LEADERS IN THERMAL ENGINEERING

ESS 85kW COOLING SKID

INSTALLATION, OPERATING AND MAINTENANCE MANUAL

CLIENT	ESS
SITE	Lund
GRE REFERENCE NUMBER	SO02839

DRAFT

DRAFT

DRAFT

DRAFT

DRAFT

DRAFT

85kW Cooling System

This cooling system has been designed and constructed so that the skid incorporates the pump, treatment and expansion sections together.

The overall system has been designed to minimise any specific danger areas. The following MUST be observed:

Keywords and Symbols

Please pay special attention to sections of text with these allocated symbols:

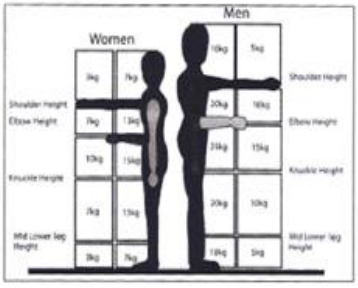
 **General symbol for:** **Danger!** **Caution!** **Attention!** **Important!**	 **Risk of Electrical Shock Hazard.**	 **Risk of Body Crush Hazard.**
 **Injury by rotating blades Hazard**	 **Lifting Hazard**	 **Body Crush / Tip over Hazard**

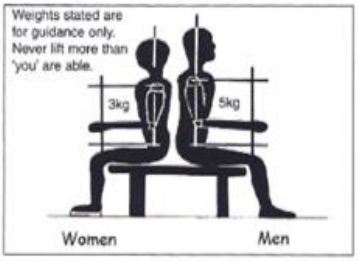
The SAFETY ADVICE section on the next page MUST BE READ before any work is attempted.

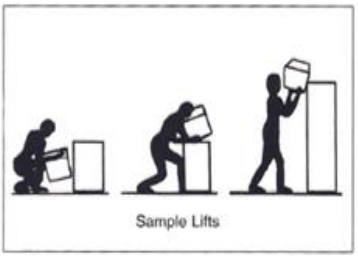
DO NOT operate this machine until this manual has been carefully read.

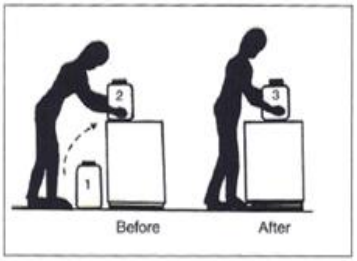
DRAFT

Lifting









Think before you:

Push – Pull – Lift – Carry

- Assess Weight, Balance, Shape, Environment, Travel, Distance
- Single OR Multi-lift
- Physical Ability
- Grip
- Read Packaging Labels
- Use the Lifting/Moving Equipment Provided
- Assistance of Others

STOP AND THINK

Plan the lift/handling activity. Where is the load going to be placed? Use appropriate handling aids where possible. Will help be needed with the load? Remove obstructions, such as discarded wrapping materials. For long lifts, such as from floor to shoulder height, consider resting the load mid-way on a table or bench to change grip.

ADOPT A STABLE POSITION

The feet should be apart with one leg slightly forward to maintain balance (alongside the load if it is on the ground). The worker should be prepared to move their feet during the lift to maintain a stable posture. Wearing over-tight clothing or unsuitable footwear may make this difficult.

ENSURE A GOOD HOLD ON THE LOAD

Where possible hug the load as close as possible to the body. This may be better than gripping it tightly only with the hands.

KEEP THE LOAD CLOSE TO THE WAIST

Keep the load close to the waist for as long as possible while lifting. The distance of the load from the spine at waist height is an important factor in the overall load on the spine and back muscles. Keep the heaviest side of the load next to the body. If a close approach to the load is not possible, try to slide it towards the body before attempting to lift it.

MODERATE FLEXION (SLIGHT BENDING) OF THE BACK, HIPS AND KNEES AT THE START OF THE lift is preferable to either fully flexing the back (stooping) or fully flexing the hips and knees (full/deep squatting).

DON'T FLEX ANY FURTHER WHILE LIFTING

This can happen if the legs begin to straighten before starting to raise the load.

AVOID TWISTING THE BACK OR LEANING SIDEWAYS ESPECIALLY WHILE THE BACK IS BENT.

Keep shoulders level and facing in the same direction as the hips. Turning by moving the feet is better than twisting and lifting at the same time.

LIFT TO LIVE ANOTHER DAY

ALWAYS ATTAIN AND MAINTAIN THE CORRECT POSTURE AND GOOD HANDLING TECHNIQUE

Q) How do I know if there is a risk of injury?

A) It's a matter of judgement and applying the above guidance.

The Circulation Pumps

THE PUMPS ARE CONTROLLED BY REMOTE MEANS AND COULD START UP WITHOUT WARNING!

This vertical type of pump is close coupled and has an electrical connection box with a sealed lid and gasket fitted upon the motor.

- This connection box must always be mounted securely in its correct position.

This pump has a rotating fan blade at the rear, (top) end. Each pump is protected with a fitted guard designed to prevent damage to hands and keep out foreign objects.

- These must always be mounted secure in their correct position.
- The motor / pump must be electrically isolated and locked off at the local isolator before any work is attempted.
- These vertical pumps are heavy. Use the appropriate lifting equipment and take care when removing / replacing.

DRAFT

Electrical Wiring / Controls

All wiring has been installed within conduits or armoured cables. All controls are within a steel enclosure. Within this enclosure are terminal strips and wiring with mixed AC and DC voltages, some of which are at high levels. Only qualified engineers should work upon this equipment.

TREAT ALL WIRING WITH GREAT CARE. ELECTRIC SHOCK CAN KILL

Control of Substances Hazardous to Health (CoSHH)

There are no substances fitted or enclosed, which are directly hazardous to health, however disposal of equipment should be undertaken within the guidelines of the customers local authority.

It is essential that this manual is referred to and used for all aspects of safe; installation, operation and maintenance of the cooling system.

All applicable Material Data Sheets are located in the appendices

DRAFT

Standards and Regulations

Where applicable, standards and regulations referenced in this manual are 'as amended'. For example: The Work at Height Regulations 2005 (as amended).

Equivalent Swedish standards and regulations should be sourced and referred to the standards and regulations stated within this manual.

Standards and regulations referred to in the rest of this manual should be referenced back to this section for full document titles (listed below).

Relevant Standards and Regulations List:

Health and Safety at Work etc. Act 1974

The Manual Handling Operations Regulations 1992

The Work at Height Regulations 2005

Personal Protective Equipment at Work Regulations 1992

Control of Substances Hazardous to Health Regulations 2002

The Chemical (Hazard Information and Packaging for Supply) Regulations 2002

The Environmental Protection Act 1990

BS EN ISO 15614 – 2004 + A1:2008 - Specification and qualification of welding procedures for metallic materials. Welding procedure test

BS 7671:2008 - Requirements for electrical installations, IEE Wiring Regulations Seventeenth Edition

BS EN 60204-1:2006+A1:2009 – Safety of Machinery – Electrical equipment of machines, Part 1: General requirements

DRAFT

GRE Systems Products

EC DECLARATION OF CONFORMITY

Green Resource Engineering Ltd (GRE) hereby declare under our sole responsibility that the products identified in this declaration and to which this declaration relates are in conformity with essential health and safety requirements of the following directives:

PRESSURE EQUIPMENT DIRECTIVE 2014/68/EU (Notified Body 0037)

MACHINERY DIRECTIVE 2006/42/EC

LOW VOLTAGE DIRECTIVE 73/23/EEC as amended by 93/68/EEC

EMC DIRECTIVE 2004/108/EC

To comply with these directives appropriate national & harmonised standards have been applied.

DESCRIPTION ESS 85kW Cooling System

SERIAL NUMBER SO02839

TECHNICAL CONTACT

A Technical Construction File for this machinery is retained by GRE Limited.

Name: Mr. R Booth Signed:

Position: Managing Director

Being the responsible person appointed by the manufacturer established in the EC and employed by:

Green Resource Engineering Ltd
Highmount Court,
Willand.
Devon.
EX15 2FB

SPARES

A recommended spares list is included at the end of this manual. Please contact GRE Ltd using the contact details below for parts availability and ordering.

CONTACTS

For information regarding any other GRE product or service, please contact:

Address: Green Resource Engineering Ltd.
Highmount Court.
Willand.
Devon
EX15 2FB.

Telephone: +44 (0) 884 820422.

Email: info@gre-ltd.com

Website: www.gre-ltd.com

CONTINUITY STATEMENT

GRE Limited maintain all documents relating to its products to a high standard. At the time of issue, every effort is made to ensure that all information contained in this document is correct and not misleading in any way.

The development of GRE products is ongoing and as a result, the information contained in this document may change. It is recommended that if there is any doubt regarding the accuracy of information contained in this document, GRE should be

DRAFT

contacted at the above address. This document should not be reproduced, transmitted, recorded or scanned by any means mechanical, digital or electronic for the use by any parties other than the purchaser without the permission of GRE Ltd

WARRANTY

This equipment carries the GRE Ltd (The Company) warranty as stated within the conditions of sale.

COVERAGE

The Company hereby warrants subject to the Clauses 2, 3, 4 and 5 hereof that each new product or part manufactured by the Company and supplied under this Contract shall be free from defects in material and workmanship. The Company does not in any way guarantee or accept responsibility for any parts not of its own manufacture. If called upon to do so the Company will assign to the Buyer the benefit of any guarantee or warranty given by the manufacturer of any such part so far as the Company is able to do so.

The company's obligations under this warranty shall be limited, at the company's discretion, to repairing or replacing ex-works, or allowing credit for any part which under normal and proper use and maintenance proves to the Company's satisfaction to be defective in material and workmanship according to the following rule:

CONDITIONS

Warranty Terms:

Full Warranty means the supply of new replacement material in exchange for those defective parts and also a free supply of Labour to effect the repair on the Company's premises. Labour, travel or carriage costs involved in effecting such replacement or repairs shall be borne by the Buyer.

Material Warranty Only: The Company will supply a new replacement part for those that are defective and the Buyer will pay all other costs incurred in effecting the repair to the Buyers satisfaction.

LIABILITY

This Warranty Does Not Apply:

to second hand products supplied hereunder;

to damage to any product or part caused by frost, overloading, abuse, misuse, tampering, neglect or accident, or putting to use other than normally recommended by the Company;

to any product or parts, repairs, altered, or assembled by anyone other than the Company, its supplier or its appointed installation or service contractor which in the sole judgment of the Company affects the performance, stability or purpose for which it was manufactured;

to payment for removal or installation charges for chargeable or warranted parts;

to loss of produce or contents of the equipment, due to failure for any reason;

to components not manufactured by the Company;

for any claim in excess of the contract price.

This warranty is in lieu of all other warranties, express or implied, including any implied warranty of interchangeability or fitness for a particular purpose and in no event shall the Company be liable for consequential loss or special damages.

DRAFT

Foreword

This manual has been compiled to assist in the installation, commissioning, operation and maintenance of the complete cooling system and fitted equipment. This foreword chapter covers how the manual should be used, a brief outline of what it contains and provides an issue record page for tracking relevant changes to the manual.

Using this Manual

This manual is intended solely for the Green Resource Engineering (GRE) Cooling System.
The specific Sales Order Number identifies the GRE project:

SO02839

The introductory section explains the overall site setup, individual cooling system layouts and how the cooling system works. The installation section provides guidance on how to install each main component of the cooling system. Commissioning covers the correct equipment setup once the system has been completely installed. Operation provides full instructions on how to operate the machine. Maintenance includes information on maintaining / repairing / replacing items. The appendices contain the following: complete set of general arrangement (GA), flow diagrams and engineering drawings for this site and individual supplier manuals/documents.

DRAFT

Revision Control

Rev.	Description	Revised By	Issue Date
0	Not released	N/A	N/A
1	First Issue	NVM	01JUN18

Distribution is electronically and uncontrolled.

It is the responsibility of the reader to ensure that they have the most up-to-date revision of this manual

If in doubt, please contact GRE by email on info@gre-ltd.com

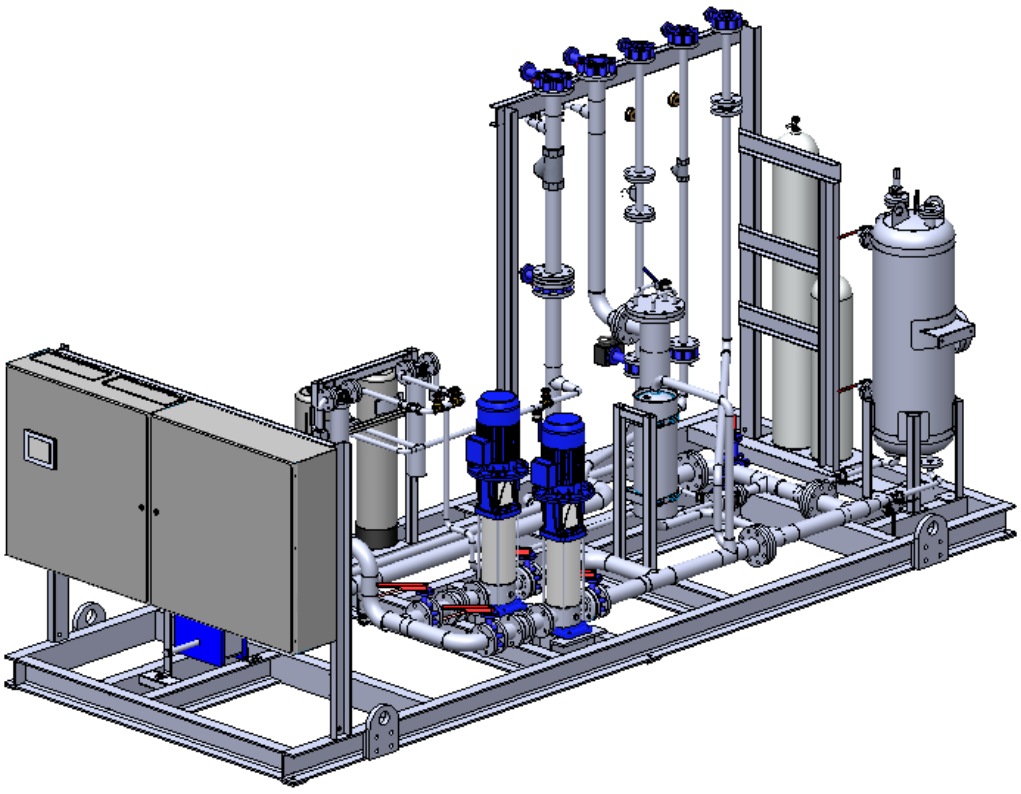
DRAFT

1. Introduction

This chapter addresses general information about the complete cooling system. This structure will help you to understand the various cooling system setups and where the cooling system is situated. The chapter will also help you to understand the fundamental principles of the cooling system and explain the basics of how the cooling system works.

1.1. Overall Site

This manual applies to an individual 85kW cooling system.



2. System Specification

2.1. Short form specification – 85kW System

Performance		
Nett Cooling Capacity at Rated Condition[1]	85	kW
Process Circuit		
Fluid	Deionised water, No Glycol	
Fluid conductivity Running Condition	<0.3	µS/cm
Fluid Conductivity Maximum (Trip) Condition	1	µS/cm
Process Inlet Temperature, Rated condition [1]	24.0	°C
Process Outlet Temperature, Rated condition [1]	20.0	°C
Process Fluid, Density at Rated condition [1]	998	kg/m³
Process Fluid, Specific heat capacity at Rated condition [1]	4.18	kJ/kgK
Design Flow Rate	305	LPM
Outlet pressure at Design Flow Rate	6.0	barg
Base Pressure, Nominal	1.0	barg
Maximum operating pressure	8.0	barg
Maximum test pressure	10.0	barg
Material, Pipework & Components	Stainless Steel, Low Carbon content, 304 / 316	
Water connections	2x DN80 Flanged to PN16	
	1x DN40 PN16 Flanged for make-up water	
Process circuit main components	Run/Standby End-suction centrifugal pumps	
	All stainless steel plate heat exchanger with EPDM gaskets	
	Deionisation sub-circuit	
	Degassing system	
	Isolation valves, water filters, Expansion vessel, fill loop	
Primary cooling water circuit		
Fluid	Water, Industrial cooling supply	
Inlet Temperature, Nominal	8	°C
Outlet Temperature, Nominal	12	°C
Design Flow Rate	305	LPM
Minimum operating pressure	1	barg
Maximum operating pressure	8	barg

DRAFT

Maximum test pressure	10	barg
Pressure drop at design flow rate	1.1	bar
Material, Pipework & Components	Stainless Steel 304/316L, EPDM Gasket material	
Water connections	2x DN80 PN16 Flanged	
Primary cooling circuit main components	Inlet Y-strainer, Isolating valves Flow / Temperature control valve	
Electrical		
Supply	Mains supply 400 / 3 / 50	
Maximum Running current	22.3	A
Max. Start Amps (without variable speed drive pump option)	152	A
Max. Start Amps (with variable speed drive pump option)	22.3	A
Pump motor Start	Three phase, DOL, option for inverter soft start	
Electrical Enclosure	All electrical components housed in a rugged weatherproof electrical cabinet	
Rating	IP55	
Controls		
Controller	Siemens S7-1500 colour, touch-screen HMI	
Instrumentation	Inlet and outlet water temperature/s on both circuits Inlet and outlet water pressure on process circuit Mechanical inlet / outlet pressure gauges Process circuit flow rate Process circuit conductivity	
Physical		
Construction	Powder-coated Steel Base Frame assembly Open-frame construction with access to all components All Low Carbon Stainless Steel Waterside pipework Colour RAL 9002 (framework) / RAL9002 (superstructure) - others available on request	
Dimensions	3000 (L) x 2000 (W) x 2400(H)	mm
Weight, Machine	2,200	kg
Weight, Operating	2,720	kg
Sound		
Sound Power Level	78	dB(A)
Sound Pressure @ 10m	46	dB(A)
Certification	CE	

DRAFT

3. Pre-Installation Preparation

The instructions provided under the pre-installation chapter are applicable to the skid

You must refer to these instructions for the correct installation and commissioning of each part of the cooling system.

The overall setting up of this equipment consists of three main stages;

Delivery of the equipment / unpacking

Installation

Commissioning

It is required to read these sections whilst carrying out the work in the order as listed above.

DRAFT

3.1. Health and Safety.

3.1.1. General Statement of Policy

It is the policy of GRE Limited to comply with the terms of the Health and Safety at Work etc. Act 1974: and subsequent legislation to provide and maintain a healthy and safe working environment. GRE Limited's Health and Safety objective is to minimize the number of instances of occupational accidents and illnesses and ultimately to achieve an accident-free workplace.

All employees will be provided with such equipment, information, training and supervision as is necessary to implement the policy and achieve the stated objective.

All employees will comply with Health and Safety requirements and undertake the necessary inductions relevant for third party sites working.

GRE Limited recognise and accept their duty to protect the Health and Safety of all employees visiting the site, including contractors and temporary workers, as well as any members of the public who might be affected by our operations.

While the management of GRE Limited will do all that is within its powers to ensure the Health and Safety of its employees, it is recognized that Health and Safety at work is the responsibility of each and every individual associated with the company. It is the duty of each employee to take reasonable care of their own and other people's welfare and to report any situation which may pose a threat to the wellbeing of any other person and to refer to the site safety coordinator in any instance.

The management of GRE Limited will provide every employee with the training necessary to carry out their tasks safely. if an employee is unsure how to perform a certain task or feels it would be dangerous to perform a specific job then it is the employee's duty to report this to their immediate supervisor**.**

An effective Health and Safety program requires continuous communication between workers at all levels. It is therefore every worker's responsibility to report immediately any situation which could jeopardize the well-being of themselves or any other person.

All incidents are to be reported to the GRE supervisor and ESS site safety officer. All injuries, however small, sustained by a person at work must be reported to the First Aider.

Accident records are crucial to the effective monitoring and revision of the policy and must therefore be accurate and comprehensive.

DRAFT

GRE Limited's Health and Safety policy will be continually monitored and updated, particularly when changes in the scale and nature of our operations occur. The policy will be updated at least every 12 months.

All employees should be aware of, respect and adhere to the rules and procedures contained in this policy statement, and the specific site safety arrangements described in the site induction.

All employees shall promptly report any unsafe practices or conditions to their supervisor and site coordinator if required.

Any person under the influence of alcohol or any other intoxicating drug which might impair skills or judgment, whether prescribed or otherwise, shall not be allowed to conduct their work, ESS can carry out spontaneous tests if suspicion arises in this nature.

Horseplay, practical joking or any other acts which might jeopardize the Health and Safety of any other person are forbidden.

Any person whose levels of alertness and/or ability are reduced due to illness or fatigue will not be allowed on site if this might jeopardize the health and safety of that person or any other person.

All waste materials must be disposed of carefully and in such a way that they do not constitute a hazard to other workers.

No employees should undertake a job which appears to be unsafe.

No employees should undertake a job until he or she has received adequate safety instruction and is authorized to carry out the task.

All injuries must be reported to the Director of Safety or a delegated representative appointed for site work.

Employees should take care to ensure that all protective guards and other safety devices are properly fitted and in good working order and shall immediately report any deficiencies to the supervisor.

Work shall be well planned and supervised to avoid injuries in the handling of materials and while using equipment.

No employees should use chemicals without the knowledge required to work with those chemicals safely.

DRAFT

Suitable clothing and footwear will be worn at all times. Personal protective equipment shall be worn wherever appropriate.

GRE Ltd are expected to attend safety meetings and "toolbox" talks dependent on site safety requirements.

3.1.2. Working Environment

Work areas must be kept clean and tidy.

Any spillages must be cleaned up immediately.

Waste materials and rubbish must not be allowed to accumulate.

All flammable waste materials must be discarded in sealed metal containers.

Other requirements will be set out in the site safety induction.

3.1.3. Work at Heights

Work at height will be undertaken in accordance with the Work at Height Regulations 2005.

Avoidance of risks from work at height:

Regulation 6 of the Work at Height Regulations 2005

(1) In identifying the measures required by this regulation, every employer shall take account of a risk assessment under regulation 3 of the Management Regulations.

(2) Every employer shall ensure that work is not carried out at height where it is reasonably practicable to carry out the work safely otherwise than at height. (3) Where work is carried out at height, every employer shall take suitable and sufficient measures to prevent, so far as is reasonably practicable, any person falling a distance liable to cause personal injury.

GRE Limited will:

- Organize and plan work at height, ensuring that it is properly planned, appropriately supervised and carried out in a safe manner;
- Make effective provision for emergencies and rescue in accordance with site safety;
- Assess weather conditions;

DRAFT

- Use competent persons;

In order to avoid risk from work at height, or prevent falls, or mitigate the consequences of a fall (using netting, airbags, fall arrest equipment, etc.)

GRE Limited will:

- Select suitable work equipment for work at height;

Use ladders only where justified for low-risk, short duration work (in conjunction with a management system for checking ladder integrity, managing stability, etc.) considering:

- Working conditions
- Distance to be negotiated
- Distance and consequences of a fall
- Duration and frequency of use
- Rescue
- Installation and removal risks

GRE Limited will:

- (Where work is carried out at height) take suitable and sufficient measures to prevent, so far as is reasonably practicable, any person falling a distance liable to cause personal injury.

DRAFT

3.1.4. Protection of the Environment

- We will endeavor to conduct our undertaking in such a way that adverse effects to the environment will be avoided or minimized so far, as reasonably practicable.
- Employees will be informed on all environmental aspects and issues as they affect our undertakings, and standard operating practices will be employed to control the pollution of the working and general environmental from noise, dust and hazardous substances.
- Due care and attention will be given to the protection of all waste courses from spillage and wastes arising from workplaces.
- All waste materials from site will be handled by registered waste carriers in accordance with the 'Duty of Care' Requirements contained in the environmental protection act.

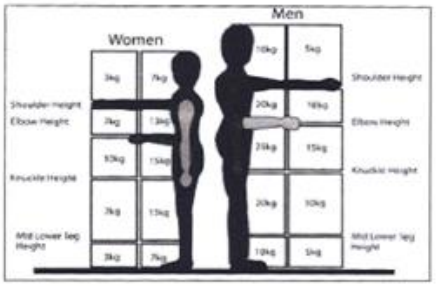
Any other requirements due to site safety must be adhered to and fully comprehended in the site safety inductions, and any other toolbox talks required by ESS or the site safety coordinator.

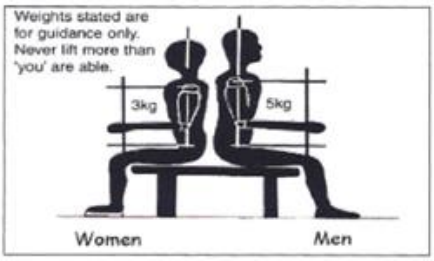
Emergency evacuation procedure shall be given in tool box talks during site safety inductions supplied by ESS safety coordinator.

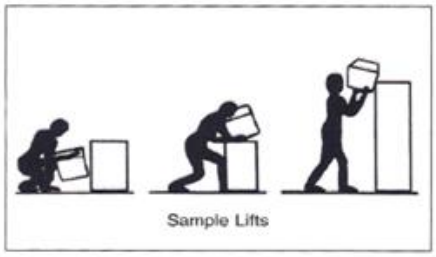
DRAFT

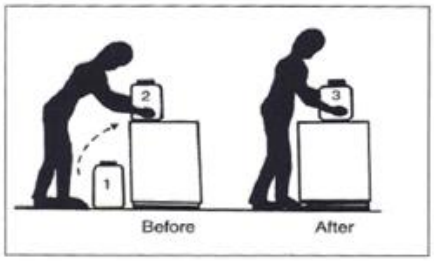
3.1.5. Manual Handling.

Where manual handling is required, refer to the following guidance.









LIFT TO LIVE ANOTHER DAY

ALWAYS ATTAIN AND MAINTAIN THE CORRECT POSTURE AND GOOD HANDLING TECHNIQUE

Think before you:

Push – Pull – Lift – Carry

- Assess Weight, Balance, Shape, Environment, Travel, Distance
- Single OR Multi-lift
- Physical Ability
- Grip
- Read Packaging Labels
- Use the Lifting/Moving Equipment Provided
- Assistance of Others

Q) How do I know if there is a risk of injury?

A) It's a matter of judgement and applying the above guidance.

3.2. Skill Set Matrices

All the work instructions detailed in any of the pre-installation, installation, commissioning or maintenance chapters must carried out in accordance to the guidance and standards set in this section.

3.2.1. General Labour Activities

All general labouring activities are to be carried out by a trained and competent person who has been site inducted with all relevant risk assessment, method statements, safe systems of work assessed and approved by site safety.

3.2.2. Assembly Work and Pipe Fitting

All assembly work and pipe fitting activities are to be carried out by a trained and competent person who has been site inducted with all relevant risk assessment, method statements, safe systems of work assessed and approved by site safety.

3.2.3. Welding

All welding is to be carried out by a trained and competent person who has been site inducted with all relevant risk assessment, method statements, safe systems of work assessed and approved by site safety (see section 8.3.3.1 Welding)

3.2.4. Electrical

All electrical work is to be carried out by a trained and competent person who has been site inducted with all relevant risk assessment, method statements, safe systems of work assessed and approved by site safety.

This work should be done to a minimal standard as set out in:

- BS 7671:2008 - Requirements for electrical installations, IEE Wiring Regulations Seventeenth Edition
- BS EN 60204-1:2006+A1:2009 – Safety of Machinery – Electrical equipment of machines, Part 1: General requirements

DRAFT

3.3. Pre-Installation

This section details the following:

- The necessary installation area preparations and requirements.
- How to unpack the complete cooling system properly.

Read the Health & Safety section (section 3.1) prior to undertaking any pre-installation or installation work.

3.3.1. Delivery of Skid

The client is to ensure that the skid is delivered to site and placed into an accessible position. It is the responsibility of the customer to ensure that the skid is safely placed at site.

3.3.2. Work Schedule

With the skid unloaded and ready to unpack, we recommend carrying out work in the following order:

- Prepare the installation areas – make sure they are ready for the units to be positioned
- Plan a transport route from the unpacking area to the installation areas
- Offload the containers and unpack the skid

DRAFT

3.3.3. Preparation of Installation Area

Before the unit are positioned into place, the installation areas must be of an acceptable condition and clear for receiving the skid.

3.3.4. Pipe Sets

Ensure that:

- There are no obstructions around any pipe run areas.
- The wall and floor material is of a suitable type, allowing for ease of fixing or mounting the pipe clamps, mounts and pipe sets.

