C Series
HYDROGEN GAS GENERATOR

Maintenance Manual

C Series 3 Hydrogen Gas Generator
Maintenance Manual

Model Numbers:
C10, C20, C30
(10, 20, 30 Nm^3/hr @ 30 bar)

C Series Serial Number: _____

C Series Model Number: _____

SIC 3569-901	Gas Generating Equipment
NAICS 333-999-8556	Gas Generating Equipment

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WARNING **C SERIES HYDROGEN GENERATOR NOT INTENDED FOR USE IN ANY MEDICAL, LIFE SAVING OR LIFE SUSTAINING APPLICATIONS.**

READ THIS DOCUMENT THOROUGHLY AND CAREFULLY

Information in this document is provided in connection with Nel C Series Hydrogen Generator. This document has been prepared to provide familiarization with Nel's requirements for installation of the C Series Hydrogen Generator and the operation of the C Series Hydrogen Generator. However, the information in this document is furnished for informational use only, is subject to change without notice, and should not be construed as a commitment by Nel. Nel assumes no responsibility or liability for any errors or inaccuracies that may appear in this document.

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C Series 3 Hydrogen Generator
MAINTENANCE MANUAL

CONTENTS ***Page***

FIGURES ***Page Number***

TABLES ***Page Number***

Key Definitions, Acronyms, and Abbreviations Used in this Document

µS/cm – MicroSiemen per centimeter, a measure of water conductivity
Bar – 14.5 PSI or 100 KPa (KiloPascals or Newton/cm), a unit of system pressure. All pressures are at gauge pressure unless otherwise specified.
cc – Cubic centimeter
CPI – Chemical Process Instrumentation
FPT – Female Pipe Thread
FuelGen® - Registered TM of Proton Energy Systems, Inc. for hydrogen systems, comprised of a hydrogen generator, hydrogen storage container, hydrogen dispensers and parts and accessories
HCS – H Series Control System
HGMS – Hydrogen Gas Management Subsystem
HOGEN® - Registered TM of Proton Energy Systems Inc. for packaged water electrolysis-based hydrogen generators
kVA – Kilovolt - Ampere
kW – Kilowatt
L/m – Liters per minute flow (for hydrogen, calculated at a standardized temperature & pressure)
LAN – Local Area Network
LFL – Lower Flammability Limit
Mohm-cm – Mega ohm – cm, a measure of water resistivity
NEC – National Electric Code, NFPA 70
NFPA – National Fire Protection Association, a Standards Organization
Nm^3/h – Normal cubic meter per hour (International Normal conditions are 1.01325 bar and 0 Celsius)
NPT – National Pipe Thread
NRTL – Nationally Recognized Testing Laboratory
P&ID – Piping and Instrumentation Diagram (Fluid Schematic)
PEM - Proton Exchange Membrane
PPE – Personal Protective Equipment
PPM – Parts per Million
PSI – Pounds force per square inch (lb_f/in^2=6894.7 Pa)**,** a unit of pressure. All pressures are at gauge pressure unless otherwise specified.
SCFH – Standard cubic foot per hour (US Standard conditions for air are 1 atmosphere and 70°F)
Standard atmosphere = 1.01325 bara = 14.696 psia
TCU – Thermal Control Unit
TVSS – Transient Voltage Surge Suppressor
VAC – Volts Alternating Current
VDC – Volts Direct Current
WOMS – Water/Oxygen Management Subsystem

- Notes contain helpful suggestions or references.

- **Indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices. This could result in equipment damage or loss of data.**

- **INDICATES A POTENTIALLY HAZARDOUS SITUATION, WHICH, IF NOT AVOIDED, COULD RESULT IN DEATH OR SERIOUS INJURY. THE READER IS IN A SITUATION THAT COULD CAUSE BODILY INJURY.**

1. INTRODUCTION

Our Nel Hydrogen US C Series Hydrogen Generator (Figure 1) is a Proton Exchange Membrane (PEM) water electrolysis system packaged for easy onsite installation and automatic operation. Depending on which model, the C Series Hydrogen Generator delivers 10, 20, or 30Nm^3/hr H_2 (21.6, 43.3, or 65 kg/day H_2). The C Series Hydrogen Generator is configured at the factory per customer requirements to operate in 'Tank Filling' or 'Load Following'. In Tank Filling configuration, the generator monitors an external hydrogen storage tank. When the pressure in the storage tank declines below a configurable threshold, the C Series unit produces H_2 until the pressure is above a second configurable threshold. In Load Following configuration, the generator monitors customer H_2 demand and automatically adjusts hydrogen generation rate to match the customer's process. In this configuration, the generator can deliver H_2 between 0 and 100% of rated flow rate.

The C Series Hydrogen Generator is designed to operate in a non-classified area. The generator can be configured at the factory according to customer environmental needs to operate in an indoor or outdoor environment.

Nel provides these instructions to guide the maintenance of a C Series Hydrogen Generators. Important safety information is also included in this manual. Please take the time to familiarize yourself with the system and this manual.

DO NOT USE THE C SERIES HYDROGEN GENERATOR IN A MANNER NOT SPECIFIED BY PROTON.

Figure 1 - C Series Hydrogen Generator

This manual attempts to answer most of the frequently asked questions with regards to the operation of the unit. NEL technical staff is also available to answer questions and support the

successful deployment of this equipment. Please call **(203) 949-8697** and ask for technical service or email techsupport@nelhydrogen.com. Please have the serial number of your unit available.

WARNING **After performing any service or maintenance work, make sure the doors to the enclosures are completely closed prior to the startup operation of your C Series Hydrogen Generator.**

WARNING **If the C Series is not operational, check for DI water content in the cell stack hoses every 30 days. If DI water is not present in the cell stack hoses, re-hydrate the cell stack hoses as needed. A cell stack hydration kit is available through NEL.**

NOTE NEL can offer a full range of maintenance services. Contact NEL Customer Service at (**203) 949-8697** or your local service provider/supplier for more information.

1.1 General Procedures

Prior to performing scheduled maintenance, the following measures should be taken:

- Make sure the work area is clean before beginning any maintenance work.
- Personal Protective Equipment (e.g. safety glasses, gloves, etc.…) should be worn prior to beginning service of the system.

NOTE Periodic inspection and maintenance of the hydrogen generator shall be performed by a qualified service personnel.

NOTE When hydrogen lines have been altered in any way, a system leak check is to be performed using a liquid gas detection method, handheld combustible gas sensor (supplied with unit) or equivalent.

NOTE Contact Nel for instructions on how to disassemble and transport the hydrogen generator or components of the hydrogen generator.

CAUTION **Take special care to avoid introducing dust or metal particles into the water system. This may cause damage to the system.**

CAUTION **Take special care to avoid damaging the doors and seals of the hydrogen generator. Visually inspect for dents, cracks, broken plastic, and other signs of damage on a regular basis. Contact PROTON or your local service provider/supplier to determine if damaged parts need to be replaced.**

WARNING **THE CELL STACK RETAINS A SIGNIFICANT CAPACITIVE CHARGE EVEN WHEN THE SYSTEM IS DISCONNECTED FROM POWER. CARE SHOULD BE TAKEN WHEN WORKING NEAR THE CELL STACK TO AVOID SHORT CIRCUITING THE TERMINALS.**

IT IS ESSENTIAL THAT THE SAFETY SYSTEM IS NOT BYPASSED. CONTINUED OPERATION COULD RESULT IN SERIOUS INJURY AND/OR DAMAGE TO THE GENERATOR.

FAILURE TO CHECK FOR LEAKS IN THE SYSTEM AFTER MAINTENANCE TO HYDROGEN COMPONENTS MAY RESULT IN A SYSTEM SHUTDOWN AND MAY LEAD TO A DANGEROUS SITUATION.

1.2 References

PD-0100-0099, MANUAL, INSTALLATION, C SERIES 3
PD-0100-0100, MANUAL, OPERATION, C SERIES 3
XPE2871, SCHEMATIC, ELECTRICAL, C SERIES 3
XPE2869, P&ID, HYDROGEN GENERATOR, C SERIES 3
PD-9900-0038, PARAMETERS, SOFTWARE, DEFAULT, C SERIES 3
PD-0600-0068, C SERIES PRODUCT SPECIFICATION
PD-9900-0039, DIAGRAM, INTERFACE, MECHANICAL, C SERIES 3
PD-0900-0009, CELL STACK HYDRATION AND STORAGE

2 MAINTENANCE PREPARATION

2.1 Manual Shutdown – Tank Filling and Load Following Operation

Manual shutdown of the C Series hydrogen generator occurs by pressing the red "Stop/Reset" button.

The E-Stop and power disconnect switch cause an immediate stop and does not allow the unit to go through the normal shutdown process. Repeated use of the E-Stop button can degrade the C Series Hydrogen Generator's performance. The preferred method of shutdown is to press the red "Stop" button on the keypad.

For Tank Filling configurations, pressing the red "Stop" button will stop the unit, but it **will not** automatically start when the external tank pressure is below the reset start value.

When engaging the E-Stop the unit will not be able to make hydrogen when the safety circuit is triggered. The safety circuit does not shutdown the system entirely. Fans and other areas of the safety circuit will remain engaged. The C Series Hydrogen Generator safely depressurizes when the E-Stop is engaged.

2.2 Draining the System

1. Turn on the Electrolyzer circuit breaker handle (CB1) while depressing the *Up* and *Down* Arrow Keys on the user interface at the same time until the system momentarily displays 'Booting System in Service Mode' as shown in Figure 2.

Figure 2 - Flash Screen for Boot in Service Mode

2. Using the *Down* Arrow Key, scroll down to the 'Service Mode' menu item as shown in Figure 3 and depress the Enter button.

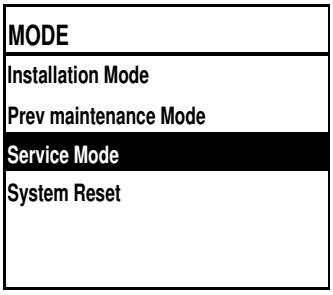

Figure 3 - 'Service Mode' Selection Screen

3. The C Series prompts the user for a password. Press the *Right* Arrow Key eight (8) times to access the required menu.
4. Once in 'Service Mode' menu, scroll down to the 'Adjust digital output' menu item and depress *Enter* (Figure 4).

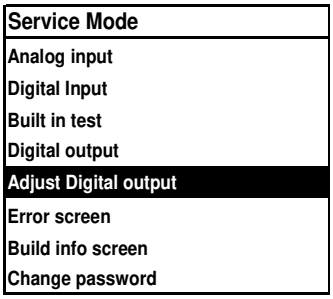

Figure 4 - 'Adjust Digital Output' Selection Screen

5. Within the 'Adjust digital output' sub-menu, scroll down to the 'SV211 A200 Drain Valve' as presented in Figure 5. Depress the *Enter* key to toggle between CLOSE and OPEN. The A200 can be drained with the valve in the OPEN position.

Adjust Digital output		
SV307-A	Stack A valve	CLOSE
SV307-B	Stack B valve	CLOSE
SV307-C	Stack C valve	CLOSE
SV329	Vent valve	CLOSE
CP205	Pump control	OFF
SV801	Calibration gas valve	CLOSE
SV211	A200 Drain valve	CLOSE
SV510	A500 Inlet valve	CLOSE

Figure 5 - 'A200 Drain Valve' Selection Screen

2.3 Lockout/Tagout Procedure

The Lockout/Tagout procedure is intended to prevent injuries during machine or equipment service and maintenance operations. Lockout/Tagout prevents injuries that can be caused by the unexpected energizing or start-up of machines or equipment, or the release of stored energy during maintenance and service jobs. This procedure should be applied any time maintenance or service work is done on the C Series hydrogen generator or TCU.

NOTE

Follow the Lockout/Tagout policy for the facility where the C Series hydrogen generator is installed.

WARNING

CONFIRM THE SYSTEM IS DE-ENERGIZED WITH A VOLTMETER.

WARNING

WEAR PROPER PPE PER NFPA 70E FOR VOLTAGE TESTING.

WARNING

DO NOT PERFORM SERVICE WITHIN THE DISCONNECT PANEL WITHOUT REMOVING POWER TO THE DISCONNECT PANEL AND LOCKING OUT THE POWER SOURCE.

The following steps outline an example of a Lockout/Tagout Procedure:

1. Prepare for shutdown.
   Before the authorized employee removes power on the C Series hydrogen generator and/or TCU, the authorized employee must know the type and magnitude of the energy and its hazards and must know how to control the energy. Before

Lockout/Tagout devices can be applied, either the employer or the authorized employee must notify the affected employees.

2. Shutdown.
   The C Series hydrogen generator or TCU must be turned off (not generating hydrogen or in stand-by mode) according to the established procedures. Shutting down the machine must not create any increased hazards from equipment stoppage.
3. Isolate the equipment.
   The authorized employee, who is performing the servicing or maintenance work, must isolate the C Series hydrogen generator or TCU from its energy sources. The energy-isolating device must be physically located and operated by the authorized employee.
4. Apply Lockout/Tagout devices.
   The authorized employee is to apply Lockout/Tagout devices to the energy-isolating device. Lockout devices must hold the switch in the "OFF" position. If a Tagout system is used, the tags must clearly show that moving the energy-isolating device from the "OFF" position is not allowed.
5. Release stored energy.
   Any potentially hazardous stored or residual energy from all sources and components must be released, relieved, disconnected, or restrained to make sure they are safe.
6. Verification.
   The authorized employee must verify that the Lockout/Tagout procedure successfully isolated the C Series hydrogen generator or TCU from its energy sources before electrical work begins. To verify that power is disconnected from the power source, use an approved voltage meter, rated to Category II or higher to check for no AC voltage.

To release the C Series hydrogen generator or TCU from Lockout/Tagout, use the following steps:

1. Check the C Series hydrogen generator and/or TCU.
   Before any Lockout/Tagout devices are removed, the authorized employee must replace all machine guards and remove all tools and nonessential items from the area. Remove any blocking devices that were inserted. Make sure the C Series hydrogen generator or TCU is intact and ready to operate.
2. Check for employees.
   The authorized employee must check the work area to make sure all employees are in a safe place away from the C Series hydrogen generator or TCU before any Lockout/Tagout devices are removed.
3. Remove Lockout/Tagout devices.
   The authorized employee who applied the Lockout/Tagout device is the only person authorized to remove it. After the Lockout/Tagout devices are removed and before

the generator is started, the affected employees must be notified that the Lockout/Tagout devices have been removed.

