Truck and Tractor CNG Fuel System
Operation, Maintenance & Inspection Manual
ENP-516
Rev. B: August 2017
# Table of Contents

I. Proprietary Statement ................................................................. 3  
II. Trademark Notice .................................................................... 3  
III. Preface .................................................................................. 3  
IV. Warning Statements Used in this Manual ................................. 3  
V. Obtaining Product Support, Service or Parts .............................. 4  
1. Safety ...................................................................................... 5  
2. Fuel Storage, Fuel Flow and System Components .................... 10  
3. Fueling the CNG System .......................................................... 16  
4. CNG Fuel System Operation .................................................. 18  
5. CNG Fuel System Inspections ................................................ 19  
6. CNG Fuel System Maintenance ............................................. 51  
7. Troubleshooting ..................................................................... 67  
8. References .............................................................................. 73

ENP-516: Truck and Tractor CNG Fuel System Operation, Maintenance & Inspection Manual  2 of 79
I. Proprietary Statement

The information provided within this document is proprietary and confidential. All prior versions, including updates and revisions forwarded separately, are also proprietary and confidential. The information provided by Agility Fuel Solutions to its customers is solely for the use of those customers. No portion of this manual may be reproduced or distributed without prior written consent of Agility Fuel Solutions. Agility Fuel Solutions reserves all rights, including intellectual property rights, contained within this publication.

II. Trademark Notice

Agility® and TUFFSHELL® are registered trademarks of Agility Fuel Solutions.

III. Preface


This manual contains general operation, maintenance and inspection information for Agility Fuel Solutions CNG vehicle fuel systems. If an OEM fuel system manual exists, it shall take precedence over this manual. Your system or specific components may vary slightly from this text, but the operating principles and functions of the components are the same.

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

IV. Warning Statements Used in this Manual

⚠️ DANGER

Personal injury or death will occur if procedures are not followed.

⚠️ WARNING

Personal injury or death may occur if procedures are not followed.

⚠️ CAUTION

Damage to equipment, fuel system or vehicle is possible if instructions are not followed.

⚠️ NOTICE

Best practices or hints to help an operation or procedure go smoothly.
A. All replacement parts must adhere to standards and ratings specified by Agility Fuel Solutions. Using any part that is not approved by Agility Fuel Solutions is not recommended and may compromise the integrity and safety of the system.

B. 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.

V. Obtaining Product Support, Service or Parts

Fuel system in- or out- of warranty product support can be obtained by calling the Agility Fuel Solutions Customer Care Hotline at 949-267-7745. Toll free: 855-500-2445.

Customer Care: support@agilityfs.com
Parts: parts@agilityfs.com

Visit our website for more information, including CNG and LNG fuel system videos. Go to www.agilityfuelsolutions.com

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3335 Susan Street, Suite 100
Costa Mesa, CA 92626
http://www.agilityfuelsolutions.com/
1. Safety

**WARNING**

If the vehicle has been in an accident or fire, cylinders and system must be examined by a qualified inspector.

This section outlines general safety guidelines that must be followed when operating and servicing natural gas equipment provided by Agility Fuel Solutions.

### 1.1. Qualified Personnel

CNG systems should be maintained and inspected exclusively by trained personnel. As with all pressure vessels, CNG storage and fuel delivery systems are dangerous.

### 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 all fire extinguishers are charged and up to date.
3. Areas designated for CNG fueling systems must have adequate lighting that complies with NFPA and other applicable codes.
4. Search for leaks using only certified leak detecting solutions and equipment such as Swagelok Snoop®. Any other product or solutions are unacceptable.
5. Use tools that are in good working order with proper calibration.
6. Wear appropriate attire and personal protective equipment (PPE) while servicing or maintaining any CNG system.

### 1.3. General Safety Precautions

1. Follow all maintenance procedures in order; do not skip steps unless so noted.
2. Never use an open flame as a source of illumination near a CNG system.
3. CNG fuel systems are to be serviced in designated areas that comply with all federal, state and municipal laws and regulations.
4. CNG servicing and fueling areas must be well ventilated.
5. Perform all maintenance and service procedures in a dust free environment.
6. Never attempt to depressurize or vent a system by loosening a fitting.
1.4. CNG Vehicle Safety Precautions

**WARNING**

Strict compliance to proper safety and handling practices is essential when operating compressed natural gas fuel systems.

The following safety precautions 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. Never attempt to open system components that are under pressure.
4. Do not smoke or produce an open flame within 30 feet of a CNG vehicle or a CNG dispensing/filling station.
5. Always ground a vehicle prior to defueling.
6. If a CNG vehicle must be out of service for an extended period of time, turn cylinder valves to the “off/closed” position and run the engine until it stalls. This will consume the residual fuel in the closed off lines.

1.5. Welding & Hot Work Precautions

**WARNING** **CAUTION**

A. Before performing any hot work procedure, make sure the fuel system is leak-free by performing a leak test with a suitable leak detection solution.
B. Before performing any welding on the vehicle chassis or body, ensure the main battery disconnect switch is turned off. Follow OEM or body builders’ manual for welding procedures.
C. Disconnect the CNG fuel system electrical connector at the rear of the FMM box or at the Agility ECU to prevent damage.

For any welding in or near a CNG storage system, follow these safety recommendations:

1. Ensure the vehicle is parked in a well-ventilated area. Do not park the vehicle in an area where natural gas may accumulate.
2. If welding or hot work is performed more than six feet/two meters away from the CNG vehicle, it is not necessary to defuel the system. However, the fuel system should be depressurized.
3. If performing hot work closer than six feet/two meters from the CNG cylinders, they must be de-fueled.
a. Cover all CNG components, including the cylinders and fuel lines, with fireproof blankets or a metal shield. Isolation must prevent sparks and slag from hitting the cylinders.

b. A single spark or weld slag could compromise CNG components.

c. If the cylinder is hit by a spark or slag, the vehicle must be taken out of service and inspected.

1.6. Codes and Compliances

USA: NFPA 52
Canada: CAN/CSA B109
North America: ANSI/AGA NGV 3.1/CGA 12.3 and NGV 12.3-M95
1.7. First Responder Guide

**NOTICE**

Refer to the “Agility Fuel Solutions First Responder Guide,” ENP-084 for CNG and LNG first responder information for firefighters.

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

![Figure 1. CNG vehicle blue diamond identification decal.](image)

Natural gas possesses unique hazards that are not present in gasoline or diesel fuel. CNG is in a gaseous state at room temperature and pressure. For storage purposes, natural gas must be compressed to 3600 psi. Agility Fuel Solutions minimizes these potential hazards with state of the art design and testing practices.

1.8 CNG Cylinders

CNG fuel cylinders are housed in metal frames that are bolted to the truck body or chassis. These structures are designed to protect the cylinders in 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 system. During normal operation, all cylinder valves should be open.
Agility Fuel Solutions CNG systems mainly use Agility cylinders. However, other types and manufacturers of CNG cylinders may be present in your vehicle. Always check the permanent labels on each cylinder to verify the cylinder manufacturer, and the expiration date.

**NOTICE**

Agility Fuel Solutions CNG systems mainly use Agility cylinders. However, other types and manufacturers of CNG cylinders may be present in your vehicle. Always check the permanent labels on each cylinder to verify the cylinder manufacturer, and the expiration date.

**DANGER**

A. CNG storage cylinder pressure can reach 4500 psi. DO NOT cut fuel supply plumbing.
B. All pressure relief device (PRD) lines contain full cylinder pressure at all times and cannot be isolated by cylinder valves. Make sure you know where the PRDs and PRD lines are on your vehicle.

### 1.9 Emergency Response for Gas Leaks

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

1. Do not approach the vehicle if any sources of ignition may exist such as fire, sparks, electrostatic charges, lights or electronic devices.
   a. If ignition sources may be present, vehicle fuel cabinet doors should remain closed.
   b. If no ignition sources are present, keep the vehicle and fuel cabinet doors open to prevent gas accumulation.

2. If the vehicle is indoors, move the vehicle outside and away from any ignition sources.

3. Do not use road flares.

4. Do not smoke or allow anyone else to smoke near the vehicle.

5. Turn the ignition switch off, set the parking brake and turn off the battery at the main disconnect.

6. 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.

7. Keep traffic and pedestrians away.

8. Beware that gas may continue to leak once ignition is turned off and the manual shutoff valves are closed.

9. Verify leak locations with suitable methane detection fluid.
**NOTICE**

Leaks must be repaired by a qualified technician.

**1.10 Vehicle Fire Procedures**

1. Always call 9-1-1 first.
2. Get passengers out of the vehicle as quickly as possible.
3. Evacuate the area.

**WARNING**

In case of fire, thermally activated pressure relief devices (PRDs) protect cylinders from rupturing. PRDs typically activate between 212°F and 220°F and will release high pressure CNG which may ignite and add to the fire.

**1.10.1 Emergency Shut Down Procedure**

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

**2. Fuel Storage, Fuel Flow and System Components**

All figures and illustrations are intended for reference only and do not necessarily reflect the exact configuration for any given system. All plumbing and fuel management module layouts are consistent across platforms; however there may be some differences depending on vehicle-specific options. Please contact Agility Fuel Solutions Customer Care if you have any questions about your system that are not covered in this manual.

**CAUTION**

Cylinders involved in an accident or incident should be depressurized prior to inspection.

Periodic inspection is mandatory for safe operation of any fuel cylinder. Safe operation depends upon proper installation, use and maintenance.
Cylinders should be inspected immediately if:

1. The vehicle has been in an accident.
2. The fuel cylinder 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 indications of loose parts.
4. The fuel cylinder has been transferred to another vehicle or the cylinder installation has been altered significantly.

**WARNING**

Failure to perform regular or emergency inspections may put the vehicle and its operator at risk of serious injury or death.

2.1. CNG Fuel Cylinders

**NOTICE**

Agility Fuel Solutions CNG systems use Type 3 or Type 4 cylinders from a variety of manufacturers. Always check the permanent labels on each cylinder to verify the cylinder manufacturer and the expiration date.

2.2. System Configurations

The fuel system structures and components are designed to meet or exceed all safety and vehicle standards. The figures below represent the typical systems available.
2.3. Fuel Flow

Refer to Figures 3 and 4. Fuel is stored in one or more CNG cylinders. Gas is stored in these cylinders at a nominal pressure of 3,600 pounds per square inch (psi). Every Agility system is housed in a protective structure, and can be found on the roof, at the sides or behind the cab. Each cylinder is protected by one or more pressure relief devices, or PRDs.

Figure 3. CNG fuel system overview. The low pressure fuel filters at the engine are not considered part of the Agility fuel system.
Starting from the fuel cylinder(s), high-pressure gas flows through the cylinder shut-off valves to the fuel management module (FMM). The FMM houses control valves, a high pressure coalescing filter and a pressure regulator to condition the fuel for use by the engine.

The CNG regulator reduces pressure from 3,600 psi to approximately 125 psi. Gas at 125 psi leaves the regulator and flows through the low-pressure filter and finally to the engine.

Note: The CNG fuel system ends at the input side of the low pressure fuel filter, usually located in the engine bay.

