C Series 3
HYDROGEN GAS GENERATOR

Operation Manual

C Series 3 Hydrogen Generator
Installation & Operation Manual

Output:

C10 – 10 Nm^3/Hour
C20 – 20 Nm^3/Hour
C30 - 30 Nm^3/Hour

Serial Number: _____

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

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

READ THIS DOCUMENT THOROUGHLY AND CAREFULLY

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Table of Contents

Table of Figures

Symbols and Symbology used in this document:

- 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 SAFETY

The safety guidelines below may not cover all situations. Please address concerns or questions to Nel or check with local authorities.

DO NOT USE THIS EQUIPMENT IN A MANNER NOT SPECIFIED BY NEL.

NEL offers a full range of training services. Contact NEL Customer Service at +1 **203.949.8697** or your local service provider/supplier for more information.

If freezing conditions exist at your site, you must take measures to prevent condensation from freezing and obstructing the H_2 vent line, O_2 vent line, and freezing the water supply and drain lines.

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.

It is the customer's responsibility to organize a backup hydrogen supply to bridge critical times during maintenance and service.

CONTACT WITH HIGH VOLTAGE/CURRENT MAY RESULT IN DEATH OR SERIOUS INJURY. ALL ENCLOSURE DOORS MUST BE CLOSED DURING OPERATION.

It is important for users to be aware, understand, and comply with all local safety requirements related to the handling of hydrogen and compressed gases. It is important to operate the C Series Hydrogen Generator in a fully ventilated, non-hazardous (non-classified) area.

1.1.1 Using Hydrogen Gas

Hydrogen is odorless, tasteless, colorless, and highly flammable. It is highly combustible in the presence of oxygen and burns with a colorless flame.

The lower flammability limit of hydrogen is 4% hydrogen in air by volume. If fire occurs, follow the instructions in the site Emergency Response Plan (ERP).

NOTE

Hydrogen gas is lighter than air and diffuses quickly.

Prevent overexposure to hydrogen. Hydrogen is non-toxic, but it can act as an asphyxiant by displacing the oxygen in the air. Effects of oxygen deficiency include rapid breathing, diminished mental alertness, impaired muscular coordination, faulty judgment, depression of all sensations, emotional instability, and fatigue. As asphyxiation progresses, nausea, vomiting, prostration, and loss of consciousness may result.

WARNING

FIRE OR EXPLOSION DANGER! KEEP ALL SOURCES OF IGNITION AWAY FROM HYDROGEN.

WARNING

DO NOT BYPASS THE C SERIES SAFETY SYSTEM - UNCONTROLLED OPERATION CAN RESULT IN DEATH, SERIOUS INJURY AND/OR DAMAGE TO THE C SERIES HYDROGEN GENERATOR.

1.1.2 Hazards of an Oxygen Enriched Atmosphere

Oxygen is odorless, tasteless, colorless and heavier than air. Oxygen is not flammable, but supports and accelerates combustion. Materials that do not burn in air including fire resistant material, can burn vigorously in an oxygen enriched atmosphere. Customer-supplied area ventilation around the C Series Hydrogen Generator must be sufficient to keep oxygen levels below a volume fraction of 23.5% in air. The normal path for oxygen to be vented from the hydrogen generator is from the oxygen vent stack at a maximum production rate of approximately 15Nm^3/hr (32.5kg/day, 573 SCF/hr).

1.2 References

PD-0100-0099, MANUAL, OPERATION, C SERIES 3
PD-0200-0023, MANUAL, MAINTENANCE, 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-0900-0007, CELL STACK HYDRATION AND STORAGE

NOTE

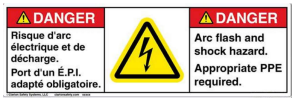
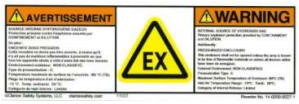
Specifications are subject to change. Consult factory for latest specifications and tolerances on figures specified without ranges.

1.3 Wire Colors

AC wires are black. 24VDC wires are blue and blue/white. Control/instrumentation wires are various colors. All earth ground wires are green/yellow. Any exceptions are listed in XPE2871.