3.3.5. Transport Routes

Please read this section before unpacking any of the skid

It is important at this stage to check and assess the transport routes from the unpacking area to the main installation area.

There must be a clear route (free from obstructions) to the plant room (for the skids) with easy access through any doors (particularly for the skid room).

Any ramp, lift or crane equipment must be available on-site.

If necessary, discuss the complete procedure of moving the units (from the offloading point to the installation areas) with an on-site member of staff who will provide full site guidance on plant movement.

Now plan how to move the unit into its required installation areas before carrying out the work.

DRAFT

3.3.6. Offloading and Unpacking.

This section covers the requirements for offloading the skids, un-packing and inspecting the cooling system unit upon arrival to the site.

3.3.6.1. Tools Required

The required tools (as a minimum) for offloading and unpacking the skid:

- Wheeled skates with handles.
- 2 x toe jack
- Step ladders or low platforms to aid un-carting

3.3.6.2. Personal Protective Clothing

A full set will be required for each engineer.

3.3.7. Unpacking the Skid Schedule

At this stage the skid will be offloaded.

1. First, check that all packaging is intact and there is no obvious damage to the skid.
2. Unwrap skid.
3. Cross check all parts unpacked with the relevant packing lists and inventories.
4. Inspect for any damage or irregularities and immediately move all indoor items to the plant room (or to a safe and clean indoor storage area).

Unpacking Procedure:

Apply the following procedure to remove the base of the skid:

WARNING! When the timber sheets are removed nails and sharp splinters will be evident. It is ESSENTIAL that as the sections are removed each piece MUST be taken immediately to a safe scrap storage area. This will minimise the risk of personal injury from nails or splinters.

3.3.8. Inspections

At this stage the Pump Skid should be unpacked and fully exposed.

DRAFT

Check all the units, pipe sets and spares thoroughly for any signs of damage including; dents, corrosion, cracks etc.

If any damage is noticed at any stage, contact GRE for advice

It is essential that during storage:

All the equipment is kept absolutely clean during storage.

Do not allow any contamination of the pipe interiors by debris or wildlife.

DRAFT

4. Installation

This chapter covers the positioning and securing of each cooling system unit including the interconnecting pipe sets and cables.

At this stage, the unit will have been unpacked, accounted for and inspected. Therefore, all equipment ready to position and install.

You will require a full set of engineering drawings to carry out this work. A full drawing package will be available from the GRE.

4.1. Installation Work Schedule

Installation work should be carried out in the following order:

- Position and Secure the Pump Skid Unit.
- Install all Cable Trays and Wiring.

Before starting any work ensure the safety advice in the Pre-Installation, Installation and Commissioning chapter has been read and fully understood.

4.2. Position the Pump Skid Unit

Procedure:

Using a forklift and the standoffs (x6) position the skid. Alternatively if there is a crane or lifting device then the lifting eyes provided may be used.

DRAFT

DRAFT

Ensure this unit is level so that all connecting pipe sets align up correctly.
Using drawing No M01887, mark the drill hole centres (the holes used to secure the pump skid unit) onto the floor of the plant room installation area using chalk etc.

DO NOT DRILL THE HOLES AT THIS STAGE! The holes will be drilled later. The marked positions will be used for positioning the pump skid unit initially.
Providing the floor surface is flat and clear, wheel the unit into its final site position, being careful to align the base frame with the marked positions. If it is not possible to position the unit using the skates, use a forklift truck to assist in pushing the pump skid unit into position or use a pulling device such as a Turfer to drag the unit into position.
The Pump Skid Unit should now be in position.

DRAFT

4.3. Secure the Pump Skid Unit

Reposition the unit (if required) so all pipe connection inlets and outlets are flush to the interconnecting pipework. This may involve slightly moving the units laterally (forward, backward or sideways) away from the original marked hole positions.

Using the final base frame hole positions, drill into the floor using an electric hammer drill. Drill the six holes using a long masonry bit. Drill each hole one at a time and to a depth suitable for the stud fitting.

Use an industrial vacuum to collect any drilling dust.

The Pump Skid Unit should now be in position and ready to secure.

DRAFT

5. Pre-Commissioning

The pre-commissioning phase is to be treated as part of the installation work. This section addresses all pre-commissioning procedures for the cooling system. Only proceed with this section after the cooling system has been fully installed.

Note: It is only after the pre-commissioning that the complete installation work can be signed-off and the cooling system commissioning work can commence.

5.1. Pre-Commissioning Inspections

The whole cooling system should now be inspected to ensure it has been installed correctly and is in a condition fit for use. Any faults or problems found at this stage must be dealt with before proceeding.

This section provides guidance on suitable mechanical and visual inspections to ensure that the cooling system is safe to energise and will not cause future failures.
The following preliminary checks apply to all units:
Electrically isolate the cooling system prior to carrying out the pre-commissioning work.

Make sure that all external isolators are in the off position.

Make sure that **ALL** isolation valves on the water circuits are closed.

Check all electrical connections for tightness, ensuring they are fully secure.

Now fill out the relevant tables starting on the next page when inspecting the cooling system.

DRAFT

5.2. Commissioning Checks - Pump Skid Unit.

The state of the pump unit should be 'as dispatched' and any damage noted and reported.

The following table will provide a simple check for signs of damage and provide confirmation that all supplies are connected.

Step	Action	**Confirm** (circle Yes / No)
1	Confirm ALL power supplies are connected and ON.	Yes / No
2	Check all power wiring to pumps and pump isolators.	Yes / No
3	Check all instruments for damage / pulled wiring.	Yes / No
4	Confirm all brackets are secure.	Yes / No
5	Confirm the unit is firmly bolted down.	Yes / No
7	Confirm that the de-ionisation cylinders are now connected to their hoses.	Yes / No
NOTES		

5.3. Filling the System

The system filling procedure is to be carried out according to GRE documents T00060.
It is preferable to use PURE CLEAN WATER ONLY for pre-commissioning testing as leaks may be encountered.

DRAFT

6. Commissioning

Prior to commencing commissioning, reconfirm that:

- All installation work has been completed.
- The site is completely clean and debris free.
- The relevant Sign-off section is signed by the customer.

Commissioning must be carried out by competent and suitably qualified personnel. It is suggested that only installers accredited by GRE Ltd carry out commissioning to ensure correct, efficient cooling system functionality and to retain the cooling system warranties.

COOLING SYSTEM TEST SPECIFICATIONS.

A comprehensive Factory Acceptance Test (documents T00060) will have been completed at the GRE factory in Devon, England.

The following drawings may be useful references whilst carrying out commissioning:

- P&ID Drawing - see drawing No M01811
- Unit GA - see drawing No M01887

WARNING!

Ensure that all site personnel are aware that this equipment will be operating intermittently

DRAFT

7. Description of Operation

It will be useful to follow P&ID drawings M01811 during this description.

7.1. Pump Skid Operation Description

7.1.1. Process Circuit

Two speed controlled pumps G101 and G102 are fitted to operate on a run and standby basis.

Water comes from valve Q101, through filter HQ101 to ensure no debris enters the system and causes issue to sensitive components. This filter is monitored by differential pressure transducer BP101 to create a warning if the filter starts to block. The system pressure, temperature and conductivity is measured here to ensure reliable control of the cooling.

The pipework then comes to an orifice plate R101 to restrict the flow slightly and force a bypass line through the expansion tank. The expansion tank is protected by a level transducer and a pressure relief valve to ensure correct operation.

There is an additional orifice plate between the expansion vessel and the pump inlet, again to restrict flow and direct it through the oxygen degassing vessel C102. On this line there is also a flow meter and isolation valves for maintenance. On a smaller line there is an oxygen sensor monitoring the oxygen before the degassing vessel.

Coolant at a positive pressure enters the body of the selected duty pumps and as the pump impellors of the selected pumps rotate to the required speed to achieve the design flow / pressure characteristic, the coolant's pressure is raised before escaping via each discharge port.

As it leaves each port the coolant passes through non-return valves RM102 and RM103. These valves will only allow flow in one direction and are fitted to eliminate any possibility of coolant re-cycling via the standby pump.

The coolant continues through isolation valves Q116 and Q118, pressure is visible locally and on the HMI by pressure transmitters KF105 and KF106 before entering the heat exchanger. This is where the cooling takes place with the water from the primary circuit cooling the water down

DRAFT

The process water then makes its way to the outlet valve Q129, again temperature and pressure measurements are taken as well as flow via orifice plate R104 and differential pressure transducer BP104.

7.1.2. DI Circuit

Before the process water exits the system, there is a bypass DI circuit where flow is balanced through a gate valve, through a pair DI bottles (C104 and C105). In this circuit the water passes through crystals in the bottle and then through a filter after each bottle to ensure no crystals enter the system. The flow of each branch is monitored via KF112 and KF113 and can be controlled via the gate valves Q122 and Q125, these valves are used to balance the flow. Finally the circuit joins back to the main circuit via a sight glass PG106 after the initial filter HQ101.

7.1.3. Primary Circuit

The primary circuit has temperature and pressure measurements on the inlet, similar to the process circuit. It has a filter HQ106 to protect the heat exchanger. On the outlet pipework there is a motorised valve to control the cooling flow. Again there are temperature and pressure devices monitoring the water as well as a flow transducer on the outlet.

7.1.4. Adding Coolant to the System.

The following is a descriptive circuit explanation.

Should the system indicate a low coolant level, (detected at the expansion skid), it is possible to add coolant safely in order to restore the coolant to a normal level. Premixed coolant would be either poured or pumped (IF pumped then all parts in contact with the coolant MUST BE non-ferrous) into the skid via Q112.

DRAFT

7.1.5. Nitrogen Gas Circuit

This system has four main functions:

1. To provide an oxygen absorbing blanket at the head of the expansion vessel should any entrained gasses be present in the coolant.
2. To strip oxygen from the process water in the degassing vessel
3. To allow for expansion and contraction of the circuit coolant within the expansion vessel.
4. To set the base pressure of the whole system, in order to give a positive value at the highest point in the overall system

A permanent nitrogen source will be provided on site. The gas is controlled via main pressure regulator Q108 and can be measured via KF104. There are then two additional pressure regulators, one for the expansion vessel and one for the degassing vessel. Both of these lines have check valves to ensure that the nitrogen only flows one way.

For the expansion vessel pressure regulator Q250 is used and can be isolated via Q109. Solenoid valve Q111 controls the flow. The nitrogen gas cap will be periodically vented to atmosphere via solenoid valve Q105. After venting the base pressure will be reset automatically.

The nitrogen feed to the degassing vessel is controlled via regulator Q251 and can be isolated via Q110. Solenoid valve Q107 controls the flow. The nitrogen flows through the degassing vessel and vents through a valve into the room. The flow rate needed for effective oxygen removal will be between 20-50Lpm. There is a flow meter (located on the circuit

NOTE THAT THE USE OF NITROGEN FOR THE DEGASSING VESSEL IS VENTED INTO THE ROOM.

OTHERS MUST ENSURE SUITABLE MEASURES ARE TAKEN TO ENSURE A SAFE WORKING ENVIRONMENT. THIS IS NOT THE RESPONSIBILITY OF GRE.

DRAFT

7.2. Electrical Supply System

All Electrical and controls hardware is housed in electrical enclosure located at the end of the skid.

7.2.1. Mains Supply

This section should be read in conjunction with the GRE electrical drawings as follows:

- E00143 - ESS SO02839 CWS01 85kW Cooling Skid

The incoming mains supplies is 400V / 3Ph / 50Hz.

The supply is fed to the main Isolator (Q1). The supply is monitored by a Phase Monitoring relay, which reports back the status of the supply to the main PLC.

Should the active mains supply fail, this will be detected by the phase monitoring relay, and an alarm will be raised.. In this event, the system does not stop, and cooling continues to be provided for approximately an hour on the battery backup system.

7.2.2. Mains Supply To Pumps

Each pump is fed via a dedicated isolator (one per pump). The mains is fed to a manual motor starter to protect against overcurrent, short-circuit or phase imbalance. From the manual motor starter, the mains enters the variable frequency drive. The output of the variable frequency drive is then wired to an isolator situated locally to the pump on the pump skid, and from there to the pump itself.

DRAFT

7.3. Controls Systems

7.3.1. Controls Infrastructure

The entire system is controlled by a Siemens S7-1500 PLC with a bank of IO to support the system requirements.

All controls devices are powered by the battery backed up low voltage DC supply.

There is a colour touch screen HMI for ease of navigation.

7.3.2. Availability and Inherent Redundancy

Redundancy has been designed in to the system. In the unlikely event that the Process Outlet sensors, pump or DI bottle fail, a backup with automatically be brought into operation and system monitoring will continue.

Component redundancy includes, but is not limited to:

- Process Pump
- Process Outlet instrumentation - Pressure, temperature,
- Deionizing resin-filled bottles

DRAFT

7.3.3. Interface Signals

The system is designed to interface with the master controller using hard-wired signals for basic commands, as well as profinet for a complete oversight.

The hard-wired signals are scheduled as follows:

Signals From Cooling equipment to Master Controller

State	Action	Description
K31A		
Rising edge pulse	Start	When this signal is received the cooling system will enter Run Mode
Falling edge pulse	Stop	When this signal is received the cooling system will enter Stop Mode
K32A		
Spare		

Signals to Cooling equipment from Master Controller

System Running	Contact Closed When Running	The system is in Run Mode
Enable Load	Contact Closed to Enable Load	The System is in Run Mode AND Flow has been established AND Flow Temperature is within acceptable limits AND Conductivity is within acceptable Limits
Alarm Present	Contact Closed for Alarm	There is an active or unacknowledged alarm on the system
Trip Present	Contact Closed for Trip	There is an active trip.
High Temperature Alarm	Contact Closed for Trip	

DRAFT

7.3.4. EPICS Comms

The Siemens S7 range has integrated profinet communications, which provides the interface for profinet communication back to the master. Communication is in both directions – instructions from the main plant controller to the GRE cooler main panel, and operating data back from the GRE cooler main panel to the main plant controller.

7.3.5. Functional Operation

7.3.5.1. Modes of Operation

The system control is fully automated and the system can be started by simply energising relay K31A (refer to electrical diagram).

The system will then start the pump with the fewer run hours, and the speed of the pump will modulate to achieve the desired parameter. There are two methods of pump speed control:

1. Outlet pressure setpoint
2. Flow rate setpoint

The desired method of control can be selected from the HMI on the Parameters >Process Page

From this point on, the system will run automatically, to control pressure / flow, temperature, conductivity, oxygen content all within stated parameters.

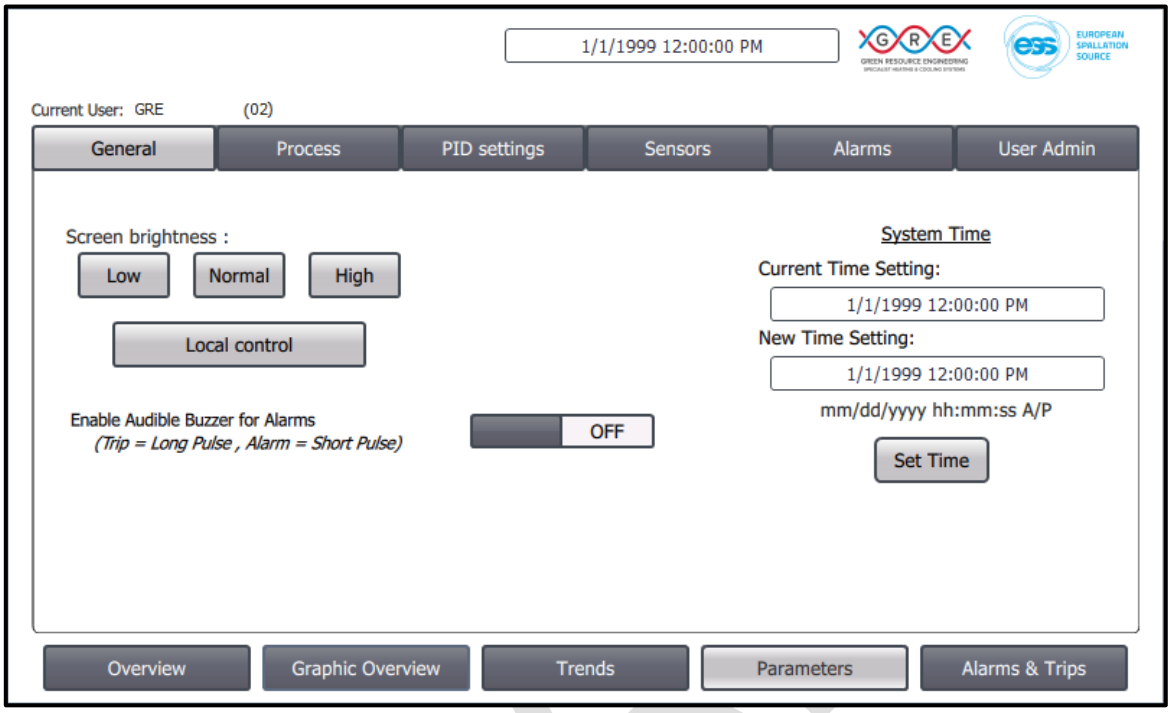
The system can also be controller in manual mode, though this should not be necessary once the system has been commissioned

MANUAL MODE SHOULD ONLY BE UNDERTAKEN BY AN EXPERIENCED OPERATOR AS IT CAN CAUSE DAMAGE TO THE SYSTEM IF USED INCORRECTLY

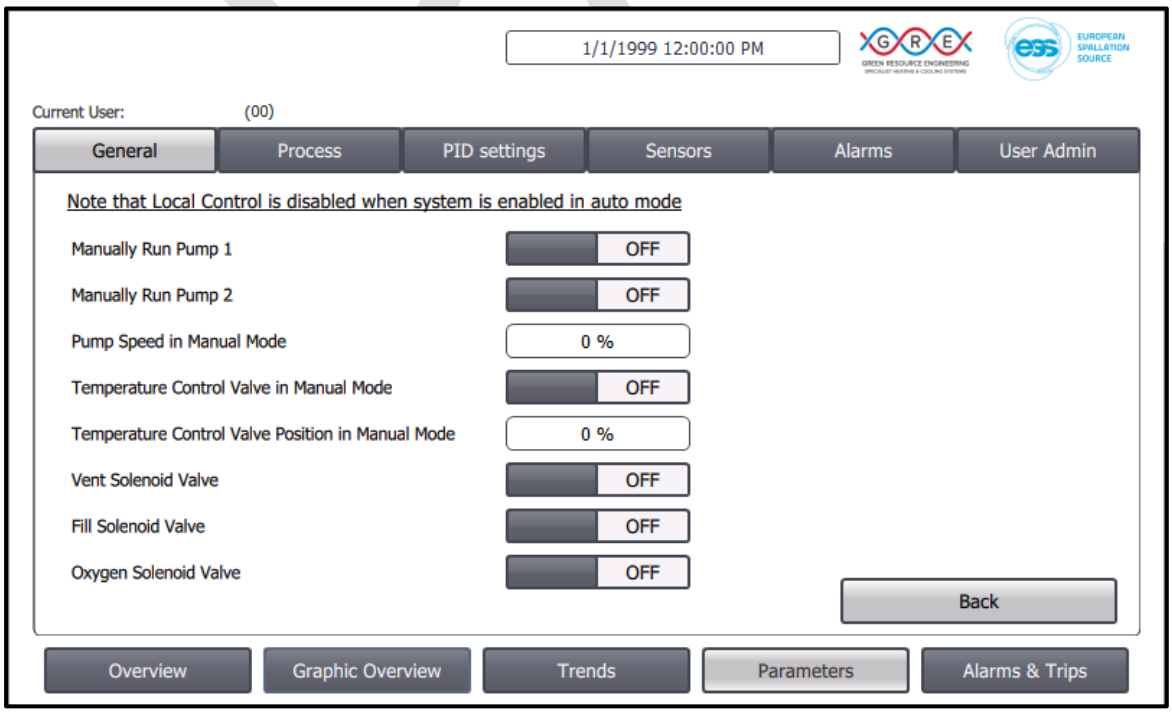
To use the system in manual mode it is necessary to log in. Contact GRE for the login details.

DRAFT

Once logged in you will see the below screen when you navigate to Parameters > General where there is an additional button called “Local control”



Once pressed it will bring up the following page where the pumps can be run in manual mode. This also allows the user to manually position the actuated and solenoid valves.

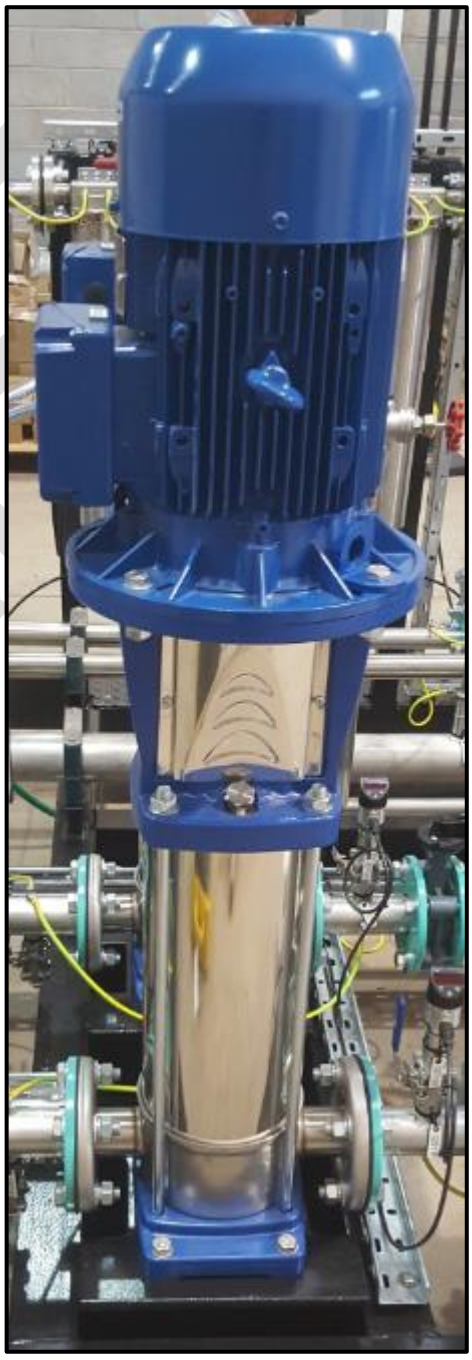


8. Component Specifications

8.1. Component Specification - Pumps

8.1.1. Main Circulation Pumps

Vertical, multistage, centrifugal in-line pumps in run/standby configuration.



Stainless steel (EN 1.4401) to all wetted parts, with hard-faced seals. The pump seals are constructed of an O-ring seal, a rotating Silicone carbide (SiC) face, a stationary SiC seat and a secondary EPDM seal. This has been selected specifically for its compatibility with ultra-pure deionised water.

The circulation pumps include non-return valves to prevent back-circulation through a non-operating pump. These pumps permit an automatic changeover from the operating pump/s to the standby pump/s in the event of a failure of the service pump or during timed pump changeover.

It is possible to isolate a failed pump using isolation valves for maintenance purposes while the remainder of the cooling system remains in operation.

Each pump has its own dedicated switchgear line, including to the variable frequency drive, therefore any failure of any component within the electrical supply to any pump does not affect the other pump/s.

The pump motors have been selected to take into account the highest viscosity of coolant possible, that being when the system is started at the coldest possible coolant temperature.

DRAFT

8.2. Component Specification - Water Treatment

8.2.1. Deionising Bottles and resin

A duo of deioniser resin bottles are provided to continuously purify the water. This accounts for reserve capacity, such that a bottle can be removed for maintenance at any time, without affecting the system's conductivity or flow rate.

Each bottle features a filter at the outlet, to catch any deionising resin that is "blown over".

Flow through each bottle is measured and displayed on the HMI,. This is used to balance the flow on commissioning, and also to provide indication of a blocked filter. Furthermore, this ensures that the correct amount of flow is sent through each deionising bottle in order achieve optimal purification from the resin.

Each bottle can be isolated, removed, replaced, and flushed independently of all others, and whilst the system is running.

A Gate valve is fitted in line with each bottle to allow the system flow to be balanced.

Mixed-bed nuclear grade deionising resin is used throughout the system, with no deviation.

Once the initial conductivity is lowered, it is expected that the cooling system is capable of operation for at least a year without replacing the resin.

DRAFT

8.2.2. Water Filtration

8.2.2.1. Main Pump Skid Filter

The skid features a full flow filter system at the inlet which filters the coolant before it enters the skid.

The filter media has a double mesh, with filtration capacity of 840 micron.

The filter is a serviceable part, and is fully cleanable. It is not anticipated that the filter will require maintenance once the system is clean and in regular operation. The intended functions of this filter is to allow installation debris to be collected and removed from the system during first fill

Isolation valves are provided before and after the filter, and drain and vent valves are provided on the filter side of all isolating valves. The system is designed such that the filter can be flushed with deionised water before re-entering into service.

The filter features a differential pressure transducer, to alert the user to potential blockage.

DRAFT

8.2.2.2. DI Filter

Fine filters are fitted at the outlet of each resin bottle in the deionising loop and at the outlet of the make-up deionising circuit. The filters have a mesh size of 25micron.

Flow meters are included on each deionising resin bottle circuit, to alert the user to potential blockage of this filter.

8.2.2.1. Y- Filter

Larger filters are fitted at the outlet of the process and the inlet of the primary. These strainers are fitted between two valves for isolation purposes during maintenance which reduces the need to drain the leg of pipework.

DRAFT

8.2.3. Degassing Vessel

The coolant is continuously treated to remove oxygen. This is achieved with a vertical gas separator with a membrane. The nitrogen sweeps in a counter current motion against the process flow.

The degassing vessel is located on a lower flow rate line and can be isolated for maintenance. It is also located at the lowest pressure point in the common suction pipework, that being mounted on the pump suction header on the pump skid.

A drain vent is fitted to the bottom of the vessel in order to expel the nitrogen and oxygen mixture.

.

DRAFT

The system is designed with a generously-sized integrated expansion capacity, to take up the variation in volume that results from the changing temperatures within the system. This is achieved by a Stainless Steel vessel.

8.2.4. Expansion Vessel

The vessel is sized to accommodate the entire system coolant volume being cooled/heated through the full temperature range specified for this system.

The vessel is equipped with a level indicator, with both visual indication and an analogue (4-20mA) output.

The expansion system is designed to maintain a minimum positive pressure at ANY point in the system to prevent cavitation. Typically, the lowest point-of-pressure in the system is the return line from ESS to the pump skid, and this is taken into account.

The expansion vessel has a maximum operating pressure of 2.5barg. A pressure relief device of suitable flow capacity is installed on the head of the vessel, and will vent the gas until the pressure is reduced in the event that the maximum operating pressure is exceeded.

The expansion vessel has been sized to ensure that the pressure relief device does not operate as part of normal system operation.

DRAFT

8.2.5. Nitrogen Gas Cap Maintenance

The pressure fluctuations that are inevitable in a water cooling system are taken up by a cap of inert gas in the expansion vessels.

Clean, pure (99.99%) Nitrogen gas (N2) is used for this purpose.

The Pressure in the N2 gas cap is controlled by the cooling system's PLC, to a value that is adjustable by parameter. This allows the user to set a base pressure which eliminates the risk of any cavitation, and at the same time prevent over-pressurisation of the system.

A further function of this gas cap is to remove the final trace gasses (Hydrogen and Oxygen) from the system. This is done by periodically venting the N2 gas cap for a specified time period (adjustable by parameter) and then refilling with virgin, pure N2 gas. This 'topping up' takes into account the fact that warm gas is vented and cool (20°C) gas is added, which will subsequently expand.

The filling and venting is achieved using solenoid valves.

The system is designed to minimise the use of N2 Gas whilst performing the required function.

The system is designed to accommodate the maximum possible coolant expansion as defined in the specification by the extremes of temperature range.

Periodically the gas cap contents are exhausted and replaced with fresh Nitrogen, this mode is Inactive unless the system is in Auto.

If the Cap pressure rises to a maximum limit, the vent valves will open from the parameters PP04 and PP05.

If the Cap pressure falls below the Low Set, the Fill Valve will open to raise the pressure set by parameters PP02 and PP03. The operation of the fill valve is compensated for the fact the warm Nitrogen is vented, and ambient-temperature nitrogen is filled.

DRAFT

8.2.6. Vessel Level Control

The level in the expansion vessel will naturally vary as the coolant is heated and cooled.

The expansion system is designed to accommodate this expansion across the entire temperature range in the specification **without** either:

- The low-level alarm occurring when the system cools (if the system is leak-free)
- A high-level alarm occurring when the system heats up
- The pressure-relief device on the expansion vessel gas cap blowing off

The expansion vessel level control has a number of key levels, defined as follows:

- High trip
- High alarm
- Low alarm
- Low trip

The level in the expansion vessels are all visible on the level indicator gauge, and on the HMI via the 4-20mA Output.

