

1. These buttons are used to adjust the start and stop times of the pump for each level and are entered as the actual time required in 24 – hour time format.
   eg. A start time of "6 hr 30 Min" = 6.30am
   eg. A stop time of "18hr 30Min" = 6.30pm
   Touch the buttons to adjust.

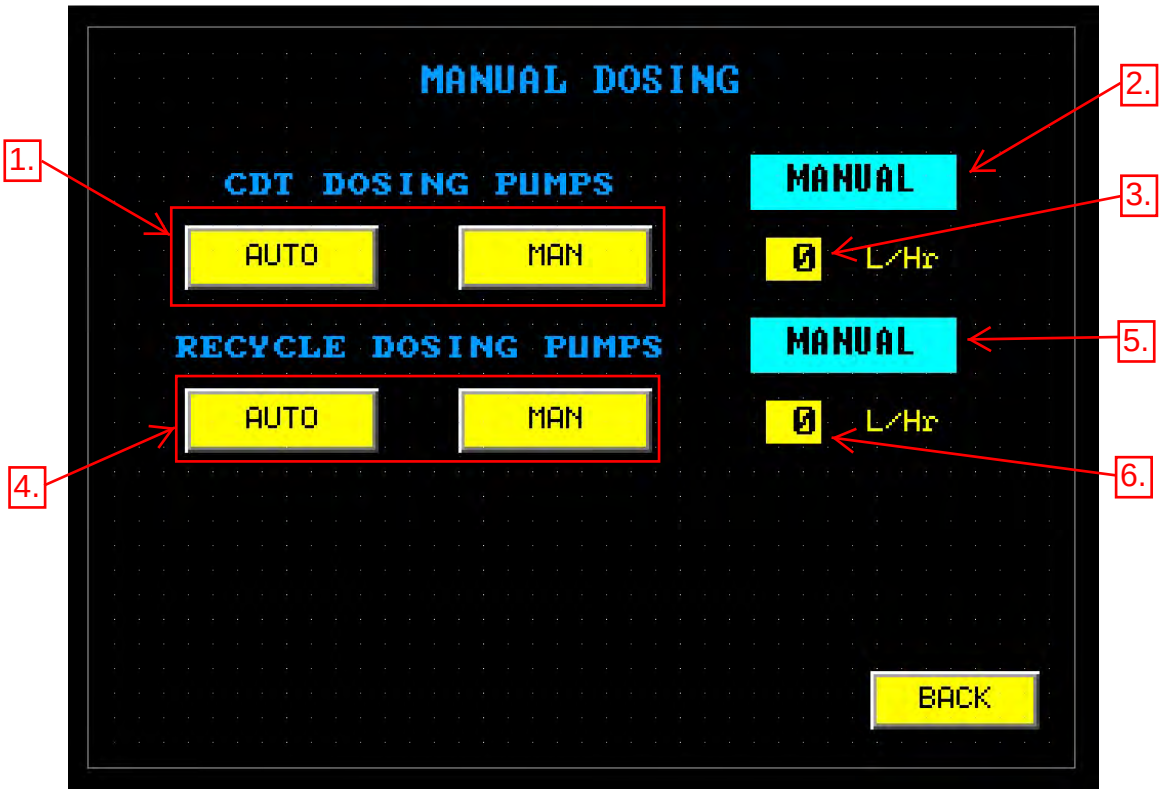
University of Queensland Pump Times



The University of Queensland Pump Times screen displays the restriction times applied to the University of Queensland Pump for each Detention Tank level.

1. These buttons are used to adjust the start and stop times of the pump for each level and are entered as the actual time required in 24 – hour time format.
   eg. A start time of "6 hr 30 Min" = 6.30am
   eg. A stop time of "18hr 30Min" = 6.30pm
   Touch the buttons to adjust.

Manual Dosing

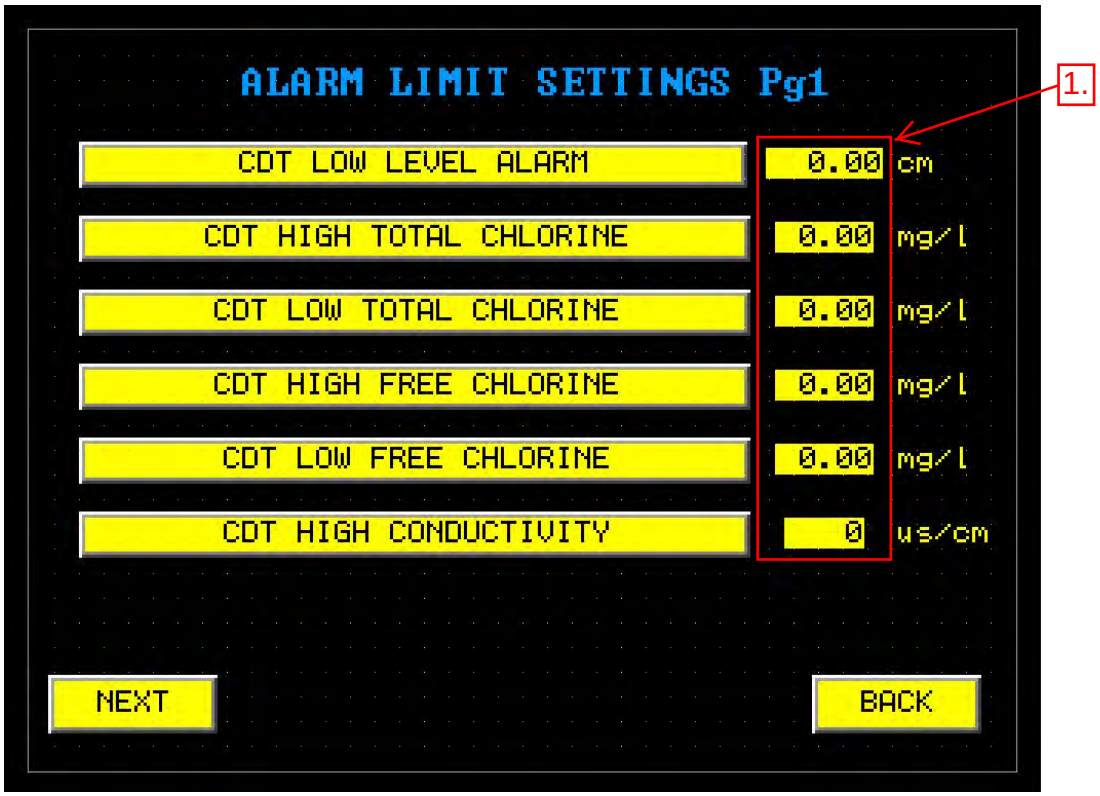


The Manual Dosing screen is used to select automatic or manual dosing for the Detention Tank and Recycled Water dosing pumps.

1. Touch these buttons to select between auto / manual dosing in the Detention Tank.
2. "MANUAL" will be illuminated if the Detention Tank dosing is in manual. This is not a button.
3. Touch this button to adjust the Detention Tank dose rate in L/hr while in manual dosing mode.
4. Touch these buttons to select between auto / manual dosing in the Recycled Water.
5. "MANUAL" will be illuminated if the Recycled Water dosing is in manual. This is not a button.
6. Touch this button to adjust the Recycled Water dose rate in L/hr while in manual dosing mode.

WARNING: While dosing in "Manual" dosing mode all alarms and interlocks are bypassed therefore it is only recommended to use this mode for short periods of time while being strictly monitored by an operator. Under no circumstances should the system be left in manual dosing mode while unattended!!!