1.4 Warning Labels

Table 1. Warning Labels

Label	Description	Label	Description
	No Smoking		No Open Flames
	Hazardous AC or DC voltages could be present inside. Do not remove guards.		Do not work within the enclosures with energized parts due to a risk of arc flash and shock hazard. Appropriate PPE is required.
	Warning that there is an internal source of hydrogen.		It is important to read and understand the manuals before performing service on the electrolyzer.
	Enriched Oxygen Hazard - Oxygen is odorless, tasteless, colorless and heavier than air. Materials that do not burn in air including fire resistant material, can burn vigorously in an oxygen enriched atmosphere. Oxygen levels must be kept below a volume fraction of 23.5% in air.		Residual Voltage Warning

2 OPERATION

The C Series Hydrogen Generator is a fully automated system and is configured for operation in either Tank Filling or Load Following operations.

2.1 Applying Power

Procedure for applying power (refer to Figure 1):

1. Confirm the Service Bypass Switch Key is removed (Figure 2).
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. See Figure 1
7. Turn the Electrolyzer Circuit Breaker (CB1) on the Electrolyzer enclosure from OFF to ON. See Figure 1

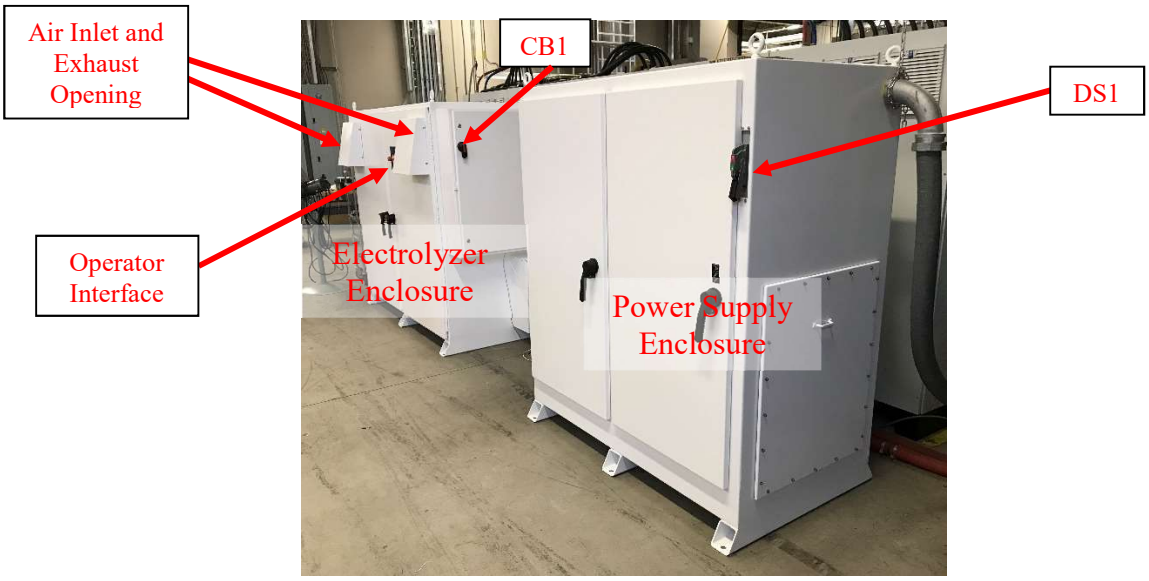


Figure 1 C Series System

AC POWER IS PRESENT IN THE ELECTROLYZER UNTIL THE MAIN POWER DISCONNECT IS SWITCHED OFF. FOR MAINTENANCE, LOCK OUT/TAG OUT AT THE MAIN POWER DISCONNECT.

DC voltage and can persist at cell stack terminals and power supply busbars for up to thirty minutes after removing power. Refer to Maintenance Manual for instructions on how to safely dissipate cell stack voltage.

CAUTION

Do not remove power until "Ready to Start" is displayed. Shutting off prematurely can damage the electrolyzer.

2.2 Operator Interface

The operator interface shown in Figure 2 is located on the front right door panel of the C Series Hydrogen Generator Electrolyzer enclosure. The "Stop/Reset" button stops operation and is used to reset certain errors. An Emergency Stop (E-Stop) switch is provided on the operator interface.