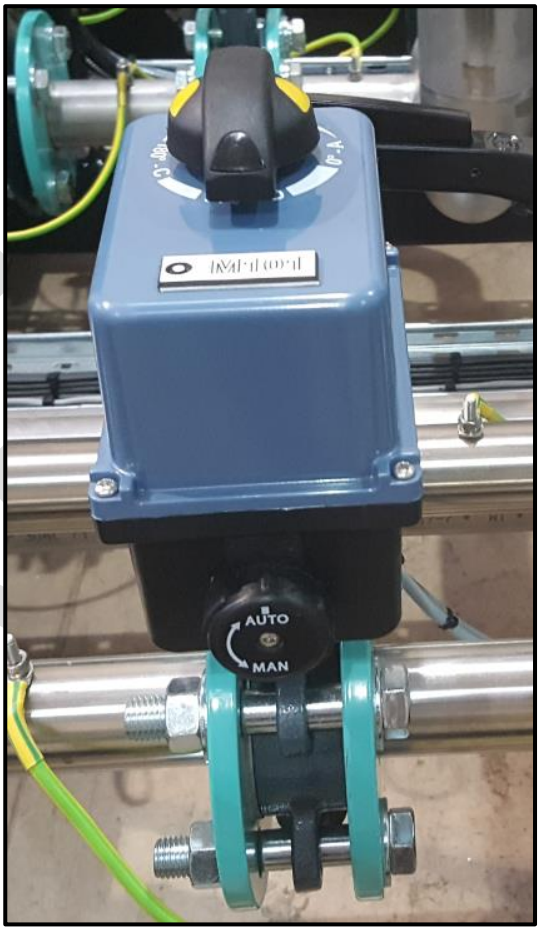
There is also a physical low level switch to offer final system protection.

DRAFT

8.3. Component Specification - Mechanical components

8.3.1. Valves

8.3.1.1. Actuated Valves - Butterfly Type



Cast iron body with EPDM liner and stainless steel (316) disc and stem. Lugged and tapped connection of flange bolts. Pressure rating PN16 or greater.

The valve body is powder-coated to offer resilient protection, and the indicator disc is stainless steel to eliminate the risk of corrosion.

Actuator is Burkert type 3003 mounted directly to the valve on a DN40/PN16 flange.

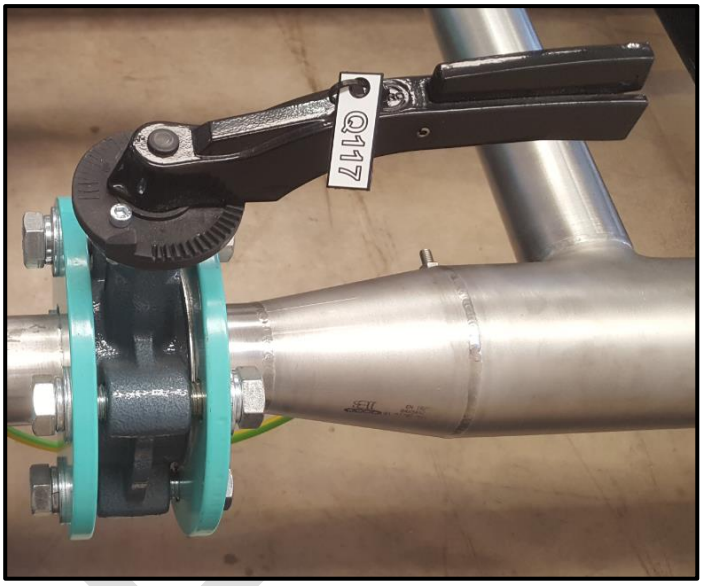
The actuator torque rating is selected to precisely match the requirements of the valve with at least 10% contingency.

The actuator has the following standard features:

- Direct mounting on quarter-turn valves
- Manual override as standard
- Corrosion resistant
- Adjustable limit switches
- 24VDC supply voltage throughout

DRAFT

8.3.1.2. Manual Isolating Valves - Butterfly Type



Cast iron body with EPDM liner and stainless steel (316) disc and stem. Lugged and tapped connection of flange bolts. Pressure rating PN16 or greater.

Valves DN80, DN50 & DN40 are level operated

All valves feature a positional indicator.

The valve body is powder-coated to offer resilient protection, and the indicator disc is stainless steel to eliminate the risk of corrosion.

8.3.1.3. Isolating Valves - Ball Type

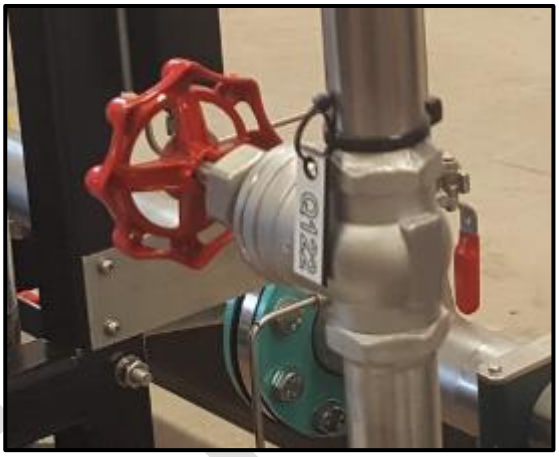
All are three-piece, Full Bore valves, suitable for welded connections. Stainless Steel CF8M Body, Ball & Stem with PEEK Seats & Seals.

.

DRAFT

8.3.1.4. Isolating Valves - Gate Type

Stainless Steel Body, Bonnet & Wedge. PEEK Seats and seals.
With non-rising stem and miniature handwheel operation.



These valves are used to set the differential resistance across a certain part of the circuit, and therefore are used to balance the flow across the system at critical points.

8.3.1.5. Pressure Relieving Valves

Stainless Steel Pressure 316L relief valve, with 1" BSP inlet and outlet connections.

Pre-set by the manufacture, calibrated and certified to suit the maximum working pressure of the expansion vessel.

Tolerance on the set pressure is ±3% or better.

Designed and manufactured in accordance with EN-4126-1 / 7 and EN-12516-1, and fully CE marked for PED compliance.

The setting is sealed with a crimped witness device to prevent tampering.

DRAFT

8.3.1.6. Solenoid Valves

Electrically-actuated solenoid valves are used to fill and vent (purge) the expansion vessel.

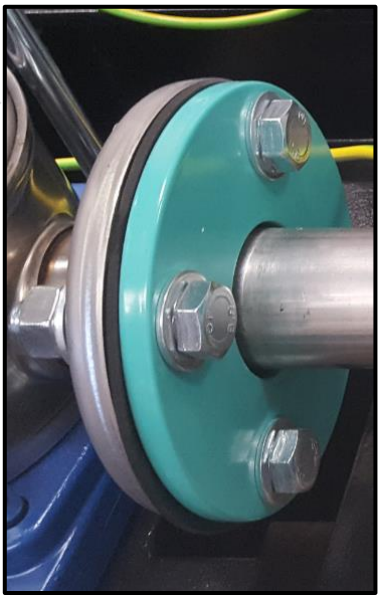
The valve bodies are Stainless Steel, 2-port with a process connection of 1/4" BSP female. The valves are normally closed, direct acting Solenoid Valves.

The valves are suitable for liquid and gas up to a maximum Pressure of 50bar within the temperature range 0°C to +130°C.

Opening time: 10ms / Closing time: 10ms.

The coils have an actuation voltage of 24VDC.

8.3.2. Flanges



Constructed from two parts - a pressed collar of Stainless Steel 304L (1.4307) and a backing ring of mild steel, powder coated to prevent corrosion. All flanged PN10 as a minimum.

8.3.2.1. Flange Gaskets

EPDM material with a thickness of 3mm. With bolt holes to match the pattern on the flange to hold the gasket in place.

8.3.2.2. Flange Fixings

All flanges are held tightly in place with Zinc-plated screws with a pair of flat washers either side of the flange, and nut, tightened to the specified torque.

All nuts and bolts are selected according to BS EN 1092-1:2002.

DRAFT

8.3.3. Pipework

All pipework is designed to cope with the maximum design pressure of the system, multiplied by 1.43. This defines the GRE test pressure.

The maximum design pressure of the system must be greater than or equal to the base pressure plus the dead-head pressure of the pump.

Pipework is clamped to the frame regularly, such that all mechanical load is borne by the frame and support structure, and not by the pipework.

8.3.3.1. Welding

GRE Specialised Welding Requirements

All pipework is fully welded to eliminate the risk of leaks. This includes all non-serviceable items.

All welding for deionised water systems is carried out under a full purge of inert gas (argon) and visually inspected after the joints are made. All external welds are electrostatically cleaned for a pleasing aesthetic finish.

The PED is the relevant legislation covering the entire fluid system and the applied standard to conform to the PED is EN378 in accordance with D. of C. 2017/68/EU

GRE can provide a PWPS (Preliminary welding procedure specification) in accordance with BS EN ISO 15614-1 to fully qualify a WPS specific for the requirements. This stipulates the materials of the project to be welded and identifies how this is carried out within the procedure. GRE's requirements for sub contract welders would be to this or an equivalent standard and evidence to be shown for the below:

- (WPQR) Weld Procedure Qualification Record
- Record of Weld Test
- Laboratory Report (Including photographs)
- Parent material Certificate
- Welding Consumables Certificate
- Welding Procedure Specification.

DRAFT

- NDT Reports

GRE's Technical welders are tested in accordance with clauses 6 and 7 of which our operator will undertake the procedure within test conditions to a satisfactory level according to EN ISO 9606 - 1 Or EN ISO 9606 - 4 or EN 1418 providing the relevant testing requirements are met. This is witnessed by the examining body that will test the sample and provide a certificate and report.

Sub-contractors would need to demonstrate certification to this level of standard and qualified against the weld procedure set in the above arrangement.

DRAFT

8.3.4. Air Vents / Drains

The system is designed with air vents and drains at all appropriate positions. Every major component can be isolated, and the coolant drained out locally, without the need to stop the system or disassemble pipework.

These points can also be used to refill the local system with deionised coolant after maintenance has taken place.

8.3.4.1. Automatic Air Vents

Fully stainless steel automatic air vent manufactured by Spirax Sarco.

Featuring an integrated check valve to prevent air ingress.

The body and cap are of austenitic stainless steel type 316L.

Automatic air vents are fitted to the top of the degassing vessel on the pump skid.

DRAFT

8.3.4.2. Manual Drain / Vent Points

Manual drain points are provided at all low points in the system, and adjacent to any device which can be isolated for maintenance. All drain points are a half-inch BSP ball valve. A hose-tail can be attached to the outlet of the valve if a hose is to be used to carry the drained coolant away, thus minimising spillage.

Manual vent points are provided at all high points in the system, and adjacent to any device which can be isolated for maintenance. All vent points are a half-inch BSP ball valve. A hose-tail can be attached to the outlet of the valve if a hose is to be used to carry the vented gas/coolant mixture away, thus minimising spillage.

All drain and vent valves can be locked in the closed position should this be required to prevent accidental draining of system coolant. All drains and vents have been plugged to ensure no debris collects in the valve therefore entering the system when used.

If a component is isolated for maintenance, the local drain valve is opened to allow the volume of coolant in that section to be drained, and the air vent is opened to assist this. Once the coolant is filled, the drain and vent valves are closed and the device can be put back into service by simply opening the isolating valves.

Refer to the P&ID drawing for the locations of these valves. Example can be seen on the heat exchanger.

DRAFT

8.4. Component Specification - Electrical & Controls

8.4.1. Electrical Enclosures

The main electrical enclosure houses all major mains and control components.

This includes, but is not limited to:

- Isolators
- Contactors
- Phase Monitoring Relays
- Manual Motor Starters
- Programmable Logic Controllers (PLC)
- Communication Modules
- HMI
- Distributed IO
- DC/DC Power Supplies
- Electronic circuit breakers

There are two cabinets, each measuring 100W x 600D x 1000H, mounted together on the skid. The two panels are connected together and open independently. In essence this gives two individual housings.

DRAFT

8.4.2. Programmable Logic Controller (PLC)

The entire system is controlled by a Siemens SIMATIC S7-1500 PLC.

The S7-1500 Advanced Controllers are custom designed for industrial applications and offer maximum performance, communication, flexibility, and technology functions.

It has industry-leading short reaction times, and a command processing time of up to 1 ns in the CPU. The PROFINET interface with deterministic time behaviour provides reproducibility and precision in the µs timeframe.

The inherent diagnostics functionality integrated into the SIMATIC S7-1500 system ensures that error messages are visualized identically as plain text information. The configuration and the diagnostic reporting channels are integrated into the system in a user-friendly manner. The trace function is supported on all CPUs. If a fault occurs, the corresponding channel can be quickly identified and precisely assigned. That reduces downtimes and increases availability of the cooling equipment.

The S7-1500 PLC features industry-leading security measures ranging from authorization stages and block protection to communication integrity. This helps to prevent tampering, and helps to ensure a high level of plant availability. The controller can detect modified engineering data or if data is being transmitted from an unauthorised source.

DRAFT

8.4.3. HMI

The system is supplied with a state-of-the-art, 9" graphical, colour, touch screen interface, with bespoke software to suit this project.

The HMI offers a bright, full colour display quality. The HMI is rated to IP65 degree of protection, and features high EMC and extreme vibration resistance.

The Siemens Simatic HMI is mounted in the front of the left enclosure.

The entire system can be reviewed from the HMI, with features including but not limited to:

- Monitor operation of the entire system in real time
- Operating status of all devices
- All pressure, temperature, flow, level, and conductivity values
- View all key system variables on a trend graph in real time, with adjustable time base
- Status of all alarms
- Review and modify control parameters (with the appropriate level of user access)
- Modify user administration rights (only available to authorised users)

Navigation through the HMI is via a toolbar of buttons which is permanently displayed on all screens. This enables the user to quickly and simply move from one section to another.

The HMI will also datalog all key system variables to a .csv file which is stored locally on a USB drive. At any time, the user can remove this USB drive and download the data for offline viewing on a software platform of their choice (e.g. MS Excel, Labview). Typically, the operating data for the previous seven days will be stored.

DRAFT

8.5. Instrumentation

8.5.1. General

GRE have provided high quality instrumentation, from well-known suppliers, throughout the system.

Some instrumentation on the Process Outlet is installed with a backup device, such that if a component fails, the system continues to operate and will raise an alarm to alert the user to the failed device.

Refer to the P&ID for circuit location of all instrumentation.

8.5.2. Conductivity Transmitter

The Conductivity/Resistivity Electrodes are manufactured by Georg Fischer, and feature an integral angle adjust adapter and the Mount Kit, with a transmitter and display directly mounted to the sensor.

The electrode material is Stainless Steel 316.

The electrode features a built-in dual-threaded PVDF insulator and process connections, which are injection over-moulded to minimize variance between electrodes.

The range of measurement is:

- 0.055 to 100 µS/cm
- 0.02 to 50 ppm
- 18.2 MΩcm to 10 KΩcm

The electrodes have a maximum response time of five seconds and are calibrated to meet ± 2% accuracy.

It is not possible to isolate the conductivity transmitters because this would introduce a huge risk factor should the system be operated and the conductivity meter isolated.

DRAFT

8.5.3. Oxygen Sensor

This device is housed in a manifold on a small leg to measure the oxygen content before the degassing vessel.

This value is displayed on an internal HMI on the inside of the electrical panel.

The sensor has an operating range of 0-10,000 ppb (µg/L) with an accuracy of ± 1% of reading or 1 ppb, whichever is greater.

8.5.4. Temperature transmitter

High-accuracy temperature transmitters manufactured by Pentronic with process connection 1/2" BSP are installed in a Stainless steel thermowell in the pipework. The measuring element is type PT 100.

DRAFT

8.5.5. Pressure transmitter

High-accuracy pressure transmitters manufactured by Wika with process connection 1/2" BSP are installed via an isolation valve for quick and simple maintenance. The measuring element is a ceramic-capacitive pressure measuring cell.

Measuring range is -1 to +9 barg.

Accuracy of the probe is ± 0.5% of span.

DRAFT

8.5.6. Flow transmitter

8.5.6.1. Main System Flow Transmitter

The main system flow is measured by an orifice plate that has been sized and selected to perfectly match the characteristics of the system.

The orifice plate is installed within a straight section of pipework.

The differential pressure across the orifice is measured by a Wika differential pressure transmitter.

The differential pressure transmitter is installed on a five-way manifold block.

This allows the differential pressure transmitter to be isolated for maintenance, vented, or equalised quickly and easily and without the need to dismantle pipework.

The differential pressure transmitter has a measuring range of 0 to 3 bar.

The value of the differential pressure is transmitted back to the main PLC via 4-20mA Analogue signal.

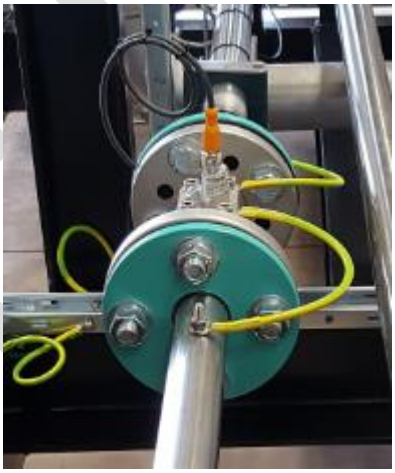
The differential pressure transmitter features an in-built display to show the raw differential pressure value.

DRAFT

8.5.6.2. Skid Flow Transmitter

The flow on each bottle of the skid is measured and displayed at the HMI.

This provides the following functionality:



- The flow can be perfectly balanced through each bottle
- The total flow through all bottles is summated within the main software and therefore can be used to set the flow through the treatment and expansion sub system
- A drop of flow through any single deionisation bottle (for example in the event that the filter blocks) will be visible and an alarm will be generated.

There is also a flow meter to report the flow rate of the primary circuit

DRAFT

8.5.7. Flow Sight Glass

A flow sight glass is provided on the treatment skid inlet to enable the user to ensure that there are no entrained air molecules within the system.

8.5.8. Differential pressure transmitter

The differential pressure across the main system filter is displayed on the transmitter, and on the main system HMI

The filter differential pressure transmitter is installed on a five-way manifold block for simple, quick and effective maintenance access.

The value of the differential pressure is transmitted back to the main PLC via 4-20mA Analogue signal (IO Link is not available on this device).

There is also differential pressure measured across the orifice plate to measure flow in a similar way.

DRAFT

8.5.9. Level Visual gauge and transmitter

The expansion vessel features a combined level visual gauge / level transmitter device.

These devices are used for continuous measurement, display, and monitoring of liquid levels.

These devices are mounted in bypass configuration, with isolating valves provided for maintenance purposes.

8.5.9.1. Expansion Vessel Visual Level Gauge

A float, with embedded circular magnets, is located in the bypass tube and follows the liquid level, transferring the level in a non-contacting manner to a series of red/white rollers. As the magnet passes, these are rotated in succession by 180° around their own axes and the visible side changes from white to red. The level in the expansion vessel is continuously displayed as a red column, even when the power fails.

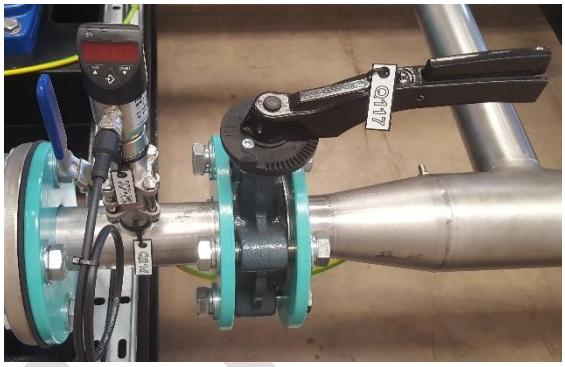
8.5.9.2. Expansion Vessel Level Transmitter

To provide transmission of the level back to the main PLC, a level transmitter is mounted outside the bypass tube. A continuous standard signal of 4-20 mA is sent back to the PLC. This expansion vessel level signal is then used (a) to display the level on the HMI and comms and (b) to generate the low/high expansion vessel warnings / trips.

DRAFT

8.6. Finishing

8.6.1. Tagging



All components are tagged with an engraved label to denote its identification symbol ('tag'). This tag is used throughout the system, on all drawings, within this manual, on the electrical schematic and on the software.

The tag is secured to each device with a non-removable tie.

8.6.2. Labelling

All live electrical enclosures are marked with a yellow/black warning label, stating the hazard and the voltage present.

8.6.3. Paint finish

Skid frames are powder coated to RAL9005 to provide a tough, durable finish.

Flanges are epoxy-coated to provide good protection against corrosion and damage.

Electrical enclosures are powder coated to RAL7035 and all weatherproof.

8.6.4. Pipework

All external welds are electrostatically cleaned for a pleasing aesthetic finish.

DRAFT

9. Equipment Operation (Control Functions)

The cooling equipment will be operated from the HMI screen situated on the electrical enclosure.

9.1. Introduction

The Unit features a custom-developed control platform, which incorporates:

- Siemens analogue PLCs
- Colour, touch-screen Human-Machine interface (HMI).
- Communication via Profinet to the master PLC
- Instrumentation and protection devices
- Display and monitoring of all system values and statuses

9.2. Alarms

The cooling equipment is protected by a series of alarms and trips. All alarm handling is carried out automatically within the PLC.

All alarms are displayed on the HMI, and all are transmitted to the upper controller via profinet.

9.2.1. Definition of an Alarm

An **Alarm** is a warning that there is a problem with the system or a device within it. An alarm will NOT stop the system from operating, such an alarm should be addressed at the earliest opportunity. When an alarm is present then the beacon on top of the electrical panel will show orange.

9.2.2. Definition of a Trip

A **Trip** a terminal fault that issues a trip command to the upper controller, and disables the signal to the ESS. A trip is effective immediately. When a trip is present then the beacon on top of the electrical panel will show red.

There are several conditions under which the system will trip as shown in the table below in.

DRAFT

9.2.3. Alarms List

The following pages provide information on the following:

- Alarm code
- Tag of device creating alarm
- Description of the alarm
- The method by which the alarm is reset
- The alarm tag is built as follows and is linked back to all parameters and times as explained in the control logic section later.

Alarm Code Example **AL 1 01**

AL	
1	Sensor Fault
2	Electrical Fault (e.g. overload, Phase Loss)
3	Process Alarm - Pressure
4	Process Alarm - Temperature
5	Process Alarm – Conductivity
6	Process Alarm – Flow
7	Process Alarm – Level
8	Other
9	Terminal Fault (ANY Cause)
01	Sequential number
XX	Sequential number

All alarm parameters follow the structure below:

Code	Description	
PPXXX	Pressure	Where XXX is the parameter value used throughout e.g. 601 is Process Low Flow Alarm and Y denotes the a or b which relates to the On or Off time of the device.
PTXXX	Temperature	
PFXXX	Flow	
PLXXX	Level	
PSXXXY	Time	
PAXXX	Alarm	
PCXXX	Conductivity	
POXXX	Other	

DRAFT

Alarm Code	Tag	Fault conditions to be manually simulated	Auto/ Manual Reset	Stop Pump	Disable Heat Load	Alarm or Trip
AL101	BP101	Process Circuit Inlet Filter - Differential Pressure Sensor Fault	Manual			Alarm
AL102	BP104	Process Circuit Outlet Flow Orifice - Differential Pressure Sensor Fault	Manual			Alarm
AL103	KF101	Process Circuit Inlet Pressure Sensor Fault	Manual			Alarm
AL104	KF102	Process Circuit Inlet Temperature Sensor Fault	Manual			Alarm
AL105	KF103	Expansion Vessel Level Sensor Fault	Manual			Alarm
AL106	KF104	Nitrogen Pressure Post Reg Sensor Fault	Manual			Alarm
AL107	KF105	Pump 1 Base Pressure Sensor Fault	Manual	G101 only		Alarm
AL108	KF106	Pump 2 Base Pressure Sensor Fault	Manual	G102 only		Alarm
AL109	KF107	Process Circuit Outlet Pressure #1 Sensor Fault	Manual			Alarm
AL110	KF108	Process Circuit Outlet Pressure #2 Sensor Fault	Manual			Alarm
AL111	KF109	Process Circuit Outlet Temperature #1 Sensor Fault	Manual			Alarm
AL112	KF110	Process Circuit Outlet Temperature #2 Sensor Fault	Manual			Alarm
AL113	KF111	Process Circuit Inlet Conductivity Sensor Fault	Manual		Disable	Trip
AL114	KF112	Treatment Circuit #1 Flow Sensor Fault	Manual			Alarm
AL115	KF113	Treatment Circuit #2 Flow Sensor Fault	Manual			Alarm
AL116	KF114	Primary Circuit Inlet Temperature Sensor Fault	Manual			Alarm
AL117	KF115	Primary Circuit Inlet Pressure Sensor Fault	Manual			Alarm
AL118	KF116	Primary Circuit Flow Sensor Fault	Manual			Alarm
AL119	KF117	Primary Circuit Outlet Temperature Sensor Fault	Manual			Alarm
AL120	KF118	Primary Circuit Outlet Pressure Sensor Fault	Manual			Alarm
AL121	M101	Actuated Valve Feedback Sensor Fault	Manual			Alarm
AL122	BQ101	Process Circuit Oxygen Content Sensor Fault	Manual		Disable	Trip
AL126	KF109/10	Temperature Transducer Discrepancy Fault	Manual			Alarm
AL127	KF107/8	Pressure Transducer Discrepancy Fault	Manual			Alarm
AL201	PRR1	Phase Fail	Manual		Disable	Trip

DRAFT

Alarm Code	Tag	Fault conditions to be manually simulated	Auto/ Manual Reset	Stop Pump	Disable Heat Load	Alarm or Trip
AL202	PSU1	DC Power Supply Fault	Manual			Alarm
AL203	VFD1	Pump 1 Inverter Fault	Manual			Alarm
AL204	F1	Pump 1 Overload	Manual			Alarm
AL205	TBC	Pump 1 Local Isolator Open	Auto after 5s			Alarm
AL206	VFD2	Pump 2 Inverter Fault	Manual			Alarm
AL207	F2	Pump 2 Overload	Manual			Alarm
AL208	TBC	Pump 2 Local Isolator Open	Auto after 5s			Alarm
AL301	KF101	Process Inlet Pressure Low Alarm	Auto after 15s			Alarm
AL302	KF101	Process Inlet Pressure Low Trip	Manual		Disable	Trip
AL303	KF101	Process Inlet Pressure High Alarm	Auto after 15s			Alarm
AL304	KF101	Process Inlet Pressure High Trip	Manual		Disable	Disable
AL305	KF107/8	Process Outlet Pressure Low Alarm	Auto after 15s			Alarm
AL306	KF107/8	Process Outlet Pressure Low Trip	Manual		Disable	Trip
AL307	KF107/8	Process Outlet Pressure High Alarm	Auto after 15s			Alarm
AL308	KF107/8	Process Outlet Pressure High Trip	Manual		Disable	Trip
AL309	KF115	Primary Inlet Pressure Low Alarm	Auto after 15s			Alarm
AL310	KF115	Primary Inlet Pressure Low Trip	Manual		Disable	Trip
AL311	KF115	Primary Inlet Pressure High Alarm	Auto after 15s			Alarm
AL312	KF115	Primary Inlet Pressure High Trip	Manual		Disable	Trip
AL313	KF118	Primary Outlet Pressure Low Alarm	Auto after 15s			Alarm
AL314	KF118	Primary Outlet Pressure Low Trip	Manual		Disable	Trip
AL315	KF118	Primary Outlet Pressure High Alarm	Auto after 15s			Alarm
AL316	KF118	Primary Outlet Pressure High Trip	Manual		Disable	Trip
AL317	KF105	Pump 1 Base Pressure Low Alarm	Auto after 15s			Alarm
AL318	KF105	Pump 1 Base Pressure Low Trip	Manual		Disable	Trip
AL319	KF106	Pump 2 Base Pressure Low Alarm	Auto after 15s			Alarm
AL320	KF106	Pump 2 Base Pressure Low Trip	Manual		Disable	Trip
AL321	KF104	Nitrogen Pressure Low Alarm	Auto after 15s			Alarm
AL322	KF104	Nitrogen Pressure Low Trip	Manual		Disable	Trip
AL323	KF104	Nitrogen Pressure High Alarm	Auto after 15s			Alarm
AL324	KF104	Nitrogen Pressure High Trip	Manual		Disable	Trip
AL325	KF104	Nitrogen Bottle 1 Low Pressure	Manual			Alarm
AL326	KF104	Nitrogen Bottle 2 Low Pressure	Manual			Alarm
AL401	KF102	Process Inlet Temperature Low Alarm	Auto after 15s			Alarm
AL402	KF102	Process Inlet Temperature Low Trip	Manual		Disable	Trip
AL403	KF102	Process Inlet Temperature High Alarm	Auto after 15s			Alarm
AL404	KF102	Process Inlet Temperature High Trip	Manual		Disable	Trip
AL405		Temperature Setpoint Discrepancy Alarm	Auto after 15s			Alarm
AL406	KF109/10	Process Outlet Temperature Low Alarm	Auto after 15s			Alarm
AL407	KF109/10	Process Outlet Temperature Low Trip	Manual		Disable	Trip

DRAFT

Alarm Code	Tag	Fault conditions to be manually simulated	Auto/ Manual Reset	Stop Pump	Disable Heat Load	Alarm or Trip
AL408	KF109/10	Process Outlet Temperature High Alarm	Auto after 15s			Alarm
AL409	KF109/10	Process Outlet Temperature High Trip	Manual		Disable	Trip
AL410	KF114	Primary Inlet Temperature Low Alarm	Auto after 15s			Alarm
AL411	KF114	Primary Inlet Temperature Low Trip	Manual		Disable	Trip
AL412	KF114	Primary Inlet Temperature High Alarm	Auto after 15s			Alarm
AL413	KF114	Primary Inlet Temperature High Trip	Manual		Disable	Trip
AL414	KF117	Primary Outlet Temperature Low Alarm	Auto after 15s			Alarm
AL415	KF117	Primary Outlet Temperature Low Trip	Manual		Disable	Trip
AL416	KF117	Primary Outlet Temperature High Alarm	Auto after 15s			Alarm
AL417	KF117	Primary Outlet Temperature High Trip	Manual		Disable	Trip
AL501	KF111	High Conductivity - High Alarm	Auto after 15s			Alarm
AL502	KF111	High Conductivity - High Trip	Manual		Disable	Trip
AL601	BP104	Process Flow Low Alarm	Auto after 15s			Alarm
AL602	BP104	Process Flow Low Trip	Manual		Disable	Trip
AL603	KF116	Primary Flow Low Alarm	Auto after 15s			Alarm
AL604	KF116	Primary Flow Low Trip	Manual		Disable	Trip
AL605	BP101	Process Filter Blockage Alarm	Auto after 15s			Alarm
AL606	BP101	Process Filter Blockage Trip	Manual		Disable	Trip
AL607	KF112	DI Bottle 1 Low Flow Alarm	Auto after 15s			Alarm
AL608	KF112	DI Bottle 1 Very Low Flow Alarm	Manual			Alarm
AL609	KF113	DI Bottle 2 Low Flow Alarm	Auto after 15s			Alarm
AL610	KF113	DI Bottle 2 Very Low Flow Alarm	Manual			Alarm
AL701	KF103	Expansion Vessel Low Alarm	Auto after 15s			Alarm
AL702	KF103	Expansion Vessel Low Trip	Manual		Disable	Trip
AL703	KF103	Expansion Vessel High Alarm	Auto after 15s			Alarm
AL704	KF103	Expansion Vessel High Trip	Manual		Disable	Trip
AL801	M101	Three way valve fault	Auto after 15s			Alarm
AL802	BQ101	Oxygen Concentration High Alarm	Auto after 15s			Alarm
AL803	BQ101	Oxygen Concentration High Trip	Manual		Disable	Trip
AL901		Both Pumps in Fault	Auto after 15s		Disable	Trip
AL902		Process Outlet Temperatures sensors KF109 & KF110 both in fault	Auto after 15s		Disable	Trip
AL903		Process Outlet Pressure sensors KF107 & KF108 both in fault	Auto after 15s		Disable	Trip
AL904		Both DI Bottles Fault	Auto after 15s		Disable	Trip

DRAFT

9.3. Parameters

All operating parameters can be viewed and modified from the parameters pages, which can be accessed by pressing the 'parameters' button at the bottom of any screen.