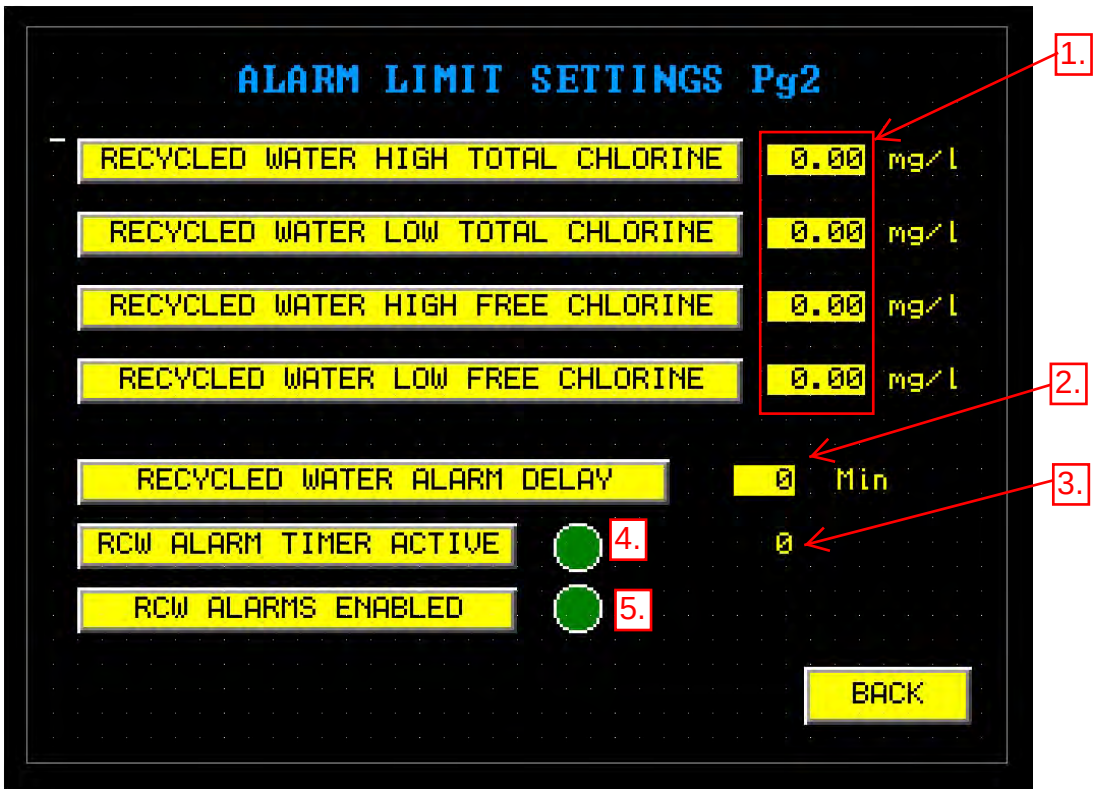
Alarm Limit Settings Page 1



The Alarm Limit Settings Page 1 screen is used to adjust the alarm limit settings for the Detention Tank Effluent levels, Chlorine levels and Conductivity levels.

1. Touch these buttons to adjust the set points.

Alarm Limit Settings Page 2



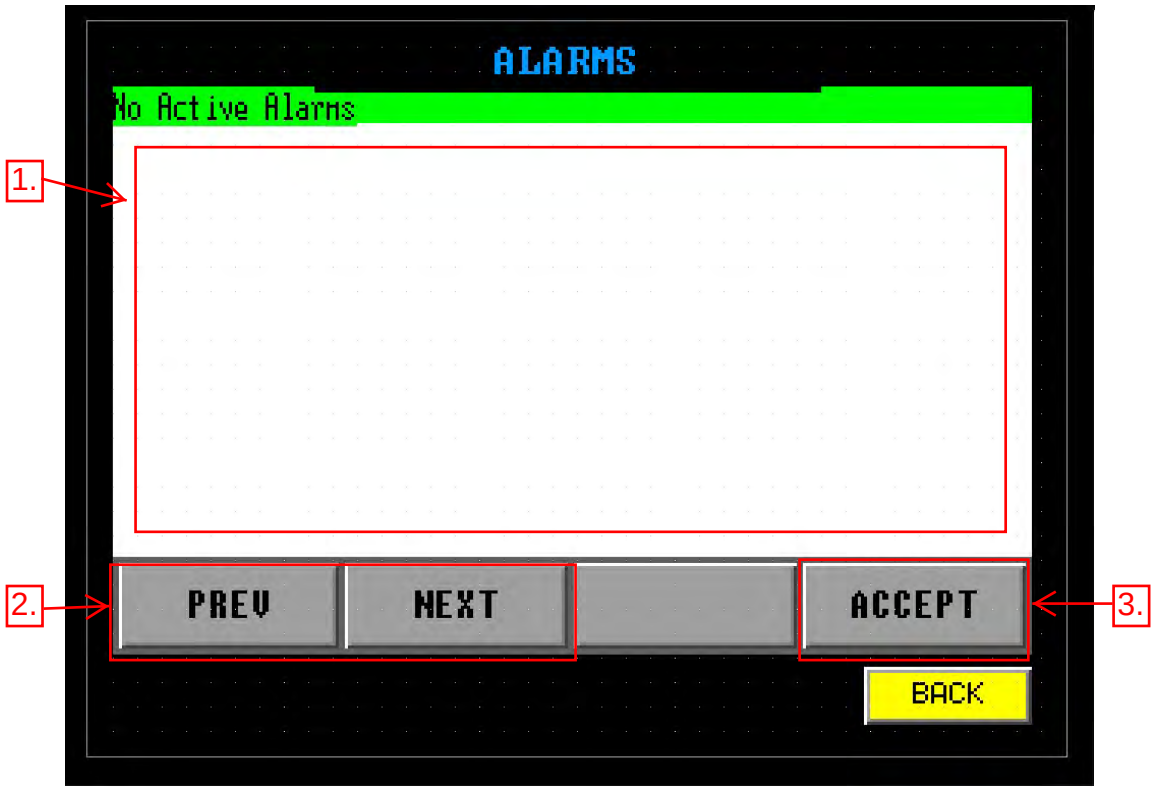
The Alarm Limit Settings Page 2 screen is used to adjust the alarm limit settings for the Recycled Water Chlorine levels.

1. Touch these buttons to adjust the set points.

This screen is also used to adjust the Recycled Water Alarm Delay used for starting the Recycled Water pumps when the Recycled Water Chlorine level is below the low limit or above the high limit alarm set points. The delay time is operator adjustable and once the Recycled Water pumps have been started if the Chlorine level is not within the lower and upper limit within the delay time, the Recycled Water Pumps will be automatically shut down and disabled.

2. Touch this button to adjust the time delay set point.
3. Displays the current elapsed time of the delay timer, this is not a button.
4. A GREEN circle signifies the Recycled Water alarm delay is active.
5. A GREEN circle signifies the Recycled Water alarms are enabled.

Alarm History



The Alarms screen displays the history of activated alarms.

1. This area will list the active alarms and the time it occurred.
2. Use these buttons to scroll through the active alarm list.
3. Use this button to accept and clear the selected alarm.

To be able to clear an alarm the fault that caused the alarm must first be identified and rectified. If an alarm cannot be cleared from the alarm history it means the cause of the alarm is still current and must be rectified.

If "No Active Alarms" is displayed in the green bar it means the system is healthy and no alarms are active.

6.4 SHUT DOWN PROCEDURES

For the disinfection system to be shut down there needs to be no influent from the sewage treatment plant entering the inlet box. This is a very unlikely scenario but should this situation occur there are some critical procedures that need to be undertaken to take the disinfection system out of service. If there is no flow into or out of the chlorine detention tank then all chemical dosing should have automatically stopped, this is the first thing that should be checked. If dosing is continuing then turn the dosing pumps to standby mode at the dosing pumps local control interface.

Once it has been confirmed that dosing has stopped, carry out the following procedures:

- Set the penstock local control to manual operation mode and close the penstock if it's not already in the closed position.
- Turn off the sample pumps to stop sample flow to the analysers.
- Turn all the dosing pumps into standby mode at the dosing pumps local interface if not already done and isolate power to the pumps.
- Isolate the dosing system from the sodium hypochlorite storage tank.
- Isolate power to the ammonia and chlorine analyser systems.
- Isolate power to the main control panel.

If the system will be shut down for more than 1 week carry out the following additional procedures:

- Flush the dosing system and dosing lines with clean water.
- Clean the dosing system Y-strainer elements.
- Clean the analyser sample panel filter elements.

7 CALIBRATION PROCEDURES

7.1 SODIUM HYPOCHLORITE DOSING PUMPS

Before the dosing pumps can be calibrated the system must be primed and deaerated. There must be enough available chemical in the storage tank to fill the calibration cylinder. Carry out the following procedures:

1. Fill the calibration cylinder to the "zero" mark.
2. Isolate the dosing pump from the storage tank.
3. Isolate the de-gassing stand pipes.
4. Ensure the dosing pump will draw chemical only from the calibration cylinder.
5. Enter the pump calibration menu and start the calibration.
6. The pump will execute 200 strokes and stop.
7. Using the pump keypad enter the actual volume dosed.
8. Return the pump to the standby screen to complete calibration.
9. Isolate calibration cylinder.
10. Open valves to de-gassing standpipes.
11. Open isolation from storage tank.
12. Repeat calibration procedure on all dosing pumps.

7.2 INLET BOX AMMONIA ANALYSER

The inlet box ammonia analyser system is self-calibrating so manual calibrations are not required during normal operation.

7.3 CHLORINE DETENTION TANK TOTAL CHLORINE SENSOR

The Total Chlorine Sensor used is a CCS120 which can be identified by the model on the sensor label. Prior to being calibrated, the sensor should be cleaned by removing it from the sensor housing, rinsing in clean water and wiped with a soft cloth if necessary. Do not use any harsh chemicals or abrasive physical cleaning media such as a scouring cloth. Re-install the sensor back into the sensor housing ready for calibrating.

Calibration will be carried out using the key pad control of the CCM253 Transmitter.

The calibration procedure should be as follows:

1. Take a physical sample of the effluent being analysed from as close as possible to the sensor housing.

2. Carry out three (3) DPD tests on the same sample and if all test results are reasonably close and average should be taken as the figure to calibrate to. If the tests are not reasonably close to each other then discard the sample and repeat all three (3) tests on a new sample until a satisfactory average is achieved.