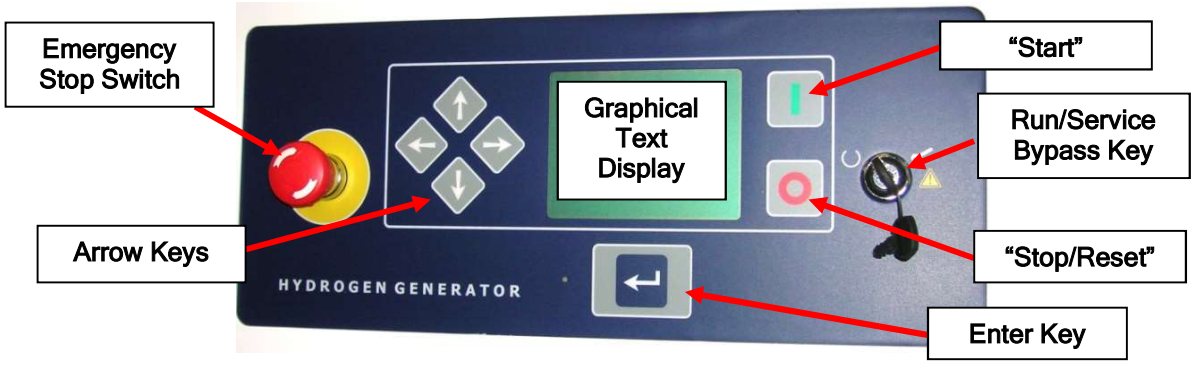


Figure 2 – Operator Interface Control PaNel

2.3 Display Screens

Table 2 - Display Titles

Title	Description
Ready to Start	The system is ready to accept a start pushbutton command
Setting Up System	The system is initializing, filling the A200 and the A500
Standby	The Standby menu displays the values: Product Pressure, Refill Pressure Setpoint, Full Pressure Setpoint, Total Hydrogen Produced, H_2 Production Time, Standby Time
Generating	The default menu displays the values: Product Pressure, Full Pressure Setpoint, Hydrogen Purity, Hydrogen Production Rate, Total Hydrogen Produced, H_2 Production Time, Standby Time
Menu	The Menu screen is selectable when a system mode is displayed. The system mode is displayed on the left-hand side of the status bar and has the form "M##." (See Table 3)
Warning Screen	The Warning Screen displays all system warnings since the last power cycle. The screen utilizes a circular buffer and retains the last 15 (fifteen) warnings.
Error Screen	The Error Screen displays all system errors since the last power cycle. This screen resets system errors.

2.4 Operation

Apply power per Section 2.1. The operator interface Graphical Display shows several initialization screens

To operate the C Series from "Ready to Start"

- Press the green "Start" button to begin generating hydrogen in the factory configured operational modes as described in the next section.
- Press the red "Stop" button to stop hydrogen generation, returning the C Series to the "Ready to Start" state with no hydrogen generation.

2.5 Generating Hydrogen

During operation, the C Series Hydrogen Generator system provides hydrogen through the product hydrogen port. The unit is factory configured to run in Tank Filling (tank topping) or Load Following modes of operation. These states and modes are described below.

Table 3 - Operating Modes

Mode	Description	Mode	Description
M01	Hydrogen Generation – Load Following Mode	M12	Degraded Mode due to Stack Water Flow Issue
M03	Hydrogen Generation – Tank Filling Mode	M13	Combustible Gas Sensor Calibration Mode
M04	Standby / Idle	M14	Firmware Upgrade
M05	Degraded Mode due to Power Supply Failure	M15	Generate to Vent
M09	Degraded Mode due to Low Current	M16	Error Condition - Unit Shutdown Mode
M11	Degraded Mode due to High Temperature		

2.5.1 Tank Filling Operation

This mode fills an external tank to a customer-specified set point. After reaching the set point, the system stops generating hydrogen and enters the "Standby" state. When the product pressure reaches a customer-specified tank refill set point, the system again initiates hydrogen generation and begins to fill the tank.

2.5.2 Tank Filling – Standby Operation

Once the tank pressure is greater than the fill pressure set point, the system stops hydrogen generation and begins the shutdown process; enters the "Standby" mode.

2.5.3 Load Following Operation

This mode follows a customer's process hydrogen demand by responding to sensed H_2 product pressure drop or rise. The system is capable of generating hydrogen between 0 and 100% of full production rate as long as the demand for hydrogen does not exceed the rated capacity of the product.

2.6 Manual Shutdown – Tank Filling and Load Following Operation

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

NOTE

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.

NOTE

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.

NOTE

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.

2.7 System Warnings and Errors

In the event the control system detects a measured value outside of Nel's normal anticipated ranges, the graphical display will output any one of the following warnings (See Table 4). Failure to resolve system warnings in a timely manner may result in lower system performance.