NOTE

The C Series hydrogen generator may be locked/tagged out using the built in disconnect, which disconnects L1, L2 and L3 (Figure 6).

WARNING

SUPPLY CONDUCTOR TO INPUTS OF L1, L2 and L3 WILL STILL BE ENERGIZED UNLESS THE FACILITY DISCONNECTS FOR THE HYDROGEN GENERATOR HAS ALSO BEEN LOCKED AND TAGGED OUT.

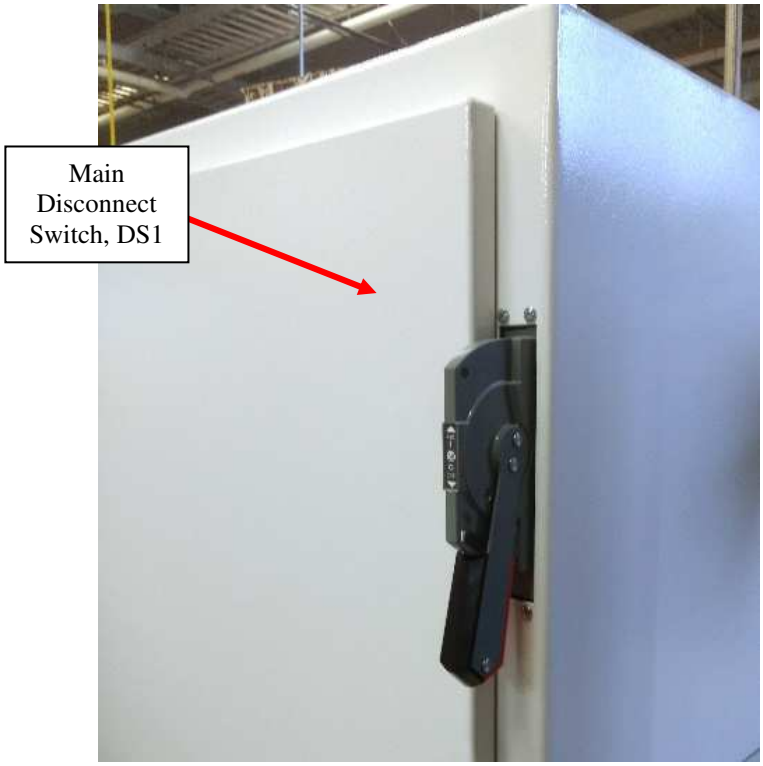

Figure 6 - C Series main disconnect switch, DS1

2.3.1 Discharging the Cell Stack

WARNING

THE CELL STACK RETAINS A SIGNIFICANT CAPACITIVE CHARGE EVEN WHEN THE SYSTEM IS DISCONNECTED FROM POWER. CARE SHOULD BE TAKEN WHEN WORKING NEAR THE CELL STACK TO AVOID SHORT CIRCUITING THE TERMINALS.

The cell stack holds a capacitive charge for an extended period of time. The charge may be as high as 90 volts DC immediately after the C Series is shutdown. This DC potential is exposed at the positive terminal of the cell stack and the positive DC terminals on the Power Supply module. It is important to prevent electric shock use the Cell Stack Voltage Dissipating Tool which is supplied with each system.

To use the Cell Stack Voltage Dissipating Tool, first remove the front cover to access the cell stack and then attach the alligator clips to the positive and negative terminals on the cell stack. DC voltage below 5 volts DC is considered safe.

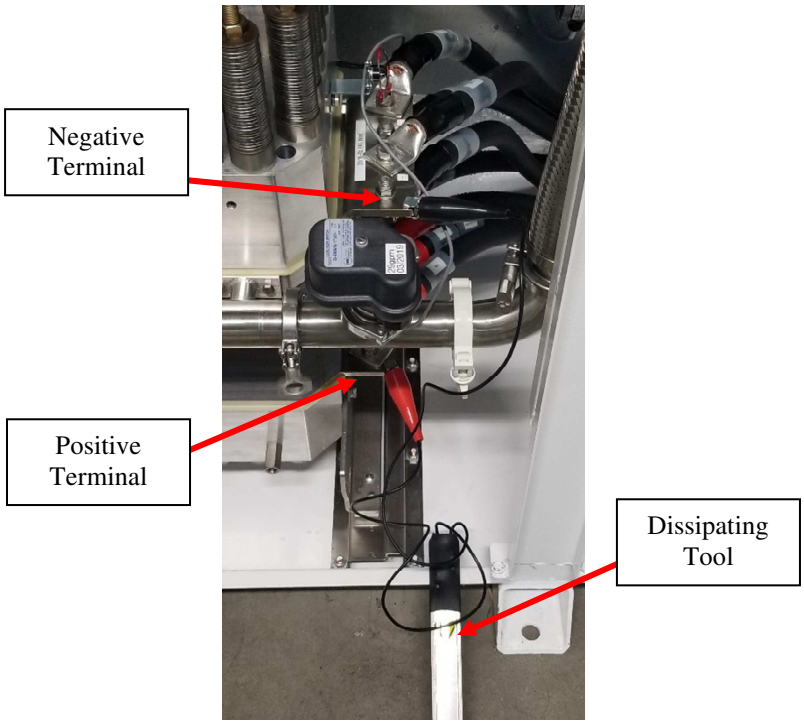

Figure 7 – Cell Stack Voltage Dissipating Tool in Use

CAUTION **Personnel with pacemakers, defibrillators or other electrical medical equipment should not perform any cell stack or power supply maintenance.**

2.4 Applying Power to the System

Upon the completion of generator maintenance use the following instructions for applying power to and turning the system back on.

1. Confirm the Service Bypass Switch Key is removed (Figure 9)
2. Verify the doors for both enclosures are closed and secured.
3. Verify the air inlet and exhaust openings are clear (free from blockage) and the air filters and screens are installed.
4. Verify the DI water supply is on.
5. Verify the Main Power Disconnect switch for the Thermal Control Unit (TCU) (*when configured*) is ON, (*else assure all customer supplied cooling is on and available to both enclosures*).
6. Turn the Main Disconnect Switch (DS1) on the Power Supply enclosure from OFF to ON (Figure 6).

7. Turn the Electrolyzer Circuit Breaker (CB1) on the Electrolyzer enclosure from OFF to ON.
8. Press the green “Start” button when the display screen shows “Ready to Start”.

2.5 Tools Required

Most service procedures require basic hand tools: SAE wrenches, screwdrivers, pliers, etc. Some specialized tools are required and are listed in Table 1.
A detailed description on how to use the tool in its application can be found in the section where the tool is used. Before beginning any maintenance procedure, it is good practice to review the appropriate section of the manual to ensure the proper tools are assembled before beginning a maintenance procedure.

Table 1 - Specialized Tools Required for Scheduled Maintenance

Tools Required	Function	Provider
Basic Hand Tools: SAE Wrenches, Screwdrivers, Pliers, etc.	General Maintenance	Customer supplied
60 ohm, 1000 Watt Resistor and Spring Clips	Cell Stack Discharge	Included in Loose Parts
Hand Held Combustible Gas Detector and charger	Fault Analysis	Included in Loose Parts
Wrench, Spanner, Solenoid	Solenoid Replacement	Included in Loose Parts
Key, Enclosure, 7mm triangle	Open or lock door compartments	Included in Loose Parts
Wrench, Spanner 15, 20, 30, 50, 80	Orifice Replacement	Included in Loose Parts
Wrench, Spanner 70	Orifice Replacement	Included in Loose Parts
Liquid Leak Detector (SNOOP)	General Maintenance	Sold separately
Calibration Gas: 2 Percent Hydrogen in Air Regulated to 50 psig	Combustible Gas Detector Calibration	Sold separately
Multimeter / DC Amp Clamp	Fault Analysis	Sold separately
Krytox® synthetic lubricant	O-ring Replacement	Sold separately

A standard set of tools is available from Nel. Contact NEL Customer Service at **(203) 949-8697** for more information.

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2.6 Compression Tube Fitting Information

The C Series Hydrogen Generator is designed to produce hydrogen that contains no more than 5 PPM of water and 1 PPM of other contaminants. Hydrogen can be delivered at pressures ranging from 0 to 30 barg (435 psig) and up to the unit's rated flow rate. The product hydrogen port uses a compression tube fitting for ¼" OD tubing 0.035" wall stainless steel. These fittings are reusable when used properly, according to the procedures included in this section.

To ensure proper connections, use the following procedure and See Figure 8 and Table 2.

1. Mark the fitting and nut for assembly reference.
2. Use the appropriate SAE wrench to loosen the nut.
3. Completely unthread the nut from the fitting before pulling off the nut.
4. When reassembling the fitting, make sure the assembly has been inserted into the fitting until the ferrule sits in the fitting.
5. Re-tighten the nut by hand.
6. Using an appropriately sized SAE wrench, tighten the nut until the reference marks are aligned (A noticeable increase in mechanical resistance should be felt.).
7. Tighten the nut an additional 1/12th of a turn (equal to ½ a flat surface on the nut).

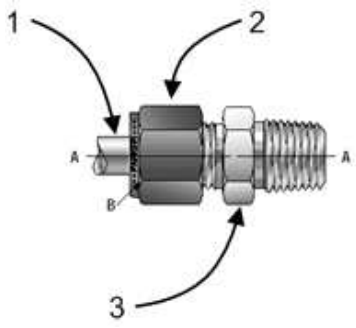

Figure 8 - Compression Tube Fitting Assembly

Table 2 - Tube Fitting Assembly Details

Reference	Detail
A	Reference Marks Made
B	1/12th Extra Turn of Nut
1	Tubing
2	Nut
3	Fitting

3 SERVICE BYPASS MODE, REMOTE BYPASS AND ERROR CODES

3.1 Service Bypass Mode

ONLY AUTHORIZED SERVICE PERSONNEL SHOULD USE THE BYPASS KEY. EXTREME CARE SHOULD BE TAKEN WHEN WORKING IN THE VICINITY OF ENERGIZED COMPONENTS. NEVER OPERATE THE SYSTEM IN A POORLY VENTILATED AREA.

The service bypass mode can be used for the purpose of service, to allow the hydrogen generator to operate with the electrolyzer doors open without losing power, for one hour. If the doors remain open for longer than one hour the unit will shut down on an E-Stop error. The key is designed so that it is unable to be removed while in the bypass position facilitating detection of a bypassed condition.

In order to activate the service bypass mode on the C Series hydrogen generator during hydrogen generation, turn the key in the control panel area to the right after the dilution fan is rotating at full speed (Figure 9).

In order to exit the service bypass function while the hydrogen generation:

- Close all doors and covers securely.
- Wait for one minute for the system to ensure proper dilution air pressure.
- Return the key-switch to the left (RUN) position and remove the key.

REMOVE AND STORE THE SERVICE BYPASS KEY AWAY FROM THE C SERIES HYDROGEN GENERATOR WHEN SERVICE IS COMPLETE.

Figure 9 - Key in Service Bypass Mode

AUTHORIZED SERVICE PERSONNEL SHOULD ONLY CARRY OUT THIS PROCEDURE. EXTREME CARE SHOULD BE TAKEN IN WORKING IN THE VICINITY OF ELECTRICAL COMPONENTS. NEVER OPERATE THE SYSTEM IN A POORLY VENTILATED AREA. IF A HYDROGEN LEAK IS SUSPECTED, DO NOT USE THIS FEATURE AS AN OVERRIDE.

3.2 Remote Start/Stop Bypass

The remote start/stop bypass key (SW2) is used to disable the remote start (TB16-25/26) and stop (TB16-11/12) commands. The key switch is located on the side of the controller panel inside the electrolyzer enclosure. The key uses two normally open contacts to open the signals from the customer to the control board when the key is in the "Local" mode. While in the Local mode the key can be removed from the switch and held by the service technician while performing maintenance or troubleshooting. To allow the remote start and stop commands to pass through to the controller the key should be placed in the switch and turned to "Remote". The key can remain in the key switch and in the Remote position during normal operation.

Figure 10 - Key switch in Local mode and Key switch in Remote Mode

3.3 Warning Codes

In the event the control system detects an abnormal condition, the system will output one or more of the following warning codes (

Table **3**). Please contact the Technical Service department at **(203) 949-8697**or email techsupport@nelhydrogen.com, or call your local service provider/supplier for more information.

Table 3 - Warning Codes

Code	Abbreviated Description	Detailed Description
W01-W05	RESERVED	
W06	Low Temp – TE601 Coolant	TE601: Coolant temperature is low (< 3°C, 37.4°F).
W07	High Temp – TE601 Coolant	TE601: Coolant temperature is high (> 47°C, 116.6°F).
W08	High Temp – TE219 System	TE219: DI system temperature in A200 is high (> 63°C, 145.4°F). The hydrogen output will start to degrade.
W09	High Concentration – CG220	CG220: CG gas concentration in A200 is high (> 45% LFL).
W10-W17	RESERVED	
W18	High Temp – TE159 P/S Enclosure	TE159: Air temperature in Power Supply enclosure is high (> 50°C, 122°F).
W19-W20	RESERVED	
W21	Due – CG calibrations	CG220 calibration is due within 2 weeks. CG121 and CG131 (if present) must also be calibrated when CG220 is calibrated.
W22	CG in O_2 Low Reading	Hydrogen Concentration in A200 is reading <5% LFL
W23	RESERVED	
W24_1…12	High Temp – Power Supply	Power Supply Module [1…12] is high (> 75°C, 167°F)
W25	Repetitive High Temp – Power Supply	W24 Warning occurrence > 10 times

Warnings do not shut down the C Series. Warnings alert that an undesirable condition exists and may result in an error. A corrective action should be taken to eliminate the warning before an error code results.

3.4 Error Codes

In the event the control system detects a fault that may require the C Series to cease operation, the unit will automatically shutdown. The graphical display will output any one of the following error codes (Table 4). Please contact the Technical Service department immediately at **(203) 949-8697**or email techsupport@nelhydrogen.com, or call your local service provider/supplier for more information.