There are three levels of access (1) User (2) Engineer (3) Manufacturer

The user must be logged in at the correct level to access certain parameters – refer to the parameter lists on the following pages for access level required details.

There are some timing Parameters as detailed below that can only be set within the software:

Code	Title	Default Value	Units
PS01	Sensor Fault Delay On Time	5	secs
PS02	Pumps Stir Time Period	30	mins
PS03	Alarm Run Pumps – Run on Time	5	mins
PS04	System Enable Load Delay On Time	30	secs
PS07	Pump Changeover Time	100	msec

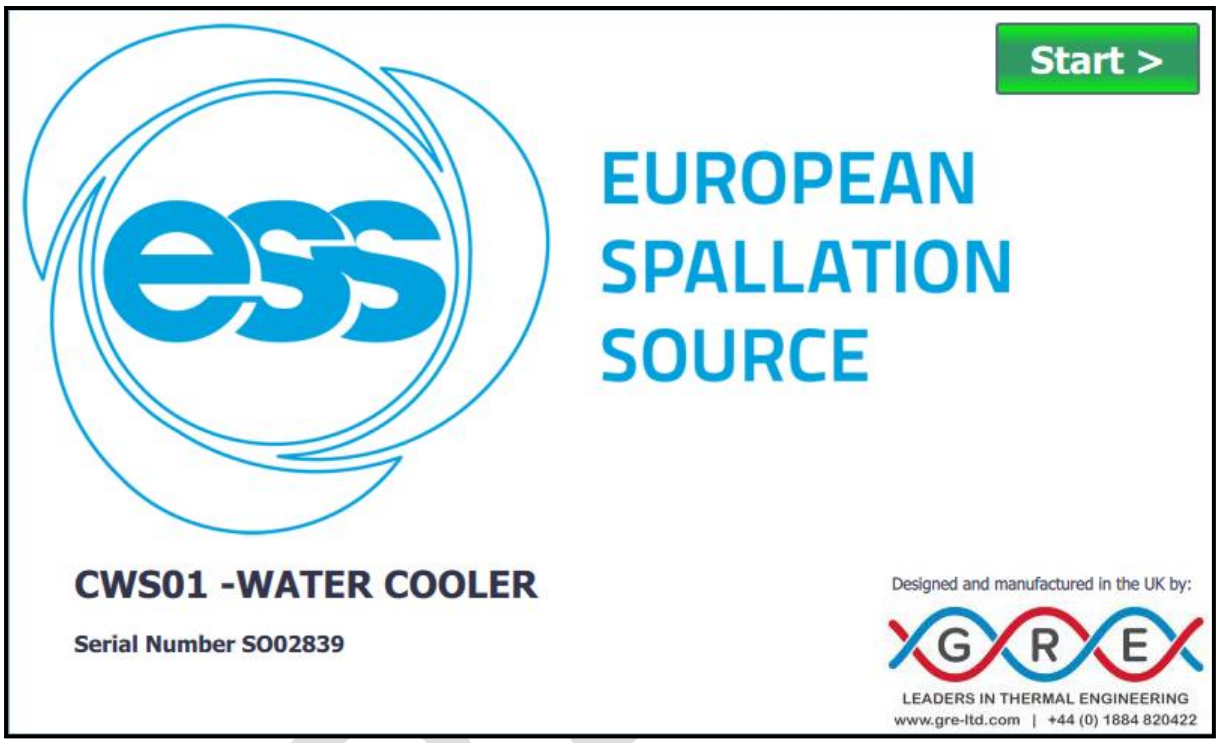
Process Parameter Default Values:

Code	Title	Default Value	Units
PP01	Pump Speed Setpoint - Outlet Pressure	5	Barg
PP02	N2 Base Pressure Setpoint	1	Barg
PP03	N2 Base Pressure Hysteresis	0.1	Bar
PP04	N2 High Pressure Vent ON	2	Barg
PP05	N2 High Pressure Vent Off	1.8	Barg
PF01	Pump Speed Setpoint - Flow	300	Lpm
PS08	Pump Run Hours Balance – Changeover Time	24	hours
PF04	Min Flow Enable Load	50	Lpm
PL01	Expansion Vessel Fill Level	50	%
PS05	Vent – Time Period between Vent	48	hours
PS06	Vent – Length of Vent Pulse	10	secs
PO804	Oxygen Concentration Setpoint On	50	ppb
PO805	Oxygen Concentration Setpoint Off	40	ppb
PT01	Outlet Temperature Setpoint	20	°C
PT02	Low Ambient Run Pump Setpoint	5	°C

DRAFT

9.4. Navigation

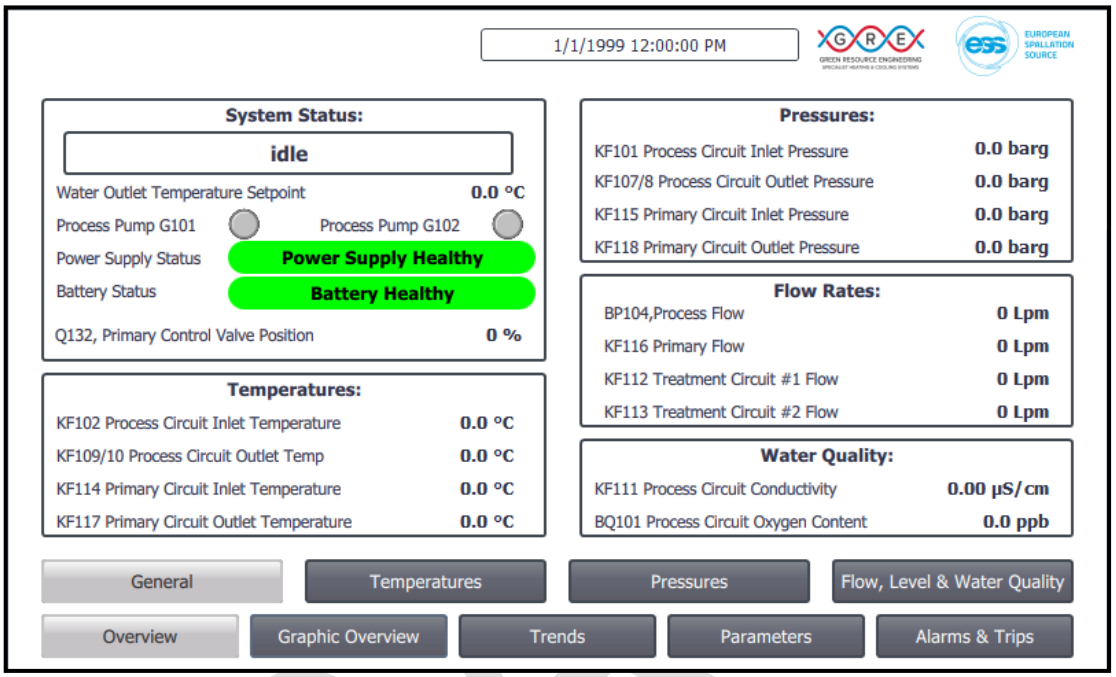
When first powered up, the system displays the splash screens. Press 'Start' to continue:



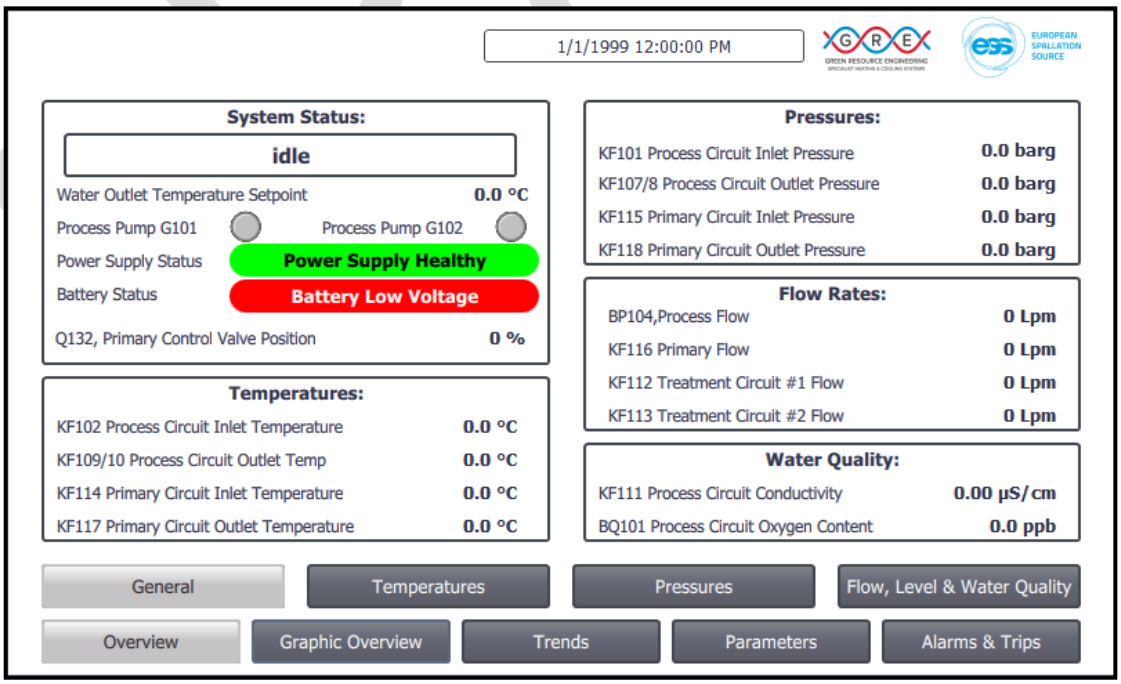
DRA

9.4.1. Home Screen

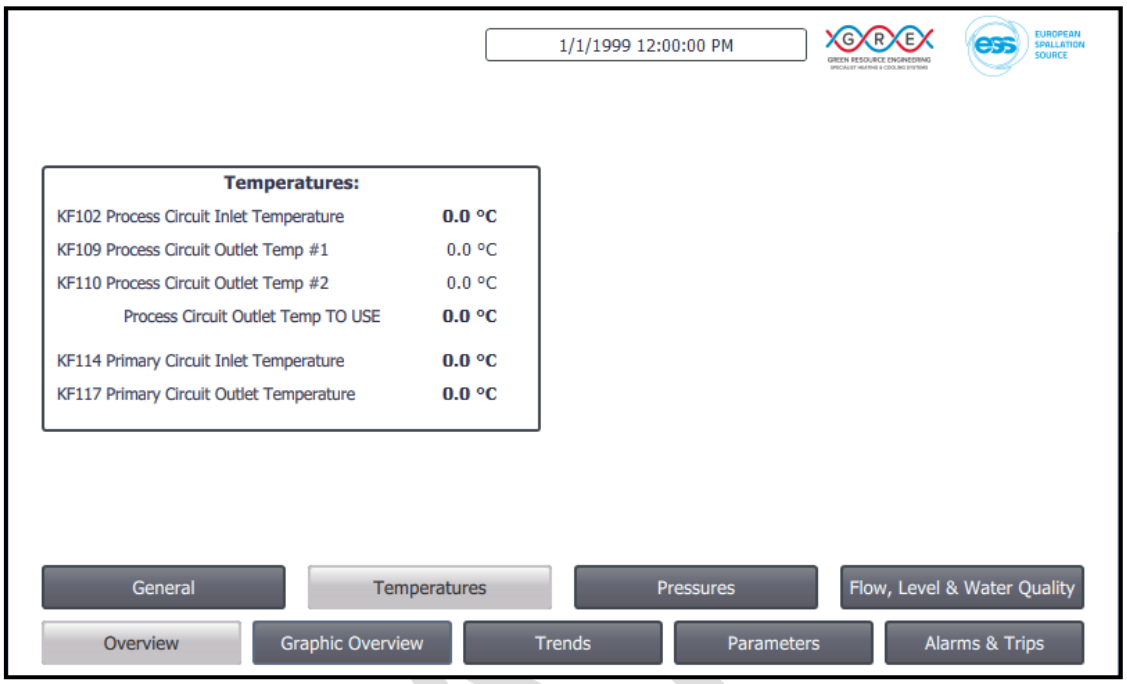
This displays all major operating values, and allows the user to view the overall status of the cooling equipment.



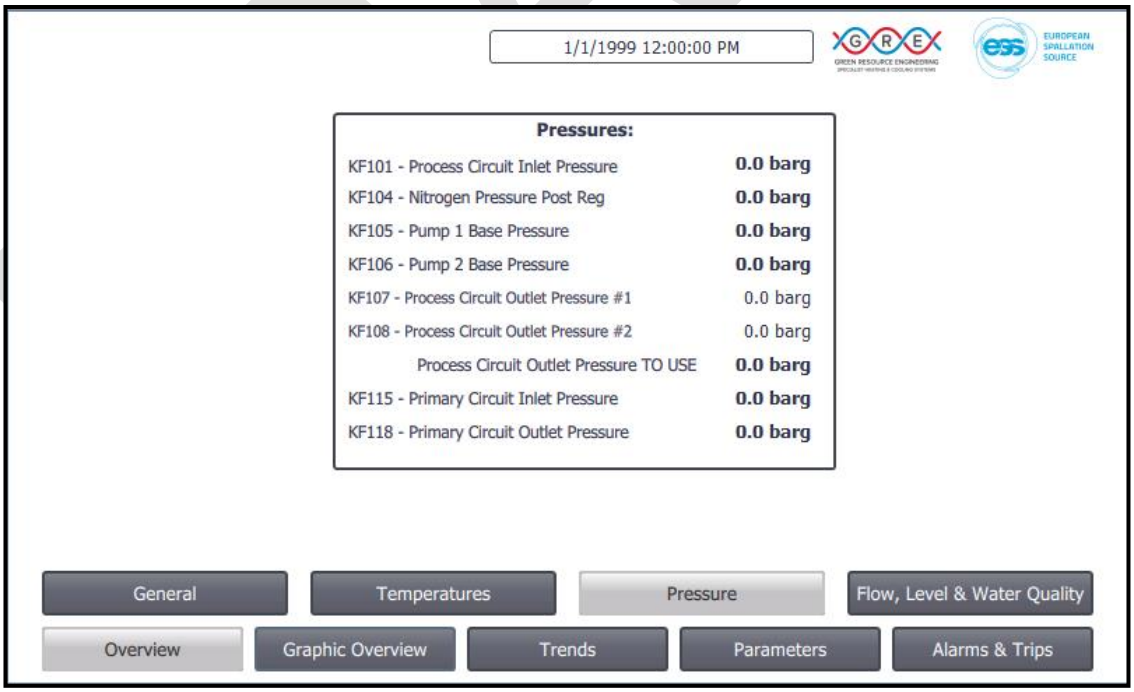
On initial start up the following fault will occur due to the battery not being charged. This will clear.



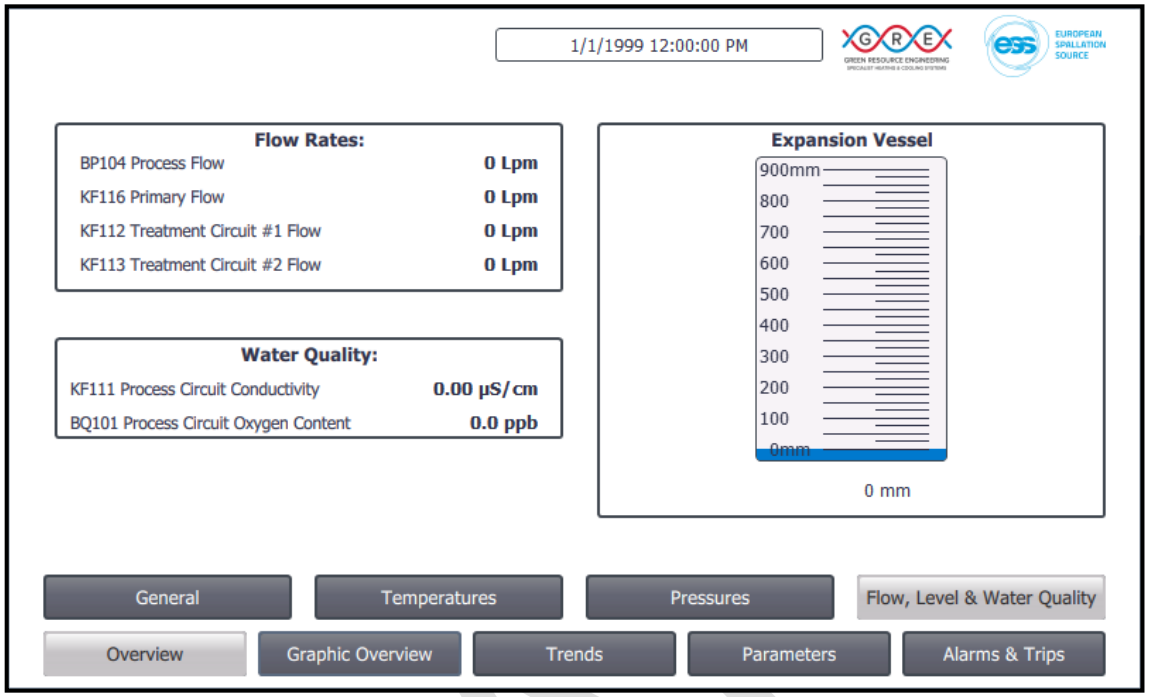
9.5. Overview - Temperatures



9.6. Overview - Pressures

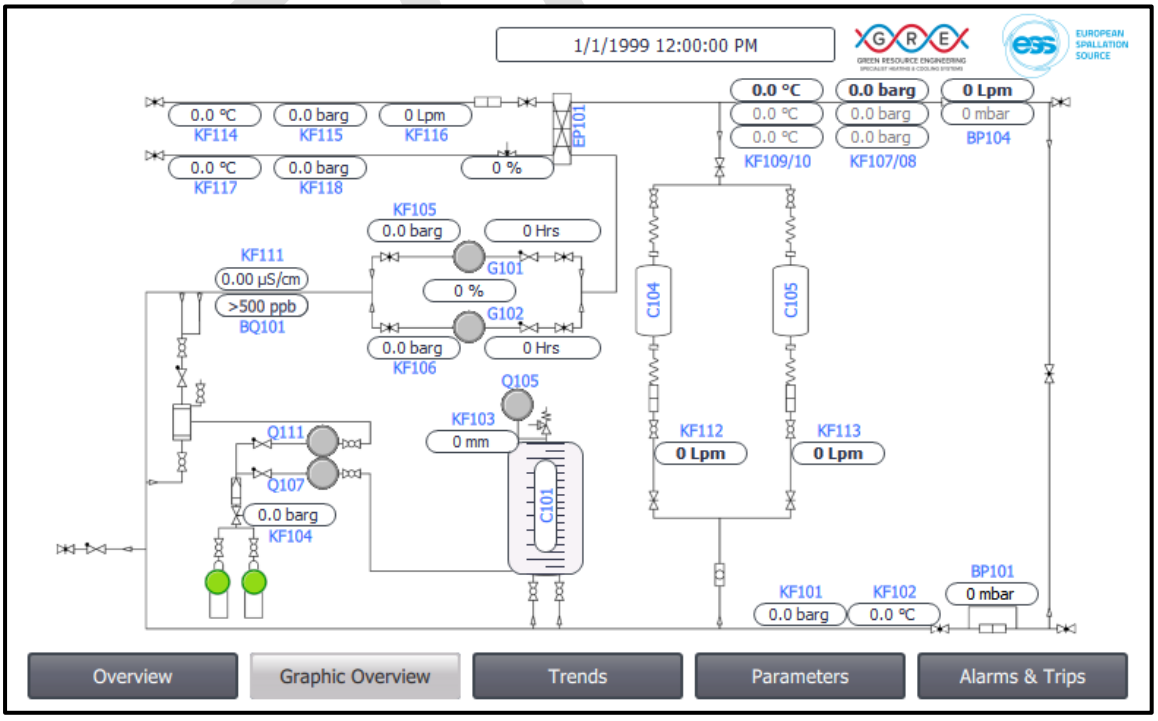


9.7. Overview - Flow, Level & Water Quality



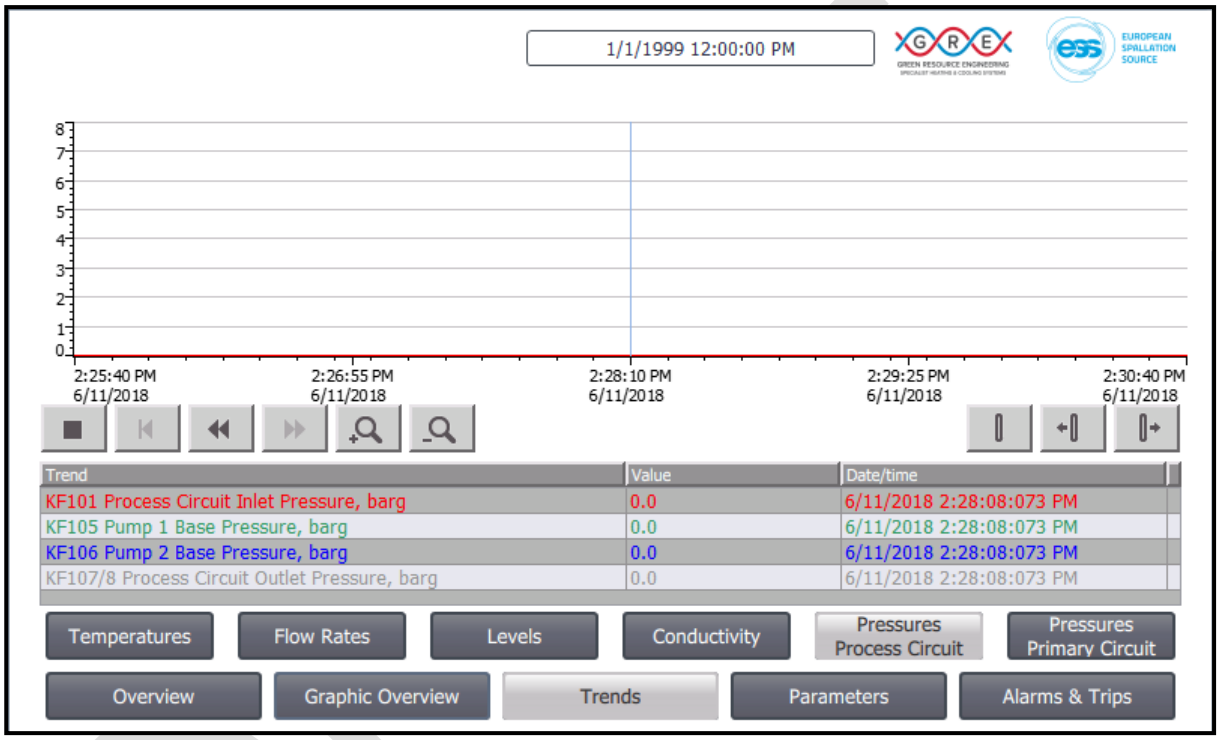
9.8. Graphic Overview

This displays live values of the system, this is based on the P&ID.



9.9. Trend Views

From here, the user can review the operation of major system parameters over time. The trend view allows the user to zoom in/out on the time scale, and also to examine spot point operation at a point in time. The trend views are separated into six pages: Temperature, Flow, Level, Conductivity, Process Pressure and Primary Pressure. The current page is can be seen via the buttons at the bottom. The Process Pressure can be seen below:



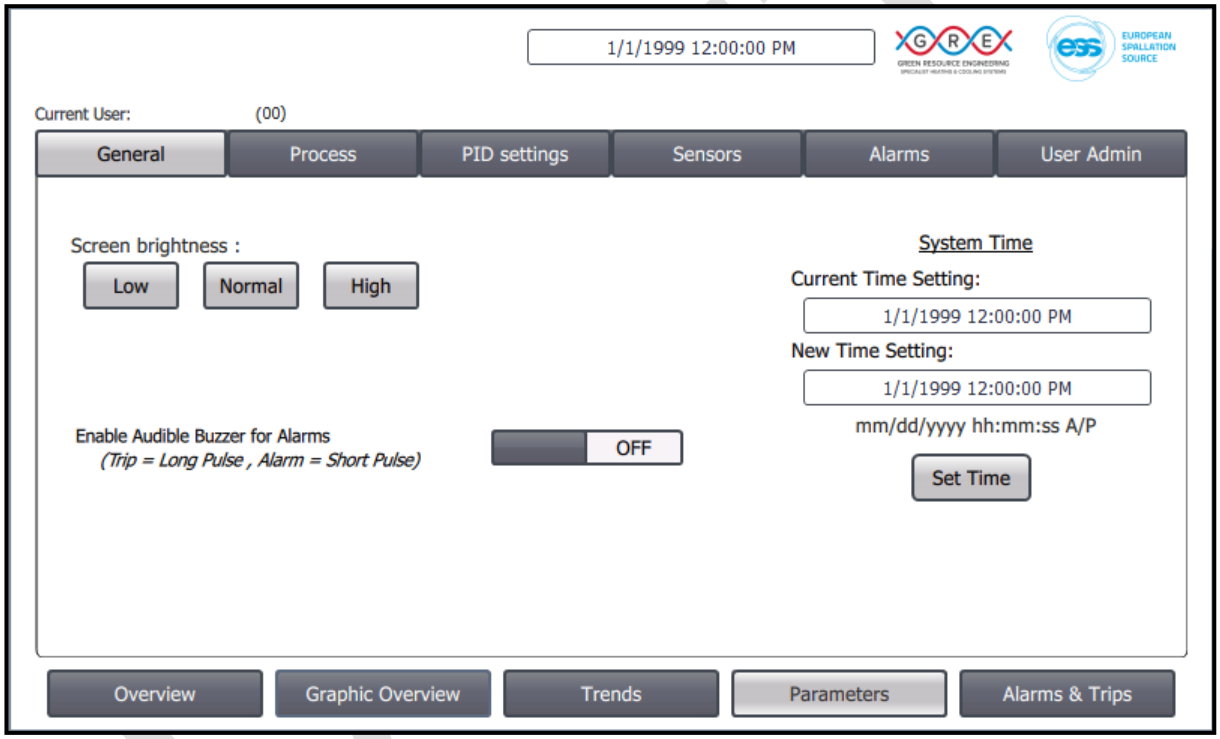
The blue line acts as a cursor and shows you the values at that point in time. The magnifying glass can be used to zoom in or out of the graph display.

