

PE14-020

11-4-2014

DATA TO ODI

NO LETTER

Request No. 9 Data Files

Agility Fuel Systems Product
Support



Product Support Group (PSG)

Contact the Agility Fuel Systems PSG Hotline for Technical Support, Field Service, Training and Aftermarket Parts.

Please have chassis number and system serial number handy when inquiring

Product Support Group

Hours: Monday through Friday

7 AM to 4 PM Pacific Time

Hotline: 949-267-7745

Service/Warranty: support @agilityfs.com

Parts Sales: parts@agilityfs.com

PE14-020

11-4-2014

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Agility Fuel Systems Routine
Maintenance



Maintenance Schedule

Leak test with methane detector or solution	Monthly
Component inspection	Monthly
Drain high pressure filter	Every 1500 miles*
Replace high pressure filter element	Every 3,000 miles*
Check vent lines	Monthly, or immediately if vent caps are missing

*High pressure filter drainage and element changes may vary depending on fuel quality and operating conditions

PE14-020

11-4-2014

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Agility Fuel Systems Training
Information



Training

CNG Fuel System Training Available Upon Request

Introduction to CNG Fuel Systems

Overview & function of cylinders, fuel management module (FMM)

Operation

Filling, daily check, startup, fuel shutoff, emergency procedures

Maintenance

Depressurization, filter change, inspection requirements, intervals

Diagnostics

Troubleshooting and repairing components

Warranty Claim Procedures

**Contact Product Support for more information:
949-267-7745, support@agilityfs.com**

PE14-020

11-4-2014

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Agility Universal CNG
Operation Manual



Universal CNG System Operation Manual



ENP-007
Rev. F, November 2013

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Glossary

AGA	American Gas Association	CSA	Canadian Standards Association
AHJ	Authorities Having Jurisdiction	FMM	Fuel Management Module
ANSI	American National Standards Institute	HP	High Pressure
ASM	Assembly	LP	Low Pressure
BOM	Bill of Materials	NFPA	National Fire Protection Association
CAN	National Standards of Canada	NGV	Natural Gas Vehicle
CGA	Compressed Gas Association	OEM	Original Equipment Manufacturer
CNG	Compressed Natural Gas	PRD	Pressure Relief Device
		psi	Pounds per square inch (lb/in ²)

Proprietary Statement

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It should be noted that the version of this manual dated 11/26/2013 replaces any prior version. Any information reproduced by clients and customers of Agility should be drawn from this manual.

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 Agility fuel systems.

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.

OEM Replacement parts may be obtained by contacting Agility or approved distributors and retailers of Agility products.



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

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.

Table 1 Revision Level

	F	WY	11/26/13	Added defuel procedure
	E	WY	8/06/13	Revised title, moved Emergency Defuel Procedure to Section 1.6, corrected valve designations in Sect. 2, general edits
	D	AD	3/25/13	Added cylinder information
	C	AD	3/07/13	Added defuel procedure
	B	AD	2/06/13	Added safety information
	A	AD	7/05/12	Updated imagery
ECN #	REV	BY	DATE	DESCRIPTION

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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 followed when operating and servicing equipment provided by Agility Fuel Systems.

1.1 Certified Personnel

CNG systems should be maintained and inspected exclusively by trained personnel with certifications in accordance with the applicable codes. As with all pressure vessels, CNG storage and fuel delivery systems are inherently dangerous and should be treated as such. Individuals involved in any aspect of CNG fuel system maintenance, emergency response, servicing, or testing must be properly trained and certified. Individuals who are not trained and certified in all aspects concerning CNG fuel delivery systems are not permitted to service, maintain, test, or inspect a system in any way.

1.2 Safety Equipment

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. Be sure that 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 in close proximity to a CNG system.
6. When locating the source of a leak only use certified leak detecting solutions and

equipment such as Swagelok Snoop®. 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.

1.3 General Safety Precautions

1. Follow all maintenance procedures in order; do not skip steps unless there is explicit permission to do so.
2. Never use an open flame as a source of illumination in proximity to a CNG system.
3. Any process or procedure that generates sparks, flames, or heated particles should not be practiced 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 with 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.

1.4 CNG Vehicle Safety Precautions



WARNING: Strict compliance with proper safety and handling practices is essential when operating this compressed natural gas fuel system.

The following safety precautions are vehicle specific and should be considered at all times 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 the engine if a natural gas leak is detected!
3. Ensure that 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 3000 psi for public vehicles in Canada.
6. For all other vehicles the system pressure must not exceed 3600 psi (i.e. Private captive fleets).
7. Do not smoke or produce an open flame within 30 feet of a CNG vehicle or a CNG dispensing/filling station.
8. Always ground a vehicle prior to defueling.
9. If a CNG vehicle has been out of service for an extended period of time, turn tank valves to the "OFF/CLOSED" position and run the engine until it stalls. This will burn the residual fuel in the closed off lines.



CAUTION: this procedure is not the same as depressurizing the system. For depressurizing see Section 3.4.

1.5 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

1.6 First Responder Guide

1.6.1 Identifying a Natural Gas Vehicle

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 Diamond



Figure 2 LNG 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 pressure. For storage purposes natural gas must be either compressed to 3600 psi (CNG) or cooled to a liquid state at -260°F (LNG). Agility Fuel Systems

minimizes these potential hazards through state of the art design and testing practices.

1.6.2 General Information

The storage tanks for CNG fuel are housed in steel or aluminum frames that are bolted to the truck body or chassis. 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 the fuel in that cylinder to be isolated from the rest of the fuel system. During regular operation all cylinder valves are open, although some operators prefer to close one cylinder and use it as a reserve tank. The fuel management module (FMM) is equipped with a 1/4-turn shutoff valve which isolates the fuel storage system from the engine for emergency situations. It is not to be used to introduce high pressure gas to downstream components that have been previously depressurized.

1.6.3 Emergency Response for Gas Leaks



Warning: CNG storage pressure can be up 4250 psi. DO NOT cut fuel supply plumbing.

If the vehicle has sustained damage or a gas leak is detected:

1. Do not approach the vehicle if any sources of ignition are present, including but not limited to: fire, sparks, electrostatic charges, lights, electronic devices. Do not smoke or allow anyone else to smoke in the vicinity of the vehicle. Avoid using road flares.
2. Turn the ignition switch off, set the parking brake, and turn off the battery at the main disconnect.
3. If it is safe to do so, close the main shutoff valve and the cylinder valves. Check the fuel system near the

damaged area for leaks, by smell, sight, and sound. CNG is odorized.

4. Make sure that traffic and pedestrians steer well clear.
5. Keep the vehicle doors open for air circulation.
6. If the vehicle is indoors, open windows and doors to allow ventilation. Avoid turning on any lights or electronics which may spark. Pay special attention to overhead sources of ignition; natural gas is lighter than air.
7. Beware that gas may continue to leak once ignition is turned off and the manual shutoff valves are closed.
8. Check the fuel system again for leaks.

1.6.4 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. Evacuate the area.
2. Get passengers out of the vehicle as quickly as possible.
3. Extinguish the fire using an appropriately rated fire extinguisher. Note a CNG fire is similar to a gasoline fire. However if the fire is not extinguished quickly the CNG cylinder pressure relief devices (PRDs) may activate to relieve excess pressure from the cylinders. PRDs typically activate between 212-220°F and will cause CNG to exit rapidly from the storage tanks. Escaping CNG may ignite and add to the fire. DO NOT attempt to extinguish a natural gas fire with water, this will cause the gas to vaporize. Use dry powder or Purple-K-Powder.

1.6.5 Emergency Shut Down Procedure

To completely shut down a CNG storage system observe the following steps:

1. Turn the ignition switch to “OFF” and set the parking brake to the engaged position.
2. Turn off the battery disconnect switch.
3. Shut off fuel at 1/4-turn valve.
4. Inform emergency personnel.

1.6.6 Emergency Venting/Defuel Procedure

If an emergency arises in which the fuel must be purged immediately without following proper procedure, an emergency vent can be performed as follows:

1. Ensure that an electrical ground connection has been established between the cylinders, the vent system, and earth ground.
2. Connect the on-board defueling connection to the vent system using a high pressure flexible hose; consult the vehicle manufacturer for information.

3. Slowly open the hand valve to release the gas. Adjust the hand valve to achieve a steady flow of gas out the vent pipe. Allow the transfer of fuel at a slow pace to prevent freezing. No gas flow may indicate a normally closed solenoid valve on the cylinder. Consult the vehicle manufacturer for information to open electronic solenoids.
4. Allow the on-board storage system to vent completely.
5. When completed disconnect all connections.

Return to Service

If the vehicle has been subjected to a fire or collision exceeding 5 mph, the fuel storage system must be inspected by a certified inspector before it can be returned to service.

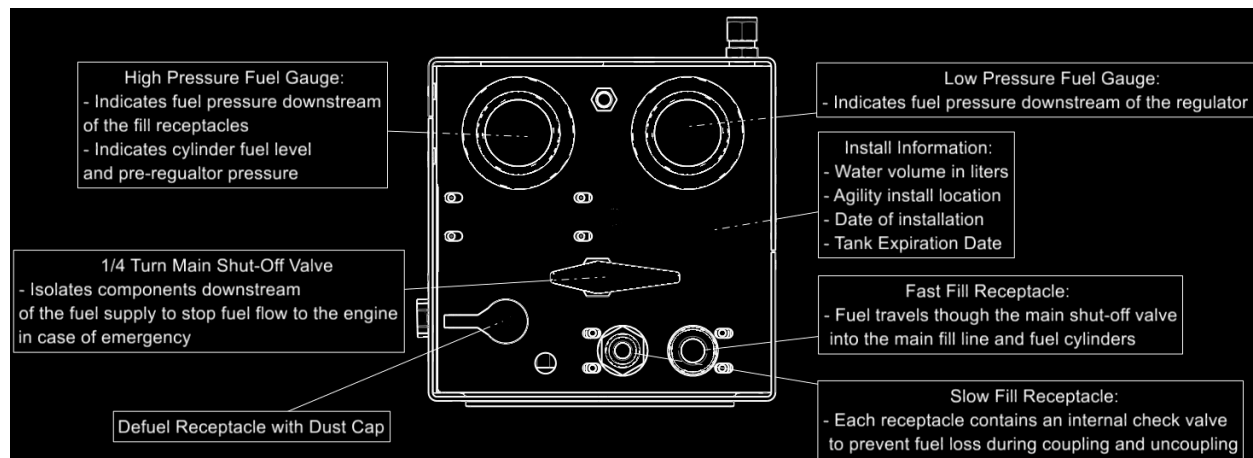


Figure 3 FMM Details

2. Fuel System Components and Specifications

This section illustrates component specifications. All figures and illustrations are intended for reference only and do not necessarily reflect the exact configuration for any given system. In principle the plumbing and fuel management module layouts are consistent across platforms; however there may be some variance depending on the options and configuration requirements. Please contact Agility for the latest version of this document.