Table 4 - Error Codes

Code	Abbreviated Description	Detailed Description
E01	Low Voltage – Cell Stack	Cell Stack voltage is low (< 0.8 Volts/cell).
E02	High Voltage – Cell Stack	Cell Stack voltage is high (> 2.3 Volts/cell).
E03	Low Current – Cell Stack	Cell Stack current is low (< 1 Amp).
E04	High Current – Cell Stack	Cell Stack current is high (C10=1407 A, C10,30=1400 A).
E05	RESERVED	
E06	Comm. Error (Startup) – Power Supply	Communications error between system controller and power supply modules during startup.
E07	Comm. Error (Generating) – Power Supply	Communications error between system controller and power supply modules during hydrogen generation.
E08	RESERVED	
E09	High Pressure – PT307 System	PT307 system pressure is high (> 33barg, 478.6psig).
E10	Low Pressure – PT307 System	PT307 system pressure is low (< 26.2barg, 380psig) for more than 50 seconds.
E11	Pressure Timeout Error	System Pressure, PT307, does not reach or exceed 26.2barg (380psig) within 200 seconds from startup.
E12	High Temperature – TE219 System	TE219 system temperature is high in A200 (>65°C, 149°F).
E13	Low Temperature – TE219 System	TE219 system temperature is low in A200 (< 2°C, 35.6°F). *** MUST ENTER SERVICE MODE TO RESET ***
E14	Empty –A200	LS201 level sensor is at empty position in A200.
E15	Flooded – A200	LS201 level sensor is at flooded position in A200.
E16_A	Bad Water Quality – RS209	RS209 water quality sensor has detected poor water quality (<1Mohm-cm, >1µS/cm) for greater than 30 seconds.
E16_B	Bad Water Quality – RS507	RS507 water quality sensor has detected poor water quality (<1Mohm-cm, >1µS/cm) for greater than 45 seconds when SV510 is on.
E17	A200 Pre-Start Timeout	Time for LS201 level sensor in the A200 takes more than 30 minutes to reach high level during Start-up.
E18	A300 Empty	LS301 level sensor is at empty condition in A300.
E19	A300 Flooded	LS301 level sensor is at flood condition in A300.
E20_A	Bad Sensor – RS209	RS209 water quality sensor value is out of range.
E20_B	Bad Sensor – RS507	RS507 water quality sensor value is out of range.
E21	Fault – Safety Relay 1 Status	Safety relay SR1 is de-energized or SR1 is energized before the dilution fan (FAN132) is powered
E22	RESERVED	

Code	Abbreviated Description	Detailed Description
E23	Fault – Safety Relay 2 Status	Safety circuit SR2 is de-energized
E24	High Concentration – CG220	CG220 hydrogen concentration in A200 exceeds 50 % LFL.
E25	RESERVED	
E26	Out of Range – CG220	Calibration values for CG sensor are out of range (CG220).
E27	RESERVED	
E28	Unexpected FSW250 Flow	Cell stack flow switch(es) are detecting flow prior to pump Start-up.
E29	Checksum Error – Controller	System controller has memory storage error
E30	Out of Range – 24V, 5V, 3.3V Supply	Input power source values to system controller are out of range.
E31	Fault – I/O Board Fuses	A digital output fuse is failed.
E32	High Temperature – Controller Board	The air temperature on the system controller board exceeds 65°C (149°F).
E33	Invalid State – A200 Level Switch	LS201 level sensor in the A200 is in a contradicting / illogical state.
E34	Invalid State – A300 Level Switch	LS301 level sensor in the A300 is in a contradicting / illogical state.
E35	LS301 – Empty Drain Time Too Long	LS301 level sensor in the A300 does not go to empty state during 10 minutes of Gen-to-Vent state.
E36	Low Water Flow – Cell Stack	Flow switch is not detecting required flow condition for Cell Stack.
E37-E39	RESERVED	
E40	Calibration Due – CG220	Validity of CG sensor has elapsed (>104 days) and needs to be recalibrated. CG121 and CG 131, if present, must also be calibrated.
E41	High Temperature – TE159 P/S Enclosure Air	Power supply enclosure air temperature is high (>55°C, 131°F).
E42	Out of Range – TE601 Customer Stack Coolant Supply Temperature	Coolant water temperature sensor value is out of range.
E43	Out of Range-PT312 Product Pressure	PT312 pressure sensor value is out of range.
E44	RESERVED	
E45	Out of Range – DPS340 Hydrogen Purity	DPS340 hydrogen purity sensor value is out of range.
E46	Out of Range – TE219 System Temperature	TE219 system temperature sensor value is out of range.
E47	Out of Range – PT307 System Pressure	PT307 system pressure sensor value is out of range.
E48	RESERVED	
E49	Low Purity – DPS340 Water Vapor	DPS340 product dew point sensor is low (< configurable parameter P48).
E50	Low Product Pressure – PT312	PT312 product pressure is low (<configurable parameter P50) for more than 10 seconds.

Code	Abbreviated Description	Detailed Description
E51	Out of Range – TE128 Electrolyzer enclosure Temperature	TE128 electrolyzer enclosure air temperature sensor is out of range.
E52	High Pressure – PT312 Product	PT312 product pressure is high (> 35barg, 507.6psig).
E53	Time Out – Cold Start Temperature	TE219 system water temperature is low (< 22°C, 71.6°F) for more than 300 minutes after generation.
E54	Alarm – TCU	Thermal Control Unit is either faulted or is not on-line during hydrogen generation.
E55	Time Out – A500	Time for LS501 level sensor in the A500 takes more than 90 minutes to reach low level during Start-up.
E56	Empty – A500	LS501 level sensor is at empty condition in A500.
E57	Flooded – A500	LS501 level sensor is at flooded condition in A500.
E58	Invalid State – LS501	LS501 level sensor in the A500 is in a contradicting / illogical state.
E59	Out of Range – PT207 Oxygen	PT207 oxygen pressure sensor value is out of range.
E60	High Pressure – PT207 Oxygen	PT207 Oxygen pressure is high (> 2.76barg, 40psig)
E61	High Pressure – PT307 Gen to Vent Hydrogen	PT307 system pressure value is too high during Gen-to-Vent state (>10 minutes).
E62_ 1…12	PS Shelf [1…12] Fault	Power Supply Module [1…12] AC Failure
E63_ 1…12	PS Shelf [1…12] Over Temp Fault	Power supply module [1…12] high temperature (> 85°C, 185°F)
E64_ 1…12	PS Shelf [1…12] High Voltage	Power supply module [1…12] high voltage (C10= 60V, C20=120V, C30=180V)
E65_ 1…12	PS Shelf [1…12] Comms Fault	Communications error between system controller and power supply module [1…12]
E66-E67	RESERVED	

NOTE

Errors E62 and E64 shut down the individual power supplies, but the C Series still operates at partial capacity (degraded mode operation) (Table 5).

3.5 Operating Modes

The C Series will display the following operating modes:

Table 5 - Operating Modes

Mode	Description
M01	Hydrogen Generation – Load Following Mode
M02	RESERVED
M03	Hydrogen Generation – Tank Filling Mode
M04	Standby / Idle
M05	Degraded Mode due to Power Supply Failure
M06-M08	RESERVED
M09	Degraded Mode due to Low Current
M10	RESERVED
M11	Degraded Mode due to High Temperature
M13	Combustible Gas Sensor Calibration Mode
M14	Firmware Upgrade
M15	Generate to Vent Mode
M16	Error Condition - Unit Shutdown Mode

4 MAINTENANCE ACTIVITIES

There are specific activities that must be performed on a quarterly (three months) basis, and others on an annual maintenance basis. These are identified in the table below, and the detailed instructions for each of these activities is included here.

Table 6. Maintenance Activities

Frequency	Subsystems affected	Kit / Parts
Quarterly	General Area Inspection Mechanical Inspection CG Sensor Calibration Power component inspection Surge protection inspection Air Filter Inspection and Maintenance Inspect/Adjust Date & Time	KT-0100-0056
Annual	Torque AC connections Safety Circuit check Filter maintenance DI guard bed maintenance O-ring and Orifice maintenance Level Sensor Maintenance Dryer Desiccant Maintenance	

Maintenance kits can be obtained from Nel Customer Service for your specific system. Identify and make note of your unit serial number, then contact Nel Customer Service by phone at (203) 949-8697 or by email at customerservice@nelhydrogen.com to identify the appropriate spare part numbers needed.

For the highest in equipment reliability and performance, contact NEL Customer Service at (203) 949-8697 or your local service provider/supplier to purchase the Recommended Spares Kit, Major Spares Kit or Premium Spares Kit as recommended.

AVAILABLE SPARES		KIT NUMBER	Requirements
Recommended Spares	Recommended Spares	KT-0300-0039	√ = Purchased during Year 1
Major Spares	Major Spares for Mechanical and Electrical	KT-0300-0040	x* = Optional
Premium Spares	Premium Spares for Mechanical and Electrical	KT-0300-0041	x* = Optional

4.1 Quarterly Maintenance

Tools Required: Combustible Gas Detector; Calibration Gas (2 Percent Hydrogen in Air) and regulator
Estimated Time to Complete: <1 Hour Total

Complete Table **7**, and file a copy in the Unit Log Book.

Table 7. Quarterly Maintenance Checklist

Qtr: 1, 2, 3 or 4	**Date:**	**Location:**	
Ref.	**Action**	**Completed?**	**Comments**
4.1.1, 4.1.2	Perform General Area and Vent Stack Inspection		
4.1.3	Inspect hoses and connections for DI water leak		
4.1.4.1	Perform Combustible Gas Sensor Calibration (CG220)		
4.1.4.2	Perform Combustible Gas Sensor Calibration (CG121)		
4.1.5	Inspect High Power Electrical Connections		
4.1.5	Visual check AC service (line)		
Fig 14, #2	Visual check Main fuses (line & load)		
Fig 14, #3A&B	Visual check AC disconnect (load)		
Fig 14, #4	Visual check CBA, CBB, CBC (line & load)		
Fig 14, #5	Visual check CBD (line & load)		
Fig 14, #6	Visual check Surge Protector (line and ground)		
4.1.6	Visual check Surge Protection		
4.1.7	Inspect & perform maintenance on air Filters		
4.1.8	Inspect / Adjust Date and Time of controller		
Other maintenance performed, or issues identified:			
Name:		Signature:	

4.1.1 General Area Inspection

It is important that the area surrounding the C Series is kept clear of combustible materials as well as any excess materials that might obstruct any intake or exhaust openings.

Qualified Service personnel shall examine the Hydrogen Generator and surrounding to ensure that:

1. Intake and exhaust openings are clear and free of obstructions and clearances specified in the Installation Manual (PD-0100-0099) are respected
2. There are no obvious signs of physical deterioration of the Hydrogen Generator or its support (i.e., base, frame, cabinet, etc.);
3. The area surrounding the Hydrogen Generator is clear and free of combustible materials. Factors like the likelihood of the area being used as a storage area and whether walls or fencing might trap combustible materials should be taken into consideration.
4. The area surrounding the Hydrogen Generator is clear and free of insulation materials
5. DI water feed lines to Hydrogen Generator are clean and in good condition.

4.1.2 Vent Stack Inspection

The C Series has a hydrogen vent and oxygen vent that can be configured to either be integrated into existing hydrogen and oxygen vent systems or both to be stand-alone vent stacks. The oxygen vent releases oxygen continuously during operation and the hydrogen vent releases small amounts of hydrogen during operation and to depressurize the system upon shutdown. It is important that these two vent systems always be clear of obstructions to ensure proper operation of the C Series. Perform routine inspection to ensure the vent lines are clear from obstruction and it provides a free vent path to the atmosphere. The internal vent system and drain traps should also be routinely inspected. This inspection is to include any customer supplied components.

4.1.3 Plumbing Inspection and Maintenance

Both the C Series Power Supply Enclosure and Electrolyzer Enclosure have configured plumbing with liquid flowing through them. In case of a major leak, each enclosure is equipped with two flood switches attached to the floor (see Section 4.2.2.3 on page 45) to immediately stop hydrogen production and remove electrical energy from potentially dangerous equipment. The Electrolyzer Enclosure requires DI water and coolant and the Power Supply Enclosure requires just coolant.

The Electrolyzer Enclosure has three separate drain traps to collect condensate from the hydrogen dryer, oxygen and hydrogen vent lines. It is common to see a small amount of

water accumulate from these traps on the inside floor of the Electrolyzer Enclosure. The forced air flow through the Electrolyzer Enclosure causes evaporation, which will keep any water accumulation to a minimum.

The Power Supply Enclosure is a sealed enclosure with an active dehumidifier that drains to the outside. It is not common to see any liquid or condensate accumulate inside.

For both enclosures, use the following instructions:

1. Immediately after operation, open the doors on the Electrolyzer Enclosure and visually check for excessive DI water or coolant leaks at all plumbing connections.

If leaks occur in the Electrolyzer Enclosure, evaluate the size of the leak and components that are exposed to the leak to determine if an immediate repair is required or to monitor the leak and repair it at a later date.

2. Check the condensate drain of the Power Supply Enclosure to monitor if any large amount of water is dispelled. Open the doors of the enclosure and visually check for any coolant leaks or condensation on any components. Repair as required.
3. Check coolant level in TCU. If coolant level is low add an appropriate mix of distilled water (or de-ionized water) and propylene glycol. Use a mixture of propylene glycol and water appropriate for local ambient temperatures.
   Water/Propylene Glycol Specifications: pH 7.0 to 9.0, chloride <20ppm, nitrate <10ppm, sulfate <100ppm, total solids <250ppm, calcium carbonate <250ppm

4.1.4 Combustible Gas Sensor Calibration

The combustible gas sensors output a signal that is proportional to the percentage of combustible gas present at the catalytic bead up to 100 percent Lower Flammability Limit (LFL).

THE COMBUSTIBLE GAS DETECTORS NEED TO BE CALIBRATED EVERY THREE (3) MONTHS WITH 2% HYDROGEN IN AIR MIX AND REGULATED TO 50 PSIG (3.5 BARG) FOR PROPER OPERATION OF GAS DETECTING EQUIPMENT WITHIN THE HOGEN GENERATOR.

The controller issues a W21 CG calibration warning, which indicates that calibration needs to be completed within a 2-week period or the C Series shuts down on an E40 error, CG Calibration Expired + 2 Weeks.

4.1.4.1 Combustible Gas Sensor Calibration Instructions (P&ID Tag CG220)

Every three months, a Cal gas warning, W21, is displayed for expired calibration, which prompts the user to initiate calibration through the user interface.

During calibration, in the event of an error, an appropriate error code is displayed.

