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CNG Fuel System Operation Manual
FMM with Manifilter

Covers Type 4 eight-cylinder systems equipped with the following Hexagon® Agility® assemblies:

Fuel Management Module (FMM) p/ns
20860000
20860500
20861000
20861500
20862500
20862600
20863500

Roof Mount (RM) p/ns	Description	Cylinder Valve Type
25518000	Roof Mount, 155 DGE, 2084 L, 8 Tanks, Type 4	manual
25519000	Roof Mount, 155 DGE, 2081 L, 8 Tanks, Type 4	electric solenoid
25520000	Roof Mount, 185 DGE, 2474 L, 8 Tanks, Type 4	manual
25521000	Roof Mount, 185 DGE, 2468 L, 8 Tanks, Type 4	electric solenoid
25522000	Roof Mount, 126 DGE, 1657 L, 8 Tanks, Type 4	manual
25523000	Roof Mount, 126 DGE, 1657 L, 8 Tanks, Type 4	electric solenoid

ENP-728 REV C
December 19, 2022

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Table 1. Revision level.

ECN	REV	AUTHOR	APPROVED	DATE	DESCRIPTION
--	C	C. Grasso	B. Witt / C. Forsberg	12/19/2022	UPDATED: §3.7. Cylinder specification to NGV-2 2016; §4.10.1 Cylinder inspection interval and details. ADDED: §4.1. "Label FMM faceplate decal with the date of the next inspection." REVISED: Figure 35
--	B	C. Grasso	B. Witt / J. Wainz	11/23/2022	ADDED: §4.2. Fuel System Maintenance §4.2.1. Maintenance Schedule. SOURCE: ENP-516 REV E. CHANGED: kPa and MPa units to bar REVISED: Figure 35 UPDATED: CNG FS inspection interval to every year UPDATED: Hexagon branding and contact information DELETED: HP fuel filter (Manifilter) drain interval from Maintenance table. CORRECTED: HP fuel filter (Manifilter) element change interval CHANGED: HP fuel filter to "Manifilter" throughout CORRECTED: "shut off" to "shutoff;" "high pressure" to "high-pressure; "low pressure" to "low-pressure" throughout
--	A	C. Grasso	CCG Team	11/13/2020	UPDATED: Warning & signal word flags and definitions; REVISED: Figure 5; RENAMED: "Needle Valve" is now "Defuel Valve;" ADDED: Cylinder valve images and specs; REVISED: HP filter maintenance intervals; DELETED: Draining the HP filter; DELETED: Draining PRD Vent Lines; UPDATED: Defueling Preparation and Procedures
--	--	B. Witt/C. Grasso	CCG Team	7/27/2020	Initial release

Preface

This manual is designed as a supporting document to mechanics and operators trained in the operation procedures and maintenance of the compressed gas fuel system provided by Hexagon Agility.

No attempt shall be made to fill, install, or maintain this system until this manual and all referenced supporting documentation have been read and fully understood.

This manual dated 12/21/2022 is an update of ENP-044 to reflect changes in the fuel fill module design; contact Gillig to obtain ENP-044 for earlier systems. Any information reproduced by Gillig for their use, or that of their customers and clients, should be drawn from this manual.

Original Equipment Manufacturer (OEM) replacement parts may be obtained by contacting Gillig.

⚠CAUTION **⚠WARNING**

All replacement parts must adhere to the accepted standards and ratings as specified by Hexagon Agility. The usage of any part that is not approved by Hexagon Agility is not recommended and may compromise the integrity and safety of the system.

NOTICE

Do not remove components from original packaging until absolutely necessary. Any components that are to be reinstalled must be thoroughly cleaned, inspected, and stored in a satisfactory manner until reinstallation.

Acronyms

AGA	American Gas Association
ANSI	American National Standards Institute
ASM	assembly
BOM	bill of materials
CAN	National Standards of Canada
CGA	Compressed Gas Association
CNG	compressed natural gas
CSA	Canadian Standards Association
FMM	fuel management module

HP	high-pressure
LP	low-pressure
MPa	megapascal
NFPA	National Fire Protection Association
NGV	natural gas vehicle
nm^3/hr	normal cubic meters per hour
OEM	original equipment manufacturer
PRD	pressure relief device
psi	pounds per square inch (lb/in^2)
SCFM	standard cubic feet per minute

1. Safety

In the interest of ensuring the safety of all personnel involved with compressed natural gas (CNG) fuel storage systems, this section outlines general guidelines that must be adhered to when operating and servicing equipment provided by Hexagon® Agility®. Please observe the procedures and recommendations below.

1.1. Warning Messages and Symbols Used in This Document



DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.



WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.



CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.



***NOTICE* is used to address practices not related to physical injury, such as best practices or tips to help an operation or procedure go smoothly and prevent equipment damage.**



SAFETY INSTRUCTIONS indicate specific safety-related instructions or procedures.



Critical Characteristic

Product feature directly affects:

- **Safety of vehicle users, people nearby and maintenance personnel, or**
- **Regulatory compliance.**



Manufacturing Characteristic

- **A product feature solely used to improve manufacturability or maintain process control.**
- **A process parameter or step that has a significant effect on achieving a Critical Characteristic or Significant Characteristic, or maintaining material identification/traceability.**

1.2. Qualified Personnel

CNG systems should be maintained and inspected exclusively by trained personnel with qualifications in accordance with the applicable codes. As with all pressure vessels, CNG storage and fuel delivery systems are inherently dangerous.

⚠WARNING

Individuals involved in any aspect of CNG fuel system maintenance, emergency response, servicing or testing must be properly trained. Individuals who are not trained are not permitted to service, maintain, test, or inspect a system.

1.3. Safety Equipment

SAFETY INSTRUCTIONS

Observe all recommendations below when operating or servicing a CNG fuel system.

1. CNG safety signage should be visible at all applicable locations as stipulated by federal, state, and municipal law.
2. Natural gas rated fire extinguishers should be accessible and visible throughout all servicing and fueling areas. Verify fire extinguishers are charged, up to date, and rated correctly.
3. In case of emergency, self-contained breathing apparatus should be on site in an easily accessible area.
4. Areas designated for CNG fueling systems must have adequate lighting that complies with NFPA code.
5. Protective footwear and eyewear should be worn by all personnel near a CNG system.
6. When locating the source of a leak only use certified leak detecting solutions or equipment such as Swagelok Snoop® or a combustible gas detector. Any other product or solutions are unacceptable.
7. Only use tools that are in good working order with proper calibration.
8. Wear appropriate attire while servicing or maintaining any CNG system.

1.4. General Safety Precautions

⚠WARNING

Observe all recommendations below when operating or servicing a CNG fuel system.

1. Follow all maintenance procedures in the order in which they are written, do not skip steps unless with explicit permission.
2. Never use an open flame as a source of illumination in proximity to a CNG system. Natural gas is both volatile and explosive.
3. Any process or procedure that generates sparks, flames, or heated particles should not be applied in areas designated for CNG.
4. If a CNG system does require a process or procedure that generates sparks, flames, or significant heat, conduct the procedure in an isolated area and make sure that the CNG system has been completely purged with an inert gas.
5. CNG fuel delivery systems are to be serviced in designated areas that comply will all federal, state, and municipal laws and regulations.
6. CNG servicing and fueling areas must be well ventilated as stipulated by federal, state, and municipal law.
7. Perform all maintenance and service procedures in a dust free environment.
8. Never attempt to depressurize or vent a system by loosening a fitting.

1.5. CNG Vehicle Safety Precautions

⚠WARNING

Strict compliance with proper safety and handling practices is essential when operating this CNG fuel system.

The following safety precautions are vehicle specific and should always be observed when operating natural gas fuel systems and equipment:

1. A portable fire extinguisher must be installed on the vehicle in an easily accessible location.
2. Do not start engine if a natural gas leak is detected!
3. Verify all systems are grounded before transferring CNG fuel from one vehicle to another. Transferring CNG may cause a buildup of static electricity which could discharge and ignite the fuel.
4. Never attempt to open system components that are under pressure.
5. System pressure must not exceed 3600 psi (250 bar) @ 70°F (21°C).
6. Do not smoke or produce an open flame within 30 feet (9 m) of a CNG vehicle or a CNG dispensing/filling station.
7. Always ground vehicle prior to defueling.
8. If a CNG vehicle will be out of service for an extended time, turn the quarter turn main shut off valve to the “OFF/CLOSED” position and run the engine until it stalls. This consumes residual fuel in the closed off lines.

1.6. Codes and Compliances

For complete and detailed information concerning CNG codes and regulations please refer to the following:

USA: NFPA 52

Canada: CAN/CGA B109

North America: ANSI/AGA NGV 3.1 / CGA 12.3 and NGV 12.3-M95

1.7. First Responder Guide

⚠WARNING

For comprehensive emergency response procedures, refer to Hexagon Agility publication ENP-084, "First Responder Guide: CNG and LNG Vehicle Fuel Systems."

A vehicle equipped with natural gas will have a blue reflective decal on the rear of the vehicle identifying the fuel as compressed natural gas (CNG) or liquid natural gas (LNG).



Figure 1. CNG blue diamond.

Natural gas possesses unique hazards that are not present in gasoline or diesel fuel. The primary concern is that CNG is in a gaseous state at room temperature and stored at 3600 psi (250 bar). Hexagon® Agility® minimizes these potential hazards through state of the art design and testing practices.

1.7.1. General Information

The CNG fuel storage cylinders are housed in steel frames bolted to the roof. These structures are designed to protect the cylinders in the event of a collision.

Each individual cylinder has a valve at one end which allows fuel in that cylinder to be isolated from the rest of the fuel system. During regular operation, all cylinder valves are open.

Additionally, the fuel management module (FMM) is equipped with a 1/4-turn manual shutoff valve which isolates the fuel storage system from the engine for emergency situations.

1.7.2. Vehicle Fire Procedures

In the event of a CNG fire it is imperative that the vehicle operator acts quickly and efficiently by observing to the following steps:

1. Turn off engine and set parking brake.
2. Get passengers out of vehicle as quickly as possible.
3. Evacuate the area.
4. Call 9-1-1.
5. Notify attending emergency personnel the vehicle is a CNG vehicle.
6. *If possible and only with the proper training:* Extinguish fire using an appropriately rated fire extinguisher.

⚠WARNING

A CNG fire is like a gasoline fire. However, if the fire is not extinguished quickly, CNG cylinder pressure relief devices (PRDs) may activate to relieve excess pressure from the cylinders.

⚠WARNING

PRDs activate at 230°F (110°C) and will cause CNG to exit rapidly from the storage cylinders. Escaping CNG may ignite and add to the fire.

1.7.3. Return to Service Inspection

If the vehicle has been subjected to a fire or collision, the fuel storage system must be inspected by a qualified inspector before it can be returned to service.

1.7.4. Emergency Manual Shutdown Procedures

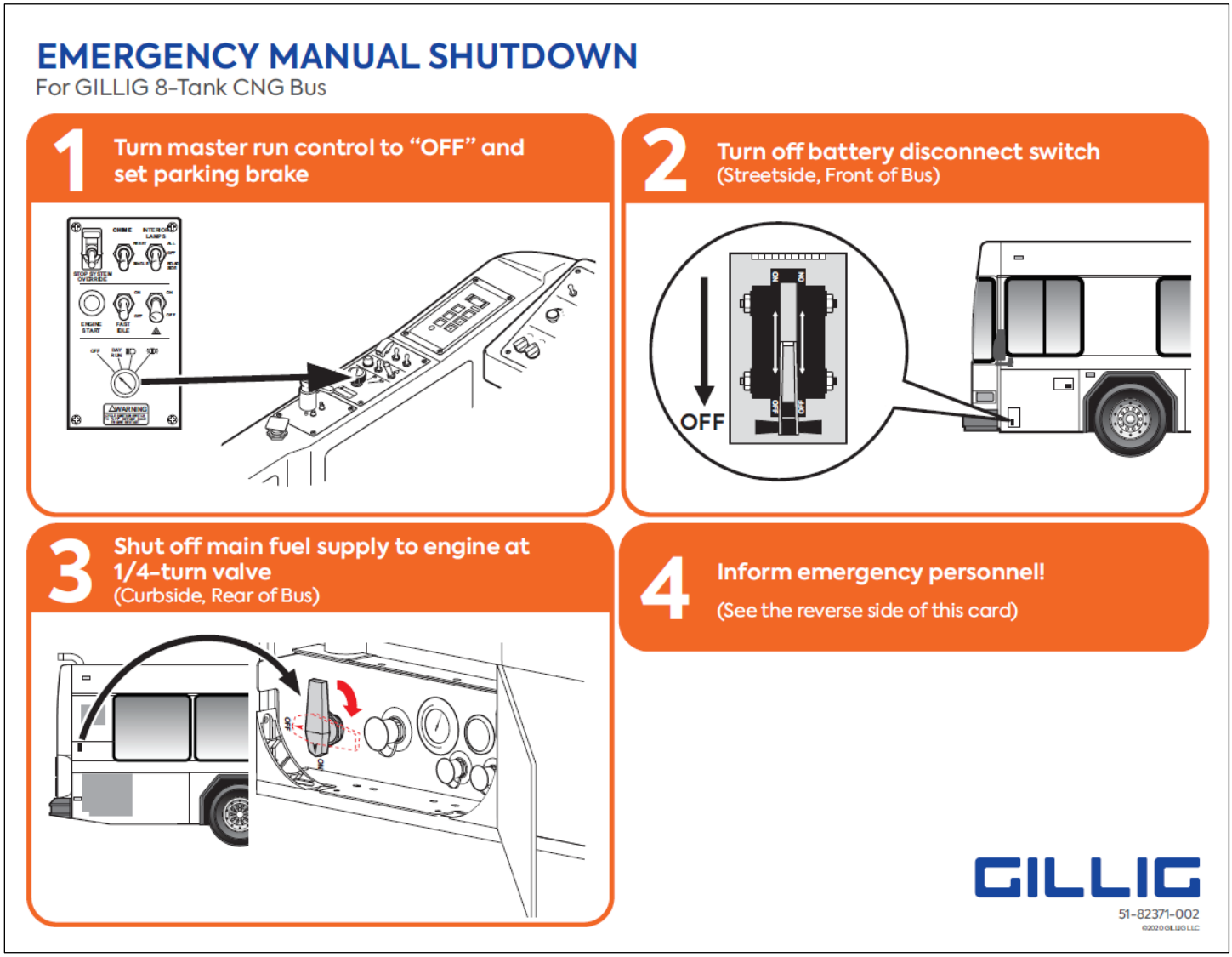


Figure 2. Emergency shutdown procedure.