2.1 Fuel Specifications

Fuel quality is crucial to maintaining engine performance characteristics, life expectancy, and emission standards. CNG fuel must meet or exceed the minimum requirements. The Table below references the minimum fuel quality standards as determined by the Cummins Engine Company®, SAE J1616 “Natural Gas Recommended Practice”.



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

Table 2 Fuel Specifications

Property	Limit	Test Method
Hydrocarbon		
Methane	90% min.	ASTM 1945-81
Ethane	4% max.	ASTM 1945-81
Propane	1.7% max.	ASTM 1945-81
Other		
C4 and Higher	0.7% max.	ASTM 1945-81
C6 and Higher	0.2% max.	ASTM 1945-81
Other Gaseous Species		
Hydrogen	0.1% max.	ASTM 2650-88
Carbon Dioxide + Nitrogen	3% max.	ASTM 1945-81
Carbon Monoxide	0.1% max.	ASTM 2650-88
Oxygen	0.5% max.	ASTM 1945-81
Other Species		
Sulfur	10 ppm max.	Title 17 CCR Sect. 94112 Meth. 16
Performance Related Properties		
Wobbe Index	1300-1377	Calculated

2.2 Superstructures

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. Figures 4 through 7 illustrate the array of available configurations depending on the desired application.

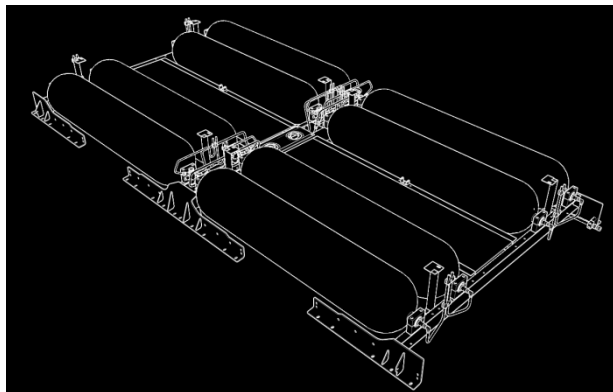


Figure 4 Roof Mount Configuration

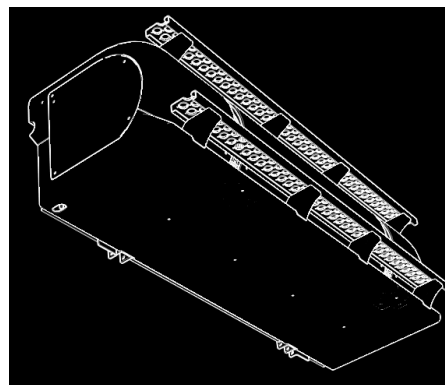


Figure 6 Side Mount Configuration

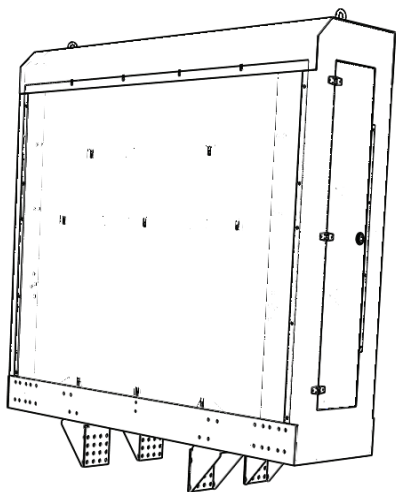


Figure 5 Behind the Cab Configuration

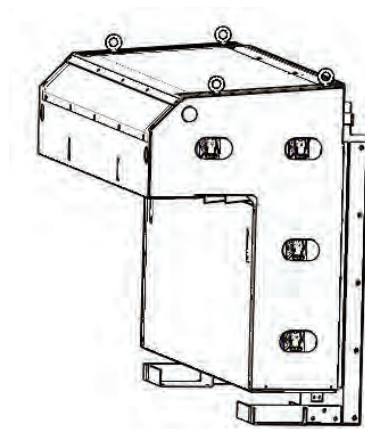


Figure 7 Front of Body Configuration

2.3 Fuel Management Module (FMM)

The fill panel control interface illustrated in Figure 8 is accessible by opening the fill panel access door at the rear passenger side of the vehicle.

Table 3 FMM Faceplate BOM

FMM Faceplate	
1	Emergency Shut-off Valve
2	Transit (Fast) Fill Receptacle
3	NGV1 Fill Receptacle
4	Defuel Receptacle
5	High Pressure Gauge
6	Low Pressure Gauge

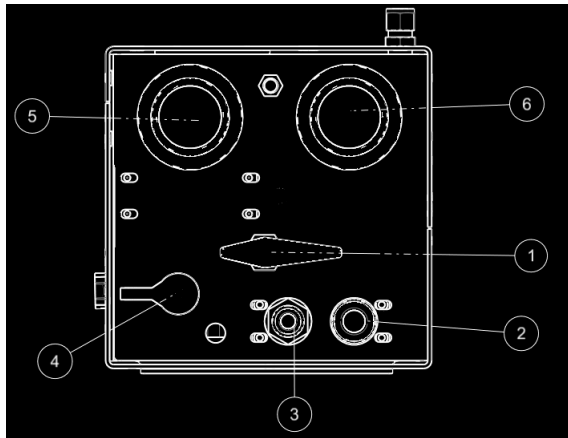


Figure 8 FMM Faceplate

Figure 9 illustrates key plumbing components and connections inside the fill panel.

Table 4 FMM Components BOM

FMM Components	
1	High Pressure Connection to Cylinders
2	High Pressure Filter
3	Solenoid Valve
4	Pressure Regulator
5	Coolant Ports
6	Low Pressure Fuel Line
7	Defueling Valve
8	Manifold

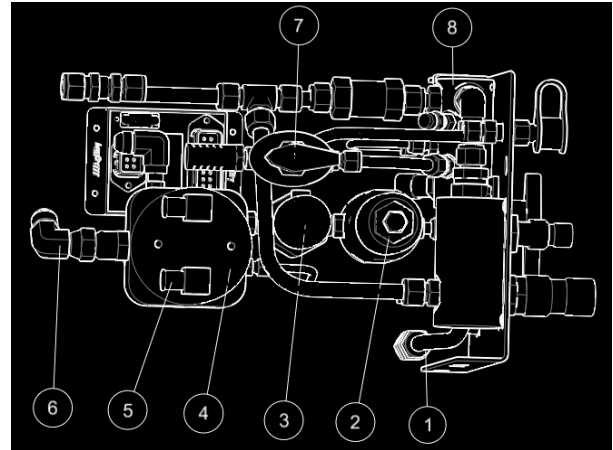


Figure 9 FMM Components (Bottom View)

2.4 Gauges

FMMs typically have two gauges, a high pressure gauge measuring the pressure in the tanks and a low pressure gauge downstream of the regulator.



Figure 10 High Pressure Gauge

The high pressure gauge reads 0 to 5000 psi. When tanks are filled to capacity, maximum allowable pressure is typically 3600 psi. However this number may vary based on federal and local regulations. Some jurisdictions stipulate that maximum pressure may not exceed 3000 psi. Some jurisdictions allow for over-filling of the tanks to 1.25 times service pressure (4500 psi) so that when the gas cools

to ambient temperature the pressure will be at the maximum allowable limit of 3600 psi.



Figure 11 Low Pressure Gauge

The low pressure gauge is located downstream of the pressure regulator. The output of the regulator is calibrated to 125 psi; during regular operation the low pressure regulator should read the same.

2.5 Filters

Agility CNG systems have two filters, one for high pressure and another for low pressure. The high pressure filter is located in the FMM and the low pressure filter is located in the engine bay.

2.5.1 High Pressure Filter

The high pressure coalescing filter can be found in the FMM, downstream of the manifold and main shutoff valve and upstream of the solenoid valve. The high pressure filter purifies the fuel by removing moisture and contaminants.

The high pressure filter element has an efficiency rating of 1 micron. It should be changed with every oil change or once every 3000 miles, whichever occurs first.

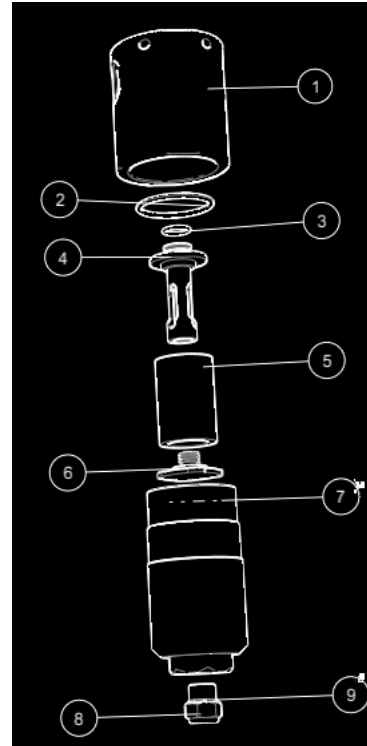


Figure 12 High Pressure Filter

Table 5 High Pressure Filter BOM

HP Filter Assembly BOM		
Item	Part Number	Description
1	20100106	Filter Housing
2	10500022	Filter Bowl O-Ring
3	10500017	O-Ring
4	20100108	Element Housing
5	20100109	Filter Element
6	20100110	Element Base
7	20100107	Filter Bowl
8	10200266	Hex Head Plug
9	10500014	Hex Head Plug O-ring

2.5.2 Low Pressure Filter

The low pressure coalescing filter can be found downstream of the main shutoff valve, high pressure filter, and regulator. The low pressure filter removes residual contaminants and oil from the fuel before it enters the engine.

The operating range of the low pressure filter is -43°F to +250°F. The filter is 99.9% efficient for 0.3 micron liquid droplet and 100% efficient for

25 micron particles. The filter is the spin-on variety with a 1-1/2-16 UN-2B thread.

The filter is sealed with a lubricated gasket. The filter functions similarly to an automotive oil filter with a drain cock at the bottom of the drain sump.

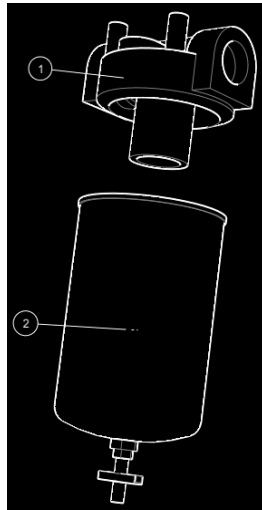


Figure 13 Low Pressure Filter

Table 6 Low Pressure Filter BOM

Low Pressure Filter Assembly		
Item	Part Number	Description
1	10300017	Filter Housing
2	10300018	Filter Element

2.6 Solenoid Valve



CAUTION: The solenoid valve generates considerable heat during operation and may cause burns on contact with unprotected skin.