1. Cycle power to the control board by turning off power using CB1, waiting 10 seconds, and then turning CB1 back on. While applying power hold the up and down arrows on the front panel to put the unit into the Mode menu. Scroll down to Preventative Maintenance and press enter. The password is 8 down arrows.
    a. Remove the electrical connector, unscrew and remove CG220 from the A200 manifold. Re-install the electrical connector (Figure 11).
    b. Press the Down Arrow Key and scroll down to the 'Calibrate CG sensor' menu option and press Enter.
    c. Step C02 will automatically set the zero of CG220 ("Wait for Offset").
    d. At step C03, apply the calibration gas ("Apply Cal Gas"). Immediately apply the calibration gas (Figure 11).

Figure 11 - Calibration Gas for CG220

    e. At step C04 ("Remove Gas"), remove the calibration gas and the hood.
    f. At the conclusion of C04, 'SUCCESS' should be displayed in the lower left information bar represented in Figure 12.

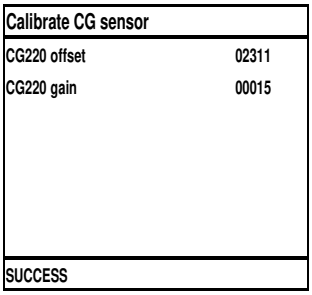

Figure 12 - CG Calibration Success Screen

g. Remove the electrical connector, screw CG220 back into the A200 manifold and re-install the electrical connector.
h. Press the Left Arrow Key two times, scroll down to 'System reset' and press Enter.

CAUTION

If calibration fails, the C Series aborts Cal values, reverts to the previous calibration values, including calibration due date, and issues a warning, W20.

4.1.4.2 Combustible Gas Sensor Calibration (P&ID Tag CG121)

The following steps shall be performed every three months at the same time CG220 is calibrated. For full calibration details and instructions see PD-0110-0018, *Manual, Gas Detection, MSA X5000* that is additionally supplied with your unit.

1. Attach the calibration bottle hose to the calibration port on CG121. Do not apply gas at this point. See Figure 13.
2. Using the left button (down arrow), scroll to "Calibration" using the right arrow key (right arrow).
3. Enter the password for calibration, "6359".
4. Select "Sensor #1"
5. Once the screen displays "Zero Soaking" wait for the device to countdown the zero calibration. Do not apply calibration gas at this point.
6. Once complete, the screen will display "Span in Progress". Open the regulator to start the flow of gas.
7. Allow gas to flow until "Remove Gas" is displayed on the screen then close the regulator. **NOTE:** This can take several minutes for the measurement to stabilize.
8. Remove the tube from the calibration cap.
9. Turn off the calibration gas. Wait for the CG121 screen to display 0% LFL.
10. Turn on the calibration gas and verify that the CG121 screen displays 50% LFL with the calibration gas applied.
11. Once 50% LFL has been verified, close the regulator and remove the calibration gas from the calibration port.
12. Return the system to normal operation.

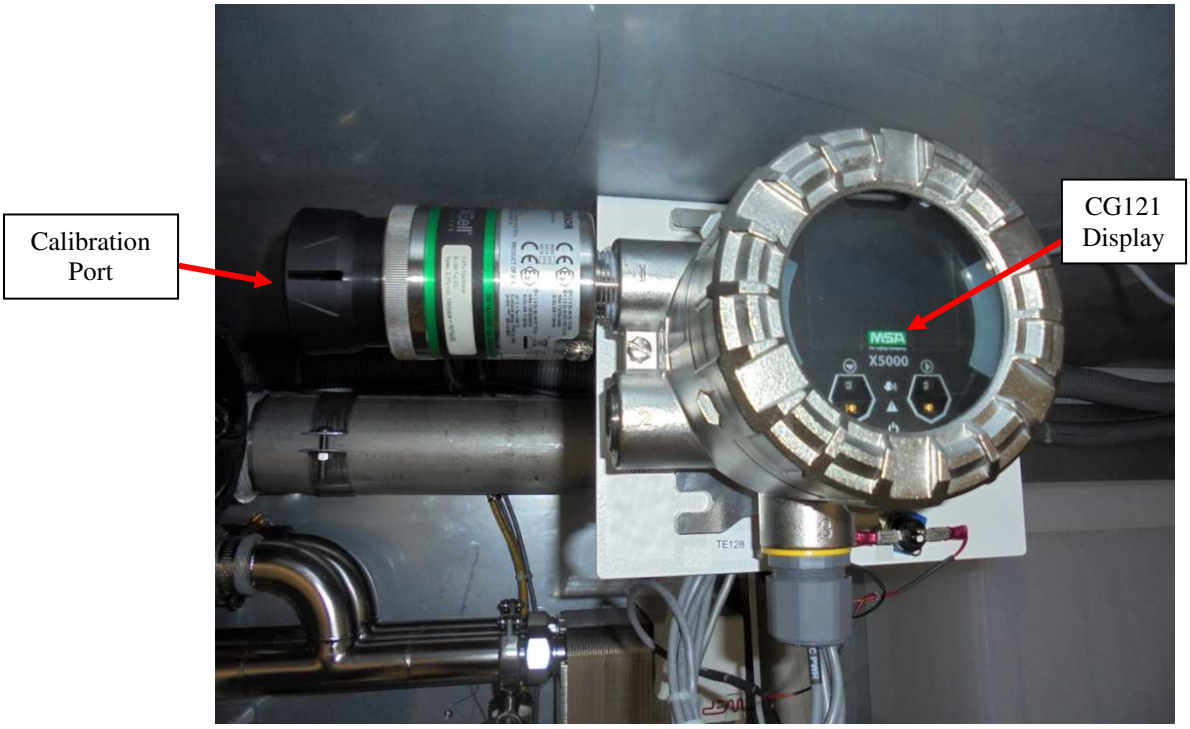

Figure 13 - Calibration gas for CG121

4.1.5 High Power Electrical Connection Check

To perform the electrical supply connection check, use the following instructions:

1. Place the C Series in 'Ready to Start' state by depressing the "0" Stop button.
2. Turn off the electrolyzer circuit breaker (CB1)
3. Remove the electrical power by turning the Main Disconnect Switch (DS1) to off position (Figure 6).
4. Perform all necessary Lockout/Tagout procedures (Section 2.3)

Open the electrical enclosure door and check the wire locations listed for the respectively sized equipment using the images in this section.

Inspect the switch gear and connections for visual signs of thermal damage or deformation due to lose connections, pinched insulation, and pitting etc.

Re-check fastener torques to ensure fasteners are tightened to values listed.

C30 Disconnect Switch

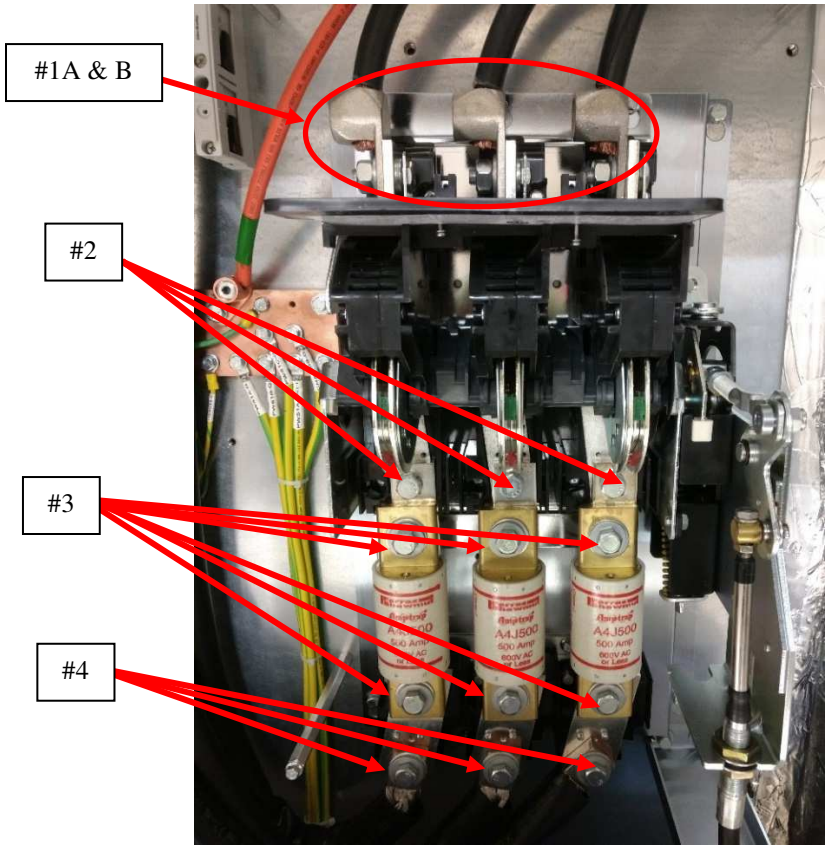

Figure 14 – C30 Disconnect Switch Connections

Location	Description	Recommended Torque
Figure 14, #1A	AC service (line) – Torque Terminal Screw	275-300 lb-in (31-34 N-m)
Figure 14, #1B	AC service (line) – Wire Connector	350-375 lb-in (40-42 N-m)
Figure 14, #2	Fuse Lug Connection	275-300 lb-in (31-34 N-m)
Figure 14, #3	Fuse Bolt	275-300 lb-in (31-34 N-m)
Figure 14, #4	Bus Bar Connection	350-375 lb-in (40-42 N-m)

C20 Disconnect Switch

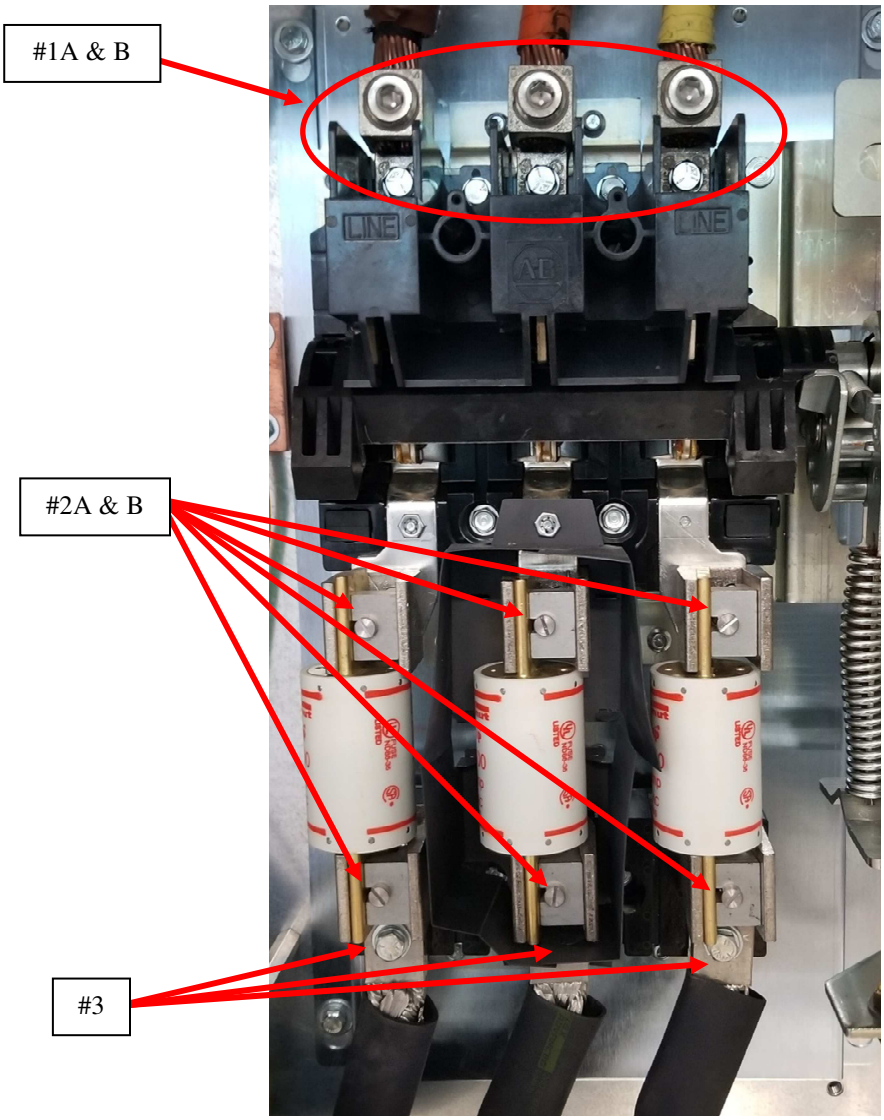

Figure 15 – C20 Disconnect Switch Connections

Location	Description	Recommended Torque
Figure 16, #1A	AC service (line) – Torque Terminal Screw	175-225 lb-in (20-25.5 N-m)
Figure 16, #1B	AC service (line) – Wire Connector	275 lb-in (31 N-m)
Figure 16, #2A	Fuse Clip – Mount to Disconnect	22-37 lb-in (1.8-2.5 N-m)
Figure 16, #2B	Fuse Clip – Fuse Torque	40-55 lb-in (4.5-6.2N-m)
Figure 16, #3	Fuse Lug Connection	175-200 lb-in (20-22.5 N-m)

