

C SERIES HYDROGEN GAS GENERATOR



Installation Manual

C Series 3 Hydrogen Gas Generator
Installation Manual

Model Numbers:
C10, C20, C30
(10, 20, 30 Nm³/hr)

C Series Serial Number: _____

SIC 3569-901
NAICS 333-999-8556

Gas Generating Equipment
Gas Generating Equipment

May 2019

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

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1 INTRODUCTION

The C Series 3 Hydrogen Generator (Figure 1) is a Proton Exchange Membrane (PEM) water electrolysis system packaged for easy onsite installation and automatic operation. Depending on cell stack configuration, the C Series Hydrogen Generator is capable of delivering 10, 20, or 30 Nm³/hr H₂ (21.6, 43.3, or 65 kg/day H₂) [382, 764 or 1146 SCF/hr H₂]. The C Series Hydrogen Generator is configured at the factory per customer requirements to operate in ‘Tank Filling’ or ‘Load Following’ mode. 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 hydrogen until the pressure is above a second configurable threshold. In Load Following configuration, the generator monitors customer hydrogen demand and automatically adjusts hydrogen generation rate to match the customer’s process. In this configuration, the generator can deliver hydrogen between 0 and 100% of rated flow rate.

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

Nel Hydrogen provides these instructions to guide the installation of a C Series Hydrogen Generator. Important safety information is also included in this manual. Please take time to familiarize yourself with the system and this manual before installing your C Series Hydrogen generator.



IT IS THE CUSTOMER’S RESPONSIBILITY TO CONSULT WITH THE LOCAL AUTHORITY HAVING JURISDICTION (AHJ) REGARDING LOCAL CODE REQUIREMENTS FOR INSTALLATION AND OPERATION OF THIS EQUIPMENT.



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



Figure 1 - C Series Hydrogen Generator

This manual attempts to answer most of the frequently asked questions regarding to the installation of the unit. Nel Hydrogen 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 support or email techsupport@nelhydrogen.com. Please have the serial number of your unit available.



NOTE

Nel offers a full range of training services. Contact Nel Customer Service at **203-949-8697** or your local service provider/supplier for more information.



NOTE

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



CAUTION

The cell stacks must be hydrated with DI water once every 30 days before commissioning per instructions (PD-0900-0004) that ship with each cell stack.



CAUTION

If freezing conditions exist at your site, you must take measures to prevent condensation from freezing and obstructing the H₂ vent line, O₂ vent line, and freezing the water supply and drain lines.



WARNING

AFTER PERFORMING ANY SERVICE OR MAINTENANCE WORK PER INSTRUCTIONS (PD-0200-0023), MAKE SURE THE DOORS TO THE ENCLOSURES ARE COMPLETELY CLOSED PRIOR TO THE STARTUP OPERATION OF YOUR C SERIES HYDROGEN GENERATOR.



CAUTION

Do not remove or install the C Series controller's compact flash card while the unit is powered.

1.1 Key Definitions, Acronyms, and Abbreviations Used in this Document

µS/cm – Micro Siemens 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
FNPT – Female National Pipe Thread
HCS – H and C Series Control System
HGMS – Hydrogen Gas Management Subsystem
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
MNPT – Male National Pipe Thread
Mohm-cm – Mega ohm – centimeter, a measure of water resistivity
NEC – National Electric Code, NFPA 70
NFPA – National Fire Protection Association, a Standards Organization
Nm³/hr – 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 ($\text{lb}_f/\text{in}^2=6894.7 \text{ Pa}$), 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

Symbols and Symbology used in the 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.

1.2 SAFETY

1.2.1 General Information

If any portion of this document is not understood, contact Nel.

SAVE THESE SAFETY INSTRUCTIONS. This document contains important instructions that are to be followed during installation of and operation of the C Series Hydrogen Generator. Nel suggests that the safety rules in this document be posted in potential hazard areas. Safety must be stressed to all installers and operators.

The information and instructions contained in this document are not intended to, and do not, replace or supersede any applicable local, state, or national safety laws, rules, regulations, codes or standards; and such applicable laws, rules, regulations, codes or standards always take precedence over the information and instructions contained in this document.

This system produces hydrogen and dilutes oxygen into the ventilation air stream. 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 3 in a ventilated, non-hazardous (non-classified) area. (The C Series 3 complies with NFPA 70, NFPA 79, and NFPA 496.)




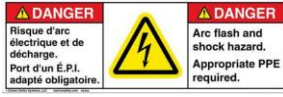






It is important for users to be aware, understand, and comply with all local safety requirements related to the handling of hydrogen and compressed gases. It is important to operate the C Series Hydrogen Generator in a fully ventilated, non-hazardous (non-classified) area.

1.2.2 Warning Labels

Throughout this document, and on tags and decals affixed to the C Series Hydrogen Generator, the following warning labels are used to alert personnel to special instructions about a particular operation that may be hazardous if performed incorrectly or carelessly, and they must be observed carefully at all times:

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

These warnings labels cannot eliminate the hazards they indicate, and Nel cannot anticipate every possible circumstance that might involve a hazard. The warnings in this document, and on tags and decals affixed to the unit, are not all-inclusive.

Observing safety precautions and strict compliance with the special instructions while performing the action or service are essential to preventing accidents. Operating the C Series Hydrogen Generator imprudently, neglecting its maintenance, or being careless can cause possible injury or death. Permit only responsible and capable persons to install and operate the C Series Hydrogen Generator.

1.2.3 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 your site Emergency Response Plan (ERP).



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.

The C Series 3 Hydrogen Generator is equipped with a pressure relief valve (P&ID Tag RV308). If the system experiences an over-pressure condition, the relief valve opens and allows the system to depressurize by allowing hydrogen to flow out the H₂ vent stack. (Refer to Section 2.8.2 for Pressure Relief Valves and Vent Lines.)



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



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.

1.2.4 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 15Nm³/hr (32.5kg/day, 573 SCF/hr).

The C Series 3 Hydrogen Generator is equipped with a pressure relief valve (P&ID Tag RV208). If the system experiences an over-pressure condition, the relief valve opens and allows the system to depressurize by allowing oxygen to flow

into the enclosure. (Refer to Section 2.8.3 for Pressure Relief Valves and Vent Lines.)

1.3 Product Specification

Table 2 – C Series 3 Product Specifications

Electrolyte			
Proton Exchange Membrane (PEM) – Caustic-Free			
Hydrogen Production			
Requirement	C10	C20	C30
Net Production Rate	10 Nm ³ /hr 380 SCFH 179 SLPM 21.6 kg/24hr	20 Nm ³ /hr 760 SCFH 359 SLPM 43.3 kg/24hr	30 Nm ³ /hr 1140 SCFH 538 SLPM 65.0 kg/24hr
Delivery Pressure – Nominal	30 barg (435 psig)		
Power Consumed per Volume of H ₂ Gas Produced ¹	6.2 kWh/Nm ³ (16.3 kWh/100ft ³)	6.0 kWh/Nm ³ (15.8 kWh/100ft ³)	5.8 kWh/Nm ³ (15.2 kWh/100ft ³)
Power Consumed per Mass of H ₂ Gas Produced ¹	68.9 kWh/kg	66.7 kWh/kg	64.5 kWh/kg
Purity (Concentration of Impurities) ¹	ISO 14687-1 Type 1 grade C ISO 14687-2 Type 1 grade D 99.9998% [Water Vapor < 2 ppm, -72°C (-98°F) Dewpoint, N ₂ < 2 ppm, O ₂ < 1 ppm, all others undetectable]		
Turndown Range	0 to 100% Net Product Delivery (Automatic)		
Upgradeability	Field Upgradeable to a maximum of 30 Nm ³ /hr (1140 SCFH)		N/A
DI Water Requirement			
Requirement	C10	C20	C30
Rate at Max Consumption Rate	9 L/hr 2.4 gal/hr	17.9 L/hr 4.7 gal/hr	26.9 L/hr 7.1 gal/hr
Temperature	5°C to 40°C (41°F to 104°F)		
Pressure	1.0 to 4.1 barg (10 to 60 psig)		
Input Water Quality	ASTM D1193 Type II Deionized Water Required (< 1 μS/cm, > 1 MΩ-cm), ASTM D1193 Type I Deionized Water Preferred (< 0.1 μS/cm, >10 MΩ-cm)		
Heat Load and Coolant Requirement			
Coolant	Liquid Cooled; non-freezing, non-Fouling ² ; 5-35°C (41-95°F)		
Heat Load from System	32 kW 109,189 BTU/hr (9.1 tons refrigeration)	64 kW 218,377 BTU/hr (18.2 tons refrigeration)	96 kW 327,566 BTU/hr (27.3 tons refrigeration)
Electrical Specifications			
Maximum Power Required Within Expected System Life	85 kVA	160 kVA	236 kVA
Electrical Specification	380, 400, 415 VAC, 3 phase, 50 Hz (±10% from nominal voltage) 480 VAC, 3 phase, 60 Hz (±10% from nominal voltage)		
Electrical Interface Connections			
Electrical (AC Power)	Electrical terminals at fused disconnect inside power supply enclosure		
Communications	Ethernet, RJ45		
Mechanical Interface Connections			
H ₂ Product Port	3/8" Parker CPI™ compression tube fitting, SS		

H ₂ Vent Port	1" Parker CPI™ compression tube fitting, SS with tube included		
DI Water Port	1/2" FNPT, SS		
Coolant Supply and Return Ports	Electrolyzer Enclosure: 1-1/2" MNPT, brass (Cell Stack); 1/2" FNPT, brass (Hydrogen Dryer) Power Supply Enclosure 1-1/2" MNPT, brass (Power Supply Cooling)		
Drain Port	1/2" FNPT, brass		
O ₂ Vent Port	1" Parker CPI™ compression tube fitting, SS with tube included		
Control Systems			
Standard Features	Fully Automated, E-Stop, On-board H ₂ leak detection, Remote Start/Stop, Automatic fault detection and system depressurization		
Remote Alarm	Form C relay, 5A, 250V, 150W Max. rated switching		
Remote Shutdown	Safety circuit trip		
Enclosure Characteristics			
Dimensions (W x D x H)			
Electrolyzer Enclosure	252 cm x 116 cm x 201 cm (99" x 46" x 79")		
Power Supply Enclosure	169 cm x 103 cm x 201 cm (67" x 41" x 79")		
Est. Shipping Electrolyzer Enclosure	269 cm x 122 cm x 225 cm (106" x 48" x 89")		
Est. Shipping Power Supply Enclosure	269 cm x 122 cm x 225 cm (106" x 48" x 89")		
Product Weight	2734 kg / 6026 lbs	2924 kg / 6446 lbs	3076 kg / 6781 lbs
Est. Shipping Weight	2876 kg / 6340 lbs	3089 kg / 6810 lbs	3241 kg / 7145 lbs
IP Rating	Overall unit rating of IP56		
Environmental Considerations			
Requirement	C10	C20	C30
Standard Siting Location	Indoor/Sheltered; level ±1°, 0 to 100% RH non-condensing; Non-hazardous/non-classified environment		
Storage/Transport Temperature	5°C to 60°C / 41°F to 140°F		
Ambient Temperature Range ³	5°C to 40°C / 41°F to 104°F		
Altitude Range – Sea Level to:	2000 m / 6562 ft		
Ventilation	Proper ventilation must be provided from a non-hazardous area, at a rate in accordance with IEC60079-10, Zone 2 NE		
Safety and Regulatory Conformity			
Maximum On-board H ₂ Inventory at Full Production	0.13 Nm ³ 4.9 SCF 0.011 kg	0.17 Nm ³ 6.4 SCF 0.015 kg	0.18 Nm ³ 7 SCF 0.016 kg
Cabinet Ventilation with Environment	Vent fan draws fresh air up to 8.5 Nm ³ /min (300 ft ³ /min)		
Noise (dB(A) at 1 Meter)	< 75		
Approvals	cTUVus (UL and CSA equivalent), CE (PED, Mach. Dir., EMC), ISO22734-1		

¹ Measured at standard conditions (70°F and 1atm)

² See Section 2.3 for coolant specifications and temperature requirements

³Options available for 5 to 50°C or -10 to 40°C configurations.

Options also available for Factory Matched RO/DI System, Factory Matched Cooler/Chiller, Dew Point Monitoring, Equipment Orientation.

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

1.4 General Description

The C Series Hydrogen Generator is a factory-matched and packaged PEM electrolysis system that produces high purity hydrogen from water and electricity. It is certified to ISO 22734-1, *Hydrogen generators using water electrolysis process - Part 1: Industrial and commercial application*.

The system includes an electrolyzer cell stack, and the support systems necessary for regulating electrolyzing operations and delivering pressurized hydrogen. The support systems include: circulating DI water, drying hydrogen, enclosure dilution, and liquid cooling. The unit contains sensors and supervisory controls to aid in monitoring the safety, performance and automatic operation of the system and to allow for remote monitoring and diagnostics. The unit is designed to operate in a non-hazardous (non-classified) environment. Customer-supplied interfaces are outlined in Figure 2 block diagram. The customer supplies cooling that meets Nel’s cooling water specifications. See section 2.3 for cooling flow and temperature specifications.