2.6.1 Principles of Operation

De-energized: the valve acts directly by utilizing an armature and a pilot instead of 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: this valve operates using 24 Volts DC (22 Watts) 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.

Solenoid Valve Specs

Operating Range: -40°C to 105°C

Max Operating Pressure: 3600 psi

Resistance: 28.5±2 Ohms @ 20°C Rated 200°C

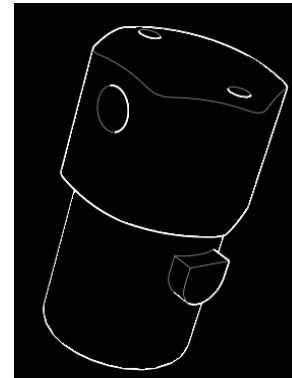


Figure 14 Solenoid Valve

2.7 Pressure Regulator

Regulator Specs

Set Point: 125 psi @ 3000 psi inlet pressure

PRD: 200 ± 40 psi Crack Pressure

Maximum Pressure: 3600 psi

Minimum Pressure: 250psi

Coolant Temperature Range: -40°F to +250°F

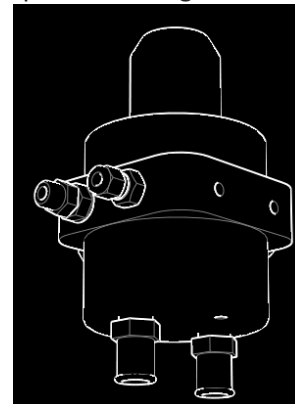


Figure 15 Pressure Regulator

2.8 Cylinders

Cylinders vary in size and volume depending on the system. All cylinders are designed, manufactured, inspected, and qualified in accordance with NGV-2 2007.

Cylinder Specs

May vary depending on application, generally cylinders are rated to 3600 psi and 20 years of useful service life.

Service Life: 20 Years

Service Pressure: 3600 psi @ 70°F

2.9 Valves

The Agility FMM uses several valve types. Depending on the system configuration, valve appearance and performance may vary.

2.9.1 Bleed Valve

The bleed valve is used to equalize pressure in the FMM to ambient pressure for maintenance and purging. It is operated by loosening the hex nut at the top.

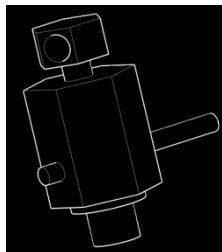


Figure 16 Bleed Valve

2.9.2 Check Valve

The check valve is a one-way valve designed to prevent backflow when fueling.

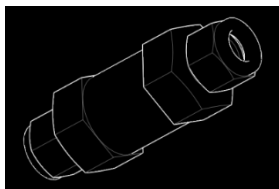


Figure 17 Check Valve

2.9.3 Defuel Valve

This valve is used in conjunction with the defueling receptacle.

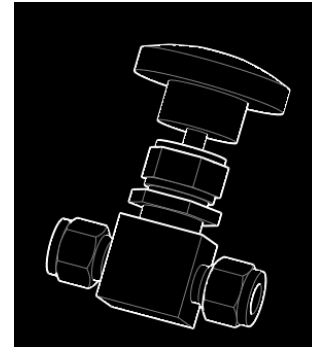


Figure 18 Defuel Valve

2.9.4 Emergency Shutoff Valve

The emergency shutoff is not to be used to repressurize downstream components.

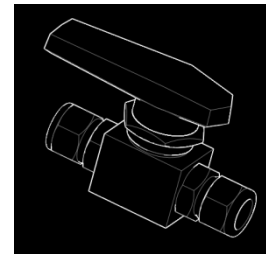


Figure 19 Emergency Shutoff Valve

2.10 Pressure Relief Devices

The pressure relief devices (PRD) are activated in the event of a fire to prevent over-pressurizing in the fuel tanks. The PRDs used on this system have been designed in accordance with PRD-1, and meet or exceed the basic requirements for fuel container pressure relief devices onboard Natural Gas Vehicles.

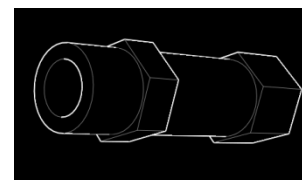


Figure 20 PRD

2.11 Fill Receptacles

Depending on the application fill receptacles may be standard NGV1 or transit fill. All have built-in check valves to prevent fuel loss during coupling and uncoupling procedures.

2.11.1 NGV1 Fill Receptacle

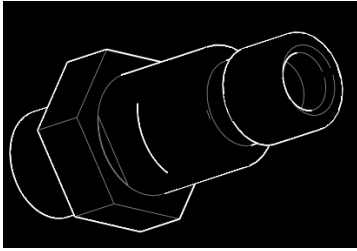


Figure 21 NGV1 Fill Receptacle
Fill Receptacle Specs

Design Pressure: 5000 psi

Flow Rate: 1500 SCFM @ 3000 psi

Temperature Range: -40°F to 250°F

2.11.2 Transit Fill Receptacle

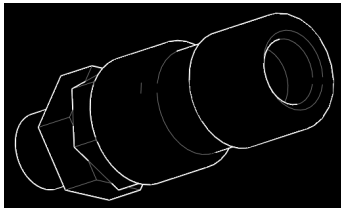


Figure 22 Fill Receptacle

Transit (Fast) Fill Receptacle Specs

Design Pressure: 5000 psi

Min. Flow Rate: 5000 SCFM @ 3000 psi

Temperature Range: -40°F to 250°F

2.12 Fittings and Connections

2.12.1 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.

2.12.2 Fittings

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

2.12.3 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 prior to utilizing Swagelok® tube fittings on a CNG system.



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

2.12.4 Fitting Safety Considerations:

1. Do **not** bleed the CNG system by loosening or "cracking" a fitting connection.
2. Do **not** disassemble new fittings prior to use.
3. Do **not** attempt to torque fittings while system is pressurized.
4. When tightening a compression nut on a fitting make sure the fitting body is held securely.

3. Operation and Maintenance

Routine maintenance of the compressed natural gas fuel system will ensure that the system and all of its components continue functioning properly.



WARNING: System components must not be under pressure during servicing to prevent serious injury or death.



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.



CAUTION: Do not expose plastic or elastomeric materials to commercial cleaning products. CNG components should be washed with a diluted soap solution and rinsed thoroughly to remove deposits.



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

3.1 Starting the Vehicle

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

1. Ensure that the system has been properly leak tested, this can be accomplished by following the Testing for Leaks procedure described in Section 4.2.3.
2. Ensure that the blue plastic caps are installed on all exposed vent lines. Vent lines are located at the rear of the fill panel

and at both ends of the cylinders. If the blue caps are missing follow the Draining Vent Lines procedure in Section 4.13.2 and contact Agility fuel Systems for replacement caps.

3. Ensure that the cylinder shutoff valves (one on each cylinder) are "OPEN" and the manual shutoff valve is turned to the "ON" position.
4. Ensure that the standard manufacturer recommended pre-vehicle start-up procedures are followed.
5. Start the engine.
6. If the vehicle is starting from cold, let the engine idle for five minutes. This will allow coolant to warm the fuel and ensure that the low-pressure lines (down-stream of the primary pressure regulator) do not freeze. On extremely cold days, allow the vehicle to idle for a longer period until the coolant temperature is high enough to warm the fuel.

Maintenance Schedule

Table 7 Maintenance Schedule

Item	Frequency
Storage System:	
Leak Test with Methane Detector	Every month
Component Inspection	Every month
Drain Filter	Every 1500 miles
Replace Filter Element	Every 3000 miles
Check Vent Lines	Every month (or immediately if blue vent cap is missing)
Cylinders	Inspect compressed gas cylinders as outlined by cylinder manufacturer

3.2 Leaks

Refer to Depressurizing (Section 3.4) and Repressurizing (Section 3.5) before performing leak repairs.

3.2.1 Tube Bottoming Requirements



CAUTION: Adjusting fittings requires accredited Swagelok® or Agility training.

In order to achieve a safe, leak free seal tubing connections must be flush and fully bottomed in the fitting. Please consider the following recommendations:

1. Tubing must be de-burred so that it sits flush in the fitting.
2. Tubing must be round; elliptical or warped tubing must not be used.
3. Tubing must have a minimum length straight section before a bend radius as specified.

3.2.2 Tightening of Fitting Nuts

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.

3.2.3 Testing for Leaks

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. All joints and connections should be tested.

Generally speaking, leaks will occur at fitting connections. When checking for leaks always use certified leak detecting equipment and solutions designed for use with stainless steel and brass such as Snoop® or FBI®.

To Find a Leak

1. Apply a certified 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.

3.2.4 Tightening Leaky Fittings

1. If a leak is detected, depressurize the system.
2. Once the system is depressurized, tighten the leaky fittings. Repressurize the system.
3. Once the system is pressurized, conduct a leak test.
4. If this does not stop the leak, depressurize the system again and then follow the leak repair procedures.

3.2.5 Testing Pressure

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.

Pressure Test Using an Inert Gas (Nitrogen)

1. Before proceeding with the nitrogen pressure test, ensure that the system has been depressurized.

2. Once the system is fully plumbed or repaired, ensure that the engine ignition is in the "OFF" position (use OEM lockout procedure), and the vehicle is at least 15 feet away from an open flame or source of ignition.
3. Ensure that the cylinder shutoff valves (one per cylinder) are in the "OFF/CLOSED" position.
4. Turn the manual shutoff valve to the "ON/OPEN" position.
5. Connect the 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 and a pressure regulator. Slowly fill the system with nitrogen to a pressure of 100 psi. While filling the system, listen for leaks. Stop if leaks are detected.
6. Perform the 100 psi leak test using leak detection solution or an equivalent alternate method.



WARNING: Be careful not to bleed the nitrogen too fast as this could cause injury.

7. If a leak is detected, disconnect the nitrogen fill line from the system fueling receptacle, depressurize the system by venting the nitrogen with the bleed valve and follow the steps in Section 3.2.6, "Repairing a Leak."
8. If no leak is detected, slowly increase the pressure to 1500 psi. Increase the pressure at no more than 500 psi per minute until a system pressure of 1500 psi is reached.
9. Perform the 1500 psi leak test using leak detection solution or an equivalent alternate method.
10. If a leak is detected, disconnect the nitrogen fill line from the system fueling receptacle, depressurize the system by using the bleed valve, and fix the leak.
11. If no leak is detected, continue to slowly increase the pressure to 3625 psi. Increase the pressure at no more than 500 psi per minute.
12. Once the system is pressurized to 3625 psi, perform the 3625 psi leak test.
13. If a leak is detected, disconnect the nitrogen fill line from the system fueling receptacle, depressurize the system by using the bleed valve, and repair the leaks.
14. After all the nitrogen leak tests have been performed, the pressure shall remain constant at 3625 psi for 10 minutes with no signs of a pressure drop. If the system pressure drops in this 10 minute time frame, observe where the leaks are occurring, depressurize the system by using the bleed valve, and repair the leaks.