C10 Disconnect Switch

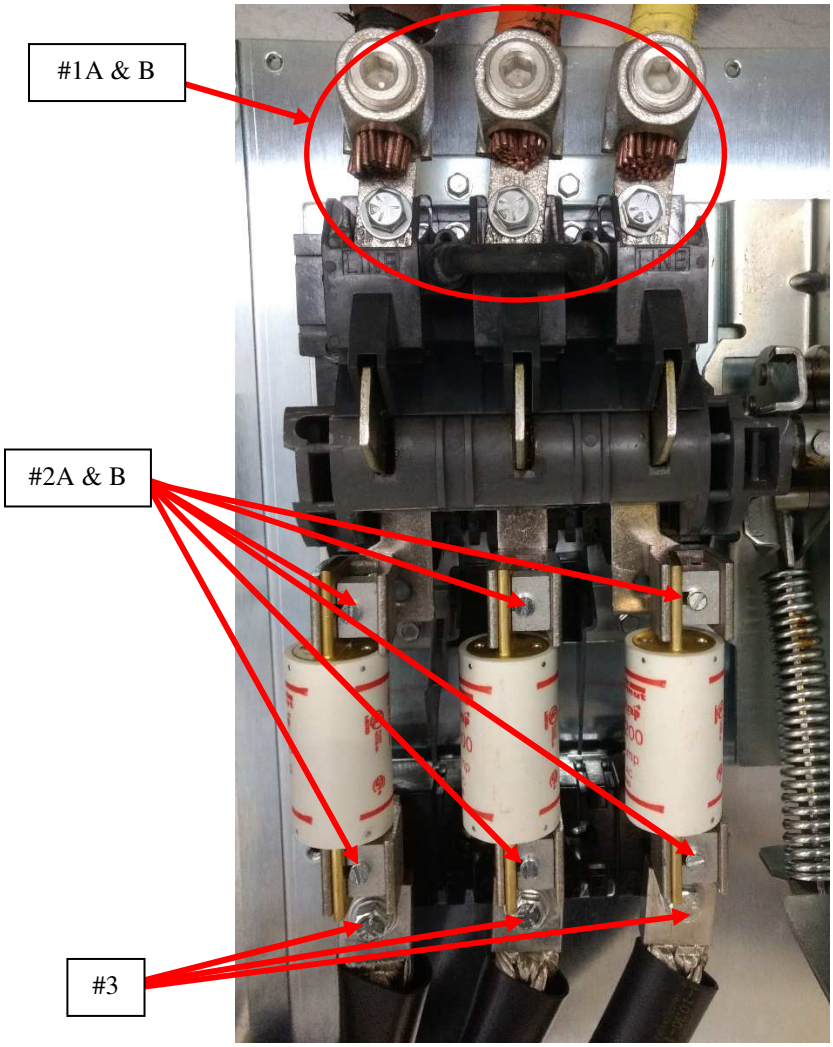

Figure 16 – C10 Disconnect Switch Connections

Location	Description	Recommended Torque
Figure 16, #1A	AC service (line) – Torque Terminal Screw	175-225 lb-in (20-25.5 N-m)
Figure 16, #1B	AC service (line) – Wire Connector	275 lb-in (31 N-m)
Figure 16, #2A	Fuse Clip – Mount to Disconnect	16-22 lb-in (1.8-2.5 N-m)
Figure 16, #2B	Fuse Clip – Fuse Torque	23-37 lb-in (2.6-4.2 N-m)
Figure 16, #3	Bus Bar Connection	175-200 lb-in (20-22.5 N-m)

Bus Bar Connection

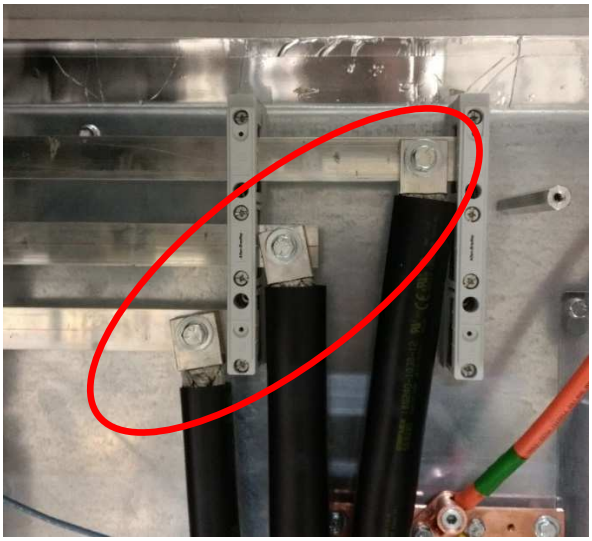

Figure 17 – Bus Bar Connections

Location	Description	Recommended Torque
Figure 17	Bus Bar Connection	200 lb-in (22.5 N-m)

Power Supply AC Connection

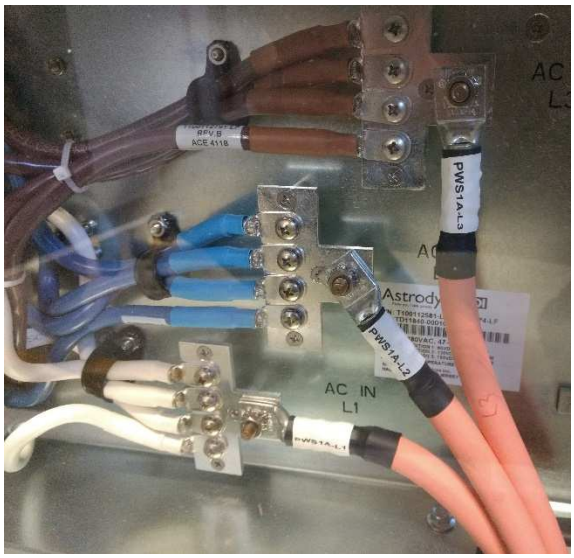

Figure 18 - Power Supply AC Connection

Location		Description	Recommended Torque
Figure 18		Bus Bar Connection	42 lb-in (5.4 N-m)

Circuit Breaker and Bus Bar Connections

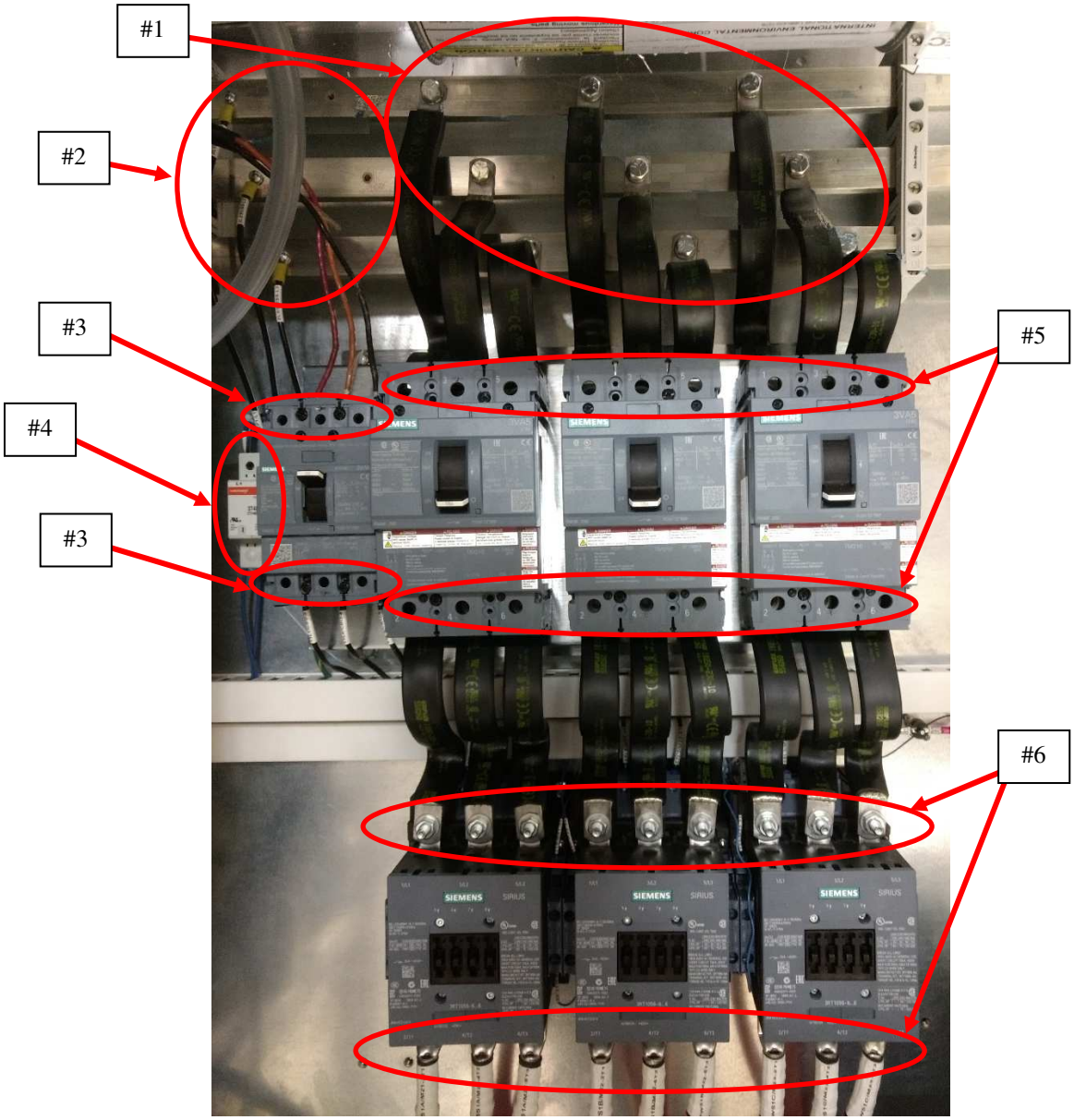

Figure 19 – Bus Bar and Device Connections

Location	Description	Recommended Torque
Figure 19, #1	Flexible Bus Bar Connection to Bus Bar	200 lb-in (22.5 N-m)
Figure 19, #2	Wire Connection to Bus Bar	26 lb-in (3 N-m)
Figure 19, #3	Circuit Breaker, CBD	100 lb-in (11.3 N-m)
Figure 19, #4	Surge Suppressor, SUP1	15 lb-in (1.7 N-m)
Figure 19, #5	Circuit Breakers, CBA, CBB and CBC	275 lb-in (31 N-m)
Figure 19, #6	Contactors, M21, M22 and M23	110 lb-in (12.4 N-m)

4.1.6 Surge Protection Inspection

To perform a surge protection check, use the following instructions:

1 Visually inspect the indicator tab locations of each surge protector (SUP1 is located next to fuse L1). See Figure 19, Item #4.
2 If an indicator tab protrudes out of any tab location, the surge protector must be replaced.

NOTE

Perform the surge protection check if there is any interruption of power that is abnormal, i.e. a power outage due to inclement weather.

4.1.7 Air Filter Inspection and Maintenance

The C Series Hydrogen Generator uses air filters on the Electrolyzer Enclosure to protect the internal components from contamination from the outside environment (ingress protection). The unit uses one disposable air filter on the inlet to remove contaminants from the dilution air entering the system and another on the exhaust to prevent contaminates from entering the C Series when the unit is in standby state. The maintenance interval for the filters is dependent upon the local ambient conditions where the C Series Hydrogen Generator is located. Very dusty and/or windy locations may require more frequent filter service. The maximum service interval for air filters is 12 months.

CAUTION

Do not prevent airflow by blocking either the air inlet or outlet.

For the inlet and outlet air filters, use the following instructions:

1. If the unit is generating hydrogen, place the C Series in 'Ready to Start' state by depressing the "0" Stop button.
2. Using a screwdriver, unscrew the exterior screws of each shroud and remove them from their respective door. Note the inlet shroud on the right door has an additional cover over the screen.
3. Remove both plastic grill covers holding the filters in place.
4. Inspect and replace the air filters as required.
5. Re-install both plastic grill covers.
6. Re-install the front shrouds to their respective doors and secure with original screws.

NOTE

When the inlet filter becomes clogged, the pressure sensor trips the safety circuit. To restart, replace the inlet filter and recycle the C Series power.

NOTE

Installing the front air shrouds to the wrong doors will cause the purge switches, PSW121A&B to not correctly function (Page 44).

4.1.8 Date and Time Check

Use the following procedure to check or change date and time on HCS display:

1. Place the C Series in 'Ready to Start' state by depressing the "0" Stop button.
2. Remove the electrical power by turning the Electrolyzer circuit breaker handle (CB1) to off position.
3. Wait 5 seconds before turning on the Electrolyzer circuit breaker handle (CB1) while depressing the Up and Down Arrow Keys at the same time until the system momentarily displays 'Booting System in Service Mode' as shown in Figure 2.
    a. Select the 'Installation Mode' menu item and depress the Enter button (Figure 20).

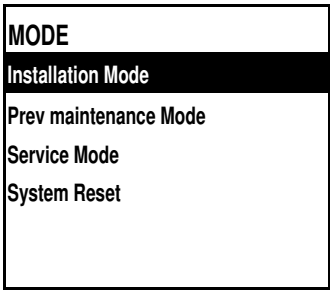

Figure 20 - User Interface Installation Mode Selection Screen

    b. The C Series prompts the user for a password. Press the Up-Arrow Key eight (8) times to access the required menu.
4. Set Time and Date
    a. Scroll down to the line identified as 'Set Time' and depress Enter (Figure 21).

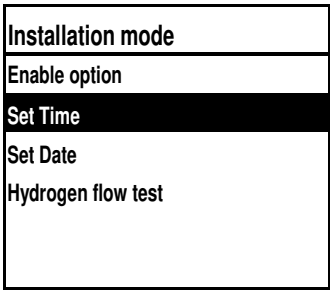

Figure 21 - Installation Mode Set Parameter Selection Screen

b. Using the Up, Down and Right arrows adjust the time to correspond with local time. When complete, depress Enter.
c. Scroll down to the line identified as ‘Set Date’ and depress Enter (Figure 21).
d. Using the Up, Down and Right arrows adjust the date to correspond with today’s date. When complete, depress Enter.

4.2 Annual Maintenance

Tools Required: A Pair of Pliers; 11/16” Wrench; 9/16” Wrench; 13 mm Wrench; Rubber Mallet; Retainer Ring Seat Tool; 3/16 Allen Wrench; Needle Nose Pliers
Estimated Time to Complete: 4 Hours Total

NOTE

It is estimated that the Dryer Desiccant Replacement, Section 4.2.8, will take two (2) hours to complete.

Complete Table 8 and file a copy in the Unit Log Book.

Table 8. Annual Maintenance Checklist

Yr.: **1, 2, 3 or 4**	**Date:**	**Location:**	
Ref	**Action**	**Completed?**	**Comments**
4.1	Perform 1st Quarterly Maintenance		
Sec 4.2.1	Torque AC Connections		
Sec 4.2.2	Check Safety Circuit		
Sec 4.2.4	Inspect & Clean Pump Filter Screen, Replace if Necessary		
Sec 4.2.5	Replace A500 Inlet Filter		
Sec 4.2.6	Replace Guard Bed DI Bags		
Sec 4.2.7, 4.2.7.2	Replace Hydrogen Filter & Drain Orifice		
Sec 4.2.8, 4.2.9	Dryer Desiccant & Orifice Replacement		
Sec 4.2.10	Replace Dew Point Sensor (when configured)		
Advise	If applicable, purchase Proton Recommended Spares Kit at End of Year 1		
Advise	If applicable, purchase Proton Major Spares Kit		
Advise	If applicable, purchase Proton Premium Spares Kit		
Other maintenance performed or issues identified:			
Name:		Signature:	

4.2.1 High Power Electrical Connections

Verify and torque all the connections listed in Section 4.1.5 based on your serial number.

4.2.2 Safety Circuit Checks

All components associated with the safety circuit chain shall be checked annually and tested to ensure the safety circuit is functioning properly.