1.7.5. Emergency Response

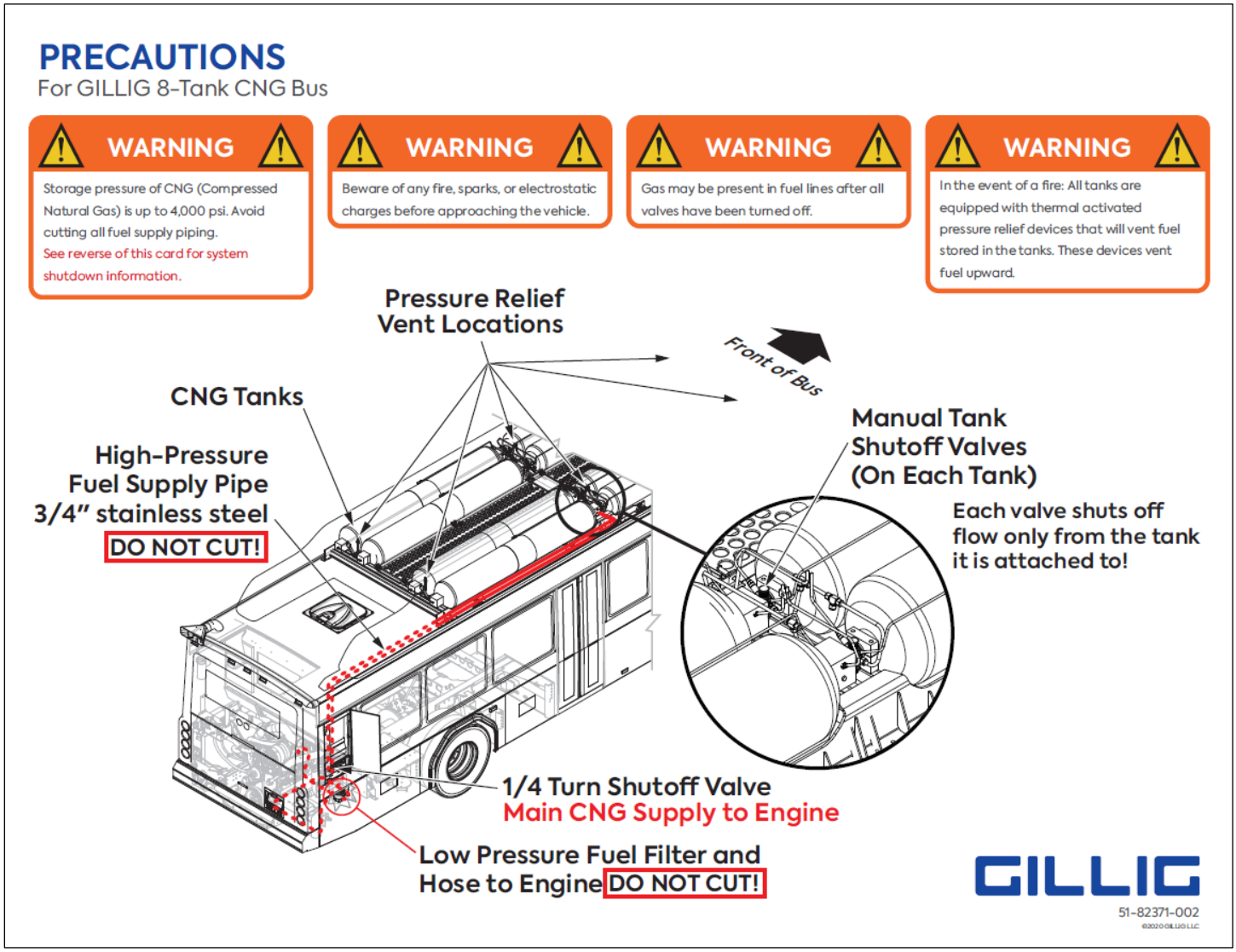


Figure 3. Emergency response procedure - precautions.

2. System Schematics and General Assemblies

This section illustrates general schematics and high level assembly drawings. All figures and illustrations are intended for reference only.

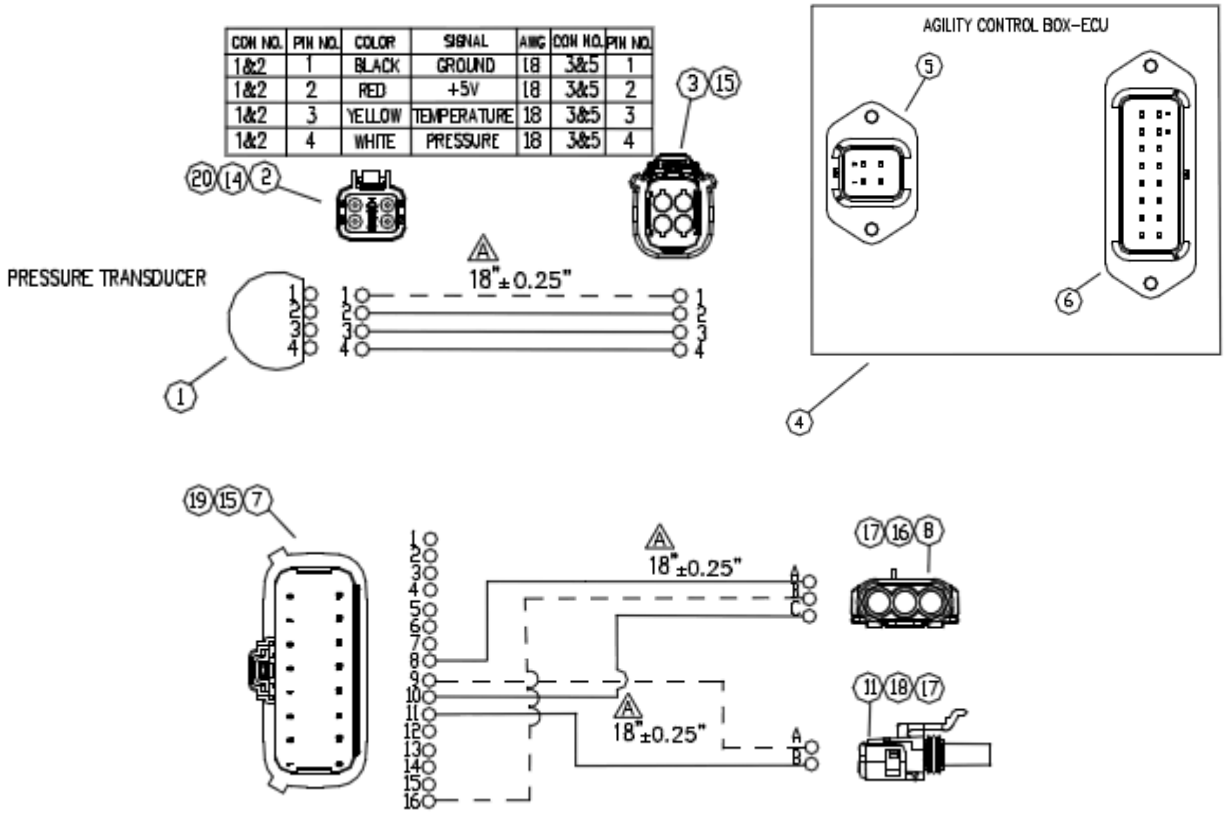


Figure 4. Electrical schematic.

Table 2.Connector pin outs

CON NO.	PIN NO.	COLOR	SIGNAL	AWG	CON NO.	PIN NO.
6	1	PLUG	KEY SOL.GROUND	PLUG	–	–
6	2	PLUG	START SOL.	PLUG	–	–
6	3	PLUG	KEY START	PLUG	–	–
6	4	PLUG	SOL. V.1 GROUND	PLUG	–	–
6	5	PLUG	SOL. V.1 POWER	PLUG	–	–
6	6	PLUG	KEY ON	PLUG	–	–
6	7	PLUG	KILL CAP 1	PLUG	–	–
6&7	8	RED	+12/24V POWER	18	8	A
6&7	9	BLACK	GAUGE GROUND	18	11	A
6&7	10	BROWN	GAUGE LIVE	18	8	C
6&7	11	WHITE	LOW FUEL LAMP	18	11	B
6	12	PLUG	SOL. V.2 GROUND	PLUG	–	–
6	13	PLUG	SOL. V.2 POWER	PLUG	–	–
6	14	PLUG	KILL CAP 3	PLUG	–	–
6	15	PLUG	KILL CAP 2	PLUG	–	–
6&7	16	BLACK	GROUND	18	8	B

Table 3. Electrical BOM

ITEM	QTY	DESCRIPTION
20	1	DEUTSCH WEDGELOCK FOR 4 WAY PLUG
19	11	MOLEX UNUSED CIRCUIT CAVITY PLUG FOR WIRES 14–22 AWG
18	2	DELPHI WEATHER PACK FEMALE TERMINAL FOR WIRES 18–20 AWG
17	5	DELPHI WEATHER PACK CABLE SEAL FOR WIRES 18–20 AWG
16	3	DELPHI WEATHER PACK MALE TERMINAL FOR WIRES 18–20 AWG
15	9	MOLEX FEMALE TERMINAL FOR WIRES 14–18 AWG
14	4	DEUTSCH SOCKET FEMALE TERMINAL FOR WIRES 14–18 AWG
11	1	DELPHI FEMALE 2 PIN WEATHER PACK CONNECTOR BLACK
8	1	DELPHI MALE 3 PIN WEATHER PACK CONNECTOR BLACK
7	1	MOLEX CONNECTOR, 16PIN, RECEPTACLE, 18–22 AWG
6	1	MOLEX CON.,16PIN, PCB HEADER VER. ST. PROFILE–GOLD/TIN TER.
5	1	MOLEX CON.,4PIN, PCB HEADER VER. ST. PROFILE–GOLD/TIN TER.
4	1	AGILITY CONTROL BOX– ECU WITH GILLIG 0–90 CALIBRATION FILE
3	1	MOLEX CONNECTOR, 4PIN, RECEPTACLE, 18–22 AWG
2	1	DEUTSCH 4 PIN CONNECTOR
1	1	PRESSURE & TEMPERATURE TRANSDUCER

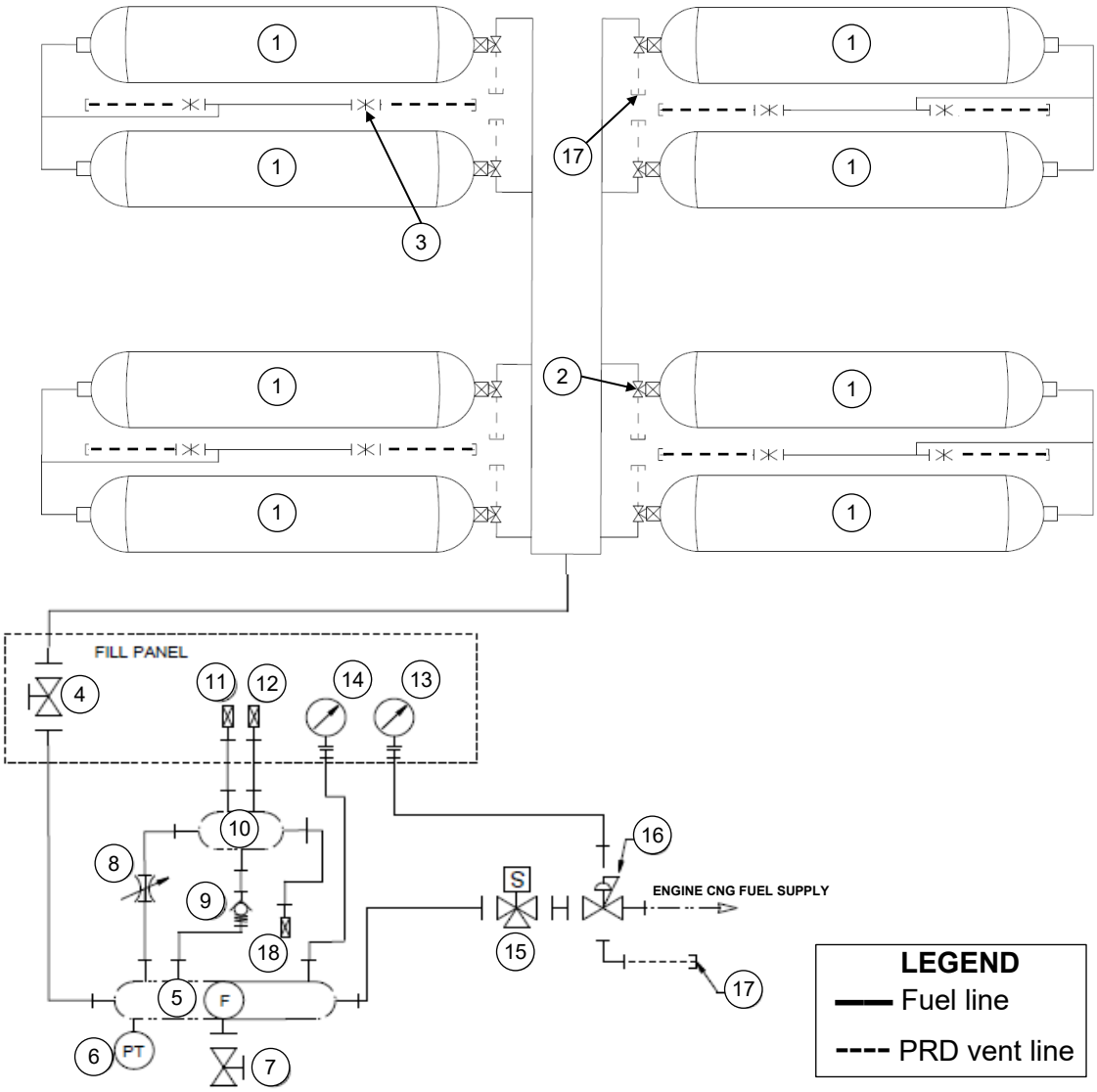


Figure 5. CNG system schematic.

Table 4. CNG system components (refer to Figure 5).

Item	Description
1	CNG cylinder
2	Cylinder valve
3	Pressure relief device (PRD)
4	1/4-turn manual shut off valve
5	Manifilter
6	Pressure transducer (on Manifilter)
7	Bleed valve (on Manifilter)
8	Defuel valve
9	Check valve

Item	Description
10	Fill manifold
11	Fuel fill / defuel receptacle
12	Transit (fast) fill receptacle
13	Low-pressure gauge
14	High-pressure gauge
15	Supply solenoid
16	Pressure regulator
17	PRD vent cap
18	Remote fill panel (optional)

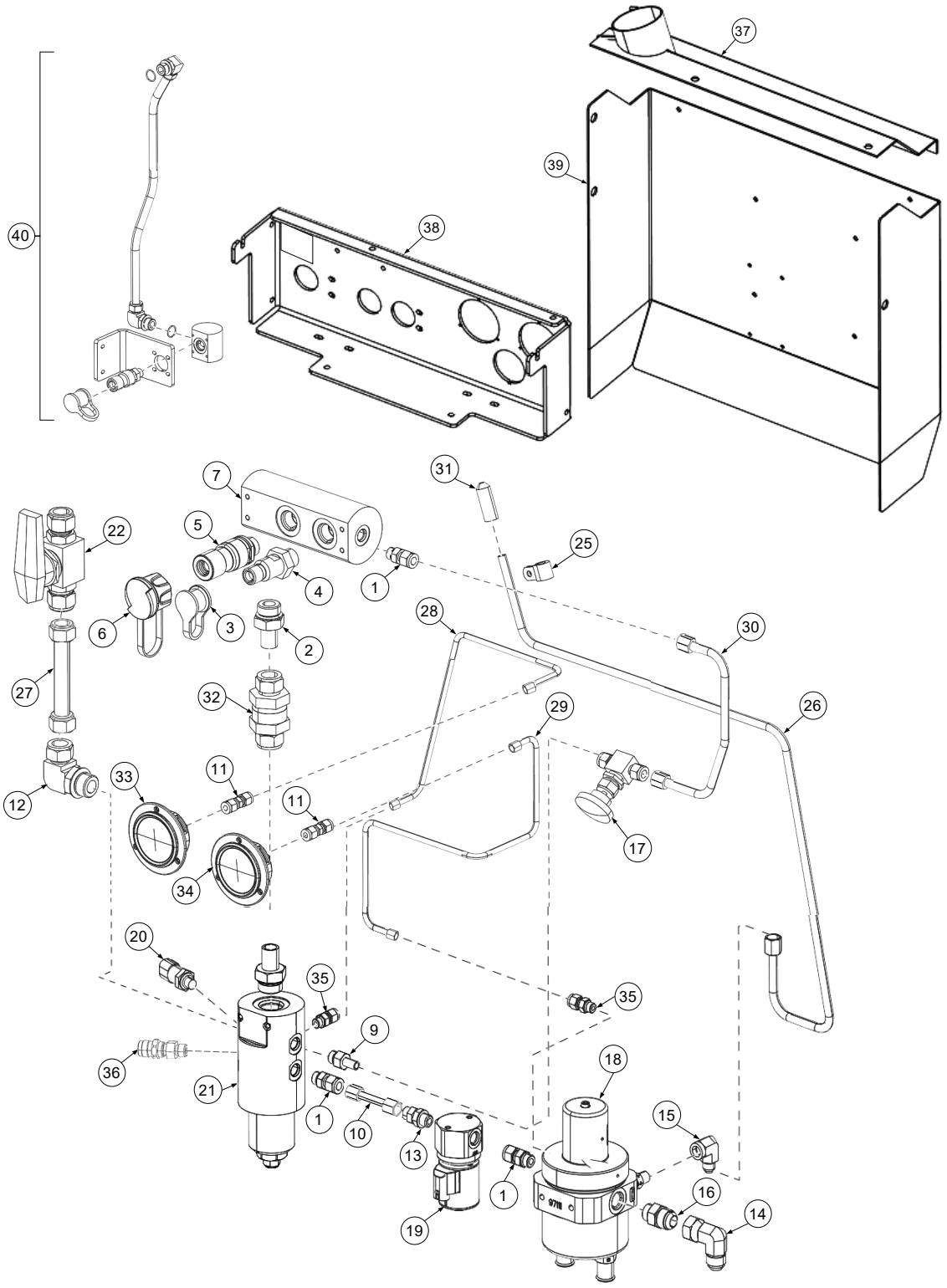


Figure 6. Fuel management module (FMM) components (refer to Table 5).