CAUTION: DO NOT TURN THE ENGINE ON to activate the primary solenoid lock-off valve for the next part of the test – make sure to use an external 24 volt power supply, do not use the vehicle's onboard power supply.

15. At this point, the system has been properly pressure tested up to the primary solenoid lock-off valve (item C in Figure 24). To test the connections down-stream of the solenoid valve, apply a 24 volt power supply to open the valve. This will allow nitrogen to flow through the rest of the system and up to the secondary solenoid shutoff valve at the engine. Conduct a leak test using a leak detection solution at all connections downstream of the fuel outlet (low pressure) line, item 6 in Figure 9.
16. If a leak is detected, disconnect the nitrogen fill line from the system fueling receptacle, depressurize the system by using the bleed valve, and repair the leak.

Repeat the Testing Pressure procedure from step 15.

17. Once the 100 psi, 1500 psi and 3625 psi tests have been performed and successfully passed, the nitrogen can be vented to the atmosphere using the bleed valve.



CAUTION: Ensure that all the safety guidelines from the Safety section are followed prior to filling the system with CNG.

3.2.6 Repairing a Leak



WARNING: Ensure that the system is depressurized before repairing any leaks.

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

Note: Move on to the next repair only if the previous repair did not fix the leak.

1. Tighten the fittings that are leaking and then follow the "Testing Pressure" procedure in Section 3.2.5.
2. Remove the fittings that are leaking and check that the mating surfaces are clean. If present check the O-rings for signs of damage.
3. Replace the leaking tubes and reinstall the fittings according to the Swagelok guidelines for tube fittings and SAE torque settings for O-ring boss fittings as specified in Table 8. Once the fittings have been reinstalled follow Section 3.2.5, "Testing Pressure."
4. If the leak cannot be repaired, the component should be replaced.
5. If replacement is necessary, ensure correct replacement parts are requisitioned and install the new parts.

If the repairs listed in section 3.2.6 do not fix the problem, contact Agility Fuel Systems Product Support at +1-949-267-7745.

Table 8 Torque Specifications

SAE Torque Specs	
Fitting	Torque (ft-lbs)
7/16-20	15
1/2-20	18
9/16-18	26
3/4-16	51
7/8-14	74
1-1/16-12	125

3.3 Inspecting Components

A visual inspection of the components ensures that the components are not damaged:

- Ensure that all PRD vent lines have blue end caps securely in place. A PRD vent line with a missing end cap may indicate that a PRD has activated. If a PRD has activated, contact Agility Fuel Systems product support.
- Ensure that all natural gas system components are solidly mounted.
- Ensure that all fuel supply tubes and flexible lines are in good condition.
- Ensure that no fuel leaks are present.
- Ensure there are no coolant leaks at the hose connections going to the high-pressure regulator.
- Visually inspect structural components for any signs of wear or cracks.
- Visually inspect rubber for wear and cracks.
- Inspect fastened joints for loose fasteners.
- Inspect mounting bolts for damage.
- Inspect mounting bolts placed through rubber for proper torque:
 - 3/4-in. bolt: 320 ft-lbs
 - 5/8-in. bolt: 185 ft-lbs
 - 1/2-in. bolt: 90 ft-lbs

3.4 Depressurizing CNG Systems

1. Ensure that the vehicle is turned off.
2. Turn the cylinder shutoff valves (one on each cylinder) clockwise to the "OFF/CLOSED" position.
3. Ensure that the manual shut off-valve is in the "ON/OPEN" position.
4. Turn on the vehicle and run the engine until it stops.
5. Ensure that the vehicle is off and that the proper vehicle lock-out procedures are followed.
6. Check the gauges on the fill panel to ensure that all the pressure is relieved.
7. Remove the access cover on the rear of the fill panel (optional).
8. Relieve the remaining pressure by slowly opening the bleed valve as illustrated in Figure 23.

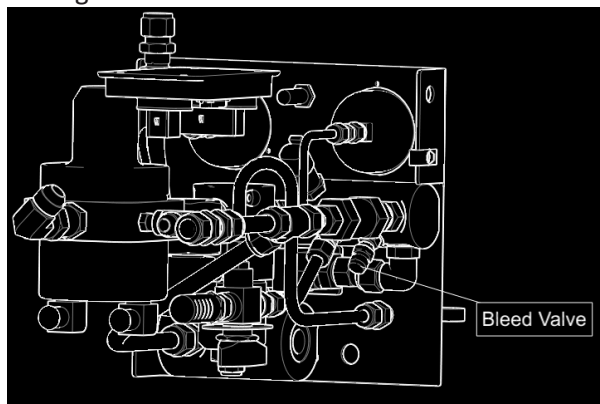


Figure 23 Bleed Valve

9. The system is now fully depressurized up to the primary solenoid lock-off valve (item C in Figure 24). There may be pressure remaining downstream of the solenoid valve. Be careful when loosening fittings for the first time because a small amount of gas may leak out of any fitting downstream of the solenoid lock-off valve, which is normal.

3.5 Repressurizing System

1. Ensure that the vehicle is off and remove the keys from the ignition.

2. Ensure that the bleed valve is closed and torqued to 4-5 ft-lbs.
3. Ensure that the filter bowl and the drain plug are installed and tightened.
4. Re-install the fill panel cover (if removed).
5. Ensure that the manual shutoff valve is still turned to the "ON/OPEN" position.
6. Slowly turn the cylinder shutoff valves (one on each cylinder) counter-clockwise to the "ON/OPEN" position.
7. Ensure that the pressure test procedure was performed if any parts were loosened or replaced.
8. Start the engine.

3.6 Gauge Considerations

Maintenance

Pressure gauges are maintenance free and do not require recalibration. If a gauge is leaking from the fittings, address the leak in the same fashion as any other leak. However if a gauge leaks internally, ceases to function, loses its glycerin filling, or reads incorrectly contact Agility for a replacement.

3.7 Removal Procedure for Regulator, High Pressure Filter (HP), and Solenoid Subassembly



To individually remove or replace either the regulator, high pressure filter, or solenoid valve all three must first be removed collectively as a subassembly.

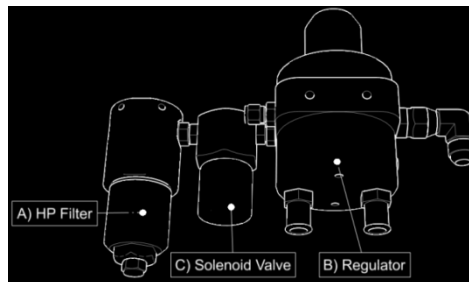


Figure 24 HP Filter, Solenoid, Regulator Subassembly

Refer to Figure 24 for reference.

1. Depressurize the system as described in Section 3.4
2. Disconnect exterior tube fittings from the HP filter (A), be careful not to bend or stress any plumbing components in the process.
3. Disconnect coolant lines from the regulator (B), to prevent coolant from overflowing drain residual fluid into an appropriate container.
4. Disconnect electrical connections from solenoid valve (C)
5. Disconnect low pressure fuel line from regulator (B)
6. Carefully remove any mounting hardware connecting the subassembly to the FMM brackets.

3.8 Maintaining the HP Filter

Regular filter element replacement is an important step towards maintaining the integrity of a CNG fuel system and ensuring maximum operating performance. In general, high pressure filter elements should be replaced every 3000 miles. In addition, the filter housing must be drained of fluid every 1500 miles. The frequency of filter element replacements could increase or decrease depending on the cleanliness of the equipment used at fueling stations and the quality of the fuel.

3.8.1 Draining the High Pressure Filter

1. Depressurize the system, as instructed in Section 3.4.
2. Slowly remove the drain plug (hex cap) with an 11/16-in. wrench. See Figure 25.
3. Drain until there is no residual liquid left.
4. Inspect the O-ring on the drain plug and replace if necessary.
5. Replace the drain plug and torque to 26 ft-lbs.

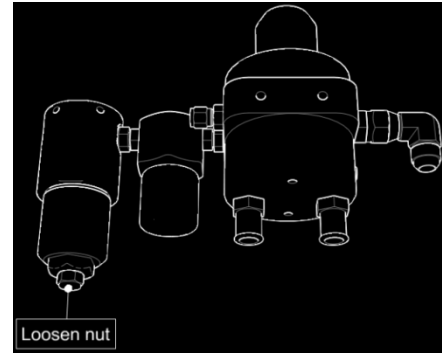


Figure 25 Drain Plug (Hex Cap)

3.8.2 Replacing Filter Element

To replace the filter element inside the Agility filter (element part number 10300024):

1. Depressurize the system.
2. Drain the filter.
3. Unscrew the filter bowl by using a filter bowl removal tool or a 1-1/4-in. wrench.
4. Remove and replace the old filter element.
5. Inspect the O-ring on the filter element holder for damage and replace it if necessary.
6. Reinstall the bowl and tighten to 40 ± 1 ft-lbs.

Table 9 HP Filter Torque Specifications

HP Filter Torque Specs (ft-lbs)	
Filter Housing	40
Hex Head Plug	25-30
Flow Ports In/Out	25-30

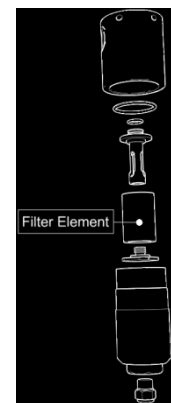


Figure 26 Filter Element

3.9 Maintaining LP Filter

3.9.1 Filter Replacement and Service

The filter manufacturer recommends purging on a daily basis, draining every 3 months of active service, and replacing every 12 months of service. Depending on the fuel quality and characteristics, drainage and replacement may be required more frequently than the prescribed schedule.

3.9.2 Draining Low Pressure Filter & Replacing the Filter Housing

1. Follow steps 1-3 as described in the Draining the High Pressure Filter section.
2. Once the system has been depressurized, the filter housing may be drained by turning the drain cock counter-clockwise until it stops or liquid begins draining. Once liquid has ceased to drain, turn the drain cock clockwise until fully seated hand tight.

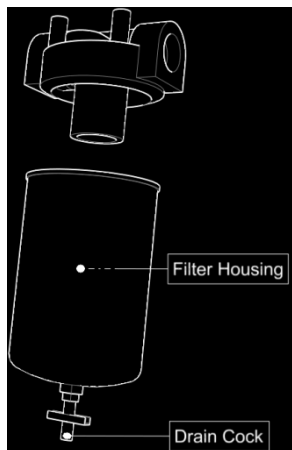


Figure 27 Low Pressure Filter Drainage

3. To replace the filter element, loosen the filter housing by turning it counter-clockwise. This step may require a strap wrench or grip pad. Dispose of the filter element as dictated by local regulations.