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**Figure 4. CNG fuel flow and nominal pressures.**

### 2.4. Fuel Management Module Function and Components

The FMM is the interface between the vehicle fuel storage and delivery system and the vehicle engine and operator. There are several FMM configurations, depending on the fuel storage system and vehicle. The FMM can be mounted on either the driver or passenger side of the vehicle.

1. A 1/4-turn manual valve controls fuel flow from the FMM to the engine. It is “on” or open for normal operation.
   
   a. This valve isolates the fuel cylinders from the engine for emergency situations. This valve is open for normal operation.
b. Note, the 1/4-turn valve should not be used when depressurizing the system. The best practice is to close each cylinder valve when depressurizing the system.

2. The standard NGV1 fuel fill receptacle is found across North America. Some systems also have a “fast” or “transit fill” high-volume flow receptacle.

3. The defuel receptacle permits the fuel in the cylinders to be removed when necessary.

4. The high pressure gauge indicates pressure in the cylinders and plumbing components flowing to the regulator. Minimum pressure should be 500 psi, maximum pressure is 4,000 psi and nominal pressure is 3,600 psi when full.

5. The low pressure gauge shows the gas pressure coming out of the regulator and going to the engine. Minimum pressure is 115 psi, maximum pressure is 135 psi and nominal pressure should be 125 psi.

6. The manifold is a “plumbing hub” where the gas is distributed to various places in the system.

7. A bleed valve is used to relieve any remaining pressure after the depressurizing process. It is normally closed.

8. The defuel valve is opened when defueling. It is closed for normal operation.

9. The solenoid valve is activated by the vehicle ignition key.

10. If equipped with DriveAway™ Protection, the engine cannot be started unless all fuel caps (including fuel system doors and auxiliary fill caps) are securely in place. These caps include a sensor trigger (magnet) which closes a reed switch on the FMM panel to send an “OK to crank” signal to the engine control unit (ECU). If the caps are not securely attached, the engine will not crank.

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**Figure 5. Typical integrated FMM used in side mount systems. Note, some parts are hidden in this view.**
2.5. Tubing and Fittings

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.

2.6. Fittings

**CAUTION**

High pressure fittings and components must be repaired or adjusted by trained and qualified personnel.

2.7. Tube and Fitting Installation and Repairs

Installing tube fittings correctly requires training, correct parts and appropriate tools. Tubes must be bent accurately to minimize stress. Fittings must be assembled according to manufacturer’s specifications. Maintenance personnel must receive proper training from Swagelok or Agility Fuel Solutions.

2.8. Fitting Safety

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. Fueling the CNG System

**NOTICE**

These are general guidelines. Always check with your fuel station for specific pump operating instructions and procedures.

#### 3.1. Fuel Specifications

**CAUTION**

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

Fuel quality is crucial for maximum engine performance, life expectancy and emission standards. CNG fuel must meet or exceed the minimum requirements. Refer to SAE J1616 for the latest natural gas vehicle fuel standards.
3.2. Fueling Vehicles with CNG

1. Open the FMM door (if applicable) and remove the dust cap from the fueling receptacle.
2. Wipe the receptacle and nozzle. Check the O-ring, and connect the nozzle from the fueling station to the fuel receptacle.
3. Turn the nozzle valve to the “fill” position and fuel will start to flow.
4. Continue filling until the fuel station pump shuts off automatically.
5. Remove the fueling nozzle by turning the nozzle valve to the “vent” position and release it from the receptacle. The receptacles are designed so the nozzle will not come off under pressure.
6. Once fueling is complete, replace the cap and close the FMM door. When Agility fuel systems are equipped with optional safety interlocks (DriveAway Protection), the FMM doors and all receptacle caps must be in place in order for the engine to start.

**NOTICE**

Before adding fuel, swab the station fill nozzle. Look for any signs of oil or other contaminants. An oily or dusty nozzle may be an indication of poor fuel quality or a station that is not well maintained. Report this condition to the station operator.

Do you smell gas when filling the system? Turn off the station pump and check the O-ring inside the fill receptacle. If it is worn or damaged, clean the receptacle and replace the O-ring with a new one. If the O-ring is OK, contact the station provider.
3.3. Re-Fueling CNG: Pressure and Temperature

Typically, stations fill to a service pressure of 3,600 psi.

During fast filling, gas heats as it compresses inside the cylinders, which is normal. On a hot day, pressure from the filling station will indicate full system pressure, but the fuel cylinders may not be filled completely. This is normal.

Remember: Gas pressure increases as temperature increases. When temperature decreases, pressure decreases. But the amount of gas does not change.

For example, at the end of the work day, a delivery truck is fast-filled at a station. The ambient temperature is 120°F (50°C), and the CNG dispenser stops at 3,600 psi as expected.

The truck is parked in its designated spot. During the night, ambient temperature drops to 70°F (20°C). As the gas cools, pressure in the cylinders decrease. But the truck does not run while parked, so no fuel is being consumed. But the pressure gauge indicates 3,000 psi instead of 3,600 psi. Later in afternoon, the ambient temperature rises to 120°F, and the gauge indicates 3,600 psi once again.

Note: Fueling stations can partially compensate for the heat generated during fast filling, but generally cannot achieve more than 70% to 80% full.

Slow filling (overnight) results in a nearly 100% full system, because the gas is able to cool during the filling process. Slow fill stations are practical when fleet vehicles return to a home base at the end of the work day and can re-fuel during the night.

4. CNG Fuel System Operation

Starting a natural gas vehicle requires a few seconds delay between battery power (ignition switch) turn-on and starter motor activation (engine crank). This allows time for the gas to flow from the storage cylinder, through the solenoid valve and regulator and to the engine.

1. Follow standard manufacturer recommended start-up procedures.

2. If the vehicle is starting from cold, let the engine idle for about five minutes. This will allow engine coolant to warm the fuel and ensure the low-pressure lines downstream of the primary pressure regulator do not freeze.

3. On extremely cold days, allow the vehicle to idle for a longer period until the coolant temperature is high enough to warm the fuel. A good indicator of warmed coolant is warm air coming out of the cab’s heater.
5. CNG Fuel System Inspections

CNG fuel systems must be inspected regularly to ensure safety, optimum performance and compliance to legislation.

5.1. What is Inspected?

1. Mandatory Decals and Labels
2. Mechanical and Hardware Items
   a) Fasteners
   b) Clips and supports
   c) Cylinder brackets and mounts
   d) System frame
   e) Housings, covers, shields
   f) Rubber isolators
3. Fuel Cylinders, Lines and Components
   a) Fuel cylinders
   b) Pressure relief devices (PRDs)
   c) Fill receptacles
   d) Tubes and hoses
   e) Valves
   f) Fittings
   g) High pressure filter
   h) Regulator
   i) Gauges

NOTE

It is not normally necessary to disassemble anything for inspection. Visual observation, measurements and other checks can be performed by looking through vents, doorways or access panels. Inspection mirrors or borescopes may help simplify the process.

5.2. CNG Inspectors: Certified vs Qualified

Agility Fuel Solutions provides Agility-specific CNG fuel system training, but does not have a certified or certification program. Agility recommends inspection and service techs receive training and certification by third-party organizations such as CSA and NGVi (Natural Gas Vehicle Institute).

CNG fuel system inspectors are certified by CSA or NGVi after passing a written examination on CSA standards, NFPA 52 “Vehicular Natural Gas Fuel Systems Code” and NGV industry best practices.

An acceptable alternative to the certified status is a CNG fuel system inspector who is qualified and trained as described by the Compressed Gas Association (CGA) in its publication CGA C-
6.4 “Methods for External Visual Inspection of Natural Gas Vehicle (NGV) and Hydrogen Gas Vehicle (HGV) Fuel Containers and their Installations.”

A qualified inspector must have at least one of the following qualifications: (a) two years’ experience conducting container inspections on the type of cylinder being inspected; (b) supervision by a person with two years’ experience relevant to the type of cylinder being inspected; (c) approved by manufacturer of the container being inspected; (d) certified as an inspector by one of the organizations with specific OEM-approved training centers with fuel gas cylinder standards' recommended inspection guidelines; (e) certification as an inspector by a state or nationally recognized organization that tests for specific knowledge of applicable fuel gas cylinder standards’ recommended inspection guidelines; or certification as an inspector by the authority having jurisdiction.

5.3. Inspection Interval Confusion

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 not be appropriate.

5.4. CNG System Inspection Recommendations

Because of this confusion, Agility Fuel Solutions recommends a practical alternative schedule for detailed fuel system inspections, which includes cylinders – at intervals selected by the fleet manager or vehicle owner.

These guidelines are intended to be consistent with the pending Recommended Practice (RP) from the American Trucking Association’s Technology & Maintenance Council and the recommendations from the NGVA Technology Committee Working Group on CNG Fuel System Inspections, of which Agility is a member and active participant. The working group is working closely with DOT, NHTSA and FMCSA to update FMVSS 304 to be consistent with the ATA-TMC (RP) and Agility guidelines.
Agility Fuel Solutions Recommends the Following

1. The common recommendation of every 3 years or 36,000 miles, whichever occurs first, OR
2. After every 1 year, regardless of mileage

CAUTION

Regardless of which interval is selected, Agility recommends all inspection routines include a daily walk-around visual inspection, and the use of three inspection categories as outlined below.

NOTICE

A practical approach to inspection and maintenance of the fuel system would be to match intervals and procedures with other vehicle maintenance tasks, such as engine oil and filter changes and the yearly DOT inspection.
### 5.5. Cursory Visual Inspection (Daily Pre- and Post-Drive Checks)

Visually check the following items before and after vehicle operation. If all is well, the vehicle is cleared for operation. If anything is wrong, a qualified CNG system technician should make the necessary repairs. This check should take about five minutes or less.