Table 5. Fuel management module (FMM) components (refer to Figure 6).

Item	QTY	Description
1	1	Fitting, male connector
2	1	Fitting, male adapter
3	1	Dust cap, rubber, NGV1/defuel receptacle
4	1	Receptacle, CNG NGV1/defuel receptacle
5	1	Receptacle, CNG transit (fast) fuel fill
6	1	Dust cap, rubber, transit fuel fill
7	1	Fuel fill manifold, with remote fuel fill port
8*	1	Fuel fill manifold, standard
9	1	Fitting, adapter
10	1	Tube, HP fuel, Manifilter to regulator
11	2	Fitting, straight union
12	1	Fitting, 90-degree adjustable elbow
13	1	Fitting, adapter, straight
14	1	Fitting, JIC, 90-degree elbow, large
15	1	Fitting, JIC, 90-degree elbow, small
16	1	Fitting, JIC, straight
17	1	Defuel valve
18	1	Pressure regulator
19	1	Supply solenoid valve (SSV)
20	1	Pressure transducer, HP fuel filter
21	1	ASM, Manifilter
22	1	1/4-turn manual shut off valve
23*	1	Spacer, 1/4-turn manual shut off valve
24	1	High-pressure fuel filter element
25	1	P-clip, 3/8-in., rubber clamp
26	1	ASM, Tube, PRD, regulator to vent
27	1	Tube, HP fuel, Manifilter to 1/4-turn manual shut off valve
28	1	Tube, HP fuel, Manifilter to HP gauge
29	1	Tube, LP fuel, regulator to LP gauge
30	1	Tube, HP fuel, bleed valve to manifold
31	1	Cap, PRD vent, heat shrink
32	1	Check valve, 6000 psi, CNG, with fittings
33	1	Gauge, high-pressure, 0-6000 psi
34	1	Gauge, low-pressure, 0-200 psi
35	2	Fitting, connector
36	1	Bleed valve, Manifilter
37	1	Vent stack assembly
38	1	Face plate, FMM *(faceplate shown is for optional Smart Gauge; standard faceplate is similar)*
39	1	Cover, FMM, rear
40	1	Auxiliary remote fill panel *(optional)*

**Not shown*

3. Fuel System Components and Specifications

3.1. Fuel Specifications

Fuel quality is crucial to maintaining engine performance characteristics, life expectancy, and emission standards. CNG fuel must meet or exceed Cummins CES 20067 requirements.

NOTICE

Failure to meet fuel requirements may result in poor engine performance and damage that is not covered under warranty.

3.2. Superstructure

The fuel system structures and components are designed to meet or exceed all safety and vehicle standards. The systems are shipped as complete units ready to be bolted on and connected for turn-key operation. *Figure 7*

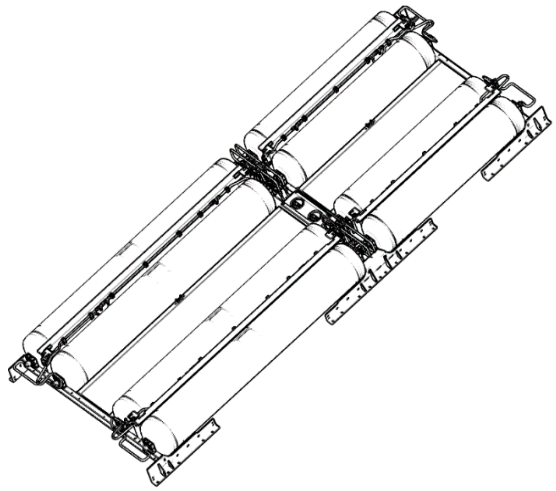


Figure 7. Eight-cylinder roof mounted CNG storage system.

3.3. Fuel Management Module

The fuel fill panel control interface *(Figure 8)* is accessible by opening the fill panel access door at the rear passenger side of the vehicle.

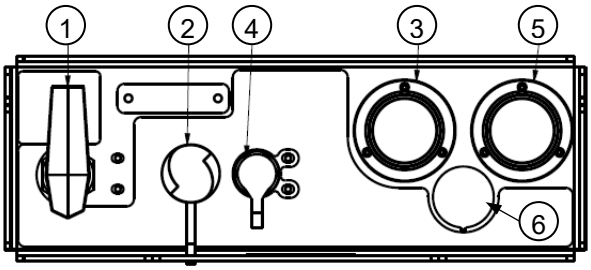


Figure 8. FMM faceplate components.

(1) 1/4-turn manual shut off valve, (2) transit (fast) fill receptacle, (3) high-pressure gauge, (4) NGV1 fuel fill / defuel receptacle, (5) low-pressure gauge, (6) Smart Gauge (if equipped).

FMM components and connections inside the fill panel. *Figure 9*

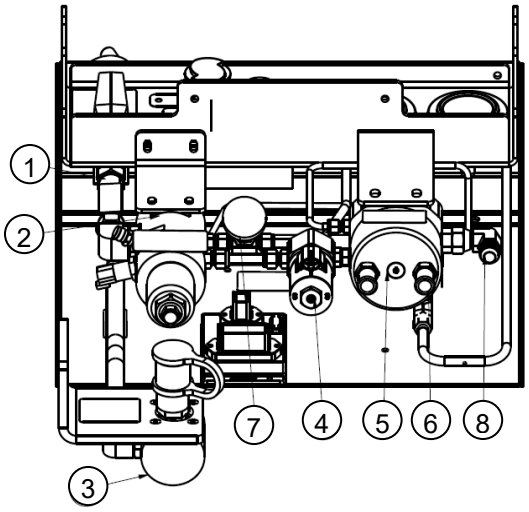


Figure 9. FMM components (rear view): (1) high-pressure fuel line to cylinders, (2) high-pressure Manifilter, (3) remote fill panel (optional); (4) solenoid valve, (5) pressure regulator, (6) regulator coolant ports, (7) defuel valve, (8) low-pressure fuel line connection.

An optional remote fill panel connects to a special manifold on the rear of the FMM for ease of fueling. *Figure 10*

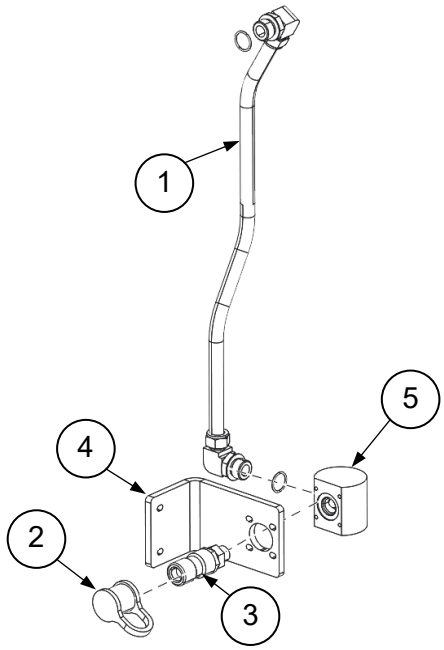


Figure 10. Remote fill option components. (1) tube, remote fill to FMM manifold. (2) dust cap, (3) transit (fast) fill receptacle, (4) remote fill bracket, (5) remote fill manifold.

3.4. Filters

3.4.1. High-pressure Filter

The high-pressure (HP) coalescing fuel filter or Manifilter is located downstream of the manifold and main shut off valve and upstream of the supply solenoid valve. The Manifilter purifies fuel by removing moisture and contaminants. *Figure 11*

High-pressure filter specs

Efficiency: 10 microns

Element Change Frequency:

Severe Duty Every 15,000 miles (24,000 km)
OR
Every 1,000 hours / 9 months
whichever comes first

Normal Duty Every 30,000 miles (48,000 km)
OR
Every 1,000 hours / 9 months
whichever comes first

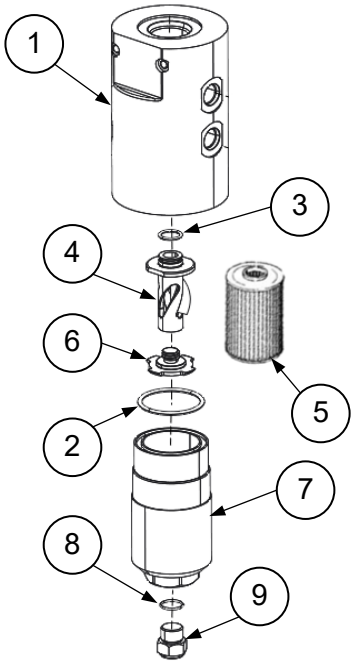


Figure 11. High-pressure filter components:
(1) Manifilter housing, (2) Manifilter bowl O-ring, (3) HP filter element O-ring, (4) HP filter element housing, (5) HP filter element, (6) element base, (7) Manifilter bowl, (8) drain plug O-ring, (9) hex head drain plug.

3.4.2. Low-pressure Filter

The low-pressure (LP) coalescing filter is located downstream of the 1/4-turn manual shut off valve, high-pressure filter, and regulator. The LP filter removes residual contaminants and oil from the fuel before it enters the engine.

Low-pressure filter specs

The LP filter is sealed with a lubricated gasket and includes a drain cock at the bottom.

Operating range: -43°F to +250°F
-42°C to +121°C

Efficiency:

- 99.9% for 0.3 micron liquid droplet
- 100% for 25 micron particles

Mounting type: Spin-on, 1-1/2-16 UN-2B thread

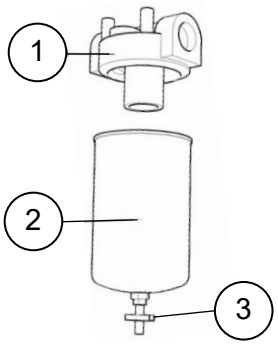


Figure 12. Low-pressure fuel filter components.
(1) LP filter head; (2) LP filter element, (3) drain cock.

3.5. Supply Solenoid Valve (SSV)

Located in the FMM between the Manifilter and the pressure regulator, the supply solenoid valve (SSV) controls CNG flow. *Figure 13*

⚠WARNING

The supply solenoid valve generates heat during operation and may cause burns on contact.

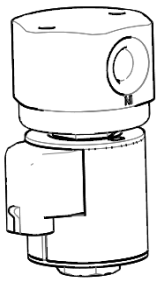


Figure 13. Supply solenoid valve (SSV).

3.5.1. Supply Solenoid Valve (SSV) Principles of Operation

De-energized: The supply solenoid valve acts directly by utilizing an armature and a pilot as opposed to a plunger. Pressure from the inlet port flows through the pilot guide surrounding the armature, the pressure is then stopped by the pilot at the orifice.

Energized: The supply solenoid valve operates using 24V DC from the onboard power supply. The armature is forced upwards and lifts the pilot from the seat of the orifice allowing pressure to flow from the inlet port to the outlet port.

3.6. Pressure Regulator

Located adjacent to the supply solenoid valve in the FMM, the pressure regulator is the dividing point between the high-pressure and low-pressure sides of the fuel system.

The pressure regulator reduces CNG up to 3600 psi (250 bar) down to a pressure usable by the engine typically around 125 psi (8.61 bar). *Figure 14*

Pressure regulator specs

Set point: 125 psi (8.61 bar) outlet @ 3600 psi (250 bar) inlet pressure

PRD: 200 ± 40 psi (13.7 bar ± 2.75 bar) crack pressure

Max. pressure: 3600 psi (250 bar)

Min. pressure: 250 psi (17.2 bar)

Gas flow rate: 0-110 lb/hr nominal

Coolant temperature range: -40°F to +257°F
-40°C to +125°C

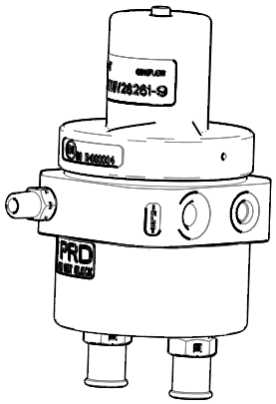


Figure 14. Pressure regulator.

3.7. Cylinders

The eight roof mounted cylinders are standard Type 4 CNG cylinders which are designed, manufactured, inspected, and qualified in accordance with NGV-2 2016.

Total system water volume is noted on the FMM face plate.

Cylinder specs

Service pressure: 3600 psi @ 70°FService life: Refer to cylinder manufacturer label or marking

3.8. Valves

3.8.1. Bleed Valve

The bleed valve (1) enables safe venting of system pressure and is located on the Manifilter (3). *Figure 15*

Bleed valve specs

Flow coefficient: 0.25

Temperature rating: -4°F to +450°F
-20°C to +232°C

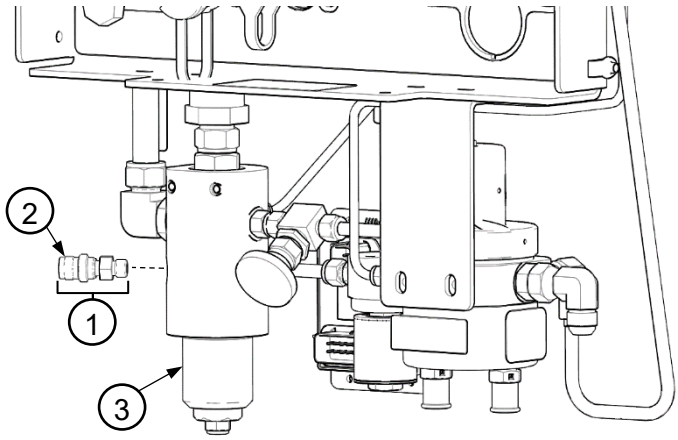


Figure 15. Bleed valve location.
(1) Bleed valve, (2) nut, (3) Manifilter.

3.8.2. Check Valve

Check valves located downstream the fill receptacles in the FMM prevent CNG from following out of the system. *Figure 16*

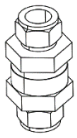


Figure 16. Check valve.

3.8.3. Defuel Valve

Located inside the FMM. the defuel valve allows fuel to be removed from the system via the defuel receptacle. *Figure 17*



Figure 17. Defuel valve.

3.8.4. 1/4-turn Manual Shutoff Valve

The 1/4-turn manual shutoff valve located on the FMM face plate is also known as the “main” or “emergency” shutoff valve.