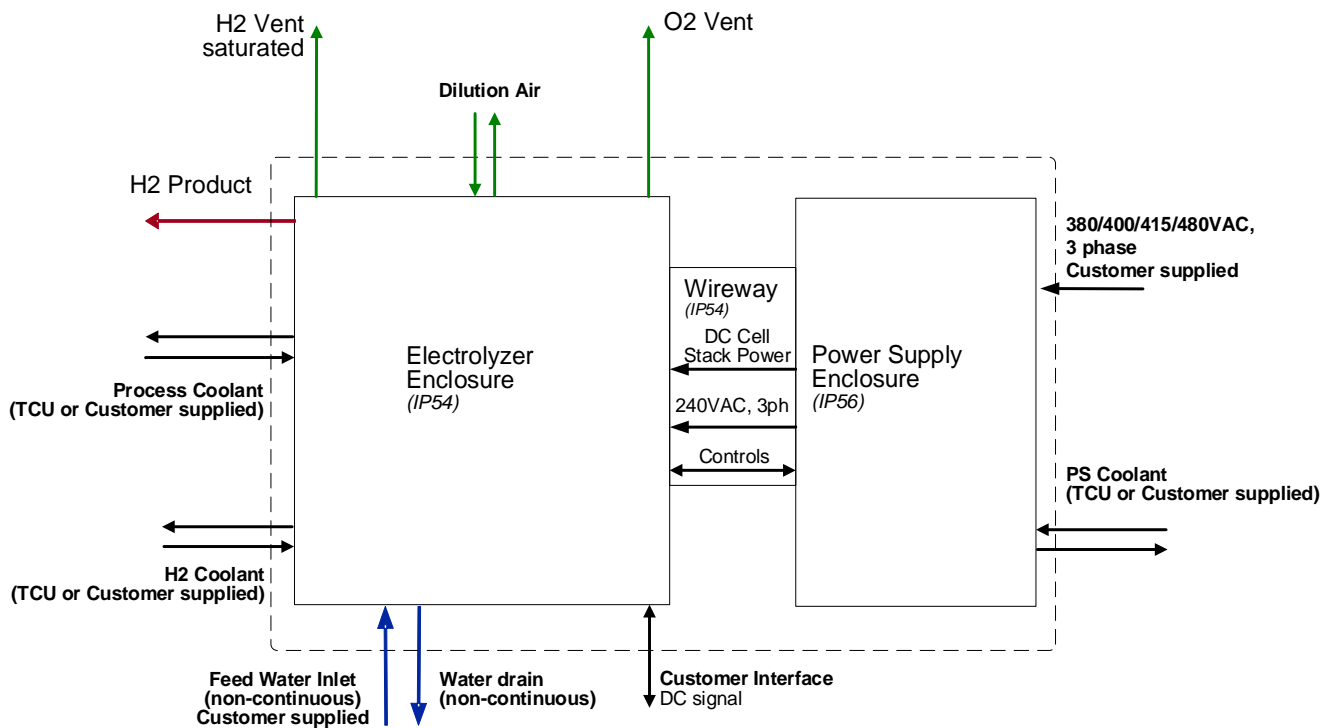


Figure 2 - C Series Hydrogen Generator Interface Block Diagram

1.5 Area Classification of the C Series Hydrogen Generator

The C Series Hydrogen Generator is a source of hydrogen, a combustible gas. When the unit is generating, it converts water to hydrogen and oxygen. When it is not generating, the production of hydrogen and oxygen stops, and the C Series Hydrogen Generator's pressurized hydrogen inventory is vented. Protection against the ignition of a potentially explosive atmosphere inside the electrolyzer is accomplished using basic protection techniques described in the international product standard ISO 22734-1, *Hydrogen generators using water electrolysis process - Part 1: Industrial and commercial applications*.

The primary protection method used is "containment of the hydrogen." Hydrogen is contained within process piping and is not allowed to mix with air to form a potentially combustible atmosphere.

Detection is the second layer of protection. A combustible gas detector is located within the electrolyzer enclosure set to detect a level of 1% hydrogen by volume (25% LFL H₂ in Air). If this level is reached the electrolyzer will shut down, stopping the source of hydrogen.

Dilution is the third layer of protection. A fan draws fresh air through the electrolyzer enclosure where the hydrogen is generated at a rate sufficient to dilute the largest anticipated hydrogen leak (per ISO 22734-1 §6.1.4) to a level below the lower flammable limit (LFL) of hydrogen. This air dilution rate is sufficient to reduce the area classification inside the electrolysis enclosure to be non-hazardous (Zone 2 NE [negligible extent]). This classification was confirmed using analysis and testing per IEC 60079-10. Additionally, the power source that drives hydrogen generation is interlocked by sensor(s) that confirm the operation of the dilution fan so that hydrogen generation is stopped upon loss of air dilution. Residual hydrogen vents; even if released within the enclosure, the volume of residual H₂ is insufficient to exceed the LFL.

The fourth level of protection provided is the elimination of ignition sources in any potentially combustible atmospheres inside the electrolyzer enclosure. All of the internal power distribution equipment and other electrical components are located in separate electronics enclosures that are sealed from where the hydrogen is generated. The electrical components that are in the hydrogen generation section of the electrolyzer enclosure are located outside any dilution zones. This protective layer is confirmed using analysis and testing per IEC 60079-10.

TÜV Rhineland, an independent National Recognized Test Laboratory for the U.S. and Canada and Notified Body for the European Union, has certified compliance of our C Series Hydrogen Generator to ISO 22734-1. TÜV opines that the

multiple levels of protection against potentially combustible atmospheres in our C Series design provides “primary protection” means against potentially explosive atmospheres in the electrolyzer and that since the electrolyzer is not designed to be placed inside a (existing) potentially explosive atmosphere, no additional certification or approval is required.

As discussed, one of the important protections against possible formation of a flammable atmosphere within the electrolyzer enclosure is dilution with air. It is essential that the source of dilution air be non-hazardous (non-classified). If fresh (non-hazardous) air is supplied as required, the exhaust from the C Series Hydrogen Generator is non-hazardous as any hydrogen is diluted below the LFL.



The installation of the C Series hydrogen generator does not change the area classification of the area in which it is installed.

1.6 Subsystems

1.6.1 Water and Oxygen Management Subsystem

The Water and Oxygen Management Subsystem (WOMS) (see Figure 3) separates a two-phase mixture of oxygen gas and water from the electrolysis cell stack. The oxygen may normally contain up to 0.5% hydrogen by volume. A combustible gas sensor (P&ID Tag CG220) monitors percent LFL of hydrogen in oxygen. The system shuts down if 50% LFL is detected. The WOMS subsystem:

- Minimizes water evaporation
- Allows draining of water
- Maintains and monitors water quality
- Manages water inventory
- Detects and accommodates hazard from PEM cell stack failure
- Accepts water stream from the Hydrogen Management System (HGMS)
- Delivers cooled and filtered water streams to the PEM cell stack
- Rejects process waste heat via a process water/coolant heat exchanger
- Vents byproduct oxygen safely

1.6.2 Hydrogen Gas Management Subsystem

The Hydrogen Gas Management Subsystem (HGMS) (see Figure 4) separates product hydrogen from water and delivers high purity dry hydrogen product at pressure. The HGMS subsystem:

- Accepts a two-phase pressurized hydrogen/water stream
- Delivers a single-phase hydrogen gas stream of at least 99.9995% or better
- Delivers a liquid water stream (which typically includes dissolved hydrogen gas) to the WOMS
- Vents excess hydrogen safely

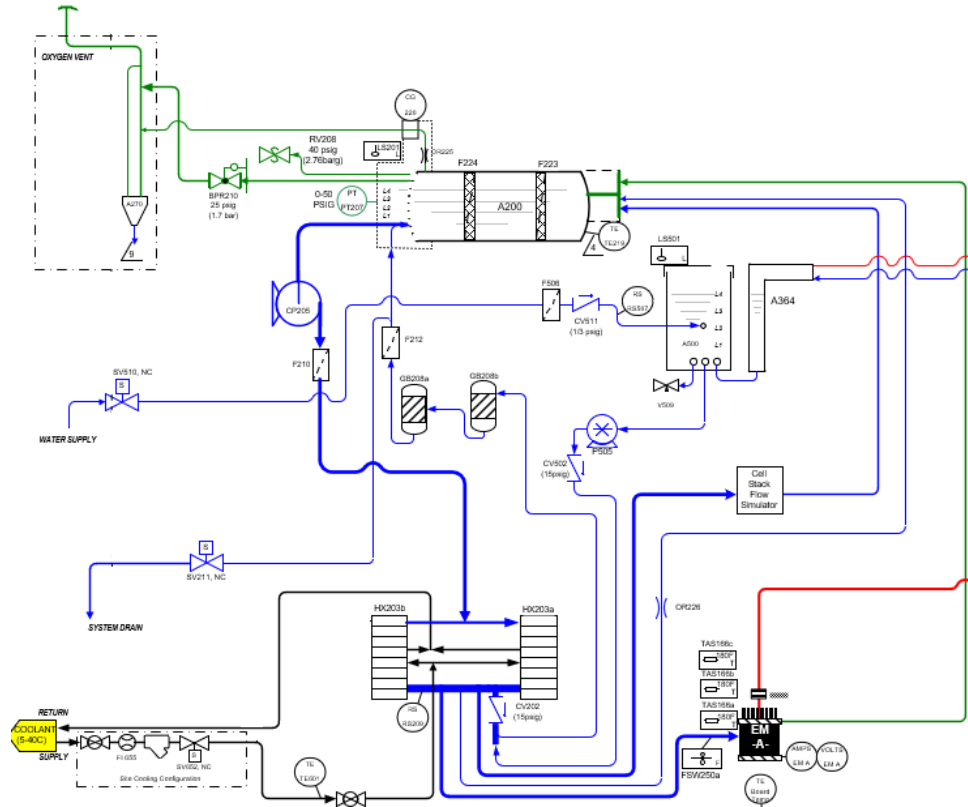


Figure 3 - C Series 3 Hydrogen Generator WOMS P&ID*

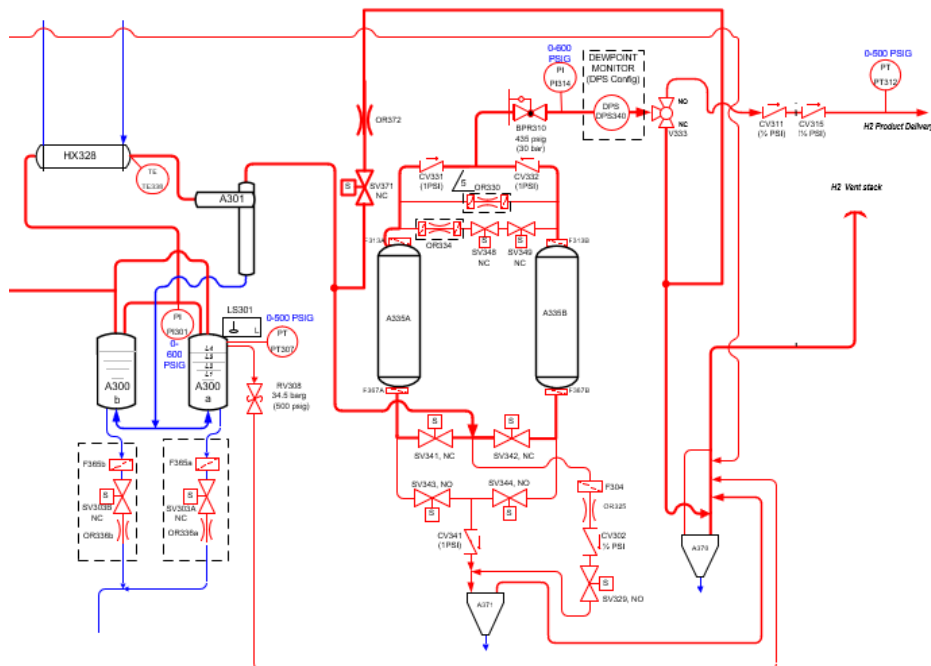


Figure 4 - C Series 3 Hydrogen Generator HGMS P&ID*

*Shown for reference, may vary slightly from shipped product

1.6.3 Control and Power Distribution

The controls affect the startup, automatic operation, product delivery rate, and monitoring for all modes of operation. The control system:

- Provides an easy-to-use user interface for equipment operation, service, and maintenance personnel
- Provides optional remote monitoring, diagnostics, service, and remote operation functions
- Provides a safety circuit, including pressure monitoring and cutoff switches such as E-Stop, Flood, and Main Disconnect, to de-energize circuits in the process enclosure

1.7 Enclosures



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

The enclosures of the C Series Hydrogen Generator:

- Protect the internal elements from shipping damage and the environment
- Provide structural mounting and support
- Provide thermal insulation for outdoor weather conditions (when configured)
- Prevent unauthorized access
- Consist of separate vented electrolyzer (with shrouds and air filter housings) and sealed electrical enclosures

1.7.1 Electrolyzer Enclosure

The Electrolyzer enclosure:

- Houses the dilution fan, cell stack, WOMS, and HGMS
- Mounts the fluid interconnect fittings
- Provides dilution of hydrogen to reduce internal environment to Non-Hazardous (Non-Classified) per IEC 60079-10
- Provides a user interface panel for unit operation
- Provides control to the various subsystems
- Supports power panel mounted on the outside

1.7.2 Power Supply Enclosure

The Power Supply Enclosure provides the necessary input and output electrical connections and houses the main cell stack power supplies.

The Power Supply Enclosure:

- Provides 380, 400, 415 or 480, 3 phase VAC nominal power to cell stack power supplies

- Provides means of isolation between incoming main AC and internal components.
- Provides DC power to the PEM cell stack based upon hydrogen demand
- Provides 240 VAC nominal power to recirculation heaters, fans, pumps, 24 VDC power supplies and laptop computer

1.8 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



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

NOTE

2 HYDROGEN GENERATOR SITE LAYOUT AND DESIGN

2.1 Installation

The C Series Hydrogen Generator is a fully integrated system. To install the generator, mechanical, electrical, fluid, and communication interface requirements must be met. This section describes the interface and installation requirements. Figure 5 through Figure 9 illustrate the hardware, mounting points and connections for system integration and packaging. Coolant isolation and distribution kits must be used.



Prior to scheduling commission activities with Nel or their representative, a Site Safety and Health Hazard Assessment Survey (OFM1005) and C Series 3 Installation Checklist (TSF1007) must be completed by the site customer representative and submitted to Nel for review.

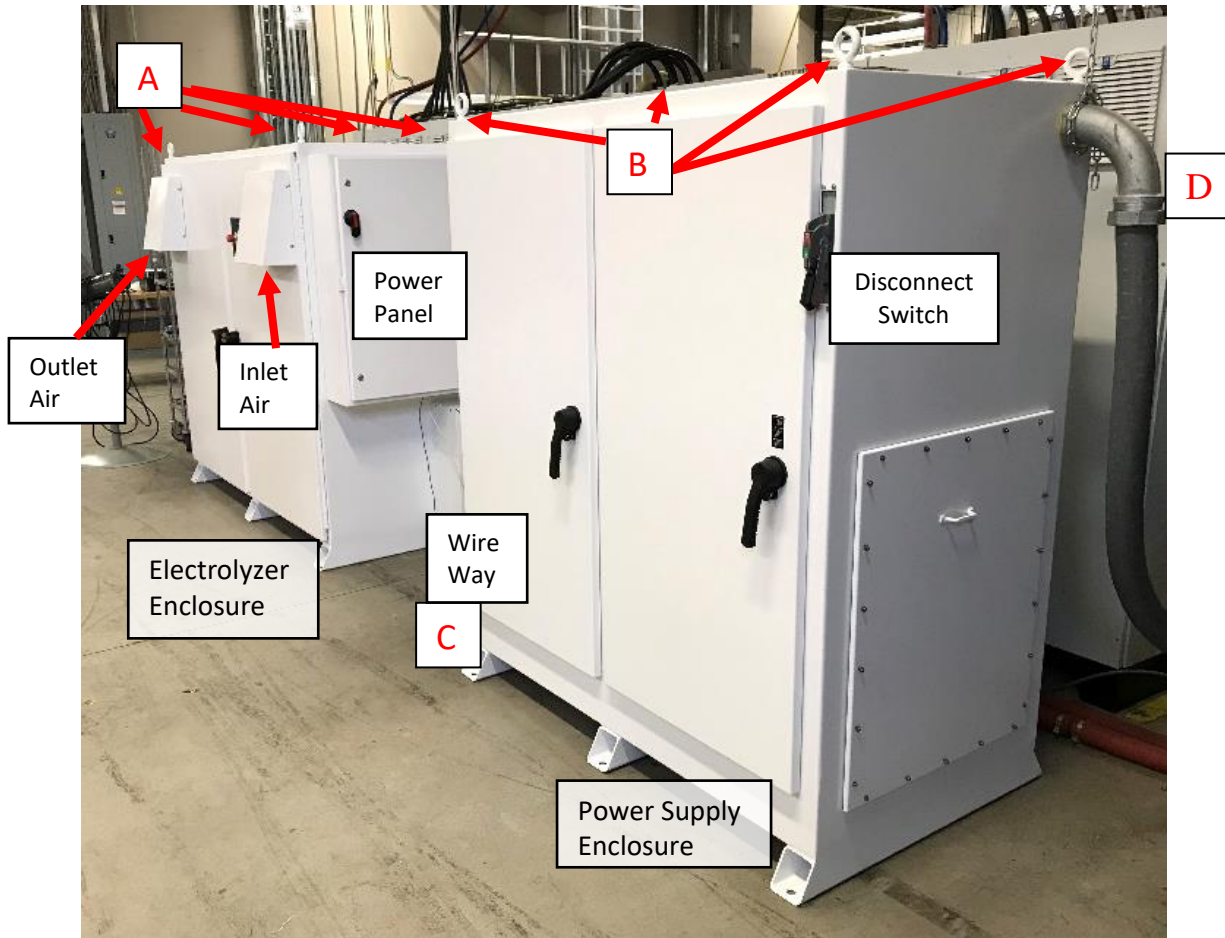


Figure 5 - C Series 3 Hydrogen Generator

Ref.	Interface Connection	Ref.	Interface Connection
A	Electrolyzer Enclosure Lifting Eyebolts	C	Communication Wiring
B	Power Supply Enclosure Lifting Eyebolts	D	AC Service

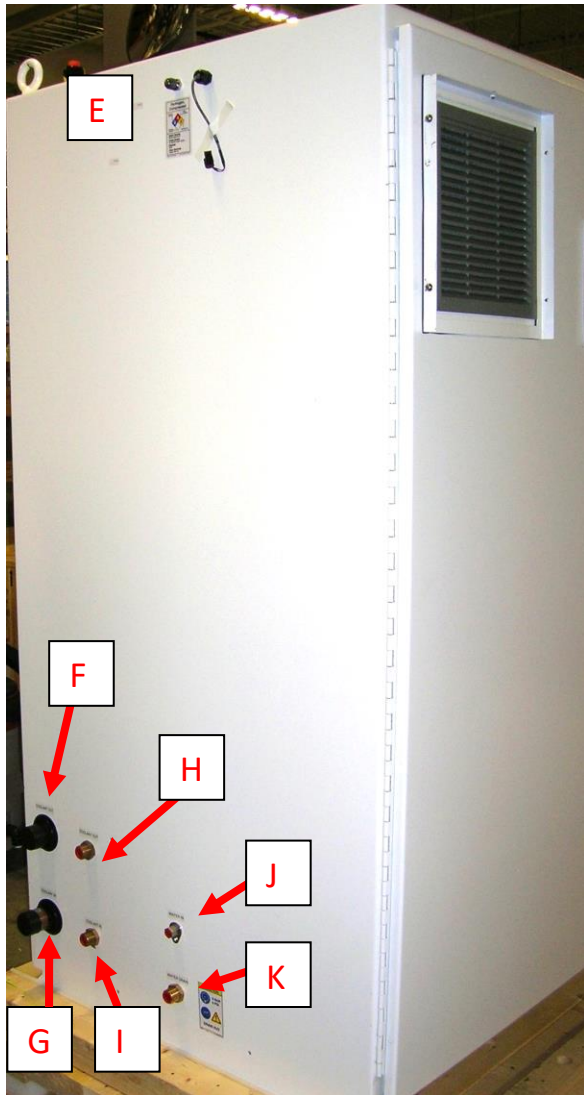


Figure 6 - Electrolyzer Enclosure Connections

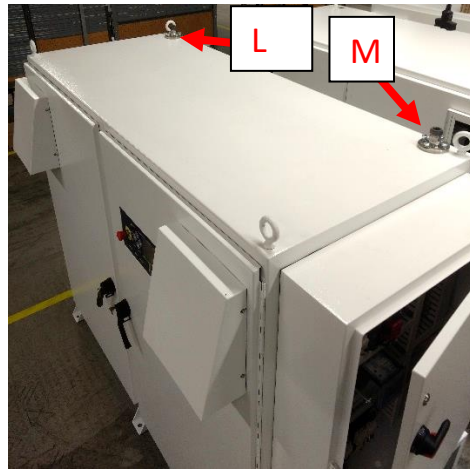


Figure 7 - H₂ and O₂ Vent Stack Connections

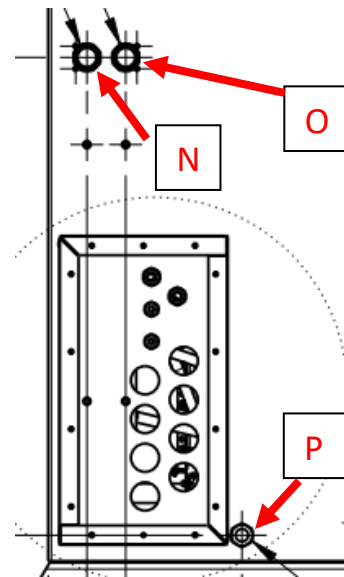


Figure 8 - Power Supply Enclosure Connections

Ref.	Interface Connection	Ref.	Interface Connection
E	CV315 & PT312 Connection (3/8" CPI, 316 SS)	K	Water Drain (1/2" FNPT, Brass)
F	Cell Stack Coolant Return (1-1/2" MNPT, Brass)	L	H ₂ Vent Stack Connection (1" CPI, 316 SS)
G	Cell Stack Coolant Inlet (1-1/2" MNPT, Brass)	M	O ₂ Vent Stack Connection (1" CPI, 316 SS)
H	Hydrogen Dryer Coolant Return (1/2" FNPT, Brass)	N	Power Supply Coolant Return (1-1/2" MNPT, Brass)
I	Hydrogen Dryer Coolant Inlet (1/2" FNPT, Brass)	O	Power Supply Coolant Inlet 1-1/2" MNPT, Brass)
J	Water Inlet (1/2" FNPT, 316 SS)	P	Dehumidifier Drain (Power Supply Enclosure)

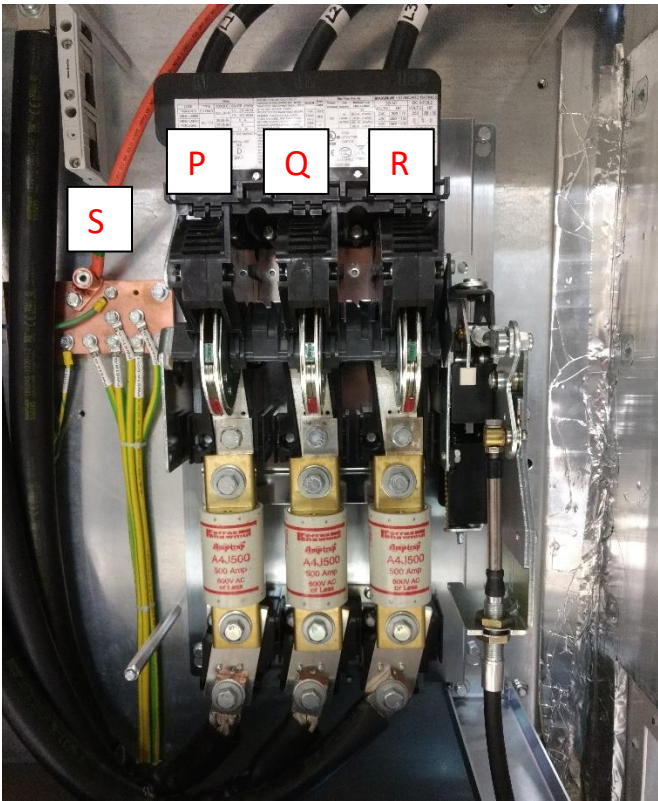


Figure 9 – AC Service Connection (typ)

Ref.	Interface Connection	Ref.	Interface Connection
P	Phase A Connection	R	Phase C Connection
Q	Phase B Connection	S	Ground Connection

2.2 Facility Air Ventilation Requirements

The C Series hydrogen generator design implements an enclosure ventilation scheme in accordance with ISO 22734-1 §6.1.4 (see section 1.5 for discussion). A fan (P&ID Tag FAN132) at the outlet draws in at least 270 cubic feet per minute (CFM) of fresh purge air through the electrolyzer enclosure. The fan suction is sufficient to maintain an internal negative static air pressure in the enclosure. Two pressure switches within the cabinet detect any loss of ventilation pressure or over pressure and will produce a safety shutdown of the generator upon a loss or over pressure. Further, the air purge rate is such that it dilutes any anticipated internal hydrogen leakage to a concentration below 1 percent hydrogen in air (25 percent of the lower flammable limit (LFL)).



Although the unit will stop hydrogen production and release any stored 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.

As an additional benefit, this air ventilation rate excessively dilutes any anticipated leak of byproduct oxygen, precluding any hazards associated with enriched oxygen atmospheres.

Additionally, an internal hydrogen detector produces an automatic alarm if excessive hydrogen is detected. If required, the C Series system can interface with facility fire detection systems, combustible gas sensor or other external facility alarms as required.



THE C SERIES HYDROGEN GENERATORS ARE DESIGNED TO OPERATE IN NON-EXPLOSIVE, NON-HAZARDOUS, NON-CLASSIFIED ENVIRONMENTS. THE EQUIPMENT CABINET IS VENTILATED WITH FRESH AIR TO MAINTAIN A SAFE, NON-EXPLOSIVE INTERNAL OPERATING ENVIRONMENT.

For indoor installations of the C series by itself, Nel Hydrogen recommends an installation area fresh air change rate the greater of 250 cfm per C series generator or 1 cfm/square foot (0.3048 m³/ m²-min) of room floor area. Co-location of other equipment such as compressors or storage tanks may require additional ventilation and separation - consult local codes and/or model codes such as NFPA 2 for additional guidance.



Combustible dust environments require an optional external filter and shroud kit from Nel (contact factory).



Always refer to local code requirements to determine minimum facility ventilation requirements.

2.3 Operating Environment

The C Series hydrogen generator is designed for indoor or outdoor use (covered). It shall be located or sited on a grade of no more than ± 1 degree. The area that the system occupies shall have the ventilation schemes described in Section 2.2.

The standard C Series hydrogen generator is rated for ambient temperatures and is not designed for freezing conditions (per C Series Specifications PD-0600-0068) unless the cold ambient temperature option was purchased and installed. If the system is introduced to freezing conditions, damage to the system will occur.



Consult Nel Hydrogen for information on placing the unit in a freezing environment.

The C Series hydrogen generator contains a systems thermocouple that monitors the water temperature in the process water circulation loop of the system. The unit runs up to 100 percent hydrogen output at 62°C. If the system water temperature reaches 63°C, the unit begins reducing the maximum hydrogen output and triggers a warning. If the warning is undetected, the unit continues reducing hydrogen output until it shuts down at 65°C. Additionally, the power supply modules have active temperature monitoring, which will disable modules (degraded output) or the entire power supply set if cooling flow and temperature is inadequate.

Coolant Specifications:

pH 7.0 to 9.0, chloride <20ppm, nitrate <10ppm, sulfate <100ppm, total solids <250ppm, calcium carbonate <250ppm



USE A MIX OF WATER AND GLYCOL SUITABLE FOR THE AMBIENT ENVIRONMENT.

The C Series hydrogen generator can be stored and transported in certain environments (per C Series Specifications discussed in PD-0600-0068). In the event that the unit is to be transported in a freezing environment, water must be completely drained from the system.



THE GENERATOR IS NOT SHIPPED WITH THE PEM CELL STACK INSTALLED. DO NOT EXPOSE THE STACK TO FREEZING CONDITIONS WHEN THE UNIT IS NOT RUNNING. PLEASE CONSULT THE FACTORY FOR SPECIAL STORAGE AND HANDLING INSTRUCTIONS IF THE CELL STACK WILL BE EXPOSED TO FREEZING CONDITIONS PRIOR TO INITIAL START UP.

2.4 Site Preparation

The C Series hydrogen generator is designed for installation on a level concrete pad. AC power, DI water and cooling water that meets the specifications outlined in PD-0600-0068 are the key utilities required. Ensure the generator is located so that it is safe from

vehicle traffic and is in compliance with local safety regulations. Nel Hydrogen recommends the use of barriers if placing the unit near a vehicle traffic area.

A level floor, ± 1 degrees, capable of supporting the generator is required. The minimum clearance requirements of the area around the generator are shown in Figure 10. There is a zero minimum clearance requirement on the back of the generator.

The minimum clearance requirement on the front is 41in (1.05m), left is 12in (0.3m) and right is 48in (1.21m). Additional spacing may be required depending on the installation of the piping and electrical connections. It is the customers' responsibility to verify that the local code requirements for this type of equipment are met when installing this equipment.

All facility connections are identified in Figure 6 and Figure 8. Leave sufficient clearance to permit adequate air movement in and out of the generator from the front of the unit.

Front and right side access is very important for operation, ventilation and maintenance. The generator is controlled from the front control panel, which has start and stop switches, E-Stop, keypad, and service bypass key switch. The main disconnect is located on the right side of the generator. Opening the door of the electrolyzer enclosure permits access for routine maintenance. Refer to mechanical interface drawing (PD-9900-0039) for additional details.

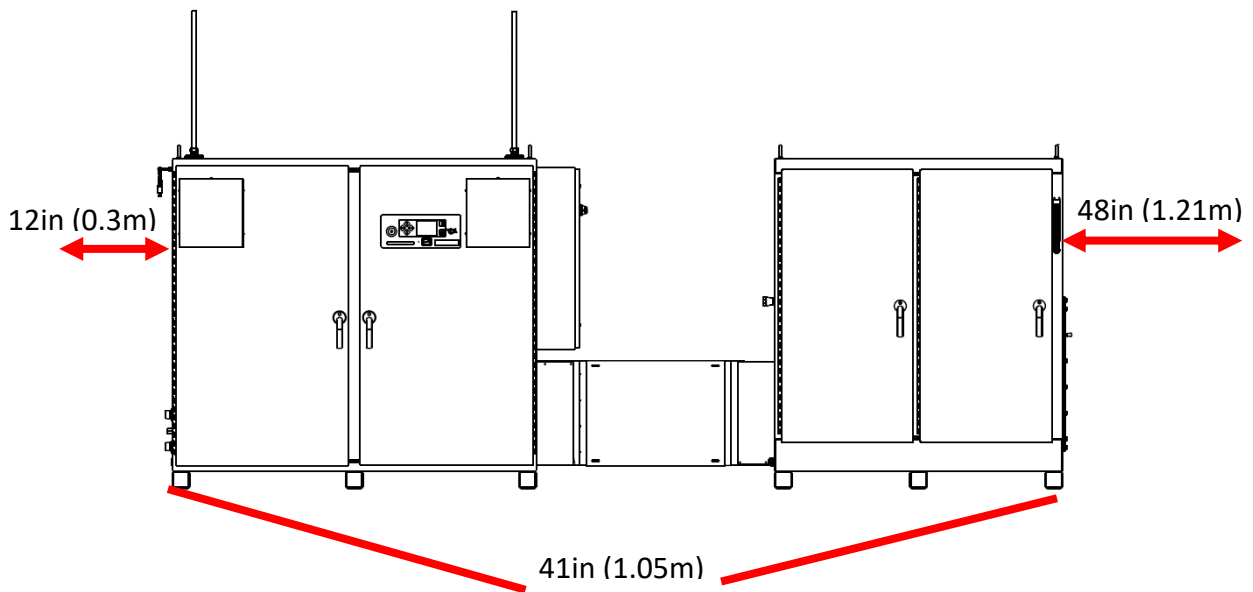


Figure 10 – C Series Hydrogen Generator Plan View for Installation



THE C SERIES UNIT MUST BE PLACED AN APPROPRIATE DISTANCE FROM VEGETATION, SIDEWALKS, PUBLIC WAYS, ROADS AND RAILROAD TRACKS PER LOCAL CODES AND STANDARDS.

2.5 Unpacking the C Series Hydrogen Generator



For some hydrogen generators shipping overseas, wooden crates are installed onto the wooden pallets to further protect against any shipping damage.

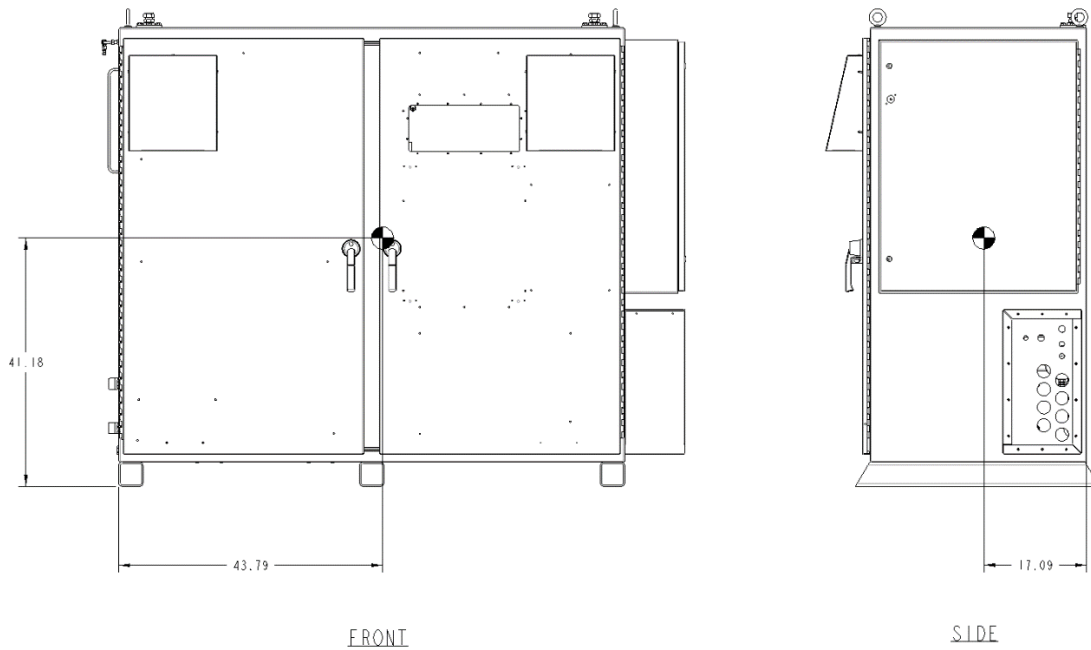


Figure 11 – Center of Gravity* (Electrolyzer Enclosure, approximate, as shipped)

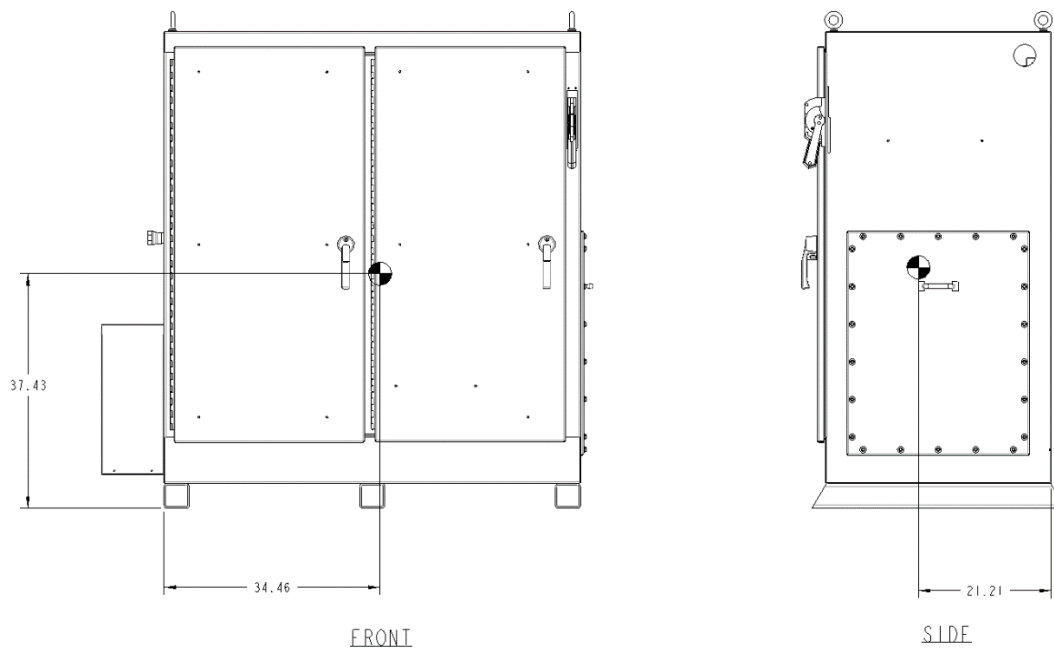


Figure 12 –Center of Gravity* (Power Supply Enclosure, approximate, as shipped)

*Dimensions shown are in inches.

Please use the following instructions to unpack each pallet:

1. If applicable, remove the top and all four sides of the wooden crates using a Phillips screw driver.
2. Remove the protective wrapping around the enclosure and inspect for any damage. If damage has occurred, please file a claim with the shipper and contact Nel Hydrogen Customer Service at **(203) 949-8697**.
3. Remove the vent piping from the back of each enclosure by cutting the nylon strap holding it in place at the eyebolt and pull the piping out of the hole in the
4. Using a 9/16" wrench with socket and ratchet, unscrew and remove all the nuts from the front (4), back (4) and sides (2) shipping beams.
5. Once all nuts are unscrewed, push down on each bolt until it drops to the bottom. See Figure 13.

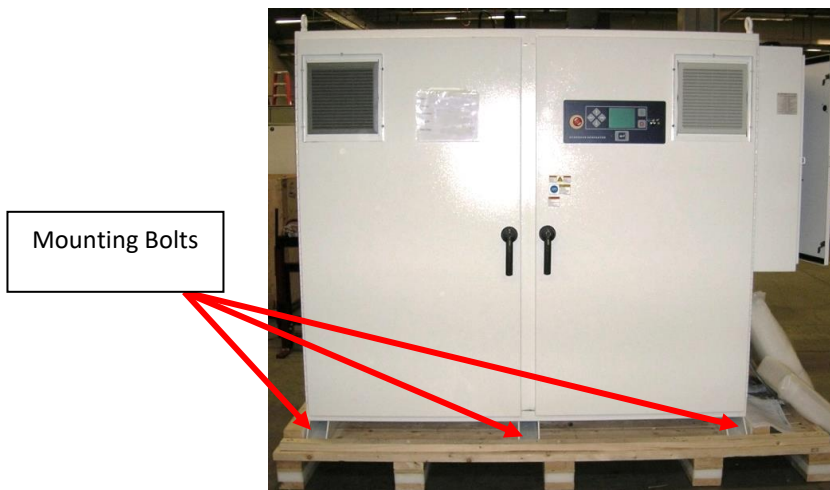


Figure 13 – Electrolyzer Enclosure

6. Remove all four shipping beams from the unit.
7. If using a forklift, lift the enclosure from under the floor. Make sure the forks extend past the back of the unit before picking up the enclosure (See Figure 14).

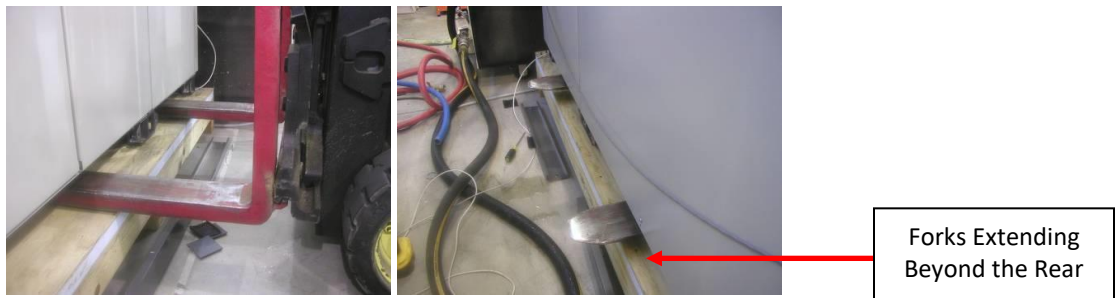


Figure 14 – Lifting the Unit using a Forklift

8. If transporting by hoist, lift each enclosure separately using either a spreader bar of appropriate design or a four-leg lifting sling with >3m (>10ft) legs to prevent structural damage to the enclosures.

2.6 Anchoring Instructions

It is required to properly secure the C Series hydrogen generator to a concrete pad when siting the equipment outdoors. Refer to drawing, PD-9900-0039, for specific anchoring points and locations. All materials and methods used should be appropriate for anchoring the C Series hydrogen generator in the intended environment (seismic, severe wind, etc.).



NOTE

If the C Series hydrogen generator is placed in a freezing environment and there is a loss of power, take necessary provisions to keep the unit from freezing.

2.7 Electrical Interfaces

2.7.1 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.

2.7.2 Cabling Procedure



NOTE

Do not supply the C Series system power from a GFCI (Ground Fault Circuit Interrupter) or a GFEP (Ground Fault Equipment Protector) circuit breaker. AC power filtering performed by the C Series will naturally exceed GFCI trip limits as well as lower level GFEP trip limits.

The AC power cabling procedure is as follows:

1. Size the AC power conductors according to the service rating listed on the nameplate.
2. Ensure that connections conform to appropriate dust and water intrusion standards and are compliant with the local electrical codes.
3. Remove the plug placed over the hole on the right side of the disconnect panel.
4. Verify that the selected connectors are appropriately sized for the pre-drilled holes.
5. Install the appropriate dust and water-resistant connector into the hole drilled in the side of the panel.
6. Feed the power and ground conductors through the AC power feed connector.
7. Connect the power conductors to the top of the main disconnect inside the unit.
8. Bring the protective earth ground conductor into the unit along with power to the conductors.



CAUTION

Ensure proper clockwise phase rotation of service power prior to operation.



NOTE

Install AC service to optional TCU per manufacturer's instructions and per local code. Ensure proper rotation of service power prior to operation.

2.7.3 Main Disconnect Torque Requirements

To perform the electrical supply connection check:

1. Perform all necessary Lockout/Tagout procedures (Section **Error! Reference source not found.**)
2. Verify that the input power to the system has been torqued to the values in Table 3. Refer to the C Series Maintenance Manual, PD-0200-0023 for other AC connection torque values.

Table 3 – Recommended Torque for C10, C20 and C30 Disconnect Switches

Location	Recommended Torque
C Series C30	325 in-lb (37 N-m))
C Series C20	325 in-lb (37 N-m)
C Series C10	275 in-lb (31 N-m)

2.7.4 Verifying Transformer Voltage Configuration

Systems will be factory tested and configured to operate at the voltage specified at the time of order (380, 400, 415 or 480 VAC). If the installed input voltage is different than that which was ordered, the transformer (TXFM1) will need to be configured to the proper input voltage. Follow the manufacturer’s instructions on the transformer and local codes when configuring the transformer. Refer to electrical schematic and Table 4.



Figure 15 - 380/400/415/480 to 240 Transformer (TXFM1)

2.7.5 Remote Customer Interface and TCU Connections

The C Series system has external monitoring and remote shutdown interface connections available to the customer at the orange terminal blocks 16 located in the power supply enclosure (see Figure 16). Refer to electrical schematic and Table 4 below.

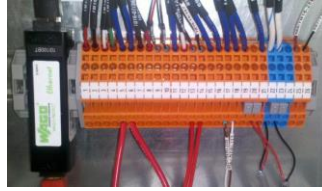


Figure 16 - Terminal Block 16 - Customer Interface

Table 4 – Customer Interface and TCU Connections

Signal Name	Terminal Location	Input or Output to C Series	State	Rating	Description
Electrolyzer E-Stop Notification	TB16-01 to TB16-02 and TB16-03 to TB16-04	Output	Open = E-Stop Pressed	Dry Contact, 240VAC, 3A max 24VDC, 2A max	Notifies customer if the hydrogen generator E-Stop has been pressed.
Customer Remote E-Stop	TB16-05 to TB16-06	Input	Open = E-Stop Pressed	Sourcing 24VDC, 0.5A	Customer emergency shutdown signal into the hydrogen generator. Immediately stops the unit and safely vents hydrogen gas through vent system (example: Customer E-Stop, CG Sensor, IR Detector or equivalent).
Remote Shutdown Indicator	TB16-07 to TB16-08	Output	Open = Electrolyzer Offline	Dry Contact, 240VAC, 5A max 30VDC, 5A max	Notifies customer if the hydrogen generator is powered off, stopped or in an error state.
Enclosure CG Sensor Alarm	TB16-09 to TB16-10	Output	Open = >25% LFL Hydrogen	Dry Contact, 240VAC, 0.3A max 24VDC, 3A max	Notifies customer if hydrogen >25% LFL is detected in the electrolyzer enclosure.
Remote Stop	TB16-11 to TB16-12	Input	Close = Stop Electrolyzer	Sourcing 24VDC, 0.5A	Customer remote stop signal into the hydrogen generator. Closing a contact allows the customer to remotely stop the hydrogen generator. A 1 second momentary closure of the contact is required for stopping.
TCU Alarm	TB16-13 to TB16-14	Input	Open = Alarm	Sourcing 24VDC, 0.5A	Alarm signal from the TCU to the hydrogen generator. Sets an error and performs a scheduled stop of the hydrogen generator.
TCU E-Stop	TB16-15 to TB16-16	Output	Open = E-Stop Pressed	Dry Contact, 240VAC, 5A max 24VDC, 5A max	Emergency shutdown signal to the TCU if the electrolyzer E-Stop has been pressed.
TCU On/Off	TB16-17 to TB16-18	Output	24VDC = Enabled	Dry Contact, 240VAC, 3A max 24VDC, 4A max	Signal from the hydrogen generator to turn the TCU on and off.
TCU Isolation Valves	TB16-19 to 21 for +24VDC, TB16-22 to 24 for DC Return	Output	24VDC = Enabled	Sourcing 24VDC, 3A max	Used for powering relay for customer provided isolation valves.
Remote Start	TB16-25 to TB16-26	Input	Close = Start Electrolyzer	Sourcing 24VDC, 0.5A	Customer remote start signal into the hydrogen generator. Closing a contact allows the customer to remotely start the hydrogen generator. A 1 second momentary closure of the contact is required for starting.
Remote Monitoring	Ethernet Connection	Output	Ethernet	Standard Ethernet	Used to connect with Remote Monitoring software.

2.8 Mechanical Interfaces

This section provides a detailed description of the mechanical interface requirements. The physical layout and dimensions of the C Series hydrogen generator are shown. On Mechanical Interface drawing PD-9900-0039 detailed interface connections for the hydrogen outlet, hydrogen and oxygen vents, DI feed water and cooling water supply are also supplied on the drawing.

2.8.1 Physical Layout, Connections and Dimensions

For the physical layout of the C Series hydrogen generator refer to Mechanical Interface Drawing PD-9900-0039.

2.8.2 H₂ Vent Stack Interface

The C Series hydrogen generator vents hydrogen during startup, system depressurization, dryer purging cycles, and overpressure relief. The C Series hydrogen generator vents up to 34.8 liters of hydrogen per minute to purge and condition the Hydrogen Gas Management Subsystem (HGMS) in normal operation.



NOTE

In the GENERATE-VENT mode, the C Series hydrogen generator shall operate at approximately 4 to 11 percent generation while discharging generated hydrogen to vent. This operation purges the phase separation portions of the HGMS with hydrogen to eliminate any air gases that may be present.

At the end of GENERATE-VENT (130 seconds minimum/10 minutes maximum), the vent valve (P&ID Tag SV329) closes and the system begins to pressurize. During system shutdown, the on-board inventory hydrogen (< 6 SCF/0.16 Nm³) is vented to atmospheric pressure, leaving some residual hydrogen in the system. Depressurization occurs when gas generation stops and the vent valve (P&ID Tag SV329) is opened, allowing hydrogen to flow out of the H₂ vent.

The internal dryer of the C Series hydrogen generator is a pressure-swing dryer. Each bed operates alternately in two half-cycles of equal duration: pressurization followed by adsorption and depressurization, followed by a purge with product hydrogen from the alternate bed. It is during this purge that desorbed water vapor with hydrogen is blown out of the non-operating bed and directed out the H₂ vent. During these purge cycles, approximately 13.8 liters per minute (max) of hydrogen exits the H₂ vent stack with desorbed moisture. Additionally, the generator is equipped with an ASME rated pressure relief valve. If the system experiences an over-pressure condition, the relief valve cracks open and depressurized hydrogen is directed out the H₂ vent.



The pressure relief valve (RV308) is factory set and should not adjusted.

Due to the operational nature of the hydrogen generator as described in the above two paragraphs, a hydrogen vent system must be provided by the customer to manage and direct hydrogen from the generators dedicated H₂ vent port to a safe location.

The local authority having jurisdiction (AHJ) needs to be consulted regarding proper vent system design, construction and routing. When considering vent system design, the customer shall ensure back pressure at the H₂ vent stack interface is no greater than 0.035 barg (0.5 psig) for the following production flow rates:

For 10 Nm³/hr Systems: 30 Nm³/hr

For 20 Nm³/hr Systems: 60 Nm³/hr

For 30 Nm³/hr Systems: 90 Nm³/hr



NOTE

If the hydrogen generator may be upgraded to a higher production rate in the future it is recommended that the future higher production rate be considered in the vent system design.



NOTE

Codes and standards that can be helpful in vent system design include NFPA 50A, CGA G-5.5 and EIGA Doc 211/17.



WARNING

DO NOT ALLOW HYDROGEN TO VENT INDOORS, NEAR VENTILATION INTAKES, WORK AREAS, OR ANY SOURCE OF IGNITION. THE HYDROGEN VENT LINE AND VENT STACK TO ATMOSPHERE MUST REMAIN FREE FROM OBSTRUCTIONS AND KEPT FROM FREEZING.

2.8.2.1 H₂ Vent Stack Installation

The H₂ vent stack uses a length of 1" stainless steel tube, connected to a 1" compression port inside the electrolyzer enclosure through a compression bulkhead fitting at the top left rear of the electrolyzer enclosure. For proper hydrogen dryer operation and compliance with pressure safety codes, 1" tubing (25.4mm) or larger is required.

A length of 1" tube is provided, which is to be passed through the bulkhead to the port on the manifold inside and should be installed per best practice for hydrogen vent lines and must not be reduced or restricted.

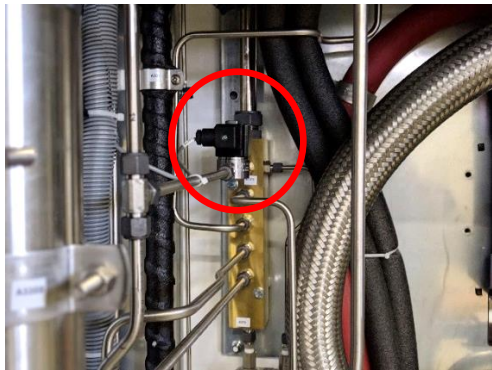


Figure 17 - H₂ vent manifold connection (inside)



Figure 18 - H₂ vent bulkhead passthrough (external)



The vent line shall not be restricted by excessive length of tubing or by the use of check valves. Vent backpressure adversely affects the moisture content of the hydrogen produced.



In applications operating below freezing, precautions must be taken to prevent freezing of the vent lines.



The vent line must be installed to minimize the possibility of restriction or blockage due to animals, insects, dirt, rust, etc.

2.8.3 O₂ Vent Stack Interface

The C Series hydrogen generator vents oxygen during startup, system operation, and overpressure relief. The C Series hydrogen generator vents up to 12.3 liters of oxygen per minute in normal operation.



The pressure relief valve (RV208) is factory set and should not adjusted.

Due to the operational nature of the hydrogen generator as described above, an oxygen vent system must be provided by the customer to manage and direct oxygen from the generators dedicated O₂ vent port to a safe location.

The local authority having jurisdiction (AHJ) needs to be consulted regarding proper vent system design, construction and routing. When considering vent system design, the customer shall ensure back pressure at the O₂ vent port interface is no greater than 0.070 barg (1.0 psig) for the following flow rates:

For 10 Nm³/hr Systems: 15 Nm³/hr
 For 20 Nm³/hr Systems: 30 Nm³/hr
 For 30 Nm³/hr Systems: 45 Nm³/hr



Codes and standards that can be helpful in vent system design include NFPA 53, CGA P-8.1 and CGA P-8.7.

2.8.3.1 O₂ Vent Stack Installation

The O₂ vent stack uses a length of 1" stainless steel tube, connected to a 1" compression port inside the electrolyzer enclosure through a compression bulkhead fitting at the top right rear of the electrolyzer enclosure. For proper vent operation and compliance with pressure safety codes, 1" tubing (25.4mm) or larger is required.

A length of 1" tube is provided, which is to be passed through the bulkhead to the port on the manifold inside, and should be installed per best practice for oxygen vent lines and must not be reduced or restricted.



Figure 19 - O2 vent manifold connection (inside)



Figure 20 - O2 vent bulkhead passthrough (external)

2.8.4 H₂ Product Output Interface

The C Series hydrogen generator is designed to produce hydrogen that contains ≤ 2 PPM of water. Hydrogen is delivered at a nominal pressure of 30 barg (435 psig) and up to the unit's rated flow rate.

2.8.4.1 Check Valve (CV315) and Pressure Transducer (PT312)

The assembly is to be installed using the bulkhead fitting located at the left side of the electrolyzer enclosure.

1. Connect the transducer assembly to the bulkhead fitting.
2. Connect the connector to the transducer.

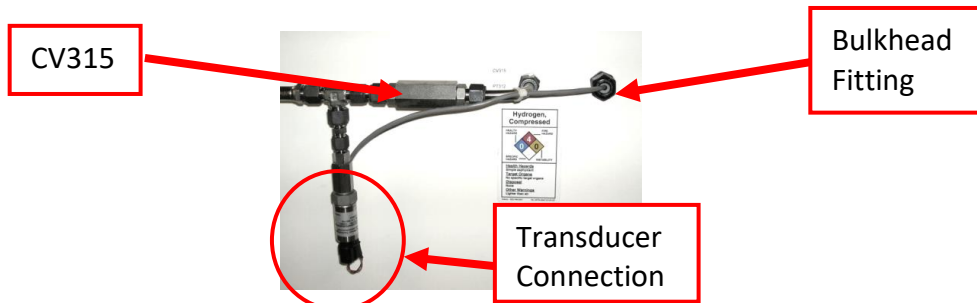


Figure 21 - Transducer Assembly (PT312)

2.8.4.2 H₂ Product Output Installation

The product hydrogen port uses a compression tube fitting for 3/8" OD stainless steel tubing with 0.035" thick wall. Figure 22 shows the connection location.



Figure 22 – H₂ Product Output Connection

2.8.5 Coolant Interfaces

The C Series uses 3 different coolant supply and return loops for the cell stack, H₂ dryer and power supply cooling. The cell stack coolant supply and return (1-1/2" MNPT connections) and the H₂ dryer coolant supply and return (1/2" FNPT) are located on the left side of the Electrolyzer Enclosure, shown in Figure 23 below.



Figure 23 - Electrolyzer Enclosure Coolant Interfaces

The power supply coolant supply and return (1-1/2" MNPT connections) are located on the left side of the Power Supply Enclosure, shown in Figure 24 below.



Figure 24 - Power Supply Enclosure Coolant Interfaces

Figure 6 and Figure 8 show the connection locations of these ports. It is recommended that the user provide isolation valves to permit maintenance and servicing of the coolant loop.



Nel Hydrogen requires that the available Coolant Isolation Kit (or equivalent) must be used to isolate the coolant supply and monitor flow.

A strainer must be installed on the fluid inlet to prevent clogging of the system with particulate. Typically, strainers have low holding capacities and are only designed for a low numbers of particles. Facilities with high particle counts in the cooling water may require additional filtration to prevent frequent clogging of this strainer. Nel Hydrogen recommends a 50 mesh filter element.



The C Series system has options for either a factory matched TCU or facility coolant. Electrical interface connections can be found at TB16 in the power supply enclosure (See XPE2871).



For coolant isolation valves, use a minimum 14 AWG cable suited for the environment (600V, 90°C, UL/CE Approved).



All connections through the electrical panels must be made with an >IP66 rated strain relief to maintain the integrity of the electrical enclosures environmental rating.

2.8.6 H₂O Interfaces

The C Series hydrogen generator uses de-ionized water to produce hydrogen and to actively cool the cell stack. It requires a minimum of ASTM Type II de-ionized water. ASTM Type II de-ionized water calls for a resistivity of at least 1.0 MΩ-cm (or conductivity below 1μ Siemens /cm) and a maximum 50-μg total organic carbon per L of water. Other qualities of the water can be found in ASTM designation D1193-99: Standard Specification for Reagent Water. Although ASTM Type II water is required, ASTM Type I de-ionized water is recommended. By using the highest quality water recommended, the life of the guard bed cartridge and the cell stack will be extended. The water quality sensor will trigger a fault if water quality drops below 1 MΩ-cm (or the water conductivity exceeds 1μ S/cm). Therefore, it is highly recommended that ASTM Type I de-ionized water be used to prevent this fault.



During normal unit operation the maximum volume of DI water drained from the unit is approximately 10L (2.5 gallons) at a maximum flow rate of 6L/min (1.5 gallons /min). The maximum volume of DI water in the A500 is approximately 76L (20 gallons) and in the A200 is approximately 38L (10 gallons) and may need to be drained entirely during a service or maintenance operation (at the same rate).



DO NOT USE: copper, aluminum, iron or other metal for de-ionized water inlet tubing as this will result in significant contamination and performance loss over time. *PVC plastics are not acceptable, as they will damage the electrolyzer cell stacks.*



In order to assure integrity of structure and fluid containment and minimize ionic and particle contamination please follow the guidelines outlined below. Approved materials for DI water feed plumbing and connections are given in Table 6. Materials forbidden are given in Table 5.



DI water treatment options are available. Please consult Nel or your service provider/supplier with any questions.

Table 5 – Materials forbidden for use with DI Water Feed

Brass
Bronze
Aluminum or Aluminum Alloy (Bare, Conversion-Coated, or Anodized)
Pure Nickel
Nickel Plating
Carbon Steel
High Strength Low Alloy Steel (e.g. 4130, 4340, etc)
Cast Iron
Cadmium
PVC

Table 6 – Approved Materials in Contact with DI Water Feed

Material	Surface Treatment
Polypropylene	-
Polyethylene Plastic	-
Titanium, Commercially Pure	-
CRES 316L (Or Equivalent)	Passivate per AMS-QQ-P-35 Type VI or Equivalent
CRES 316 (Or Equivalent)	Passivate per AMS-QQ-P-35 Type VI or Equivalent
CRES A286 (Or Equivalent)	Passivate per AMS-QQ-P-35 Type VIII or Equivalent
INCONEL 718 (Or Equivalent)	-
INCONEL 625 (Or Equivalent)	-

The C Series controller manages water levels. When the water level drops below a set point in the A500, the Water Feed Valve (P&ID Tag SV510) opens to allow water into the system through the water inlet.

2.8.6.1 H₂O Inlet

The H₂O DI water inlet port is a 1/2" FNPT connection, located on the left side of the electrolyzer enclosure, shown in Figure 25. Polypropylene plastic tubing is highly recommended for the water feed line. FEP and PFA plastics are also acceptable. The only recommended metal line is clean, passivated 316SS. The drain line should be appropriately plumbed based on your specific facility requirements. Post-deionization water tanks should be constructed from polypropylene only as stainless steel tanks will leach out impurities that will damage the system.



Use only Teflon tape to seal the DI water supply threaded connection.



Figure 25 - Water inlet connection (external)

2.8.7 H₂O Drain

The water drain port is a 1/2" FNPT connection. Figure 26 shows the connection locations of this port.



Figure 26 - Water drain connection (external)



The drain line should not be raised overhead. The unit must drain downward to a drain, or a pumping station is required. The unit drain is pump assisted during operation, however when the water level gets low, it is a gravity only drain, and must go to a lower level than the system.



An obstructed drain line could prevent the C Series hydrogen generator from draining properly and may result in permanent damage.

2.8.8 Condensate Drain Interface

The power supply enclosure contains a thermal electric dehumidifier whose condensate drain line exits the power supply enclosure as shown in Figure 27. The flexible drain tube shall be routed separately to a drip pan or open gravity drain.



Figure 27 - Power Supply condensate drain



CONDENSATE FROM THE POWER SUPPLY ENCLOSURE CONDENSATE DRAIN SHALL ALWAYS BE SEPARATELY ROUTED TO A DRIP PAN OR OPEN GRAVITY DRAIN TO AVOID A HAZARDOUS CONDITION AND NEVER CONNECTED TO A POTENTIAL SOURCE OF HAZARDOUS GAS OR LIQUID.

2.9 Installation of Loose Parts and Removal of Blocking & Bracing

2.9.1 Inlet and Exit Air Filter Housing Installation (F124A and F124B)

The C Series hydrogen generator uses air filters to protect the inside of the system from contamination from the outside environment (ingress protection). The generator uses two disposable air filters to remove contaminants from the dilution air entering the system.

To install the air filter housings, use the following instructions:

1. Pull off the pop-off standard filter louver. Lift up on the bottom of the louver.
2. Once the standard filter louver is off, place the filter in the housing (Figure 29).



Figure 28 - Filter Louver

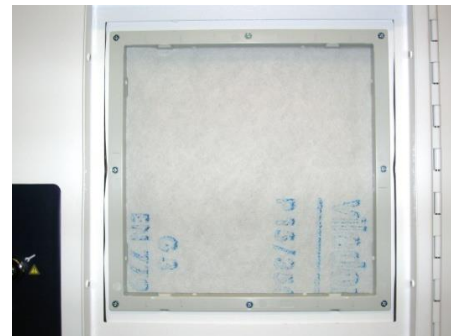


Figure 29 - Filter Element

3. Snap the filter louver back in place over the filter element.
4. Locate the shroud with the restrictor plate and install that on the air inlet side located on the right door of the Electrolyzer Enclosure.
5. Place the shroud over the filter louver and attached with 4 Phillips head screws.
6. Repeat steps for air outlet shroud located on the left Electrolyzer Enclosure door.



Figure 30 - Air Inlet Shroud with Restrictor Plate



Figure 31 - Shroud Placement

2.9.2 Removal of Blocking and Bracing

Remove any and all foam, wood or other packing materials from inside the generator before continuing installation.

2.10 Installation of Wire Way and Cabling

2.10.1 Wire Way

1. Press on the back panel between the two enclosures (loose fit only – do not use screws). (See Figure 32).

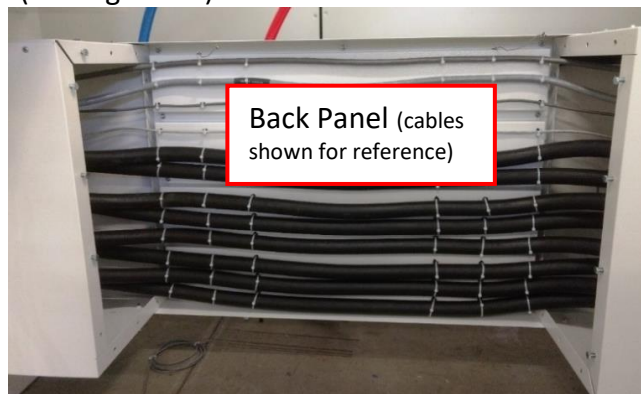


Figure 32 - Wire Way Back Panel



Refer to PD-9900-0039 for details and arrangement.

2.10.2 Routing Cables

2.10.2.1 Routing the Cell Stack Cables and AC/DC Cables

Use the following instructions for connecting the cell stack on the C Series hydrogen generator:

1. Place the DC cell stack cables including the pre-installed strain relief fittings through the openings on the Electrolyzer enclosure. Follow Figure 33 below with the DC (+) cables on the left and the DC (-) cables on the right. The nut of the strain relief can be 'threaded' over the lug from the inside and used to secure the cable. The strain reliefs should be left loose for adjustments (tightened at a later stage).

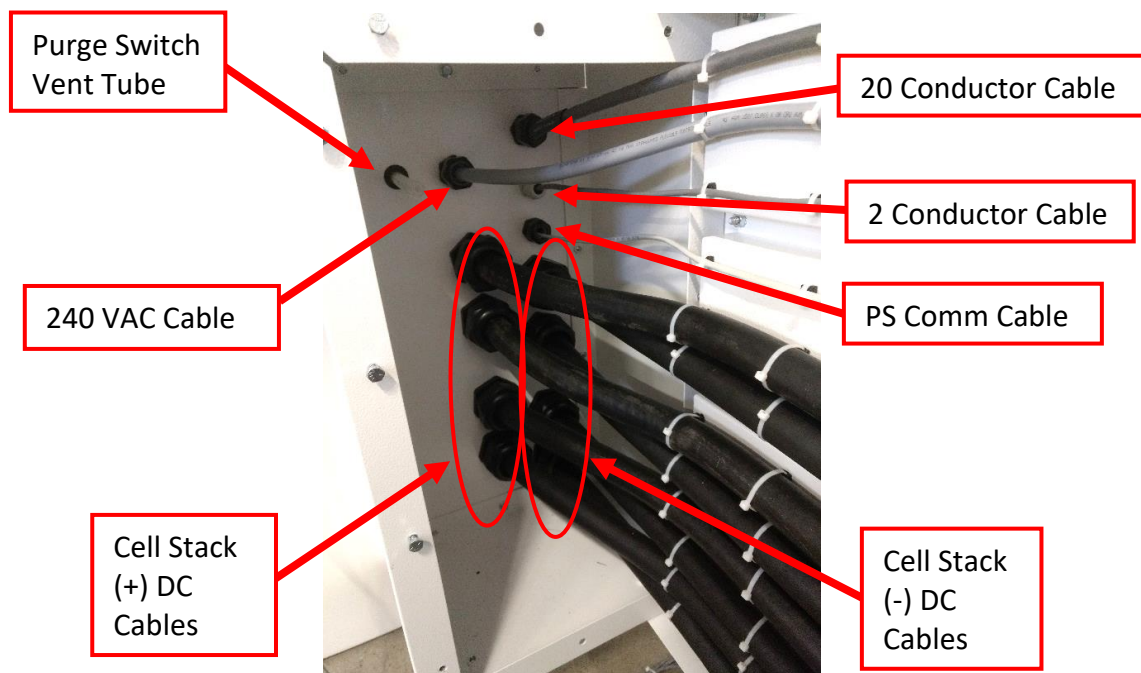


Figure 33 - Electrolyzer Enclosure Strain Relief Connections

2. Pull the power supply communication cable, 20 conductor cable, 2 conductor cable and 4 wire AC cable through the Power Supply Enclosure strain relief fittings. See Figure 34.
3. Place the DC cell stack cables including the pre-installed strain relief fittings through the openings on the Power Supply enclosure. Follow Figure 34 below with the DC (+) cables on the right and the DC (-) cables on the left. The nut of the strain relief can be 'threaded' over the lug from the inside and used to secure the cable. The strain reliefs should be left loose for adjustments (tightened at a later stage).

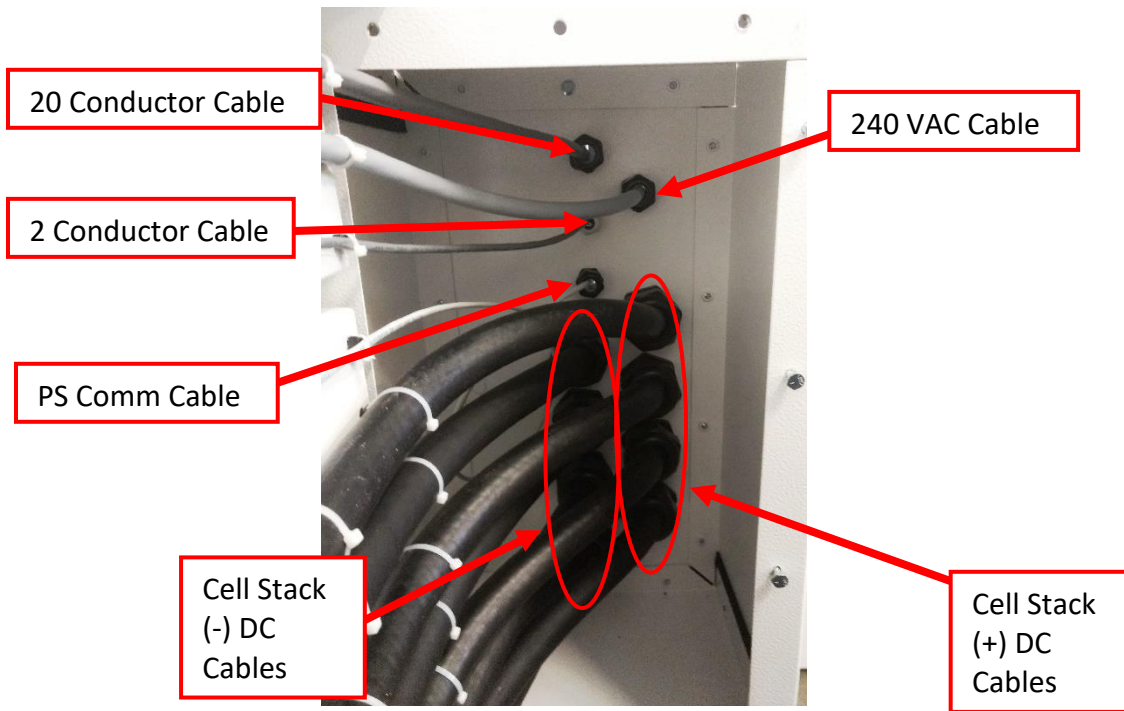


Figure 34 - Power Supply Strain Relief Connections

4. Loosely secure the cables into the wire way to allow movement and adjustment of cables during final termination (Figure 35).

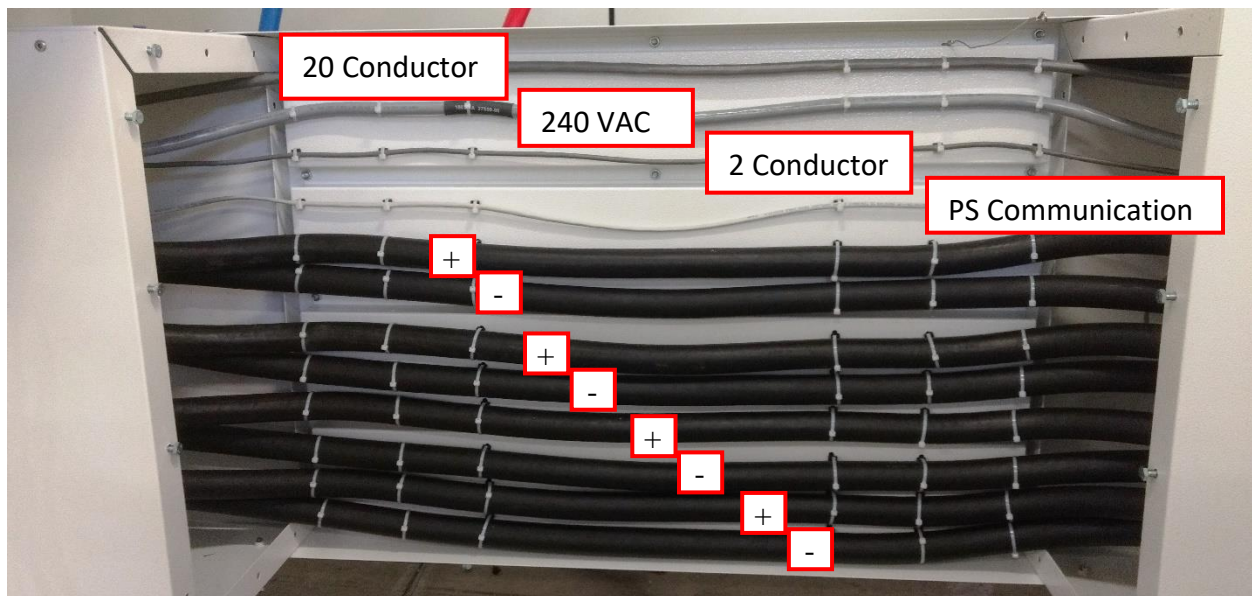


Figure 35 - Wire Way Cable Installation

5. Route the cables through the Power Supply enclosure and connect to the DC bus on the power supply as shown in Figure 36 below. Torque to 57 in-lb (6.4 N-m).

6. Connect the power supply communication cable to the power supply as shown in Figure 36.

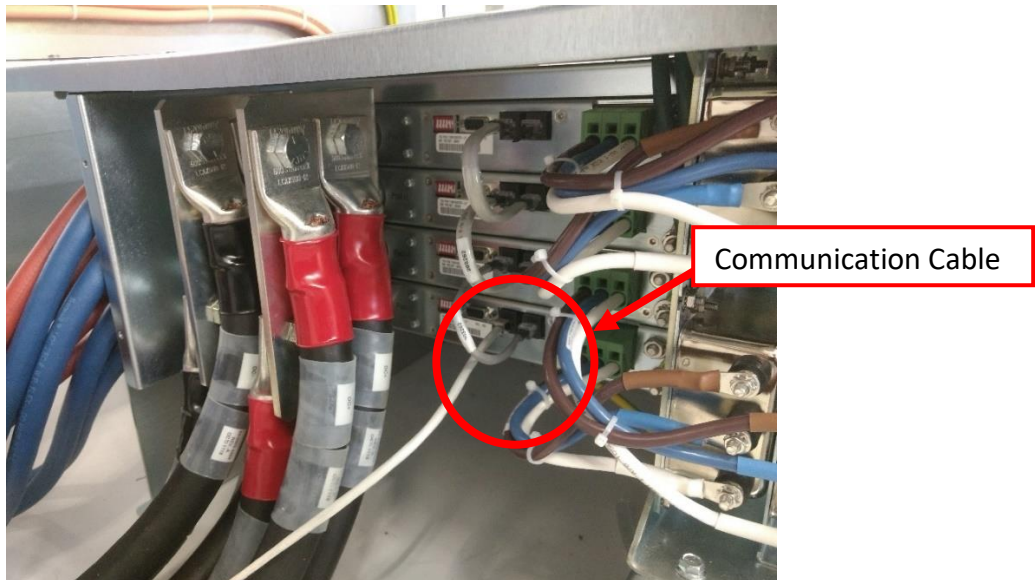


Figure 36 - DC Cable Cell Stack Power Supply Connection

7. Install power supply terminal cover, see Figure 37.

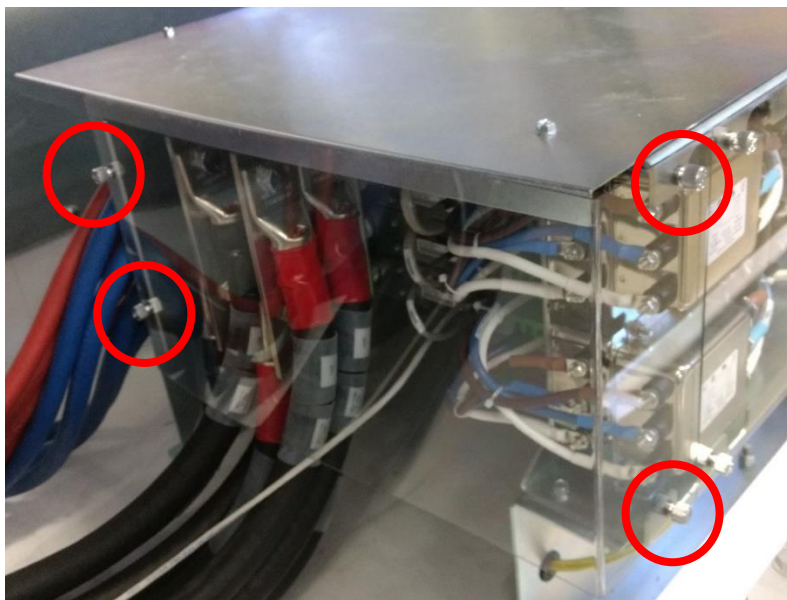


Figure 37 - Power Supply Terminal Cover

8. Route the 20-conductor cable, 2 conductor cable and 240 VAC cable through the wireway as shown below in Figure 38.

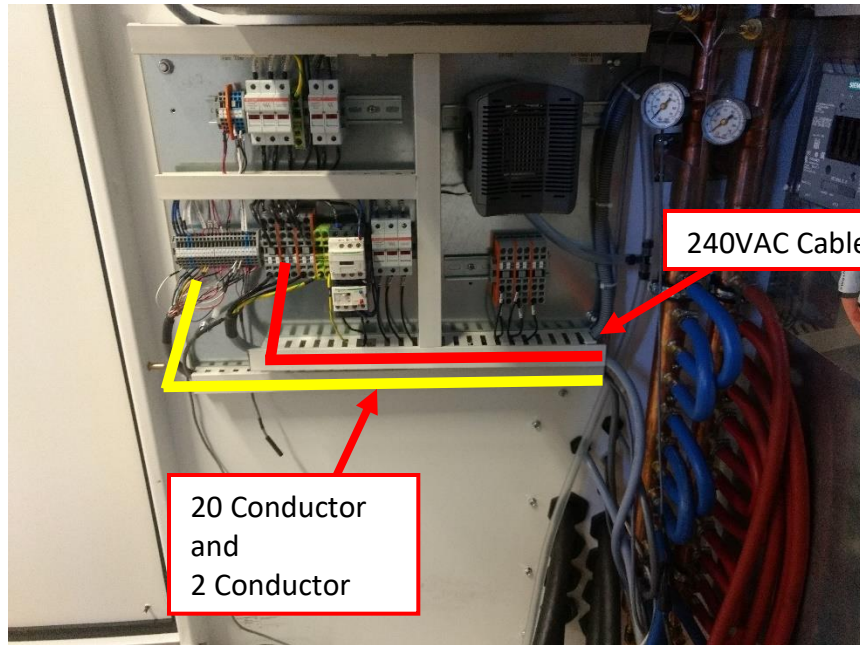


Figure 38 - AC/DC Cable Routing

9. Connect the 20 conductor and 2 conductor cables to TB1B and the 240 VAC cable to TB2, TB3 and TB4. Refer to electrical schematic XPE2871 for details.

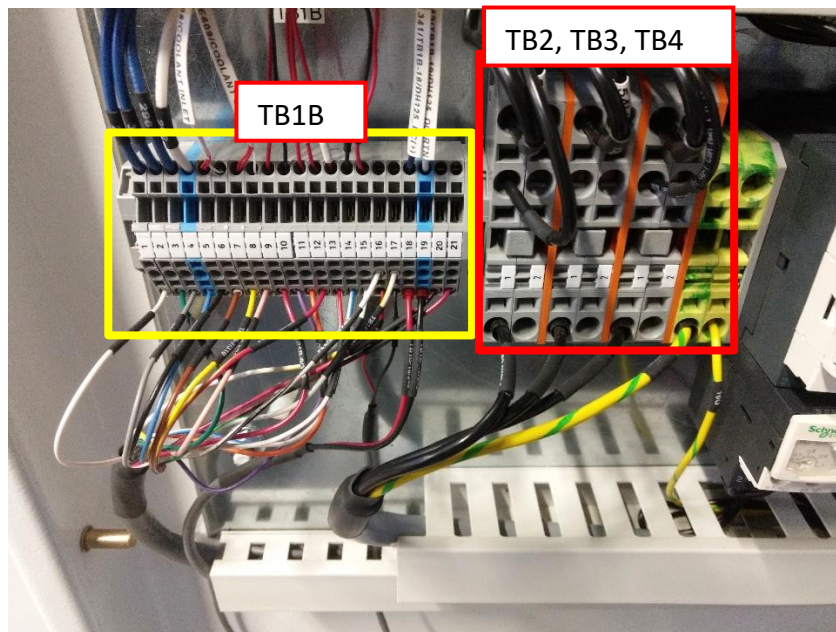


Figure 39 - TB1B and TB2, TB3 and TB4 Connections

10. After all wire and cables are installed, press on the two side covers (right and left side) and then secure to the side panels and back panel using, ¼-20 screws for each cover. (See Figure 40).
11. Press the front cover over the front and secure in the 4 corners (two on the bottom) with ¼-20 screws. (See Figure 41).

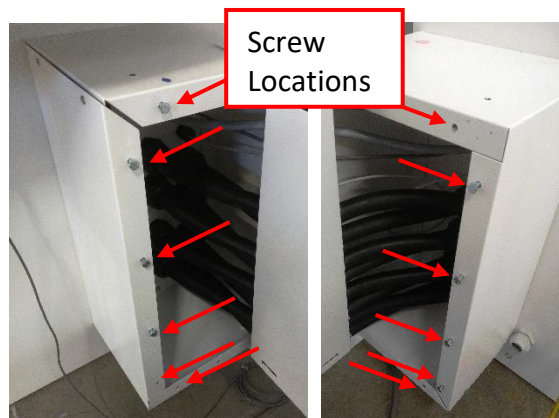


Figure 40 - Wire Way Left and Right Side Covers



Figure 41 - Wire Way Front Panel

2.11 Installing Cell Stack

Use the following instructions for installing the cell stack into the C Series hydrogen generator:



THE CRATED CELL STACK WEIGHS APPROXIMATELY 600 POUNDS. TAKE CAUTION WHEN LIFTING AND MOVING THE CELL STACK.

1. Open the latches and remove the top panel from the cell stack crate.



Figure 42 - Cell Stack Crate

2. Remove the 2 sides of the cell stack crate so that the remaining sides are parallel to the cell stack mounting rails.

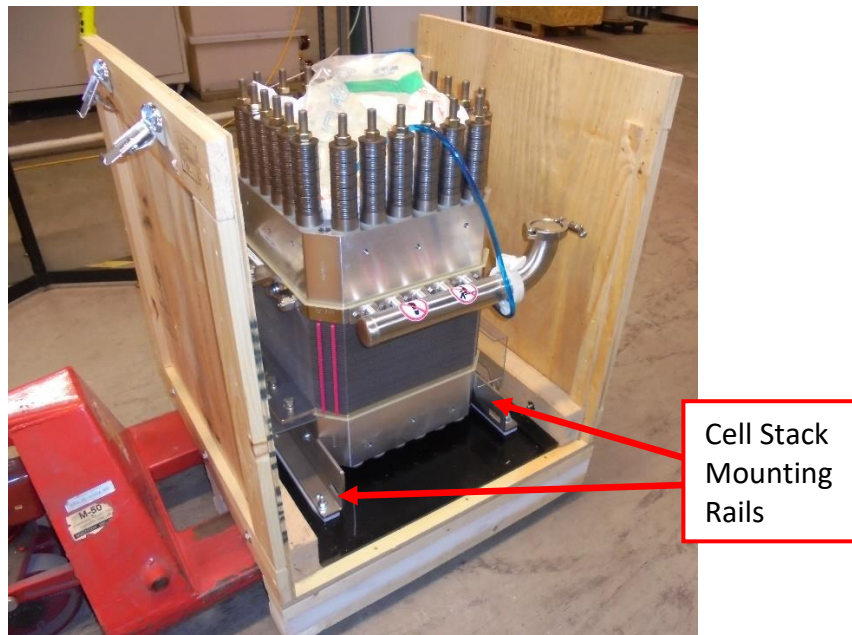


Figure 43 - Cell Stack Crate with 2 Sides Removed

- Remove the 4 bolts that secure the cell stack to the crate.

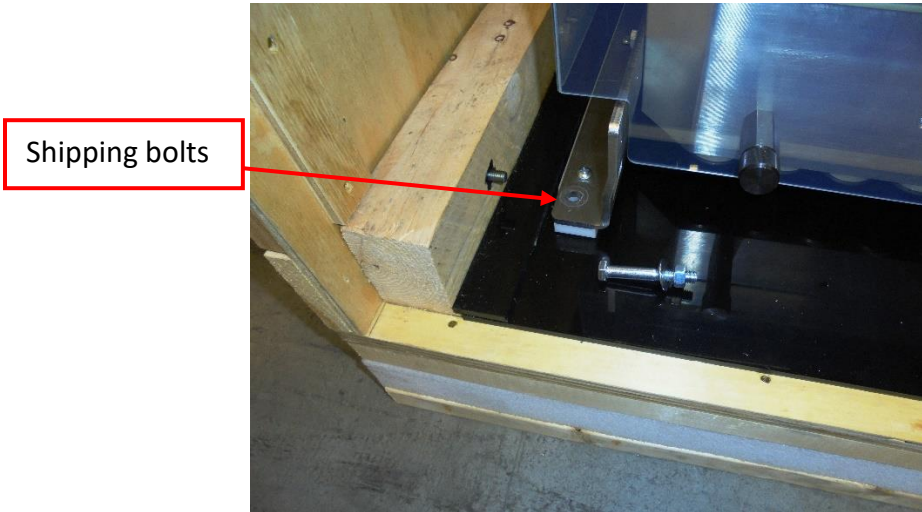


Figure 44 - Cell Stack Crate Mounting Bolts

- Place the cell stack crate on a pallet jack or forklift. With the DC cell stack cable terminals on the right put the forks under the crate as shown below.

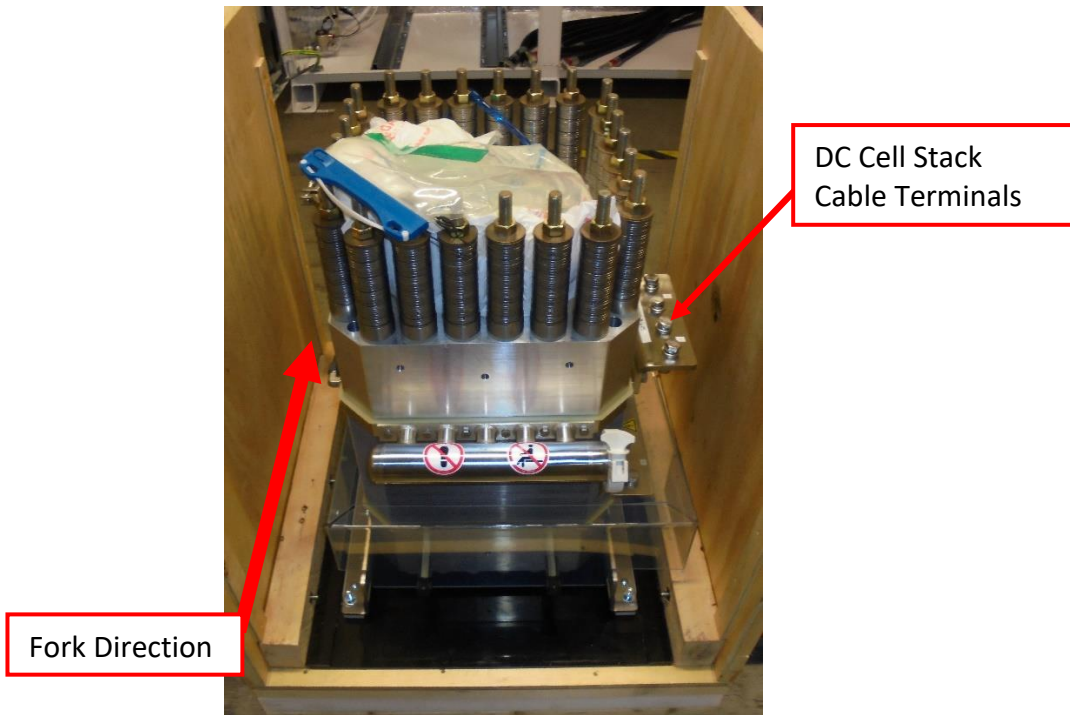


Figure 45 - Cell Stack and Crate on Pallet Jack

5. Move the crate and cell stack in front of the C Series. Line up the cell stack mounting rails with the cell stack support rails in the enclosure. Lower the forks so that the cell stack is just above the support rails. Slide the cell stack out of the crate and onto the support rails. Lower the forks as needed to set the stack on the rails.

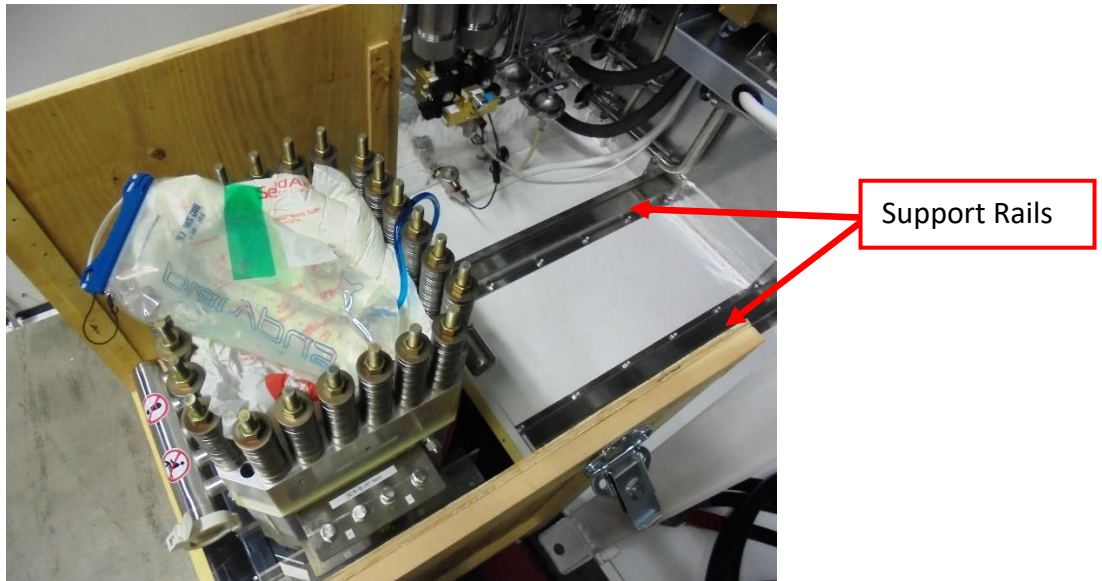


Figure 46 – Align Crate with Support Rails



Figure 47 – Crate and Support Rails

2.12 5

2.12.1 Cell Stack Power Connections



Improperly torqued connections can lead to localized heating, potential arcing and damage to the terminal and device.

1. Connect the positive DC cell stack cables (DC+) to the positive cell stack terminal at the bottom of the cell stack. Torque to 360 in-lb (41 N-m).

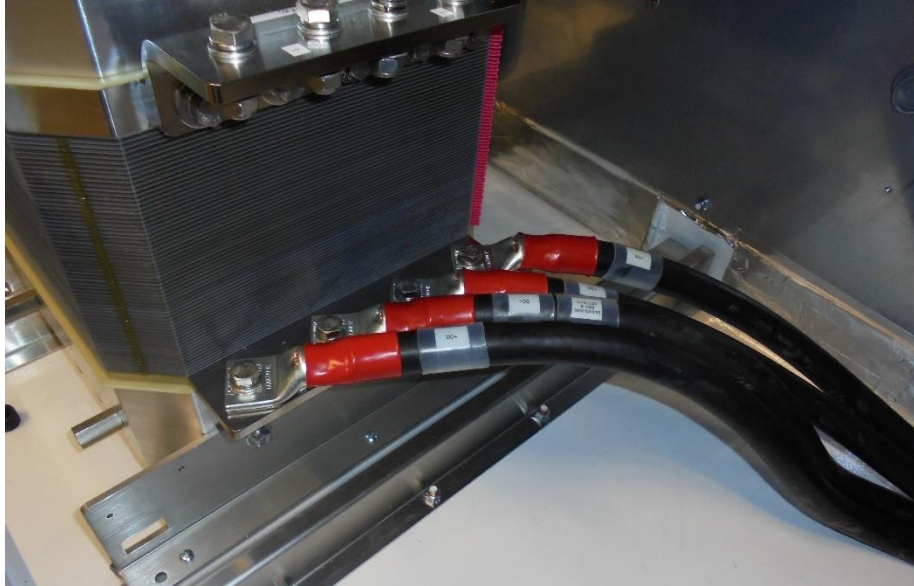


Figure 50 – Positive (DC+) Cell Stack Terminal Connection

2. Install the positive bus terminal cover.



Figure 51 - Positive bus terminal cover

3. Connect the return DC cell stack cables (DC-) to the cell stack return terminal.
Torque to 360 in-lb (41 N-m).



Figure 52 - Cell Stack Return (DC-) Terminal Connection

4. Verify that the cell stack tabs on the cell stacks have not been damaged or touching together.

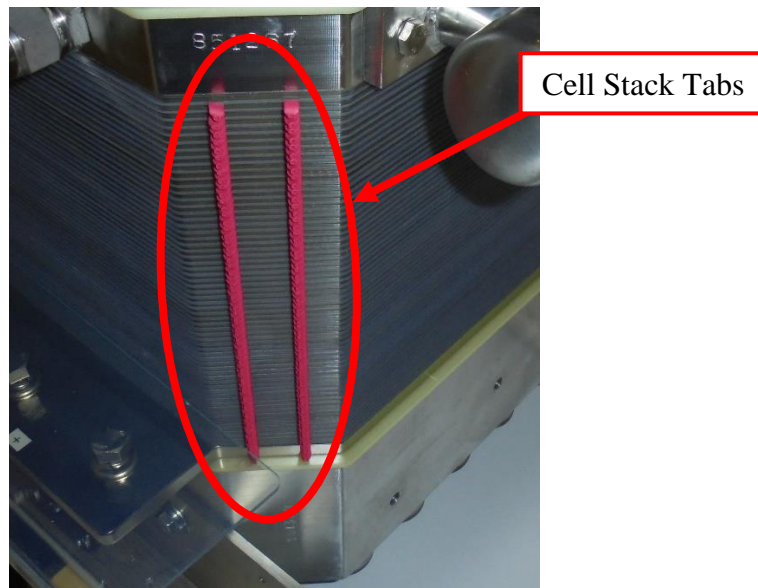


Figure 53 - Cell Stack Tab Locations

5. Install the cell stack thermal switches to the left and right sides of the cell stack as shown below.

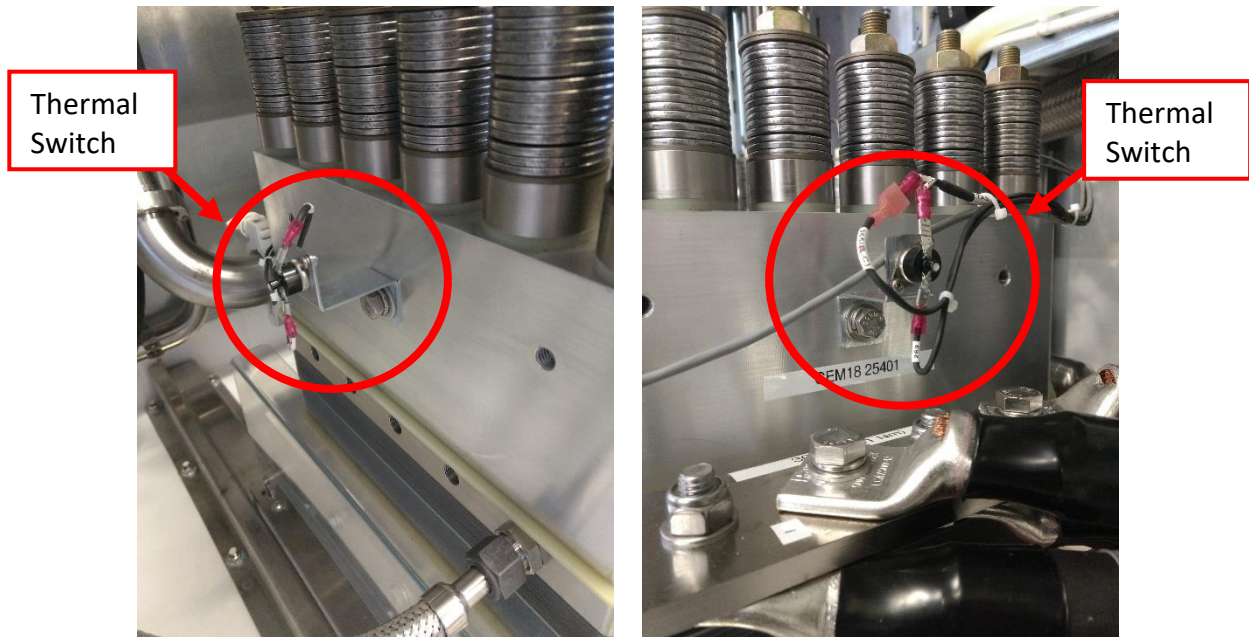


Figure 54 - Cell Stack Thermal Switches

1. At this point, secure all wire ties and strain reliefs in the wireway and enclosures (ref. Figure 35).

2.12.2 Cell Stack Fluid Connections



NOTE

The cell stack is shipped hydrated with DI water and sealed. The following steps should be done at the time of commissioning. Do not connect/attach cell stack hoses unless you are able to also fill the A200 with DI water. Doing so can cause the cell stack to lose hydration and cause permanent damage.

1. Connect the cell stack water inlet hose and flow switch to the cell stack.

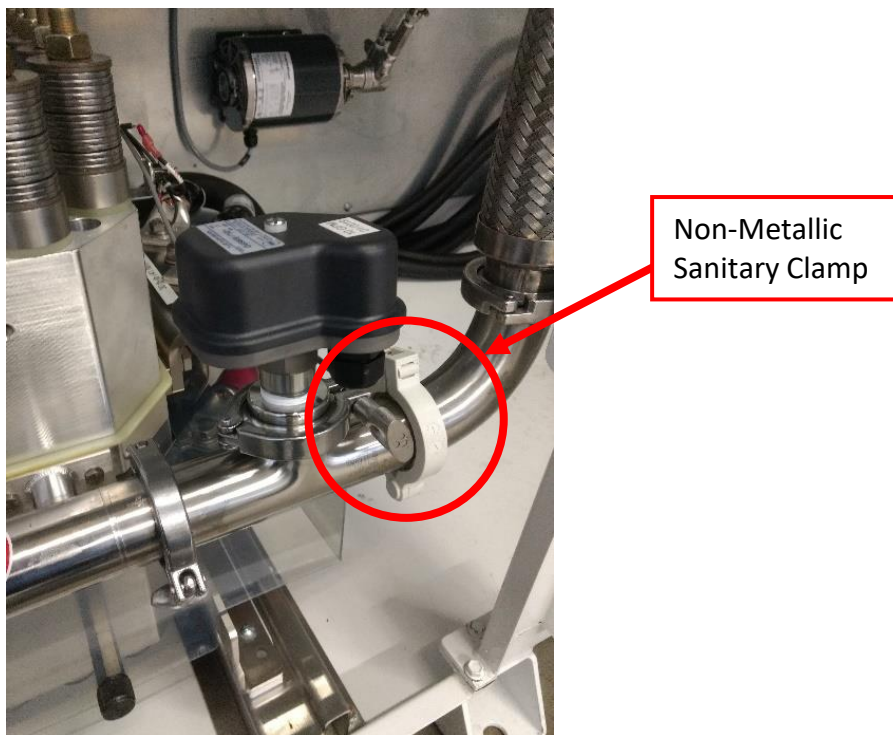


Figure 55 – Cell Stack Water Inlet and Flow Switch Connection



ALWAYS ENSURE THE NON-METALIC CLAMP IS LOCATED UP STREAM OF THE FLOW SWITCH AS SHOWN IN FIGURE 55

2. Connect the return hoses and hydrogen product line to each cell stack.



Figure 56 - Cell Stack Return and Hydrogen Product Connections

3. Connect the hydrogen product line.

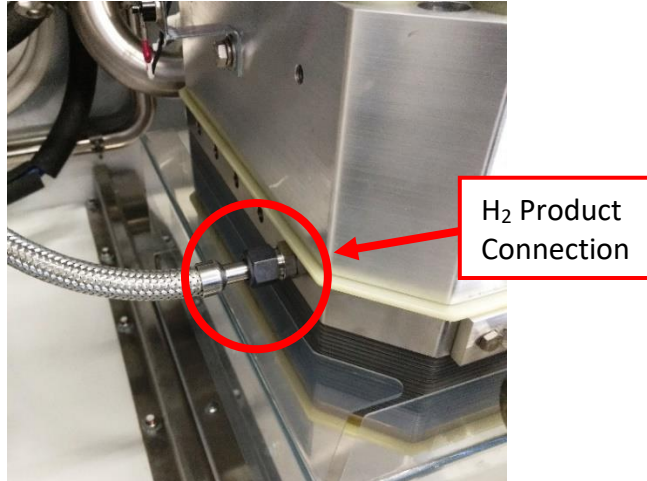


Figure 57 – Hydrogen Product Connection



Verify the inlet and outlet hoses are connected properly.



Do not over-tighten the fittings.

3 REMOTE MONITORING AND SOFTWARE CONFIGURATION

3.1 IP Address



NOTE

The IP address and network configuration of the C Series unit is static and configured at the factory. It can be updated prior to installation or at a scheduled maintenance visit. Please contact Nel Customer Service at **(203) 949-8697**.

C Series Default Network Configurations:

HCS Controller

IP: 192.168.0.10

Subnet: 255.255.255.0

Gateway: 192.168.0.1

Beckhoff Switch

IP: 192.168.0.111

Subnet: 255.255.255.0

Gateway: 192.168.0.1

As a standard feature the C Series Hydrogen Generator is supplied with a laptop computer, which can be connected to the customer's network to allow for remote monitoring and status of the C Series. This monitoring feature is available via a MODBUS/TCPIP protocol. A USB to Ethernet adapter can be used to connect from the laptop computer to the customer control/monitoring system.

The laptop continuously monitors key system values during hydrogen production and standby states and logs (stores) the data.



WARNING

PROVIDE APPROPRIATE NETWORK SECURITY TO ISOLATE THE C SERIES CONTROLLER

3.2 Software Configuration

Several software parameters are customer configurable. See PD-9900-0038 for instructions and a list of configurable parameters.

The software default for parameter P50 is 1 barg (14.5 psig). The P50 parameter is active for both load following and tank filling systems. The purpose of this is to detect a leak in the external product line or the loss of connection to an external pressure vessel. If the external pressure transducer, PT312, drops below the P50 parameter at any time an E50 error will be set.



NOTE

During initial startup of the system the P50 parameter should be lowered to 0 barg then increased once there is an external pressure above the P50 set point

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