3. Using the following key pad sequence on the CCM253 Transmitter enter the calibration value.

4. From the measurement screen, press the "CAL" button.

5. Using the "+" and "-" keys enter the code "22"

6. Press "E" button once to display the "C12 Calibrat" screen.

7. Press "E" button again to display the "DPD Value" screen.

8. Use the "+" and "-" keys to enter the calibration value in mg/L.

9. Press "E" button to display the "Slope" screen.

10. Press "E" button to display the "OK Status" screen.

11. Press "E" button to display the "Store Yes" screen.

12. Press "E" button to return to the measurement screen.

Calibration of the Total Chlorine Sensor is complete.

7.4 CHLORINE DETENTION TANK FREE CHLORINE SENSOR

The Free Chlorine Sensor used is a CCS142D which can be identified by the model on the sensor label. Prior to being calibrated, the sensor should be cleaned by removing it from the sensor housing, rinsing in clean water or if necessary rinsed in a dilute solution <5% of Hydrochloric Acid (HCL) before being rinsed again and re-installed into the sensor housing. Do not wipe or touch the sensor with any physical cleaning media such as cloth or tissue etc.

Calibration will be carried out using the key pad control of the CM444 Transmitter.

The calibration procedure should be as follows:

1. Take a physical sample of the effluent being analysed from as close as possible to the sensor housing.

2. Carry out three (3) DPD tests on the same sample and if all test results are reasonably close an average should be taken as the figure to calibrate to. If the tests are not reasonably close to each other then discard the sample and repeat all three (3) tests on a new sample until a satisfactory average is achieved.

3. Using the following key pad sequence on the CM444 Transmitter enter the calibration value.

4. From the measurement screen, press the rotary control navigator to turn on the LCD screen backlighting.

5. Press the "CAL" button to start the calibration procedure.

6. Using the rotary control navigator highlight Channel 1 Chlorine and press the rotary control knob to select.

7. Using the rotary control navigator select "Chlorine"

8. Using the rotary control navigator select "Slope"

9. Using the rotary control navigator select "Sample Calibration"

10. Press the "OK" button to start the calibration.

11. Press the "OK" button again confirming you have cleaned the sensor.

12. Wait for a stable measurement value.

13. After "Sample Measurement Successful" is displayed press "OK"

14. Press the rotary control navigator to "Continue Calibration"

15. Press the rotary control navigator to select "Nominal Value"

16. Use the rotary control navigator to enter the DPD calibration value.
17. Use the rotary control navigator to select and press the "✓"
18. Use the rotary control navigator to select and push "Accept Calibration Data"
19. Push "OK" to "Accept Calibration Data for Adjustment"
20. Confirm "Calibration is Finished" by pressing "OK"
21. Hold down the "ESC" button for more than 1 second to return to the measurement screen.

Calibration of the Free Chlorine Sensor is complete.

7.5 CHLORINE DETENTION TANK PH SENSOR

The pH Sensor used is a CPS71D which can be identified by the model on the sensor label. Prior to being calibrated, the sensor should be cleaned by removing it from the sensor housing, rinsing in clean water or if necessary the sensor can be cleaned with a mild detergent, alcohol or rinsed in a dilute solution <3% of Hydrochloric Acid (HCL). Before being re-installed into the sensor housing the sensor should be rinsed with distilled water but not dried. Do not wipe or touch the sensor with any physical cleaning media such as cloth or tissue etc.

Calibration will be carried out using the key pad control of the CM444 Transmitter.
It is recommended to always carry out a two (2) point calibration for a pH sensor using pH 4 and pH 7 buffer solutions.

The calibration procedure should be as follows:

1. Go to the "CAL/2-pnt. calibration" menu.

2. Follow the instructions on the display.

3. Remove the sensor from the sensor housing and rinse with distilled water.

4. Press "OK" after you have immersed the sensor into the pH7 buffer.
   The system starts calculating the measured value for the first buffer. Once the stability criterion is met, the measured value is displayed in mV.

5. Continue to follow the instructions on the display.

6. Remove the sensor from the first buffer and rinse with distilled water.

7. Press "OK" after you have immersed the sensor into the pH4 buffer.
   The system starts calculating the measured value for the buffer. Once the stability criterion is met, the measured values of the two buffers and the calculated values for the slope and zero point are displayed.

8. Select "OK" when you are asked to accept the calibration data for adjustment.

9. Put the sensor back into the medium and press "OK" again.
   This deactivates the hold and the system starts measuring again.

7.6 CHLORINE DETENTION TANK CONDUCTIVITY SENSOR

Endress & Hauser conductivity sensors are factory calibrated and using Memosens technology the calibration data is stored in the sensor itself. It is recommended by the manufacturer that no on site calibration is performed.

If it is suspected that the conductivity reading is not accurate please consult your Endress & Hauser service representative.

7.7 RECYCLED WATER TOTAL CHLORINE SENSOR

The Total Chlorine Sensor used is a CCS120 which can be identified by the model on the sensor label. Prior to being calibrated, the sensor should be cleaned by removing it from the sensor housing, rinsing in clean water and wiped with a soft cloth if necessary. Do not use any harsh chemicals or abrasive physical cleaning media such as a scouring cloth. Re-install the sensor back into the sensor housing ready for calibrating.

Calibration will be carried out using the key pad control of the CCM253 Transmitter.

The calibration procedure should be as follows:

1. Take a physical sample of the effluent being analysed from as close as possible to the sensor housing.

2. Carry out three (3) DPD tests on the same sample and if all test results are reasonably close an average should be taken as the figure to calibrate to. If the tests are not reasonably close to each other then discard the sample and repeat all three (3) tests on a new sample until a satisfactory average is achieved.

3. Using the following key pad sequence on the CCM253 Transmitter enter the calibration value.

4. From the measurement screen, press the "CAL" button.

5. Using the "+" and "-" keys enter the code "22"

6. Press "E" button once to display the "C12 Calibrat" screen.

7. Press "E" button again to display the "DPD Value" screen.

8. Use the "+" and "-" keys to enter the calibration value in mg/L.

9. Press "E" button to display the "Slope" screen.

10. Press "E" button to display the "OK Status" screen.

11. Press "E" button to display the "Store Yes" screen.

12. Press "E" button to return to the measurement screen.

Calibration of the Total Chlorine Sensor is complete.

7.8 RECYCLED WATER FREE CHLORINE SENSOR

The Free Chlorine Sensor used is a CCS142D which can be identified by the model on the sensor label. Prior to being calibrated, the sensor should be cleaned by removing it from the sensor housing, rinsing in clean water or if necessary rinsed in a dilute solution <5% of Hydrochloric Acid (HCL) before being rinsed again and re-installed into the sensor housing. Do not wipe or touch the sensor with any physical cleaning media such as cloth or tissue etc.

Calibration will be carried out using the key pad control of the CM442 Transmitter.

The calibration procedure should be as follows:

1. Take a physical sample of the effluent being analysed from as close as possible to the sensor housing.

2. Carry out three (3) DPD tests on the same sample and if all test results are reasonably close and average should be taken as the figure to calibrate to. If the tests are not reasonably close to each other then discard the sample and repeat all three (3) tests on a new sample until a satisfactory average is achieved.

3. Using the following key pad sequence on the CM444 Transmitter enter the calibration value.

4. From the measurement screen, press the rotary control navigator to turn on the LCD screen backlighting.

5. Press the "CAL" button to start the calibration procedure.

6. Using the rotary control navigator highlight Channel 1 Chlorine and press the rotary control knob to select.

7. Using the rotary control navigator select "Chlorine"

8. Using the rotary control navigator select "Slope"

9. Using the rotary control navigator select "Sample Calibration"

10. Press the "OK" button to start the calibration.

11. Press the "OK" button again confirming you have cleaned the sensor.

12. Wait for a stable measurement value.

13. After "Sample Measurement Successful" is displayed press "OK"

14. Press the rotary control navigator to "Continue Calibration"

15. Press the rotary control navigator to select "Nominal Value"

16. Use the rotary control navigator to enter the DPD calibration value.
17. Use the rotary control navigator to select and press the "✓"
18. Use the rotary control navigator to select and push "Accept Calibration Data"
19. Push "OK" to "Accept Calibration Data for Adjustment"
20. Confirm "Calibration is Finished" by pressing "OK"
22. Hold down the "ESC" button for more than 1 second to return to the measurement screen.

Calibration of the Free Chlorine Sensor is complete.

7.9 RECYCLED WATER PH SENSOR

The pH Sensor used is a CPS71D which can be identified by the model on the sensor label. Prior to being calibrated, the sensor should be cleaned by removing it from the sensor housing, rinsing in clean water or if necessary the sensor can be cleaned with a mild detergent, alcohol or rinsed in a dilute solution <3% of Hydrochloric Acid (HCL). Before being re-installed into the sensor housing the sensor should be rinsed with distilled water but not dried. Do not wipe or touch the sensor with any physical cleaning media such as cloth or tissue etc.