9.10. Parameters

From here, the user can change alarm, trip, and runtime setpoints. For full list of setpoints, default values, and values range. The Sensors Parameters are separated into six pages: Pressure, Water Quality, Temperature, Level, Flow and Other. The five pages are accessed via tabs at the top. The Alarms Parameters are separated into five pages: Pressure, Water Quality, Temperature, Level and Flow. The five pages are accessed via tabs at the top.

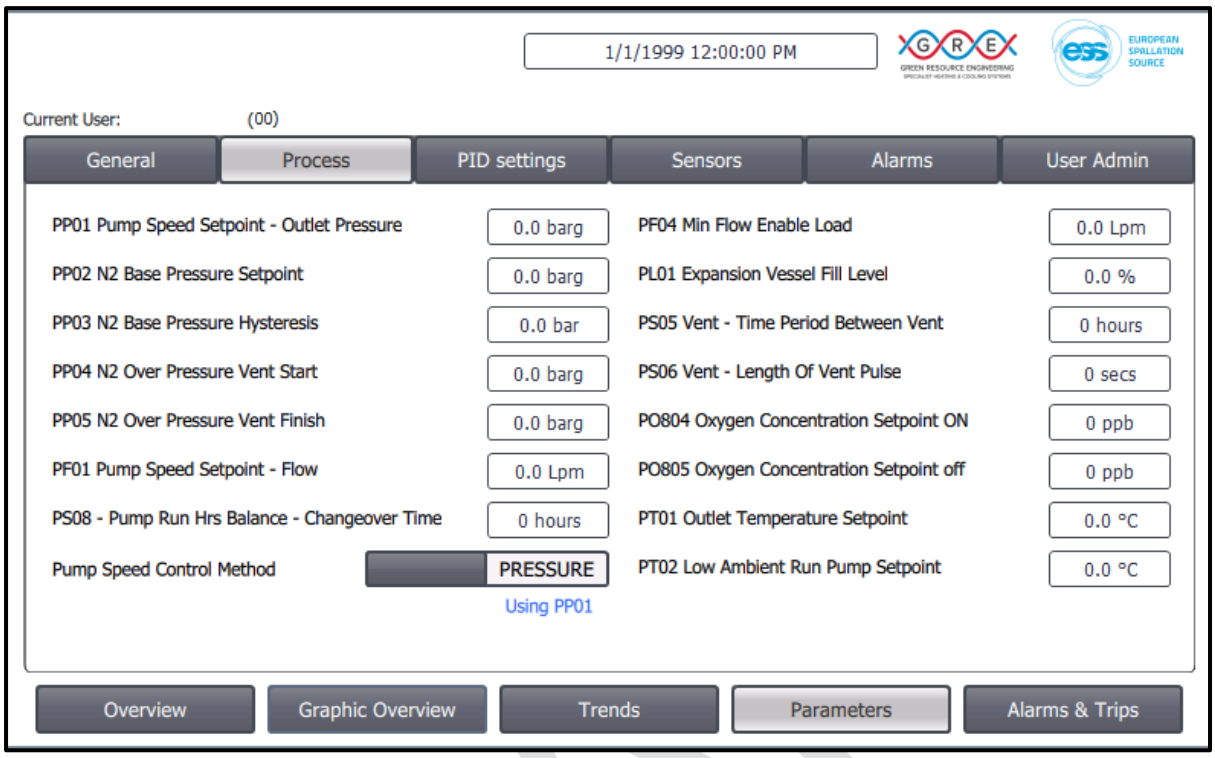
9.10.1. Parameters - General

This is where settings such as buzzer, brightness and date settings



The time can be set by entering the value under *New Time Setting*, then click *Set Time.* Watch the *Current Time Setting* update.

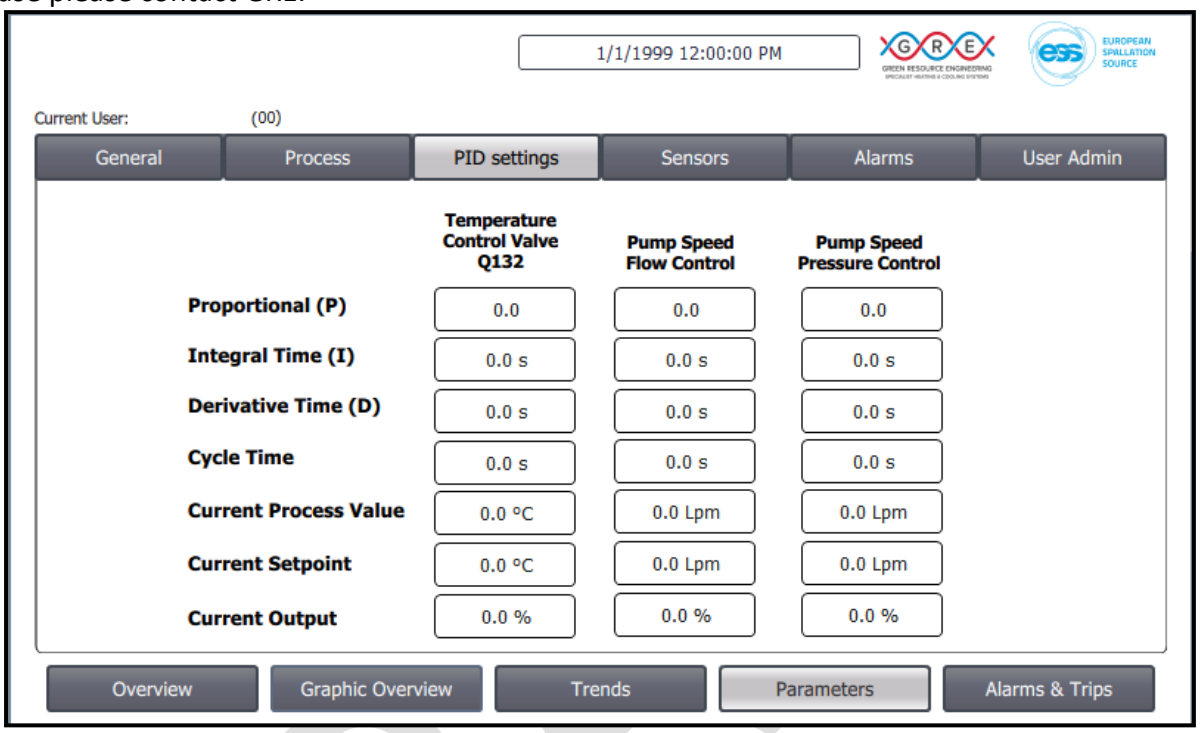
9.10.2. Parameters - Process



DRAFT

9.10.3. Parameters - P&ID settings

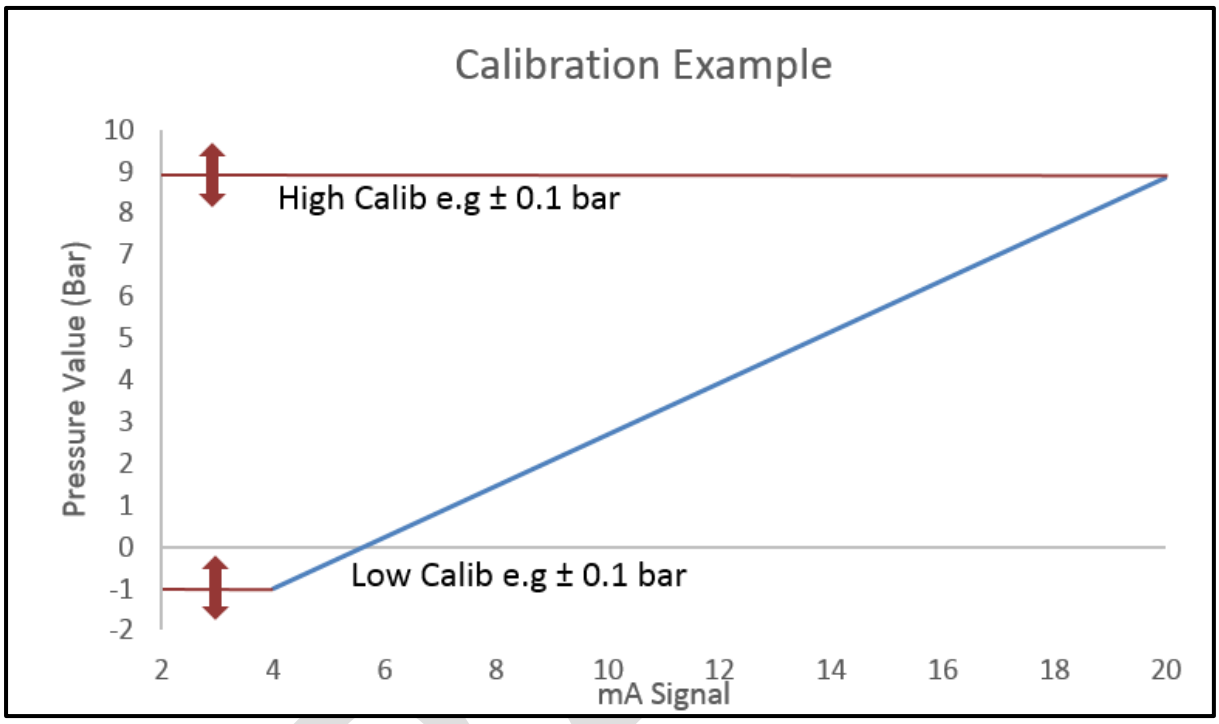
These are to be left alone unless there are concerns with the control of the skid, if this is the case please contact GRE.



DRAFT

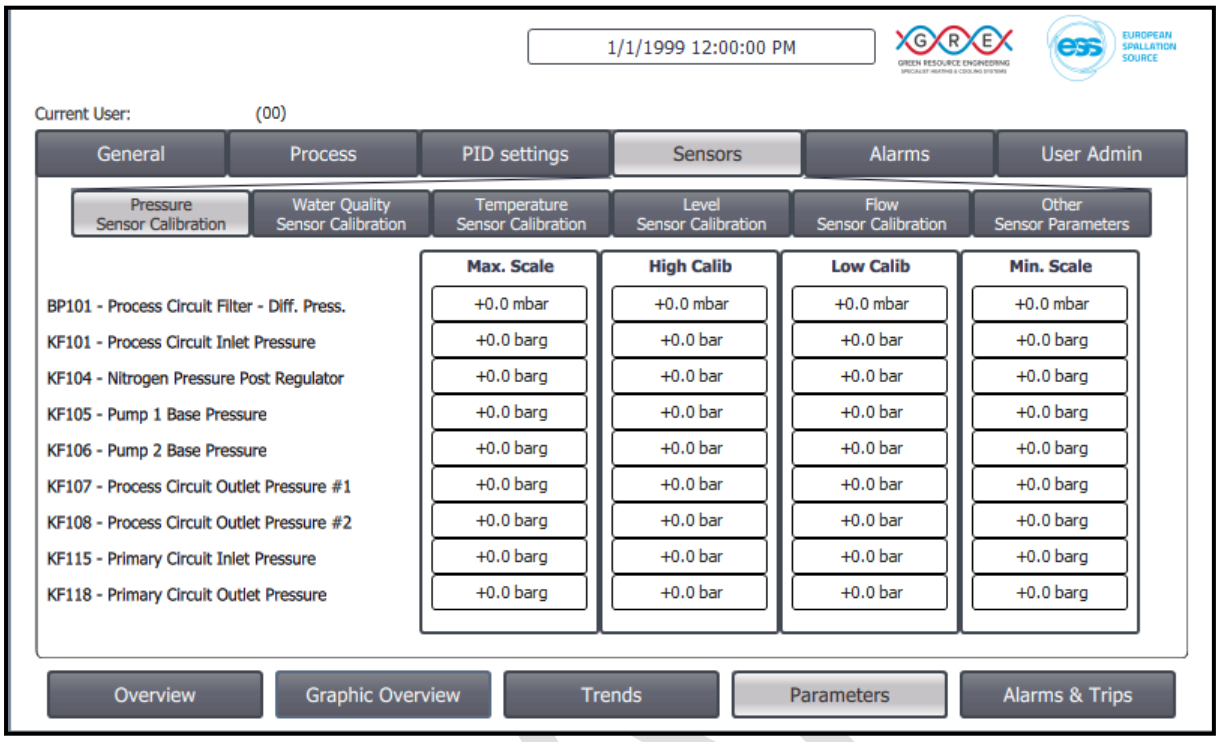
9.10.4. Parameters - Sensor – General

These sensors are calibrated in the software. For example the Pressure transducer KF101, the maximum and minimum values can be seen as 9 and -1 respectively:

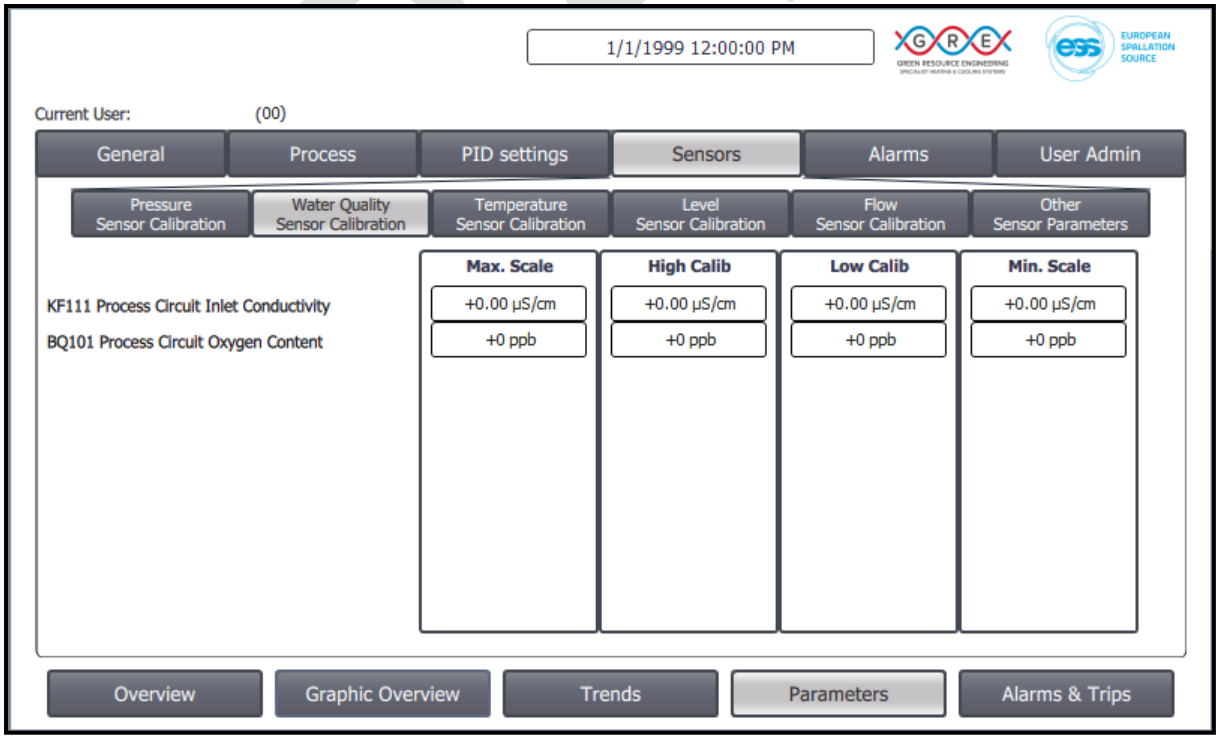


DRAFT

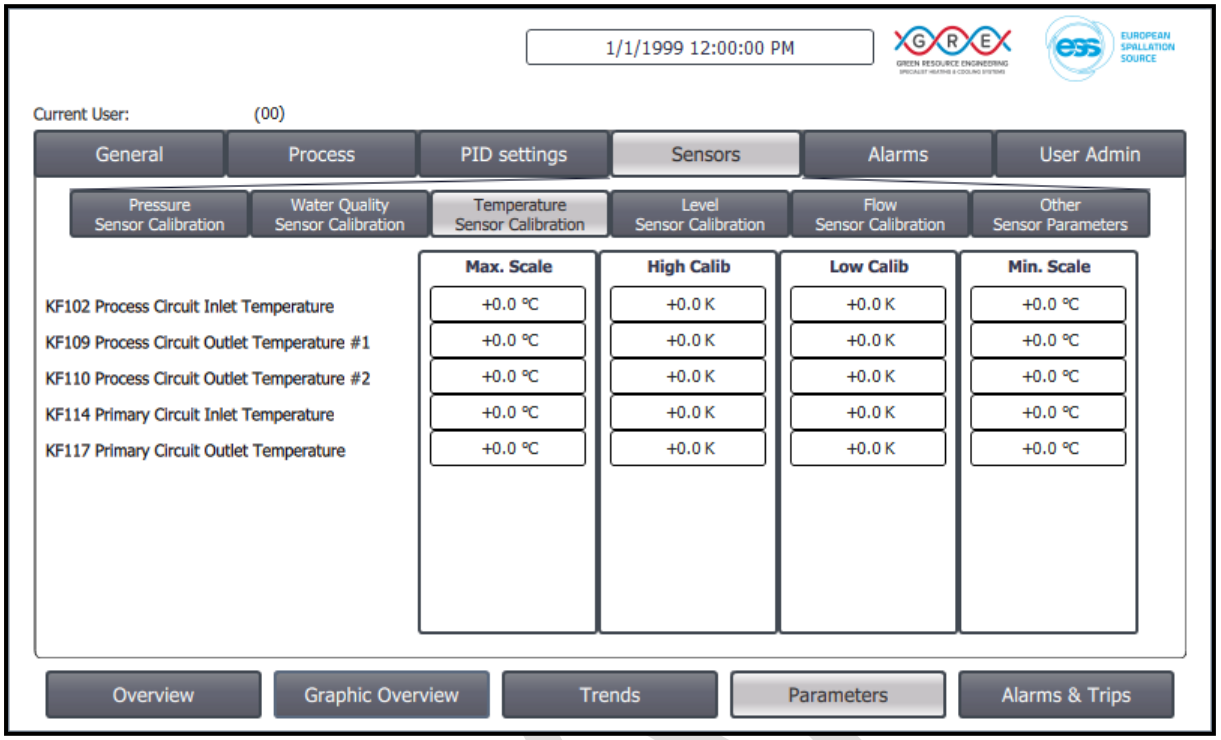
Parameters - Sensor – Pressure



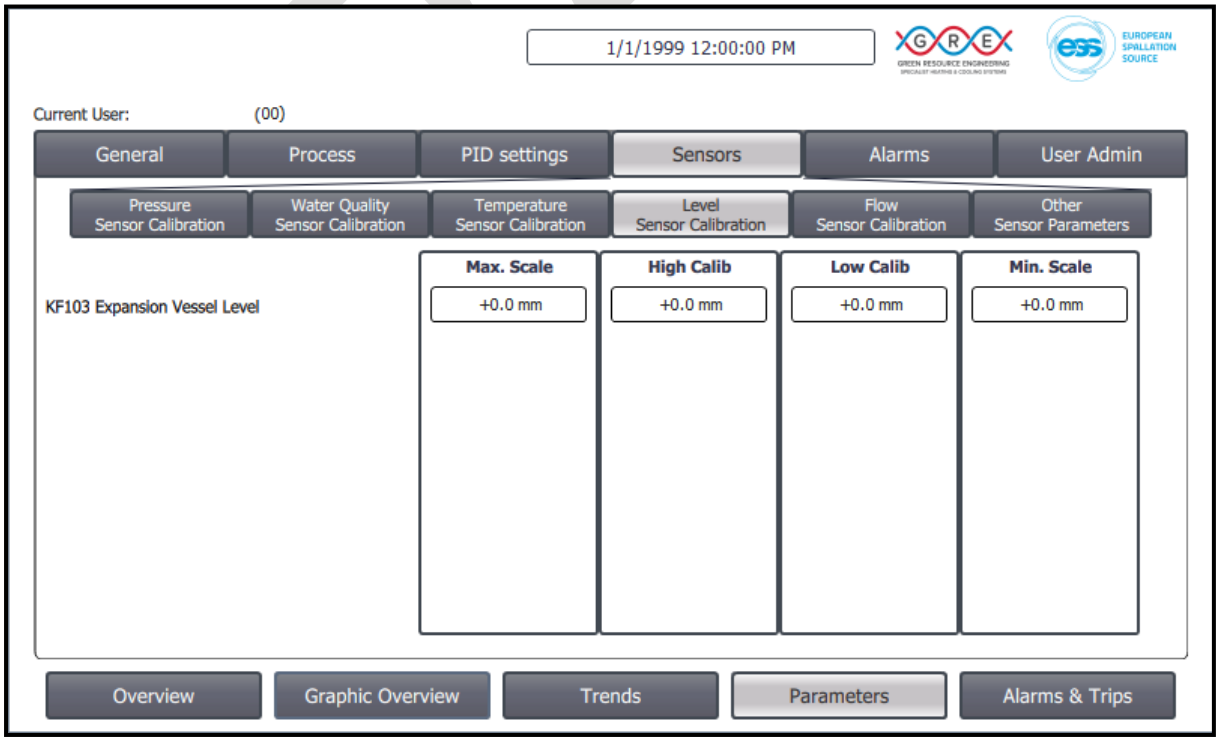
9.10.5. Parameters - Sensor - Water Quality



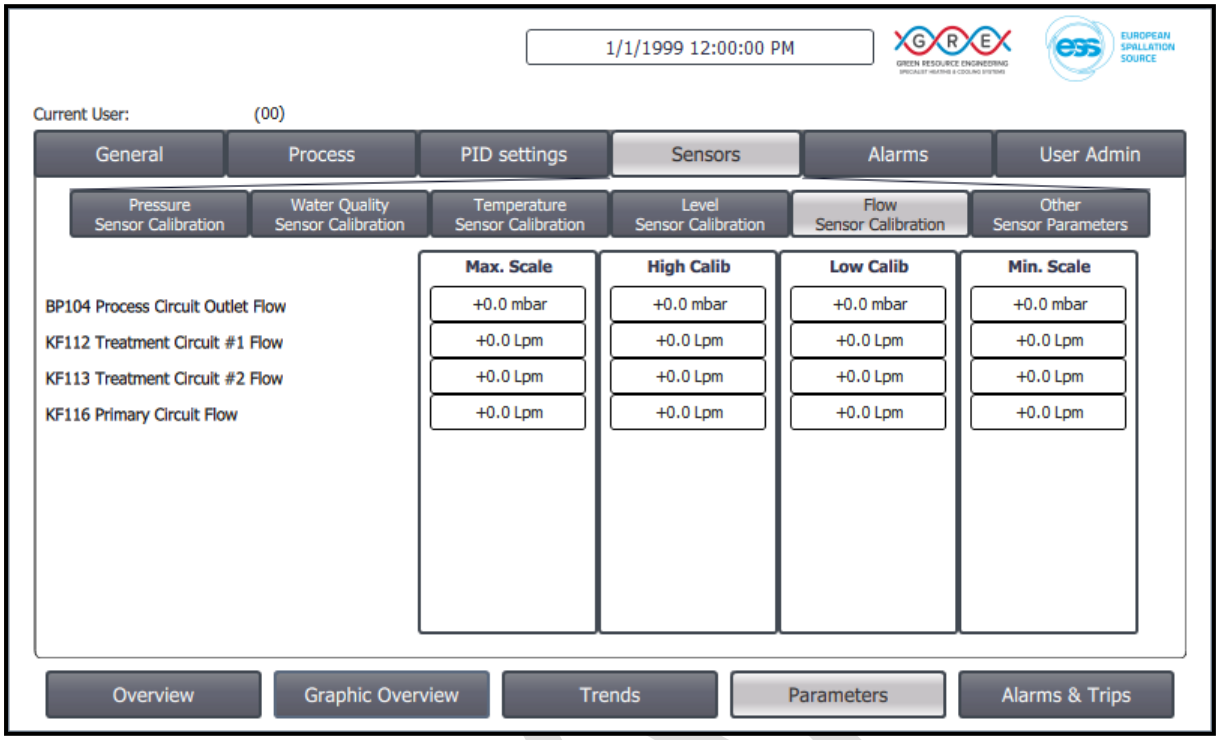
9.10.6. Parameters - Sensors - Temperature