4.2.2.1 PSW121 A&B

The pressure switches measure the pressure in the Electrolyzer Enclosure relative to the ambient atmosphere. There are two pressure switches (PSW121 A&B) located in the ceiling of the Electrolyzer Enclosure. When the fan creates negative pressure on the Electrolyzer Enclosure, the pressure switches close and closes the safety chain circuit.

To check the pressure switches, perform the following tests:

1. With the 240VAC Electrolyzer circuit breaker handle (CB1) on and the door open, turn on the hydrogen generator by depressing the "1" Start button.
2. When the purge fan turns on, watch when the TR1 timer starts flashing (indicating both pressure switches have been satisfied – closed.)
3. On the right door, completely cover the screen of the air inlet shroud to "choke off" the airflow. Visually verify that the TR1 timer quits flashing until the obstruction is removed.
4. On the left door, completely cover the screen of the air outlet shroud to "block" the airflow. Again, visually verify that the TR1 timer quits flashing until the obstruction is removed.

NOTE

The C Series will lose negative pressure if the Electrolyzer doors are open while the C Series is generating hydrogen, if the fan is not operating properly, the air filters are clogged, or something is blocking the air flow. Pressure levels out of range will indicate improper air flow and prompt the pressure switches to open the safety circuit.

4.2.2.2 E-Stop Check

An emergency stop, designed in accordance with ISO 13850, is located on the control panel. Observe all 3 lights on the Safety Circuit SR2 are illuminated and depress the red E-Stop button. This will trip safety relay SR2. Note: only A1/A2 Fuse is illuminated. Release the E-Stop button to verify all lights are again illuminated on SR2.

NOTE

The E-Stop is a NORMALLY CLOSED circuit. Engaging the E-Stop trips the contactor, which stops hydrogen production and removes power to safety-critical components and circuits, but the 24V power supply and controller inside the electrical enclosure remain energized. If generating hydrogen, the generator safely depressurizes and releases all gas through the hydrogen vent when the E-Stop is engaged. Error E23 will be displayed on the front display.

4.2.2.3 Flood Level Switches

The level sensors detect flooding in the enclosures. There are two level sensors in each enclosure of the C Series Hydrogen Generator. LS101F and LS102F are in the Electrolyzer Enclosure and LS101P and LS102P are in the Power Supply Enclosure.

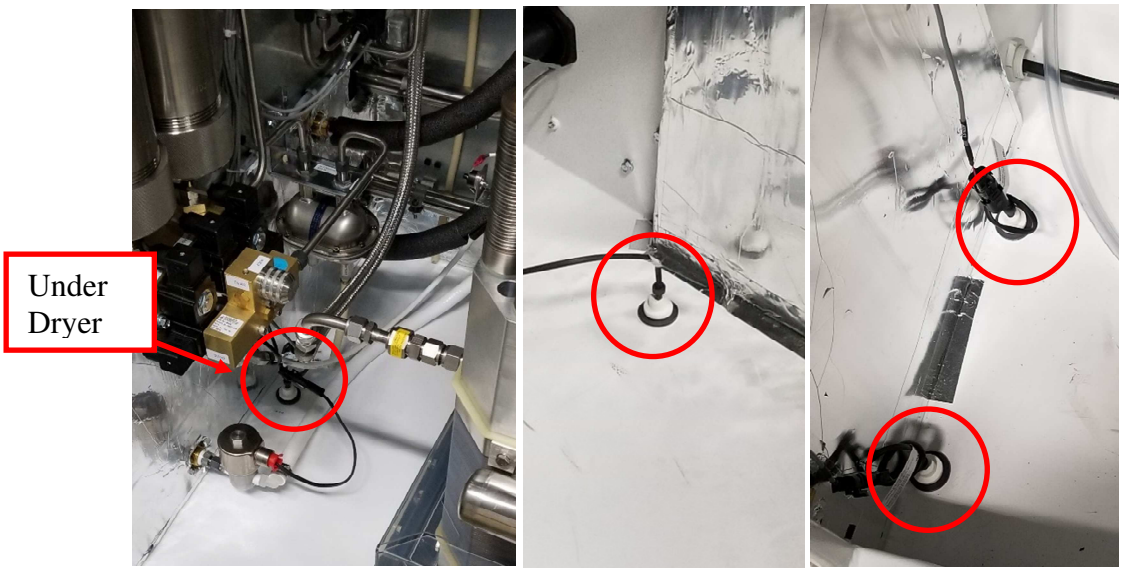

Figure 22 - Flood Level Switches

CAUTION

The level sensors are NORMALLY CLOSED, which means they have electrical continuity through them.

If there is a flood in the enclosure, the level sensors will open and trip the safety circuit to remove DC power to the cell stacks.

To test the level sensors, perform the following tasks:

1 Place the C Series in 'Ready to Start' state by depressing the "0" Stop button.
2 Observe all 3 lights on the Safety Circuit SR2 are illuminated.
3 Lift the float on any level sensor.
4 Observe that the safety circuit is tripped.
5 Release the float and verify associated SR2 input illuminates.
6 Reset safety circuit by depressing the E-Stop on the door and releasing.

7 Perform above steps for the other level sensors.

4.2.2.4 TAS102 P & F and TAS166 A & B

In the case of an internal high temperature event, the thermal switches will detect the excessive high temperature in the enclosure. There are four thermal switches in the C Series Hydrogen Generator - TAS102P (located in the Power Supply Enclosure), TAS102F and TAS166 A & B located in the Electrolyzer Enclosure (Figure 23).

NOTE

The contacts are NORMALLY CLOSED and open when the surface or the ambient temperature set point is reached. The circuit remains open until the manual reset button is depressed and also only when the ambient temperature is approximately 70% of the set point temperature.

If there is an excessive temperature increase in the enclosure, the thermal switches open and trip the safety circuit to shut down power. To test the thermal switches (TAS102 E & F and TAS166 A, B, & C), use the following directions:

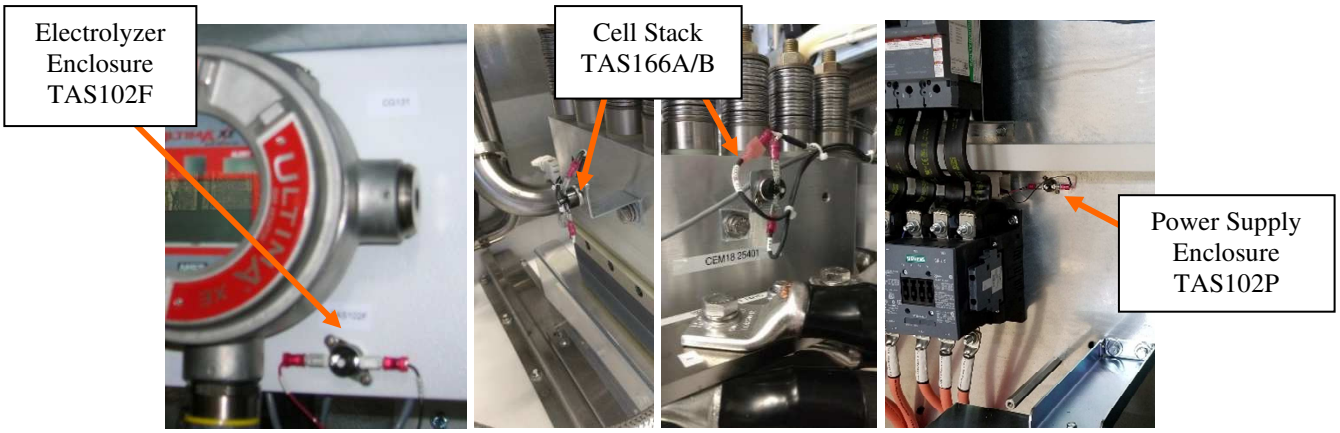

Figure 23 - Electrolyzer and Power Supply Enclosure Thermal Switches

1. Place the C Series in 'Ready to Start' state by depressing the "0" Stop button.
2. Remove one Quick Connect terminal from one temperature switch.
3. Observe that the safety circuit is open. (This is a latching fault. The safety circuit does not reset when the Quick Disconnect is replaced.)
4. Replace removed Quick Connect.
5. Reset safety circuit by depressing the E-Stop on the door and releasing.
6. Perform above steps for each of the other sensors.

4.2.2.5 Remote E-Stop Button

The electrolyzer's Remote E-Stop will shut down the electrolyzer any time the circuit loses connection between TB16-5 and 6. Error E21 will be displayed on the front display if the remote E-Stop is opened while the system is generating. The customer may connect TB16-5 and 6 to the site's emergency-stop circuit to shut down the electrolyzer

remotely. Separately, spare contacts from the electrolyzer's own emergency stop button are made available to TB16-1, 2, 3, and 4. The customer can monitor the status of the electrolyzer's E-Stop button by connecting to TB16-1, 2, 3, and 4 (refer to electrical schematic XPE2730).

4.2.3 Time Delay Relay

The time delay relay, TR1, is a 30-second, factory-set window that allows the C Series dilution fan to turn on and reach normal flow which triggers a negative pressure in the enclosure (Figure 24).

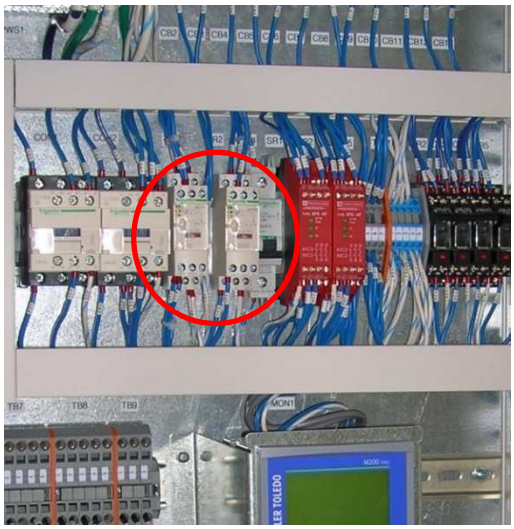

Figure 24 - Time Delay Relay Location

NOTE

The time delay relay is factory-set and should not be adjusted.

4.2.4 Pump Filter Inspection & Replacement (P&ID Tag F210)

Use the following instructions to inspect the pump filter:

1. If the C Series is either in generating or standby state, stop it down by pressing the Stop key.
2. Drain the system by activating the A200 drain on the user interface See Section 0.
3. Turn off electrolyzer circuit breaker (CB1)
4. Remove the electrical power by turning the Main Disconnect Switch (DS1) to off position (Figure 6)
5. Perform all necessary Lockout/Tagout procedures (Section 2.3)
6. Shut off the DI water supply.
7. Open the front doors of the C Series Electrolyzer Enclosure.

CAUTION

10 gallons (38L) of water stored in the system need to be drained before the system can be shut down.

1. Unscrew the sanitary clamp from the elbow coming out of the circulation pump CP205 (Figure 25).

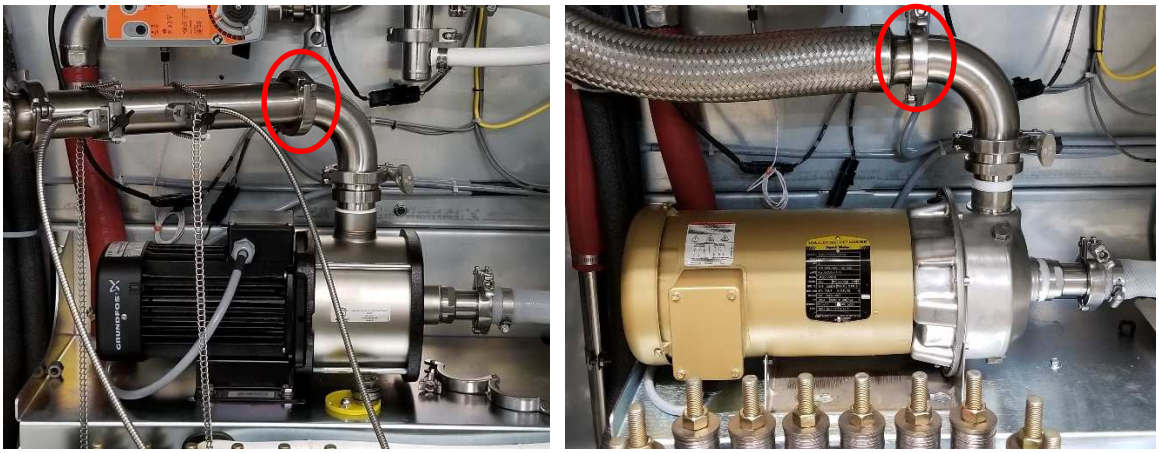

Figure 25 – Screen Filter Locations C10/20 (Left) C30 (Right)

NOTE

Water will spill out from the strainer housing. Use a catch pan to minimize water spillage.

2. Remove the old screen filter from the strainer housing and inspect. Replace the O-ring if necessary. (Figure 26).

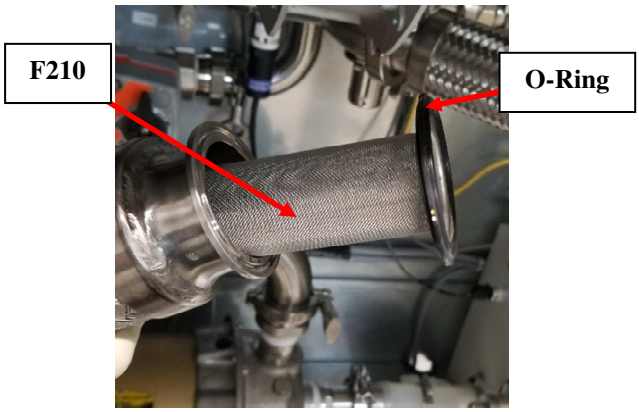

Figure 26 - Removing the Filter

3. Insert the new filter element into the strainer housing.
4. Re-install the strainer housing. Hand-tighten.

NOTE

Make sure the O-ring is centered in the fitting.

4.2.5 A500 Inlet Filter Replacement (P&ID Tag F506)

1. Ensure the A500 is drained to below the inlet.

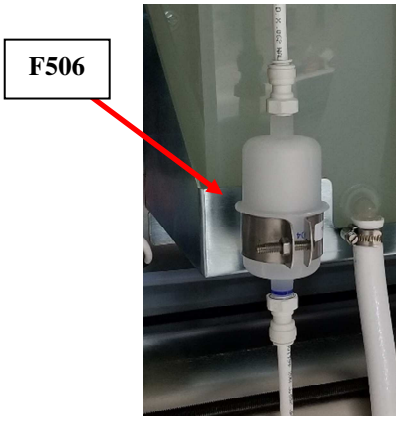

Figure 27 - F506 Filter

2. Note the flow direction arrow on the installed filter.
3. Remove the filter from the water lines (Figure 27). Use a catch pan to minimize water spillage.
4. Retain the fittings from the filter; they need to be reused, as they are not provided with the replacement filter.