4. Install the new filter. The filter gasket is pre-lubricated at the factory, no additional lubrication is required. Tighten the new filter housing by hand until gasket contact is achieved, then turn the housing another 3/4-turn. Be careful to avoid cross threading.

3.9.3 Replacing LP Filter Assembly

1. Depressurize the system (Section 3.4). Before proceeding further make sure the work space is clean to avoid contamination.
2. Use a 1/2-in. wrench to remove the three 5/16-18 fasteners that affix the filter assembly to the mounting bracket. Carefully remove the filter assembly. Notice the orientation at the top of the large flow ports, the new filter assembly will be oriented the same way with the arrow (→) pointing towards the engine.
3. Double check flow direction and reinstall the new filter assembly to the bracket along with the three 5/16-18 fasteners. Torque to 7 ft-lbs.
4. Check the two 1-15/16-in. connectors for damage, debris, and contaminants. Check the condition of the O-rings, replace if necessary. Lubricate the O-rings accordingly and thread the fitting into its port. Be careful to avoid cross threading, torque to 20 ft-lbs.
5. Reinstall all fittings and components previously removed and ensure they are properly tightened.
6. Once the filter has been replaced and all components reinstalled, the system must be repressurized and leak tested.
7. If a leak is detected, depressurize the system and fix the leak. Repeat re-pressurization and conduct another leak test.

3.10 Solenoid Valve

The high pressure solenoid is a two-way valve that operates electrically. By default it is in the "OFF/CLOSED" position.

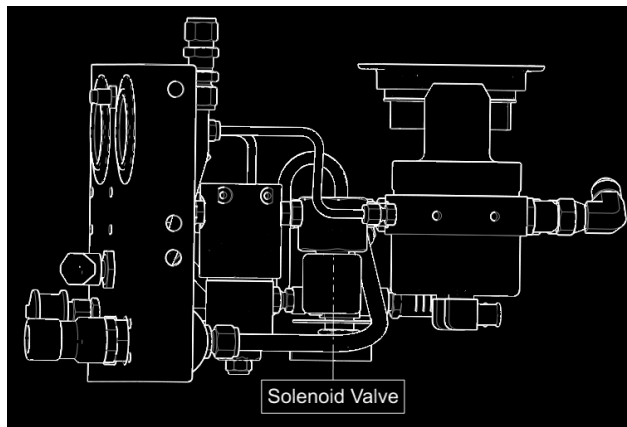


Figure 28 Solenoid Valve

3.10.1 Installation Instructions

The solenoid valve is located inside the Fuel Management Module as seen in Figure 28. Line pressure is rated to 4500 psi. To install a new solenoid proceed as follows:

1. If necessary remove shipping plugs from the inlet and outlet ports.
2. Check to ensure the O-rings are in good condition and free of contaminants. Check the valve ports as well, remove any foreign particles and contaminants.
3. Apply O-ring lubricant then tighten the fittings by hand to avoid cross threading. Once the fitting are properly aligned torque them to 25-30 ft-lbs.
4. Connect the inlet and outlet fuel lines.
5. If the coil assembly is awkwardly oriented, reorient it before proceeding to the next step. This can be accomplished by loosening the coil assembly nut and repositioning the assembly by hand. Once satisfied, re-torque the nut to 43-55 in-lbs.

6. Plug the electrical connector back into the wiring harness.
7. Open all cylinder manual shutoff valves.
8. Start the engine and let it idle for 5 minutes, then shut the engine off.
9. Perform a leak inspection on any section of plumbing that was serviced. Make sure that testing is done at 3600 psi.



CAUTION: Leaks may not appear immediately, allow a minimum of 10 minutes before confirming that no leaks are present.

10. If a leak is detected, see Section 3.2. After the system has been depressurized loosen the leaking connection and visually inspect the fittings and O-rings for damage. If necessary replace the damaged fittings or O-rings and repeat steps 2-11.
11. If no leaks are detected, the vehicle may be returned to active service.



CAUTION: This valve cannot be repaired internally; if the valve ceases to function, replace the valve.

3.10.2 Coil Temperature



CAUTION: Valve coils are designed to operate continuously for a lifecycle of 22,000 hours and generate significant heat. When a coil is energized for extended periods it will be hot. Although the coil is designed to operate under these conditions, smoke or the scent of burning insulation may be an indication of overheating and should be replaced.

Table 10 Solenoid Valve Troubleshooting

PROBLEM	PROCEDURE
Valve fails to operate	1. Check the electrical supply with a voltmeter. Voltage must be in accordance with nameplate rating.
	2. Check coils with an ohmmeter for an open or shorted condition.
	3. Make sure the pressure complies with the nameplate rating.
	4. If no apparent system problem exists, remove and replace the solenoid valve.
Valve is sluggish or inoperative, but there are no issues with the power supply and pressure complies with the nameplate rating.	1. If no apparent system problem exists, remove and replace the solenoid valve.

3.11 Pressure Regulator

3.11.1 Coolant Bowl Installation

1. Depressurize the system.
2. Remove the regulator, solenoid, and high pressure solenoid subassembly, see Section 3.7, "Removal Procedure for Regulator, High Pressure Filter (HP), and Solenoid Subassembly" for details.
3. Remove the old coolant bowl and discard the large O-ring found in the groove of the regulator body. Clean the groove surface in preparation for the new O-ring.
4. Lubricate the new O-ring with the lubricant provided, then install it. Use the remaining lubricant inside the bowl.
5. Orient and install the bowl onto the regulator.
6. Install the small O-ring in the screw pocket of the bowl.
7. Install bowl retention screw with 7/32-in. hex driver. Torque to 60± 6 in-lb.

3.12 Cylinders



CAUTION: Cylinders that have been involved in an incident that registers at level 2 or 3 should be depressurized prior to inspection.

3.12.1 Inspecting Cylinders

The composite containers on the vehicle are manufactured to comply with FMVSS 304, NAI/IAS, or the CSA B51 Part 2 specifications and must be inspected by a certified cylinder inspector every 3 years or 36,000 miles, whichever comes first. The inspector should provide a report for each cylinder and place an inspection label on each of the cylinders. Containers must also have permanent labels in accordance with applicable regulations. These labels provide valuable information to both the inspector and the manufacturer.

Tanks should 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.



CAUTION: Failure to perform regular inspections or emergency inspections in the case of suspected damage may put the vehicle and its operator at risk of serious injury or death.

The system owner/operator should be questioned if there are any known incidents or

conditions which may have caused damage to the fuel container. The owner/operator should keep records of any unusual observations as well the service history of the container and any repairs that have been carried out since the container was last inspected.

3.12.2 Venting/Defueling Notes

The following information is provided in the absence of formalized procedures from local authorities and governing bodies. Figure 29 shows a typical venting facility.



CAUTION: Atmospheric venting of natural gas to depressurize a cylinder must be done with care. Improper equipment or procedures raise the risk of fire.

Before depressurizing, ground the venting orifice with a minimum 3-gauge wire to an approved electrical ground system



Be sure to vent a CNG tank in an open area with good air circulation with no nearby sources of open flame, ignition, or heat. Do not vent the system in an area where flammable gas is permitted to accumulate and potentially ignite.

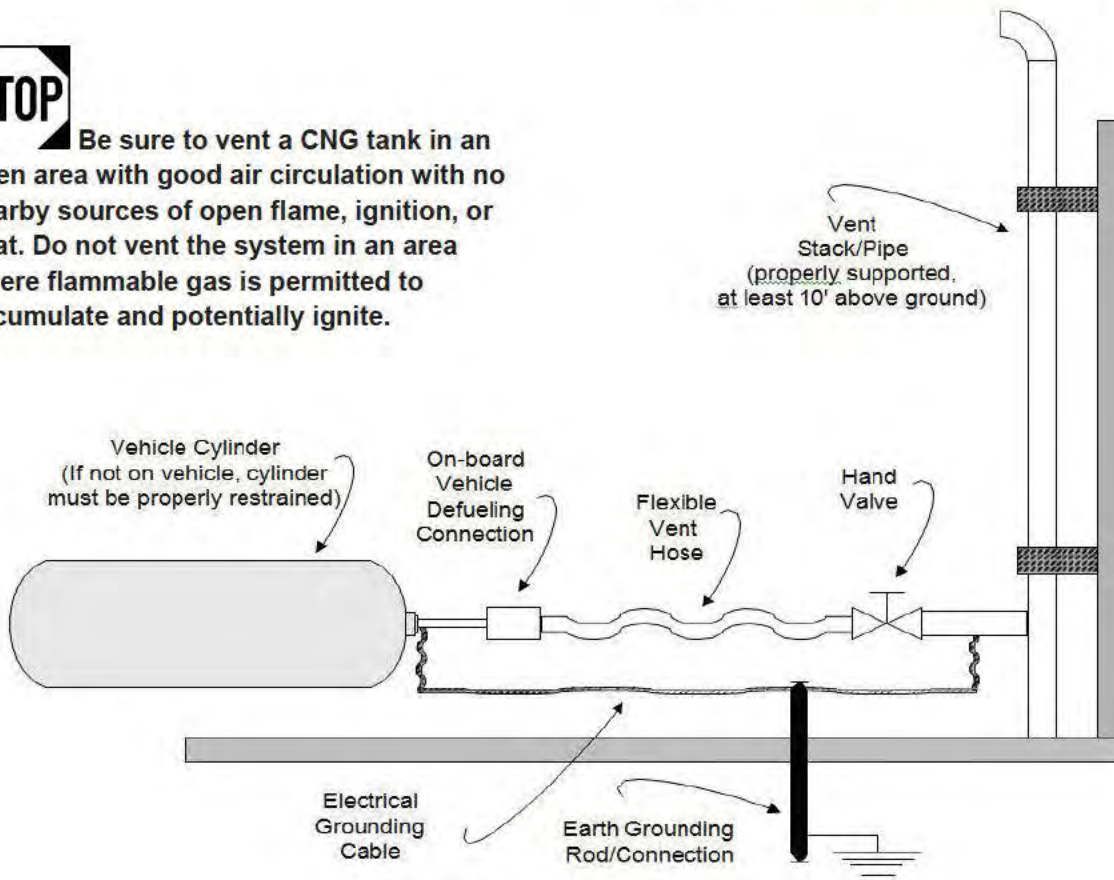


Figure 29. Typical Atmospheric Venting Equipment

A venting facility should include the minimum equipment:

- An on-board defueling connection, installed on the vehicle. Consult the vehicle manufacturer for further information.
- A vent pipe on the premises. This typically consists of a two-inch diameter steel pipe attached to a support structure. The pipe must extend a minimum of two feet higher than the support structure and a least 10 feet above ground level. The vent pipe must be connected to an electrical ground. There should be no ignition sources in proximity to the pipe.
- An electrical ground connection with a minimum 3 gauge or heavier stranded copper wire attached at one end to a ground rod, or an equally suitable electrical ground. The other end should be securely fastened to both the venting pipe and cylinder valve.
- A high pressure electrically conductive flexible hose.
- A hand valve to control the flow of gas.

Additionally, it would be good practice to include the following items:

- A 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”.
- A flame arrestor downstream of the hand valve.



CAUTION: Freestanding cylinders must be restrained prior to venting procedures. Cylinders will contract and move if gas is released at a rapid rate.



CAUTION: Certain plastic-lined cylinders may be sensitive to rapid defueling, consult the cylinder manufacturer for guidance.

3.13 Valve Maintenance

Valves do not require regular maintenance. If a malfunction should occur, consult Section 3.2 on Leaks and replace the valve if necessary.

3.14 Pressure Relief Devices (PRDs)

The pressure relief devices used on this system have been designed in accordance with PRD-1, and meet or exceed the requirements for fuel container pressure relief devices onboard Natural Gas Vehicles.

3.14.1 PRD Inspection

Prior to installation visually inspect the PRD for any visible signs of damage or manufacturing defects. PRDs must not have any aesthetic or structural deficiencies. Remove any visible contaminants, debris, and moisture from the inlet port of the PRD.

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

3.14.2 Draining Vent Lines

The vent lines have a drainage hole in the lowest point on the tube. The lines should be checked for blockage monthly to prevent water build-up that can corrode the components. If your system is operating in a region with high humidity, the vent lines should be drained more often. If the blue caps are missing, the vent tube should be drained immediately and new blue caps should be installed. The vent tubes are not under pressure so it is safe to remove them. Ensure that the vent lines on both sides of the cylinders are clear.

can result in serious injury because they contain high pressure gas.



NOTE: The COMPRESSED FUEL line is the tubing that is CLOSEST to the handle on the valve. If uncertain, trace the line in question. If it 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. Vent lines are open on one end with a blue cap.



WARNING: Ensure that you loosen or remove the drain vent lines and NOT the fuel lines. Loosening or removing fuel lines

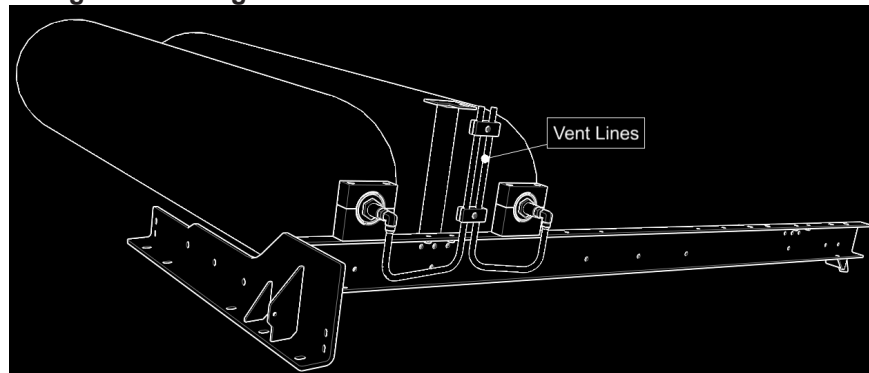


Figure 30 Vent Lines

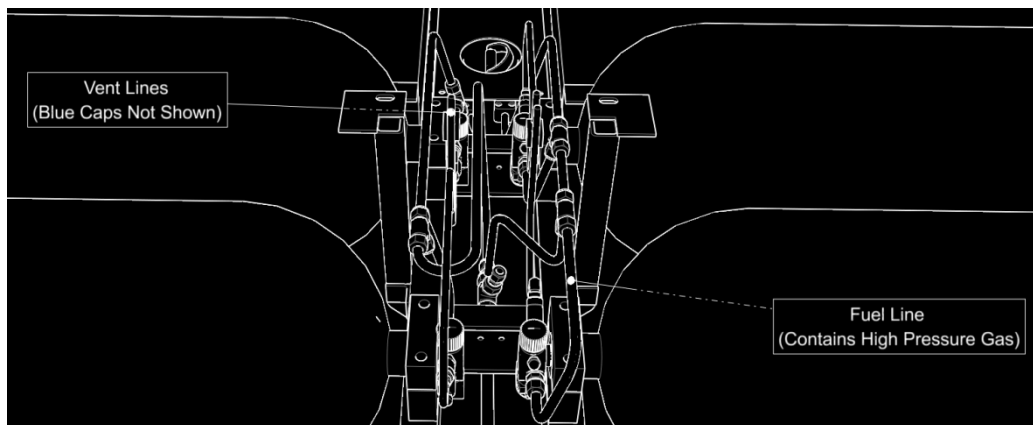


Figure 31 Vent Lines and Fuel Lines

3.15 Fill Receptacles

3.15.1 Fill Receptacle Maintenance

1. External surfaces of the receptacles must be kept clear of contaminants and debris at all times. A dust cap is provided for this purpose.
2. External mounting hardware and dust caps should be checked periodically to ensure components are functioning properly without leaks. If 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.
3. A vehicle operator must not tamper, alter, disconnect, or disassemble the receptacle or any component connected to the receptacle.



CAUTION: Only qualified technicians are permitted to perform mechanical procedures to the receptacles.



WARNING: Installations shall be conducted in accordance of the regulations stipulated by the authorities having jurisdiction (AHJ). Only qualified technicians are permitted to install and remove receptacles. The receptacles connect to the Fuel Management Module via straight threads to the female SAE port.

3.15.2 Receptacle Removal and Installation

1. Depressurize the system as described in Section 3.4, "Depressurizing System."

2. Remove the receptacle. The boss O-ring should be removed and replaced regardless of condition.



Each receptacle assembly comes complete with an O-ring and a dust cap. Do not substitute other manufacturer's components or hardware.

3. Inspect the receptacle for signs of excess wear or damage.
4. Inspect the adapter shaft and the port to ensure the threads are free of debris and contaminants. Lubricate the O-ring with an approved lubricant or lubricate the adapter shaft with hydraulic oil at the O-ring interface. Install the receptacle.
5. Torque the adapter shaft into the port (30-35 ft-lbs).
6. Visually inspect the interface to ensure the O-ring has not been damaged.
7. Check the seal for leaks with an approved leak testing product. Follow approved leak testing procedures as described in Section 3.2, "Leaks."

3.15.3 Transit (Fast) Fill Freeze-Up

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

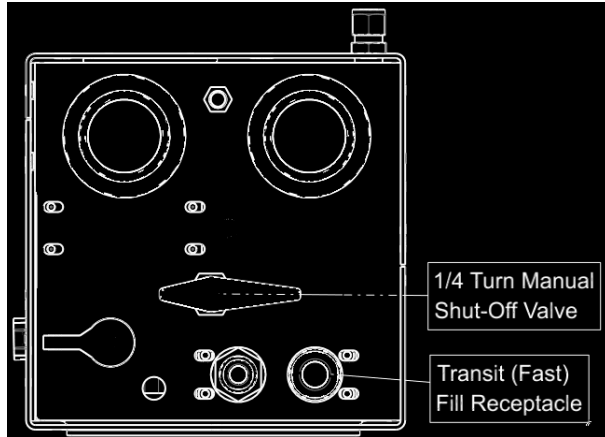


Figure 32 Transit (Fast) Fill Freeze-Up

To remedy the issue, keep the 1/4-turn main shutoff valve in the “OFF/CLOSED” position until ice is no longer visible and the internal poppet assembly achieves a seal. Once sealed, the internal check valve will resume normal operation and gas will cease to escape from the receptacle.



WARNING: The receptacle is to be used solely on vehicles fueled by compressed natural gas. The receptacle is designed to operate in conjunction with AGA/CGA NGV1 certified fueling nozzles. For information on coupling and uncoupling procedures please consult the CNG fueling dispenser the instructions.



NOTE: Receptacles come with protective caps that prevent contaminants and debris to enter the system and cause internal components to wear prematurely.

3.16 Welding Procedure

For any welding in or near a CNG storage system, consider the following recommendations:

1. Ensure the vehicle is in a well-ventilated area. Do not park the vehicle in an area where natural gas may accumulate.
2. Turn all cylinder shutoff valves to the closed position.
3. Make sure the manual shutoff valve on the FMM is turned to the “ON” position.
4. Turn on the vehicle and run the engine until it stops.
5. Ensure the vehicle is off and proper vehicle lock-out procedures have been followed.
6. Check gauges on FMM to ensure all pressure has been relieved.
7. Remove access cover to fill panel.
8. Slowly relieve excess pressure using the bleed valves.
9. The system is now fully depressurized up to the primary solenoid lock-off valve. There may be residual pressure downstream of the solenoid valve.
10. To remove gas downstream of the primary solenoid lock-off valve, disconnect the electrical connector from fuel panel and use a 12 volt power source to active the solenoid lock-off valve.



CAUTION: With the bleed valve still in the open position any remaining gas trapped between the solenoid and the engine block will flow through the bleed valve. Ensure that the operator is well clear of the direction of gas flow.

11. Slowly undo the fittings between the low pressure fuel hose and low pressure coalescing filter.



CAUTION: This fitting is still under pressure. Place a metal shield between the fitting and operator in case the fitting

becomes a projectile. Use caution and loosen slowly.

12. Let the vehicle sit for a minimum of 10 minutes in a well-ventilated area. Natural gas is lighter than air, and may become trapped in pockets underneath the chassis.
13. Disconnect the main vehicle battery. Use a 12 volt power supply to open the solenoid and disconnect remaining electrical connectors from the FMM.
14. Isolate tanks using a metal shield or welding blanket. Isolation must ensure no path for sparks to hit the cylinder. If the cylinder is hit by a spark the vehicle must be taken out of service and inspected.
15. Perform the welding procedure.

3.16.1 To Repressurize After Welding

1. Make sure vehicle is turned off and keys removed from the ignition.
2. Ensure bleed valve is closed.
3. Ensure low pressure coalescing filter is reconnected.
4. Perform a leak test as described in Section 3.2.3, "Testing for Leaks."
5. Reconnect the electrical connectors and main vehicle battery.
6. Re-install the FMM cover.
7. Slowly turn the cylinder shutoff valves to the "ON" position.
8. Start the engine.

4. Defueling Preparation and Procedures

A CNG vehicle may need to be defueled for maintenance or storage at some point. The best and safest way to defuel a CNG system is to transfer fuel back to a dispensing station, if so equipped. Check with your CNG filling station for specific procedures.