Calibration will be carried out using the key pad control of the CM442 Transmitter.
It is recommended to always carry out a two (2) point calibration for a pH sensor using pH 4 and pH 7 buffer solutions.

The calibration procedure should be as follows:

1. Go to the "CAL/2-pnt. calibration" menu.

2. Follow the instructions on the display.

3. Remove the sensor from the sensor housing and rinse with distilled water.

4. Press "OK" after you have immersed the sensor into the pH7 buffer.
   The system starts calculating the measured value for the first buffer. Once the stability criterion is met, the measured value is displayed in mV.

5. Continue to follow the instructions on the display.

6. Remove the sensor from the first buffer and rinse with distilled water.

7. Press "OK" after you have immersed the sensor into the pH4 buffer.
   The system starts calculating the measured value for the buffer. Once the stability criterion is met, the measured values of the two buffers and the calculated values for the slope and zero point are displayed.

8. Select "OK" when you are asked to accept the calibration data for adjustment.

9. Put the sensor back into the medium and press "OK" again.
   This deactivates the hold and the system starts measuring again.

8 PREVENTATIVE MAINTENANCE

Preventative maintenance is an important aspect of keeping the disinfection system in good working order. Equipment, instruments and pipe work should be cleaned only with mild detergent and a damp cloth. No solvents or abrasive cleaners should be used.

Meyjor Industries recommend the development of and adherence to a quality preventative maintenance program.

8.1 SODIUM HYPOCHLORITE DOSING SYSTEM

Line Strainers may require frequent cleaning due to contaminants in the chemical tank or pipe work. Frequency of cleaning should be as required until a normal frequency can be established during the initial few months of operation.

The Sodium Hypochlorite Dosing Pumps should be serviced with the installation of a diaphragm repair kit at least every two (2) years to ensure trouble free operation.

The chemical dosing system should be flushed with clean water prior to carrying out any maintenance work that involves disassembly of any components or if the system will be out of service for more than 1 week. Always ensure the operator wears the appropriate PPE while flushing chemicals from the dosing system. Failure to do this will create a safety hazard for operators.

System flushing should be carried out as per the following procedures:

- Isolate the dosing system from the chemical supply tank.
- Isolate the discharge line from the dosing point to avoid contaminating the process with flushing water.
- Open the discharge drains to relieve pressure and drain excess chemical.
- Connect service / flushing water to the flush point/s in the suction lines and open the flushing point isolation valve.
- Flush water through the entire system until the flushing water flows out the discharge drain.
- Continue flushing the entire system until all residual chemical has been adequately removed.
- Turn off the flushing water and close the flushing point isolation valve/s.
- The system is now adequately flushed to allow safe disassembly.

8.2 INLET BOX AMMONIA ANALYSER SYSTEM

Cleaning - general

Clean all components of the Inlet Box Ammonia Analyser System including PVC backboard, PVC pipework, valves, filters, and transmitter housings with usual commercial cleaning agents as listed below:

- Isopropanol
- Diluted acids (max. 3%)
- Diluted alkalis (max. 5%)
- Esters
- Hydrocarbons
- Ketones
- Household cleaners

Caution!
For cleaning purposes, never use:

- Concentrated mineral acids or alkalis
- Benzyl alcohol
- Methylene chloride
- High-pressure steam

Cleaning Sample In-Line Filters

The Inlet Box Ammonia Analyser sample panel is fitted with two (2) 915 micron mesh filters to reduce the amount of contaminants such as algae etc. from entering the analyser. These should be cleaned at regular intervals to ensure a constant flow of clean sample to the analyser.

It is recommended to clean the 915 micron pre-filters on a weekly basis or as required.

CAUTION !
You must not carry out any procedures not listed in the following chapters, yourself. Not listed works must only be carried out by Endress & Hauser service staff.

If you use components for maintenance or modification, which are not approved by Endress+Hauser, the warranty and the certified conformity of the device will become void.

Maintenance schedule

All maintenance duties that have to be carried out during normal operation of the analyser are explained below.

Period of time	Duty	Note
Weekly	– Check and note calibration factor (for service purposes) – Move valve hoses into their position and spray with silicone (extends the service life). – Clean sample filters. – Flush sample line hose system with pressurized water (disposable syringe supplied) – Check reagents, cleaner and calibration standard for level and expiry date, replace if necessary. – Check sample collector for fouling and clean it if necessary	CONFIGURATION
Monthly	– Grease pump hoses with silicone grease.	– Remove the cassette of the sample pump.
Every 3 months	– Cleaning the drain lines: Flush all hoses and then rinse with sample for at least 30 minutes – Rotate pump hoses – Cleaning of the filter mat of the housing fan	– SERVICE: V1: P, P1: g, P2: s, V2: S, V3: P Add solution to sampling connection – s. chapter "Replacing the pump hoses" – s. chapter "Cleaning the filter mat of the housing fan"
Every 6 months	– Replace pump hoses – Replace valve hoses	– Refer to Endress & Houser Instructions – Refer to Endress & Houser Instructions

Whenever working on the reagent hoses, the hoses must be disconnected from the canisters, in order to prevent contamination of the reagents. Empty the reagent hoses via the service menu.

Reagents

CAUTION !
Corrosive chemicals and other risks
Eye or skin injuries or crushes possible
► There is a danger of crushing limbs at doors, inserts and pump heads.
► Refer to the warning instructions in the safety data sheets when handling reagents or cleaning solutions. Wear protective clothing, gloves and goggles.
► Make sure the workplace is well ventilated when you work with bleaching lye. If you feel unwell, consult a physician immediately.

► If reagents come into contact with the skin or eyes, carefully rinse with copious amounts of water and consult a physician immediately.
► Never add water to reagents. Reagents containing acids may splash and heat may build up.

If you store the reagents correctly (in the dark, not over 20 ˚C) they will be stable for minimum 12 weeks from the date of manufacture (batch number). When this period of time has expired, the reagents must be replaced. Shelf life can be prolonged by keeping the reagents in a dark, cool storage place. The reagents absolutely must be replaced when:

- The reagents have been contaminated by sample.
- The reagents are too old.
- The reagents have been spoilt by incorrect storage conditions or environmental influences.

Checking Reagents

1. Check the concentration of the standard in the laboratory. Adapt the values (PARAMETER ENTRY, calibration solution") or replace the standard solution.

2. Mix 5 ml of standard (c=500 µg/l or higher) and 5 ml each of reagent AM 1 and AM 2 in a beaker.

The finished mixture must be free of particles.
The reagents must be replaced if no visual coloration (green-blue) occurs after max. 2 minutes or if the mixture is not free of particles.

Replacing Reagents

1. Carefully remove the hoses from the canisters and wipe them with a clean and dry (paper) towel. Wear protective gloves when doing this.

2. Switch on the reagent pump for about 5 seconds for the hoses to be drained.

3. Flush the reagent hose externally with plenty of distilled water.
   For this purpose, place a beaker with distilled water into the device.

4. Wipe the reagent hose with a clean and dry (paper) towel.

5. Replace the reagent canisters and feed the hoses into the new canisters.

6. Fill the reagent hose with the new reagents. Switch all pumps to "g" for this purpose.
   Do not switch the pumps off ("s") until no more air bubbles are to be seen in the hoses.

7. Determine the reagent blank value by using deionized water as a sample.
   The value determined is saved by the analyser as the frequency offset.

8. Carry out a manual calibration (refer to Endress & Hauser instructions).

Replacing Pump Hoses

CAUTION !
Risk of splashing reagents when removing hoses from the hose nozzles
► Wear protective clothing, gloves and goggles.

The peristaltic pumps used for the analyser convey the medium in a combination of vacuum and displacement pump. The pump rate is dependent on the elasticity of the pump hoses. Elasticity decreases and the pump rate drops as mechanical stress increases. Wear depends on mechanical stress (measuring interval, pump pressure). The wear effect can be compensated by periodical calibration. If the hose elasticity becomes too low and the pump rate is no longer reproducible, it is necessary to replace the hoses.

Removing the old hoses

1. Remove the reagent hoses from the reagent canisters in order to prevent contamination of the reagents.

2. Flush the old hoses with water first and then with air to empty them.

3. Remove the hoses from the nipples of the hose boxes.

4. Release the hose boxes.
– Press against the lower retainer.
– You can now remove the hose box along with the pump hose.
– Remove the old hose from the box any dispose of it.
– Clean the hose box and the roller head with a tissue.

Installing the new hoses

1. Grease the new pump hoses and the pump heads with silicone grease.

2. Make sure you connect the new pump hoses to the correct connections at the T-hose connector.

3. Fit the new hose on the hose box.

4. First pull the hose downwards at both ends and then push the guide on the hose into that of the nipple on the hose box. Make sure it is seated correctly.