5. Discard the old filter
6. The NPT threaded fittings will require new Teflon tape to be added to its threads. Apply a minimum of two wraps of tape in the direction of the threads.
7. Remove all old Teflon tape from removed fittings.
8. Install the new filter into the system with the flow direction arrow facing upwards toward the A500.

4.2.6 Guard Bed Polishing Bag Replacement (P&ID Tag GB208A & GB208B)

NOTE

A C10 configuration only has one guard bed. A C20 or C30 has two guard beds.

Figure 28 - Guard Bed Housing Assemblies Location

1. Loosen the top clamp screw(s) on the guard bed housing and swing out of the way (Figure 28).
2. Carefully remove DI bag from the housing. Use a catch pan to help minimize any water spillage.

Figure 29 - DI Bag Removal

3. Replace the consumed DI bag with the new one by carefully forming and inserting into the housing.

Figure 30 - Guard Bed Filter DI Bag

CAUTION

ENSURE care is taken to not damage the DI bag. Damaging the bag will free the resin beads into the water system.

4. Ensure bag is inserted below the top fitting.

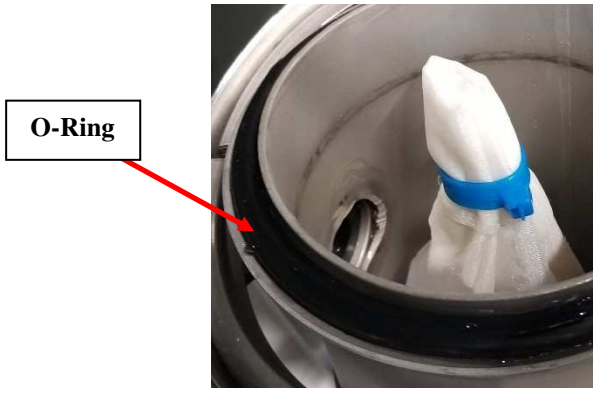

Figure 31 - DI Bag below Upper Fitting

5. Place cover on housing and tighten the three top clamp screws.

4.2.7 Hydrogen Filter & Orifice Replacement

Tools Required: A pair of pliers.

NOTE

A C10 configuration has only one A300 (F365A). A C20 or C30 has two A300's (F365A and F365B). The replacement instructions are the same for F304, F365A and F365B.

4.2.7.1 Hydrogen Filter Replacement (P&ID Tag F304, F365A and F365B)

Use the following instructions to replace up to three (3) hydrogen filters and two (2) drain orifices:

1. Unscrew the cap to the hydrogen filter and set aside (Figure 32).

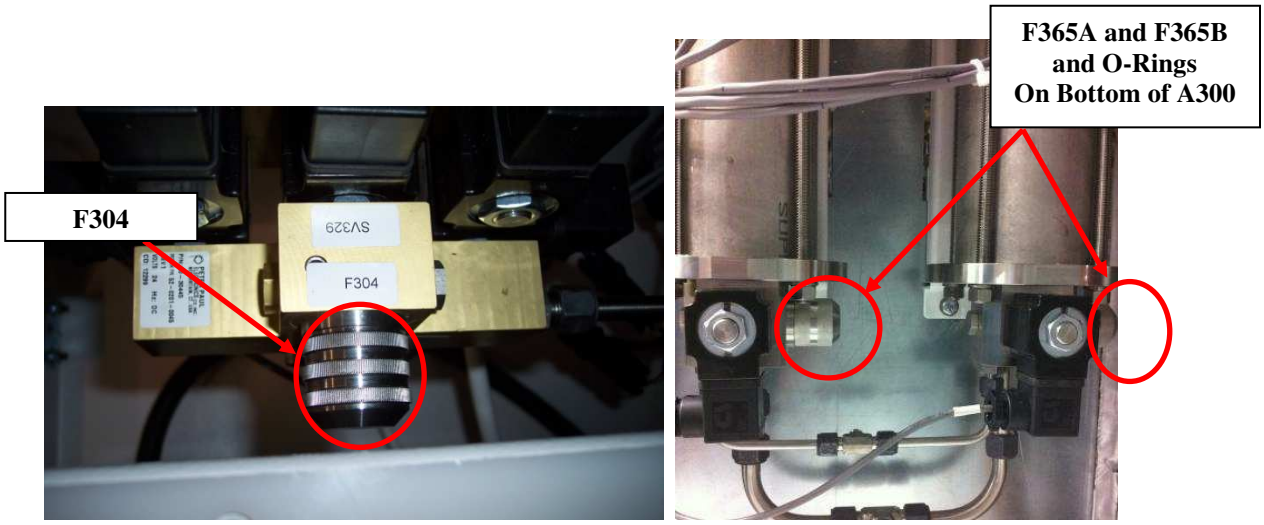

Figure 32 - A300 Hydrogen Filter Locations

NOTE

If the cap is screwed on tightly, use a pair of pliers to loosen it.

2. Remove the old screen element from the filter and discard.
3. Install the new screen element to the filter (Figure 33).
4. Inspect the O-ring on the cap for damage. Replace if necessary.

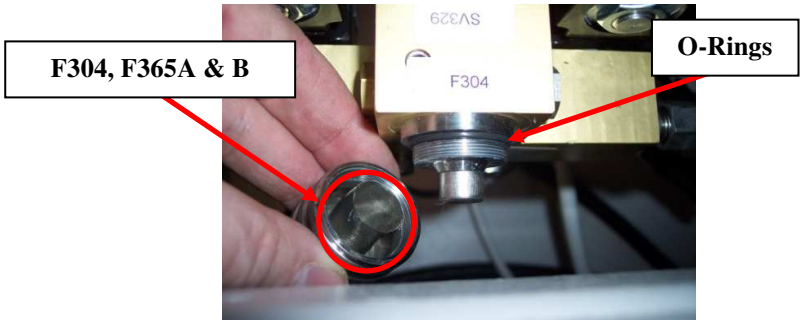

Figure 33 - Hydrogen Filter Screen

CAUTION

Hydrogen may escape during operation if the O-ring is not properly installed. Make sure the O-ring is seated within the grooves.

5. Reinstall the Hydrogen filter cap. Hand-tighten turning clockwise.
6. Repeat Steps #1-5 for the other hydrogen filter(s) (F365A and F365B).

4.2.7.2 Drain Orifice Replacement (P&ID Tag OR336A and OR336B)

Tools Required: 13/16" wrench, 11/16" wrench, 9/16" wrench, 1/8" Allen wrench, 3/32" Allen wrench.

Use the following instructions to replace up to three (3) hydrogen filters and two (2) drain orifices:

NOTE

A C10 configuration has only one A300 (OR336A). A C20 or C30 has two A300's (OR336A and OR336B). The replacement instructions are the same each.

Use the following instructions to replace up to two (2) drain orifices:

1. Unscrew the plug to the A300 drain orifice using a 9/16" wrench and set aside (Figure 34).
2. Using an Allen wrench, remove the existing drain orifice and discard.
3. Install the new orifice into the manifold block (Figure 35).
4. Check the O-ring on the cap for damage. Replace if necessary.
5. Reinstall the plug and tighten using a 9/16" wrench.
6. If A300B, repeat Steps #1-5 for the other drain orifice.

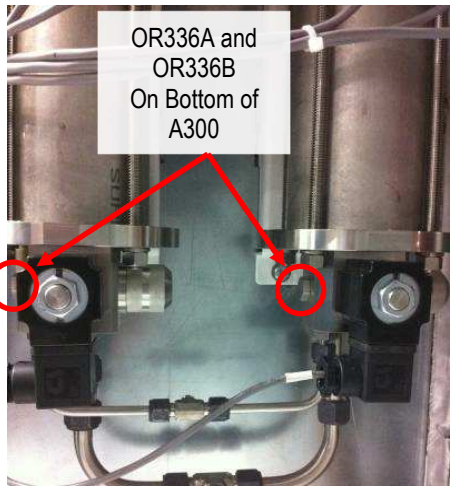

Figure 34 – Drain Orifice Locations

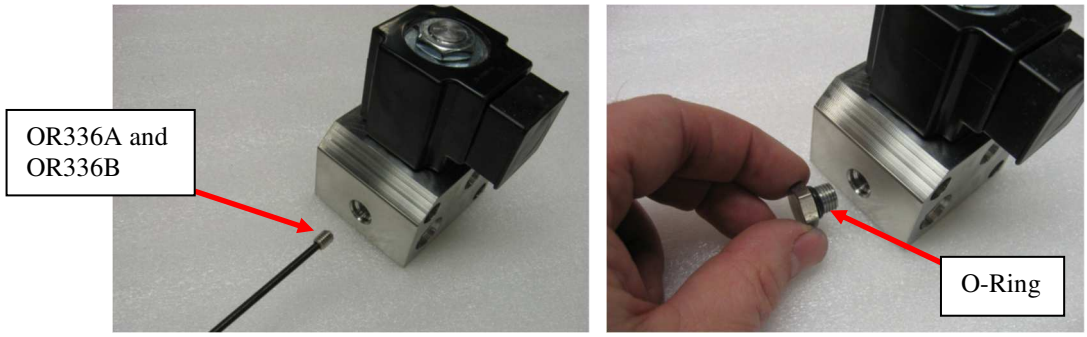

Figure 35 – Drain Orifice Replacement

4.2.8 Dryer Desiccant Replacement

Tools Required: 11/16” Wrench; 13/16” Wrench; 13 mm Wrench; Rubber Mallet or Ball Peen Hammer; Retainer Ring Seat Tool; Needle Nose Pliers; Flat Blade Screwdriver

1. Bleed any pressure from the dryer by loosening the purge valve. Once pressure has been released tighten the valve to close.

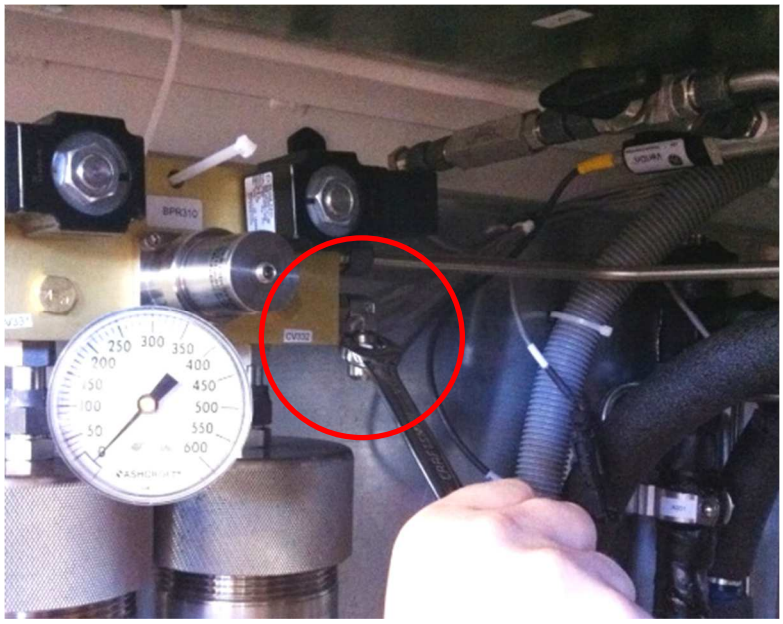

Figure 36 - Purge Valve

2. Loosely put a cable tie through the top dryer manifold block and to the cable tie clip on the ceiling of the Electrolyzer Enclosure.

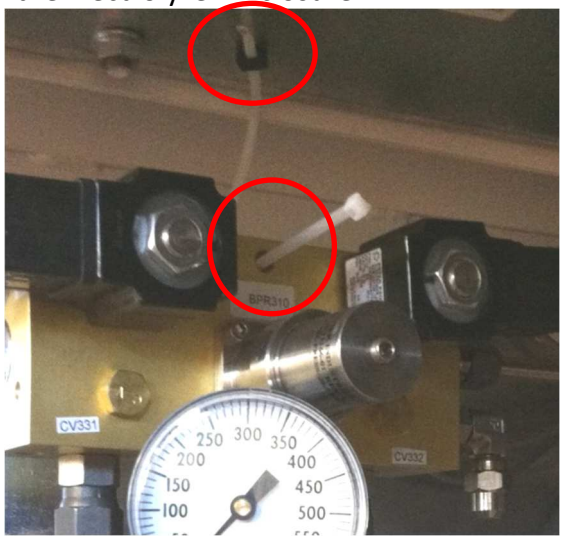

Figure 37 – Cable Tie Connection

3. Loosen the fittings on the top of each dryer column.

Figure 38 – Top Fittings

4. Pull the cable tie tight and lift the manifold block off of the dryer columns.

Figure 39 - Lifting the Top Manifold

5. Loosen the fittings on the bottom of each dryer column.

Figure 40 - Bottom Fittings

6. Loosen the column support clamps and remove the dryer beds. Start with the bottom clamps.

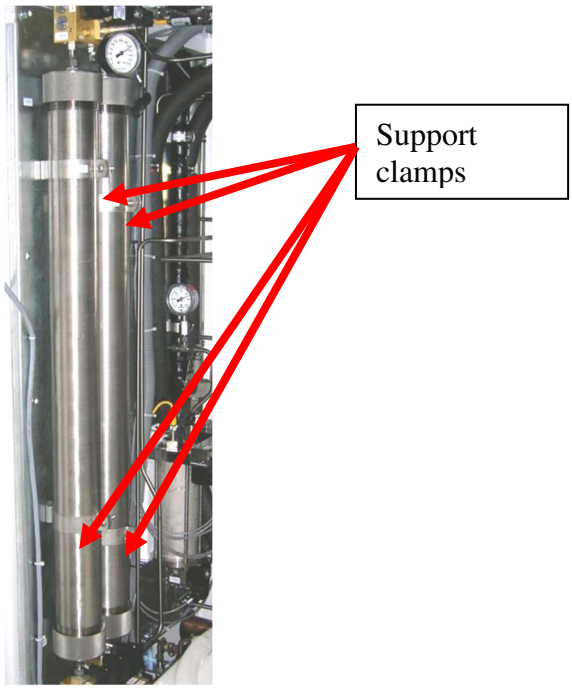

Figure 41 - Dryer Supports

CAUTION

The dryer column weight is approximately 45 pounds.