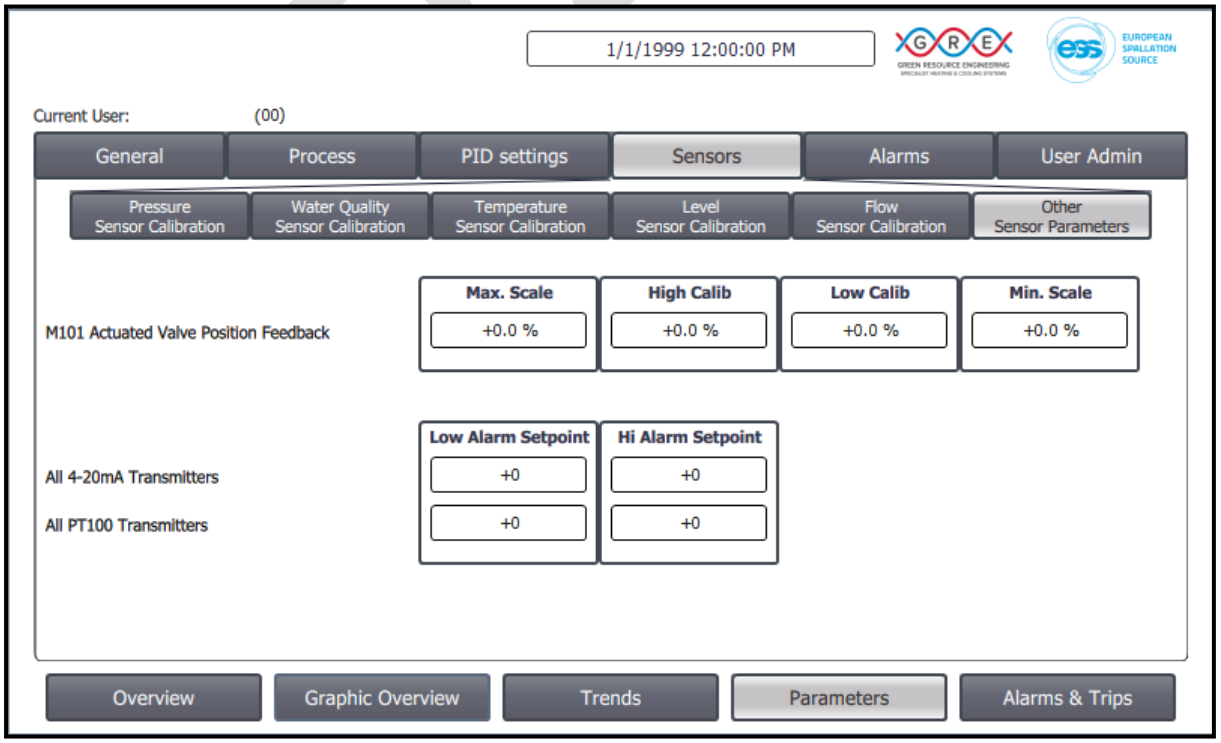
9.10.7. Parameters - Sensors - Level



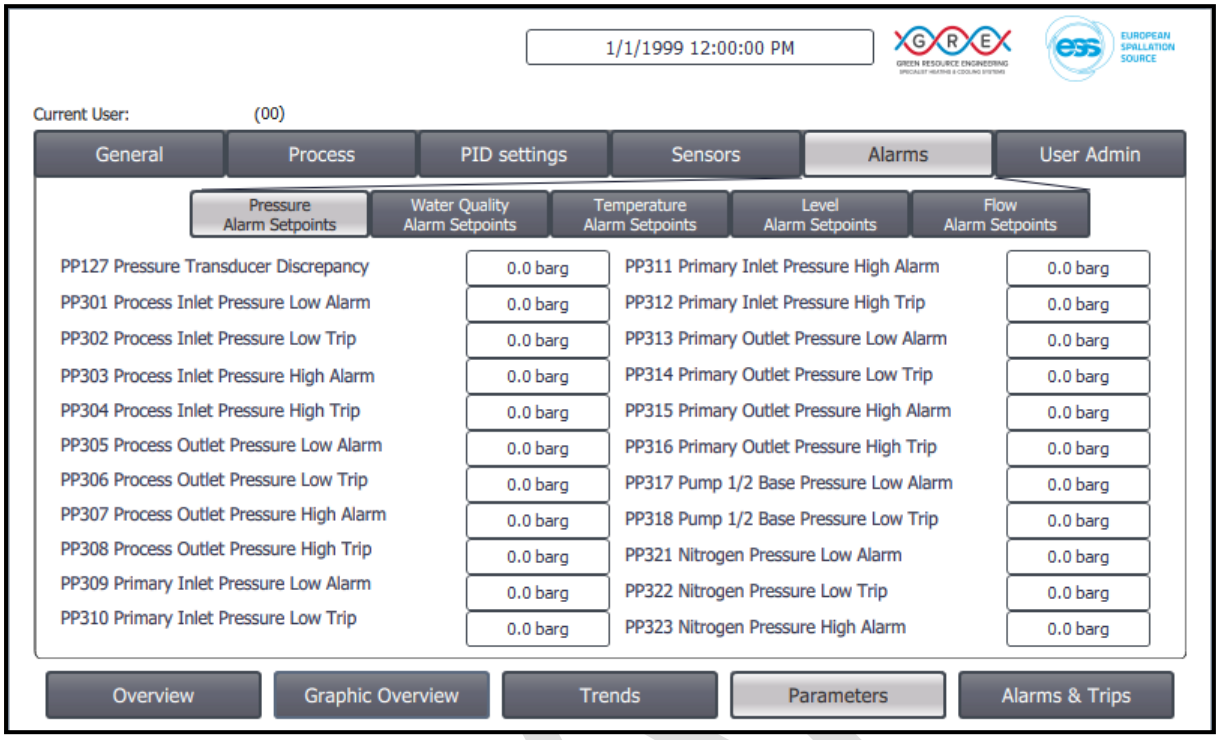
9.10.8. Parameters - Sensors - Flow



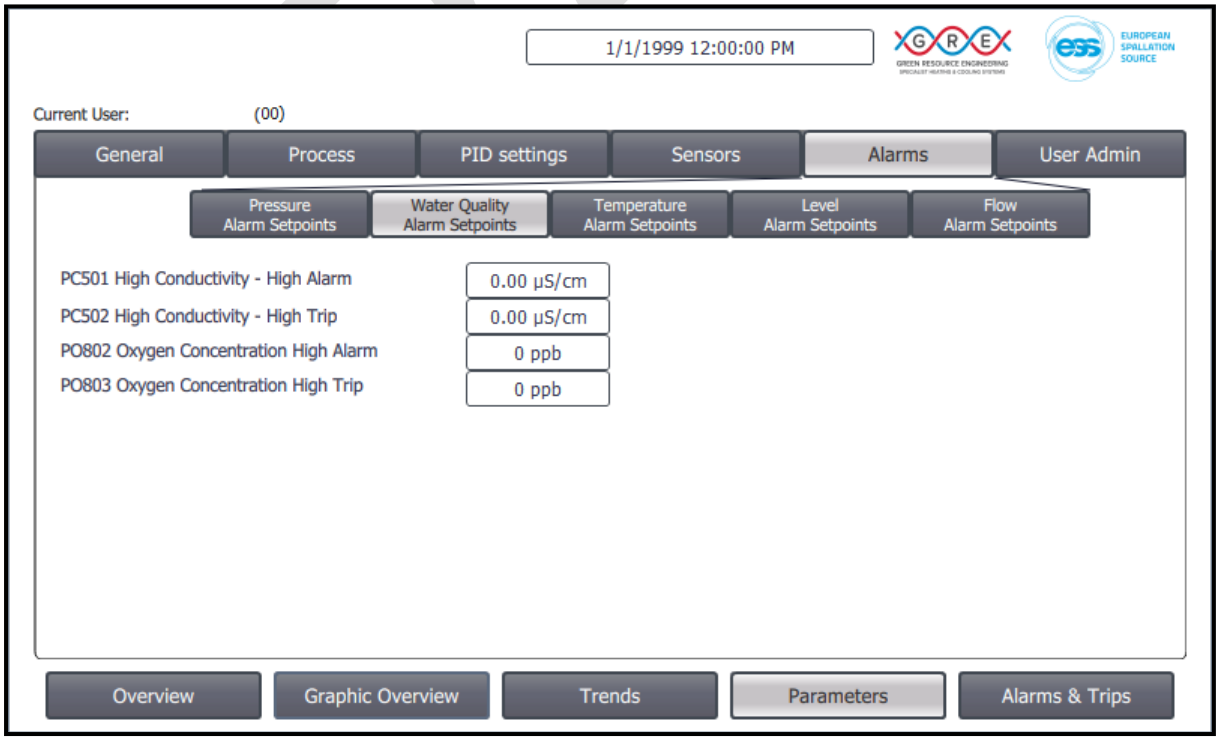
9.10.9. Parameters - Sensor - Other



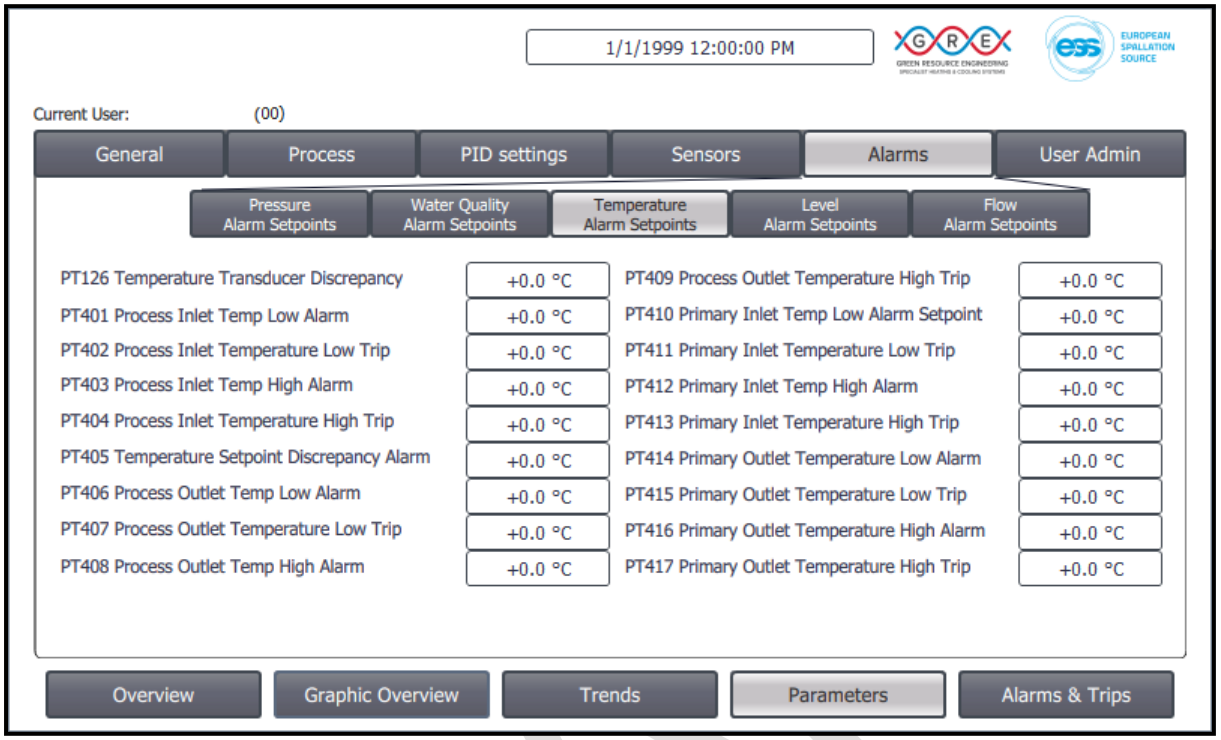
9.10.10.Parameters - Alarms - Pressure



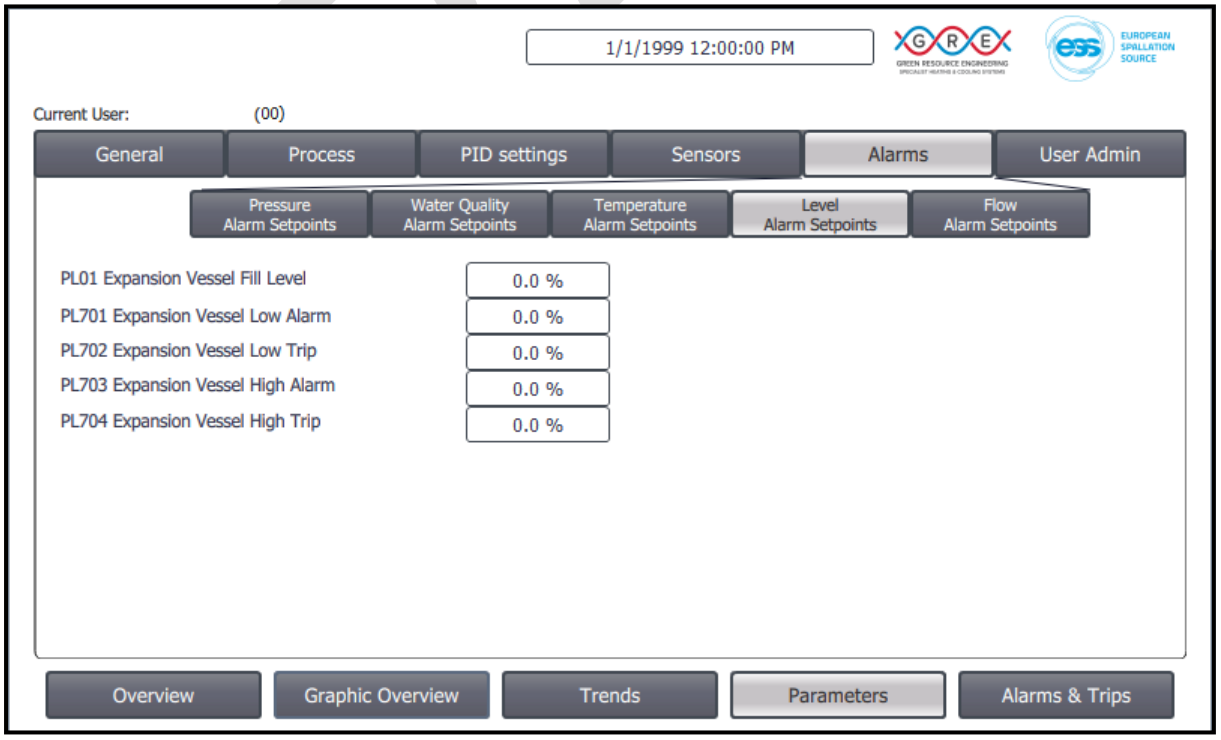
9.10.11.Parameters - Alarms - Water Quality



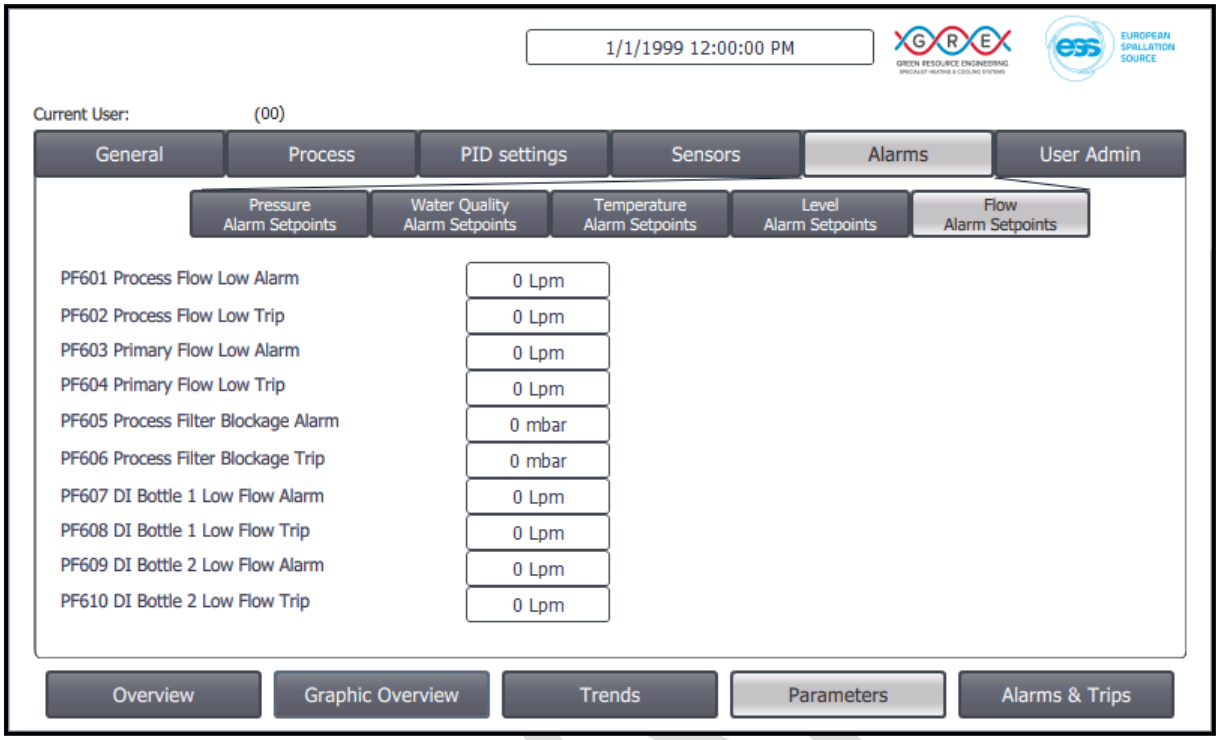
9.10.12.Parameters - Alarms - Temperature



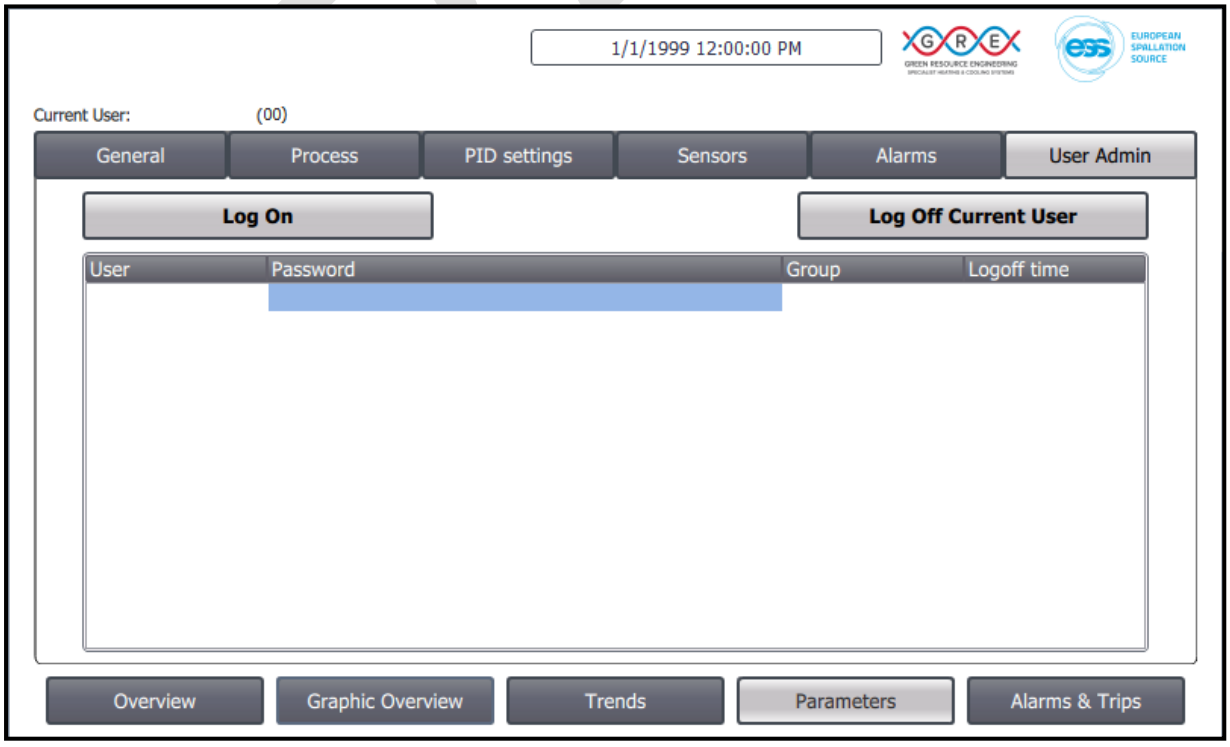
9.10.13.Parameters - Alarms - Level



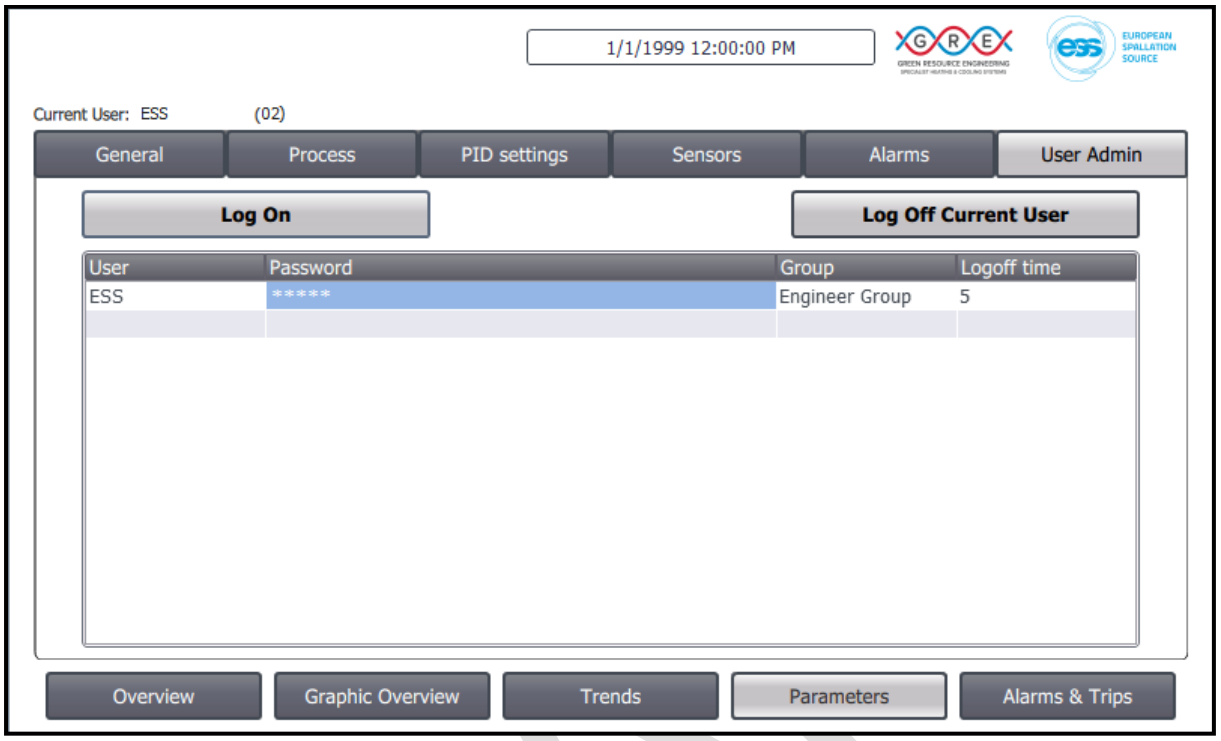
9.10.14.Parameters - Alarms - Flow



9.10.15.Parameters - User Admin



When logged on the screen will look like so:



Several user access levels are configured:

- User
- Engineer
- Manufacturer

The user is prompted to log on as shown above on the left. Current status of logged-on users can be seen on the HMI page shown above on the right, from which the user can control user administration as follows:

- Control user login credentials
- Manage users – create / change / delete
- View the current user logged in
- Log in / out

User access has been restricted to prevent untoward operation of the machine.

Under no circumstances should the system be operated under any password-protected user by an inexperienced technician. Contact GRE if in doubt.

Contact GRE for default user credentials.

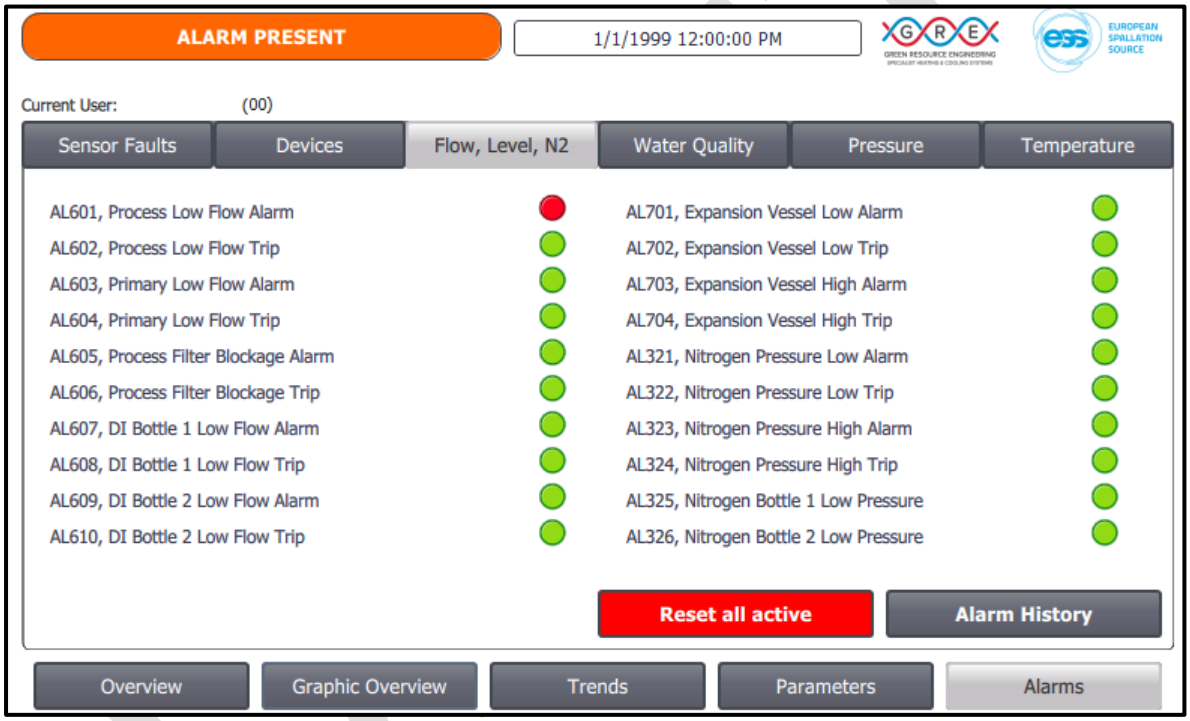
DRAFT

9.11. Alarms View

From here, the user can review all active alarm, reset alarms, review alarm history, and reset alarm history.

9.11.1. Alarms Logic

In the top left there will be a warning stating if an Alarm or Trip present on each page. Alarms are orange and Trips are red. Examples of these pages can be seen in 9.9.3 – Alarms – Devices. A red line shows underneath the tab with an alarm. A red doe denotes the active alarm on the relevant page. To reset the Alarm click the button at the bottom of the screen.



Each alarm is linked to a parameter.

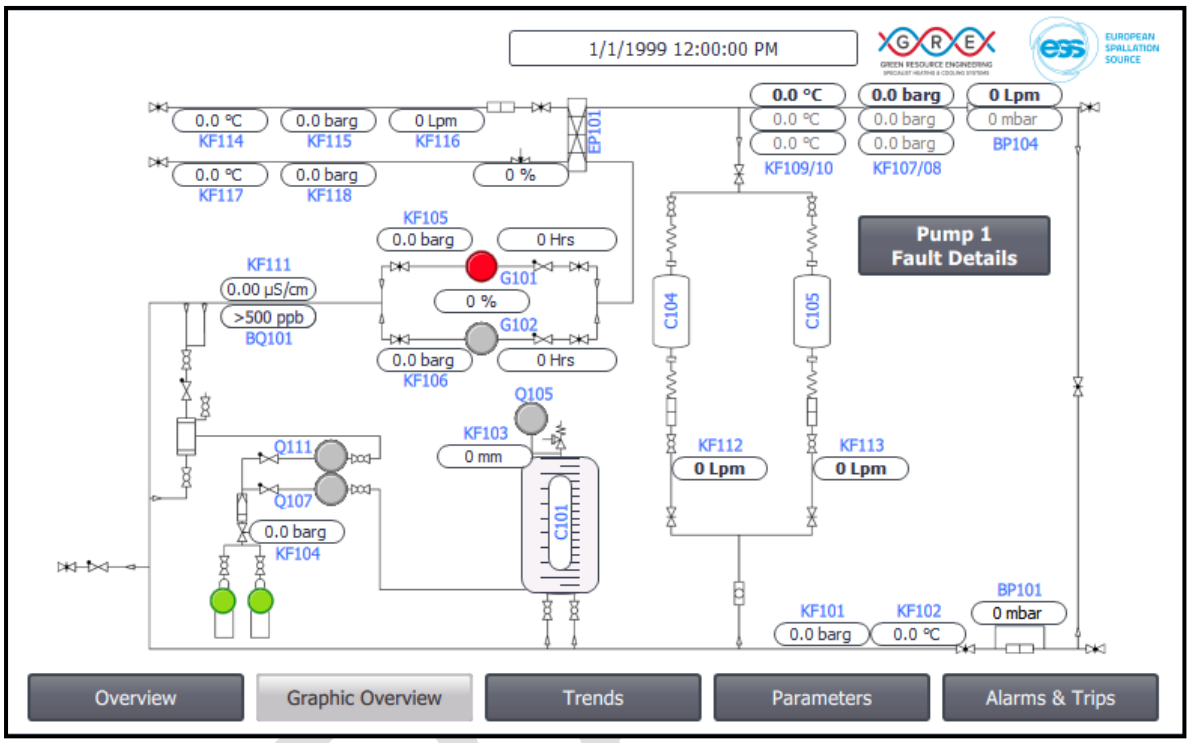
For example AL601 – Process Low Flow Alarm is generated above.