5. First place the hose box into the upper retainer of the pump and then press the box into the lower retainer.

6. Make sure the hose boxes are in the correct order in the pump.

Setting the contact pressure of the pump

If the pump hoses cannot be filled free of bubbles, adjust the adjuster screw for the contact pressure of the pump:

1. Release the adjuster screw to the extent that no more sample is pumped.

2. Tighten the screw just to the point that sample is pumped.

3. Tighten the screw another complete rotation.

CAUTION !
The reagent would become immediately unusable if sample is pumped into it.
► Adjust the contact pressure of the reagent hoses so that no sample is pumped into the reagent.
► Only perform tests with distilled water.

Replacing Valve Hoses

To replace the hoses, proceed as follows:

1. Rinse the old hoses first with water and then with air to empty them.

2. Remove the hoses from the valves.
   You can disconnect the front hoses directly because the valves are open when de- energised. To remove the back hoses, press the black button on the valve and disconnect the hoses.

3. Grease the new hoses with silicone grease before inserting them.

4. Install the new valve hoses in the reverse sequence of operations.
   Ensure that the hoses are connected correctly.

5. After installation, refill the hoses with sample, standard or cleaning agent.

6. Carry out an offset calibration and a calibration.

Replacing the Static Mixer

To replace the mixer, proceed as follows:

1. Rinse first with water and then with air.

2. Unscrew the four screws on the photometer housing and remove it.

3. Disconnect the mixer from the photometer and from the T-piece below the photometer housing or release the mixer from the holder.
4. Remove the old mixer and insert the new one.

5. Connect the new mixer to the photometer and the T-piece again.

6. Attach the photometer housing and screw it down.

7. After installation, refill the hoses with sample, standard or cleaning agent.

8. Carry out an offset calibration and a calibration.

Replacing the photometer optical cell

CAUTION !

Electrostatic discharge (ESD) can cause damage to electronic assemblies.
Discharge yourself at a protective earth before handling the assemblies.

Removing the old cell

1. Rinse first with water and then with air.

2. Switch the analyser off.

3. Unscrew the four screws on the photometer housing and remove it.

4. Release the nuts from the guide screws and remove the photometer completely.

5. Unscrew the four screws on the side of the photometer on which there is no ribbon cable.

6. Take the photometer's electronics apart.

7. Take out the cell and remove the hoses.

CAUTION!

Traces of grease on the optical surfaces can cause corrupted measured values
Do not under any circumstances touch the optical window of the cell with your fingers.

Installing the new cell

1. Insert the new cell.
2. Connect the cell to the hoses such that the sample is fed in from below.
3. Secure the hoses with the supplied cable connectors to stop the cell from slipping.
4. Reassemble the photometer and tighten the screws and nuts.
5. Attach the photometer housing and screw it down.
6. After installation, refill the hoses with sample, standard or cleaning agent.
7. Carry out an f-offset measurement and a calibration.

Placing out of service

You must place the analyser out of service before shipping or before longer operation breaks (more than 5 days).

CAUTION !
Residues of chemicals can cause injuries.
Thoroughly rinse all of the lines of the measuring system with ultrapure water.
To place the analyser out of service, proceed as follows:

1. Remove the reagent and standard hoses from the canisters and immerse them in a tank containing ultrapure water.
2. Switch valve 1 to "Standard" and switch pumps 1 and 2 on for one minute.
3. Remove the hoses from the water and allow the pumps to run until the hoses are completely dry.
4. If you are using a continuous sample supply, disconnect sampling line.
5. Flush sampling hoses with ultrapure water and then with air, in order to completely empty the hoses.
6. Remove the valve hoses from the valves.
7. Remove the load from the pump hoses by removing the hose cassette from the bracket below.

CAUTION !

Keep opened reagents and standards in a refrigerator. Observe the shelf-life.

8.3 CHLORINE DETENTION TANK CHLORINE ANALYSER SYSTEM

Cleaning - general

Clean all components of the CDT Chlorine Analyser System including PVC backboard, PVC pipework, valves, filters, sensor housings and transmitter housings with usual commercial cleaning agents as listed below:

- Isopropanol
- Diluted acids (max. 3%)
- Diluted alkalis (max. 5%)
- Esters
- Hydrocarbons
- Ketones
- Household cleaners

Caution!
For cleaning purposes, never use:

- Concentrated mineral acids or alkalis
- Benzyl alcohol
- Methylene chloride
- High-pressure steam

Cleaning Sample In-Line Filters

The Chlorine Detention Tank Analyser sample panel is fitted with two (2) 915 micron mesh filters to reduce the amount of contaminants such as algae etc. from entering the sensor housings. These should be cleaned at regular intervals to ensure a constant flow of clean sample to the sensors.

It is recommended to clean the 915 micron pre-filters on a weekly basis or as required.

Cleaning Sensor Housings

To ensure a reliable measurement, the assembly and the sensor must be cleaned at regular intervals. The frequency and intensity of the cleaning operation depend on the process medium. All parts in contact with the medium, e.g. the sensor and the sensor holder, must be cleaned at regular intervals.

- Remove the sensors.
- Remove light dirt using suitable cleaning agents.
- Remove severe fouling with a soft brush and a suitable cleaning agent.
- Remove persistent fouling by soaking in a liquid cleaner and if necessary by cleaning with a soft brush.

Note:
A typical cleaning interval for e.g. drinking water is at every 6 months.
This interval may vary due to water quality.

Total Chlorine Sensor Maintenance

Check the measurement daily and calibrate at least once a month.

Service the sensor regularly to avoid incorrect dosing within a control system, due to an incorrect measured value. Do not touch the sensors or allow them to come into contact with greasy substances. Never attempt to clean the membrane with acid/alkaline solutions, cleaning reagents or mechanical aids (brushes or similar). Maintenance intervals based on experience range from 1 to 4 weeks depending on the level of contaminants in the measured media.

Perform the following maintenance work:

- Check the sensor for dirt, algae and air bubbles. If necessary clean the sensor with clear water and a soft tissue. Eliminate air bubbles by increasing the flow rate.
- Check the displayed sensor value on the transmitter according to the DPD testing procedure.
- If necessary, recalibrate the sensor.
- If calibration cannot be carried out properly, replace the membrane cap, electrolyte and repeat the calibration.

Free Chlorine Sensor Maintenance

Check the measurement daily and calibrate at least once a month.

Service the sensor regularly to avoid incorrect dosing within a control system, due to an incorrect measured value. Do not touch the sensors or allow them to come into contact with greasy substances. Never attempt to clean the membrane with acid/alkaline solutions, cleaning reagents or mechanical aids (brushes or similar). Maintenance intervals based on experience range from 1 to 4 weeks depending on the level of contaminants in the measured media.

Perform the following tasks:

- If the membrane is visibly soiled, clean the sensor.
- Refill the sensor with electrolyte once per season or every 12 months. Depending on the chlorine content on site, this period can be reduced or extended.
- Calibrate the sensor when necessary.

Cleaning the sensor:

CAUTION - Hydrochloric acid and surface tension reducing chemicals!
Diluted hydrochloric acid causes irritations when in contact with skin or eyes. Surface tension reducing chemicals can penetrate into the sensor membrane and cause measuring faults due to blocking.

- When using diluted hydrochloric acid, wear protective clothing like protective gloves and goggles. Avoid splashes.

- Do not use chemicals reducing the surface tension.

If the membrane is visibly soiled, proceed as follows:
1. Remove the sensor from the flow assembly.
2. Clean the membrane mechanically with a gentle water jet or immerse for several minutes in a 1 to 5 % hydrochloric acid without chemical additives.

Replacing the membrane:

1. Unscrew the measuring chamber from the shaft.
2. Unscrew the front screw cap.
3. Remove the membrane cap and replace it with a CCY14-WP replacement cartridge.
4. Refill the measuring chamber with CCY14-F Electrolyte.

Refilling the Electrolyte:

WARNING!

- Do not touch or damage the membrane or electrodes.
- The electrolyte is chemically neutral and not hazardous, however do not swallow it and avoid contact with the eyes.
- Keep the electrolyte bottle closed after use. Do not transfer the electrolyte into other containers.
- Do not store the electrolyte for more than 1 year. The electrolyte may not show a yellow colour, see label for use by date.
- Avoid forming air bubbles when pouring the electrolyte into the membrane cap.

Proceed as follows to refill the electrolyte:

1. Unscrew the measuring chamber from the sensor shaft.
2. Hold the measuring chamber at an angle and fill in about 7 to 8 ml of electrolyte, up to the internal thread of the measuring chamber.
3. Tap the filled measuring chamber several times on a flat surface so that adherent air bubbles can detach and rise.
4. Insert the sensor shaft vertically from above into the measuring chamber.
5. Slowly tighten the measuring chamber to the stop. Excess electrolyte is pressed out at the sensor bottom during the tightening.

Storing the sensor:

During short-term interruptions in measurement:
- If it is ensured that the assembly will not drain off, you can leave the sensor in the assembly.
- If the assembly might drain off, remove the sensor from the assembly. To keep the membrane of the uninstalled sensor wet, moisten the inner sponge of the protection cap and slide the cap onto the measuring chamber.