NOTE

Warnings do not shut down the unit. 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.

Table 4 - Warning Codes

Code	Abbreviated Description	Code	Abbreviated Description
W06	Low Temp – TE601 Coolant	W18	High Temp – TE159 P/S Enclosure
W07	High Temp – TE601 Coolant	W21	Due – CG calibrations
W08	High Temp – TE219 System	W22	CG in O_2 Low Reading
W09	High Concentration – CG220	W24	(1…12) Power Supply High Temp
--	--	W25	Power Supply High Temp > 10 Cumulative Events

Table 5 - Error Codes

Code	Abbreviated Description	Code	Abbreviated Description
E01	Low Voltage – Stack	E34	Invalid State – A300 Level Switch
E02	High Voltage – Stack	E35	LS301-Empty Drain Time Too Long
E03	Low Current – Stack	E36	Low Water Flow
E04	High Current – Stack	E38	Reserved
E05	Reserved	E40	Calibration Due – CG220
E06	Comm. Error (Startup) – Power Supply	E41	High Temperature – TE159 P/S Enclosure
E07	Comm. Error (Generating) – Power Sup.	E42	Out of Range – TE601 Coolant Temperature
E09	High Pressure – PT307 System	E43	Out of Range-PT312 Product Pressure
E10	Low Pressure – PT307 System	E45	Out of Range – DPS340 H_2 Purity (dew point)
E11	Pressure Timeout Error	E46	Out of Range – TE219 System Temperature
E12	High Temperature – TE219 System	E47	Out of Range – PT307 System Pressure
E13	Low Temperature – TE219 System	E49	Low Hydrogen Purity – DPS340 Water Vapor
E14	Empty – A200	E50	Low Product Pressure – PT312
E15	Flooded – A200	E51	Out of Range – TE128 Electrolyzer Encl. Temp
E16_A,B	Bad Water Quality (RS209, RS507)	E52	High Pressure – PT312 Product
E17	A200 Pre-Start Timeout	E53	Time Out – Cold Start Temperature
E18	A300 Empty	E54	Alarm – TCU
E19	A300 Flooded	E55	Time Out – A500
E20_A,B	Bad Resistivity Sensor (RS209, RS507)	E56	Empty – A500
E21	Fault – Safety Relay 1 Status (SR1)	E57	Flooded – A500
E23	Fault – Safety Relay 2 Status (SR2)	E58	Invalid State – LS501
E24	High Concentration – CG220 %LFL	E59	Out of Range – PT207 Oxygen
E26	Out of Range – CG220 %LFL	E60	High Pressure – PT207 Oxygen
E28	Unexpected FSW250 Flow	E61	High Pressure – PT307 Gen to Vent
E29	Checksum Error – Controller	E62	(1...12) AC Failure – Module Specific
E30	Out of Range – 24V, 5V, 3.3V Supply	E63	(1...12) Over Temp – Module Specific
E31	Fault – I/O Board Fuses	E64	(1...12) Over Voltage – Module Specific
E32	High Temperature – Controller Board	E65	(1...12) Comms Timeout – Module Specific
E33	Invalid State – A200 Level Switch	--	--

For detailed error and warning codes refer to Maintenance Manual: PD-0200-0023

Contact the Service department at +1 **203.949.8697** for field service technical support or email techsupport@Nelhydrogen.com.

2.8 Remote Monitoring Software

Monitoring of the hydrogen generation is performed using the C Series Monitoring software. The software comes pre-loaded on the laptop provided with the electrolyzer (). During power up, the laptop will automatically login and load the monitoring software.

For consistency alternate stack position items are still shown on the interface but are not populated (i.e. FSW250B/C, etc).