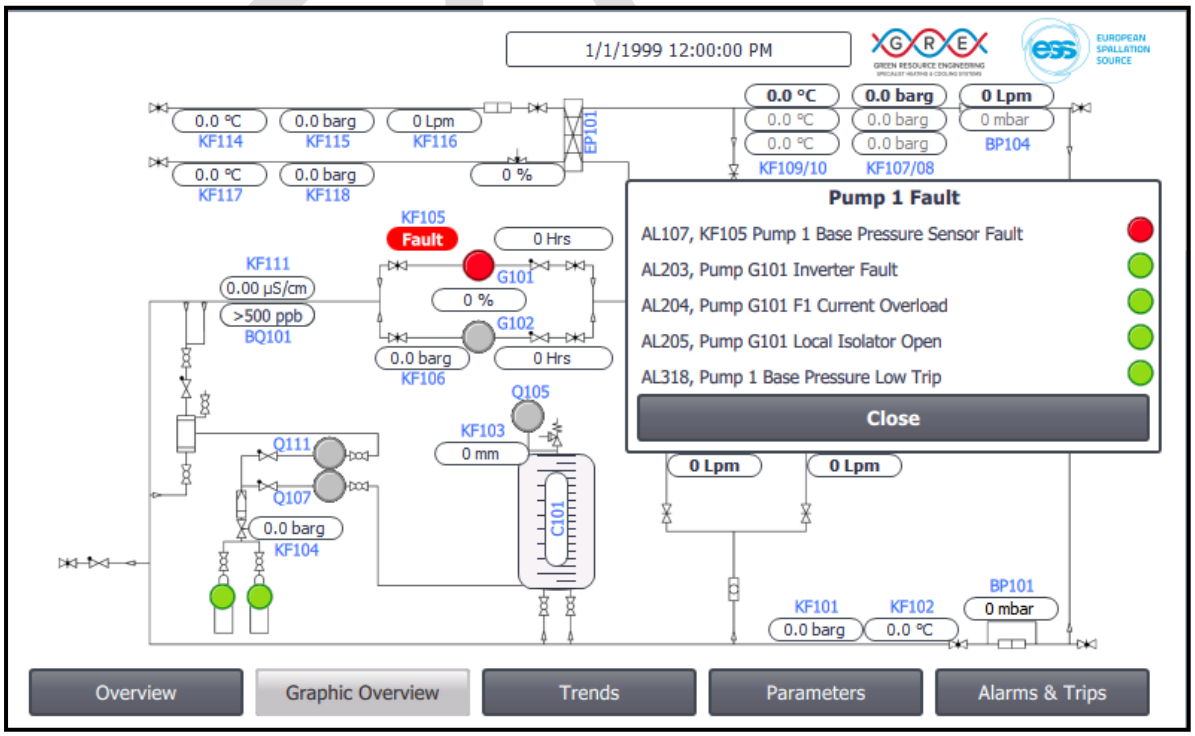
This means that PF601 - Process Flow Low Alarm is the parameter generating the alarm. This can be seen and set in section on the screen shown in 9.8.15 under Parameters – Alarms – Flow.

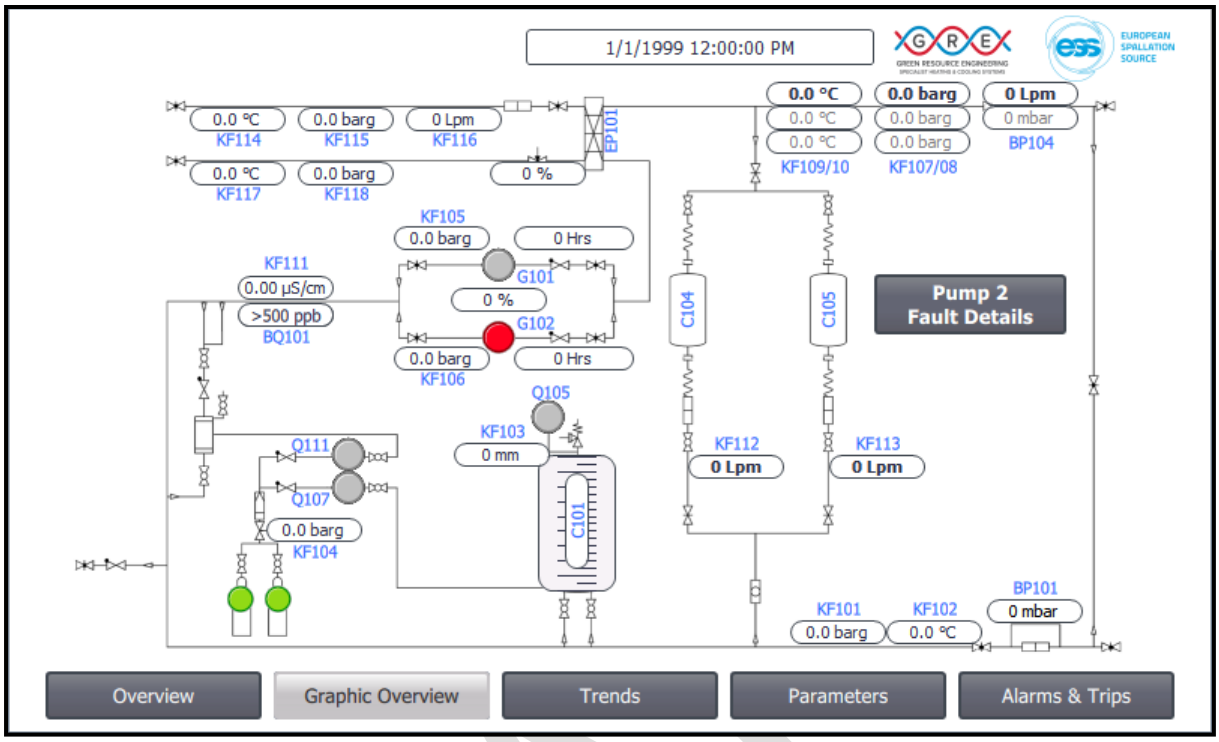
The relevant times can also be linked back to PS601a and PS601b where ‘a’ is the on time and ‘b’ is the off time. The 3 digit number is linked throughout for ease of tracking values.

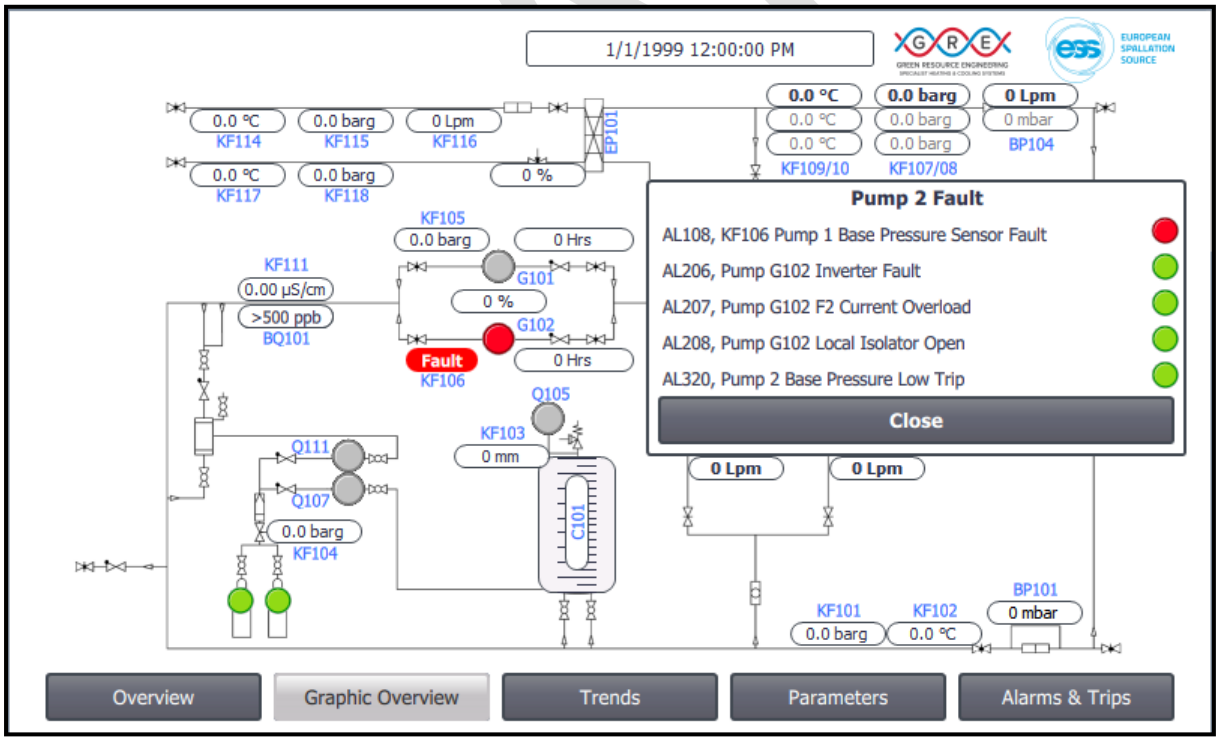
9.11.2. Alarms Pump Fault

When a pump is stopped you can see from the following pages when you click on 'Pump X Fault Details' what has caused the pump to stop. There are different faults for each pump:

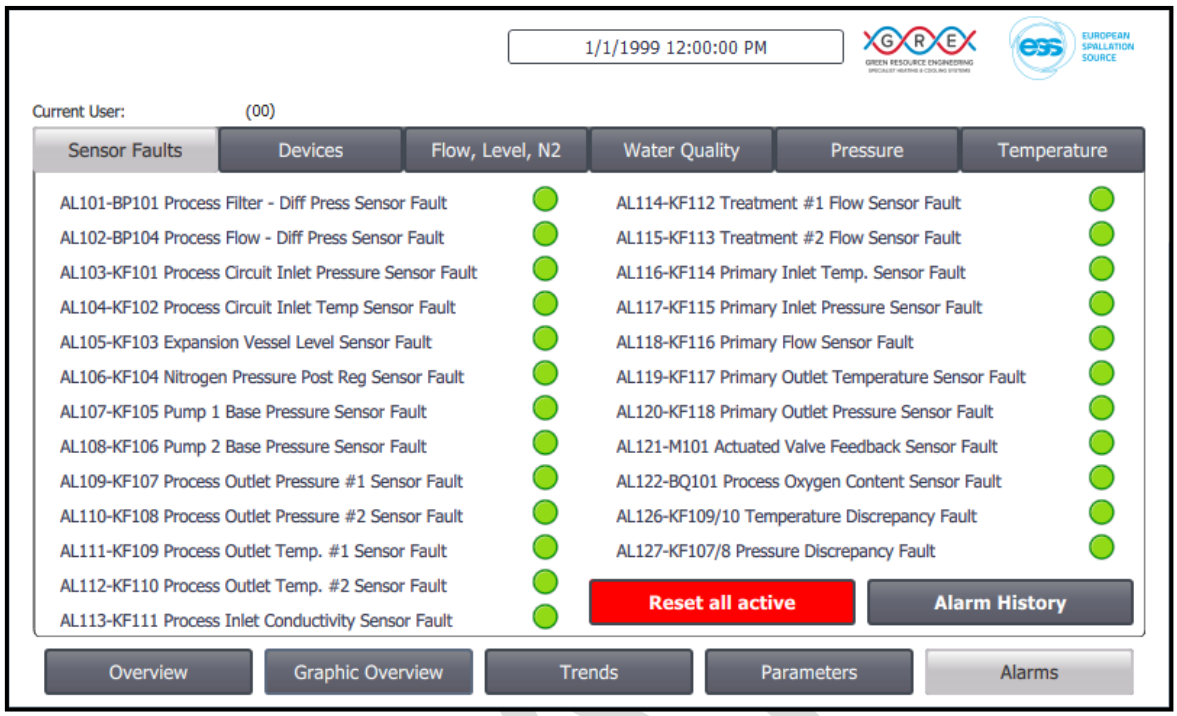





1/1/1999 12:00:00 PM
0.0 °C
KF114
0.0 barg
KF115
0 Lpm
KF116
BP101
0 %
KF117
KF118
KF105
0.0 barg
0 Hrs
G101
KF111
0.00 µS/cm
>500 ppb
BQ101
G102
KF106
Q105
KF103
0 mm
Q111
Q107
KF104
C101
C104
C105
KF109/10
KF107/08
BP104
0 mbar
Pump 2
Fault Details
KF112
KF113
KF101
KF102
Overview
Graphic Overview
Trends
Parameters
Alarms & Trips

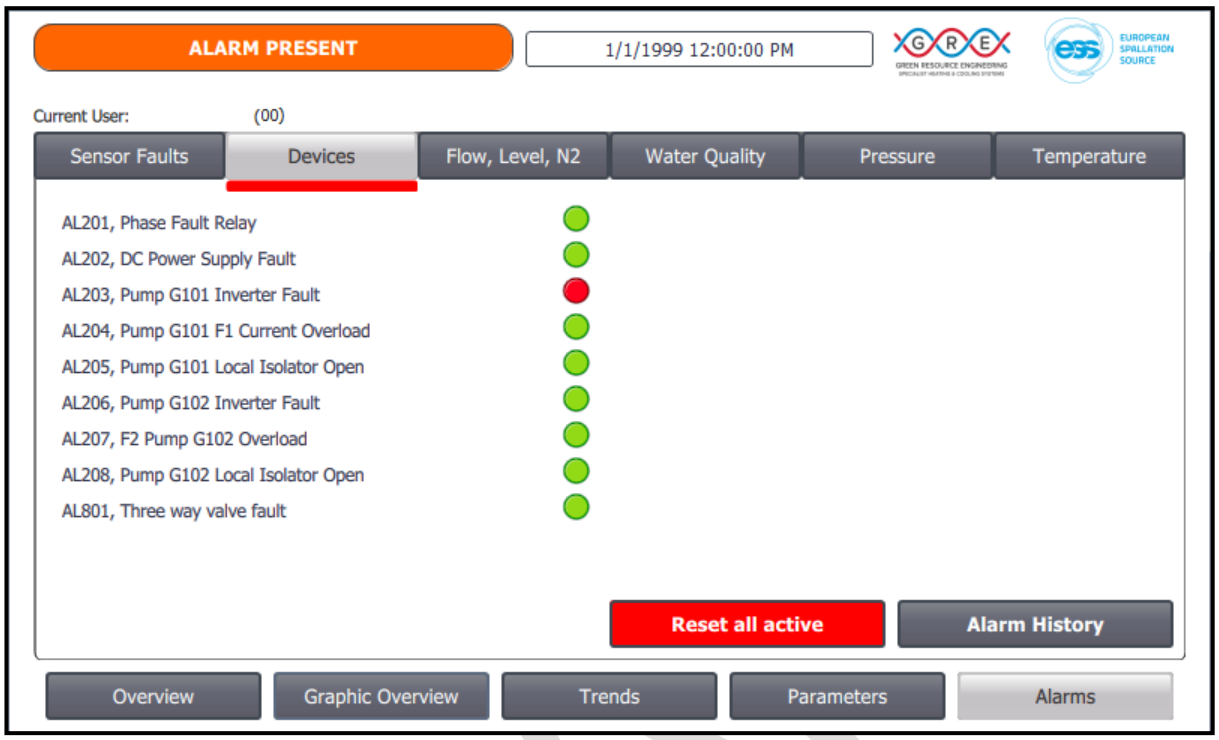

1/1/1999 12:00:00 PM
Pump 2 Fault
AL108, KF106 Pump 1 Base Pressure Sensor Fault
AL206, Pump G102 Inverter Fault
AL207, Pump G102 F2 Current Overload
AL208, Pump G102 Local Isolator Open
AL320, Pump 2 Base Pressure Low Trip
Close
Fault
Overview
Graphic Overview
Trends
Parameters
Alarms & Trips

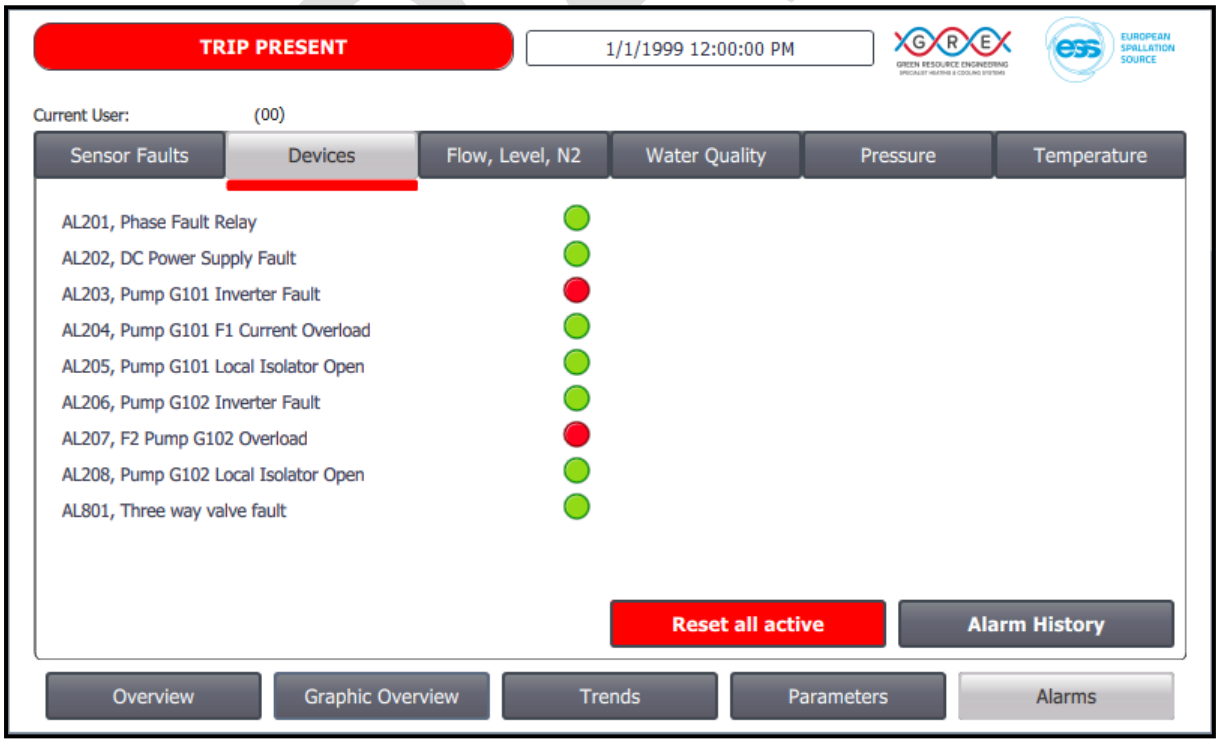
9.11.3. Alarms - Sensor Faults



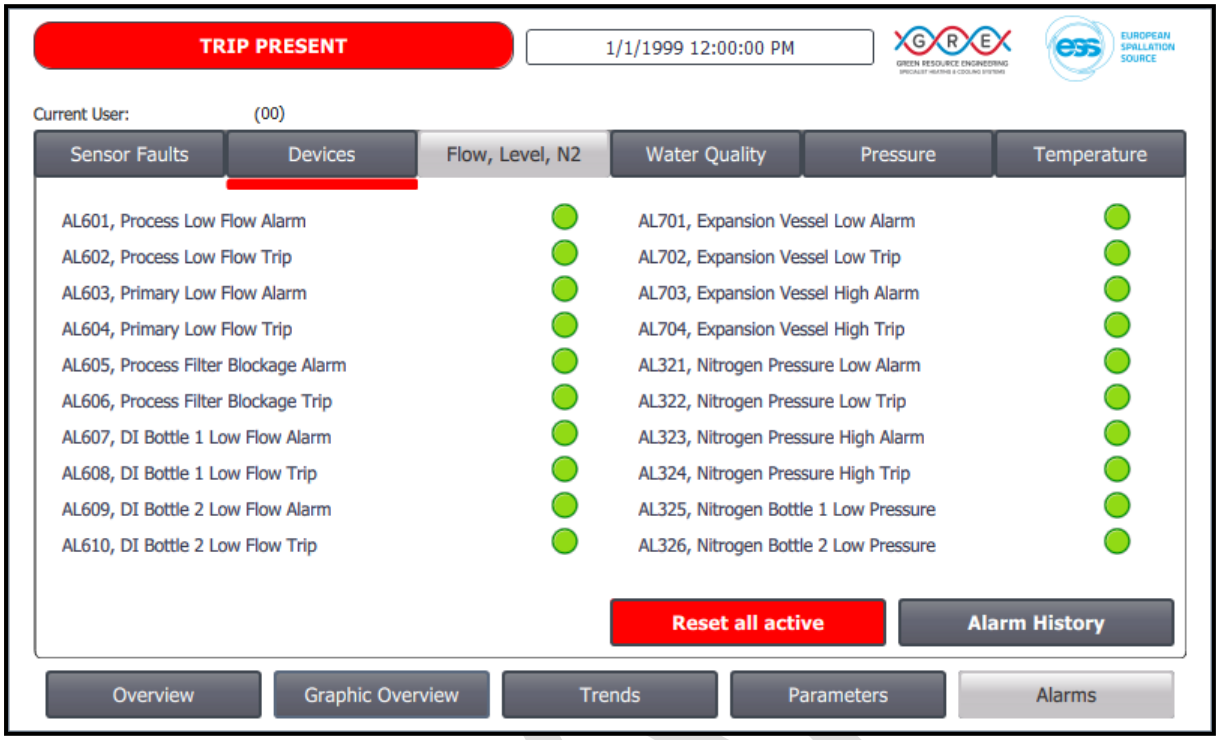
DRAFT

9.11.4. Alarms – Devices

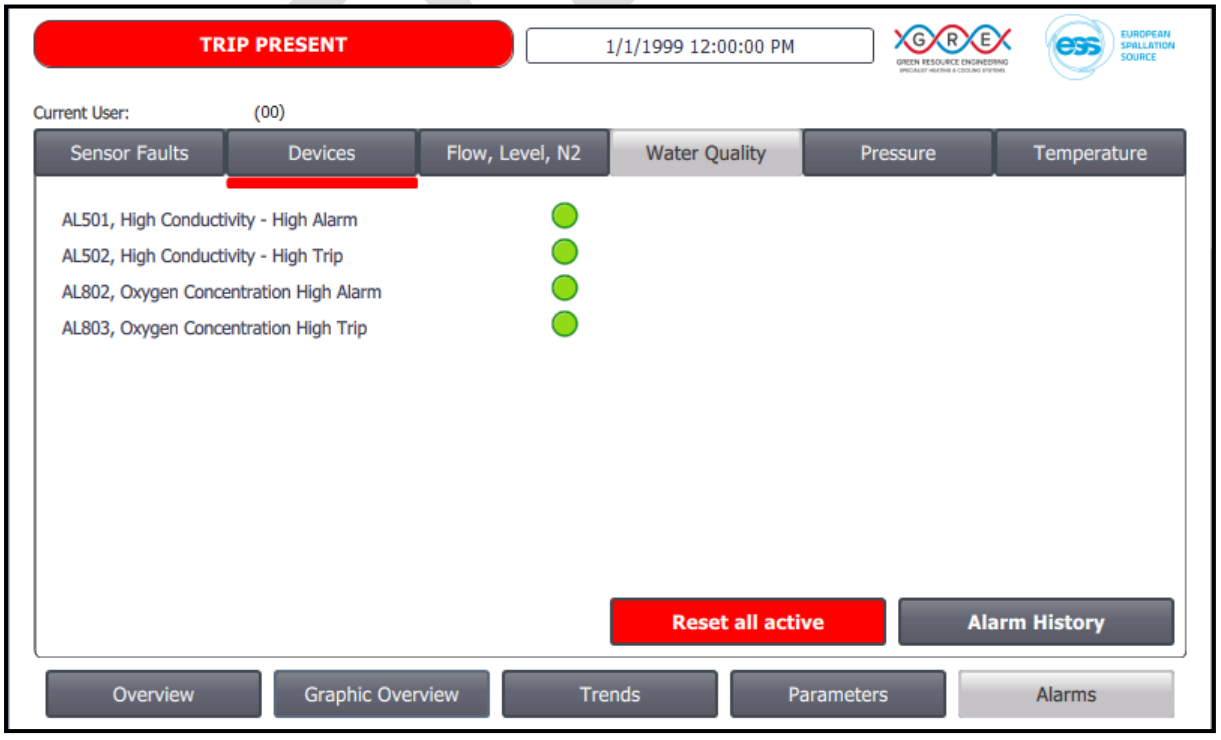




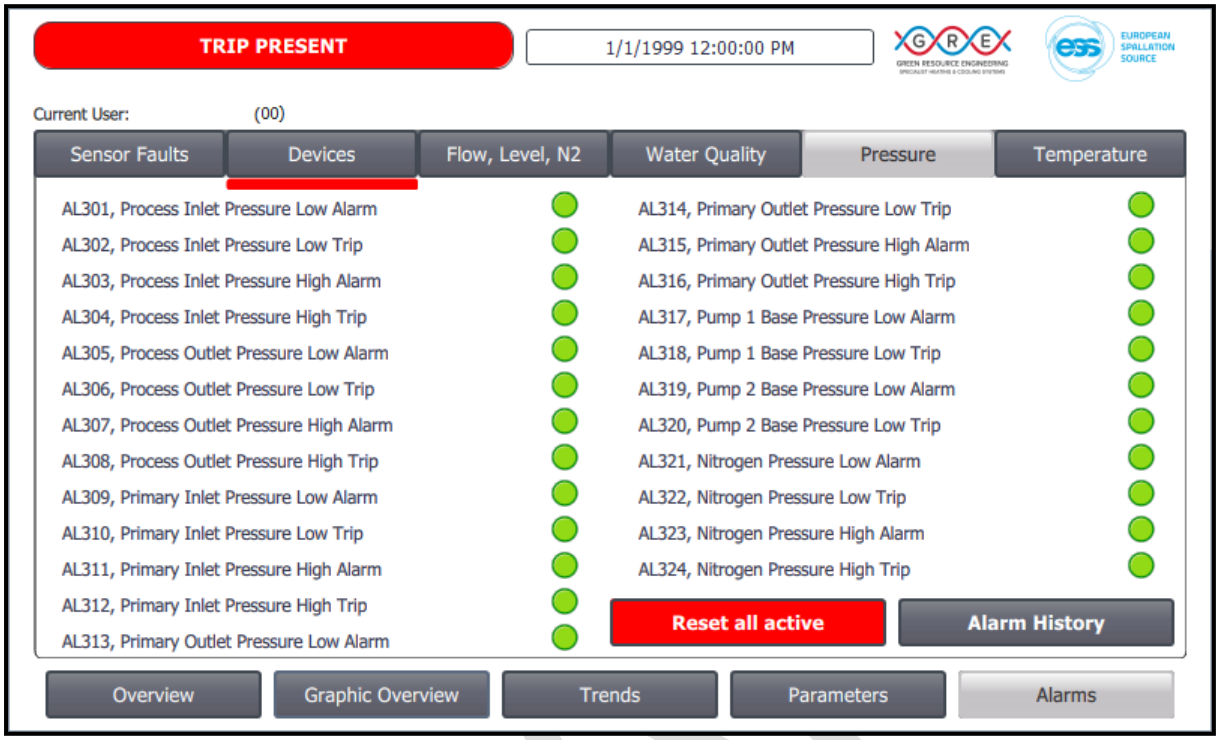
9.11.5. Alarms – Flow, Level, N2



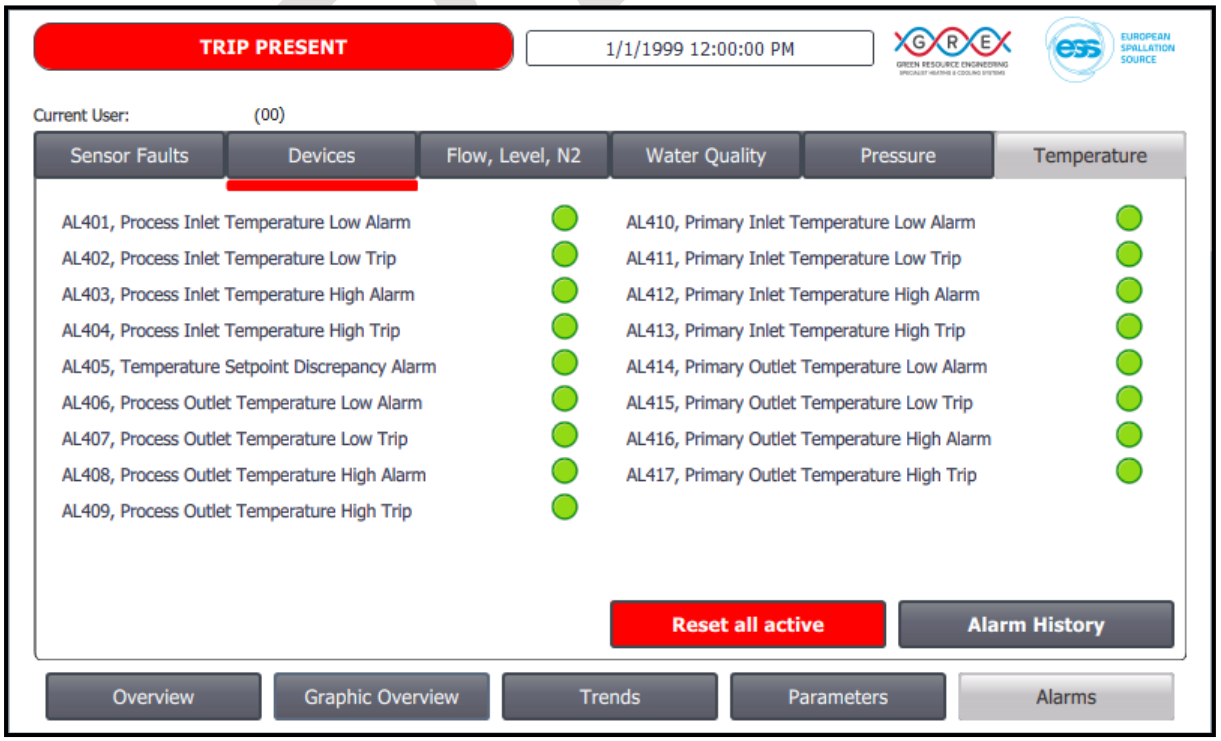
9.11.6. Alarms – Water Quality



9.11.7. Alarms - Pressure



9.11.8. Alarms - Temperature



10. Equipment Maintenance

This chapter addresses all necessary information on maintaining the cooling system.

It is recommended that damaged or worn parts are wholly replaced, not just part of the item.

All maintenance work must be carried out by competent personnel

10.1. Maintenance Schedule

The maintenance checks are given in the following table

10.1.1. GENERAL MAINTENANCE SCHEDULE

IMPORTANT NOTE	CHECKS ALLOWED WHILST SYSTEM IS OPERATING	SYSTEM MUST BE OFFLINE FOR THESE CHECKS.		
Item	Action	Weekly	Monthly	Annually
Pump G101	Regular check for leak at motor / pump interface			
	Check for vibration.			
	Check conduit / wiring condition			
	Check flow rate reading			
Pump G102	Regular check for leak at motor / pump interface			
	Check for vibration.			
	Check conduit / wiring condition			
	Check flow rate reading			
Modulating Valve Q132	Manually operate for four open / close cycles.			
	As moving check for leaks			

DRAFT

	Confirm end of travel is reached at both directions			
	Confirm motor / valve coupling is secure			
	Check control wiring and conduits are secure			
Pump skid Main Filter HQ101	Remove basket and check for condition			
	Remove basket and check for debris.			
Expansion Vessel level indicators	Check all visually indicating the same level as reported on the HMI			
	Check wiring and conduits to switches and indicators			
	Check for leaks			
Gas Systems	Check gas pressures. (Both stages)			
	Check for gas leaks			
Conductivity.	Check wiring and conduits to each device.			
	Check readings are in range.			

DRAFT

10.2. Maintenance Procedures

All maintenance procedures within this chapter are applicable to the whole system.

Please note: The electrical cabinet will require minimal maintenance. Any failures will require a replacement.

The Following areas are addressed:

- Instrumentation
- Motorised Valves.
- Mechanical Valves
- Pumps
- Cleaning the Main System Filter
- Replacing the Deionisation Circuit Filter
- Deionisation Cylinder Change

10.3. Instrumentation

This section includes a list of all the main instrumentation that may require maintenance through the life of the cooling system. All fitted instrumentation will generally operate as intended for a minimum period of five years. Should any instrument not function correctly or fail, replace it and discard the original.

Should an issue occur with any instrument:

Find the item on the cooling system (it will have an identification tag attached to it) or find the tag ID by locating the item on a P&ID drawing.

Refer to the Spares list provided as a separate document and quote the relevant part number to GRE regarding replacements.

Use P&ID Drawing M01811 for component identification.

DRAFT

10.4. ISOLATION, CONTROL AND SAFETY VALVES.

There are several different types and sizes of valves fitted to this equipment and most will be common to the system as a whole. The following is a description of each type and in ALL cases the whole system MUST be shut down as these valves are in contact with the coolant at all times. Changing a valve will require at least a section isolated where possible.

10.4.1. MOTORISED VALVE

In this application it is unlikely that there will ever be any maintenance or replacement requirement throughout its service life.

Any work carried out upon the valve assemblies will introduce a **COOLANT CONTAMINATION** risk, which when opened to the main circuit could affect the conductivity for a short period. This may result in an **ALARM or TRIP** situation.

Ensure that the system is off line when carrying out this work.

10.4.2. ACTUATOR REPLACEMENT ON MOTORISED VALVE.

The electrical drive component can be carried out whilst the pump skid is operating so long as the valve position signal is maintained.

10.4.2.1. Motorised Valve Actuator Replacement

Type. BURKERT model 3003.

This actuator can be operated electrically by a positioner input as well as an override hand wheel to allow for manual adjustment. At the head of the unit is a positional indicator.

Fitting the unit to a valve is extremely easy by removing the standard valve operating handle and simply placing the actuator upon the exposed stub shaft and tightening the locking bolts at the base of the actuator.

DRAFT

10.4.3. Replacement of Motorised Butterfly Isolation Valve

SHOULD the mechanical part of the “butterfly” valve Q132 require replacement the system **MUST** be off line and the pumps stopped.

Mechanical Butterfly Valve Type:

- Close valves Q131 and Q133
- Now attach a pipe to air bleed valve Q236 Open slowly to relieve the contained pressure then close again.
- Using a short hose drain the contained coolant into a clean container by opening Q237.

Motorised valve Q132 can now be replaced as follows:

- Remove all eight bolts from each side which attach the pipe flanges to the valve. Take these out diagonally using a few turns at a time and remove the valve and motor assembly.

DRAFT

- Check the condition of the flange faces. Clean if required!
- Replace a new valve body and replace the bolts FINGER TIGHT.
- Using a diagonal pattern, tighten the bolts.
- Detach the motor assembly from the removed valve and replace it upon the new valve and secure.
- Open valve Q131
- Remove trapped air by bleeding it from air bleed valve Q236 as applicable
- Restart the pump.

AT THIS TIME some contamination of the coolant WILL have occurred therefore continue to operate the pumps for at least 30 minutes to ensure that the circulating coolant is pure.

DRAFT

10.4.4. Replacement of Manually Operated Butterfly Valves.

All lever isolation valves irrespective of their position may be replaced, HOWEVER, the system MUST be OFFLINE, the pumps STOPPED and the Nitrogen gas pressure released before any attempt is made to replace any of these valves.

It is highly unlikely that any of these valves will ever need replacement. If this does become necessary the whole portion of the system must be drained or partially drained, depending upon the position of the valve to be changed.

It is preferable to isolate the local area if possible to avoid a complete system coolant drain.

Adapt procedure in section 10.4.3 Replacement of Motorised Butterfly Isolation Valve for all other mechanical butterfly valves.

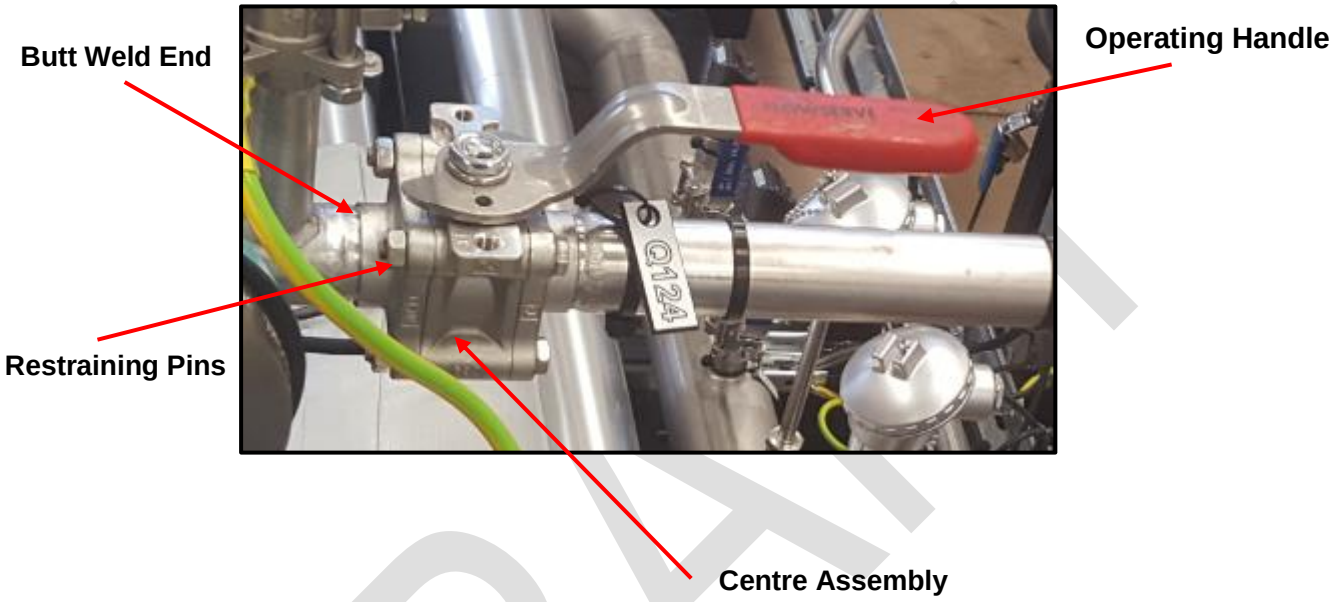
Once replaced the hydraulic section MUST be refilled, the valve positions reset, and the whole system operated for at least 30 minutes before allowing the system to go back online.

DRAFT

10.4.5. Replacement of Lever Operated Ball Isolation Valves

This series of valves all have replaceable assemblies with each flange welded to the pipe system as appropriate

Each of these valve types are of the three part re-sealable type and are easy to repair / replace.



As defined by their use, each valve is directly positioned into the water circuit. The section of circuit containing the valve must be isolated and the pressure relieved / coolant drained before working upon the valve. To replace a complete centre section or to replace the seals, refer to sketch above and proceed as follows:

Replacement Procedure:

- Confirm that the relevant system portion is drained
- Unscrew the four fixing bolts which compress the centre section
- Replace the centre section
- Replace the four pins and tighten to a torque of approximately 6Nm
- Refill the system as described in GRE documents T00060 – SO02839 ESS CWS01 85kW Cooling Skid - ITP

DRAFT

10.4.6. Replacement of Non-Return Valves

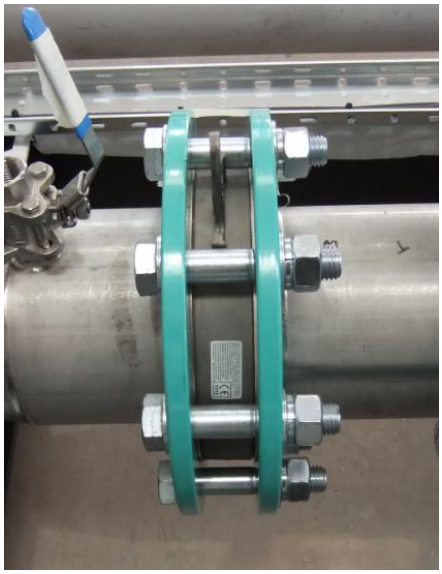
On the pump skid it is possible for non-return valves RM101, RM102 and RM103 units to be maintained. We recommend that if a failure is experienced they should be simply replaced.

Replace Procedure:

If a non-return valve is to be changed then a flow failure will have occurred and the system will have stopped. STOP the whole system and turn ALL **appropriate motor isolators off and apply a padlock**.

To replace RM102.

- Close Q115 and then Q116
- Drain coolant from pipe section using Q213.
- Then close Q213
- Sequentially loosen the nuts on the clamping bolts. (As the unit becomes loose coolant will briefly spill out due to a little residual pressure contained within the pipes).



Loosen the nuts to allow the bottom flange plate to expose a gap of circa 10mm. Now fully remove the top bolts ONLY.

The NRV may now be eased sideways out from between the flange faces.

- Replace the valve with a new valve.
- Ensure that the flow arrow direction points vertically in the direction of flow.
- When confirmed replace the removed bolts, nuts and washers.
- Tighten all evenly, all until finger tight.
- Use a spanner to tighten the bolts sequentially and diagonally until tight.
- Open the appropriate (presently closed) valve Q115 and Q116 **very slightly**.

DRAFT

- Coolant will now pass through the pump body slowly and proceed to fill the pipe until the air contained is compressed at the pipe high point air bleed valve, Q217.
- Slowly open the bleed valve Q217. A little coolant will escape at this point as the contained air pressure is released.
- Air will now be observed escaping at the bleed valve.
- When the air ceases and a steady coolant stream is observed close the bleed valve.
- Fully open valves Q115 and Q116
- Fully check for flange leaks. Wait for approximately an hour and again check for leaks again.
- The isolator padlocks can now be removed and the isolators switched on. The system can now be operated, the conductivity monitored and when in range the system can be returned to service.

Refer to the above procedure to replace non-return valves RM101 and RM103.

DRAFT

10.5. Replacement of Auto Air Vent

In case of auto air vent failure, it can be replaced with the system running. The procedure for replacing the auto air vent is as following:

- Source new auto air vent
- Close valve Q225.
- Remove auto air vent
- Clean old PTFE tape from threads
- Apply new PTFE tape to the male thread
- Replace auto air vent onto valve Q225

10.6. Replacement of Solenoid Valves

In case of solenoid valve failure, it can be replaced with the system still running. The procedure for replacing a solenoid valve depends on its position, and if the valve itself has failed, or just the coil.

10.6.1. Replacing Solenoid Valve Coil

Solenoid valve coils can be replaced with the system running. Refer to the wiring diagram of the coils for the following procedure. Coil to be replaced by qualified engineer. To replace the coil, proceed as following:

- Source new solenoid valve coil
- Electrically isolate the coil.
- Remove the wire from the coil
- Remove coil from valve body
- Connect new coil to the valve body
- Connect wire to coil
- Reconnect coil to rest of system

DRAFT

10.6.2. Replacing Solenoid Valve on Expansion Vessel

The following procedure is for replacing solenoid valve Q105 on expansion vessel c101. Refer to the wiring diagram of the coils for the following procedure. Coil to be replaced by qualified engineer. Proceed as following:

- Source new solenoid valve
- Close valves Q103, Q104 and Q107
- Vent gas cap in expansion vessel C101
- Electrically isolate the coil on solenoid valve Q105.
- Remove the wire from the coil on solenoid valve Q105.
- Remove coil from valve body of solenoid valve Q105.
- Remove coil body of solenoid valve Q105 from expansion vessel head
- Remove old PTFE tape from thread
- Apply new PTFE tape to thread
- Replace valve body of solenoid valve Q105.
- Connect new coil to the valve body
- Connect wire to coil
- Reconnect coil to rest of system
- Observe base pressure on pressure transducers KF101
- Manually initiate nitrogen gas cap venting procedure (using HMI)
- Observe solenoid valve Q105
- Observe HMI screen for pressure drop of pressure transducer KF104
- Observe solenoid valve Q105 closing when Base Pressure Low Alarm is activated.
- Observe solenoid valve Q107 open
- Observe HMI screen for pressure increase of pressure transducer KF104
- Observe base pressure on pressure transducers KF101 return to pre-vent procedure values

DRAFT

10.6.3. Replacing Solenoid Valves Q107 and Q111

The following procedure is for replacing solenoid valve Q107 on nitrogen gas cap refill line. Refer to the wiring diagram of the coils for the following procedure. Coil to be replaced by qualified engineer. This procedure can be adapted to replace solenoid valve Q111. Proceed as following:

- Source new solenoid valve
- Isolate nitrogen gas at Q108 and Q250 (Q251 if changing Q111)
- Electrically isolate the coil on solenoid valve Q107.
- Remove the wire from the coil
- Remove coil from valve body
- Undo the fittings either side of solenoid valve Q107
- Remove old PTFE tape from threads
- Apply new PTFE tape to threads
- Replace valve body of solenoid valve Q107.
- Reconnect union halves to new solenoid valve body
- Redo the unions either side of solenoid valve Q107
- Connect new coil to the valve body
- Connect wire to coil
- Reconnect coil to rest of system
- Open valve Q108 and Q250 (Q251 if changing Q111)

DRAFT

10.7. Replacement of Pressure Relief Valve

This valve is fitted to the expansion tank gas head and is used to avoid any possibility of over-pressurising the overall system. It has a spring-loaded disc positioned against a seat. It is the spring pressure upon this disc that determines the point at which it can lift, ie relieve the system pressure.

The unit FL101 can be maintained as follows:

- Close the hydraulic valves Q103 and Q104
- Close Nitrogen gas valve Q109
- Relieve the tank standing gas pressure.
- Remove pressure relief valve FL101.
- Clean out old PTFE tape from thread.
- Source a new PRV.
- Apply PTFE tape to male thread.
- Replace pressure relief valve FL101

DRAFT

10.8. Replacing Pumps

The following information covers pump removal / replacement as well as servicing. We recommend that any pump servicing is carried out by specialist engineers or manufacturers themselves.

In the event of a pump replacement or service, the pump assembly and associated pipe leg must be filled and air bled with the system off line. Failure to do so could allow a slug of contaminated coolant to enter the circuit and thereby cause an alarm or trip.

These pumps have been selected for ease of spares supply and maintenance and are selected from the LOWARA family range. They have all wetted parts constructed in stainless steel and have been selected to operate at a point on its performance curve to be as efficient as possible.

The pump body must be kept clean at all times to allow correct transmission of heat.

NEVER use a pressure washer for cleaning the pumps as high pressure water may enter the bearings.

The three phase motor is wired and protected from overload by a ‘remote overload cut out’ to protect it from over current, lack of phase and excessive variations in voltage.

These pumps are wired to isolators. Control is via variable speed control units, designed to minimise water hammer and shock loading upon start up and allows for very accurate flow control.

DRAFT

10.8.1. Pump Removal Procedure

Firstly isolate the pump to be worked upon hydraulically by:-

For Pump G101 Close valves **Q115 and Q116**

For Pump G102. Close valves **Q117 and Q118**

- Electrically isolate the appropriate pump and **OPEN** the local isolator by turning the handle anti-clockwise and use a padlock to lock the isolator into its open position.
- Remove the cover of the terminal board and remove the mains wiring from the terminal posts.
- Remove the flexible conduit connection to the terminal block and draw clear of the motor.

- Use drain valves Q213 and Q211 for G101 and Q216 and Q214 for Q102 to drain the water within the pipes
- Remove the four pump base fixing bolts and the support bracket and place safely to one side.
- Now remove the flange fixing bolts on both the suction and discharge ports. Place the bolts, washers and nuts to a safe place (some water spillage will occur at this time from the sealed pipe sections).
- Remove the seals from between the flange faces and store safely.
- The pump may now be withdrawn using a lifting device and strap.
- The pump can now be returned to the manufacturer for overhaul.

OR

If attempting to service at site, place the pump on a clean and well illuminated workbench.

General information

The electric cable should be removed in accordance with local regulations.

Before assembly, clean and check all parts. Parts that are defective should be replaced by new parts.

Order the necessary service kits, see "Parts list".

Gaskets and O-rings should always be replaced when the pump is overhauled.

The pump should be tested according to the test specifications below:

400V / 3Ph / 50Hz

Pumps: **15SV07F055T**

The pump is now ready to return to service. It is recommended that the pump now runs for approximately 30 minutes to allow the conductivity level to return to normal.

DRAFT

IMPORTANT NOTES

During this operation the system coolant level will fall as the pump / pipe is filled. It is essential that the recommended coolant level is restored immediately (use the fill procedure in GRE document T00060 – SO02839 ESS CWS01 85kW Cooling Skid - ITP

Also, the pump during overhaul MUST BE absolutely clean and flushed with deionised water. IF ANY CONTAMINANT (ie drinking water or soluble substances) are left in the pump, a 'slug' of contaminated water will enter the system and could lead to a trip alarm condition.

DRAFT

10.9. Cleaning the Main System Filter

One 840 Micron double-ply basket filter unit is fitted to the main circuit to ensure that the coolant leaving the unit is clean and for ultimate system protection.

This unit is able to be withdrawn for cleaning. However, once the system is clean and in service, this requirement is extremely unlikely in the lifetime of this system.

Cleaning the Filter Element (HQ101) Procedure:

It is NOT possible for this procedure to be carried out during system operation. It is ESSENTIAL to stop the whole system.

- Close valves Q101, Q102, Q112 and Q126
- Loosen the bolts around the top flange
- Remove the bolts and store safely
- Lift the flange away from the filter housing.

Take care when lifting the flange off the top of the filter housing

- Store the flange and gasket in a safe location.
- This exposes the double-ply filter mesh, which can then be removed using the handle provided.

DRAFT

- Clean the filter mesh in clean, solvent-free solution

NEVER use detergents or any cleaning chemicals to clean the elements

- Very slowly replace the element into the body.
- Replace the gasket and flange to the top of the filter housing, and tighten the M24 bolts to 250Nm
- Flush the filter housing with fully deionised water, by connecting a hose to Q112 and filling the housing
- This is to ensure that the filter is full of DEIONISED water when it is brought back into circuit.
- Close Q112 and remove hose
- Fully open Q101 and Q102 for normal operation. Open Q126 if bypass is required.

The system now has the clean filter in operation.

DRAFT

10.10. Cleaning the Deionisation Circuit Filters.

These deionisation filter units are fitted one after each deionising bottles and each is designed to capture any escaping resin beads or resin dust that may escape from the cylinder.

Example: Replacing filter element HQ103

Should flow monitor KF112 indicate low flow, the following method to remove and replace filter element on HQ103 is as follows:

System will be filled and running when changing a filter element. This test procedure is for changing filter element HQ103. The procedure can be adapted to change filter elements HQ104. The procedure must only be carried out on one filter at a time.

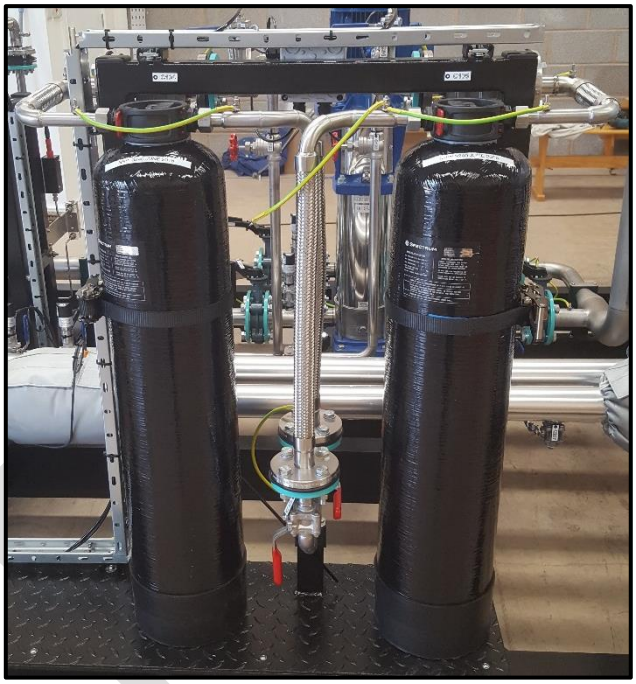
- Check water level PG105 or via HMI. Make a note of water level
- Close Q120 and Q121
- Drain water from DI system into a bucket, place bucket under Q223
- Open Q223 to drain water from DI bottle pipe work
- Open Q231
- Close Q223 when all water is drained
- Using the tommy bar you can now undo the collar and release the filter housing. To do this firmly hold the filter housing and place the tommy bar into one of the holes of the collar, pull on the tommy bar anticlockwise to unscrew the collar.
- Lower the filter housing and filter element into a bucket to catch any remaining coolant and remove the old filter element from the filter housing, making sure to retain the metal filter element core.
- Install the new filter element and metal filter element into the filter housing.

DRAFT

- Offer the filter housing up to the head, ensuring the upper spigot is located in the center of the cartridge and slide the collar all the way up the filter housing until it reaches the head.
- With a clockwise motion, screw together until hand tight, then using the tommy bar tighten by a ¼ turn to ensure the housing is watertight.
- Check Q223 is closed
- Open Q120. Air will bleed via Q231
- Flush filter housing via Q231 into a bucket. When the filter is flushed and water runs free of air Close Q231
- Slowly open Q121
- Check for leaks on the filter housing
- Observe flows of DI circuits via HMI, see KF112 and KF113, balance flows using Q122 and Q125 if required
- Check water level and system conductivity
- The filter is now clean and fully operational

DRAFT

10.11. Replacing Deionising Bottle



The deionising bottles remove any impurities from the coolant and reduce the conductivity to an acceptable level. The deionising resin inside the deionising bottles will eventually be depleted and need replacing.

Example: Replace the deionising resin in deionising bottle C104 on the treatment skid using the following method:

System will be filled and running when changing a deionising bottle. This test procedure is for changing Deionising Bottle C104. The procedure can be adapted to change deionising bottles C105. The procedure must only be carried out on one deionising bottle at a time.

- Check water level PG105 or via HMI. Make a note of water level
- Close Q120 and Q121
- Drain water from DI system into a bucket, place bucket under Q223
- Open Q223 to drain water from DI bottle pipe work
- Close Q223
- Remove retaining strap from DI bottle
- Remove DI bottle
- Remove distribution head from DI bottle.
- Remove deionizing resin from DI bottle.
- Rinse DI bottle out to remove all old resin
- Replace DI bottle distribution head, and refill with new nuclear grade resin

DRAFT

- Reposition DI bottle on treatment skid, and redo ratchet strap to fix bottle to bottle stand
- Reattach flexible hoses to DI bottle, making sure the deionizing bottle is connected in the right orientation (align arrow on distribution head with flow direction)
- Open Q231
- Partly open Q120 to slowly fill C104 DI system. Air will bleed via Q231
- Flush water via Q231 to bucket, to clear all air in new DI bottle.
- Open Q120 fully
- Close Q231 when flushing is complete
- Open Q122 partly to slowly open the new DI bottle to the system.
- Watch the system Conductivity. If system Conductivity remains good, slowly open the new bottle fully to the system
- Rebalance the flow between the two DI bottles if required.
- Check water level. Refill system to level in step 1 if required.
- The deionizing bottle is now clean and fully operational

DRAFT

11. Troubleshooting

The purpose of this troubleshooting section is to pinpoint possible system fault causes and solutions. This section should be referred to in case of cooling system alarm or trip, or any other fault.

11.1. Troubleshooting Active Alarms

In case of any active alarm refer to the table below for possible causes and solutions. All recommended actions to be carried out by qualified engineer. If fault persists contact GRE.

Active Alarm / Trip Type	Possible Cause	Recommended Action
Isolator Open	• Isolator Open	• Close Isolator, Reset Alarm
Supply Fault	• Voltage Discrepancy • Supply Overload	• Rectify Supply Fault, Reset Alarm
Supply Overload	• PSU Fault • Too Much Current	• Contact Component Manufacturer. • Rectify Supply Fault, Reset Alarm
DC Supply Overload	• PSU Fault • Too Much Current	• Contact Component Manufacturer. • Rectify Supply Fault, Reset Alarm
Inverter Fault	• Check Inverter alarms	• Contact Component Manufacture • Rectify Fault, Reset Alarm
Sensor Fault	• Sensor Failure • Communication Failure	• Replace Sensor, Reset Alarm • Replace Wire, Reset Alarm

DRAFT

Active Alarm / Trip Type	Possible Cause	Recommended Action
Sensor Discrepancy	• Sensor Fault	• Rectify Fault, Reset Alarm
Position Fault	• Valve Fault • Actuator • Valve Position Deviation Time Limit Too Low	• Replace Valve / Actuator, Reset Alarm • Check Valve Position Deviation Time Limit, Reset Alarm
Main Flow Low	• Main Filter Blocked	• Clean Main Filter Mesh, Reset Alarm
DI Bottle Flow Low	• DI Filter Blocked	• Replace DI Filter Element, Reset Alarm
Main Filter Blocked	• Debris in coolant	• Clean Main Filter Mesh, Reset Alarm
Temperature Low	• Actuated Valve Position Fault	• Contact Component Manufacturer. Rectify Fault, Reset Alarm
Temperature High	• Actuated Valve Position Fault • Air Blast Heat Exchanger Fan Failure	• Contact Component Manufacturer. Rectify Fault, Reset Alarm
Pressure Low	• Coolant Leak • Nitrogen Gas Leak • Nitrogen Gas Cap Not Set	• Determine Leak Type and Location, Replace Leaking Component, Reset Alarm • Set Gas Cap

DRAFT

Active Alarm / Trip Type	Possible Cause	Recommended Action
Pressure High	• Valve Shut • Main Filter Blocked	• Open Relevant Valve, Reset Alarm • Clean Main Filter Mesh, Reset Alarm
Conductivity High	• DI Resin Exhausted	• Replace DI Resin, Reset Alarm
Level Low	• Coolant Leak	• Determine Leak Type and Location, Replace Leaking Component, Reset Alarm
Level High	• System Overfilled with Coolant • System Temperature Too High	• Drain Coolant to Re-establish Correct Level, Reset Alarm. • Reduce Coolant Temperature, Reset Alarm

DRAFT

13. Supporting Documents

Manuals for cooling plant components, and relevant component GRE drawings are supporting documents available on request from GRE.

DRAFT