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



Basic Rules for Defueling

- Only CNG certified personnel should attempt these processes
- Consume as much fuel as possible prior to defueling
- You must have an approved place to put the fuel removed from the vehicle
- Notify nearby personnel prior to defueling
- Always ground the vehicle and the fuel system
- Never defuel indoors

- Always wear personal protective equipment
- Be familiar with evacuation routes

4.1 Defueling Requirements

There must be an approved place to put the natural gas fuel removed from the vehicle. There are three common defueling options: Vent to atmosphere, compressor transfer and return to supply.

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

4.1.2 Vent to Atmosphere

First, verify whether or not this method is legal. There may be local air quality regulations restricting the release of methane into the atmosphere. If atmospheric venting is acceptable in your area, then a venting facility compliant to regulations must be used.

4.1.3 Compressor Transfer

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

4.1.4 Returning to Supply

The third method returns fuel to a distribution system. When using this process, pressure in the vehicle tank and the supply system pressure will equalize, so some pressure may remain in the vehicle fuel system.

4.2 A Typical Venting Facility

A typical venting facility is described in Section 3.12.2 (Figure 29).

4.3 General Defueling Procedure



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

Figures 33 and 34 show a typical Fuel Management Module and its major components and functions.

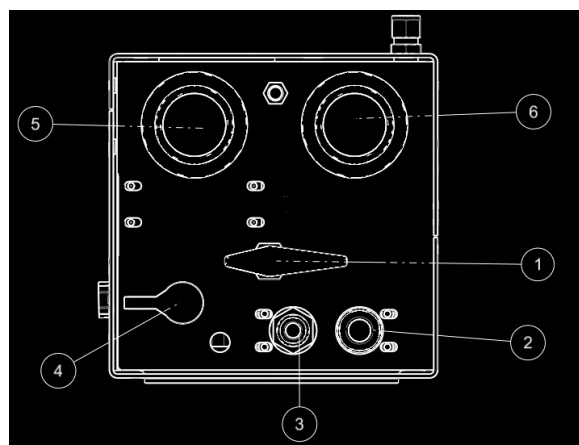


Figure 33 FMM Panel, Front View: (1) Emergency Shutoff Valve; (2) Transit (Fast) Fill Receptacle; (3) NGV1 Fill Receptacle; (4) Defuel Receptacle; (5) High Pressure Gauge; (6) Low Pressure Gauge

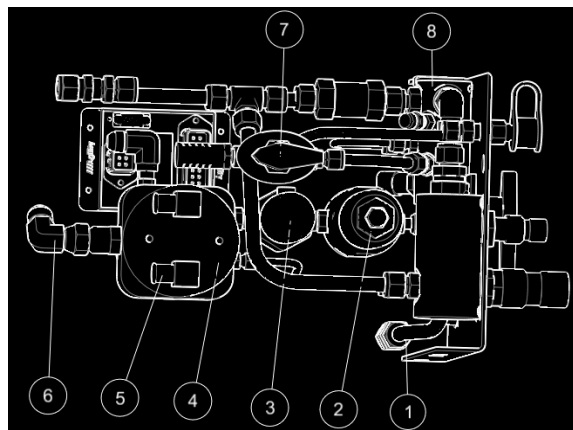


Figure 34 FMM Components, Overhead View: The Defuel Valve is Usually Located Inside the FMM

1. Connect the ground wire from the vehicle to the vent stack system.
2. Attach the defuel hose to the vent stack system.
3. Attach the defuel nozzle to the defuel receptacle on the FMM.
4. Ensure the manual shutoff valve is OPEN
5. Slowly open the defuel valve, and adjust for a slow and steady flow to avoid freeze-up.

5. 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.

For any issues that are not addressed in the Operation Manual or for warranty information please contact Agility Fuel Systems product support at +1-949-267-7745.

Table 11 Troubleshooting Problems

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 12 Troubleshooting Solutions

Troubleshooting 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

5.1 Troubleshooting Diagrams

Table 13 Low Pressure Fuel Light Troubleshooting

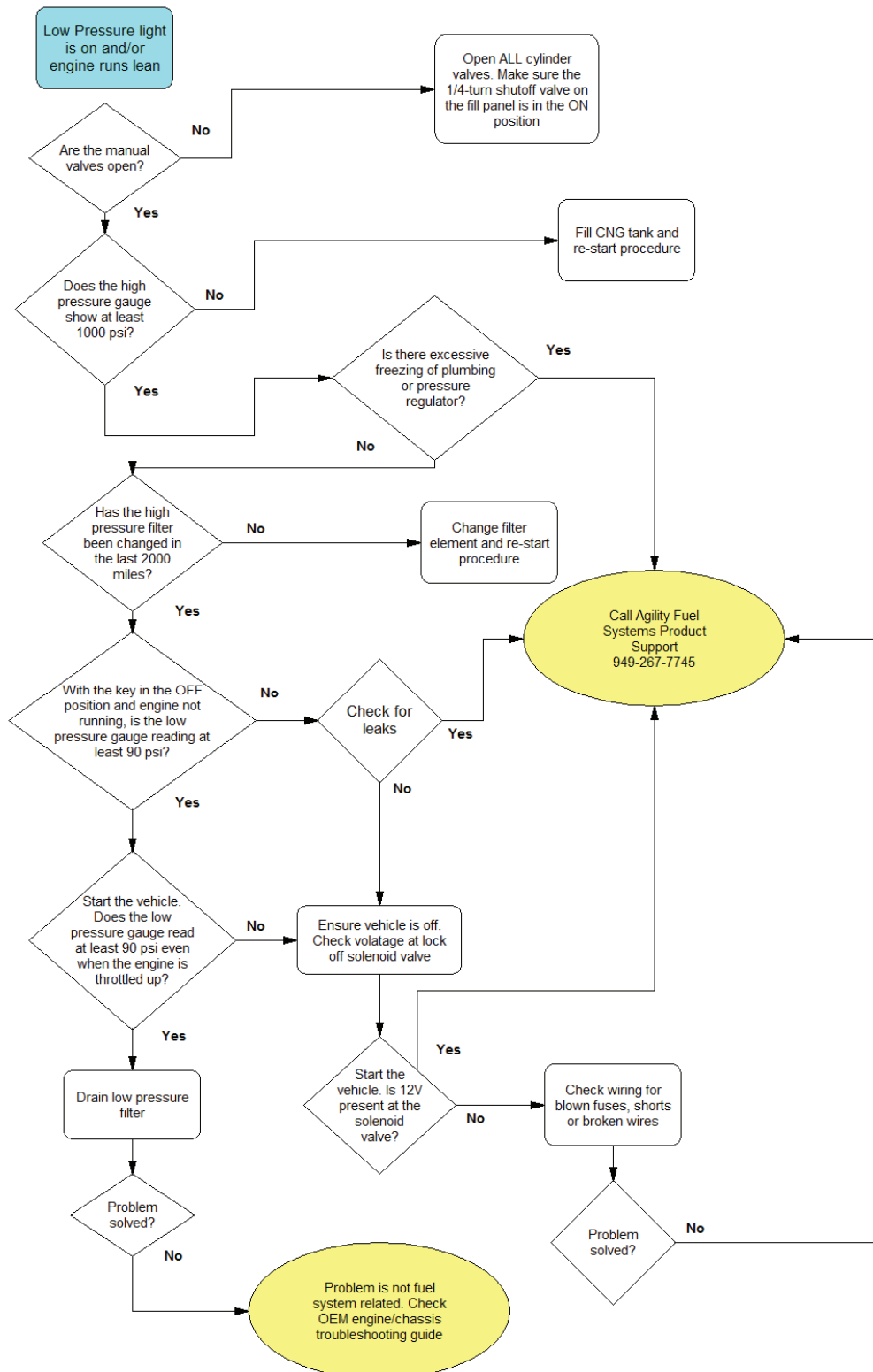
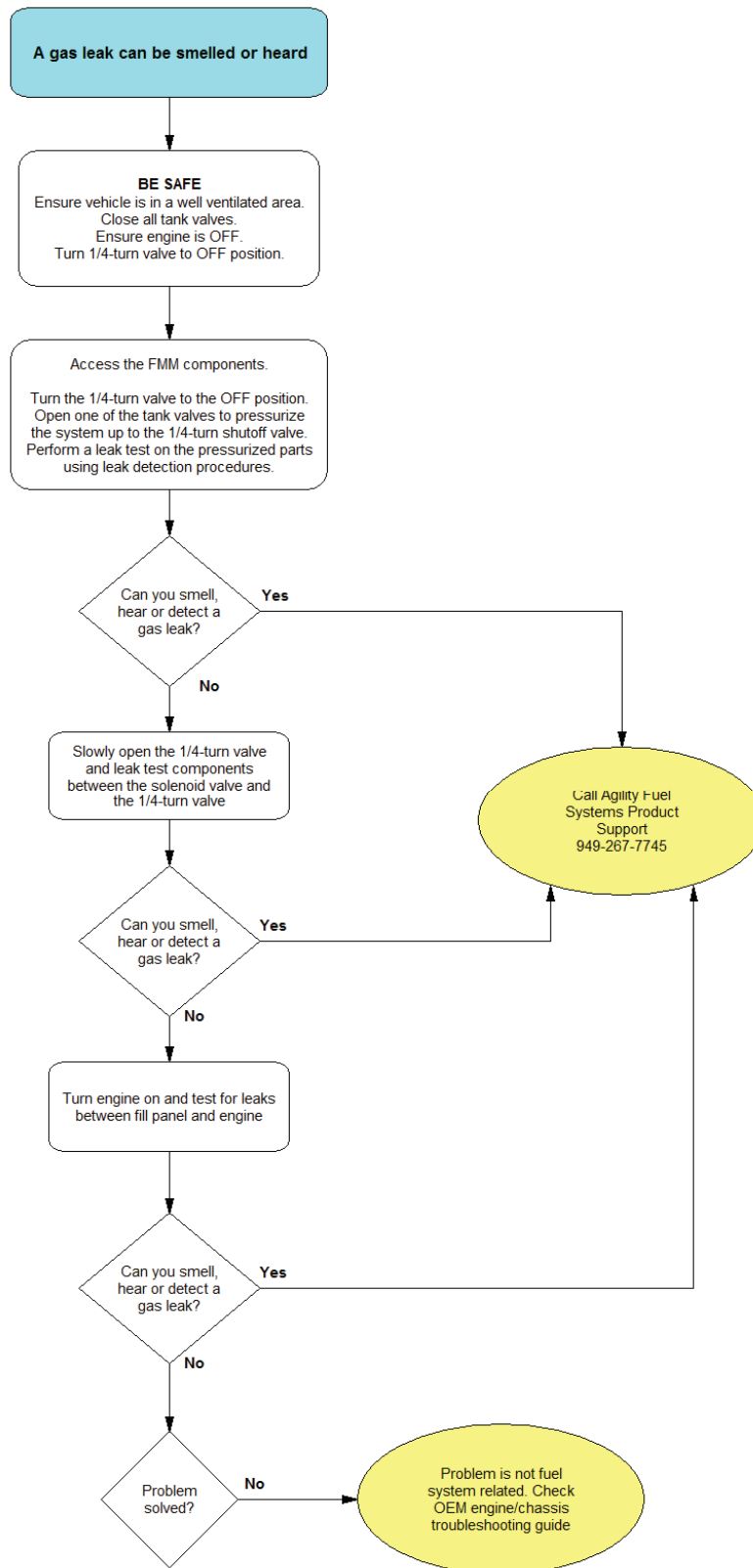


Table 14 Gas Leak Troubleshooting



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CNG System Inspections



CNG Cylinder & System Inspection



WARNING

If a CNG-fueled vehicle has been involved in an accident or fire, the system and cylinders must be inspected by a certified (CGA C-6.4) or other qualified CNG fuel system inspector.