<table>
<thead>
<tr>
<th>Number</th>
<th>Item</th>
<th>Description and Location</th>
<th>Observation / Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>System and vehicle decals</td>
<td>Various locations on vehicle body</td>
<td>Must be in place and legible. Replace if needed.</td>
</tr>
<tr>
<td>2</td>
<td>Gas or coolant leaks</td>
<td>All fittings and components</td>
<td>Look or smell for gas or fluid leaks. Notify repair personnel if leaks are found.</td>
</tr>
<tr>
<td>3</td>
<td>Cylinder mounts</td>
<td>Brackets and straps for side mounted systems, neck blocks for BTC and roof systems</td>
<td>Side mount: Manual valve handle is at 12 o’clock position, or its original location; no sign of abnormal fuel line bending Others: Check for loose or missing fasteners.</td>
</tr>
<tr>
<td>4</td>
<td>Cylinder valves</td>
<td>Mounted on each cylinder</td>
<td>Open fully</td>
</tr>
<tr>
<td>5</td>
<td>Emergency/Manual Shutoff valve</td>
<td>Red handle, 1/4-turn ball valve on the FMM</td>
<td>On/open position for normal operation.</td>
</tr>
<tr>
<td>6</td>
<td>High pressure gauge</td>
<td>High pressure gauge on or near the FMM</td>
<td>500 psi min., 4,000 psi max. nominal, 3,600 psi when full. Refuel as needed.</td>
</tr>
<tr>
<td>7</td>
<td>Low pressure filter</td>
<td>Under hood, at engine</td>
<td>Drain fluid</td>
</tr>
<tr>
<td>8</td>
<td>Low pressure gauge</td>
<td>Low pressure gauge, on or near the FMM</td>
<td>Turn ignition on or start engine. 115 psi min., 135 psi max., 125 psi nominal.</td>
</tr>
<tr>
<td>9</td>
<td>Dashboard fuel gauge</td>
<td>In cab dashboard</td>
<td>Should indicate fuel level.</td>
</tr>
<tr>
<td>10</td>
<td>Hoses and tubes</td>
<td>Various locations on vehicle and fuel system</td>
<td>Listen or smell for leaks, look for damaged or missing fasteners, excessive corrosion.</td>
</tr>
<tr>
<td>11</td>
<td>PRD components</td>
<td>Plastic or rubber vent tube caps</td>
<td>Caps must be in place. If missing, check PRD components and replace caps.</td>
</tr>
<tr>
<td>12</td>
<td>Drive-away prevention caps</td>
<td>Fuel receptacle dust caps on drive-away prevention equipped systems.</td>
<td>All caps must be in place. Remember to check remote fill receptacles, if equipped.</td>
</tr>
</tbody>
</table>
### 5.6. General Visual Inspection

A general visual inspection is performed by a service technician when performing routine maintenance on the vehicle, such as an engine oil and filter change or tire rotation. Although access panels may not have to be removed, all shields and components must be checked for damage. This inspection should take from 10 to 20 minutes.

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<td>Brackets and straps for side mounted systems, neck blocks for BTC and roof systems</td>
<td>Side mount: Manual valve handle is at 12 o’clock position, or its original location; no sign of abnormal fuel line bending. Others: Check for loose or missing fasteners.</td>
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<td>4</td>
<td>Cylinder valves</td>
<td>Mounted on each cylinder</td>
<td>Open fully.</td>
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<td>Red handle, 1/4-turn ball valve on the FMM</td>
<td>On/open position for normal operation.</td>
</tr>
<tr>
<td>6</td>
<td>High pressure gauge</td>
<td>5000 psi gauge on or near the FMM</td>
<td>500 psi min., nominal 3,600 psi when full. Re-fuel as needed.</td>
</tr>
<tr>
<td>7</td>
<td>Low pressure filter</td>
<td>Under hood, at engine</td>
<td>Drain fluid.</td>
</tr>
<tr>
<td>8</td>
<td>Low pressure gauge</td>
<td>200 psi gauge, on or near the FMM</td>
<td>Turn ignition on or start engine. 115 psi min., 135 psi max., 125 psi nominal.</td>
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<td>Drive-away prevention caps</td>
<td>Fuel receptacle dust caps on drive-away prevention equipped systems.</td>
<td>All caps must be in place. Remember to check remote fill receptacles.</td>
</tr>
</tbody>
</table>
## 5.7. Detailed Visual Inspection

Each year, a detailed visual check is to be performed on the vehicle by a certified or qualified CNG inspector. All previous visual check areas are performed. The checks are more detailed, and includes the inspection of safety components, such as pressure relief devices (PRDs). Inspections may require removing access panels or other items to view the entire fuel cylinder(s) and components. This inspection should take approximately 45 minutes to one hour.

<table>
<thead>
<tr>
<th>Number</th>
<th>Item</th>
<th>Description and Location</th>
<th>Observation / Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cylinder</td>
<td>Depends on configuration</td>
<td>Inspect cylinder per manufacturer’s instructions, or in the absence of guidance from the manufacturer, use CGA C-6.4.</td>
</tr>
<tr>
<td>2</td>
<td>Check cylinder shields and covers for damage</td>
<td>All housings and cabinets</td>
<td>A) Covers should be intact and secure. Tighten loose fasteners or replace missing fasteners. B) Look for rubbing or abrasion especially around fuel cylinders</td>
</tr>
<tr>
<td>3</td>
<td>Cylinder bracket mounts</td>
<td>Neck blocks for back of cab and roof systems, brackets and straps on side mount systems</td>
<td>Check loose or missing fasteners and all mounting points for damage.</td>
</tr>
<tr>
<td>4</td>
<td>Cylinder isolator displacement</td>
<td>Side mount systems only</td>
<td>Visually check for missing or worn rubber isolators on side mount straps.</td>
</tr>
<tr>
<td>5</td>
<td>Cylinder valves and PRDs</td>
<td>Manual valve and PRD mounted on or near each cylinder</td>
<td>Perform leak check. Valve should open and close freely by hand. If range or mileage has reduced, valve may be stuck in the closed position.</td>
</tr>
<tr>
<td>6</td>
<td>PRD vent caps</td>
<td>At the end of each PRD vent tube</td>
<td>Check all PRD vent tubes for caps. If caps are missing, always inspect the PRD lines and the PRD for water entry or corrosion.</td>
</tr>
<tr>
<td>7</td>
<td>BTC isolator mounts</td>
<td>Rubber isolators between the vehicle chassis and BTC cabinet</td>
<td>A) Check for displacement or metal-to-metal contact. B) Check height of each isolator – if isolators vary by 1/8-in. or more – the isolators should be replaced.</td>
</tr>
<tr>
<td>8</td>
<td>Leak check</td>
<td>All fittings, plumbing tubes, hoses and flow control components. Various locations</td>
<td>Visually inspect for chafing or loose clamps. Perform leak check. Repair any leaks.</td>
</tr>
</tbody>
</table>
**NOTICE**

Some states have specific requirements for CNG fuel cylinder inspections, so the alternative schedule is not applicable.

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

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

**WARNING**

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

5.8. Inspection Points for All Systems: Decals and Labels

5.8.1. Cylinder Labels

**CAUTION**

If the cylinder label is not attached to the cylinder, and the manufacturer and serial number are not available or cannot be verified, the cylinder must be condemned.

Various vehicle and highway legislative agencies require warning and informational decals for CNG fueled vehicles. Cylinder manufacturer labels must be in place and legible. If Hexagon-
Lincoln or Agility Fuel Solutions labels are damaged or missing, contact Agility Fuel Solutions Customer Care for replacement labels.

For cylinders not made by Agility, contact the cylinder manufacturer or Agility Customer Care.

![Image of CNG cylinder manufacturer's label]

**Figure 7. The CNG cylinder manufacturer’s label must be in place and legible.**

5.8.2. **Fuel System and Vehicle Decals**

Vehicle decals must comply with size, shape, color, wording and font requirements. The decals must be present in specific locations, as indicated in the following pictures and captions. All Agility Fuel Solutions decals comply with applicable regulations, and are available from the parts department.

Part numbers shown in this manual are examples only. Decals may be system- or customer-specific. Order decals using the part number and revision printed on the decal. If the part number is not legible, contact Agility Fuel Solutions Customer Care for assistance.

**NOTE**

Other informational or warning decals are present on Agility systems, however, not all of them may be required. This section addresses required decals. Local authorities or customers may have additional labeling requirements for CNG vehicles. If in doubt, contact Agility Customer Care.
5.8.3. Blue Diamond CNG Decal, Part Number 10602105

Figure 8. CNG-fueled vehicle blue diamond decal.

This decal indicates the vehicle runs on CNG. It must be located on the right rear of the vehicle, but not the bumper. When no body panels exist (for example, in a roll-off chassis refuse tractor), the decal may be placed on a frame member on the right rear of the vehicle. Other blue diamond CNG decals may be placed on the vehicle sides or front, but this is not a requirement. In any case, if the decal is missing, illegible or damaged, it must be replaced.

Figure 9. Left: CNG fueled vehicles are identified by a blue and white decal on the right rear of the vehicle. Right: A CNG decal may also be located on the front of the vehicle as shown.

5.8.4. Fill Receptacle / Fill Panel / FMM Decals

Fill receptacles and information on the fuel system are stated on the fuel management module (FMM) decal. Required information includes name of installer, installation date, cylinder storage capacity in water volume and other information. Since there are several configurations – and more to be developed in future designs – system decals must match your vehicle fuel system. Here are typical examples for some current systems. Back of cab, roof mount and bus system decals have similar wording, each decal has its own Agility Fuel Solutions part number.
200 Series Cabinet Style FMM Face Plate Decal, Part Number 10600030

![Cabinet Style FMM Front Panel Decal](image)

*Figure 10. Typical cabinet style FMM front panel decal.*

267 Series One Piece Aluminum Side Mount FMM Face Plate Decal, Part Number 10602176

![One Piece Aluminum Side Mount FMM Decal](image)

*Figure 11. One piece aluminum cover side mount system with integrated FMM decal.*
237 Series Composite Cover Side Mount FMM Face Plate Decal, Part Number 10602146

![Image of FMM Face Plate Decal](image)

*Figure 12. Side mount 237 and other similar series composite cover FMM decal.*

237 Series Side Mount Auxiliary Fill Panel Decal, Part Number 10602114

![Image of Auxiliary Fill Panel Decal](image)

*Figure 13. When equipped with an auxiliary fill panel, this decal is required.*
5.8.5. Danger Venting High Pressure, Part Number 10602108

**Figure 14.** This decal is placed near the cylinder and/or the bleed valve.

**Figure 15.** The “Danger venting gas” decal is placed near cylinder and bleed valves.

5.8.6. PRD Vent Line Decal, Part Number 10602234

**Figure 16.** Left: PRD vent line warning decal. Right: The vent line warning decal should be placed near the FMM so the operator can see it. Position this decal near the “Danger venting gas” decal as indicated in yellow.
This decal is not required, but it is a reminder from Agility Fuel Solutions to make sure there are no potential PRD problems caused by water entry. Pressure relief device vent lines must not allow moisture and debris to enter the system. This warning decal is to be placed in two locations:

1. Near the operator interface (FMM) or cylinder valve end.
2. Next to or near the “Danger venting of pressure” decal, part number 10602108

Examples of decal placement are shown below.

**General Rule:** The PRD vent line decal must be in a visible location and not cover any existing decals.

**Figure 17. PRD vent line decal locations shown in yellow.**

**Figure 18. More PRD vent line decal locations, shown in yellow.**
If a PRD vent cap is missing or damaged, the PRD vent lines and PRDs should be inspected for blockage, water intrusion, corrosion or damage. DO NOT simply replace the cap.

5.8.7. CNG Vent Line Cap Decal, Part Number 10602021

![Figure 19. CNG vent line information decal. NOTE: Caps may vary in appearance.](image)

UV-protected vent caps must be in place to prevent water and debris entry into the PRD system. This is a reminder to maintain the vent system and caps to prevent PRD damage.

5.8.8. CNG PRD Venting Hazard Decal, Part Number 10602253

![Figure 20. the CNG Vent Hazard decal is to be placed near each PRD vent outlet area.](image)

5.8.9. Natural Gas Filter, Part Number 10602239 (L) or 10602240 (R)
5.8.10. Conspicuity Marker, Part Number 10602039

This white, reflective decal is not something for natural gas vehicles, but is a requirement for any tractor-trailer. Conspicuity markers are mounted at the top of the BTC cabinet as shown. This decal is supplied as a single, straight strip. Each corner must have the L-shape as shown. Reference: FMCSA Federal Motor Carrier Safety Association, Section 393.11: “Lamps and reflective devices.” Other agencies mention conspicuity markers.