When in the CLOSED/OFF position, the 1/4-turn manual shutoff valve prevents the flow of CNG past its location in the fuel system. Turned the OPEN/ON position, the 1/4-turn manual shutoff valve permits fuel to flow from the cylinders to the FMM components. As its name implies, turning the 1/4-turn manual shutoff valve 90-degrees by hand changes it from OPEN to CLOSED and reversing the direction of rotation restores it to the OPEN position for normal operation. *Figure 18*

1/4-turn manual shutoff valve specs

Temperature rating: -40°C to 93°C
-40°F to 200°F

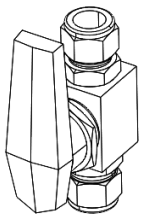


Figure 18. 1/4-turn manual shutoff valve.

3.8.5. Manual Cylinder Valve

On fuel system p/ns 25518000, 25520000, and 25522000, each cylinder is equipped with a manually operated shutoff valve to isolate CNG from the rest of the fuel system. *Figure 19a*

Manual cylinder valve specs

Service pressure: 3600 psi (250 bar)

Working temperature: -40°F to +185°F
-40°C to +85°C

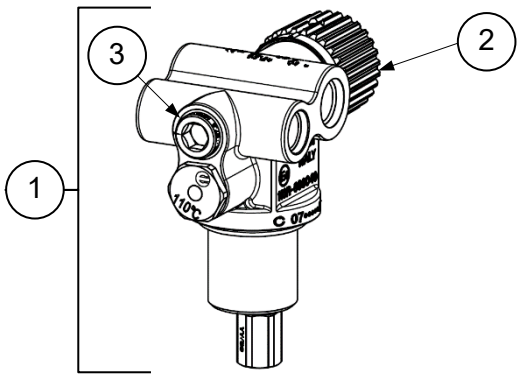


Figure 19a. Manual cylinder valve (1), shutoff knob (2), valve PRD (3).

3.8.6. Electric Solenoid Cylinder Valve

On fuel system p/ns 25510000, 25521000, and 25523000, each cylinder is equipped with an electric solenoid operated valve. Each electric solenoid valve is equipped with a manual shutoff knob to isolate CNG contained within the cylinder from the rest of the fuel system. *Figure 19b*

Electric solenoid cylinder valve specs

Service pressure: 3600 psi (250 bar)

Working temperature: -40°F to +185°F
-40°C to +85°C

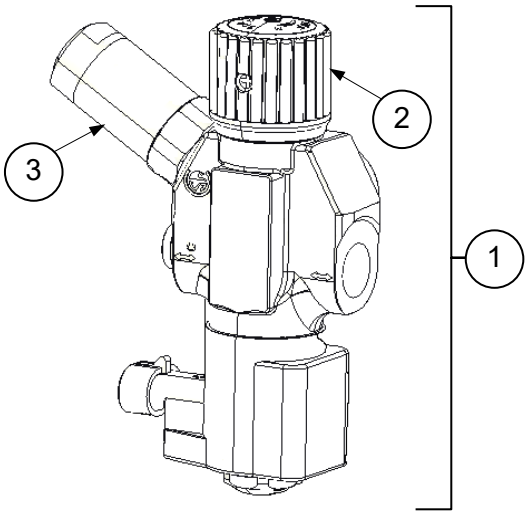


Figure 19b. Electric solenoid cylinder valve (1), manual shutoff knob (2), valve PRD (3).

3.9. Pressure Relief Devices (PRDs)

3.9.1. Valve PRD

Cylinder valves are fitted with a PRD on each valve which connect to PRD vent tubes. *Figures 19a and 19b*

Valve PRD specs

Operating temperature: -40°F to 180°F
-40°C to +82°C

Service pressure: 3626 psi at 59°F
250 bar at 15°C

Working pressure: 4467 psi at 180°F
308 bar at 82°C

Activation temperature: 230°F / 110°C

3.9.2. Remote PRD

Each cylinder is equipped with multiple remote PRDs which connect to the respective cylinder plug end via several live PRD supply tubes. *Figure 20a*

Remote PRD specs

Operating temperature: -40°F to 180°F
-40°C to +82°C

Service pressure: 3626 psi at 59°F
250 bar at 15°C

Working pressure: 4467 psi at 180°F
308 bar at 82°C

Activation temperature: 230°F / 110°C

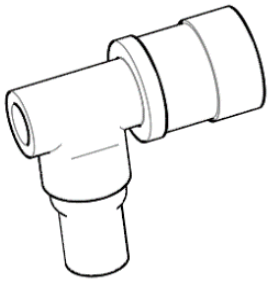
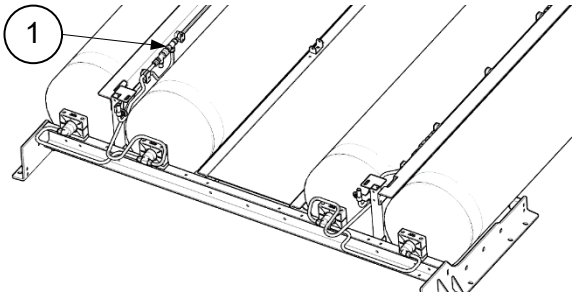


Figure 20a. Remote PRD.

⚠WARNING
PRD supply lines are always pressurized when gas is present in the system.

Plug end



Valve end

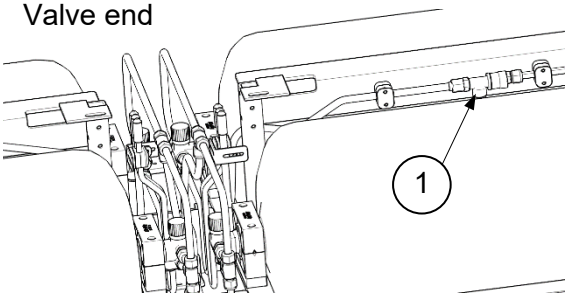


Figure 20b. Remote PRD (1) locations. Note: Manual cylinder valve system shown; electric solenoid valve system similar.

3.10. Fuel Fill and Defuel Receptacles

3.10.1. Standard fuel fill & defuel receptacles

The FMM face plate contains a transit or “fast” fill fuel receptacle (1) and an NGV1 receptacle (2) used exclusively for defueling. *Figure 21*

Fuel fill and defuel receptacle specs

Design pressure: 5000 psi (350 bar) max.

Flow rate, transit fill: 5000 SCFM (8043 nm^3/hr) @ 3000 psi (207 bar)

Flow rate, NGV1: 1500 SCFM (145 nm^3/hr) @ 3000 psi (207 bar)

Temperature range: -40°F to 250°F
-40°C to 121°C

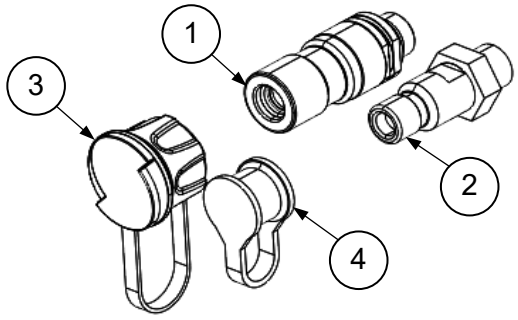


Figure 21. FMM receptacles.
(1) Transit (fast) fill receptacle, (2) NGV1 receptacle.
(3) transit (fast) fill receptacle dust cap,
(4) NGV1 receptacle dust cap.

NOTICE

Dust caps (3) and (4) must reinstalled immediately after receptacle use. *Figure 21*

3.10.2. Remote fuel fill receptacle *(optional)*

Vehicles equipped with an FMM incorporating a remote fuel fill panel include an additional transit (fast) fill receptacle matching the specifications above. *Figure 22*

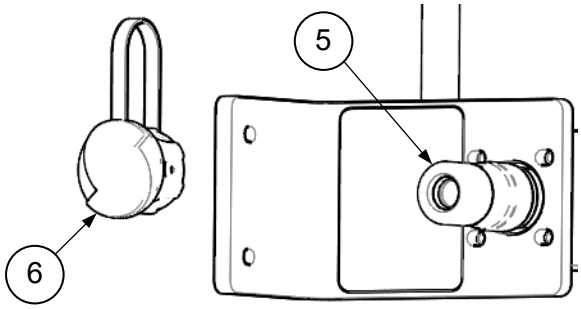


Figure 22. Optional remote transit fuel fill panel:
(5) transit (fast) fill receptacle,
(6) transit (fast) fill receptacle dust cap.

NOTICE

Dust cap (6) must reinstalled immediately after receptacle use. *Figure 22*

3.11. Fittings and Connections

3.11.1. Tubing

All tubing is stainless steel manufactured according to ASTM A-269 or ASTM A213. It is cold finished, bright annealed, seamless tube. Tubing can be 316 SS or 304 SS, maximum hardness HRB90.

3.11.2. Fittings

This system is plumbed with Swagelok® stainless steel compression tube fittings designed specifically for use in CNG applications.

3.11.3. Tube and Fitting Installations

Installing tube fittings correctly requires adequate training, correct parts, and appropriate tools. Tubes must be bent accurately to minimize system stress. Fittings must be assembled according to manufacturer's specifications. For these reasons it is mandatory that maintenance personnel receive proper training from an authorized Swagelok® distributor.

M

Do not mix tube fittings from other manufacturers; this may result in plumbing failures causing leaks, damage, or serious injury.

3.11.4. Fitting Safety Considerations

⚠WARNING

Do not bleed the CNG system by loosening or cracking a fitting connection.

NOTICE

Do not disassemble new fittings prior to use.

⚠WARNING

Do not attempt to torque fittings while system is pressurized.

M

When tightening a compression nut on a fitting, hold the fitting body securely with a second wrench.

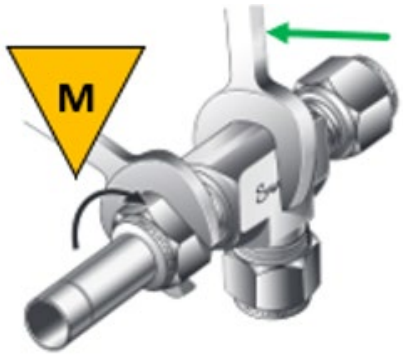


Figure 23. Always use two wrenches when loosening or tightening a fitting.

4. Operation and Maintenance

Routine maintenance of the compressed natural gas fuel system will help ensure the system and its components are functioning properly.

⚠WARNING

System must not be under pressure during servicing. Doing so may cause serious injury.

⚠WARNING

This manual is intended as a supplement to training in operation and maintenance of the CNG fuel system. Attempting to operate or maintain the CNG fuel system without proper training is dangerous.

NOTICE

Do not expose plastic or elastomeric materials to commercial cleaning products. Wash CNG components with a diluted soap solution and rinse thoroughly to remove deposits.

NOTICE

CNG components and fittings are designed to be used exclusively in CNG applications. Parts must be ordered directly through Hexagon® Agility® or through an approved Hexagon® Agility® OEM dealer. Any other parts may be unsafe and will subsequently void the warranty. All replacement parts and components must receive approval from Hexagon® Agility® prior to installation.

4.1. Inspecting Components

Daily

Walk around vehicle and check for external damage to CNG cylinder housings and covers.

Monthly

- Verify all PRD vent lines have end caps securely in place. A PRD vent line with a missing cap may indicate a PRD has activated. If a PRD has activated, contact the maintenance department or Hexagon® Agility®. If the cap is simply missing and the PRD has not activated, replace missing cap(s).
- Verify all system components are solidly mounted.
- Verify fuel supply tubes and flexible lines are in good condition.
- Verify no fuel leaks are present at any fittings or components.
- Verify there are no coolant leaks at the pressure regulator hose connections.
- Visually inspect cylinder mounting structural components.
- Inspect fastened joints for loose fasteners.
- Inspect mounting bolts for damage.

Every year regardless of mileage

A certified (CGA C-6.4) or other qualified CNG Fuel System Inspector shall perform cylinder and fuel system inspection.

- Check cylinder covers for damage.
- Verify cylinders are mounted securely. Check mounts, brackets, and all fasteners.
- Verify cylinder labels are in place and make sure cylinder service life has not expired.
- Inspect cylinder valves and PRDs for leaks and damage.
- Inspect all plumbing tubes, hoses, and fuel flow components for leaks.
- Examine all cylinders for damage using OEM cylinder guidelines.
- Test supply solenoid valve.
- *If equipped:* Test CNG cylinder solenoid valves.
- Label FMM faceplate decal with the date of the next inspection.

File cylinder and fuel system inspection records with vehicle service history.

4.2. Fuel System Maintenance

Performing regular maintenance will help ensure the vehicle fuel system delivers safe and reliable performance and minimize down time.

To determine the correct maintenance intervals for the vehicle, first determine vehicle service type and/or operating conditions.

Severe Duty

- Operation on extremely poor roads or off-roads/highways
- Frequent short-distance or stop and go travel, such as refuse or transit bus
- Construction site operation
- Poor fuel quality

Normal Duty

- Long haul
- Over the road
- Infrequent stops

4.2.1. Maintenance Schedule

NOTICE

Always select the interval that occurs first.

Table 6. Maintenance schedule.

Procedure	Frequency
Drain LP fuel filter	Daily*
Replace LP fuel filter	Every 15000 miles (24000 km)*
Replace Manifilter HP fuel filter element	**Severe Duty** Every 15000 miles (24000 km)* OR Every 1000 hours / 9 months Whichever comes first
	Normal Duty Every 30000 miles (48000 km)* OR Every 1000 hours / 9 months Whichever comes first
Leak test fuel system	Every engine oil change
Component inspection	Every engine oil change

NOTICE

***Intervals may vary depending on fuel quality, station condition, and vehicle use.**

NOTICE

Hexagon® Agility® recommends oil analysis of high-pressure (HP) fuel filter residue to assess station fuel quality and to determine whether fuel filter maintenance intervals can deviate (be extended) from these guidelines.

4.3. Leaks

This section covers leak detection, fitting replacement, and leak repair methods.

⚠CAUTION

Adjusting fittings requires accredited Swagelok® or Agility® training.

4.3.1. Tubing Bottoming Requirements

To achieve a safe leak free seal, tubing must be flush and fully bottomed in the appropriate fitting. Please consider the following recommendations:

1. Deburr tubing so it sits flush in the fitting.
2. Tubing must be round; elliptical or warped tubing should not be used.
3. Tubing must have a minimum length straight section before a bend radius as specified in the Swagelok tube fitting manual.

4.3.2. Tightening Fitting Nuts

When pre-swaging tubing, Swagelok® recommends that fitting nuts should be tightened 1-1/4 turns beyond snug. Snug is defined as the point at which the tube cannot be rotated freely in the pre-set swaging tool or fitting body. Swagelok® fittings employ a two-ferrule design, the front ferrule provides the seal, and the rear ferrule provides a firm grip on the tubing.

4.3.3. Testing for Leaks

⚠WARNING

Fittings and connections should be checked periodically for leaks. This task must be carried out by certified personnel.

For monthly maintenance, the entire fuel system can be leak tested with an inert gas, a leak detection solution, and/or a methane detector. Generally, leaks will occur at fitting connections. All joints and connections should be tested.

NOTICE

When checking for leaks always use leak detecting equipment and solutions designed for use with stainless steel and brass such as Swagelok® Snoop®.

To Find a Leak:

1. Apply leak detecting solution and look for bubbling or foaming at the site of the leak.
2. Examine connections for icing or signs of condensation around the tubing.
3. Check for signs of damaged or perforated tubing.

4.3.4. Tightening Leaking Fittings

⚠WARNING

Never tighten a fitting while the system is under pressure. Always follow proper safety and service procedures when fixing a leak. Failure to adhere to safety standards and procedures may result in system or property damage and/or personal injury.

1. If a leak is detected, depressurize the system as described in *Section 4.5*, “Depressurizing System.”
2. Once the system is depressurized, tighten the leaky fittings. Repressurize the system as described in *Section 4.5.1.*
3. Once the system is repressurized, conduct a leak test.
4. If leaks are still present, depressurize system again and repair any leaks. *Refer to* Section 4.2.6.

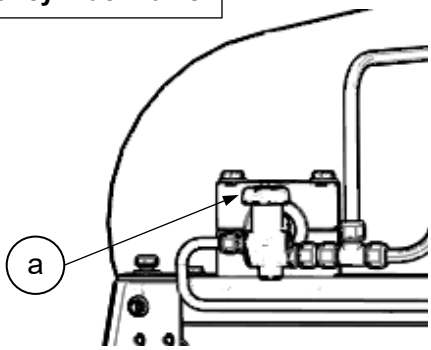
⚠WARNING

If any components are loosened or replaced, an excessive amount of fuel is being consumed, or the vehicle was involved in an accident, a pressure test using nitrogen is required before re-filling with natural gas.

4.3.5. Pressure Test Using an Inert Gas (Nitrogen):

1. Before proceeding with the nitrogen pressure test, verify the system has been depressurized. *Refer to* Section 4.5.
2. Once the system is fully plumbed or repaired, verify engine ignition is in the “OFF” position and vehicle is at least 15 feet (9 m) away from an open flame or source of ignition.
3. Verify all eight cylinder shut off valves (one on each cylinder) are in the “CLOSED/OFF” position. *Figure 24*

Manual cylinder valve



Electric solenoid cylinder valve

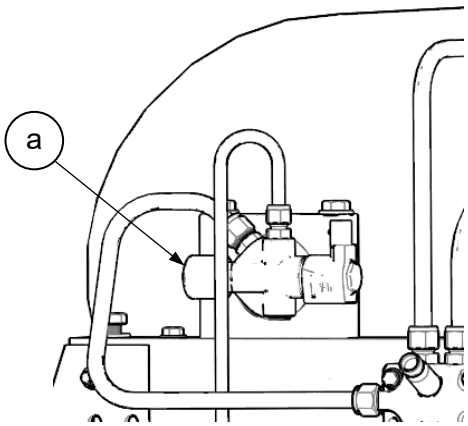


Figure 24. Manual cylinder valve and electric solenoid cylinder valve manual shutoff knobs (a).

4. Turn FMM 1/4-turn manual shutoff valve (1) clockwise to the “ON/OPEN” position. *Figure 25*

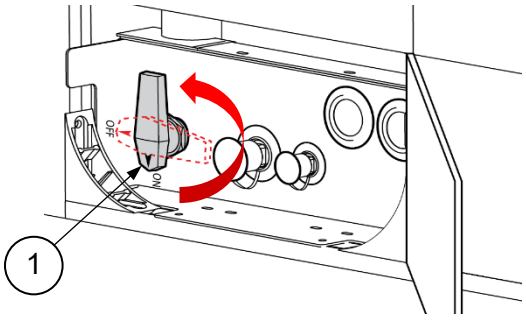


Figure 25. FMM 1/4-turn manual shutoff valve (1) operation. NOTE: Non-Smart Gauge equipped FMM shown; Smart Gauge face plate similar.

5. Connect pressure testing equipment to the system fueling receptacle using a NGV1 fueling nozzle plumbed to a nitrogen source with a flex hose rated to the system service pressure of 3600 psi (250 bar) and a pressure regulator. Slowly fill the system with nitrogen to a pressure of 100 psi (6.89 bar). While filling the system, listen for leaking. Stop if leaks are detected. *Figure 26*

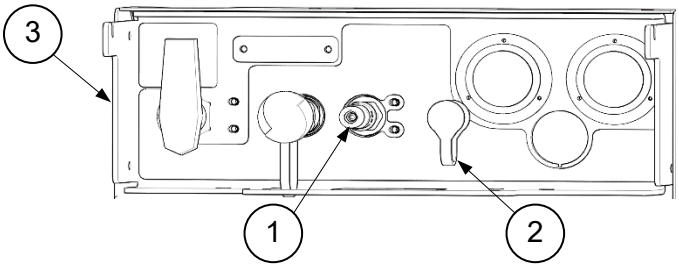


Figure 26. FMM (3), NGV1 defuel/fill receptacle (1), NGV1 defuel/fill receptacle dust cap (2). NOTE: Smart Gauge equipped FMM face plate shown; non-Smart Gauge face plate is similar.

6. Perform 100 psi (6.89 bar) leak test using leak detection solution or an equivalent alternate method.

⚠WARNING
Bleed nitrogen slowly to avoid possible injury.

7. If a leak is detected, disconnect nitrogen fill line from FMM NGV1 receptacle *(Figure 26),* and depressurize the system by venting nitrogen using the bleed valve *(Figures 15 & 23)* and repair it.
8. If no leak is detected, slowly increase the pressure to 1500 psi (103.4 bar). Increase the pressure at no more than 500 psi (34.4 bar) per minute until a system pressure of 1500 psi (103.4 bar) is reached.
9. Perform 1500 psi (103.4 bar) leak test using leak detection solution or an equivalent alternate method.
10. If a leak is detected, disconnect the nitrogen fill line, depressurize the system, and fix the leak.
11. If no leak is detected, continue to slowly increase the pressure to 3600 psi (250 bar). Increase the pressure at no more than 500 psi (34.4 bar) per minute.
12. Once the system is pressurized to 3600 psi (250 bar), perform another leak test.
13. If a leak is detected, disconnect the nitrogen fill line from FMM NGV1 receptacle *(Figure 26)*, depressurize the system and fix the leak. *Refer to* Section 4.4.
14. After all the nitrogen leak tests have been performed, the pressure shall remain constant at 3600 psi (250 bar) for 10 minutes with no signs of a pressure drop.

⚠WARNING
If system pressure drops locate and fix any leaks.

⚠CAUTION
DO NOT TURN THE ENGINE ON to activate the solenoid valve for the next part of the test. Use an external 24V power supply; do not use the vehicle onboard power supply.

15. At this point, the system has been properly pressure tested up to the solenoid valve (5). *Figure 9.*

    To test the connections downstream of the solenoid valve, apply a 24V power supply to open the valve. This allows nitrogen to flow through the rest of the system and up to the secondary solenoid shutoff valve at the engine. Perform leak test on all connections downstream of the fuel outlet.

16. If a leak is detected, disconnect nitrogen fill line, depressurize fuel system, and repair leak.
17. Once the 100 psi (6.89 bar), 1500 psi (103.4 bar) and 3600 psi (250 bar) tests have been performed and successfully passed with no leaks, vent nitrogen to the atmosphere using the bleed valve on the Manifilter. *Figure 27*

⚠WARNING
Verify all safety guidelines from Safety Section 1. are followed prior to fueling system with CNG.

4.3.6. Repairing a Leak

⚠WARNING
Verify system is depressurized before attempting to repair leak.

During the leak test or pressure test, leaks may be caused by several issues. To repair a leak found during either test, perform repairs in the order shown below.

1. Once the fittings have been reinstalled perform pressure test procedure.
2. *If the leak cannot be repaired:* replace the component.
3. *If replacement is necessary*: follow OEM procedures for replacing damaged parts and ensure correct replacement parts are requisitioned and installed.

NOTICE
If the repairs listed in Section 4.3.6. do not fix the problem, contact the Hexagon® Agility® Customer Support Center.

4.4. Starting Vehicle

Starting a natural gas vehicle requires a delay between the battery power being turned on and the starter motor being activated.

1. Verify all eight cylinder shut off valves (one on each cylinder) are “ON/OPEN” and the manual shut off valve is turned to the “ON/OPEN” position.
2. Verify that standard Gillig pre-vehicle start-up procedures are followed.
3. Start the engine.
4. If vehicle is starting from cold, let engine idle for five minutes. This allows coolant to warm the fuel and verify low-pressure lines (down-stream of the primary pressure regulator) do not freeze. On extremely cold days, allow vehicle to idle for a longer period until coolant temperature is high enough to warm fuel.

4.5. Depressurizing CNG System Tubing

⚠WARNING
The following procedure DOES NOT depressurize the CNG storage cylinders.

NOTICE
This procedure depressurizes fuel system tubing and the FMM panel ONLY and is for use with manual cylinder valve or electric solenoid cylinder valve systems.

NOTICE
This procedure does not require electrical power except to run the engine. Electrical power to the electric solenoid cylinder valve is not required to conduct this procedure.

1. *If equipped:* Turn all eight manual cylinder shut off valves (one on each cylinder) clockwise to the “CLOSED/OFF” position.
2. Turn FMM 1/4-turn manual shutoff valve (5) counterclockwise to “ON/OPEN” position. *Figure 27*
3. Start vehicle and run engine until it stops.

4. Verify vehicle is off and that the proper vehicle lock-out procedures are followed.
5. Check FMM fill panel gauges to verify all the pressure is relieved. *Figure 27*

⚠CAUTION
Some pressure will remain in the system.

6. Relieve remaining pressure by SLOWLY opening Manifilter (1) bleed valve (2) nut COUNTERCLOCKWISE. *Figure 27*

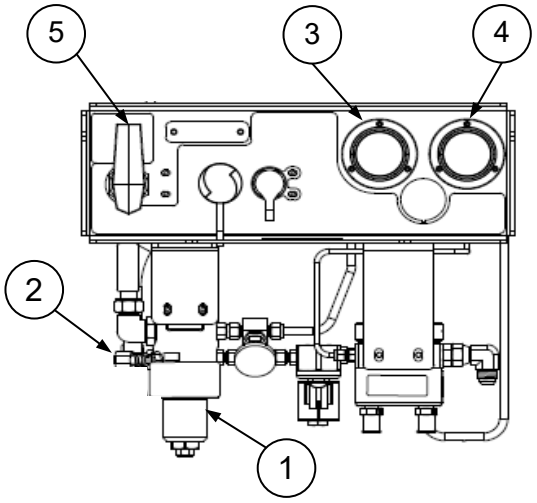


Figure 27. Bleed valve location within the FMM. Bleed valve (2), Manifilter (1).

The system is now fully depressurized up to the supply solenoid valve.

NOTICE
When loosening fittings for the first time, a small amount of gas may leak out of any fitting downstream of the supply solenoid valve; this is normal.

4.6. Re-pressurizing the System

1. Verify vehicle power is OFF.
2. Verify bleed valve on Manifilter is closed. *Figure 27*

   C **Torque bleed valve to 4 ft-lbs to 5 ft-lbs (5.42 Nm to 6.78 Nm).**
3. Verify Manifilter bowl (3) and drain plug (2) are installed and tightened. *Figure 28*
4. *If removed*: Re-install fuel fill panel cover.
5. Slowly turn cylinder shut off valves (one on each cylinder) counterclockwise to the “OPEN/ON” position.
6. Slowly turn 1/4-turn manual shut off valve (5) to the “ON/OPEN” position. *Figure 27*
7. Verify pressure test procedure was performed if any parts were loosened or replaced. *Refer to* Section 4.4.
8. Start engine.

4.7. Maintaining HP Fuel Filter (Manifilter)

Regular Manifilter high-pressure (HP) fuel filter element replacement is vital for maintaining CNG fuel system performance. Always replace the element at or before the recommended intervals.

Table 7a. Manifilter HP fuel filter element replacement intervals.*

Duty Cycle	Miles / Kilometers	Hours	Months
Normal	30000 / 48000	1000	9
Severe	15000 / 24000	1000	9

**Whichever comes first.*

NOTICE
Element replacement interval could be more frequent depending on fuel station cleanliness and fuel quality.

NOTICE
It is no longer necessary to drain the Manifilter for regular maintenance.

4.7.1. Draining the Manifilter Assembly

1. Depressurize fuel system. *Refer to* Section 4.5.
2. Slowly remove Manifilter drain plug (2) using an 11/16-in. wrench. *Figure 28*

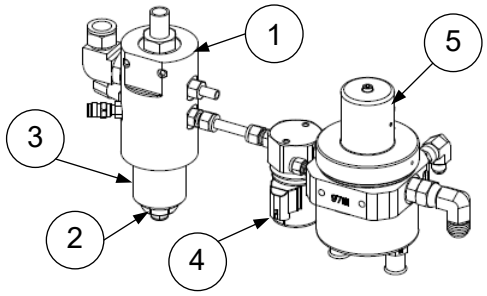


Figure 28. Manifilter assembly FMM location and drain plug. Manifilter housing (1), drain plug (2), bowl (3), solenoid valve (4), pressure regulator (5).

3. Drain Manifilter (1) until no liquid or residue remains. *Figure 28*

NOTICE

Collect any fluid and dispose of properly.

4. Inspect drain plug O-ring. *Figure 29 Obtain a replacement from Gillig if necessary.*
5. Use an 11/16-in. wrench to replace Manifilter drain plug (2). *Figure 28*

C **Torque Manifilter drain plug to 26 ft-lbs (35 Nm).**

4.7.2. Replacing the Manifilter Element

To replace the fuel filter element inside the Manifilter:

1. Depressurize the system. *Refer to* Section 4.5.
2. Drain Manifilter. *Refer to* Section 4.7.1.
3. Unscrew Manifilter bowl (7) using a filter bowl removal tool or a 1-1/4-in. wrench. *Figure 29*
4. Remove and replace old filter element (5). *Figure 29*
5. C **Apply a thin coat of lubricant (supplied with element replacement kit) to element housing O-ring (3) and filter bowl O-ring (2).** *Figure 29*
6. C **Lubricate Manifilter bowl (7) threads with silicone lubricant.** *Figure 29*

NOTICE

DO NOT allow silicone lube to contaminate filter bowl or element.

7. Reinstall Manifilter bowl (7). *Figure 29*

C *Tighten Manifilter bowl to* 50±1 ft-lbs (67.79±1.36 Nm).

Table 7b. Manifilter torque specifications.

Manifilter Torque Specifications		
Component	**ft-lbs**	**Nm**
Filter bowl	50±1	67.8±1.36
Hex head plug	25-30	33.9-40.7
Flow port fittings (IN/OUT)	25-30	33.9-40.7

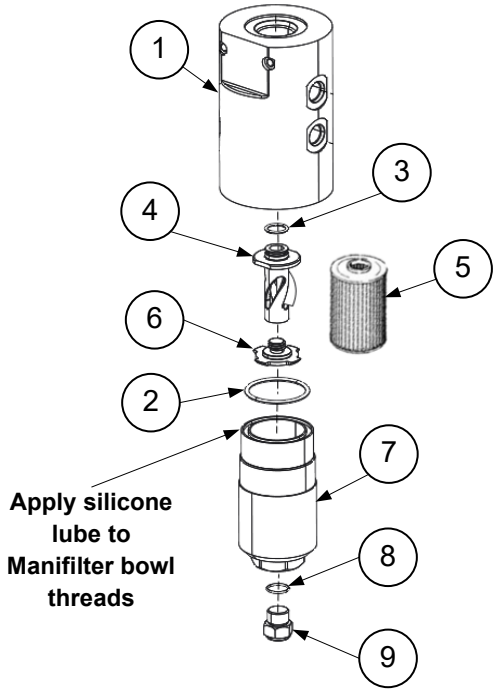


Figure 29. Manifilter components. Manifilter housing (1), bowl O-ring (2), element O-ring (3), element housing (4), HP filter element (5), housing base (6), Manifilter bowl (7), drain plug O-ring (8), drain plug (9).

4.8. Maintaining Low-Pressure Fuel Filter

4.8.1. Low-Pressure Fuel Filter Replacement and Service

The low-pressure (LP) fuel filter should be drained daily and replaced every 12 months.

NOTICE

Depending on fuel quality and characteristics, filter drainage and replacement may be required more frequently than the prescribed schedule.