Refer to Field Service Bulletin ENP-196, "CNG Fuel System Inspection Interval Recommendations for High Mileage, Heavy Duty Vehicles"



Field Service Bulletin
CNG Fuel System Inspection Interval Recommendations
for High Mileage, Heavy Duty Vehicles

ENP-196
July 23, 2014

1. Introduction

Based on cylinder manufacturer recommendations and industry standard practices, visual CNG cylinder inspections should be performed at a frequency of 3 years or 36,000 miles, whichever occurs first. This is based on common passenger car or light-duty applications, where lower mileage per year is common. This inspection frequency is applied to all CNG vehicles regardless of final use application, which results in greatly varying actual frequency from a time-based perspective.

High mileage vehicles, such as over the road trucks, may accumulate 36,000 miles in several months; well in advance of the anticipated 3 year time-frame. However, because heavy-duty vehicles are often subject to more demanding duty cycles than passenger cars, performing cylinder inspections at 3 year intervals would also not be appropriate.

The Federal Motor Carrier Safety Administration (FMCSA – part of the U.S. Department of Transportation, DOT) does not currently have out of service (OOS) inspection criteria for natural gas fuel systems, but is currently considering adding them.

A. Vehicle safety-related agencies state:

- a) **Federal Motor Vehicle Safety Standards (FMVSS) 304:** (Labeling requirements) – CNG containers should be visually inspected ... every 36,000 miles or 36 months, whichever comes first...
- b) **American National Standards Institute (ANSI)/Canadian Standards Association (CSA) NGV2:** Each container shall be visually inspected at least every 36 months, or at the time of any re-installation, for external damage and deterioration...
- c) **National Fire Protection Agency (NFPA) 52:** Recommends the same interval as the FMVSS, stating containers should be visually inspected ... every 36,000 miles or 36 months, whichever comes first...

B. According to the Canadian Natural Gas Vehicle Alliance, and the CSA Group, who offers certifications on CNG cylinder inspections, some states have specific requirements for CNG fuel cylinder inspections.

- a) **Arizona:** Inspection is required when the vehicle is placed into service and then annually. Inspection must be performed by an individual trained by the system manufacturer.
- b) **Kentucky:** Inspection is required every 36 months or 36,000 miles, whichever comes first, and after collision. Does not state who performs the inspection.
- c) **Oklahoma:** Inspection is required every 36 months or 36,000 miles, whichever comes first. Inspection is performed by a certified technician.
- d) **Texas:** The owner of the vehicle must prove that the container meets the inspection criteria of FMVSS 304. (Every 36 months or 36,000 miles, whichever occurs first.)
- e) **Utah:** Inspection is required every 36 months or 36,000 miles, whichever occurs first. Inspection must be performed by a CSA certified technician.
- f) **West Virginia:** Does not state the frequency of inspection, however, all CNG activity must be overseen by a CSA certified technician. Note, this legislation is not signed into law yet.
- g) **Ohio** – coming soon

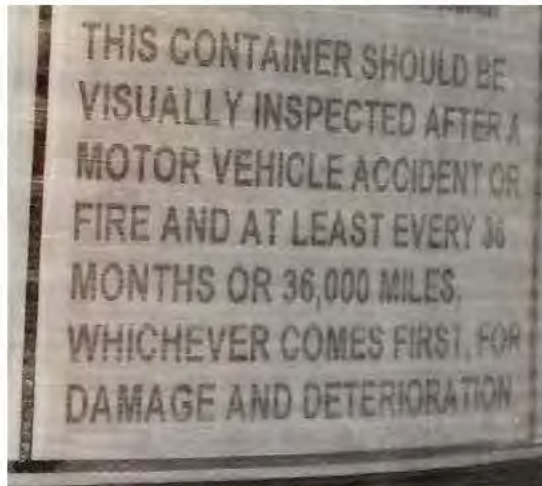


Fig. 1 A typical CNG cylinder manufacturer's label showing visual inspection interval information. The wording is from FMVSS 304 "...every 36 months/36,000 miles..."



Fig. 2 A CNG cylinder inspection record label used to document completed inspections.



Fig. 3 An Agility Fuel Systems CNG cylinder inspection record decal (part number 10602107) on a fuel management module door.

Where possible, Agility Fuel Systems recommends a practical alternative schedule for detailed fuel system inspections – selected by the fleet manager or vehicle owner.

Use either:

1. the common recommendation of every 3 years or 36,000 miles, whichever occurs first, **OR**
2. after every 1 year or 100,000 miles, whichever occurs first

In addition, Agility recommends a **daily walk-around visual inspection** be performed, regardless of which detailed fuel system inspection schedule is followed.

NOTE: Inspections must be performed by qualified inspectors using guidelines from the fuel cylinder manufacturer in addition to the guidelines listed in this bulletin.



WARNING

If a CNG-fueled vehicle has been involved in an accident or fire, the system and cylinders must be inspected by a certified (CGA C-6.4) or other qualified CNG fuel system inspector.

2. Affected Units

This procedure applies to all Agility Fuel Systems CNG-fueled vehicles.

3. Daily Walk Around Visual Inspection

Inspect the following items each day before vehicle operation:

1. Make sure all manual tank valves and the red-handled emergency shutoff valve on the FMM are in the OPEN position.
2. Check the high pressure gauge to make sure enough fuel is on-board, and re-fuel if necessary.
3. Drain the low pressure filters per the engine manufacturers' recommendation.
4. Turn the ignition key to the on position, and watch the low pressure gauge. It should show about 125 psi.
5. Check the dashboard fuel gauge to make sure it is functioning.
6. Check the entire fuel system for any signs of damage or wear. Include checks for:
 - a. Major leaks – Smell for gas, frost or ice on plumbing tubing and components
 - b. PRD components - Make sure all PRD vent line caps are in place and PRD lines are not kinked, plugged or damaged
 - c. Structural damage - Housings, covers, fasteners, fuel cylinder mounting points.
7. If any system components or structural parts are damaged, perform a detailed inspection.

If all is well, the vehicle is cleared for operation. If anything is wrong, a qualified CNG system technician should make the necessary repairs.

4. Detailed Fuel System Inspection

At 12 months/100,000 miles whichever occurs first **or** 36 months/36,000 miles whichever occurs first, a certified (CGA C-6.4) or other qualified CNG Fuel System Inspector shall perform the following in addition to the daily inspection items above:

1. Check cylinder shields and covers for damage.
2. Make sure cylinders are mounted securely. Check mounts, brackets, rubber isolators, and all fasteners.
3. Verify cylinder labels are in place and make sure cylinder service life has not expired.
4. Inspect cylinder valves and PRDs for leaks and damage.
5. Inspect all plumbing tubes, hoses and fuel flow components for leaks.

6. Examine all cylinders for damage using the cylinder manufacturer's guidelines. Inspection records should be kept with vehicle records, and the system label should be updated to reflect the current inspection status.

If all is well, the vehicle is cleared for operation. If anything is wrong, a qualified CNG system technician should make the necessary repairs.

5. CNG Fuel System Maintenance Items

Remember, the above applies to CNG fuel system inspections, not service intervals to the maintenance items, such as fuel filters. Refer to Service Bulletin ENP-114, "CNG System High Pressure Filter Maintenance" for HP filter maintenance instructions.

6. References

Agility Fuel Systems

<http://www.agilityfuelsystems.com/>

Agility Fuel Systems on YouTube

<https://www.youtube.com/channel/UCH1-yzuKiwz9kyAEJmdrLxg>

Natural Gas Vehicle Institute - NGVi

<http://www.ngvi.com/>

CSA Group

<http://shop.csa.ca/en/canada/page/home>

Clean Vehicle Education Foundation - CVEF

<http://www.cleanvehicle.org/index.shtml>

If you have any questions, contact Agility Fuel Systems Product Support at 949-267-7745 or support@agilityfs.com.

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Revision State				
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Information from Daimler Trucks and our Component Suppliers

Engine Information

Content Furnished by our Natural Gas Engine Supplier

- Cummins Westport Natural Gas Academy Videos
- [ISX12 G Maintenance Intervals](#)
- ISX12 G Maintenance Overview Video
- ISL G Maintenance Intervals
- Driver Tip Card / Important Daily Checks

Download Brochures

- Natural Gas Engine Training Information (1-Pager)
- ISL G / ISX12 G Training Requirements (Detailed)
- ISX12 G Recommended Parts List
- ISL G Recommended Parts List
- ISL G CM2180 Tool Requirements

Fuel System Information

Content Furnished by our Natural Gas Fuel System Supplier

- Agility Fuel Systems Product Support
- Agility Fuel Systems Routine Maintenance
- Agility Fuel Systems Training Enrollment Information
- Agility CNG System Inspections
- DTNA Video on Agility Fuel Management Module

- Agility Fuel Systems Instructional/Informational Videos
- Agility Fuel Systems - Universal CNG Operation Manual
- Agility Fuel Systems Leak Detection and Repair
- Agility Fuel Systems Sales Contacts
- Agility Fuel Systems - High Pressure Filter Replacement Parts Detail

Daimler Trucks Vehicle Information

Freightliner Service Literature and Other Useful Information

- Drivers and Maintenance Manuals
- Navigating to Workshop Manuals on AccessFreightliner
- Navigating to CNG & LNG Training Info on Aftermarket Resource Center
- Navigating to CNG videos on SalesCenter

- CNG Fuel Lines (Fuel Storage and Delivery System to Engine)
- Coolant Lines to Agility Regulator (From Engine to Agility Fuel System)
- Wiring to Agility Fuel Shutoff Solenoid
- Fuel Level Gauge Wiring
- Methane Detector Troubleshooting

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