Figure 21. The natural gas filter decal is placed on the upper part of the high pressure filter.

Figure 22. Conspicuity reflector decals at the top of a BTC system cabinet.
5.8.11. Maximum Height, Part Number 10602304

![CAUTION]

**CAUTION**

MAXIMUM TOTAL HEIGHT

_FT_ IN  __m

*Figure 23. The maximum height decal for roof-mount systems must be permanently mounted inside the driver's compartment, and clearly visible to the driver when seated.*

5.9. Inspecting System Covers and Framework

Make sure all fasteners are tight. Check clearance between cylinders and support framework and covers. Spacing should be from approx. 1/2-in. to 3/8-in. (Remember to check system pressure when assessing clearance around cylinders since a full cylinder will be larger than an empty one.) Look for scratches or other abrasion damage to inside surfaces of cabinet doors and panels as well as fuel cylinders. Correct the clearances before this condition worsens. Make sure metal heat shields and coverings are in place between exhaust components and fuel lines or wiring. Check hinges and latches for proper operation.

*Figure 24. Typical behind the cab system.*
5.10. Pressure Relief Devices (PRDs)

⚠️ CAUTION ⚠️ WARNING

If a PRD vent cap is missing or damaged, the PRD vent lines and PRDs should be inspected for blockage, water intrusion, corrosion or damage. DO NOT simply replace the cap.

Pressure relief devices cannot be repaired. However, they must be inspected for leaks and corrosion. PRDs are located on each cylinder and are near or part of the manual valve and along each cylinder. The PRD is considered to be a sub-system, since the PRD and its associated plumbing (such as vent lines) are needed for proper operation.

Two major PRD types are used in Agility Fuel Solutions installations: The area PRD and the point PRD. Regardless of type, the weep hole at the lowest portion of the vent tube must be kept open to drain moisture from the vent tube. It must be kept clear of debris and insects to ensure proper drainage. The caps at the end of the vent tubes must be in place to prevent moisture and debris entry.

**Area PRDs**

Area PRDs protect an entire length of the cylinder and increase the protection area to an entire cylinder cabinet.

*Figure 25. Side mount area PRD systems include a trigger line that monitors the entire length of the cylinder. A vent tube (not shown) routes the high pressure gas away from the vehicle if the PRD is activated.*
Figure 26. Back of cab system showing area PRD trigger lines behind the side door. Similar trigger lines are routed on the opposite side.

Point PRDs
Point PRDs offer protection within a specific radius around the cylinder.

Figure 27. Side mount point PRD system.
PRD Vent Tubes and Caps

![Warning]

CAUTION  WARNING

If a PRD vent cap is missing or damaged, the PRD vent lines and PRDs should be inspected for blockage, water intrusion, corrosion or damage. DO NOT simply replace the cap.

PRD vent tubes must be kept free from debris and moisture. There are two maintenance and inspection points for PRD vent lines:

1. The weep hole at the lowest portion of the vent tube must be kept clear and open to drain moisture from the vent tube.

2. The UV-protected vent tube caps must be in place. If caps are missing, the vent lines and PRDs must be inspected for moisture and corrosion and the caps replaced. Part number is 10702028 fits both 3/8- and 1/2-inch PRD vent tubes. The caps are heat-shrinkable and must be installed using a hot air gun.

Figure 28. PRD vent caps must be in place at all times to prevent water and debris from entering the system.

5.11. Fuel Lines and Flow Control Components

All components are visually inspected for excessive corrosion, loose mounting and wear. If natural gas odors are present (Mercaptan), perform a leak test on all components, fittings, tubes and hoses. Leaks must be repaired by a qualified technician.

The manual valves on each cylinder must be fully open for normal operation. The valve handles must be easy to open or close by hand, without tools.
Figure 29. The FMM covers have been removed for this view. Most flow control components are located in or near the FMM.

5.11.1. Hoses – Special Notes

High pressure, flexible CNG fuel hoses can become compromised if exposed to corrosive chemicals, such as road de-icing products, excessive heat or if hoses are altered or moved during or following a repair. Always make sure hoses remain routed and clipped properly for maximum performance and reliability.

Identifying High Pressure Flex Hoses

Motion Hoses – Stainless Steel Braid

Figure 30. Motion industries CNG flexible fuel line. Notice the crimp marks on the collet, the un-marked plastic cover (jacket), exposed braid and a metal tag around the hose.
A typical high pressure CNG hose made by Motion includes the following characteristics:

- Exposed braid between the outer jacket and collet
- Indentations on the collet crimp area
- A metal tag with manufacturing and date code

**Titeflex Hoses – Stainless Steel Braid**

*Figure 32. Titeflex CNG flexible fuel line. Notice the collet style and crimp marks, the plastic cover (jacket) with markings and exposed braid. A swaged fitting is attached on this example.*
Titeflex hoses typically feature the following:

- A plastic coated paper tag (may or may not be present)
- Marking on the sheath showing the Titeflex name and other information

**Parker Parflex® - Fiber Reinforced Hoses**

*Figure 34. Parflex fiber reinforced CNG hose feature a crimped collet, coiled spring strain relief and red outer jacket.*

Parker Parflex® CNG hoses do not have a stainless steel braid. It has a temperature rating of -40°F to 180°F (-40°C to 82°C). The cover is polyurethane. Parker recommends their hose assemblies should be visually inspected on at least a monthly basis. Any of the following conditions require immediate shut down and replacement of the hose assembly:

- Fitting slippage on hose
• Damaged, cut or abraded cover (any reinforcement exposed)
• Hard, stiff, heat cracked or charred hose
• Cracked, damaged or badly corroded fittings
• Leaks at fitting or in hose
• Kinked, crushed, flattened or twisted hose
• Blistered, soft, degraded or loose cover
Refer to the Parker Safety Guide, Parker Publication No. 4400-B.1 for more information

5.11.2. Inspection for All Hose Types
Clean hose ends and fittings with mild soap and water using a soft bristled brush to expose the braid.
1. If the hose end is covered by fire sleeve, it may be temporarily moved to expose the hose end for inspection. The fire sleeve must also be inspected for damage.
2. For metal braided hoses, corrosion is indicated by red, brown or yellow discoloration.

![Image](image.jpg)

Figure 36. If the hose is covered with a sleeve, move it to enable inspection of the braid and ferrule. Remember to inspect the sleeve for damage, too.
5.12. Routing and Clipping – Proximity to Engine Exhaust Components

<table>
<thead>
<tr>
<th>Situation</th>
<th>Acceptable Distance</th>
<th>Orientation To Heat Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unprotected hoses, tubing, harnesses, cables</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6-in. (152mm)</td>
<td>Above</td>
<td></td>
</tr>
<tr>
<td>5-in. (127mm)</td>
<td>Beside</td>
<td></td>
</tr>
<tr>
<td>4-in. (101.5mm)</td>
<td>Below</td>
<td></td>
</tr>
<tr>
<td>Hoses, tubing, harnesses and cables protected by reflective heat shielding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-in. (76mm)</td>
<td>Above</td>
<td></td>
</tr>
<tr>
<td>2.5-in. (63.5mm)</td>
<td>Beside</td>
<td></td>
</tr>
<tr>
<td>2-in. (51mm)</td>
<td>Below</td>
<td></td>
</tr>
<tr>
<td>Hoses, tubing, harnesses and cables protected by a heat shield (no reflective sheeting)</td>
<td>3/8-in. (10mm)</td>
<td>Between the component and the heat shield</td>
</tr>
</tbody>
</table>

NOTES

1. Heat shields must be un-damaged and firmly in place. Replace shields or fasteners if missing or damaged.

2. Make sure any additional protection devices – heat sleeve, tubing or other outer wraps – are in place and in good condition.

Make sure wire harnesses and supporting clips are in place and do not show signs of abrasion or wear. Replace clipping hardware with identical or better UV resistant materials.
5.13. Fuel System Mounts

5.13.1. Behind the Cab (BTC) Flat Isolators

Rubber isolators are used between the vehicle chassis and BTC cabinet mounting brackets to dampen vibration. The isolator is a maintenance item, but vehicle duty cycle, use/application and road conditions vary significantly.

Isolator service lifetime varies widely and is independent of vehicle mileage, so isolator wear is best observed visually.

Isolators that are in place and do not allow metal-to-metal contact are acceptable. Some isolator movement is considered normal as shown.

Excessive push-out, metal-to-metal contact and cracks are indications that an isolator must be replaced.

Torque specification for BTC flat isolators depends on fastener finish. The preferred finish for all fasteners is aluminum-zinc. Yellow zinc has been discontinued.

5/8-in. Grade 8 bolt settle torque: Aluminum Zinc: 120-135 ft. lbs, Yellow Zinc: 159-185 ft.lbs

Figure 37. BTC rubber isolators are located under each mounting point as shown. “Flat” rubber isolator part number is 22400136.

Figure 38. Rubber isolator between the BTC cabinet and vehicle chassis on a four year old system with 316,000-plus miles. A quick look indicates the rubber pad is in good condition.
There should be no metal-to-metal contact between the vehicle chassis and fuel system cabinet.

5.13.2. BTC Ring and Bushing Type Isolators

The gap between mounting bracket and lower frame should be within 1/8-inch of each other on back of cab systems with ring and bushing isolation mounts. If the gap difference between isolators is greater than 1/8-inch, the fuel system may have experienced loads exceeding normal operating conditions: inspect the entire fuel system for signs of damage. Measure the system and make sure it is square. If there are no signs of damage, remove and replace the isolators.

NOTE

Refer to Field Service Bulletin ENP-357, “Behind the Cab Cabinet Isolator Inspection and Replacement” for replacement procedures.
5.13.3. Side Mount Systems

Because of normal cylinder expansion and contraction, side- or rail-mount system straps and brackets may loosen over time, and can lead to cylinder (cylinder) spin or other preventable damage. Although some cylinder movement is normal, excessive movement must be corrected as soon as it is observed. Loose cylinders and mounting symptoms can be observed visually and include:

1) Changes in cylinder valve position.
2) Changes in tube routing connected to the cylinder valve.
3) Loose, damaged or missing rubber isolators around the fuel cylinder and mounting straps.
4) Loose, damaged or missing fasteners.

These conditions must be corrected immediately to prevent damage.

Figure 41. Measure gap between the system mounting bracket and the lower frame at each isolator and compare the differences. See text for more inspection details.

Figure 42. Cylinder valves must stay in their original orientation, fuel lines should not show signs of movement, fasteners should be snug and in place. Fittings and components must be leak-free. Your system may vary from this picture.
5.13.4. Bracket, Strap and Isolator Torque Specifications

CAUTION

Observe cylinder pressure when applying torque to cylinder strap mounting bolts.

Various mounting systems are used in side mount fuel systems. Belleville washer stacks, straps and isolators help maintain clamping pressure, yet allow for normal cylinder expansion and contraction.

Figure 43. Cylinder brackets, straps and rubber isolators must be in place and secure. The rubber isolators must not be displaced or distorted on the mounts.