4.8.2. Draining LP Fuel Filter & Replacing the LP Filter Housing

1. Depressurize the system. *Refer to* Section 4.5.
2. Once the work area has been depressurized, the LP filter housing may be drained by turning the drain cock counterclockwise or until liquid begins to flow. When the flow stops, turn drain cock clockwise until fully seated hand tight. *Figure 30*

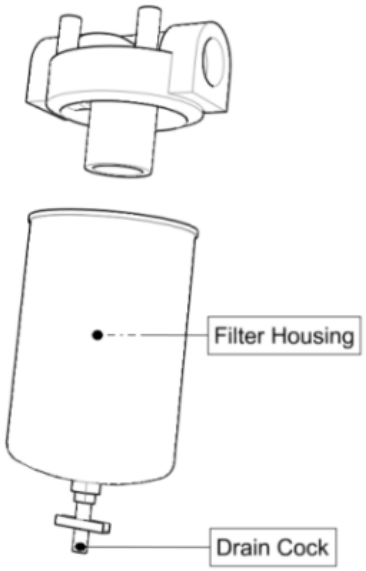


Figure 30. LP fuel filter drain cock location.

3. To replace LP filter, remove LP filter housing by turning it counterclockwise. This step may require a strap wrench or grip pad. Dispose of the filter housing per regulations. *Figure 30*
4. Install new LP filter. The filter gasket is lubricated at the factory, no additional lubrication is required. *Figure 30*
5. C Tighten new LP filter housing by hand until gasket contact is achieved, then turn the filter housing another 3/4-turn. *Figure 30*

NOTICE

Avoid cross threading.

4.9. Supply Solenoid Valve (SSV)

The supply solenoid valve (SSV) is a two-way valve activated electrically by the ignition switch. As its name suggests, the SSV controls the flow of fuel from the cylinders to the adjacent pressure regulator. By default, the SSV is in the "OFF/CLOSED" position with ignition OFF. *Figure 31*

⚠CAUTION

Supply solenoid valve coils are designed to operate continuously for a lifecycle of 22,000 hours. Coils generate significant heat and require adequate open space for dispersion. When a coil remains energized for extended periods of time the assembly will be hot. Although the coil is designed to operate under these conditions smoke or the scent of burning coil insulation may be an indication of overheating; in which case the coil may need to be replaced.

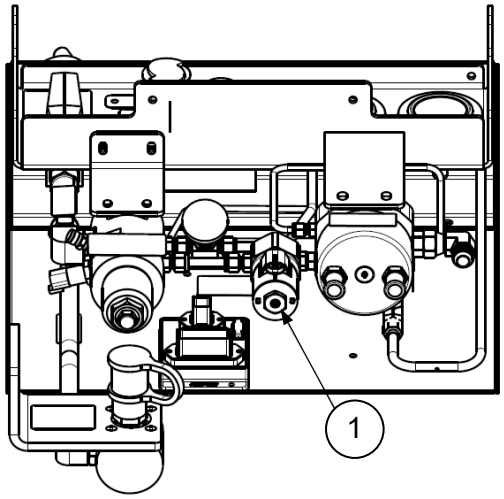


Figure 31. Supply solenoid valve (1) location in FMM.

Table 8. Supply solenoid valve (SSV) troubleshooting.

Problem	Possible Causes / Items to Check
Valve fails to operate.	Check electrical supply with a voltmeter. Voltage must match nameplate rating.
Valve fails to operate. Valve is sluggish or inoperative, but there are no issues with power supply and/or pressure	1. Check the electrical supply with a voltmeter. Voltage must match nameplate rating. 2. Check coil with an ohmmeter for an open or short condition. 3. Verify pressure complies with nameplate rating. 4. If no apparent system problem exists, remove and replace the solenoid valve.

4.10. Cylinders

⚠WARNING
CNG cylinders that have been involved in an incident that registers at level 2 or 3 should be depressurized prior to inspection.

⚠WARNING
Failure to perform regular or emergency inspections may result serious injury or death.

4.10.1. Inspecting Cylinders

The composite containers on the vehicle are manufactured to comply with FMVSS 304, NAI/IAS, or the CSA B51 Part 2 specifications.

⚠WARNING
Cylinders must be inspected by a qualified cylinder inspector every 12 months, regardless of mileage.

The inspector should provide a report for each cylinder and place an inspection label on each of the cylinders. The FMM faceplate decal must also be labeled with the next inspection interval date. Containers must also have permanent labels in accordance with applicable regulations. These labels provide valuable information to both the inspector and the manufacturer.

Cylinders must be inspected immediately if:

1. The vehicle has been in an accident.
2. The fuel container or vehicle has been subjected to fire, impact, excessive, heat, or any other means that may have caused external or internal damage.
3. Unusual behavior is observed. This may include but is not limited to, emission of natural gas odor, unexpected loss of gas pressure, snapping or hissing sounds, rattling, and any other indications of loose parts.
4. The fuel tank has been transferred to another vehicle or the tank installation has been altered significantly.
5. Question system owner/operator about incidents or conditions which may have caused damage to the fuel container. These include but are not limited to the following: dropping the container, impacts, exposure to excessive heat, fire or harsh chemicals and vehicle accidents. The owner/operator should keep records of any unusual observations as well the service history of the container and any repairs since the container was last inspected.

4.10.2. Cylinder Venting Procedure

⚠WARNING
Before depressurizing a cylinder, ground the venting orifice with a minimum 3-gauge wire to an appropriate ground source at least 8 ft (2.44 m) underground. Rapid discharge can generate enough static electricity to ignite escaping gas.

⚠WARNING
When venting a cylinder always do so in an open area with good air circulation and no sources of open flame, ignition, or heat. Do not vent the system where flammable gas is permitted to accumulate and potentially ignite. Refer to Section 5, “Defueling Preparation and Procedures.”

4.11. Valve Maintenance

Valves do not require regular maintenance.

⚠WARNING
If a malfunction should occur, check for leaks first and replace valve if necessary.

4.12. Pressure Relief Devices (PRDs)

The pressure relief devices used on this system have been designed in accordance with ANSI-CSA PRD-1 and meet or exceed the requirements for fuel container pressure relief devices onboard natural gas vehicles. *Figures 32 and 33*

4.12.1. PRD Visual Inspection

PRDs must not have any aesthetic or structural deficiencies. Remove any visible contaminants, debris, and moisture from the outlet port of the PRD. *Figures 32 and 33*

PRDs do not have consumable parts and require no additional maintenance other than visual inspection. PRDs that do not pass visual inspection must be replaced. *Figures 32 and 33*

4.12.2. PRD Vent Line Visual Inspection

PRD vent lines have a drainage hole in the lowest point on the tube. All PRD vent lines should be checked for blockage during component inspections

to prevent water build-up that can corrode the components.

If any PRD vent caps are missing, the vent tube should be inspected immediately and new caps installed. PRD vent tubes are not under pressure making it safe to service the cap.

⚠WARNING

Verify lines to be loosened or removed are vent lines and NOT fuel or PRD supply lines. Loosening or removing a fuel line can result in serious injury because it contains high-pressure gas.

⚠WARNING

The COMPRESSED FUEL line is the tubing that is CLOSEST to the handle on the valve. If uncertain, trace the line in question. If a line connects to a 3/4-in. fuel supply line, it is a high-pressure fuel line and should not be handled unless the system is depressurized. If a line is open on one end with a cap it is a PRD vent line and is not under pressure.

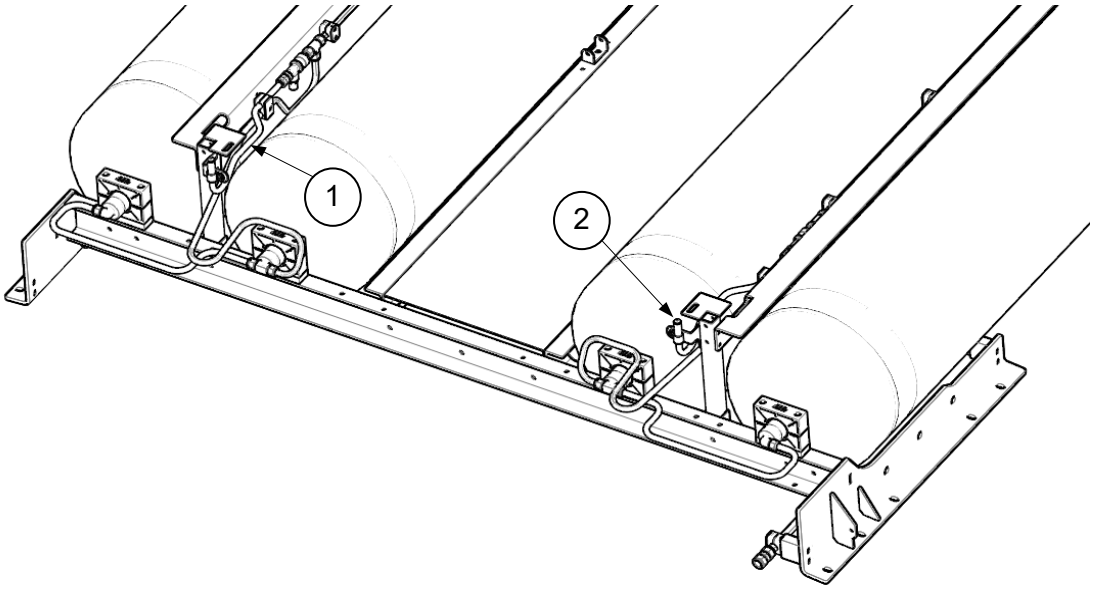


Figure 32. Eight cylinder system cylinder plug end with PRD vent lines (1) and PRD vent tube cap (2).

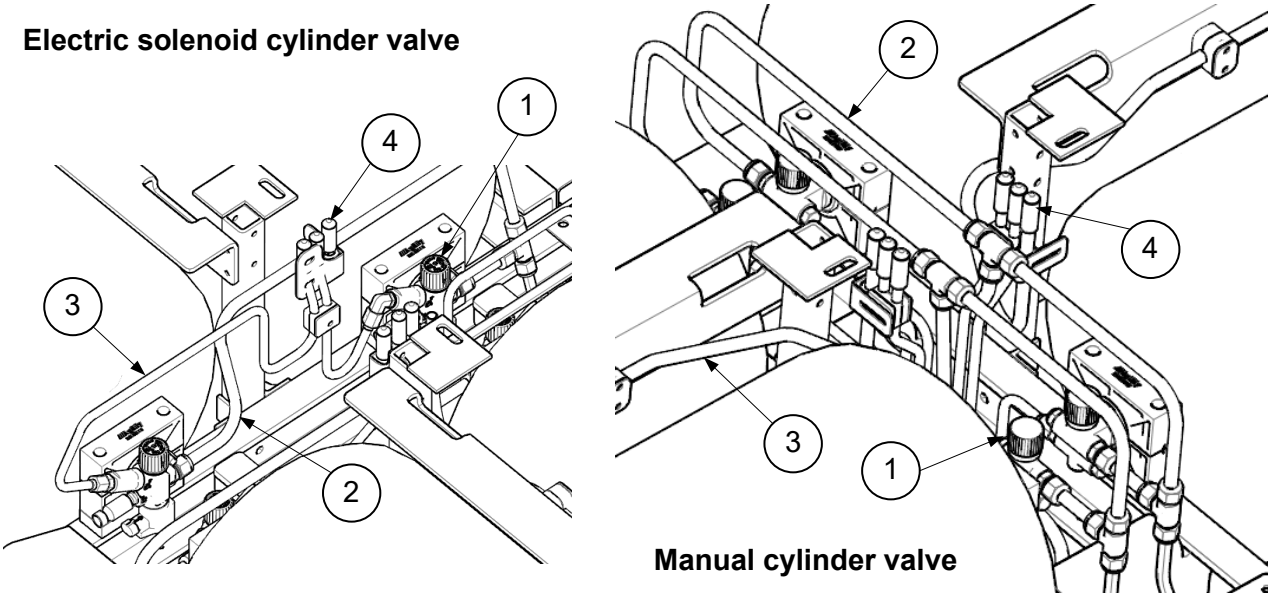


Figure 33. Eight cylinder system cylinder valve end.
Valve manual knob (1), high-pressure fuel tubes (2), PRD lines (3), PRD vent tube caps (4).

4.13. Fill and Defuel Receptacles

4.13.1. Receptacle Maintenance

NOTICE

Receptacle external surfaces must be kept clear of contaminants and debris. Dust caps (4) and (5) are provided to prevent debris intrusion and extend system life. *Figure 34*

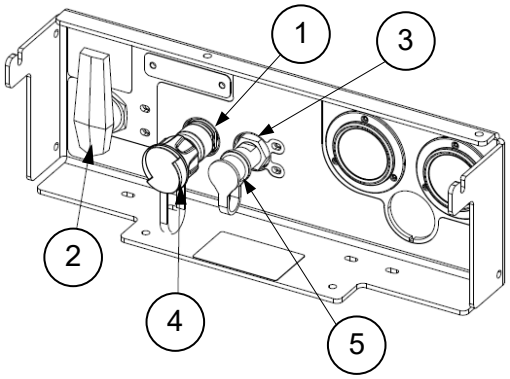


Figure 34. FMM receptacles.

Transit (fast) fill receptacle (1), 1/4-turn manual shutoff valve (2), defuel receptacle (3), fast fill receptacle dust cap (4) defuel receptacle dust cap (5). NOTE: Smart Gauge equipped FMM face plate shown; non-Smart Gauge face plate is similar.

NOTICE

External mounting hardware, receptacle O-rings (not visible), and receptacle dust caps should be checked periodically to ensure components are functioning properly without leaks. *Figure 34*

⚠WARNING

If component functionality is compromised or a leak is detected, consult a qualified technician. Only trained accredited personnel should service, maintain, remove, or install a fueling receptacle.

⚠CAUTION

The vehicle operator must not tamper, alter, disconnect, or dissemble any receptacle or component connected to a receptacle.

⚠WARNING

Installations shall be conducted in accordance with regulations stipulated by the authorities having jurisdiction (AHJ).

NOTICE

Receptacles connect to the FMM via straight threads to female SAE ports.

4.13.2. Transit (Fast) Fill Freeze-Up

NOTICE

Transit (fast) fill receptacles are prone to freezing during rapid filling procedures due to "wet" compressed natural gas conditions.

To remedy freeze-up, return FMM 1/4-turn manual shutoff valve (2) to the "OFF/CLOSED" position until external icing is no longer visible and the internal poppet assembly achieves a seal. *Figure 34*

Once sealed, the check valve will resume normal functionality and gas will cease to escape from the receptacle.

⚠WARNING

The receptacle is to be used solely on a CNG vehicle. The receptacle is designed to receive with AGA/CGA NGV1 certified fueling nozzles. For information on coupling and uncoupling procedures, please consult detailed OEM instructions provided with CNG fueling dispensers.

5. Defueling Preparation and Procedures

A CNG vehicle may need to be defueled for maintenance or storage. The best and safest way to defuel a CNG system is to transfer fuel back to a dispensing station, if so equipped.

⚠WARNING
Always follow CNG dispensing station specific procedures.

⚠WARNING
The basic defueling procedure is provided for use with CNG cylinders equipped with manual cylinder valves or with electric solenoid cylinder valves. However, CNG cylinders equipped with electric solenoid cylinder valves have additional considerations for complete system defueling; please refer to bulletin ENP-729, "Type 4 CNG Cylinder Defueling with Electric In-Tank Solenoid Valves."

⚠WARNING
Use a slow flow when transferring fuel to reduce static electricity/electrostatic discharge and to avoid freezing.

5.1. Basic Rules for Defueling

1. Only CNG qualified personnel should attempt these processes.
2. Consume as much fuel as possible prior to defueling.
3. Secure an approved place to put the fuel removed from the vehicle.
4. Notify nearby personnel prior to defueling.
5. Always ground the vehicle and the fuel system.
6. Never defuel indoors.
7. Always wear appropriate PPE.
8. Be familiar with evacuation routes.