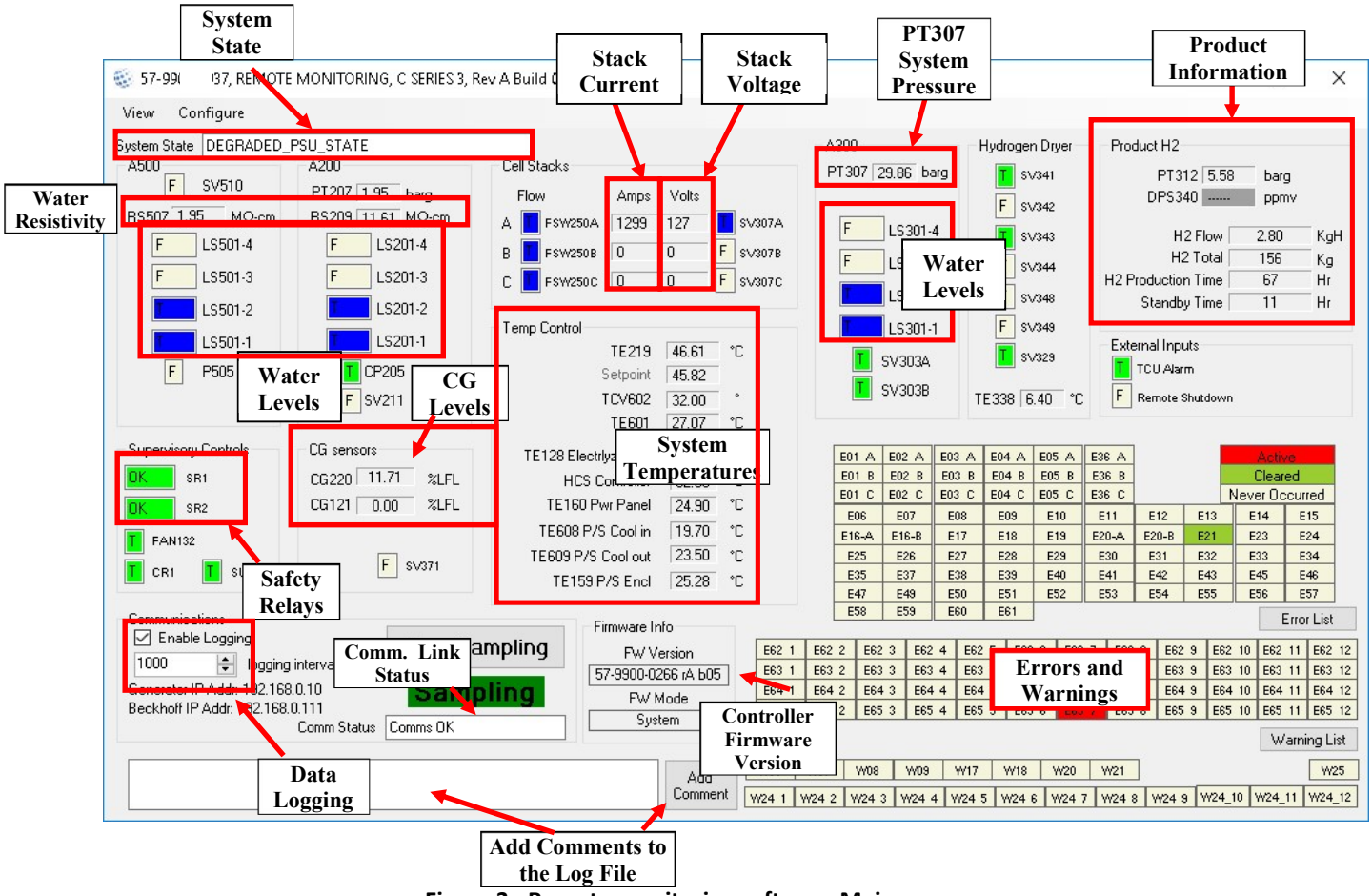


Figure 3 - Remote monitoring software Main screen

Additional details for the power supply modules are available by selecting “View>PSU Status.” The power supply shelves in the unit are numbered sequentially, from bottom to top (quantity depends on model configuration).