During long-term interruptions in measurement, particularly if dehydration is possible:
- Empty the sensor.

- Rinse the measuring chamber and electrode shaft with cold water and let them dry.
- Screw the sensor down loosely and not to the stop so that the membrane remains unstressed.

Regenerating the Sensor:

During measurement, the electrolyte in the sensor is gradually exhausted by chemical reactions. The silver chloride layer, applied to the anode at the factory, continues to grow during sensor operation. This has no effect on the reaction taking place at the cathode.

A change in colour of the silver chloride layer, however, indicates effects on the reaction at the cathode. Therefore, ensure by visual inspection that the grey-brown colour of the anode has not changed. If the anode colour has changed, e.g. if it is spotted, white or silvery, the sensor must be regenerated.
Send it back to the manufacturer for this purpose.

Reconditioning the Sensor:

Long-term operation (> 3 months) in chlorine-free media, i.e. with very low sensor currents, may lead to a deactivation of the sensor.
This deactivation is a continuous process that results in a lower slope and longer response times.
After long-term operation in a chlorine-free medium, the sensor must be reconditioned.
You need the following materials for reconditioning:

- Demineralized water
- Polishing sheet (see "Accessories")
- Beaker
- Approx. 100 ml of chlorine bleaching lye NaOCl approx. 13 %, pharmaceutical quality

WARNING !

Bleaching lye is a corrosive substance and causes dangerous gases to develop if it comes in contact with acids.

- Wear suitable protective clothing such as safety gloves and protective goggles.
- Avoid contact with the eyes and skin.
- Avoid bleaching lye coming into contact with acids.
- Observe additional information on the safety data sheets.

Proceed as follows:

1. Close the medium inlet and outlet and make sure that no medium can squirt out of the assembly.
2. Remove the sensor from the assembly.
3. Unscrew the measuring chamber and put it aside.
4. Polish the gold cathode of the sensor using the polishing sheet:
   – Place a wetted strip of the sheet in your hand.
   – Polish the gold cathode by moving it circularly on the strip.

– Rinse the sensor with demineralized water.

5. Top up the electrolyte if required (see chapter "Refilling the electrolyte") and screw the measuring chamber back into place.
6. Fill the beaker with chlorine bleach liquor to about 10 mm (0.39") and position it safely.
7. Caution! The sensor must not touch the liquid. Place the sensor in the gaseous phase about 5 to 10 mm (0.2" to 0.39") above the chlorine bleach liquor.
8. The sensor current will now increase. The absolute value and the speed of increase depend on the temperature of the chlorine bleach liquor.
   – When the sensor current has reached a value of several hundred nA, leave the sensor under these conditions over a period of 20 min.
   – If the recommended current value cannot be reached, cover the beaker to avoid quick air change.
9. After the 20 min. have elapsed, re-install the sensor in the assembly.
10. Re-establish the medium flow. The sensor current will normalize.
11. After sufficient settling time (no noticeable drift), calibrate the measuring chain.

pH Sensor Maintenance

Please clean contamination on the glass electrodes as follows:

Oily and greasy films:

- Clean with detergent.

Warning! - When using the following cleaning agents, make sure to protect your hands, eyes and clothing!

Lime and metal hydroxide layers:

- Dissolve layers with diluted hydrochloric acid (3 %) and then rinse carefully with a lot of clear water.

Layers containing sulphide (from flue gas desulphurizing or sewage treatment plants):

- Use mixture of hydrochloric acid (3 %) and thiocarbamide (usual commercial) and then rinse carefully with a lot of clear water.

Layers containing proteins (e.g. food industry):

- Use mixture of hydrochloric acid (0.5 %) and pepsin (usual commercial) and then rinse carefully with a lot of clear water.

Fibres, suspended substances:

- Water under pressure, possibly with surface-active agents.

Light biological deposits:

- Water under pressure.

Conductivity Sensor Maintenance

Cleaning:

WARNING! - Burning chemicals
Danger of chemicals burns to the eyes and skin.
Danger of damage to clothing and equipment.

- It is absolutely essential to protect the eyes and hands properly when working with acids, bases and organic solvents!
- Wear protective goggles and safety gloves.
- Clean away splashes on clothes and other objects to prevent any damage.
- Pay particular attention to the information provided in the safety data sheets for the chemicals used.

Clean away fouling on the sensor as follows depending on the particular type of fouling:

Oily and greasy films:

- Clean with grease remover, e.g. alcohol, acetone, as well as hot water and dishwashing detergent if necessary.

Lime and metal hydroxide build up:

- Dissolve build up with diluted hydrochloric acid (3 %) and then rinse thoroughly with plenty of clear water.

Sulfidic buildup (from flue gas desulfurising or sewage treatment plants):

- Use a mixture of hydrochloric acid (3 %) and thiocarbamide (commercially available) and then rinse thoroughly with plenty of clear water.

Build up containing proteins (e.g. food industry):

- Use a mixture of hydrochloric acid (0.5 %) and pepsin (commercially available) and then rinse thoroughly with plenty of clear water.

8.4 RECYCLED WATER CHLORINE ANALYSER SYSTEM

Cleaning - general

Clean all components of the CDT Chlorine Analyser System including PVC backboard, PVC pipework, valves, filters, sensor housings and transmitter housings with usual commercial cleaning agents as listed below:

- Isopropanol
- Diluted acids (max. 3%)
- Diluted alkalis (max. 5%)
- Esters
- Hydrocarbons
- Ketones
- Household cleaners

Caution!
For cleaning purposes, never use:

- Concentrated mineral acids or alkalis
- Benzyl alcohol
- Methylene chloride
- High-pressure steam

Cleaning Sample In-Line Filters

The Chlorine Detention Tank Analyser sample panel is fitted with two (2) 915 micron mesh filters to reduce the amount of contaminants such as algae etc. from entering the sensor housings. These should be cleaned at regular intervals to ensure a constant flow of clean sample to the sensors.

It is recommended to clean the 915 micron pre-filters on a weekly basis or as required.

Cleaning Sensor Housings

To ensure a reliable measurement, the assembly and the sensor must be cleaned at regular intervals. The frequency and intensity of the cleaning operation depend on the process medium. All parts in contact with the medium, e.g. the sensor and the sensor holder, must be cleaned at regular intervals.

- Remove the sensors.
- Remove light dirt using suitable cleaning agents.
- Remove severe fouling with a soft brush and a suitable cleaning agent.
- Remove persistent fouling by soaking in a liquid cleaner and if necessary by cleaning with a soft brush.

Note:
A typical cleaning interval for e.g. drinking water is at every 6 months.
This interval may vary due to water quality.

Total Chlorine Sensor Maintenance

Check the measurement daily and calibrate at least once a month.

Service the sensor regularly to avoid incorrect dosing within a control system, due to an incorrect measured value. Do not touch the sensors or allow them to come into contact with greasy substances. Never attempt to clean the membrane with acid/alkaline solutions, cleaning reagents or mechanical aids (brushes or similar). Maintenance intervals based on experience range from 1 to 4 weeks depending on the level of contaminants in the measured media.

Perform the following maintenance work:

- Check the sensor for dirt, algae and air bubbles. If necessary clean the sensor with clear water and a soft tissue. Eliminate air bubbles by increasing the flow rate.
- Check the displayed sensor value on the transmitter according to the DPD testing procedure.
- If necessary, recalibrate the sensor.
- If calibration cannot be carried out properly, replace the membrane cap, electrolyte and repeat the calibration.

Free Chlorine Sensor Maintenance

Check the measurement daily and calibrate at least once a month.

Service the sensor regularly to avoid incorrect dosing within a control system, due to an incorrect measured value. Do not touch the sensors or allow them to come into contact with greasy substances. Never attempt to clean the membrane with acid/alkaline solutions, cleaning reagents or mechanical aids (brushes or similar). Maintenance intervals based on experience range from 1 to 4 weeks depending on the level of contaminants in the measured media.

Perform the following tasks:

- If the membrane is visibly soiled, clean the sensor.
- Refill the sensor with electrolyte once per season or every 12 months. Depending on the chlorine content on site, this period can be reduced or extended.
- Calibrate the sensor when necessary.

Cleaning the sensor:

CAUTION - Hydrochloric acid and surface tension reducing chemicals!
Diluted hydrochloric acid causes irritations when in contact with skin or eyes. Surface tension reducing chemicals can penetrate into the sensor membrane and cause measuring faults due to blocking.

- When using diluted hydrochloric acid, wear protective clothing like protective gloves and goggles. Avoid splashes.

- Do not use chemicals reducing the surface tension.

If the membrane is visibly soiled, proceed as follows:
1. Remove the sensor from the flow assembly.
2. Clean the membrane mechanically with a gentle water jet or immerse for several minutes in a 1 to 5 % hydrochloric acid without chemical additives.

Replacing the membrane:

5. Unscrew the measuring chamber from the shaft.
6. Unscrew the front screw cap.
7. Remove the membrane cap and replace it with a CCY14-WP replacement cartridge.
8. Refill the measuring chamber with CCY14-F Electrolyte.

Refilling the Electrolyte:

WARNING!

- Do not touch or damage the membrane or electrodes.
- The electrolyte is chemically neutral and not hazardous, however do not swallow it and avoid contact with the eyes.
- Keep the electrolyte bottle closed after use. Do not transfer the electrolyte into other containers.
- Do not store the electrolyte for more than 1 year. The electrolyte may not show a yellow colour, see label for use by date.
- Avoid forming air bubbles when pouring the electrolyte into the membrane cap.

Proceed as follows to refill the electrolyte:

6. Unscrew the measuring chamber from the sensor shaft.
7. Hold the measuring chamber at an angle and fill in about 7 to 8 ml of electrolyte, up to the internal thread of the measuring chamber.
8. Tap the filled measuring chamber several times on a flat surface so that adherent air bubbles can detach and rise.
9. Insert the sensor shaft vertically from above into the measuring chamber.
10. Slowly tighten the measuring chamber to the stop. Excess electrolyte is pressed out at the sensor bottom during the tightening.

Storing the sensor:

During short-term interruptions in measurement:
- If it is ensured that the assembly will not drain off, you can leave the sensor in the assembly.
- If the assembly might drain off, remove the sensor from the assembly. To keep the membrane of the uninstalled sensor wet, moisten the inner sponge of the protection cap and slide the cap onto the measuring chamber.

During long-term interruptions in measurement, particularly if dehydration is possible:
- Empty the sensor.

- Rinse the measuring chamber and electrode shaft with cold water and let them dry.
- Screw the sensor down loosely and not to the stop so that the membrane remains unstressed.

Regenerating the Sensor:

During measurement, the electrolyte in the sensor is gradually exhausted by chemical reactions. The silver chloride layer, applied to the anode at the factory, continues to grow during sensor operation. This has no effect on the reaction taking place at the cathode.

A change in colour of the silver chloride layer, however, indicates effects on the reaction at the cathode. Therefore, ensure by visual inspection that the grey-brown colour of the anode has not changed. If the anode colour has changed, e.g. if it is spotted, white or silvery, the sensor must be regenerated.
Send it back to the manufacturer for this purpose.

Reconditioning the Sensor:

Long-term operation (> 3 months) in chlorine-free media, i.e. with very low sensor currents, may lead to a deactivation of the sensor.
This deactivation is a continuous process that results in a lower slope and longer response times.
After long-term operation in a chlorine-free medium, the sensor must be reconditioned.
You need the following materials for reconditioning:

- Demineralized water
- Polishing sheet (see "Accessories")
- Beaker
- Approx. 100 ml of chlorine bleaching lye NaOCl approx. 13 %, pharmaceutical quality

WARNING !

Bleaching lye is a corrosive substance and causes dangerous gases to develop if it comes in contact with acids.

- Wear suitable protective clothing such as safety gloves and protective goggles.
- Avoid contact with the eyes and skin.
- Avoid bleaching lye coming into contact with acids.
- Observe additional information on the safety data sheets.

Proceed as follows:

12. Close the medium inlet and outlet and make sure that no medium can squirt out of the assembly.
13. Remove the sensor from the assembly.
14. Unscrew the measuring chamber and put it aside.
15. Polish the gold cathode of the sensor using the polishing sheet:
    – Place a wetted strip of the sheet in your hand.
    – Polish the gold cathode by moving it circularly on the strip.

– Rinse the sensor with demineralized water.

16. Top up the electrolyte if required (see chapter "Refilling the electrolyte") and screw the measuring chamber back into place.
17. Fill the beaker with chlorine bleach liquor to about 10 mm (0.39") and position it safely.
18. Caution! The sensor must not touch the liquid. Place the sensor in the gaseous phase about 5 to 10 mm (0.2" to 0.39") above the chlorine bleach liquor.
19. The sensor current will now increase. The absolute value and the speed of increase depend on the temperature of the chlorine bleach liquor.
    – When the sensor current has reached a value of several hundred nA, leave the sensor under these conditions over a period of 20 min.
    – If the recommended current value cannot be reached, cover the beaker to avoid quick air change.
20. After the 20 min. have elapsed, re-install the sensor in the assembly.
21. Re-establish the medium flow. The sensor current will normalize.
22. After sufficient settling time (no noticeable drift), calibrate the measuring chain.

pH Sensor Maintenance

Please clean contamination on the glass electrodes as follows:

Oily and greasy films:

- Clean with detergent.

Warning! - When using the following cleaning agents, make sure to protect your hands, eyes and clothing!

Lime and metal hydroxide layers:

- Dissolve layers with diluted hydrochloric acid (3 %) and then rinse carefully with a lot of clear water.

Layers containing sulphide (from flue gas desulphurizing or sewage treatment plants):

- Use mixture of hydrochloric acid (3 %) and thiocarbamide (usual commercial) and then rinse carefully with a lot of clear water.

Layers containing proteins (e.g. food industry):

- Use mixture of hydrochloric acid (0.5 %) and pepsin (usual commercial) and then rinse carefully with a lot of clear water.

Fibres, suspended substances:

- Water under pressure, possibly with surface-active agents.

Light biological deposits:

- Water under pressure.

8.5 EFFLUENT SAMPLE PUMPS

The effluent sample pumps are Grundfos JP Rain end suction centrifugal pumps. The pumps will provide years of service with little to no maintenance.

It is recommended to carry out weekly inspections to ensure:

- Pumps are running normally without abnormal noise or vibration.
- Suction line foot-valves are clear of debris.
- Suction lines and discharge lines are free from leaks.

8.6 CHLORINE DETENTION TANK ULTRASONIC LEVEL SENSOR

The Chlorine Detention Tank Ultrasonic Level Sensor is a Vega 61 Ultrasonic. When used in the correct way, no special maintenance is required in normal operation. It is recommended to keep the unit clean by wiping external surfaces with a damp cloth, mild detergents can be used if necessary.

8.7 CHLORINE DETENTION TANK ULTRASONIC WEIR FLOW SENSOR

The Chlorine Detention Tank Ultrasonic Weir Flow Sensor is a Vega 61 Ultrasonic. When used in the correct way, no special maintenance is required in normal operation. It is recommended to keep the unit clean by wiping external surfaces with a damp cloth, mild detergents can be used if necessary.

8.8 INLET BOX PENSTOCK VALVE

F35 Penstock Gate Valve

- Penstocks in frequent use require the stem and nut to be cleaned and re-greased at least on a monthly basis. It is recommended that the old grease be cleaned off before new grease is applied. Any debris should be cleaned from the threads before re-greasing. Failure to provide consistent adequate clean lubrication will result in accelerated wear of the drive nut threads.

- Penstocks in frequent use are inherently subject to a greater wear rate on the nut threads and this should be inspected at a minimum of 3 monthly intervals. When the wear becomes excessive the nut should be replaced. A quick check is to examine the amount of backlash in the threads by rotating the hand wheel back and forth noting the angle of engagement from one direction to the other.

- Penstocks in occasional use should have stems cleaned and re-greased at 6 monthly intervals.

- It is recommended that penstocks be washed down and cleaned from grit and debris build up at 12 monthly intervals. This opportunity should also be used to inspect seals and other components for wear and damage and check bolt tension.

- Upon each inspection it is important to ensure that each penstock will open and close fully. Cycling the penstock through its full stroke should form part of the maintenance schedule.

- Infrequent use of a penstock can result in stiff operation. In this case all old grease must be removed with a suitable solvent and re-greased accordingly.

- Electric actuators, bevel and spur gearboxes should be maintained in accordance with the manufacturer's standard instructions.

- The recommended grease to lubricate stem threads and thrust bearings is Castrol EPL-2 grease or equivalent.

Rotork IQ Actuator

Rotork actuators are sealed units with actuator gearing located in an oil bath and are lubricated for life. No covers should be removed for routine maintenance or inspections.

Basic maintenance procedures include:

- Keep the actuator housing clean and free from dust and contaminants.
- Check actuator mounting fasteners are tight.
- Check the actuator housing for damage, missing or loose fasteners.
- Inspect for evidence of oil leaks.

8.9 RECYCLED WATER MAGFLOW METER

No special preventative maintenance is required to keep the flow meter in good working order.

The exterior of transmitters and sensor housings should be kept clean by wiping with a damp cloth and mild detergent if necessary.

The sealing gaskets between sensor flange mounts should be periodically visually inspected for any leaks. Gaskets should be replaced if any leaks are identified.