5.2. Defueling Requirements

CNG must be removed from the vehicle at an approved facility.

There are three common defueling options: vent to atmosphere, compressor transfer, and return to supply.

⚠WARNING
In all cases, both the vehicle and the fueling system must be grounded to prevent static electricity build-up.

5.2.1. Vent to Atmosphere

First, verify whether this method is legal. Local air quality regulations may restrict the release of methane into the atmosphere

⚠CAUTION
If atmospheric venting is acceptable, a venting facility compliant to regulations must be used. *Figure 35*

5.2.2. Compressor Transfer

In this defueling method, a compressor at the fueling station extracts fuel from the vehicle.

5.2.3. Return to Supply

The third defueling method returns fuel to a distribution system.

⚠CAUTION
When using this process, pressure in the vehicle tank and the supply system pressure will equalize leaving pressure in the vehicle fuel system.

5.3. A Typical Venting Facility

The following information is provided in the absence of formalized procedures from local authorities and governing bodies. *Figure 35* represents a typical venting facility.

⚠WARNING
Venting CNG to atmosphere to requires care. Improper equipment or procedures raise the risk of fire.

⚠WARNING
Before depressurizing, ground venting orifice to an approved electrical ground system.

⚠WARNING
Always vent CNG in an open area with air circulation and no nearby sources of open flame, ignition, or heat.

⚠WARNING
Do not vent the system in an area where flammable gas is permitted to accumulate and potentially ignite.

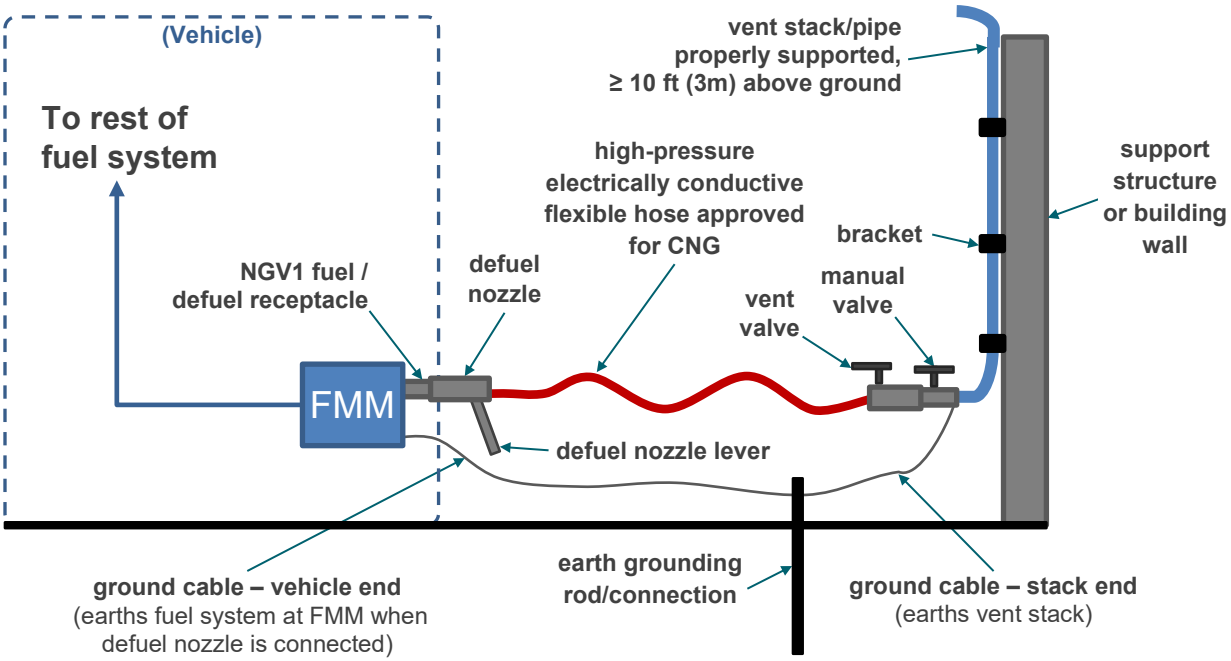


Figure 35. Required defueling connections and typical atmospheric venting facility equipment diagram.

5.3.1. Venting Facility Minimum Equipment

- **Vent pipe** consisting of a 2-in (51 mm) diameter steel pipe attached to a support structure. The pipe must extend a minimum of 2 ft (0.6 m) higher than the support structure and a least 10 ft (3 m) above ground level. The vent pipe must be connected to an electrical ground extending at least 8 ft (2.44 m) underground.

  ⚠WARNING
  Verify no ignition sources are closer than 15 ft (9 m) to the pipe.

- **Electrical ground connection** with a minimum 3 gauge or heavier stranded copper wire attached at one end to a ground rod, or other equally suitable electrical ground. The other ends of the ground wire should be securely clipped to both the venting pipe and the vehicle FMM.
- **High-pressure electrically conductive flexible hose approved for CNG**.
- **Manual valve** to control gas flow.

Additional Recommended Equipment

- **Portable fire extinguisher** in an easily accessible location at the defueling facility. The extinguisher should have a rating no less than 20-B:C.
- **Large signage** indicating “NO SMOKING” and “FLAMMABLE GAS.”
- **Flame arrestor** downstream of the manual valve.

5.4. Defueling Procedure

NOTICE

This procedure applies to vehicles equipped with a NGV1-style defuel receptacle.

⚠WARNING

Only certified CNG technicians may perform fuel system defueling.

5.4.1. Confirm All Cylinder Valves are Open

⚠WARNING

Set parking brake and use wheel chocks to block vehicle tires.

At each CNG cylinder to be defueled, verify the cylinder manual valve is fully open by turning the valve knob counterclockwise. *Figures 24, 32, 33a, and 33b*

⚠WARNING

Only cylinders with open cylinder valves will be defueled. When cylinder valves are closed, cylinders are not defueled and remain under full pressure.

5.4.2. Defuel Nozzle Operation

Hexagon® Agility® p/n 20110011 is a complete fuel transfer hose assembly used for Gillig defueling. *Figure 36*

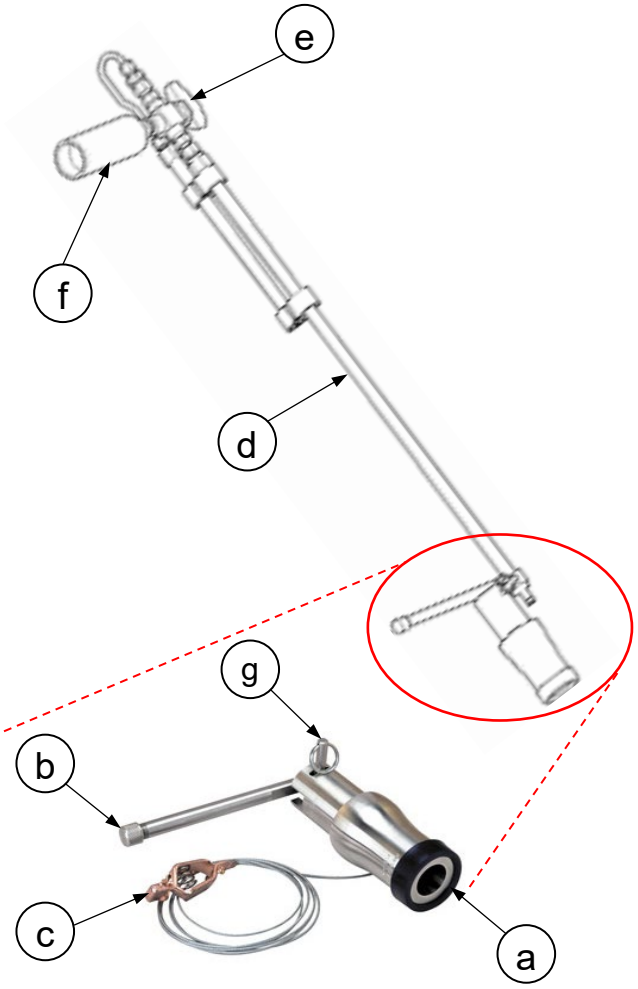


Figure 36. Fuel transfer hose assembly, p/n 20110011:

BDN defuel nozzle (a), lever (b), ground wire with clip (c), approved electrically conductive CNG hose (d), vent valve (e), fuel dispenser/vent stack nozzle (f), cotter pin (g).

⚠WARNING

Confirm BDN defuel nozzle is compatible with FMM defuel receptacle.

The FMM defuel receptacle (2) is equipped with a check valve which must be safely bypassed to perform the defuel process. *Figure 37*

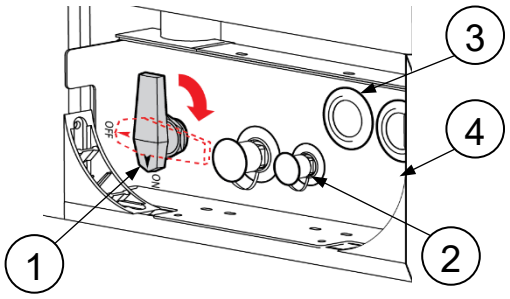


Figure 37. FMM operation. FMM (4), 1/4-turn manual shutoff valve (1), defuel receptacle (2), HP gauge (3). NOTE: Non-Smart Gauge equipped FMM shown; Smart Gauge face plate similar.

The BDN defuel nozzle lever (b) contains six brass inserts *(not shown),* one of which is placed inside the FMM defuel receptacle to depress the check valve. *Figure 36*

⚠WARNING Verify engine is OFF.

⚠WARNING
Set parking brake and use wheel chocks to block vehicle tires.

1. Connect BDN defuel nozzle ground wire clip (c) to vehicle ground. *Figures 36 and 38*

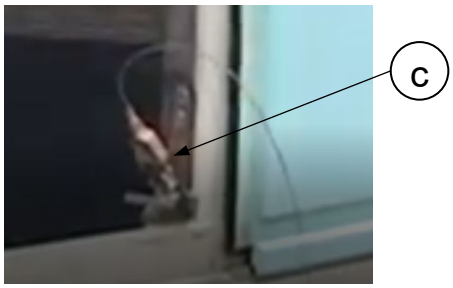


Figure 38. Ground wire clip (c) must be connected to ground on the vehicle

2. Verify other ground wire end is connected to known ground of fuel dispenser or to vent stack system. *Figure 35*
3. Attach defuel hose nozzle (f) *(Figure 36)* to fuel dispenser or vent stack defuel receptacle *(Figure 35).*
4. Turn FMM 1/4-turn manual shutoff valve (1) to the OFF/CLOSED position. *Figure 37*

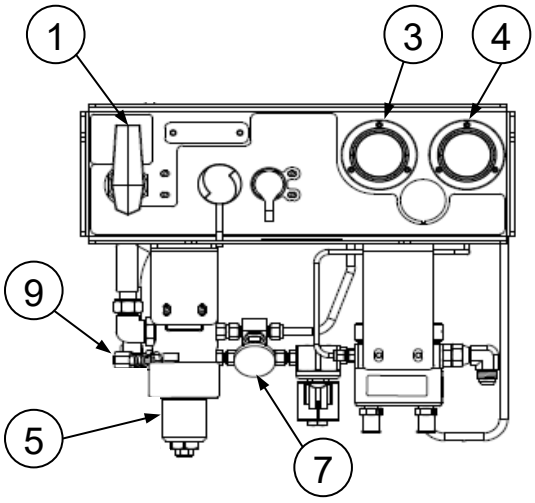


Figure 39. FMM defueling valves and gauges. 1/4-turn manual shutoff valve (1), HP gauge (3), LP gauge (4), Manifilter (5), defuel valve (7) bleed valve (9).

5. Open FMM defuel valve (7) by turning counterclockwise. *Figure 40*

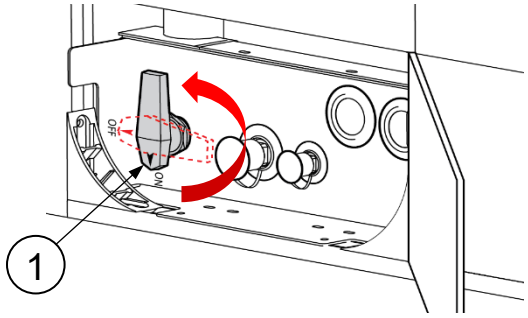


Figure 40. FMM 1/4-turn manual shutoff valve (1) in OPEN/ON position. NOTE: Non-Smart Gauge equipped FMM shown; Smart Gauge face plate similar.

6. Slowly open Manifilter bleed valve (9) to bleed any remaining pressure in the fuel manifold and defuel lines. *Figure 39*
7. Close bleed valve (9) and close defuel valve (7). *Figure 39*
8. Remove dust cap from defuel receptacle (2). *Figure 41*

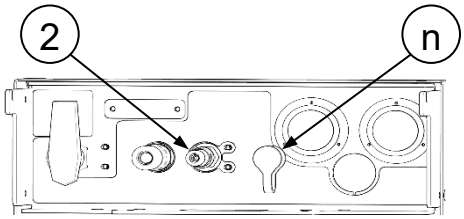


Figure 41. Defuel receptacle (2), dust cap (n).

9. Clear any debris or other obstructions from inside defuel receptacle (2). *Figure 41*

10. Use a pick or a small screwdriver to remove O-ring *(not visible)* from defuel receptacle (2). *Figure 42*



Figure 42. Use a pick (not shown) or small screwdriver (k) to remove defuel receptacle (2) O-ring (not visible).

11. Remove one brass insert (i) from inside BDN nozzle (a) lever (b). *Figures 36 and 43*

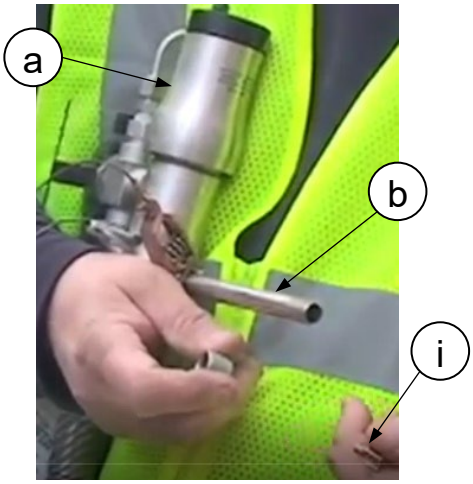


Figure 43. Brass insert (i) is located inside BDN nozzle (a) lever (b).

12. Install brass insert (j) in defuel receptacle (2). *Figure 44*

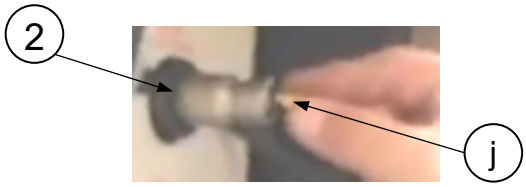


Figure 44. Brass insert (j), defuel receptacle (2).

c

Inspect defuel receptacle O-ring removed at Step 10 for damage. *Obtain replacement from Gillig as necessary.*

14. Reinstall O-ring (o) inside defuel receptacle (2). Use a pick or screwdriver to install if necessary. *Figure 45*



Figure 45. O-ring (o), defuel receptacle (2).

c

Verify O-ring (o) is properly seated in defuel receptacle O-ring groove.