Figure 44. When applying torque to the Grade 9 bolt and Belleville washer stacks, make sure to observe cylinder pressure.
5.14. Roof Mount and Front of Body Systems

Roof mounted systems are subject to damage from overhead objects such as tree limbs. Examine all cabinet panels for collision damage and missing or loose fasteners. Open the door panels and check to make sure they are not rubbing against the cylinders.

![Figure 45. Roof mount systems are subject to damage from tree limbs and other overhead objects.](image)

5.15. CNG Fuel Cylinder Inspection

Agility Fuel Solutions uses Type 3 or Type 4 cylinders supplied by several manufacturers. This section is for reference only and does not replace training needed to become a qualified or certified CNG fuel system and cylinder inspector.

**NOTICE**


**CAUTION**

Cylinder inspections must be performed by a certified or other qualified CNG fuel system inspector.
5.15.1. Inspection Preparation

Cylinder surfaces should be clean and free of dirt or other debris that impede inspection. Remove shields or covers as needed to ensure access to the cylinder surface. It is not necessary to remove the cylinder from the vehicle if the vehicle protects visually inaccessible surfaces and there is little potential for damage.

The inspector will examine, document and measure cylinder damage as defined by the cylinder manufacturer.

5.15.2. Fuel System Maintenance Intervals

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

To determine the correct maintenance intervals for your vehicle, you must first determine the type of service or conditions the vehicle will be operating. Always select the interval that occurs first.

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

Normal Duty

- Long haul, over the road with infrequent stops

Agility Fuel Solutions recommends an oil analysis be performed on the high pressure fuel filter residue to determine fuel quality from the station and to determine whether or not fuel filter maintenance intervals can deviate (be extended) from these guidelines.
### Severe Duty

<table>
<thead>
<tr>
<th>Items to Check</th>
<th>1st 1,000 Mi. 6 Mos.</th>
<th>Daily</th>
<th>5,000 Mi. 250 Hrs.</th>
<th>10,000 Mi. 500 Hrs.</th>
<th>15,000 Mi. 1000 Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel and coolant leaks</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Frame/system fastener torque check</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Cylinder strap fastener torque check (side mount)</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
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<tr>
<td>PRD vent caps check</td>
<td>x</td>
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<td>Fuel gauge operation check</td>
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<tr>
<td>Manual cylinder valves operation</td>
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<td></td>
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<td></td>
<td>x</td>
</tr>
<tr>
<td>Shut-off valve operation</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Fill receptacle inlet O-rings check</td>
<td>x</td>
<td></td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Rubber isolators condition/displacement check</td>
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<tr>
<td>Cylinder mounts</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder strap fastener torque check (side mount)</td>
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<td>x</td>
<td>x</td>
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<tr>
<td>PRD vent caps check</td>
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<tr>
<td>Manual cylinder valves operation</td>
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<tr>
<td>Emergency/Manual Shutoff valve</td>
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<tr>
<td>Fill receptacle inlet O-rings check</td>
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<tr>
<td>Replace high pressure filter element*</td>
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<td></td>
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</tr>
<tr>
<td>Replace solenoid valve coil**</td>
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<tr>
<td>High pressure gauge</td>
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<tr>
<td>Low pressure gauge</td>
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<tr>
<td>Dashboard fuel gauge</td>
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<td>x</td>
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<tr>
<td>PRD and components for corrosion</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Drive-away prevention caps</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Frame/system fastener torque check</td>
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<td>Pressure test/coolant leak check</td>
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<td>Rubber isolators condition/displacement check</td>
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<td>All fuel and coolant hoses and tubes</td>
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<td>Cylinder bracket mounts</td>
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<td>Cylinder isolator displacement</td>
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<td>Cylinder valves and PRDs</td>
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<td>BTC isolator mounts</td>
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<td>Leak check</td>
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</table>

*Or 9 months, whichever occurs first. High pressure fuel filter element replacement varies depending on fuel quality. Draining the HP filter is not required unless excessive oil is found at element change interval. **Solenoid coil replacement depends on solenoid valve type.
## Normal Duty

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<td>Leak check</td>
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</table>

*Replace element every 30,000 miles/1,000 hours or at 9 months, whichever occurs first. Interval will vary depending on fuel quality. Draining the HP filter is not required unless excessive oil is found at element change interval.*

**Solenoid coil replacement depends on solenoid valve type.
6. CNG Fuel System Maintenance

![Diagram showing CNG Fuel System Maintenance](image)

**Figure 46. A general guide to determine whether to depressurize or to defuel.**

Depending on where work must be performed, the fuel system must be either depressurized or defueled.

When working on system components downstream of manual cylinder valves, fuel pressure can be isolated by closing manual cylinder valves and depressurizing the system.

When working on fuel cylinders, cylinder valves, pressure relief devices (PRDs) and lines – the fuel system must be defueled because there is no way to isolate the high pressure contained in these components.

### 6.1. Depressurizing CNG Systems

1. Turn the vehicle off.
2. Close all cylinder valves.
3. Ensure the 1/4-turn manual shut off-valve on the FMM is in the “on/open” position.
4. Start the vehicle and run the engine until it stops.
5. Ensure the vehicle is off and the proper vehicle lock-out procedures are followed. Remove the ignition key.
6. Check the FMM gauges to ensure all pressure is relieved. (Gauges read zero.)
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 shown below.

![Figure 47. Bleed valve location.]

9. The system is now depressurized up to the primary solenoid lock-off valve. There may be some residual pressure remaining downstream of the solenoid valve, so be careful when loosening fittings for the first time.

6.2. Defueling CNG Systems

Defueling a CNG fuel system requires careful planning, since the vehicle must be towed, rather than driven to be moved.

Methane is a greenhouse gas, so it is best to drive the vehicle to near-empty to minimize the amount of fuel released into the atmosphere.

6.2.1. Defueling Preparation and Procedures

An Agility Fuel Solutions Pony Tank may be used to supply fuel a vehicle temporarily so it may be driven for a short distance.
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. The following information is provided in the absence of procedures from local authorities. A typical venting facility appears below.

**WARNING**

Be sure to vent a CNG cylinder 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.

**CAUTION**

1. Atmospheric venting of natural gas to depressurize or defuel a cylinder must be done with care. Improper equipment or procedures increase the risk of fire.
2. Before depressurizing, ground the venting orifice with a minimum 3 gauge wire to an approved electrical ground system.
3. Freestanding cylinders must be restrained prior to venting. Cylinders will contract and move if gas is released at a rapid rate.
4. Some plastic-lined (Type 4) cylinders may be sensitive to rapid defueling. To be safe, follow these best practices:
   a. To prevent damage to the cylinder liner, defuel slowly to approx. 800 psi.
   b. Wait for 60 minutes.
   c. Resume and defuel to zero psi.
5. Do not allow a vacuum to form in the cylinder at any time. Should a vacuum occur, it should be opened to atmosphere and conditioned at a temperature above 60°F (16° C) for 8 hours before being pressurized.

**Figure 48. A typical venting facility includes all these safety features. Check local building codes and authorities for requirements.**
6.2.2. Venting Facility Equipment

- A steel vent pipe, typically two-inches in diameter attached to a support structure. The pipe must extend a minimum of two feet higher than the support structure and at least 10 feet above ground. There should be no ignition sources near the pipe.
- An electrical ground connection with a minimum 3 gauge or heavier stranded copper wire attached 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.

6.2.3. Defueling Rules and Things to Know

- Only qualified personnel should perform defueling.
- Consume as much fuel as possible prior to defueling (drive the vehicle or run the engine).
- You must have an approved place to put the fuel removed from the vehicle.
- Disconnect the vehicle battery to prevent a possible ignition source.
- Notify nearby personnel prior to defueling.
- Always ground the vehicle and the fuel system.
- Use a slow flow when transferring fuel to reduce static electricity/electrostatic discharge and prevent freezing.
- Never defuel indoors.
- Always wear personal protective equipment (PPE).
- Be familiar with evacuation routes.

Rapid venting of natural gas causes a significant temperature reduction inside fuel cylinders (-100 °F or more). Residual gas in the cylinder expands after venting as the cylinder warms and will increase pressure. Therefore, to prevent over-pressurizing the cylinder, allow four hours after defueling before re-pressurizing the cylinder.
CAUTION

A. Fuel cylinders at less than 100 psi at an ambient temperature of 10°F (-12°C) or less should use a “cold fill” procedure. This condition could occur after maintenance work is performed on the fuel system or after the installation of new cylinders.

B. This procedure applies only to Agility Fuel Solutions Type 4 cylinders. Cylinders made by other manufacturers may have different cold fill instructions and should be followed.

C. Cold Fill Procedure
   1. Fill to 450 ± 50 psi (31 ± 3 bar) directly from a compressor (not from a cascade system)
   2. Wait 1 hour.
   3. Top off the system normally.

6.2.4. Defueling Options

There are three common defueling options. In all cases, both vehicle and the fueling system must be grounded to prevent static electricity build-up.

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.

Compressor Transfer

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

Return to Supply

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

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

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 freezing and static build-up.
   a. NOTE: If the system is equipped with a bleed valve, leave it closed. The bleed valve is used only when depressurizing, not defueling.
6. Close the cylinder valve.

Note: A small amount of fuel pressure will remain in the cylinder.

6.2.6. Repressurizing the System

1. Ensure the vehicle is off and remove the keys from the ignition.
2. Close the bleed valve (if it was opened for depressurizing) and torque to 4 ft-lbs to 5 ft-lbs.
3. Ensure the high pressure filter bowl and the drain plug are installed and tightened.
4. Re-install the fill panel cover (if removed).
5. Ensure the 1/4-turn manual shutoff valve on the FMM is in the “on/open” position.
6. Slowly open all cylinder shutoff valves (one on each cylinder).
7. Start the engine normally.
8. If the system is defueled, fill the CNG system normally at a fuel station, or use a Pony Tank as a temporary fuel supply.
   a. Pony Tanks are not approved for use on public roads.
   b. The Pony Tank is a low pressure CNG fuel source that connects to the inlet of the engine low pressure fuel filter.
6.3. Pressure Relief Devices (PRDs)

⚠️ DANGER ⚠️

PRDs and their plumbing lines are always under full cylinder pressure and cannot be isolated using fuel system valves.

PRDs do not have consumable parts and require no additional maintenance other than visual inspections and leak testing. PRDs that leak, are corroded or damaged must be replaced by a qualified CNG service technician.

6.3.1. Draining Vent Lines

⚠️ CAUTION ⚠️ ⚠️ WARNING ⚠️

If a PRD vent cap is missing or damaged, the PRD vent lines and PRDs should be inspected for blockage, water intrusion, corrosion or damage. DO NOT simply replace the cap.

PRD vent tubes must be kept free from debris and moisture. There are two maintenance and inspection points for PRD vent lines:

1. The weep hole at the lowest portion of the vent tube must be kept clear and open to drain moisture from the vent tube.

2. The UV-protected vent tube caps must be in place. If caps are missing, the vent lines and PRDs must be inspected for moisture and corrosion and the caps replaced. Part number is 10702028 fits both 3/8- and 1/2-inch PRD vent tubes. The caps are heat-shrinkable and must be installed using a hot air gun.

Figure 49. PRD vent caps must always be in place. If they are missing or loose, examine the vent lines and the PRD for damage or corrosion. (Cylinder plug end in a back of cab system shown.)
6.4. High Pressure Filter Maintenance

**WARNING**
The filter must not be under any pressure when servicing or personal injury may result.

1. High pressure filter element replacement intervals:
   a) Severe Duty: 15,000 miles, 1,000 hours or 9 months, whichever occurs first
   b) Normal Duty: 35,000 miles, 1,000 hours or 9 months, whichever occurs first
2. Depressurize the system.
3. Unscrew the filter bowl from the housing.
4. Remove the O-ring and clean the filter bowl inside and out with a clean, dry cloth.
5. Remove the element by pulling it off, and inspect it for oil contamination.
6. Remove the small O-ring from the element housing.
7. Un-screw the element base and remove the filter element.
8. Lubricate the small O-ring and install it on the filter element housing. Use only non-petroleum-based lube such as Parker Super-0-Lube.
9. Install the new element onto the housing, and screw the element base in place.
10. Install the filter element onto the element port inside the filter housing. Make sure it seats properly by twisting the element assembly.
11. Lubricate and install the filter bowl O-ring.
12. Carefully apply a silicone-based spray lubricant (any brand will do, 3-IN-ONE Professional is one example) to the filter bowl threads and re-assemble the filter.

Figure 50. Typical example of roof mounted PRD and vent line cap.
CAUTION

Apply lube to the threads only, DO NOT allow the lube to contaminate the filter or O-rings.

13. Torque the filter bowl to 40 ft-lbs, ±1 ft-lbs., and mark the filter bowl with a torque seal.
14. If a bleed valve was opened, make sure to close it.
15. Repressurize the system by turning the quarter-turn (main shut-off) valve to the open position.
16. Slowly open all cylinder valves.
17. Turn the vehicle ignition key on. This allows fuel to flow throughout the system.
18. Check the HP filter and connections for leaks, and repair as needed.

Torque Specifications
Filter Bowl: 40 ft-Lbs, ±1-ft-Lbs
Hex Plug: 25 to 30 ft-Lbs
In/Out Ports: 25 to 30 ft-Lbs

High Pressure Filter Assembly
20100008

Element Replacement
Severe Duty: 15,000 miles, 1,000 hours or 9 months, whichever occurs first.
Normal Duty: 35,000 miles, 1,000 hours or 9 months, whichever occurs first.

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**A filter element replacement kit is available, which includes one each filter bowl O-ring (3), filter element (5) and O-ring item 7. Order Part number 20103412.
High Pressure Mani-Filter™ Assembly
20101001

**Element Replacement**

**Severe Duty:** 15,000 miles, 1,000 hours or 9 months, whichever occurs first.

**Normal Duty:** 35,000 miles, 1,000 hours or 9 months, whichever occurs first.

**Torque Specifications**

- **Filter Bowl:** 40 ft-Lbs, ±1-ft-Lbs
- **Hex Plug:** 25 to 30 ft-Lbs
- **In/Out Ports:** 25 to 30 ft-Lbs

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**A filter element replacement kit is available, which includes one each filter bowl O-ring (3), filter element (5) and O-ring item 7. Order Part number 20103412**
6.5. Solenoid Valve Maintenance

**WARNING**

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

**Principles of Operation**

**De-energized:** The valve uses an armature and a pilot instead of a plunger. Pressure from the inlet port flows through the pilot guide surrounding the armature, and the pressure is stopped by the pilot at the orifice.

**Energized:** This valve operates on either 12V or 24V DC from the vehicle 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.

Various types of solenoid valves have been used in Agility Fuel Solutions CNG systems. To ensure maximum system reliability, we recommend the following preventative measure, depending on solenoid valve type.

**DANGER** **WARNING**

Serious injury or death may result from improper removal of a pressurized solenoid valve. Service must be performed by qualified natural gas service technicians.

6.6. AFC Solenoid Valve with Molded-In Connector

*Figure 51. AFC valve with molded-in connector (with or without internal diode).*
The molded-in connector solenoid coil should be replaced as follows:

**Severe Duty:** Every 100,000 miles or 36 months, whichever occurs first.

**Normal Duty:** Every 200,000 miles or 72 months, whichever occurs first.

Refer to “AFC Solenoid Coil Replacement (12V or 24V),” Field Service Bulletin ENP-068

### 6.7. Removal Procedure for Regulator, High Pressure (HP) Filter and Solenoid Subassembly

**NOTICE**

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

![Figure 52. High pressure filter, solenoid and regulator subassembly.](image)

1. Depressurize the system.
2. Disconnect exterior tube fittings from the HP filter, be careful not to bend or stress any plumbing components in the process.
3. Disconnect coolant lines from the regulator. Clamp or pinch off hoses to prevent coolant loss. Drain residual fluid into an appropriate container.
4. Disconnect electrical connections from solenoid valve.
5. Disconnect low pressure fuel line from regulator.
6. Carefully remove any mounting hardware connecting the subassembly to the FMM brackets.

**CAUTION**

A. Solenoid valves cannot be repaired internally; if the valve does not work, replace it.

B. Solenoid 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 the coil should be replaced.

![Figure 53. Solenoid valve location.](image)

### 6.8. Solenoid Valve – Remove and Replace

The high pressure solenoid valve operates electrically. By default it is in the “off/closed” position. The solenoid valve is located inside the FMM. 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 to the fittings, install initially by hand, then torque to 25-30 ft-lbs.
4. Connect the inlet and outlet fuel lines.
5. If the coil assembly is awkwardly positioned, reorient it before proceeding to the next step. Loosen the coil assembly nut and reposition the assembly by hand, then torque the nut to 43-55 in-lbs.
6. Plug the electrical connector 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.
10. Fix any leaks.
11. If no leaks are found, the vehicle may be returned to service.

**CAUTION**

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

<table>
<thead>
<tr>
<th>Problem</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valve fails to operate</td>
<td>1. Check the electrical supply with a voltmeter. Voltage must match the nameplate rating.</td>
</tr>
<tr>
<td></td>
<td>2. Check coils with an ohmmeter for an open or shorted condition.</td>
</tr>
<tr>
<td></td>
<td>3. Make sure pressure matches the nameplate rating.</td>
</tr>
<tr>
<td></td>
<td>4. If no apparent system problem exists, remove and replace the solenoid valve.</td>
</tr>
<tr>
<td>Valve is sluggish or inoperative, but there are no issues with the power supply and pressure complies with the nameplate rating.</td>
<td>1. If no apparent system problem exists, remove and replace the solenoid valve.</td>
</tr>
</tbody>
</table>

**6.9. Pressure Regulator**

Maintenance points on the regulator are limited to coolant hose connections to the regulator bowl and the incoming and outgoing fuel line connections. Check these items for leaks, and repair as needed. If the pressure regulator has failed, replace the regulator.

**6.10. Valve Maintenance**

Valves do not require regular maintenance. If leaks are found, depressurize the system and tighten or replace fittings or the valve as necessary.

**6.11. Fill Receptacles**

**CAUTION**

Fill receptacles are used solely on vehicles fueled by compressed natural gas. Receptacles are designed to operate with AGA/CGA NGV1 certified fueling.
nozzles. For information on coupling and uncoupling procedures, consult the CNG fueling dispenser instructions.

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 personnel should service or maintain a fueling receptacle.
3. A vehicle operator must not tamper or dissemble the receptacle or any component connected to the receptacle.


![Figure 54. If you smell gas, locate leaks using leak detection solution.](image)

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

For monthly maintenance, the entire fuel system can be leak tested with leak detection solution, and/or a methane detector. All joints and connections should be tested.

Leaks usually 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®.

1. Apply a certified leak detecting solution and look for bubbling or foaming.
2. Examine connections for icing or signs of condensation around the tubing.
3. Check for signs of damaged or perforated tubing.
6.13. Leak Repair

**WARNING**

A. Ensure the system is depressurized before repairing any leaks.
B. Maintenance and repair must be performed by qualified personnel.

Perform leak repairs in the order shown below.
**Note:** Move on to the next repair only if the previous repair did not fix the leak.

1. If a leak is detected, depressurize the system.
2. Once the system is depressurized, tighten the leaky fittings. Repressurize the system.
3. When the system is pressurized, conduct a leak test.
4. If this does not stop the leak, depressurize the system again.
5. Remove fittings that are leaking and make sure the mating surfaces are clean. Check any O-rings for signs of damage.
6. 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. Once the fittings have been assembled, repressurize the system and test for leaks.
   a. Torque specifications are in the Reference section.
7. If the leak cannot be repaired, the component should be replaced.

If replacement is necessary, obtain replacement parts, install them, perform a leak test and fix any leaks.

If the procedures listed above do not fix the problem, contact Customer Care.

6.13.1. Tube Fitting Assembly and Adjustment

**CAUTION**

Adjusting fittings requires Swagelok® or Agility Fuel Solutions fitting assembly training.

In order to achieve a safe, leak free seal, tubing connections must be fully bottomed in the fitting.

1. Tubing must be de-burred so 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.
6.13.2. Tightening Fitting Nuts

Swagelok recommends that fitting nuts should be tightened 1-1/4 turns beyond snug for tubing one inch and below. However, 1/16-, 1/8- and 3/16-in. tubing requires 3/4 turns beyond finger-tight.

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.

7. Troubleshooting

The following section covers a variety of potential problems and 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.

**NOTICE**

For any issues not addressed in this manual, contact Agility Fuel Solutions Customer Care for assistance.
### 7.1. Using Cummins Fault Codes

Cummins fault codes related to fuel delivery can be helpful when diagnosing and troubleshooting the fuel system.

<table>
<thead>
<tr>
<th>Fault Code</th>
<th>Fault Description</th>
<th>Driver Warning</th>
<th>Effects</th>
<th>Possible Causes</th>
</tr>
</thead>
</table>
| 2723       | 1. Engine gas control valve intake pressure above/below operating range  
2. Moderately severe | Check engine (amber) | Possible reduced performance | Pressure regulator failure |
| 2722       | 1. Engine gas control valve intake pressure above/below operating range  
2. Moderately severe | Check engine (amber) | Possible reduced performance | Pressure regulator failure |
| 2991       | 1. Engine gas control valve intake pressure above/below operating range  
2. Most severe | Stop engine (red) | 1. Progressive power de-rate increasing in severity from time of start  
2. If engine protection shutdown feature is enabled, engine shuts down after 30 seconds of red lamp flashing | 1. Pressure regulator or fuel flow restriction  
2. Plugged filters, damaged or kinked fuel lines  
3. Malfunctioning solenoid valve, partially closed valves |
| 2724       | 1. Gas supply pressure (regulated) above operating range  
2. Moderately severe | Check engine (amber) | Possible reduced performance | Pressure regulator failure |
| 2568       | 1. Gas supply pressure (regulated) above operating range  
2. Most severe | Stop engine (red) | Engine power de-rate | Pressure regulator failure |
| 2725       | 1. Gas supply pressure (regulated) below operating range  
2. Moderately severe | Check engine (amber) | Possible reduced performance | 1. Pressure regulator or fuel flow restriction  
2. Plugged filters, damaged or kinked fuel lines, malfunctioning solenoid valve, partially closed valves |
Figure 55. Things to check when fuel pressure related fault codes are present.
7.2. Symptom Assessment

Here are some troubleshooting hints based on symptoms or conditions.

<table>
<thead>
<tr>
<th>Item</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>After disconnecting fuel nozzle, fuel flows out of the fill receptacle</td>
</tr>
<tr>
<td>2</td>
<td>The main shutoff valve does not isolate fuel – engine continues to run even when valves have been turned to the OFF position</td>
</tr>
<tr>
<td>3</td>
<td>Too much pressure coming out of the regulator (should be approx. 125 psi)</td>
</tr>
<tr>
<td>4</td>
<td>Not enough pressure coming out of the regulator (should be approx. 125 psi)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item</th>
<th>Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>O-rings frozen due to gas expansion</td>
<td>Wait for receptacles to warm up to ambient temperature and see if leak persists</td>
</tr>
</tbody>
</table>
|      | Debris in fill receptacle                                             | 1. Depressurize fill manifold  
|      |                                                                      | 2. Remove receptacle from the manifold  
|      |                                                                      | 3. Inspect for blockage or damage  
|      |                                                                      | 4. Reinstall or replace as needed  
|      |                                                                      | 5. Test for leaks |
| 2    | Valve seats are worn or debris is not allowing the valve to fully close | 1. Depressurize system  
|      |                                                                      | 2. Remove the main shutoff valve  
|      |                                                                      | 3. Replace valve seats per valve manufacturer instructions or replace the valve  
|      |                                                                      | 4. Test for leaks |
| 3    | Regulator not working properly                                        | 1. Depressurize system  
|      |                                                                      | 2. Remove and replace the regulator |
| 4    | High pressure or low pressure filter is clogged                       | Replace filter element |

**Engine – No Crank**

**Test 1:** Does the crank signal pass through the Agility Electronic Control Unit (ECU) inside the FMM?

- Bypass the Agility ECU inside the FMM (jump blue and purple wires on the chassis side). [Some systems have reed switches wired directly through the OEM chassis wiring and will have a fuse and or a relay that will have to be jumped or checked.]

If no crank – OEM chassis issue, not fuel system - check key switch wiring

If engine cranks - Agility issue, proceed:

**Test 2:** Check reed switch, kill cap and/or proximity switch at each door and fuel cap, including auxiliary fill receptacles.
• Check the 2 single wires at the ignition switch (yellow and black) and (brown and black).
• Kill cap (single black wire). Unplug cap connector and attach to new ground.
• If more than 1 reed switch – Jump one at a time to chassis ground to find which reed switch is not working.
• Possible cause: Missing magnet or improper alignment of reed switch to magnet.
• Touch the reed switch inside the fill receptacle or door directly with test magnet and the engine should crank.

**Engine - No Run**

**Test 1:** Does the Agility fuel system maintain proper fuel pressure to the engine?
- The high pressure gauge must read more than 500 psi and the low pressure gauge must read about 125 psi, ± 10 psi.
- Make sure all valves are open (1/4 turn shutoff, all cylinder valves).
- With the ignition key on, open engine (low pressure) fuel filter petcock to allow gas to flow. Pressure should be maintained.

If fuel pressure is present, the no-run condition is an engine or chassis issue (not the fuel system).

If the checks fail, proceed:

**Test 2:** Chassis wiring power input to Agility Fuel Solutions ECU:
- Check for power going into the FMM (black and red wires).
- Check the chassis wiring harness fuse – If the fuse is blown, test the solenoid coil before replacing the fuse (Test 3).

**Test 3:** Check the Agility ECU
- Check for power at the solenoid valve inside the FMM.
- Check solenoid mechanically by plugging in and unplugging several times with the ignition key in the on position, and listen for the solenoid valve clicking.
- **If solenoid is powered** and clicks when plugged in: It is a fuel regulator issue, see Test 4.
- **If solenoid is not powered,** check for a blown fuse in chassis and for possible shorted solenoid coil. Coil resistance check (7.1 ± .5 ohms).
- Replace the solenoid coil.

**Test 4:** Pressure Regulator Testing
1. De-fueling is **not necessary** for this operation.
2. It is **not necessary** to depressurize the system.
3. It is not necessary to remove the regulator from the vehicle for this test.
4. Cylinder pressure must be between 1,500 psi and 3,600 psi before starting the test.
5. Build the test jig as shown below. A 15 psi gauge is used in the pictures below. See ENP-088, “CNG Fuel Pressure Regulator Troubleshooting”

6. Remove the maintenance cover from the FMM.

7. Clamp or pinch off the coolant hoses near the regulator and remove the connections going to the regulator.

8. Install the pressure gauge jig between the two coolant ports.

9. No need to crank or start the engine, but the ignition switch should be ON so the solenoid valve will be OPEN.

10. Observe the test jig gauge for 20 minutes to see if there is any pressure in the regulator.

11. If pressure builds, replace the regulator -- the unit is not serviceable.

See “CNG Fuel Pressure Regulator Troubleshooting,” ENP-088, for more details.

Figure 56. A shop-built regulator test jig.
8. References

8.1. Natural Gas Vehicle Cylinder Inspection Record

<table>
<thead>
<tr>
<th>Examination Features</th>
<th>Accept</th>
<th>Reject</th>
<th>Comments (Include damage level if applicable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cylinder and brackets cleaned prior to inspection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder installation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/2-in. clearance around cylinder when mounted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bracket condition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mounting pads/isolators in good condition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Labels in place</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinders not expired</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder service pressure meets or exceeds vehicle service pressure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve condition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRD condition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plug condition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel lines secure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vent lines secure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vent lines free of debris or moisture</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interfaces free of leaks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder condition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder dome with valve condition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder dome no valve condition</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
8.2. Torque Specifications: Aluminum-Zinc and Zinc Coated

Aluminum-Zinc or Zinc coated and 18.8 stainless steel fasteners are the preferred fastener finishes in Agility systems. However, if your vehicle uses yellow zinc fasteners, it is not necessary to change them.

⚠️ CAUTION ⚠️

Do not mix aluminum-zinc or zinc coated fasteners with yellow zinc fasteners.

<table>
<thead>
<tr>
<th>Grade 8 Lock Nuts</th>
<th>Minimum Torque</th>
<th>Desired Torque</th>
<th>Max Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4-20</td>
<td>7 ft-lbs</td>
<td>8 ft-lbs (96 in-lbs)</td>
<td>9 ft-lbs</td>
</tr>
<tr>
<td>5/16-18</td>
<td>17 ft-lbs</td>
<td>18 ft-lbs</td>
<td>20 ft-lbs</td>
</tr>
<tr>
<td>3/8-16</td>
<td>26 ft-lbs</td>
<td>30 ft-lbs</td>
<td>34 ft-lbs</td>
</tr>
<tr>
<td>7/16-14</td>
<td>38 ft-lbs</td>
<td>45 ft-lbs</td>
<td>52 ft-lbs</td>
</tr>
<tr>
<td>1/2-13</td>
<td>60 ft-lbs</td>
<td>69 ft-lbs</td>
<td>79 ft-lbs</td>
</tr>
<tr>
<td>9/16-12</td>
<td>85 ft-lbs</td>
<td>95 ft-lbs</td>
<td>105 ft-lbs</td>
</tr>
<tr>
<td>5/8-11</td>
<td>120 ft-lbs</td>
<td>135 ft-lbs</td>
<td>150 ft-lbs</td>
</tr>
<tr>
<td>3/4-10</td>
<td>210 ft-lbs</td>
<td>240 ft-lbs</td>
<td>270 ft-lbs</td>
</tr>
<tr>
<td>7/8-9</td>
<td>350 ft-lbs</td>
<td>380 ft-lbs</td>
<td>410 ft-lbs</td>
</tr>
<tr>
<td>1-8</td>
<td>490 ft-lbs</td>
<td>550 ft-lbs</td>
<td>610 ft-lbs</td>
</tr>
<tr>
<td>1/2-13 Neck Bolts</td>
<td>60 ft-lbs</td>
<td>69 ft-lbs</td>
<td>79 ft-lbs</td>
</tr>
</tbody>
</table>

8.3. Torque Specifications: 18.8 Stainless Steel

<table>
<thead>
<tr>
<th>Lock Nuts</th>
<th>Minimum Torque</th>
<th>Desired Torque</th>
<th>Max Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4-20</td>
<td>75 in.-lbs</td>
<td>78 in.-lbs</td>
<td>82 in.-lbs</td>
</tr>
<tr>
<td>3/8-16</td>
<td>236 in.-lbs</td>
<td>240 in.-lbs</td>
<td>259 in.-lbs</td>
</tr>
<tr>
<td>Metric 8-1.25</td>
<td>169 in.-lbs</td>
<td>169 in.-lbs</td>
<td>196 in.-lbs</td>
</tr>
<tr>
<td>1/4-20 (through nut clip)</td>
<td>75 in.-lbs</td>
<td>87 in.-lbs</td>
<td>100 in.-lbs</td>
</tr>
<tr>
<td>3/8-16 (through nut clip)</td>
<td>23 ft-lbs</td>
<td>25 ft-lbs</td>
<td>30 ft-lbs</td>
</tr>
<tr>
<td>Metric 6 -1 (through nut clip)</td>
<td>70 in.-lbs</td>
<td>84 in.-lbs</td>
<td>92 in.-lbs</td>
</tr>
<tr>
<td>Metric 8-1.25 (through nut clip)</td>
<td>169 in.-lbs</td>
<td>202 in.-lbs</td>
<td>225 in.-lbs</td>
</tr>
<tr>
<td>Metric 6 -1 (Grade 8.8)</td>
<td>70 in.-lbs</td>
<td>84 in.-lbs</td>
<td>92 in.-lbs</td>
</tr>
<tr>
<td>Metric 8-1.25 (Grade 8.8)</td>
<td>169 in.-lbs</td>
<td>202 in.-lbs</td>
<td>225 in.-lbs</td>
</tr>
</tbody>
</table>
8.4. Fastener Torque Specifications: Yellow Zinc

Information presented here is for reference only. Yellow zinc is being phased out and is no longer recommended for new installations.

**CAUTION**

Do not mix yellow zinc fasteners with aluminum-zinc or zinc coated fasteners.

<table>
<thead>
<tr>
<th>Grade 5 Lock Nuts</th>
<th>Minimum Torque</th>
<th>Desired Torque</th>
<th>Max Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2-in. Eye Bolt</td>
<td>53 ft-lbs</td>
<td>60 ft-lbs</td>
<td>80 ft-lbs</td>
</tr>
<tr>
<td>5/8-in. Eye Bolt</td>
<td>106 ft-lbs</td>
<td>125 ft-lbs</td>
<td>158 ft-lbs</td>
</tr>
<tr>
<td>3/4-in. Eye Bolt</td>
<td>190 ft-lbs</td>
<td>225 ft-lbs</td>
<td>274 ft-lbs</td>
</tr>
<tr>
<td>3/8-16</td>
<td>23 ft-lbs</td>
<td>28 ft-lbs</td>
<td>34 ft-lbs</td>
</tr>
<tr>
<td>1/2-13</td>
<td>57 ft-lbs</td>
<td>66 ft-lbs</td>
<td>75 ft-lbs</td>
</tr>
<tr>
<td>5/8-11</td>
<td>113 ft-lbs</td>
<td>120 ft-lbs</td>
<td>165 ft-lbs</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grade 8 Lock Nuts</th>
<th>Minimum Torque</th>
<th>Desired Torque</th>
<th>Max Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4-20</td>
<td>12 ft-lbs</td>
<td>14 ft-lbs</td>
<td>18 ft-lbs</td>
</tr>
<tr>
<td>5/16-18</td>
<td>19 ft-lbs</td>
<td>20 ft-lbs</td>
<td>25 ft-lbs</td>
</tr>
<tr>
<td>3/8-16</td>
<td>30 ft-lbs</td>
<td>35 ft-lbs</td>
<td>45 ft-lbs</td>
</tr>
<tr>
<td>7/16-14</td>
<td>52 ft-lbs</td>
<td>63 ft-lbs</td>
<td>70 ft-lbs</td>
</tr>
<tr>
<td>1/2-13</td>
<td>77 ft-lbs</td>
<td>90 ft-lbs</td>
<td>120 ft-lbs</td>
</tr>
<tr>
<td>9/16-12</td>
<td>120 ft-lbs</td>
<td>145 ft-lbs</td>
<td>170 ft-lbs</td>
</tr>
<tr>
<td>5/8-11</td>
<td>159 ft-lbs</td>
<td>190 ft-lbs</td>
<td>212 ft-lbs</td>
</tr>
<tr>
<td>3/4-10</td>
<td>280 ft-lbs</td>
<td>339 ft-lbs</td>
<td>376 ft-lbs</td>
</tr>
<tr>
<td>7/8-9</td>
<td>455 ft-lbs</td>
<td>505 ft-lbs</td>
<td>606 ft-lbs</td>
</tr>
<tr>
<td>1-8</td>
<td>681 ft-lbs</td>
<td>818 ft-lbs</td>
<td>909 ft-lbs</td>
</tr>
<tr>
<td>1/2-in. Neck Bolts</td>
<td>80 ft-lbs</td>
<td>85 ft-lbs</td>
<td>90 ft-lbs</td>
</tr>
</tbody>
</table>
## 8.5. Fitting Torque Specifications

<table>
<thead>
<tr>
<th>Fitting</th>
<th>Minimum Torque</th>
<th>Desired Torque</th>
<th>Max Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 3 Tank: Valve/PRD/End Plug into cylinder (1.125-12 thread)</td>
<td>110 ft-lbs</td>
<td>140 ft-lbs</td>
<td>160 ft-lbs</td>
</tr>
<tr>
<td>Valves/PRD/End Plug into Quantum cylinder (1.125-12 thread)</td>
<td>110 ft-lbs</td>
<td>115 ft-lbs</td>
<td>120 ft-lbs</td>
</tr>
<tr>
<td>Valve/PRD/End Plug into Lincoln cylinder (1.125-12 thread)</td>
<td>See note*</td>
<td>See note*</td>
<td>See note*</td>
</tr>
<tr>
<td>Constant torque gear clamp 1 1/16-in. sz. 10</td>
<td>--</td>
<td>50 in.-lbs</td>
<td>--</td>
</tr>
<tr>
<td>1/4-in. JIC</td>
<td>11 ft-lbs</td>
<td>15 ft-lbs</td>
<td>18 ft-lbs</td>
</tr>
<tr>
<td>3/8-in. JIC</td>
<td>18 ft-lbs</td>
<td>25 ft-lbs</td>
<td>31 ft-lbs</td>
</tr>
<tr>
<td>1/2-in. JIC</td>
<td>36 ft-lbs</td>
<td>45 ft-lbs</td>
<td>59 ft-lbs</td>
</tr>
<tr>
<td>5/8-in. JIC</td>
<td>57 ft-lbs</td>
<td>70 ft-lbs</td>
<td>85 ft-lbs</td>
</tr>
<tr>
<td>3/4-in. JIC</td>
<td>79 ft-lbs</td>
<td>90 ft-lbs</td>
<td>118 ft-lbs</td>
</tr>
</tbody>
</table>

*The valve or PRD manufacturer specifies the torque value:
For OMB products, the torque is 70-96 ft-lbs.

### SAE Fittings In Manifold/Valve Ports (ORB)

<table>
<thead>
<tr>
<th>Fitting</th>
<th>Minimum Torque</th>
<th>Desired Torque</th>
<th>Max Torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8-24 SAE straight</td>
<td>7 ft-lbs</td>
<td>7.5 ft-lbs</td>
<td>9 ft-lbs</td>
</tr>
<tr>
<td>7/16-20 SAE straight</td>
<td>14.5 ft-lbs</td>
<td>15 ft-lbs</td>
<td>17 ft-lbs</td>
</tr>
<tr>
<td>1/2-20 SAE straight</td>
<td>18 ft-lbs</td>
<td>18.5 ft-lbs</td>
<td>20 ft-lbs</td>
</tr>
<tr>
<td>9/16-18 SAE straight</td>
<td>25 ft-lbs</td>
<td>26 ft-lbs</td>
<td>30 ft-lbs</td>
</tr>
<tr>
<td>3/4-16 SAE straight</td>
<td>51 ft-lbs</td>
<td>52 ft-lbs</td>
<td>58 ft-lbs</td>
</tr>
<tr>
<td>7/8-14 SAE straight</td>
<td>73 ft-lbs</td>
<td>74 ft-lbs</td>
<td>81 ft-lbs</td>
</tr>
<tr>
<td>1-1/16-12 SAE straight</td>
<td>122 ft-lbs</td>
<td>125 ft-lbs</td>
<td>138 ft-lbs</td>
</tr>
<tr>
<td>1-3/16-12 SAE straight</td>
<td>155 ft-lbs</td>
<td>158 ft-lbs</td>
<td>175 ft-lbs</td>
</tr>
<tr>
<td>1-5/16-12 SAE straight</td>
<td>195 ft-lbs</td>
<td>199 ft-lbs</td>
<td>220 ft-lbs</td>
</tr>
<tr>
<td>1-5/8-12 SAE straight</td>
<td>206 ft-lbs</td>
<td>210 ft-lbs</td>
<td>231 ft-lbs</td>
</tr>
<tr>
<td>1-7/8-12 SAE straight</td>
<td>268 ft-lbs</td>
<td>273 ft-lbs</td>
<td>300 ft-lbs</td>
</tr>
</tbody>
</table>
8.6. CNG Cylinder and System Inspection Regulations, Codes and Guidelines

This is not a comprehensive list. Other local, state or province regulations may apply. Check with your authority having jurisdiction (AHJ), usually the fire department, for more information.


b. ANSI/IAS NGV2, “Basic Requirements for Compressed Natural Gas Vehicle Fuel Containers”

c. ANSI NGV2-PRD-1, “Pressure Relief Devices for Natural Gas Vehicle (NGV) Fuel Containers”


e. Compressed Gas Association (CGA) Pamphlet CGA C-6.4, “Methods for External Visual Inspection of Natural Gas Vehicle Fuel Containers and Their Installations”


g. State of California Vehicle Code 2402.6, “Regulations and Standards: Compressed or Liquefied Gas and Liquefied Petroleum Gas” and 270909, “Transporting Liquefied Petroleum or Natural Gas”

h. Cylinder manufacturer guidelines
8.7. Glossary

**Abrasion damage**: Damage to composite caused by wearing, grinding or rubbing away of composite material by friction.

**All-composite (Type 4)**: A fuel cylinder made primarily from non-metallic materials such as plastic and high strength fiber reinforced composites. May incorporate metal ports for valves and other plumbing devices.

**Boss (see “Ports”)**: The aluminum fittings at the ends of the tank, which contain the ports for installation of valves, pressure relief devices and blank plugs.

**Blank plug (see “Solid plug”)**: A threaded plug with O-ring seal.

**Carbon fiber**: One type of reinforcement fiber used in fuel cylinder composite overwrap.

**CNG**: Compressed natural gas

**Condemned cylinder**: A fuel container that has been damaged beyond repair and must be removed from service and rendered unusable. See “Destroyed.”

**Cylinder**: Preferred term for “tank” in CNG applications and systems.

**Delamination**: An induced separation between composite layers. This type of damage occurs from localized impact or resin burn out.

**Destroyed**: Alteration of a fuel cylinder to make it unusable.

**Drop-N-Go™**: Agility Fuel Solutions side- or rail-mounted systems featuring mounting brackets that simplify installation.

**Factory inspection**: An inspection and evaluation performed at an approved Agility Fuel Solutions facility, utilizing comprehensive testing techniques that are not available in field inspection.

**Field inspection**: Inspection performed at a location other than an Agility Fuel Solutions facility.

**Impact damage**: Cylinder damage caused by dropping or by a blow from another object. Impact damage may be at the surface, internal to the structure or both.

**Level 1 Damage**: Minor damage that is considered inconsequential to safe cylinder operation.

**Level 2 Damage**: Damage which is more severe than Level 1. Additional evaluation and/or rework may allow the cylinder to be returned to service.

**Level 3 Damage**: Damage that is not repairable and renders a tank unfit for continued service. Cylinders with Level 3 damage must be condemned and destroyed.

**Liner**: An internal component of a Type 4 cylinder that serves as a permeation barrier, preventing gas leakage through the composite structure.

**Manufacturer’s Label**: The label or labels containing the official markings required by the U.S. DOT, FMVSS304, ANSI/CSA NGV2, ISO 11439, CSA B51-Part 2 (Canada), and/ or other applicable standards. The label markings shall include a “CNG Only” designation, manufacturer’s symbol or trademark, manufacturer’s model number, type designation, serial number, month and year of manufacture, service pressure, the inspector’s symbol or trademark and the date when the service life expires.

**Maximum Fill Pressure**: The fill pressure allowed to obtain the settled service pressure at 70°F (21°C). For all tanks, maximum fill pressure under ANSI/ CSA NGV2 is 125% of the rated service pressure.
NGV: Natural gas vehicle.

**Pressure relief device (PRD):** A device installed in direct contact with internal pressure in the cylinder that will release the contained gas in specific emergency conditions. Excessive temperature, excessive internal pressure or both may activate the device depending on the PRD design. Thermally activated pressure relief devices are required in all installations.

**Resin:** Epoxy material in the composite overwrap filling the space and transfers the load between individual reinforcing fibers.

**Solenoid valve:** A valve which is turned on or off electrically.

**Tank:** Usually refers to liquefied natural gas (LNG) storage vessels. For compressed natural gas (CNG), use the term "cylinder."

**TUFFSHELL®:** Agility Fuel Solutions registered trademark for Type 4 cylinders. Includes protective features such as foam inserts on the ends and a glass overwrap to absorb impact and abrasion damage.

**Vent line:** A high-pressure line used to conduct gas away from a pressure relief device to a location outside of the vehicle.