PSU Status

Shelf ID	DC/DC ID	Output Current (A)	Output Voltage (V)	Output Power (W)	Temperature (°C)	Commanded Current (A)	Commanded Voltage (V)	Power Limit (W)	Status
	1	118.11	41.04	4847.23	57.00	118.18	56.70	16500	ENABLED
1	2	118.10	46.02	5434.96	55.00	118.18	56.70	16500	ENABLED
	3	118.24	39.58	4679.94	53.00	118.18	56.70	16500	ENABLED
	TOTAL:	118.15	126.64	14962.14					
	1	118.11	46.01	5434.24	57.00	118.18	56.70	16500	ENABLED
2	2	118.14	41.66	4921.71	57.00	118.18	56.70	16500	ENABLED
	3	118.35	38.93	4607.37	54.00	118.18	56.70	16500	ENABLED
	TOTAL:	118.20	126.60	14963.32					
	1	118.27	45.94	5433.32	57.00	118.18	56.70	16500	ENABLED
3	2	118.43	34.40	4073.99	57.00	118.18	56.70	16500	ENABLED
	3	117.73	46.26	5446.19	55.00	118.18	56.70	16500	ENABLED
	TOTAL:	118.14	126.60	14953.51					
	1	117.76	46.08	5426.38	59.00	118.18	56.70	16500	ENABLED
4	2	118.36	35.39	4188.76	57.00	118.18	56.70	16500	ENABLED
	3	117.92	45.20	5329.98	54.00	118.18	56.70	16500	ENABLED
	TOTAL:	118.01	126.67	14945.13					
	1	118.16	41.54	4908.37	57.00	118.18	56.70	16500	ENABLED
5	2	117.91	45.98	5421.50	58.00	118.18	56.70	16500	ENABLED
	3	118.24	39.36	4653.93	54.00	118.18	56.70	16500	ENABLED
	TOTAL:	118.10	126.88	14983.79					
	1	117.96	46.22	5452.11	57.00	118.18	56.70	16500	ENABLED
6	2	118.20	40.13	4743.37	56.00	118.18	56.70	16500	ENABLED
	3	118.22	40.60	4799.73	57.00	118.18	56.70	16500	ENABLED
	TOTAL:	118.13	126.95	14995.21					
	1	0.00	0.00	0.00	0.00	118.18	56.70	16500	COMMS LOST - DISABLED
7	2	0.00	0.00	0.00	0.00	118.18	56.70	16500	COMMS LOST - DISABLED
	3	0.00	0.00	0.00	0.00	118.18	56.70	16500	COMMS LOST - DISABLED
	TOTAL:	0.00	0.00	0.00					
	1	117.85	46.03	5424.64	57.00	118.18	56.70	16500	ENABLED
8	2	117.88	46.02	5424.84	57.00	118.18	56.70	16500	ENABLED
	3	118.41	34.95	4138.43	56.00	118.18	56.70	16500	ENABLED
	TOTAL:	118.05	127.00	14987.90					
	1	117.95	46.12	5439.85	57.00	118.18	56.70	16500	ENABLED
9	2	117.95	45.93	5417.44	55.00	118.18	56.70	16500	ENABLED
	3	118.39	34.95	4137.73	54.00	118.18	56.70	16500	ENABLED
	TOTAL:	118.10	127.00	14995.03					
	1	118.15	40.52	4787.44	57.00	118.18	56.70	16500	ENABLED
10	2	118.01	44.62	5265.61	57.00	118.18	56.70	16500	ENABLED
	3	118.17	41.72	4930.05	55.00	118.18	56.70	16500	ENABLED
	TOTAL:	118.11	126.86	14983.10					
	1	118.14	42.85	5062.30	55.00	118.18	56.70	16500	ENABLED
11	2	118.17	42.99	5080.13	55.00	118.18	56.70	16500	ENABLED
	3	118.17	41.23	4872.15	53.00	118.18	56.70	16500	ENABLED
	TOTAL:	118.16	127.07	15014.58					
	1	118.34	37.98	4494.55	57.00	118.18	56.70	16500	ENABLED
12	2	118.08	44.16	5214.41	57.00	118.18	56.70	16500	ENABLED
	3	118.10	44.81	5292.06	52.00	118.18	56.70	16500	ENABLED
	TOTAL:	118.17	126.95	15001.03					

Figure 4 – PSU Status screen (C30 shown for example)

NOTE

If the valves or power supplies are energized, then the node is turned green.

NOTE

In the Errors/Warnings list, active errors/warnings are turned red. When the error is cleared at the control panel, the error/warning turns green. When the power is cycled at the unit, all errors/warnings are cleared.

2.9 Data Logging and Data File Retrieval

To Log Data:

1. Establish communication with the C Series. See Installation Manual, PD-0100-0099.
2. Ensure that the "Enable Logging" box is selected on the C Series monitoring software and that the green "Sampling" text is shown.

Figure 5 - Monitoring Software - Enable Logging & Sampling

Figure 6 - C Series Data Shortcut

Retrieve Data Files:

Data files are written to *C:\Users\Public\C-Series Data* on the laptop provided with the system. There is a shortcut to the data folder on the laptop's desktop (Figure 6). The files can be copied to a USB drive and emailed to Nel's Service department for troubleshooting (see contact info on page 12 beneath Table **5**).

Notes: