Landi

Clean Technologies for Businesses on the Move

LANDITECHNOLOGIES.COM

UPS Ford F650 CNG Package Van Familiarization Training

2024 Model Year

Landi Technologies Low- & High-Pressure Fuel System

Natural Gas is a safe fuel

Natural Gas

- Lighter than air => rises=> if it accumulates it is in high places away from people
- Requires more heat to ignite without a spark (~1000F)
- Requires richer air-fuel mixture to ignite from spark or flame
- Non-toxic

Gasoline & Diesel

- Heavier than air => descends => if it accumulates it is in low places potentially where people are standing
- Requires less heat to ignite without a spark (~500F)
- Requires leaner air-fuel mixture to ignite from spark or flame
- Toxic

Compressed Natural Gas (CNG) Safety Background

- Fire Hazard
  - While natural gas requires richer air fuel mixtures than gasoline and diesel for ignition, these mixtures can still occur where there is a leak in the system posing a potential fire hazard.
  - Any process or procedure that generates sparks, flames, or heated particles should not be practiced in areas designated for CNG.
- High Pressure
  - Depressurize fuel system before servicing (more to come on this)
  - Never attempt to depressurize or vent a system by loosening a fitting.

Compressed Natural Gas (CNG) Safety Background

- Suffocation Risk
  - Although natural gas is non-toxic it is an inert gas and can cause suffocation in concentrations >21% (visible vapor cloud)
  - Low risk as vehicle fuel system will unlikely contain enough gas to achieve this concentration in the area where it is parked
- Detection
  - The odorant (Mercaptan) is added to pipeline natural gas giving it the rotten egg smell aiding in leak detection

Driver Information

This section will cover the main differences between gasoline trucks and CNG trucks from a driver's perspective

- Fuel storage
- PRD Vent
- Fuel Gauge
- Fueling

A hazardous material (HAZMAT) drivers license is NOT required to drive Natural Gas Vehicles

Driver GEMS Code 0375 for New Vehicle Familiarization Training

Fuel Storage

- Instead of a plastic fuel tank, CNG powered Package Vans are equipped with carbon fiber cylinders making them exceptionally safe.
- 2024 Ford F650 Vans with the Landi Technologies high- and low-pressure fuel system have two identical CNG cylinders mounted outside the frame rail on both the driver and passenger sides.

Fuel Storage – CNG Cylinders

- Type IV Cylinders
- Gasoline Gallon Equivalent (GGE): 37.5 (each) x 2 = 75 GGE total (~60 GGE usable to match OEM gasoline specifications)
- Dimensions: 18.7” diameter x 118” long
- Weight:
  - w/o fuel: 285 lb. each
- Safety
  - Meets FMVSS 304 (49 CFR 571.304), Compressed Natural Gas Fuel Container Integrity and ANSI/CSA NGV 2
  - Tests include Vibration, Corrosion, Fast fill/empty, Over pressurization, Fire, Pressuring cycling @ 185F to -40F, Impact from pendulum and firearm, Drop from 6 feet.

PRD Vent

- All CNG cylinders have pressure relief devices (PRDs) that are connected to a vent line that exits at the rear of the cab on the passenger side of vehicle
- PRDs are ***thermally*** activated at 230°F (+/- 18°F)
- Part of the driver's pre-trip activity is to check that the PRD vent cap is present. If it is missing, the car can still be used but the driver must note that PRD cap is missing on the DVIR as non-safety related.

Dash Fuel Gauge

- The amount of pressure in the cylinder will determine the fuel gauge reading in the dash. Since the OEM fuel gauge is based on liquid fuels and CNG is a gas, the algorithm is not exact. For precise fuel level please confirm with mechanical gauge
- CNG cylinder pressure will compensate with temperature.
  - Pressure increases as it warms and decreases as it cools.

PSI	Gauge
280	E
500	Low Fuel
900	1/4
1800	1/2
2700	3/4
3600	F

Temperature Compensation Chart

Table 1
Gas temperature/settled pressure relationships — P36 service pressure
(See Clauses 5.1, 5.3, 5.5, 6.2, and 6.4.)

Temperature °F (°C)	Pressure psi (kPa) Nominal Gas Composition	Pressure psi (kPa) Conservative Gas Composition
130 (54)	4,500 (31 026)*	4,500 (31 026)*
120 (49)	4,437 (30 592)	4,395 (30 302)
110 (43)	4,270 (29 441)	4,237 (29 213)
100 (38)	4,103 (28 289)	4,078 (28 117)
90 (32)	3,935 (27 131)	3,919 (27 021)
80 (27)	3,768 (25 979)	3,759 (25 917)
70 (21)	3,600 (24 821)†	3,600 (24 821)†
60 (16)	3,432 (23 663)	3,409 (23 504)
50 (10)	3,264 (22 504)	3,218 (22 187)
40 (4)	3,096 (22 346)	3,027 (20 870)
30 (–1)	2,928 (20 188)	2,836 (19 554)
20 (–7)	2,760 (19 030)	2,646 (18 244)
10 (–12)	2,592 (17 871)	2,455 (16 927)
0 (–18)	2,424 (16 713)	2,266 (15 624)
–10 (–23)	2,256 (15 555)	2,077 (14 320)
–20 (–29)	2,089 (14 403)	1,888 (13 017)
–30 (–34)	1,922 (13 252)	1,701 (11 728)
–40 (–40)	1,755 (12 100)	1,515 (10 446)

Note: *The maximum temperature of the vehicle container shall not exceed 85 °C (185 °F) per CSA NGV 2.*
* *Maximum allowable fill pressure regardless of ambient temperature.*
† *Service pressure 24.82 MPa (3,600 psi) at 21 °C (70 °F).*

Fueling

CNG vehicles use a different fueling nozzle than diesel, gasoline and LNG

- It is not possible to put CNG in diesel, gasoline or LNG vehicle and vice versa
- The filling station will fuel to about 3,600 PSI (may drop after gas cools)
  - Temperature compensated stations may fill above or below 3,600 depending on ambient temperature
- **If the fill cap is not secured the engine will NOT crank**
  - **If fill cap comes off after engine starts, engine will stay running**

Fueling Information

- Plant Engineering Role for Fueling
  - Train-the-trainer
  - Shop evacuation (alarms & procedures)
  - Fueling process (train-the-driver trainer)
  - Watch video:
    - https://youtu.be/Ha2G3wwUwLg

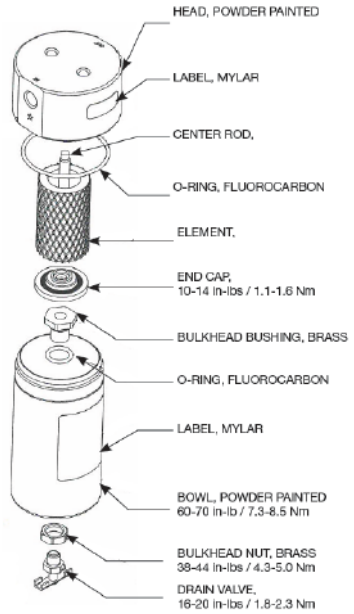
CNG Fuel System Maintenance

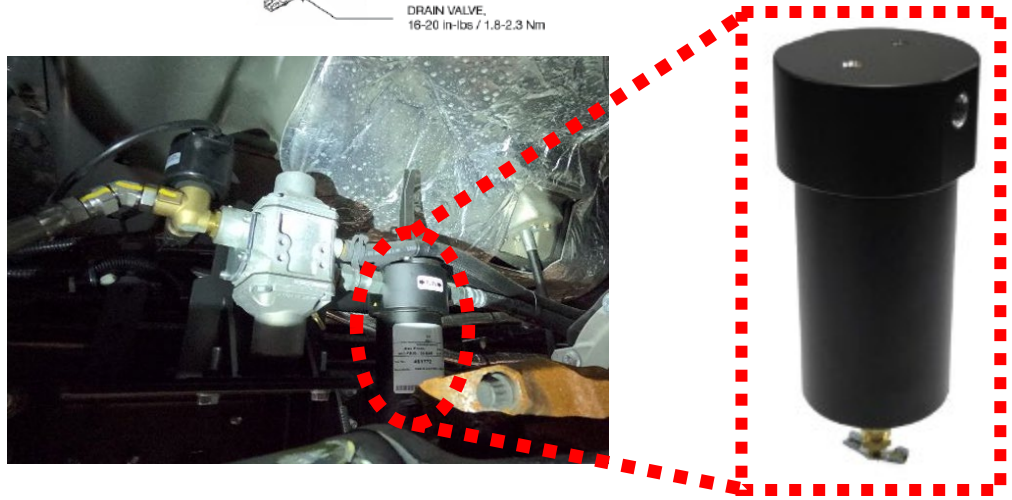
CNG System Maintenance / Inspection Item	Frequency
Replace Low- and High-Pressure Fuel Filters Low: UPS part # 4821237 (incl O-rings) High: UPS part # 4817451 (incl O-rings)	UPS PMI for LOF (5,000 mi, 200 engine hours, or 6 months whichever comes first)
Spark plugs	60,000 mi
Leak Test	UPS PMI
Component Visual Inspection	UPS PMI
CNG System Inspections*	Every 12 months

* Also, after any accident or thermal event

Low Pressure Fuel Filter Element Replacement

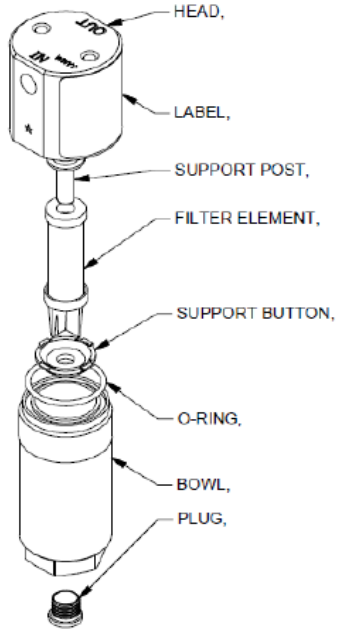
- **Replacing the Element**
  - Open petcock to drain any fluid that may be present
    - NOTE: If oil present, contact PE to have filling station inspected for passing oil.
  - Relieve system pressure **BEFORE** removing filter by shutting off main valve, start and run until engine shuts off
  - With a strap wrench, unscrew bowl and remove the old element and O-ring
  - Replace with new components supplied in UPS part # 4821237 (includes O-rings) and install bowl
  - Torque to 64-66 in-lbs.
  - Turn on main valve. Start vehicle and shut off. Test for leaks by using leak detection fluid or methane detection equipment

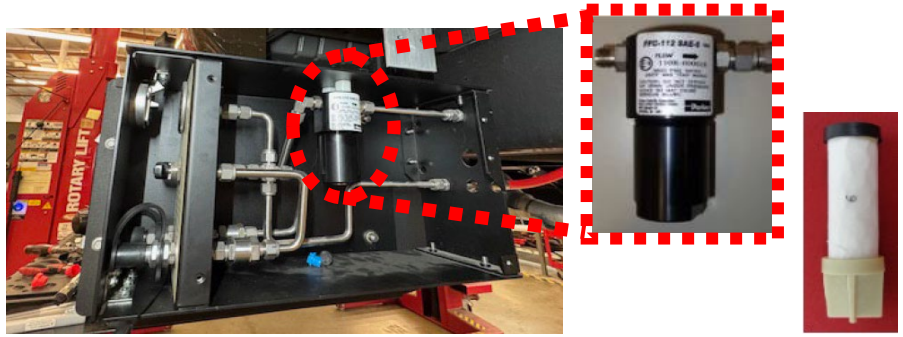




High Pressure Fuel Filter Element Replacement

- **Replacing the Element**
  - Relieve system pressure **BEFORE** removing filter by shutting off main valve, start and run until engine shuts off
  - Remove drain plug with ¼” hex key wrench to drain any liquid that may be present
    - NOTE: If oil present, contact PE to have filling station inspected for passing oil.
  - Using a crescent wrench and the flat sections located on the bottom of the bowl, unscrew the bowl and remove old element and O-ring
  - Replace with new components supplied in UPS part # 4817451 (includes O-rings) and install bowl
  - Torque bowl to 30 ft-lbs.
  - Torque drain plug to 27 ft-lbs.
  - Test for leaks, with system pressurized, by using leak detection fluid or methane detection equipment





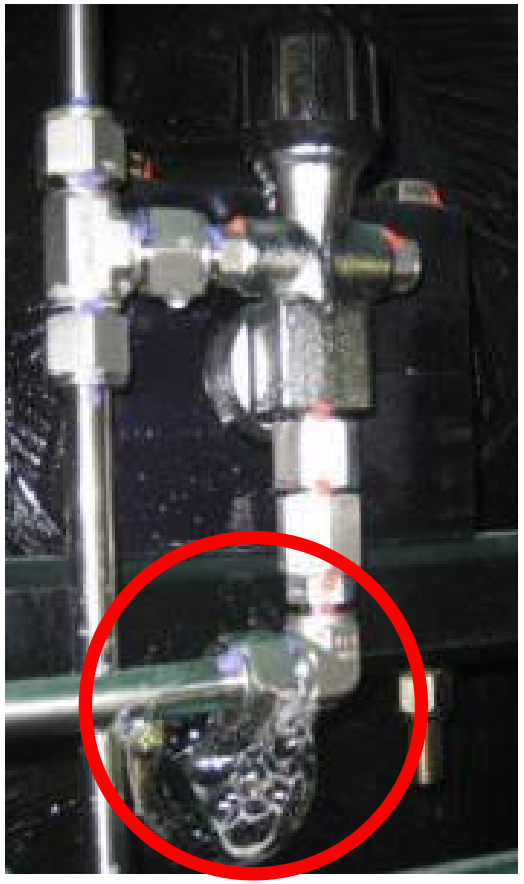
Leak Testing: PMI

- Check for leaks using combustion gas detector
- If leak detected, check fittings and connections for leaks using leak detection solution (available at MDC. Part # 3026700)
- When a leak is present the solution will cause bubbles
- Always give it at least 10 minutes
- Not all leaks will be apparent
- After a few minutes even a tiny leak will appear in a foam like manner not necessary bubbles
- Example on next slide

Leak Testing: PMI

Leak example with leak detection solution:

- Look for bubbling or foaming at point of leak
- Check for signs of damage to tubing



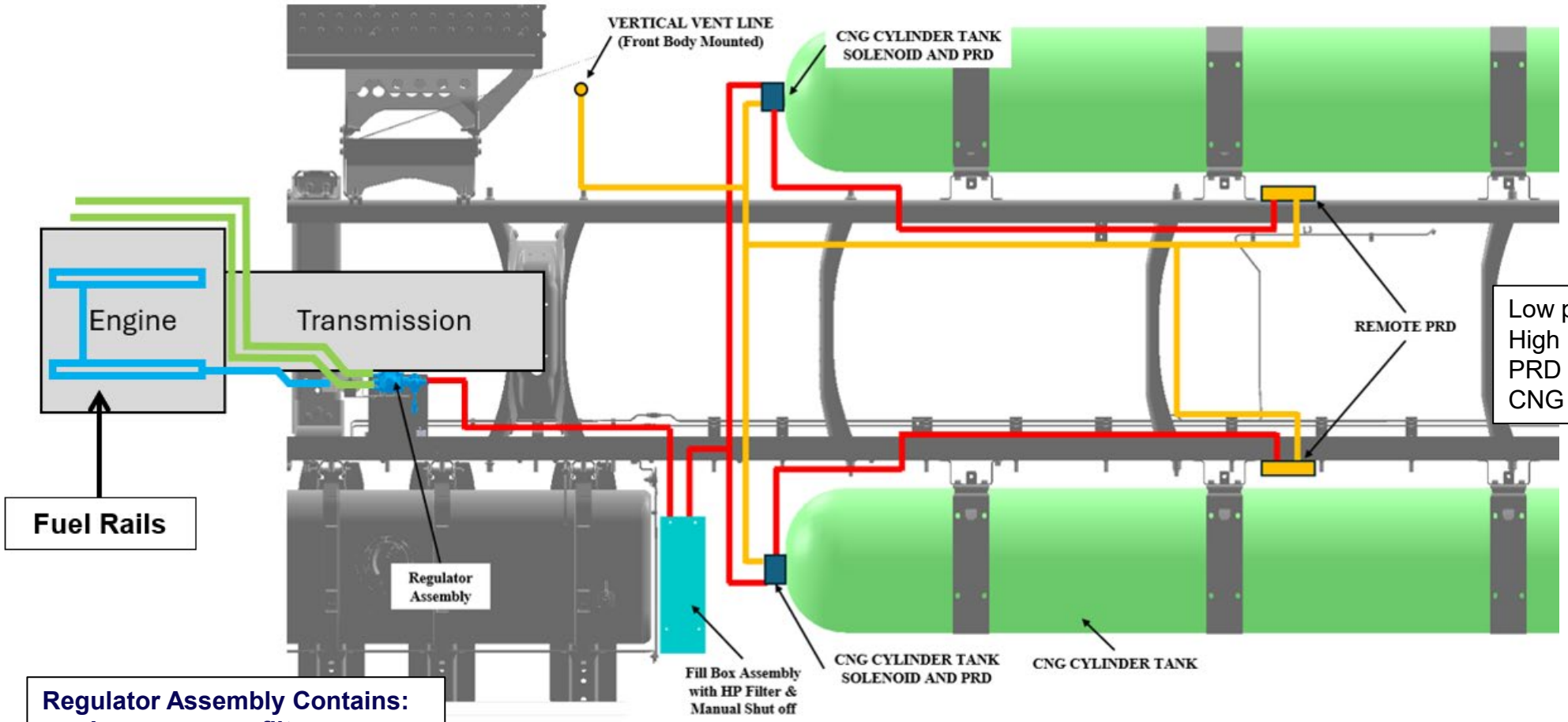
Component Visual Inspection: PMI

- Check wiring harnesses, fuel and coolant hoses
  - Securely attached
  - Free from abrasion
  - Free flowing – not kinked
- Check CNG cylinders and mounting system
  - Unacceptable
    - Damage to outer shell that does not conform to manufacture specifications
    - Damage to boss end
    - Any visible crack in frame or any other component
    - Damage to any plumbing component
    - Damage to the cylinder mounts

CNG Cylinder Inspection: Every 12 months

- Technicians must be trained and qualified to perform CNG cylinder inspections.
  - AFVI or comparable outside training
- Questionable findings during cylinder inspections must be communicated to local shop management.

CNG Major Components

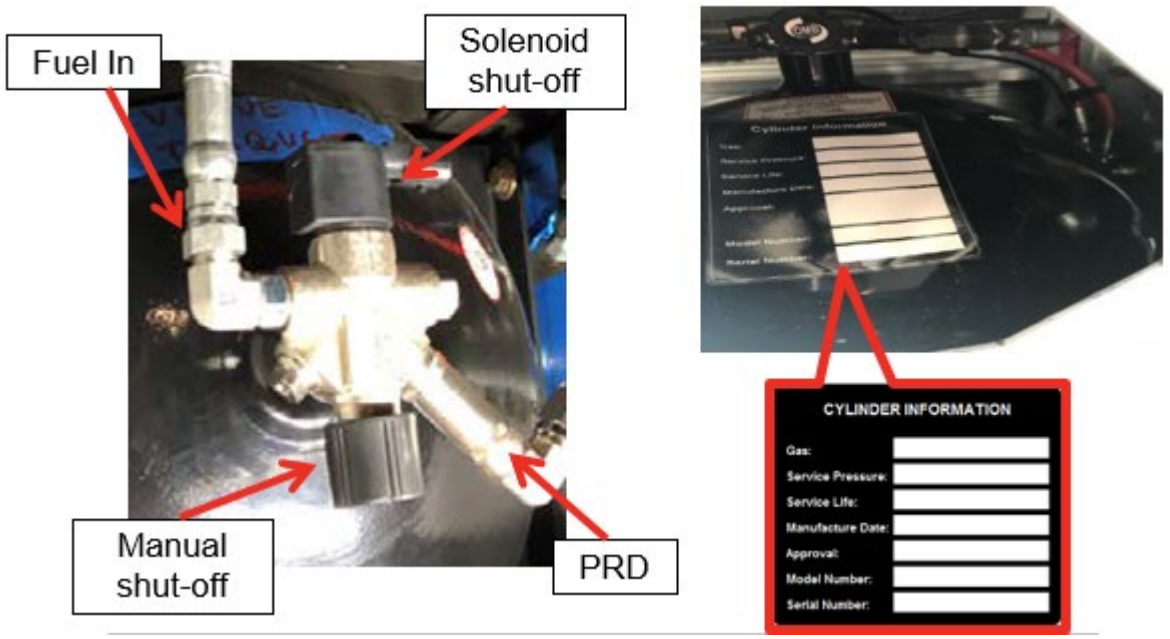


Regulator Assembly Contains:

- **Low pressure filter**
- **Regulator**
- **High pressure sensor**
- **Shutoff solenoid**

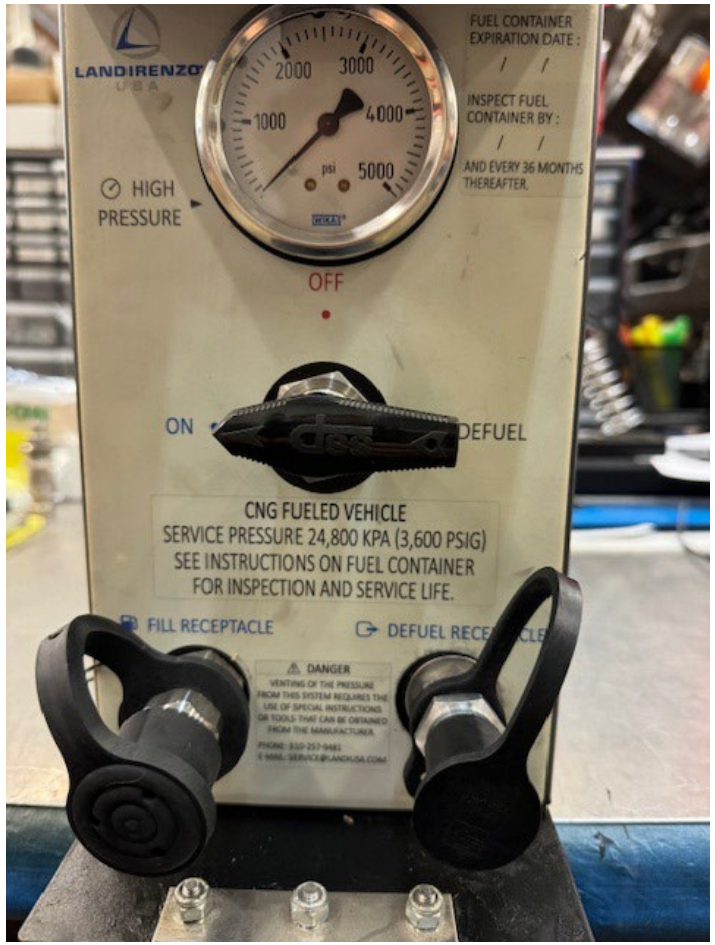
Cylinders & Cylinder Valves

- 20-year Type IV Cylinder: at the end of the 20-year life (Expiration date on cylinder), the cylinder must be discarded. No re-certification is allowed.
- Cylinder valves have:
  - Manual shut off
  - Solenoid shut-off controlled by AFCM, powered by relay (shown later in wiring diagram)
  - Fuel In port
  - PRD out port



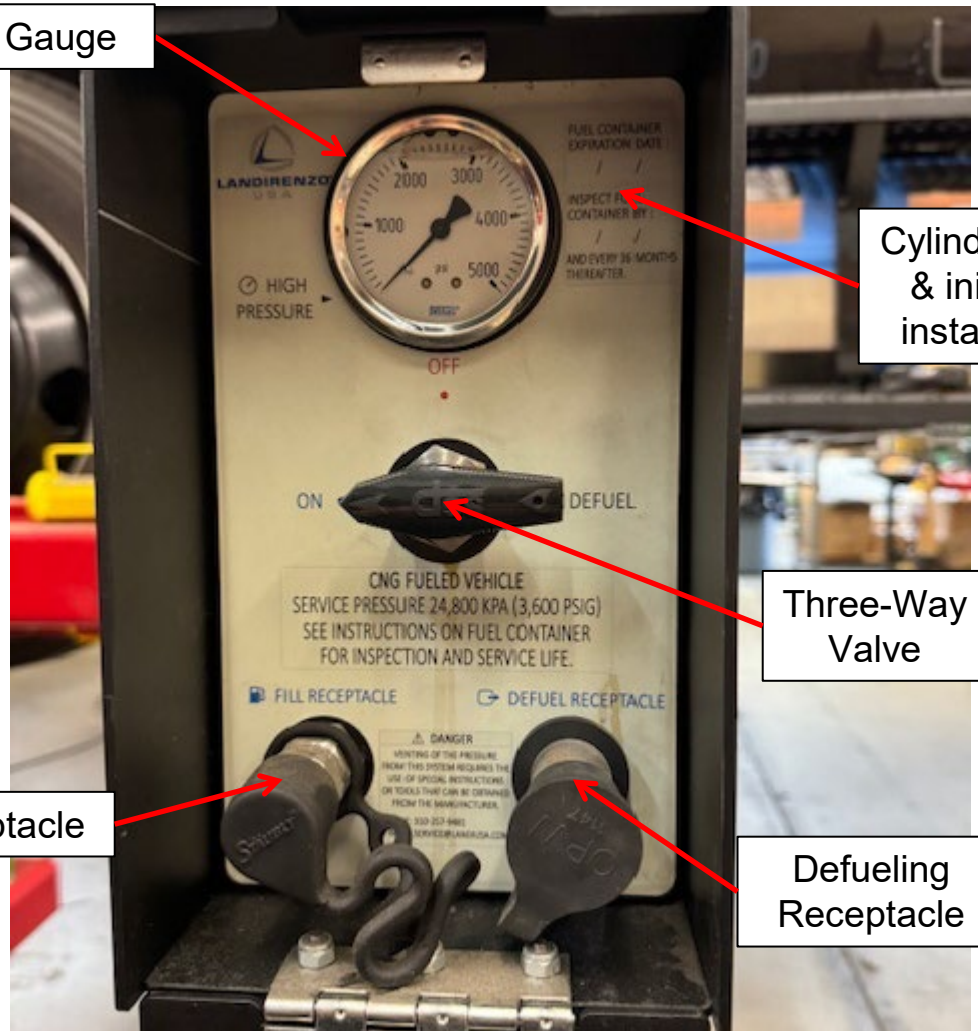
Fuel Fill Box

On / Off / Defueling valve between high-pressure system and regulator assembly



Driver side of vehicle between gasoline & CNG tank

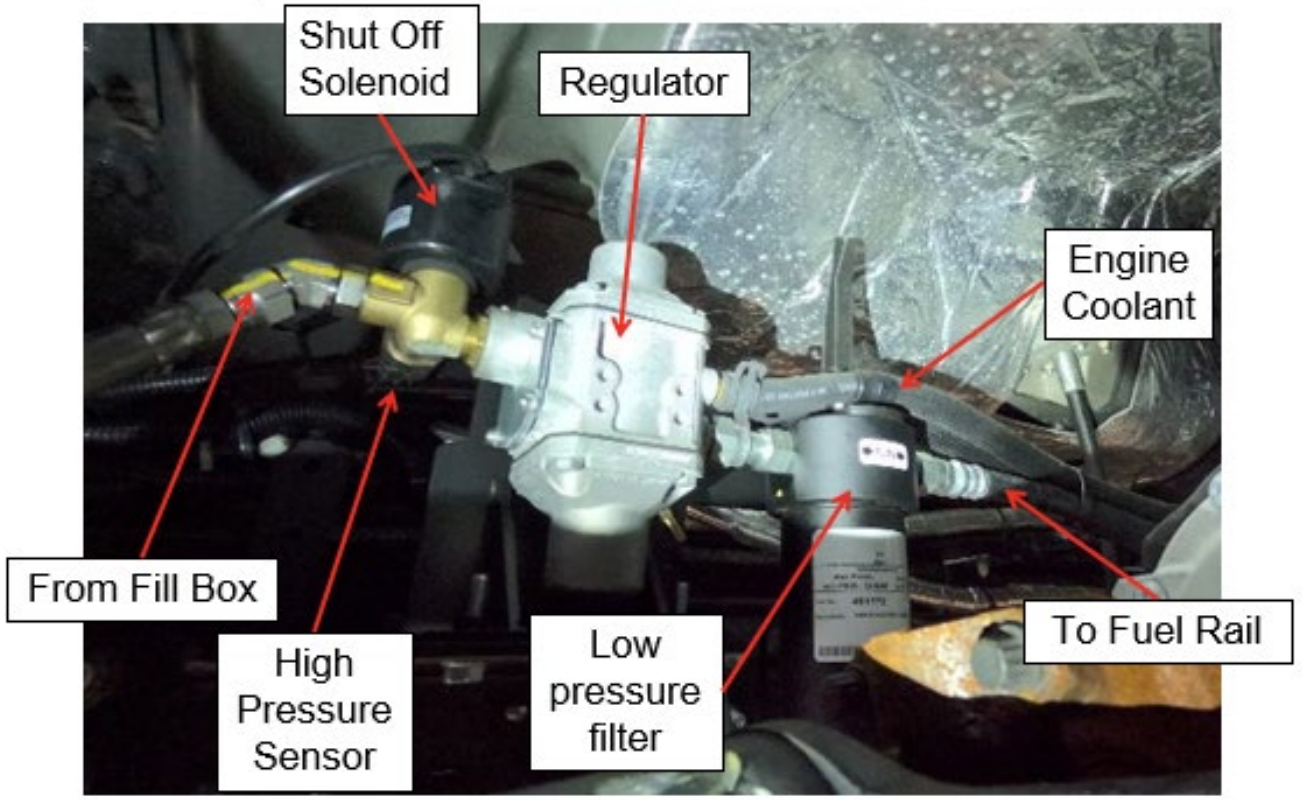
Fuel Fill Box



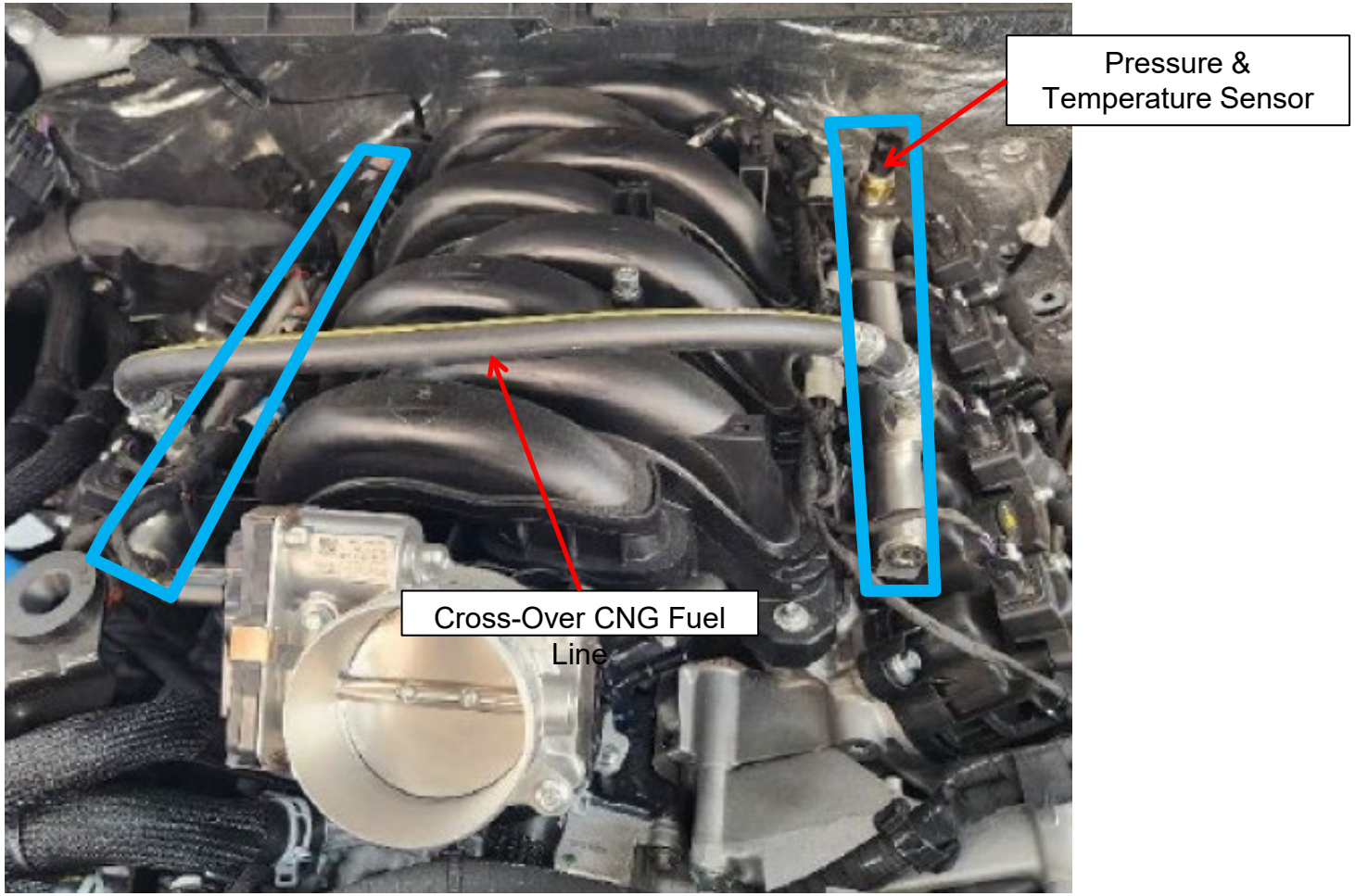
NOTE: If fill receptacle cap is not secured after fueling, engine will not crank.

Regulator Assembly

- Heat from the engine coolant system is used to keep the fuel regulator from freezing.
- View shown from behind the transmission facing the driver side of vehicle



Fuel Rail & Injectors

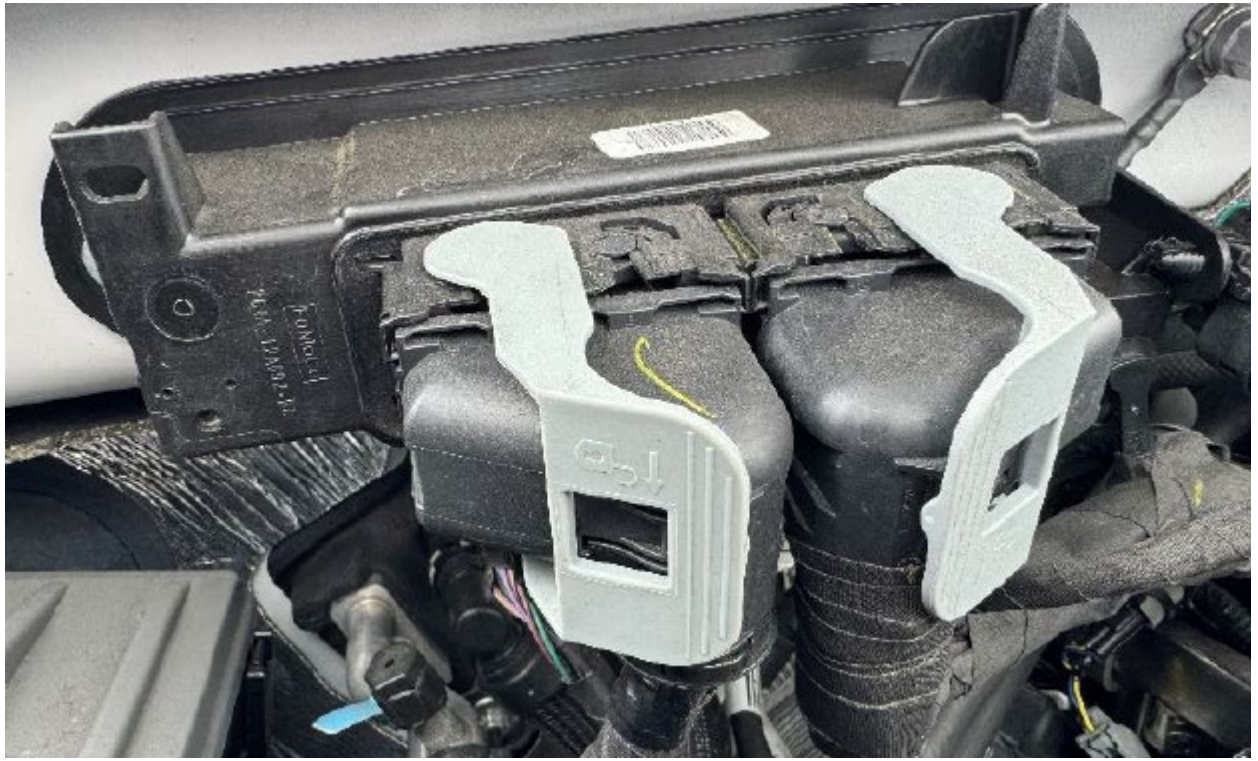


CNG Electronics (pictures on following slides)

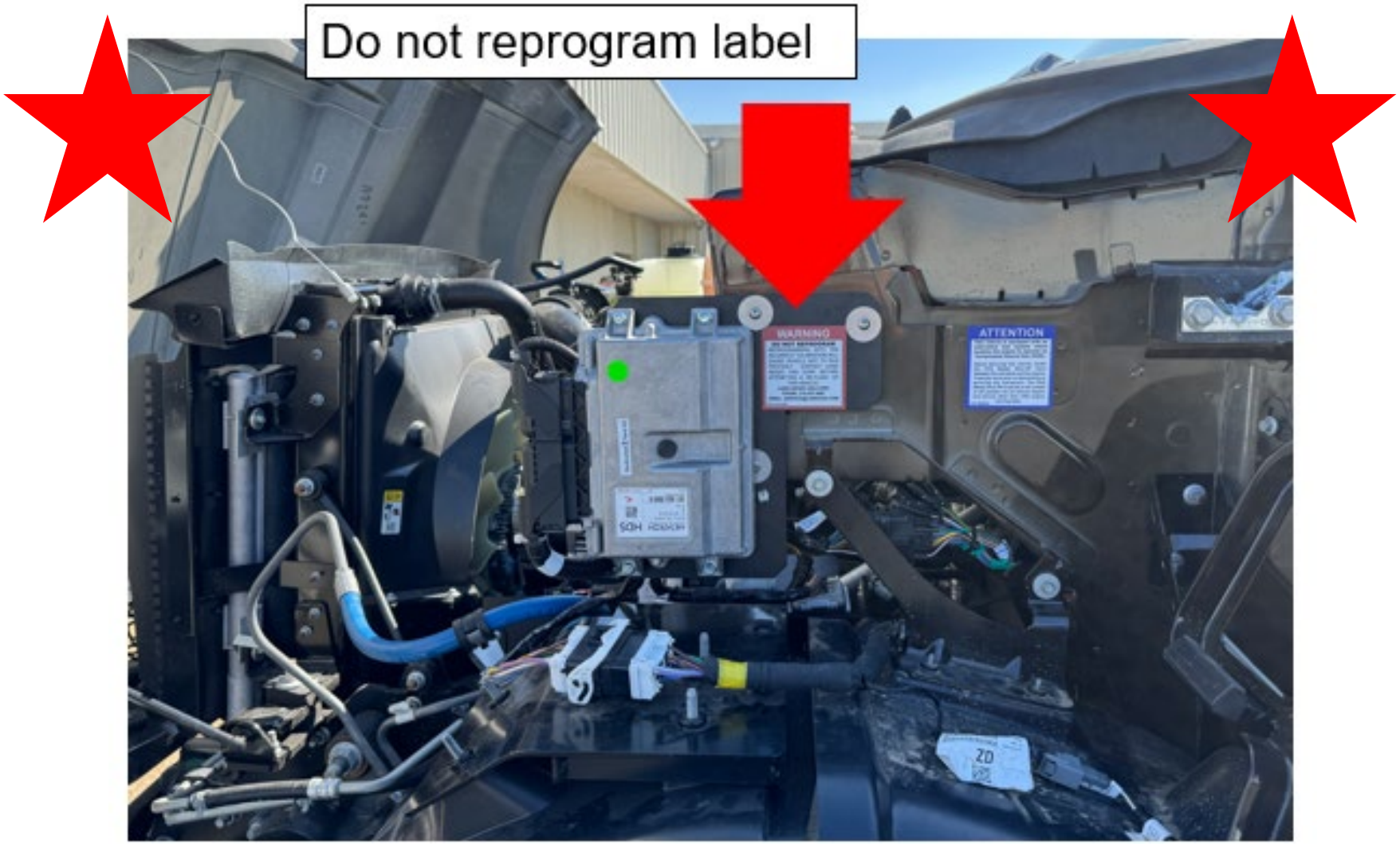
- Powertrain Control Module (PCM)
  - Ford PCM has been recalibrated for CNG conversion
    - Sticker installed by OBD connector and on firewall raising awareness
- Alternative Fuel Control Module (AFCM)
  - Supplied by Landi Technologies
  - Associated components
    - AFCM harness
    - Fuse and relay block
    - Fuel rail pressure / temperature sensor
    - High pressure sensor
    - Regulator shut-off solenoid
    - CNG tank shut-off solenoid
- Starter interrupt module (has its own harness)
  - Supplied by Landi Technologies

Ford Powertrain Control Module (PCM)

View from inside engine compartment. Located on passenger side dash panel near the cowl.



Ford Powertrain Control Module (PCM)



WARNING

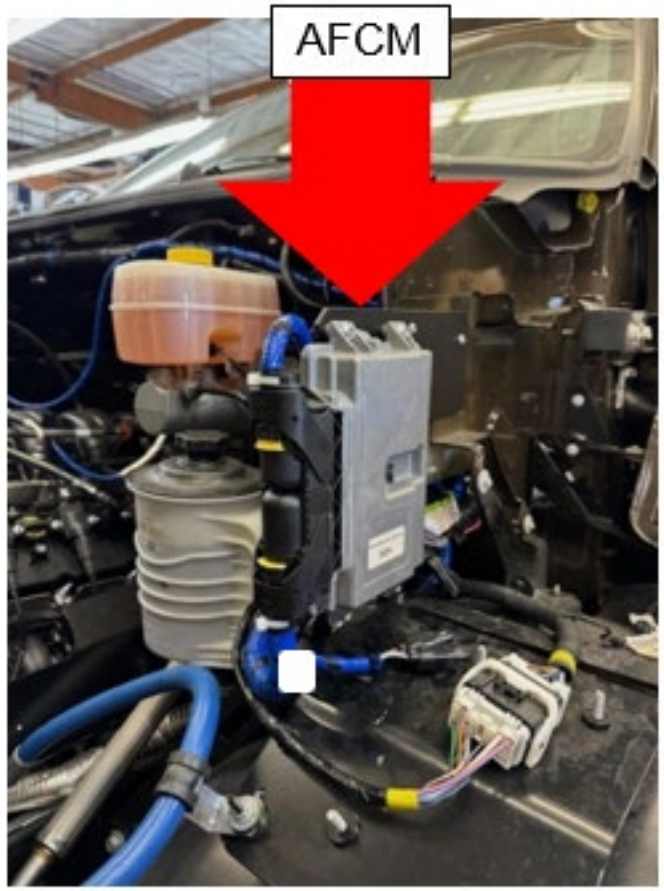
DO NOT REPROGRAM

REPROGRAMMING WITH THE INCORRECT CALIBRATION WILL CAUSE VEHICLE NOT TO RUN PROPERLY. CONTACT LANDI RENZO USA CORP BEFORE ATTEMPTING A RE-FLASH OF THIS VEHICLE.

LANDI RENZO USA CORP.
PHONE: 310-257-9481
EMAIL: SERVICE@LANDIUSA.COM

P/N 1001838

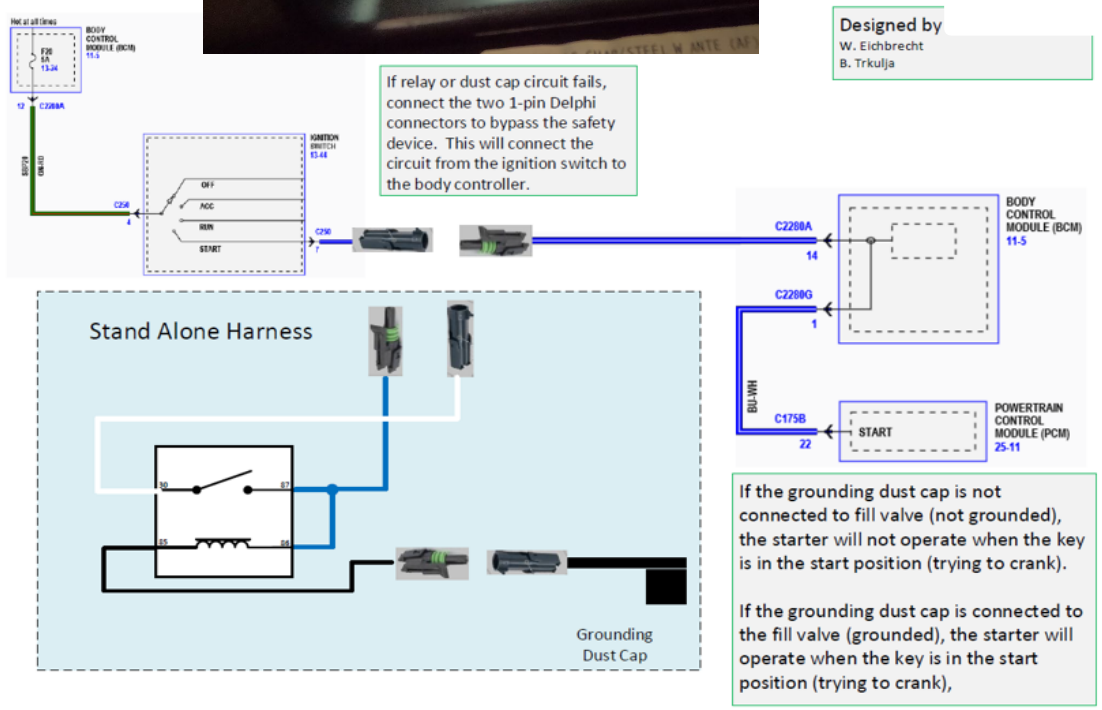
Landi Technologies Alternative Fuel Control Module (AFCM) & Fuse Relay Block



Fuse Relay Block:
- 20-amp fuse
- Relay

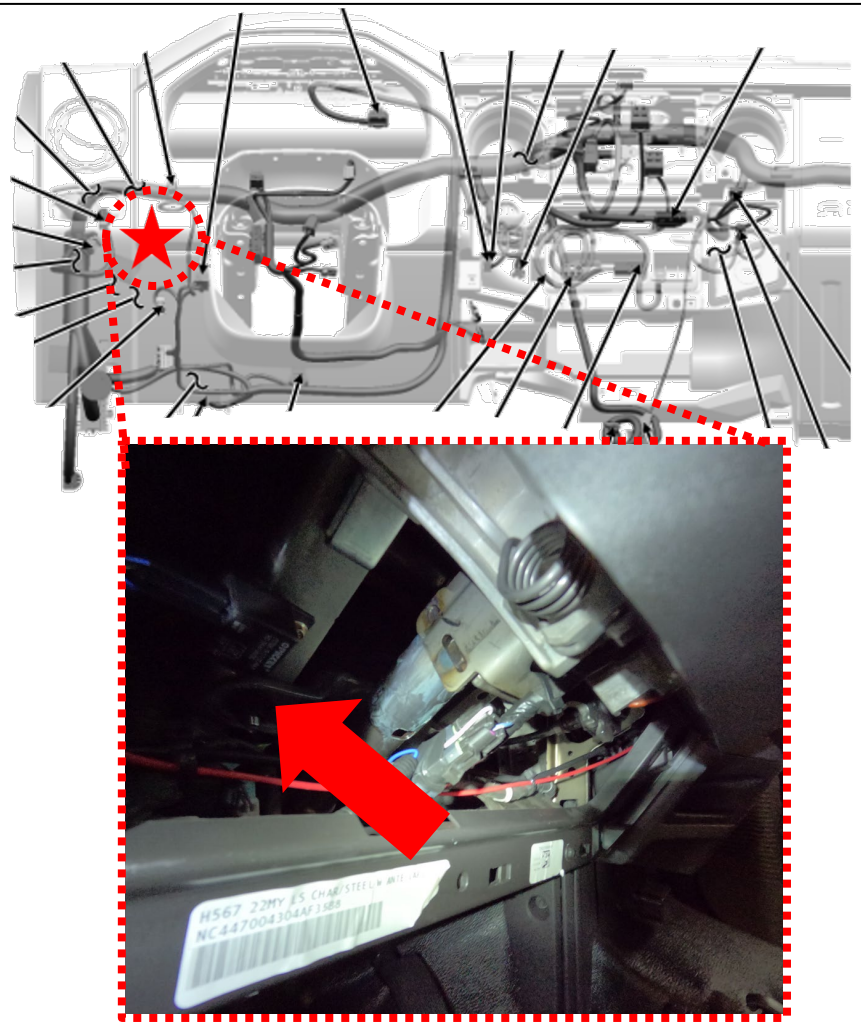
Starter Interrupt Module

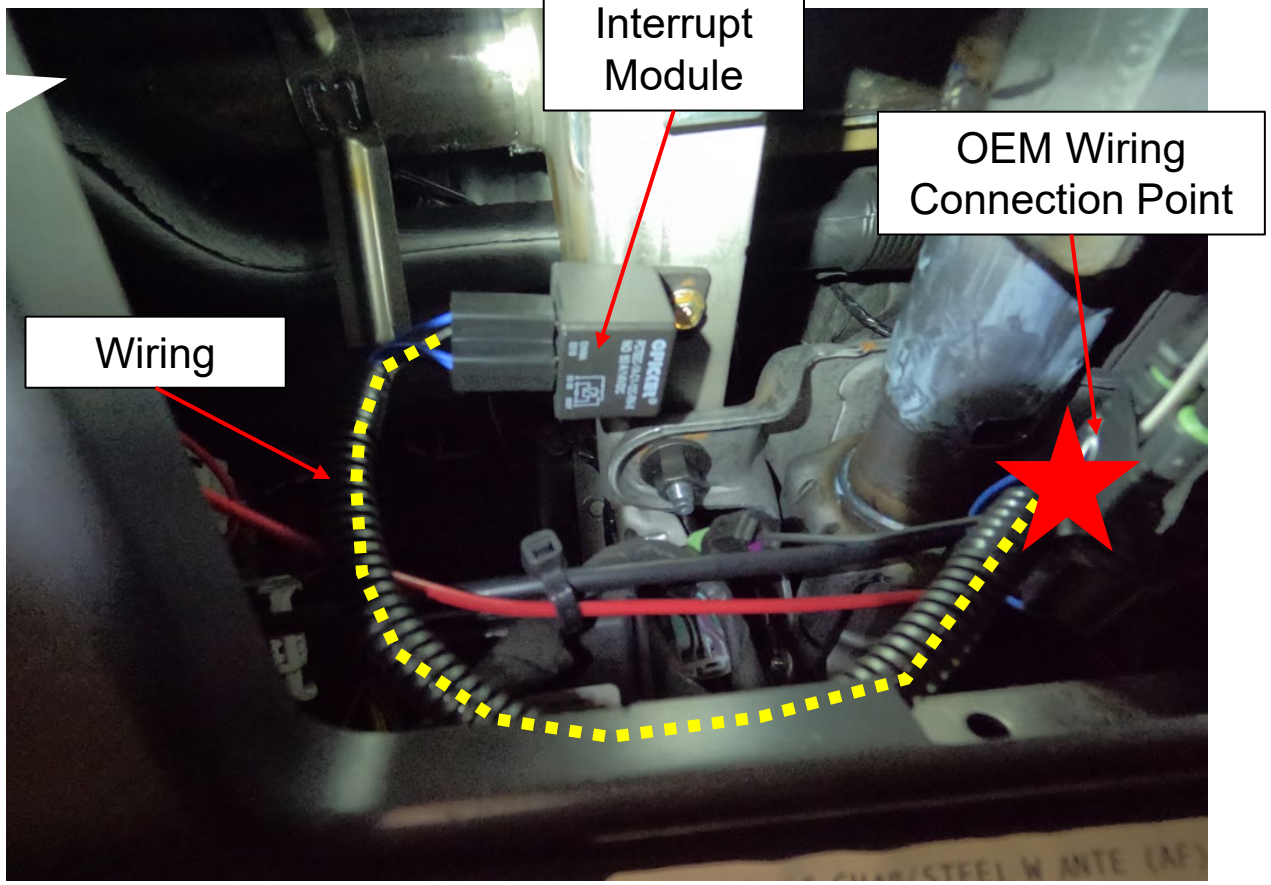
- The schematic shows how the starter interrupt is integrated into the original OEM wiring harness.
- The wire coming from the ignition switch to the body control module is “interrupted” by adding the module/relay, dust cap, connectors, and wiring to the starter system.
- The blue highlighted area with the two additional connectors summarizes the complete Landi Technologies starter interrupt system.



Starter Interrupt Module

Located behind the plastic trim near the driver's knee





Starter Interrupt Bypass (Emergency Situation)

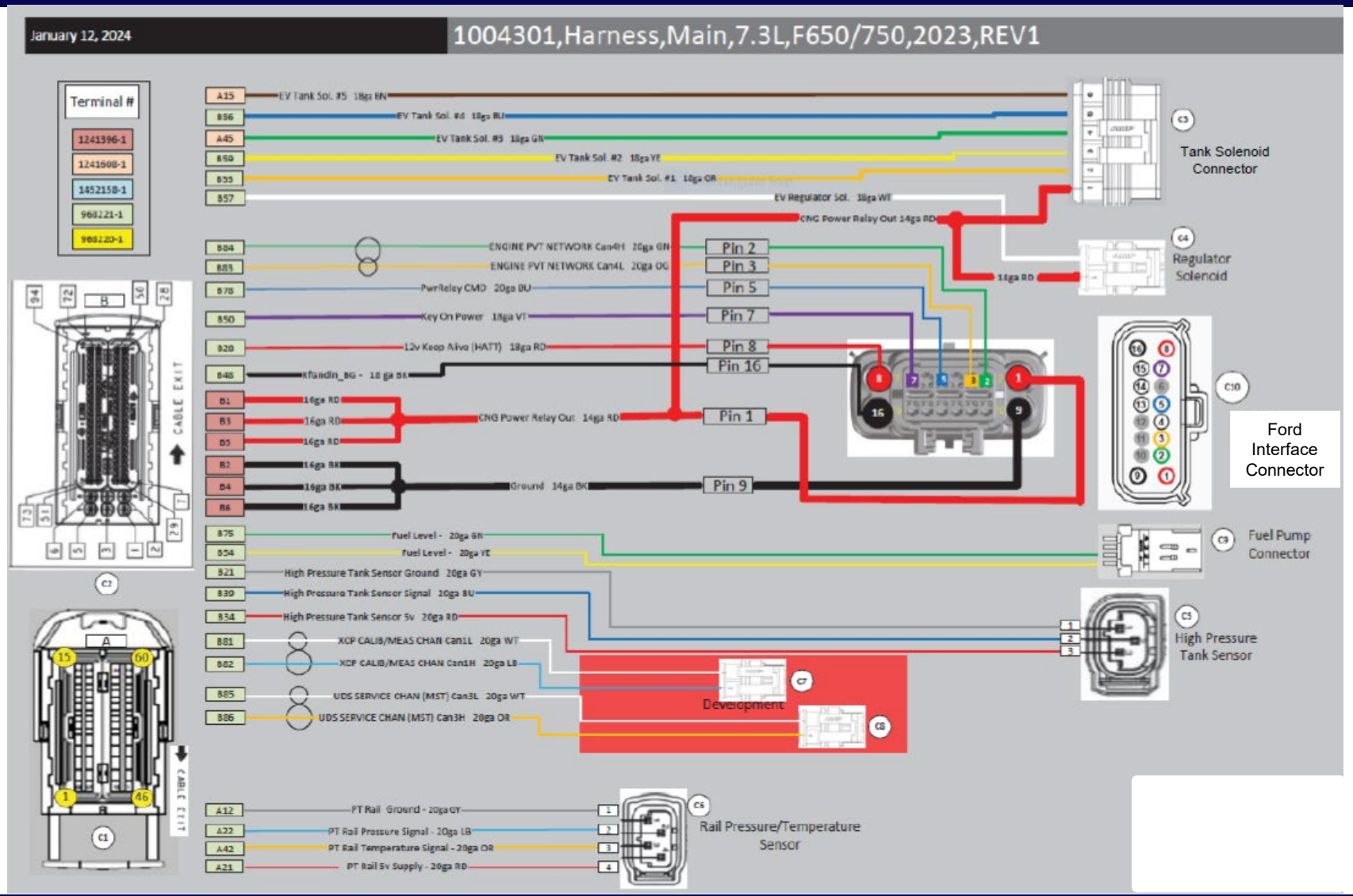
- If the dust cap on the fueling receptacle is damaged, please perform the following steps to bypass starter interrupt

- Locate starter interrupt module/relay wiring connection to OEM wiring harness
- Disconnect (2 X) module/relay connectors
- Connect two connectors on OEM wiring harness together

- Starter Interrupt is now bypassed.

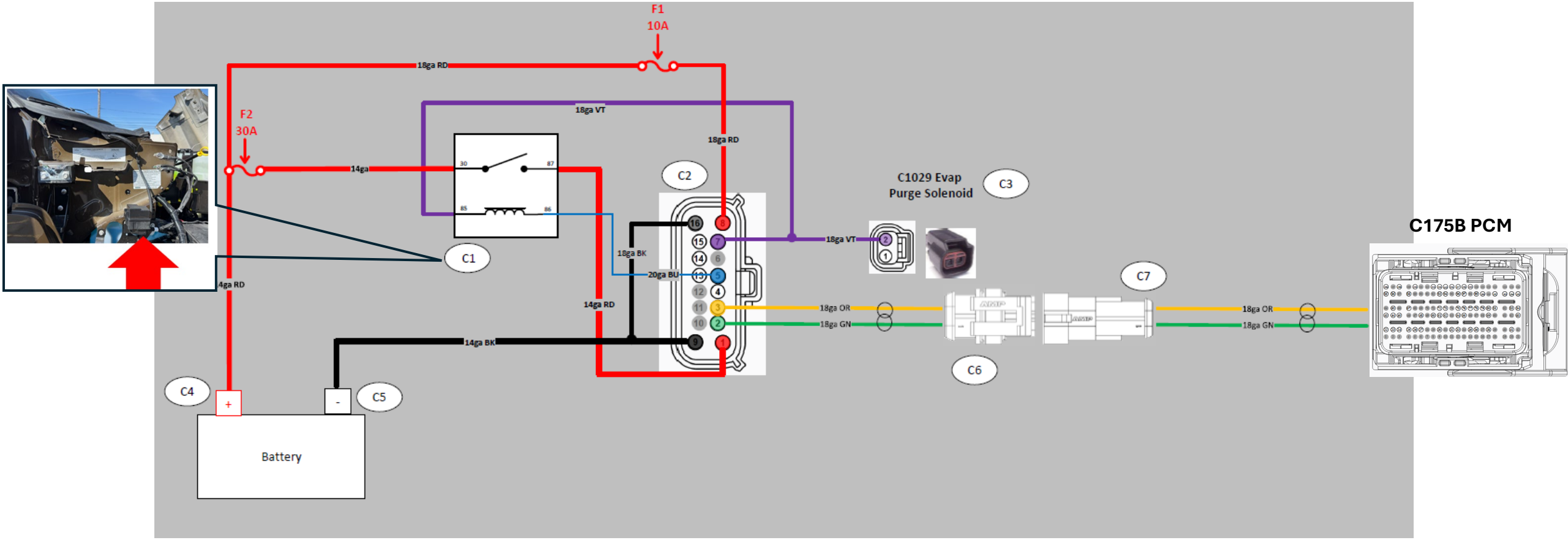
CNG Fuel System Wiring Diagram – Landi Technologies Components

- C1 & C2 connector seen on the left side of the schematic are connected to the Alternative Fuel Control Module.
- All the “pins” shown on the left side of the schematic are terminated in either C1 or C2 connector



CNG Fuel System Wiring Diagram – Landi Technologies to Ford Interface

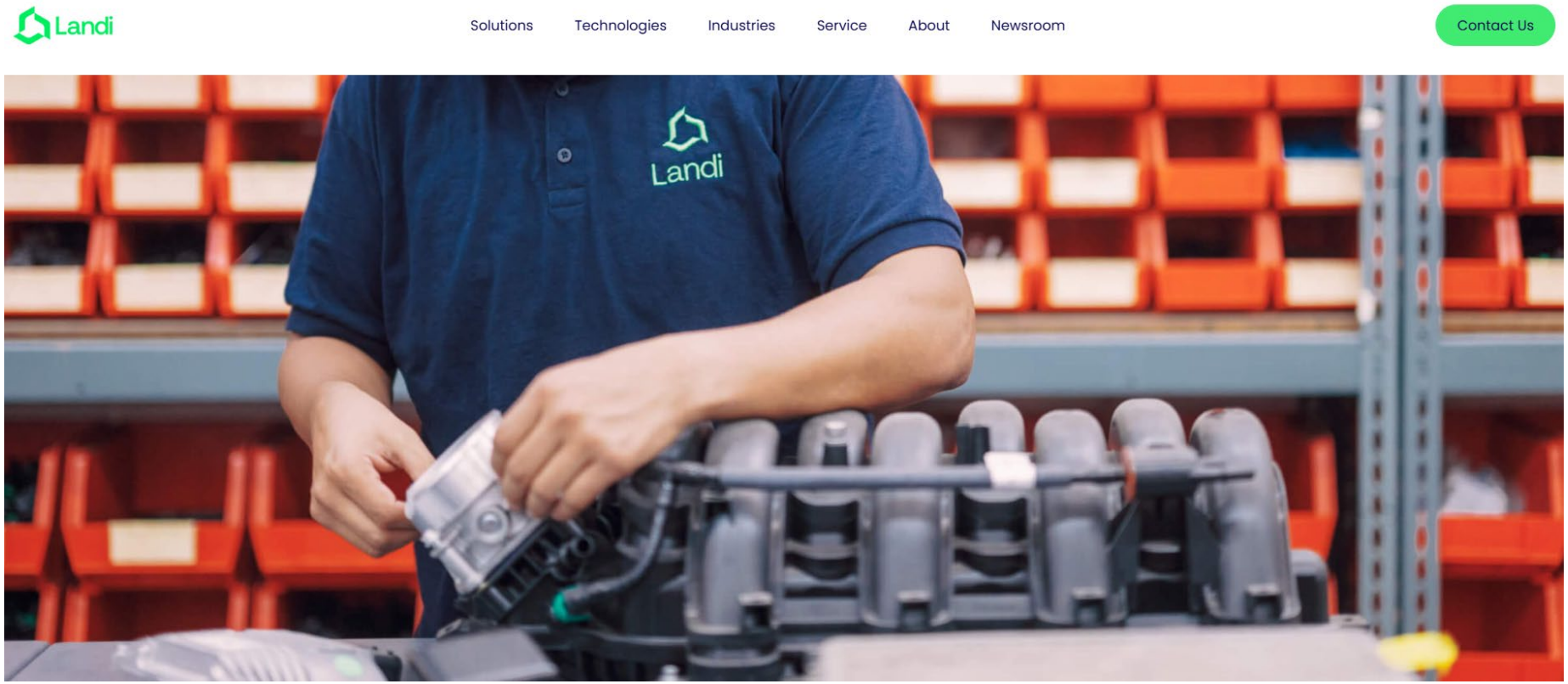
- Landi Technologies wiring schematic used for connecting the CNG wiring harness to the Ford wiring harness
- C2 connector on this schematic aligns with the C10 connector on the previous page
- C7 connector on this schematic is to be wired to the Ford Powertrain Control Module connector C175B (Pin 58 for orange & Pin 37 for green)
- C1 on this schematic is the relay which is housed with the 2 Landi fuses



Landi Technologies Repair Assistance

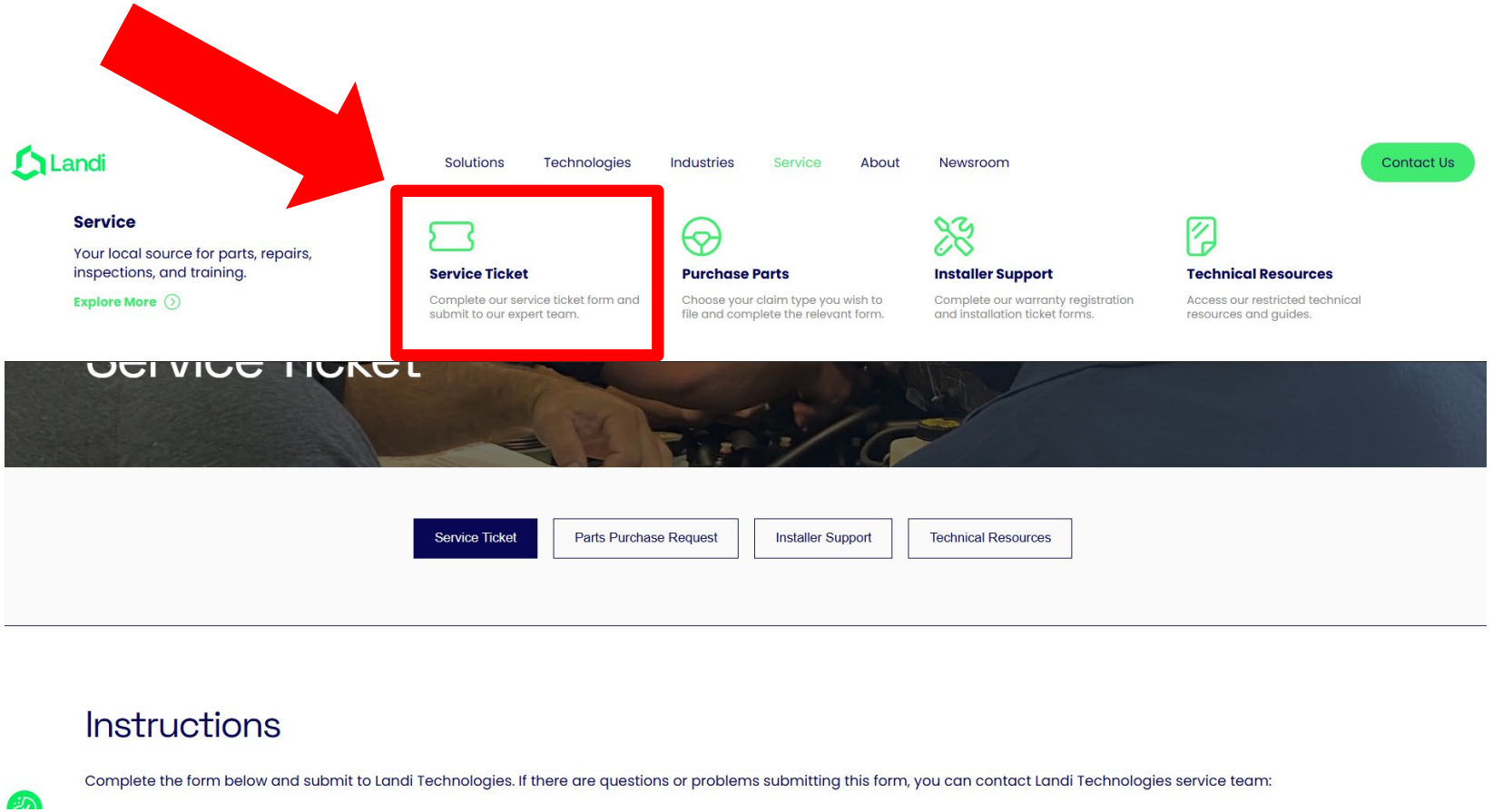
2 options:

1. Online form (Repair Assistance) - www.landitechnologies.com
2. Call 1-855-526-3400: M-F 11A-8P EST, 10A-7P CST, 9A-6P MDT, 8A-5P PST



Online Form Steps (www.landitechnologies.com)

1. Hover mouse over ”Service”
2. Drop down menu appears
3. Click on “Service Ticket”



Note: *You will receive an email confirmation of receipt and the assigned ticket #. Landi Technologies will work the issue and respond accordingly.* *service@landitechnologies.com*

Online Form Steps (www.landitechnologies.com)

4. Complete as much of form as possible (screen 1 of 3)

Vehicle Owner Information

Company Name *
Company Name*

Contact Name *
Contact Name*

Phone Number
Phone*

Email Address
Email*

Vehicle Information

17 Digit VIN *
17 Digit VIN*

Mileage *
Mileage*

This email will NOT receive a receipt confirmation or be in the original correspondence loop

Repair Facility Information

Repair Facility Name *
Repair Facility Name*

Repair Facility Contact Name *
Repair Facility Contact Name*

Repair Facility Address *
Street Address*

Apt, Suite, Bldg. (optional)

City*

State/Province*

Zip/Postal*

United States

Online Form Steps (www.landitechnologies.com)

4. Complete as much of form as possible (screen 2 of 3)

Repair Facility Information

Repair Facility Name *

Repair Facility Name*

Repair Facility Contact Name *

Repair Facility Contact Name*

Repair Facility Address *

Street Address*

Apt, Suite, Bldg. (optional)

City*

State/Province*

Zip/Postal*

United States

Repair Facility Phone

Repair Facility Phone*

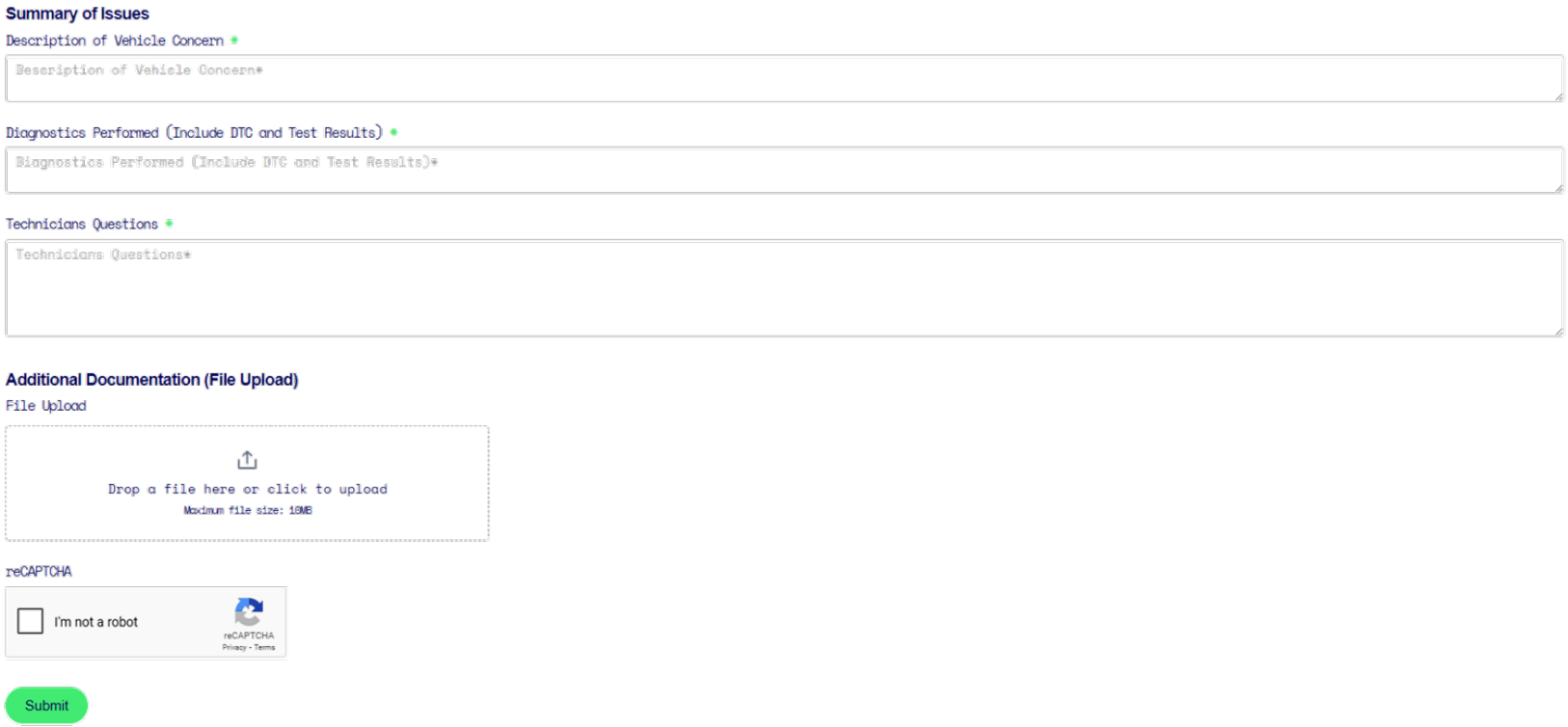
Repair Facility Email *

Repair Facility Email*

This email will NOT receive a receipt confirmation or be in the original correspondence loop

Online Form Steps (www.landitechnologies.com)

4. Complete as much of form as possible (screen 3 of 3)
5. Click in “I’m not a robot box”
6. Click “Submit”
7. Repair facility email entered will receive an email confirmation of receipt and the assigned ticket #. Landi Technologies will get engaged from that point.



Repairing Leaks - Depressurizing

Warning: Before fixing a leak at a connection, depressurize the high- and low-pressure fuel system completely

- Depressurizing the low- and high-pressure fuel system with a running engine
  - Close the valves on both cylinders
  - Run the engine at idle
  - The engine will die when the fuel pressure is depleted.
  - Verify that the pressure gauge in the fuel box reads 0 psi
- Depressurizing the low- and high-pressure fuel system with a non-running engine
  - Close the valves on both cylinders
  - Open the petcock at the bottom of the low-pressure fuel filter. About 150 psi of fuel will be removed.
  - Leave the petcock open
  - Turn the ignition key on. About 150 psi of fuel will be removed
  - Repeat the key on, key off process (leaving the key off for at least 5 sec) until no more gas is heard escaping from the low-pressure fuel filter and the pressure gauge in the fuel box reads 0 psi.
  - Tighten the petcock on the low-pressure filter

Repairing Leaks – Types of Fittings*

- O-Ring face seal and compression fittings are utilized
- Once the system has been depressurized, use the proper tools to address the leaking tube connection
  - Snugging a leaking tube fitting, assuming it was assembled properly, may stop a leak
  - If snugging the fitting does not fix the leak
    - Depressurize again
    - Disassemble, clean and reassemble
- If the leak is not fixed at this point, the component and or the tubing should be replaced

* Refer to Landi Technologies Workshop manual for proper methods

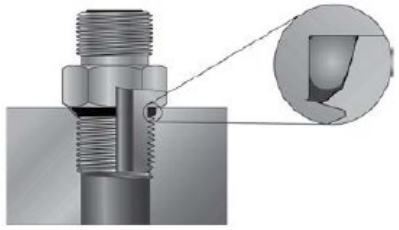


Fig. S7 — Non-Adjustable Port End Assembly

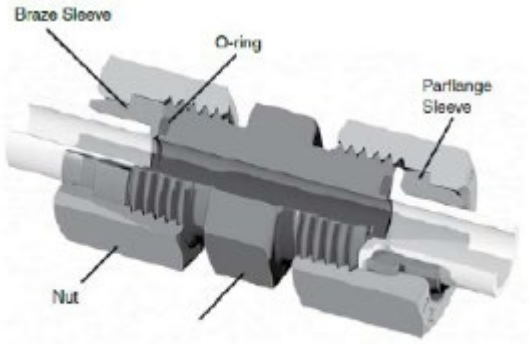


Fig. S15 – Seal-Lok Union cutaway with flanged and brazed assemblies

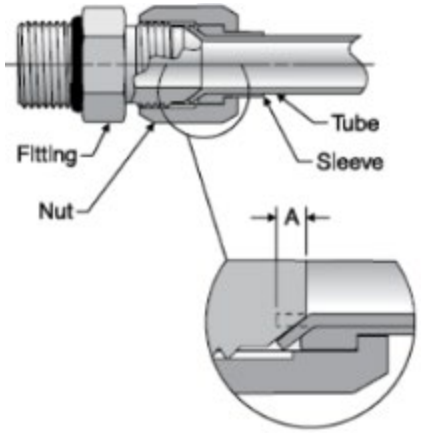
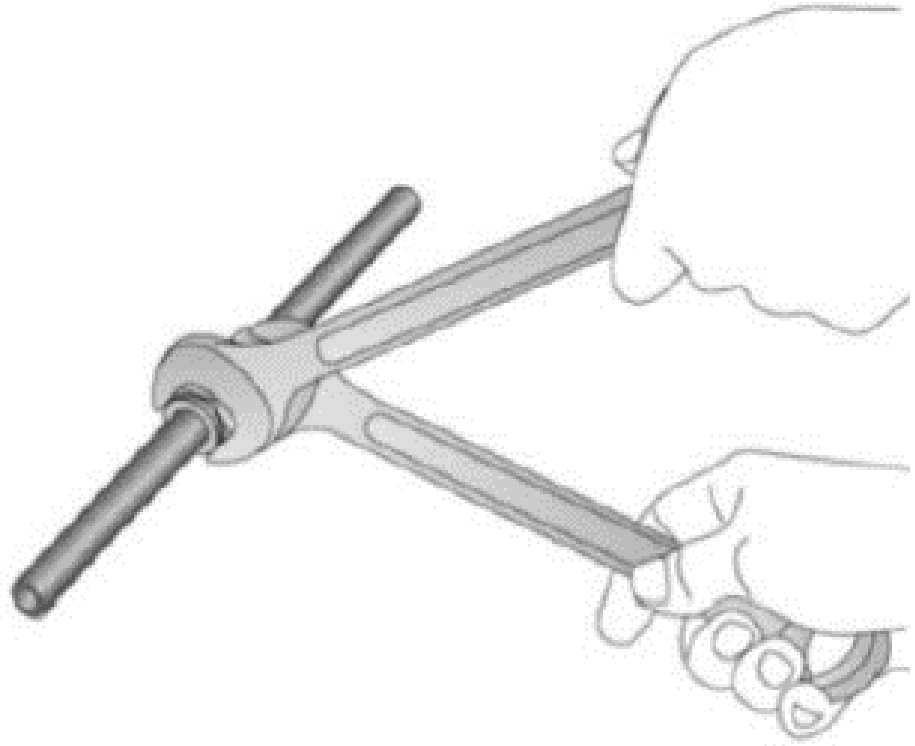


Fig. S26 — Tube length allowance

Repairing Leaks – Line Removal & Installation

- Use a touch of non-synthetic, non-detergent oil to lubricate the O-rings prior to installation
- **CAUTION: DO NOT USE silicone grease or any other type of lubricant**
- Install high pressure fittings, tubing and hoses finger tight to ensure proper fitment before fully tightening components. Be sure to use an opposing wrench to apply equal and opposite force. Refer to the following slide for torque values.
- Ensure O-rings are not damaged during the disassembly and reassembly process. All O-rings can be reused if no damage is visible and connection is leak-free



Repairing Leaks – Torque Values & O-Ring Part Numbers

- Torque Values

SAE J1926
O-Ring Boss (ORB) Fittings

Used On:
- LP Fuel Lines
- HP Fuel Lines
- PRD Vent Lines

Fig. S7 — Non-Adjustable Port End Assembly

SAE Straight Thread Port Assembly (SAE J1926)

SAE Dash Size	Thread Size UN/UNF	Assembly Torque (+10% -0) Non-Adjustables: Seal-Lok (Heavy Duty SAE J1926-2) ft.lbs. (in. lbs)	N-m	Non-Adjustables: Triple-Lok Ferulok Adapters (Light Duty SAE J1926-3) ft.lbs. (in. lbs)	N-m	Adjustables: Seal-Lok (Heavy Duty SAE J1926-2) ft.lbs. (in. lbs)	N-m	Adjustables: Triple-Lok Ferulok Adapters (Light Duty SAE J1926-3) ft.lbs. (in. lbs)	N-m	Plugs: Hollow Hex HP5ON-S (Light Duty SAE J1926-3) ft.lbs. (in. lbs)	N-m	Plugs: Hex Head P5ON-S (Light Duty SAE J1926-3) ft.lbs. (in. lbs)	N-m
6	9/16-18	(420)	47	(350)	40	(420)	47	(350)	40	(350)	40	(350)	40
8	3/4-16	(720)	81	(620)	70	(720)	81	(620)	70	(620)	70	(620)	70

Notes: Lubricate threads before assembly. Values in chart are for plated steel fittings in steel ports. For stainless steel fittings, use the upper limit of torque range. For brass and aluminum, decrease torque value by 35%.

Table S1 – SAE J1926 Straight Thread Port Assembly Torques

SAE J1453
O-Ring Face Seal Fittings (ORFS)

Used On:
- LP Fuel Lines
- HP Fuel Lines

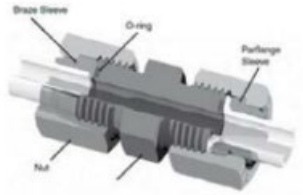


Fig. S15 – Seal-Lok Union cutaway with flanged and brazed assemblies

O.D. (in.)	O.D. (mm)	SAE Dash Size	Tube Side Thread Size (UN/UNF)	Tube Side Assembly Torque (+10% -0%) in.-lb.	ft.-lb.	N-m	Flats from Wrench Resistance (F.F.W.R.) Tube Nuts	Swivel & Hose Ends
3/8	8, 10	-6	11/16-16	360	30	40	1/4 to 1/2	1/2 to 3/4

Table S14 – Seal-Lok and UPTC assembly torque and F.F.W.R. For brass, aluminum (and other soft metals) decrease torque value by 35%, however F.F.W.R. is the same.

- O-Ring Part Numbers

Landi Technologies Replacement O-Ring Part Numbers			
Connection Type	**Dash Size**	**Landi P/N**	**Landi Description**
SAE J1926 O-Ring Boss (ORB)	-6	1002345	O-Ring, CNG, #6 MORFS, 2-012
	-8	1002346	O-Ring, CNG, #8 MORFS, 2-014
SAE J1453 O-Ring Face Seal (ORFS)	-6	1002347	O-Ring, CNG, #6 MORB, 3-906
	-8	1002348	O-Ring, CNG, #8 MORB, 3-908

Landi Technologies Warranty Coverage

3yr / 36,000 mi – Base

3yr / 50,000 mi – CNG Emissions Defect Warranty

8yr / 80,000 mi – High-Cost CNG Emissions Warranty Items

- Low-Pressure Regulator
- Alternative Fuel Control Module (AFCM)

Landi Technologies Warranty Process

UPS in-house warranty repairs

2 scenarios

1. Defective part determined without engaging Landi Technologies via online repair assistance form and part sourced from UPS MDC.
   - Submit claim through normal MDC warranty channels and return part(s) to MDC
2. Defective part determined by engaging Landi via online repair assistance form and parts supplied by Landi Technologies.
   - Submit claim through normal MDC warranty channels and reference Landi Technologies ticket number assigned.
   - Package defective parts and include a copy of the ticket number. Return label will be provided by Landi Technologies.

Dealer Repairs

The Ford dealer identified in the contact matrix for each location has signed a Landi Technologies Service Agreement which includes instructions for the dealer how to file warranty claims to Landi Technologies.

Ford FDRS Tool

Please use FDRS tool for all diagnostics

Ford PCM Recalibration Process

1. Complete a Service Ticket on the Landi Technologies Service website
2. Flash the PCM with the as-built data on gasoline using one of the following methods:
    * Providing the vehicle to a Ford dealership for flashing OR
    * Using the Ford FDRS tool by following Ford GSB 0000150. The engine serial number and transmission ID number will need to be inputted as part of the process.
3. After successfully flashing the PCM with the gasoline calibration, the MYCANIC tool needs to be used to flash the PCM. Landi can loan the MYCANIC tool if necessary. MYCANIC tools instructions provided separately.

NOTE: There can only be ONE .bin file on the SD card at a time. If there are any questions/issues, please have whoever is handling this reach out to service@landitechnologies.com.

Please contact Landi Technologies service department for CNG file.