15. Verify BDN nozzle (a) valve handle (h) is in the VENT position (p). *Figure 46*

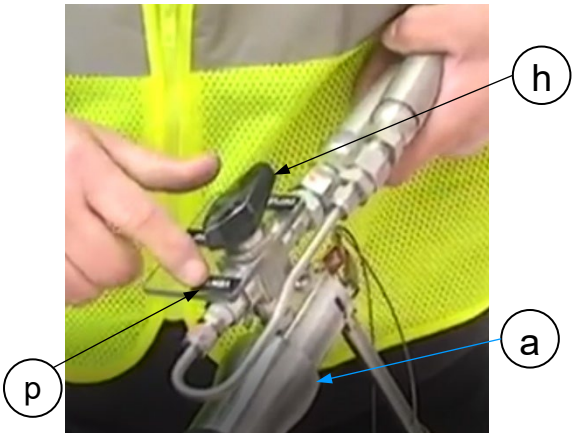


Figure 46. Before attaching BDN nozzle (a) to defuel receptacle, verify valve handle (h) is turned to VENT (p).

16. Retract BDN nozzle (a) lever (b) by pulling cotter pin (g). *Figure 47*

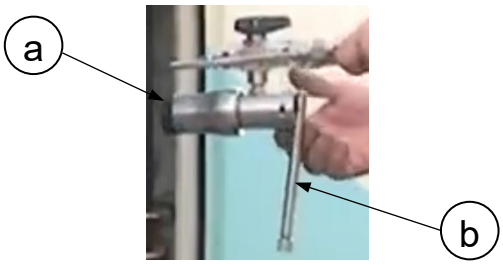


Figure 47. Pull on BDN nozzle (a) cotter pin (not visible) to retract lever (b).

17. Pull BDN nozzle (a) receiver (s) back. *Figure 48*

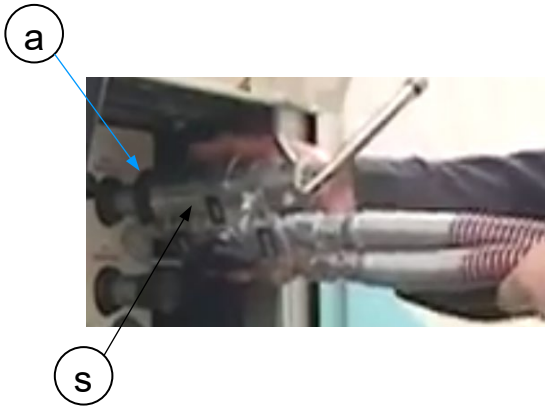


Figure 48. BDN nozzle (a), receiver (s).

18. Gently slide BDN defuel nozzle (a) on FMM defuel receptacle (2). *Figure 49.*

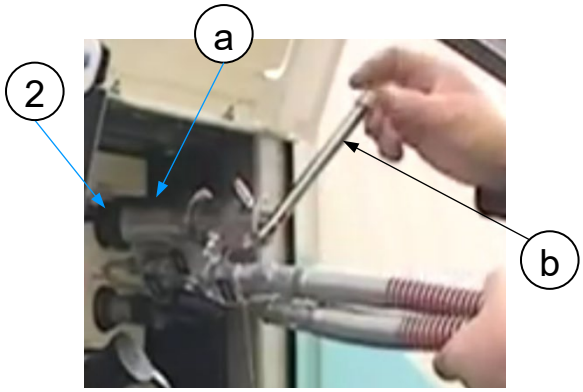


Figure 49. BDN nozzle (a), lever (b), FMM defuel receptacle (2).

19. Carefully depress BDN nozzle (a) lever (b) until it clicks. *Figure 49*
20. Gently pull on BDN nozzle (a) to confirm positive engagement. *Figure 50*

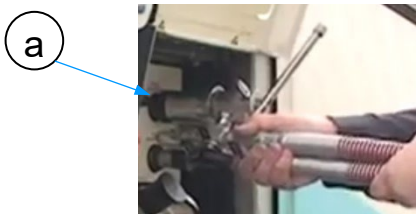


Figure 50. Pull on BDN nozzle (a) gently.

21. Turn FMM 1/4-turn manual shutoff valve (1) to the ON/OPEN position. *Figure 38*
22. Turn defuel BDN nozzle (a) valve handle (h) to DEFUEL position (m) . *Figure 51*



Figure 51. Turn BDN nozzle (a) valve handle (h) to DEFUEL position (m).

23. Slowly open fuel dispenser / vent stack system valve manual handle. *Figures 35 and 52*

Adjust fuel dispenser / vent stack system manual valve for a slow, steady fuel flow to minimize possibility of fuel system icing.



Figure 52. Always open defuel valve manual handle (q) slowly.
NOTE: Fuel dispenser defuel valve shown.

24. Monitor FMM HP gauge (3) to determine fuel pressure remaining in the fuel system. *Figure 39*
25. When FMM HP gauge (3) reads zero psi/bar (Figure 3), slowly open Manifilter bleed valve (9) in the FMM to bleed any remaining pressure in the fuel system. Close bleed valve (9). *Figure 39*
26. Close FMM defuel valve (7) by turning clockwise. *Figure 40*
27. Remove BDN defuel nozzle from defuel receptacle. *Figure 50*
28. Remove BDN nozzle static ground clamp from vehicle. *Figure 38*
29. Turn FMM 1/4-turn manual shutoff valve (1) to the CLOSED/OFF position. *Figure 37*
30. Use a pick or small screwdriver to remove the O-ring *(not shown)* from inside the defuel receptacle. *Figure 42*

31. Gently remove one brass insert *(not shown)* from defuel receptacle and replace brass insert in the BDN check valve lever. *Figure 44*

C

32. **Inspect defuel receptacle O-ring for damage.** *Obtain replacement from Gillig as necessary.*
33. Reinstall defuel receptacle O-ring using a pick or small screwdriver. *Figure 42*

    C

    Verify O-ring is seated properly in defuel receptacle groove.
34. Reinstall dust cap on defuel receptacle (2). *Figure 41*
35. Defueling is completed; turn FMM 1/4-turn manual shutoff valve (1) to the OPEN/ON position. *Figure 40*

5.5. Removing CNG Cylinders from Service

⚠WARNING

All traces of flammable vapor must be removed from cylinders before disposal to prevent the possibility of an explosion.

CNG cylinders have a pre-determined service life; this date is printed on the “Do Not Use After” label on each cylinder. Contact Hexagon® Agility® for proper disposal procedures.

6. Troubleshooting

The following section covers a variety of potential problems and their respective solutions. The issues addressed in this section are unique to CNG storage systems; however, issues concerning other onboard systems may influence or directly cause problems with the CNG storage system.

Table 9. Troubleshooting problems.

ITEM #	PROBLEM
1	After disconnecting the nozzle fuel continues to flow out of the fill receptacle
2	The main shut-off valve does not isolate the fuel (the vehicle continues to run even when the valves have been turned to the "off" position)
3	There is too much pressure coming out of the regulator (should be 125 PSI)
4	There is not enough pressure coming out of the regulator (should be 125 PSI)

Table 10. Trouble solutions.

ITEM #	CAUSE	SOLUTION
1	O-rings frozen due to gas expansion	wait for receptacles to warm up to ambient temperature and see if leak persists
	Debris in fill receptacle	1. Follow fill manifold depressurization procedures 2. Carefully remove receptacle from the manifold 3. inspect receptacle for blockage or damage 4. Reinstall or replace receptacle as necessary 5. Test and check for leaks as previously described
	Built-in check valve damaged	1. Follow steps 1-3 as listed above 2. Visual inspect the check valve for damage 3. Reinstall or replace check valve as necessary 4. Test and check for leaks as previously described
2	Seats in the valve are worn or debris is not allowing the valve to fully close	1. Follow depressurization procedures 2. After it is determined that there is no pressure in the system, remove the leaking fill manifold main shut-off valve 3. Replace valve seats as per manufacturer recommendations, or replace the component 4. Leak test as previously described
3	Regulator is not working properly	1. Remove and replace regulator following procedures listed for regulator maintenance
4	High pressure filter is clogged or low pressure filter is clogged	1. Perform maintenance for filter element replacement. Follow filter maintenance procedures

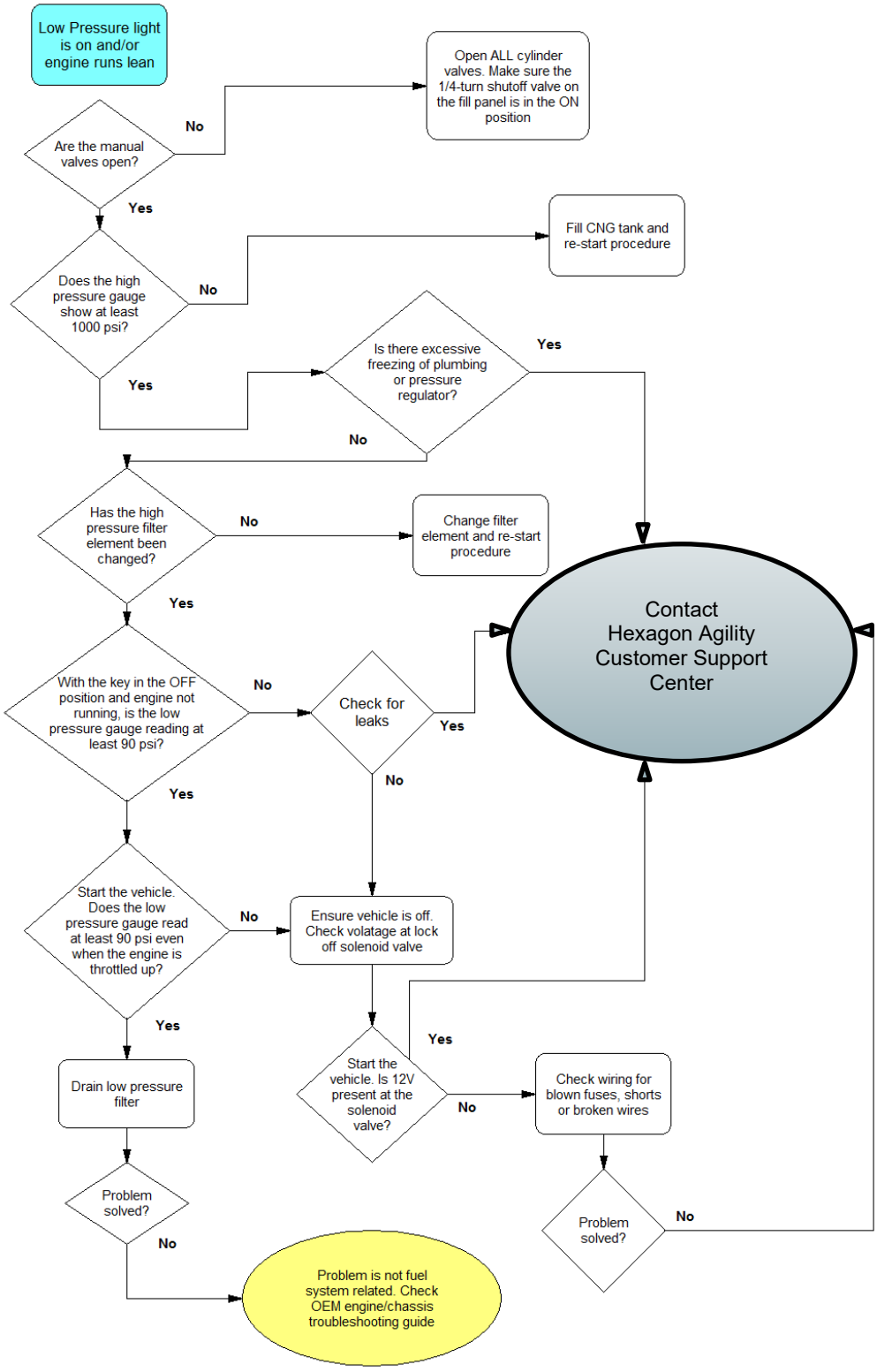


Figure 47. Low-pressure fuel light troubleshooting.

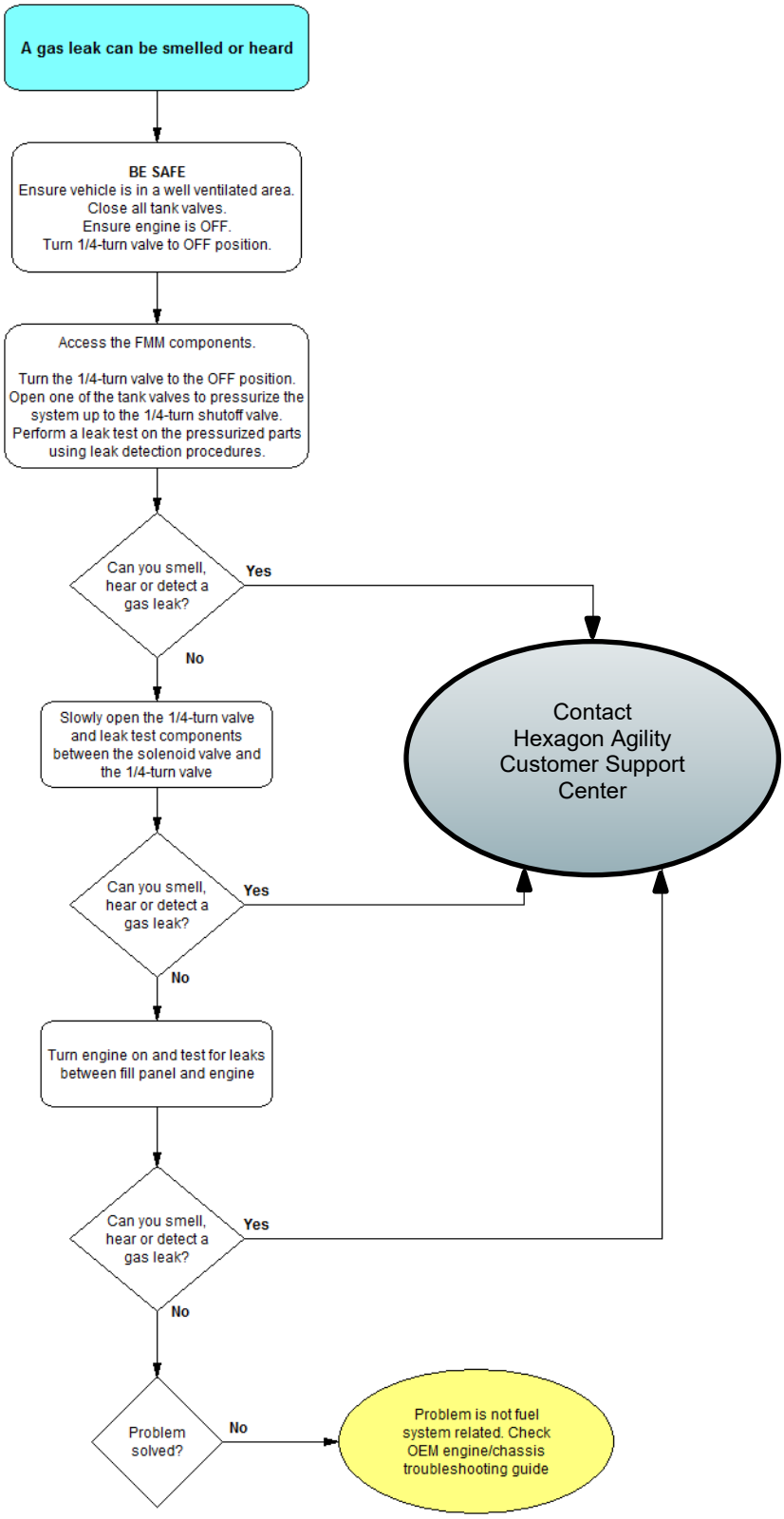


Figure 48. Gas leak troubleshooting.

7. Warranty and Contact Information

Please refer to Warranty Manual, ENP-067, for warranty reimbursement procedures.

For technical support, contact the Hexagon® Agility® Customer Support Center:

+1 833 4 HEX CARE toll free (U.S. and Canada)

support@hexagonagility.com

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