7. Using strap wrenches, remove the top cap of each column. Remove the old desiccant from the tubes and properly dispose of the desiccant.
8. Remove the bottom cap of each column.
9. Place each cap in a vice and use needle nose pliers to remove the retaining ring, filter screen and support plate. Inspect the cover and clean as required so they are free of any desiccant dust/debris.

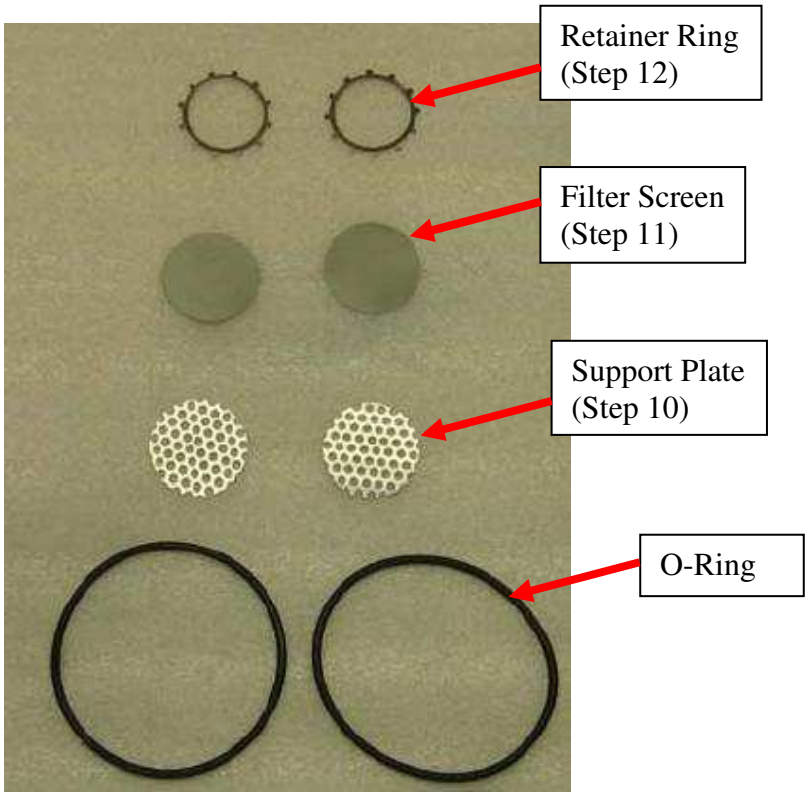

Figure 42 - Retaining Ring, Filter Screen and Screen Support Plate

10. Set the support plate back into the cap.

Figure 43 – Cap with Screen Support

11. Install new filter screen on top of screen support.

Figure 44 – Cap with Filter Screen

12. Install the retainer ring by laying it in the center of the screen. Set the retainer ring using the Retainer Ring Seat Tool and a mallet. NOTE: The seat tool is designed to seat to a specific depth.

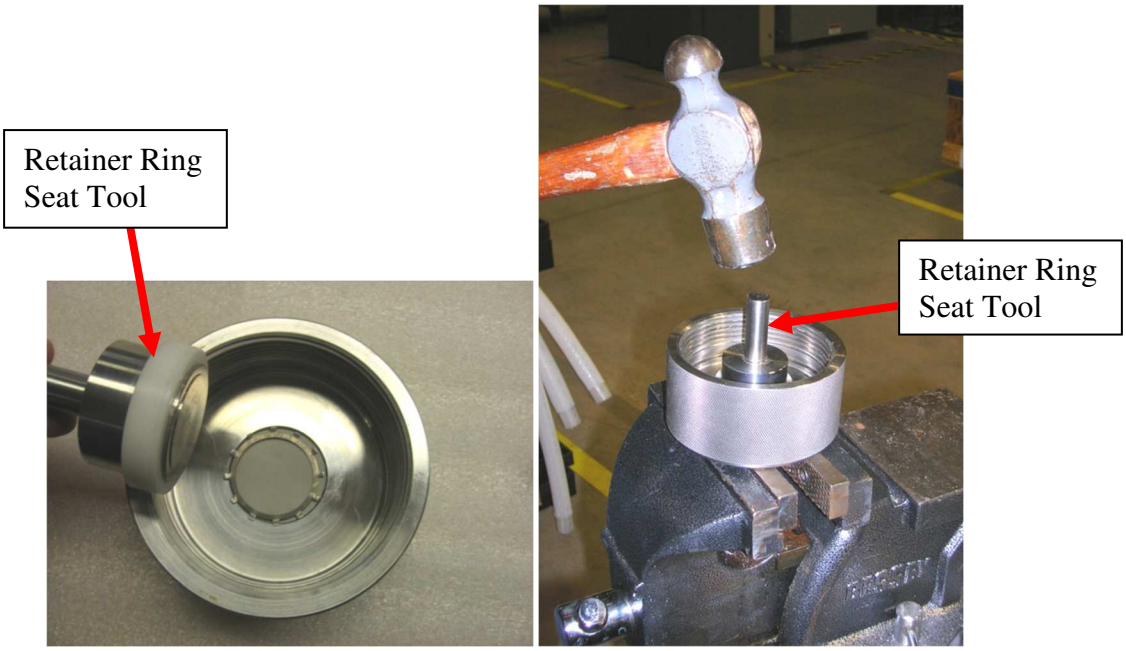

Figure 45 – Setting retainer ring

13. Tap on the tool with a hammer until the screen is locked in place.

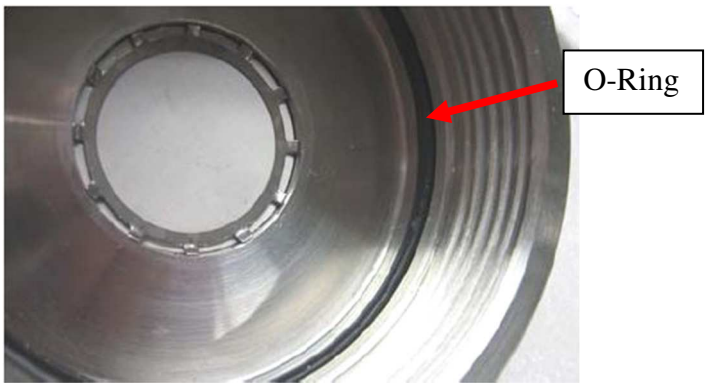

Figure 46 - Installed Retainer Ring

14. Inspect the O-ring on the cap for damage and replace if necessary. Before installing new O-ring, apply Krytox to the ring (use sparingly).
15. Repeat Steps #6-10 for the other caps.
16. Using the strap wrench, reinstall the bottom caps on each of the dryer tubes.
17. Turn the dryer cylinder upright and support bottom cap so that the bottom fitting is not contacting the ground. Note: Be careful not to lose the O-ring in the dryer fitting when turning the dryer column upside down. (See Figure 48)

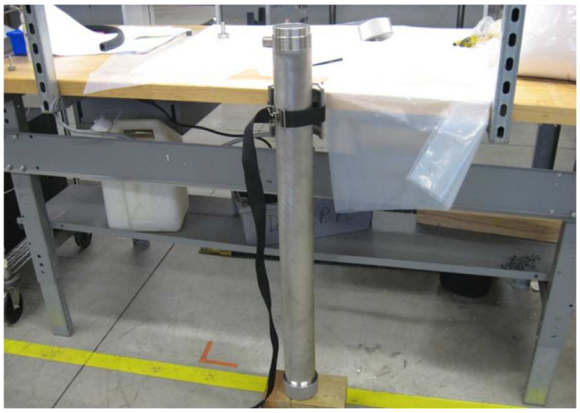

Figure 47 - Supported Dryer Cylinder

Figure 48 - Dryer Fitting with O-Ring

18. Fill each of the tubes with new desiccant.

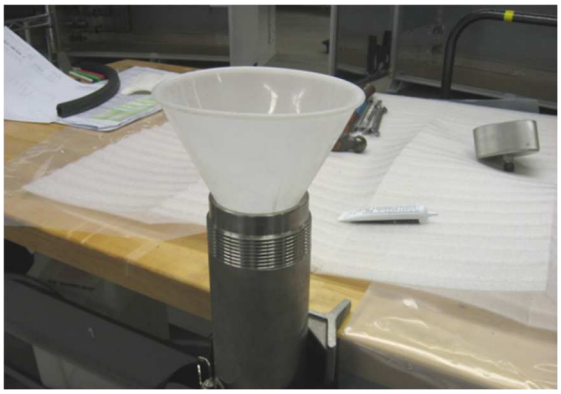

Figure 49 - Filling Dryer Cylinder and Desiccant

19. When the desiccant nears the top of the tube, lightly tap the sides of the tube with a mallet to help pack the desiccant.

Figure 50 - Desiccant at the Top of the Cylinder and Tapping the Cylinder

20. Fill the desiccant to the top of the dryer bed.

Figure 51 - Topped off Desiccant

21. Using a strap wrench, reinstall the top caps on each column and tighten.

22. Place the right dryer column in first and loosely thread the fitting from the manifold into the dryer column. Put the bolts through the support clamps and loosely tighten nuts to hold the dryer column.

Figure 52 - Right Dryer Column

23. Install the left dryer column as was done for the right dryer column.
24. Cut the cable tie that is holding the upper manifold block and lower the block onto the 2 dryer columns.

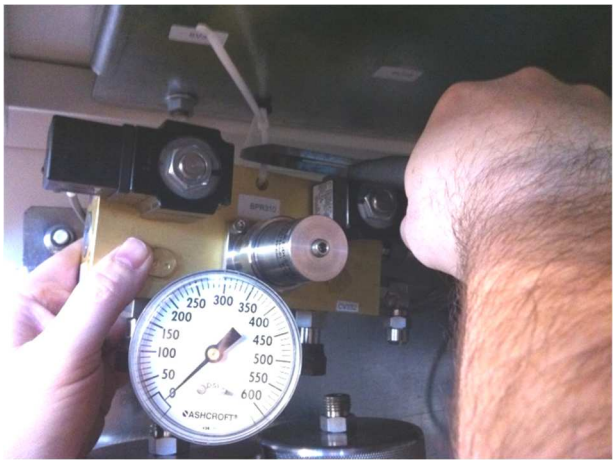

Figure 53 - Upper Manifold Block

25. Tighten the upper and lower fittings.
26. Tighten the support clamps.

4.2.9 Dryer Orifice Replacement (P&ID Tag OR330)

Tools Needed: ¼" Nut driver; Spanner Wrench

Use the following procedure to replace the orifice on the internal dryer located on the ceiling of the Electrolyzer enclosure:

Figure 54 – Orifice Cap

1. Using a spanner wrench, remove the orifice cap by turning counterclockwise. Set the cap aside. (Refer to Figure 55.)

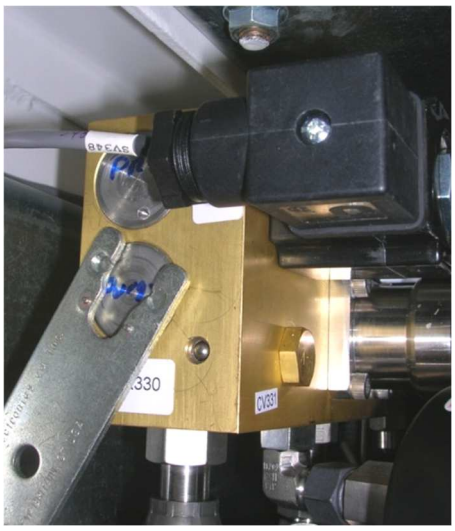

Figure 55 – Removing the Orifice Cap with Spanner Wrench

2. Using a ¼" nut driver, remove the orifice assembly. Discard the old orifice assembly (Figure 56).

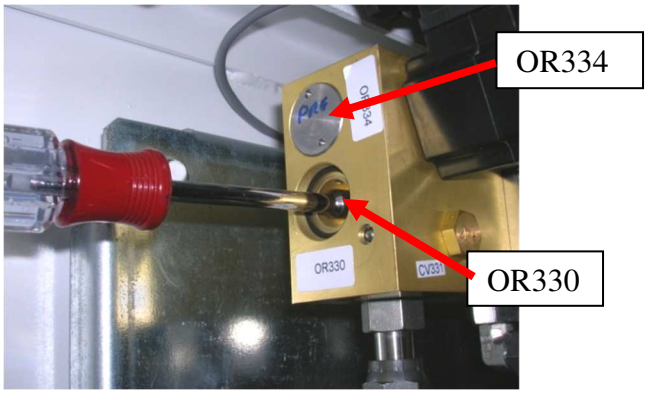

Figure 56 – Removing the Orifice Assembly

3. Install the new orifice assembly with a ¼" nut driver. Tighten clockwise.
4. Inspect the O-ring for damage. Replace if necessary.

NOTE

Make sure the O-ring is fitted in the grooves.

5. Reinstall the orifice cap with the spanner wrench by turning clockwise.
6. Repeat steps 1 through 5 to replace OR334.

NOTE

After initial hydrogen generation, place the unit in Service mode and check all fittings for leaks using the hand-held hydrogen leak detector or non-corrosive leak detection soap solution.

4.2.10 Dewpoint Sensor Calibration / Replacement (when configured)

A yearly calibration of the dew point sensor is recommended. The spare dew point sensor should be sent out for calibration ahead of time to ensure a calibrated sensor is available when needed.

For installations located in the United States, Canada, and Latin America Please call Baker Hughs, a GE company at the following:

PHONE: +1-281-542-3650
EMAIL: NAMService@bhge.com

For installations located in Europe, Asia and Middle East, please contact GE Sensing by email at the following:

Gesensingorders@ge.com

Each will be able to provide you with the information necessary to return your sensor for calibration services.

Use the following instructions to replace the dew point sensor:

1. Shut down the system and remove power to the system (Section 1.1).
2. Open the front doors of the Electrolyzer Enclosure and unscrew the cable harness from the sensor. Using an adjustable wrench, remove the sensor from the sensor housing (Figure 57).
3. Insert the new sensor into the housing and tighten. Use the adjustable wrench as required to fully seat the housing. Connect the sensor cable into the top of the sensor.
4. Close the front door of the Electrolyzer Enclosure and power up the system.

NOTE

Keep the old dew point sensor as the spare and send out for re-calibration just prior to the annual maintenance.

Figure 57 - Dew point sensor replacement

5 NOTES