8.10 ROUTINE MAINTENANCE SCHEDULES

Item	Task	Frequency			
		D	W	M	Y
Entire System	Inspect for leaks	X			
	Check valve positions are correct		X		
	Check for loose fittings or mountings			X	
	Clean external surfaces			X	
	Check for signs of wear or damage			X	
Ammonia Analyser System	Clean inline strainer screens		X		
	Clean sample lines & collection vessel		X		
	Check reagent levels & expiry		X		
	Check cleaner & calibration standard		X		
	Replace reagents & calibrate			X	
	Rotate & lubricate hoses	Every 3 months			
	Clean photometer	Every 3 months			
Chlorine / pH Analyser System	Check calibration	X			
	Calibrate sensors		X		
	Clean sensors & replace electrolyte			X	
	Replace membrane caps	As required			
Sample Pumps	Check operation	X			
	Clean Foot Valves		X		
Dosing System	Check operation	X			
	Clean system		X		
	Calibrate dosing pump			X	
	Replace dosing pump wet end kit	Every 2 years			
	Replace PLV / PRV diaphragms	Every 2 years			
	Clean strainer screens			X	
	Clean calibration cylinder			X	
Penstock Valve	Clean, Inspect & Grease Stem	Every 3 months			
	Check for free operation	Every 3 months			

NOTE: *D = Daily* *W = Weekly* *M = Monthly* *Y = Yearly*

The above maintenance schedule is intended as a basic guide only and should not be relied upon as the sole maintenance schedule. Further detailed maintenance schedules for specific components can be found in section 12 Appendices – Manufacturer's Operations and Maintenance Manuals.

9 FAULTS AND ALARMS

The following list of fault alarms should be checked for on a daily basis and any alarms current at the time inspection should be documented.

Fault Alarm	Cause	Remedy
CDT Dosing Pump #1 Fault	Refer to pump interface	Refer to pump manual
CDT Dosing Pump #2 Fault	Refer to pump interface	Refer to pump manual
RCW Dosing Pump #1 Fault	Refer to pump interface	Refer to pump manual
RCW Dosing Pump #2 Fault	Refer to pump interface	Refer to pump manual
Dosing Pump Fault General	Refer to pump interface	Refer to pump manual
Dosing Pump Warning	Refer to pump interface	Refer to pump manual
CCT Dosing Flow Switch Fault	No flow at flow switch	Rectify no flow cause
	Broken cable	Replace cable
RCW Dosing Flow Switch Fault	No flow at flow switch	Rectify no flow cause
	Broken cable	Replace cable
Ammonia Analyser Fault	Instrument Failure	Consult E&H
Ammonia Sample Flow Switch Fault	No flow at flow switch	Rectify no flow cause
	Broken cable	Replace cable
CDT Sample Flow Switch Fault	No flow at flow switch	Rectify no flow cause
	Broken cable	Replace cable
RCW Sample Flow Switch Fault	No flow at flow switch	Rectify no flow cause
	Broken cable	Replace cable
CDT Low Total Chlorine Alarm	Total chlorine in CDT <4.3	Raise chlorine level
CDT High Total Chlorine Alarm	Total chlorine in CDT >9.9	Lower chlorine level
CDT Total Chlorine Analyser Fault	Instrument Failure	Consult E&H
CDT Low Free Chlorine Alarm	Free chlorine in CDT <0.3	Raise chlorine level
CDT High Free Chlorine Alarm	Free chlorine in CDT >0.7	Lower chlorine level
CDT Free Chlorine Analyser Fault	Instrument Failure	Consult E&H
CDT High Conductivity Alarm	Conductivity in CDT >2500	N/A
RCW Low Total Chlorine Alarm	Total chlorine in RCW <5.0	Raise chlorine level
RCW High Total Chlorine Alarm	Total chlorine in RCW >9.9	Lower chlorine level
RCW Total Chlorine Analyser Fault	Instrument Failure	Consult E&H
RCW Low Free Chlorine Alarm	Free chlorine in RCW <0.3	Raise chlorine level
RCW High Free Chlorine Alarm	Free chlorine in RCW >0.7	Lower chlorine level
RCW Free Chlorine Analyser Fault	Instrument Failure	Consult E&H
Penstock Not In Remote Mode	Penstock in local or stop	Reset control switch
Penstock Gate Not Opening In Time	Penstock jammed or slow	Check for obstruction
Penstock Gate Not Closing In Time	Penstock jammed or slow	Check for obstruction
CDT Low Level Alarm	CDT level <RL103.1	Allow CDT to fill

CDT Ultrasonic Level Sensor Fault	Instrument Failure	Consult Vega
CDT Weir High Flow Alarm	Large inflow through plant	Manual dose
CDT Ultrasonic Weir Flow Sensor Fault	Instrument Failure	Consult Vega
RCW Flow Meter High Flow	RCW flow exceeding range	Check RCW flow rate
RCW Magflow Meter Fault	Instrument Failure	Consult E&H
Electrical or RTU Panel Door Open	Control or RTU panel open	Close door
Emergency Stop Alarm	Emergency stop engaged	Reset E Stop button
Circuit Breaker Q1 Tripped Alarm	Circuit breaker Q1 tripped	Reset circuit breaker
Circuit Breaker Q2 Tripped Alarm	Circuit breaker Q2 tripped	Reset circuit breaker
Circuit Breaker Q5Tripped Alarm	Circuit breaker Q11tripped	Reset circuit breaker
Circuit Breaker Q6 Tripped Alarm	Circuit breaker Q12 tripped	Reset circuit breaker
Surge Filter Activated	Power surge through circuit	N/A

10 RECOMMENDED SPARE PARTS

10.1 SODIUM HYPOCHLORITE DOSING SYSTEM

The following table contains a list of recommended spare parts to be kept on site for the Sodium Hypochlorite Dosing Pumps.

Manufacturer/Supplier	Part No.	Description	Qty
George Fischer	161305338	Suction Strainer Screen 0.8mm	2
Grundfos	97751572	Dosing Pump Repair Kit	2
Grundfos	95714466	Pressure Load Valve Repair Kit	1
Grundfos	95714466	Pressure Relief Valve Repair Kit	1

10.2 AMMONIA ANALYSER SYSTEM

The following table contains a list of recommended spare parts to be kept on site for the Ammonia Analyser System.

Manufacturer/Supplier	Part No.	Description	Qty
Endress + Hauser	CAV740-2B	Maintenance Kit	1
Endress + Hauser	CAY140-V10AAH	Reagent Set AM1 + AM2	1
Endress + Hauser	CAY141-V10AAE	Cleaner 1 litre	1
Endress + Hauser	CAY142-V10C50AAE	Standard Solution 50mg/L	
Convergent Water Controls	RV BOWL-3/4-T	Transparent Filter Bowl	1
Convergent Water Controls	RV GASKET-3/4-E	Filter Gasket EPDM	1
Convergent Water Controls	RV SCREEN-3/4-20	Screen 20 mesh - 915 micron	1

10.3 CHLORINE ANALYSER SYSTEMS

Manufacturer/Supplier	Part No.	Description	Qty
Endress + Hauser	51517284	Total Chlorine Sensor Service Kit	1
Endress + Hauser	50005255	Free Chlorine Sensor Membrane	1
Endress + Hauser	50005256	Free Chlorine Sensor Electrolyte	1
Endress + Hauser	51506973	Polishing Sheets	1
Convergent Water Controls	RV BOWL-3/4-T	Transparent Filter Bowl	2
Convergent Water Controls	RV GASKET-3/4-E	Filter Gasket EPDM	2
Convergent Water Controls	RV SCREEN-3/4-20	Screen 20 mesh - 915 micron	2

Due to the limited storage life span of chlorine sensors it is not recommended to hold any spares.

11 DAILY READINGS

Daily readings of the following parameters should be taken.

- Plant Effluent Flow
- Ammonia Concentration
- Primary Sodium Hypochlorite Dose Rate
- Secondary Sodium Hypochlorite Dose Rate
- CDT Total Chlorine Concentration
- CDT Free Chlorine Concentration
- RCW Total Chlorine Concentration
- RCW Free Chlorine Concentration

All readings should be recorded and the data safely stored for future analysis.

A suggested layout for the record page can be seen in the following table:

Date	Flow LPS	Ammonia Mg/L	CDT Dose Mg/L	RCW Dose Mg/L	CDT Total Mg/L	CDT Free Mg/L	RCW Total Mg/L	RCW Free Mg/L

12 APPENDICES – MANUFACTURER'S OPERATION & MAINTENANCE MANUALS

12.1 MANUFACTURER'S MANUALS LISTING

Manual	Q-Pulse Link
Grundfos DDA Dosing Pump Operating Instructions	
Grundfos Pressure Loading Valve Operating Instructions	
Grundfos Pressure Relief Valve Operating Instructions	
Kelco CR20 Flow Switch Operating Instructions	
Kelco MF20 Flow Switch Operating Instructions	
Endress & Hauser CA71AM Ammonia Analyser Operating Instructions	
Endress & Hauser CCM253 Total Chlorine Analyser Operating Instructions	
Endress & Hauser CM442 / CM444 Free Chlorine Analyser Operating Instructions	
Endress & Hauser Promag 50 Magflow Meter Operating Instructions	
Vega 61 Ultrasonic Sensor Operating Instructions	
AWE Penstock Valve Operating Instructions	
Rotork Electric Actuator Operating Instructions	