Table of Contents

I. Proprietary Statement................................................................. 4

II. Trademark Notice........................................................................ 4

III. Preface....................................................................................... 4

IV. Warning Statements Used in this Manual ...................................... 5

V. Obtaining Product Support, Service or Parts ..................................... 6

1. Safety ....................................................................................... 7

1.1. Qualified Personnel .................................................................. 7

1.2. Safety Equipment ..................................................................... 7

1.3. General Safety Precautions ...................................................... 7

1.4. CNG Vehicle Safety Precautions ................................................ 8

1.5. Welding & Hot Work Precautions .............................................. 8

1.6. Codes and Compliances ............................................................ 9

1.7. First Responder Guide ............................................................. 10

1.8 CNG Cylinder Safety ................................................................ 10

1.9 Emergency Response for Gas Leaks .......................................... 11

1.10 Vehicle Fire Procedures ............................................................ 12

2. Fuel Storage, Fuel Flow and System Components.......................... 12

2.1. CNG Fuel Cylinders ............................................................... 13

2.2. System Configurations ............................................................ 13

2.3. Fuel Flow ............................................................................... 14

2.4. Fuel Management Module Function and Components ................. 15

2.5. Tubing and Fittings ................................................................. 17

2.6. Fittings .................................................................................. 17

2.7. Tube and Fitting Installation and Repairs .................................... 17

2.8. Fitting Safety .......................................................................... 17

3. Fueling the CNG System ............................................................ 18

3.1. Fuel Specifications ................................................................. 18

3.2. Fueling Vehicles with CNG ..................................................... 19
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3</td>
<td>Fueling CNG: Pressure and Temperature</td>
</tr>
<tr>
<td>4.</td>
<td>CNG Fuel System Operation</td>
</tr>
<tr>
<td>5.</td>
<td>CNG Fuel System Inspections</td>
</tr>
<tr>
<td>5.1</td>
<td>CNG Inspectors: Certified vs Qualified</td>
</tr>
<tr>
<td>5.2</td>
<td>CNG System Inspection and Interval Recommendations</td>
</tr>
<tr>
<td>5.3</td>
<td>Inspection Points for All Systems: Decals and Labels</td>
</tr>
<tr>
<td>5.4</td>
<td>Inspecting System Covers and Framework</td>
</tr>
<tr>
<td>5.5</td>
<td>Pressure Relief Devices (PRDs)</td>
</tr>
<tr>
<td>5.6</td>
<td>Fuel Lines and Flow Control Components</td>
</tr>
<tr>
<td>5.7</td>
<td>Routing and Clipping – Proximity to Engine Exhaust Components</td>
</tr>
<tr>
<td>5.8</td>
<td>Fuel System Mounts</td>
</tr>
<tr>
<td>5.9</td>
<td>Roof Mount and Front of Body Systems</td>
</tr>
<tr>
<td>6.</td>
<td>CNG Fuel Cylinder Inspection and Preparation</td>
</tr>
<tr>
<td>7.</td>
<td>Fuel System Maintenance and Intervals</td>
</tr>
<tr>
<td>8.</td>
<td>CNG Fuel System Maintenance</td>
</tr>
<tr>
<td>8.1</td>
<td>Depressurizing CNG Systems</td>
</tr>
<tr>
<td>8.2</td>
<td>Defueling CNG Systems</td>
</tr>
<tr>
<td>8.3</td>
<td>Pressure Relief Devices (PRDs)</td>
</tr>
<tr>
<td>8.4</td>
<td>High Pressure Filter Maintenance</td>
</tr>
<tr>
<td>8.5</td>
<td>Solenoid Valve Maintenance</td>
</tr>
<tr>
<td>8.6</td>
<td>AFC Solenoid Valve with Molded-In Connector</td>
</tr>
<tr>
<td>8.7</td>
<td>Removal Procedure for Regulator, High Pressure (HP) Filter and Solenoid</td>
</tr>
<tr>
<td>8.8</td>
<td>Solenoid Valve – Remove and Replace</td>
</tr>
<tr>
<td>8.9</td>
<td>Pressure Regulator</td>
</tr>
<tr>
<td>8.10</td>
<td>Valve Maintenance</td>
</tr>
<tr>
<td>8.11</td>
<td>Fill Receptacles</td>
</tr>
<tr>
<td>8.12</td>
<td>Testing and Finding Leaks</td>
</tr>
<tr>
<td>8.13</td>
<td>Leak Repair</td>
</tr>
<tr>
<td>9.</td>
<td>Troubleshooting</td>
</tr>
</tbody>
</table>
9.1. Using Cummins Fault Codes ................................................................. 74
9.2. Symptom Assessment ......................................................................... 76
10. References .......................................................................................... 79
10.1. Natural Gas Vehicle Cylinder Inspection Record ................................. 79
10.2. Torque Specifications: Aluminum-Zinc and Zinc Coated ..................... 80
10.3. Torque Specifications: 18.8 Stainless Steel ...................................... 80
10.4. Fastener Torque Specifications: Yellow Zinc ...................................... 81
10.5. Fitting Torque Specifications ............................................................. 82
10.6. Torque Specifications, Side Mount System Straps .............................. 83
10.7. Torque Specifications, Behind the Cab Systems ................................. 84
10.8. CNG Cylinder and System Inspection Regulations, Codes and Guidelines ........................................................................ 85
10.9. Glossary ............................................................................................ 86

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 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.

Parts and Customer Care: parts@agilityfs.com

Agility Fuel Solutions
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.

7. Standing on cylinders creates a fall hazard and surface damage may occur from debris stuck in shoe treads or soles. Always wear fall arrestment PPE when working on roof- or high-mounted fuel systems.
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. System pressure must not exceed 3000 psi for public vehicles in Canada.
5. For all other vehicles the system pressure must not exceed 3600 psi.
6. Do not smoke or produce an open flame within 30 feet of a CNG vehicle or a CNG dispensing/filling station.
7. Always ground a vehicle prior to defueling.
8. 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**

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 fuel system, 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 system, they must be de-fueled – and the following additional precautions must be followed:
   
   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 firefighter first responder information.

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 Cylinder Safety

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.

**DANGER**

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

1. Always call local emergency services (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 (100°C) and 220°F (104°C) 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 in CNG vehicles 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. Always check the permanent labels on each cylinder to verify the cylinder manufacturer and the expiration (do not use after) 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 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 to an amount suitable for engine consumption. Gas from the regulator flows through the low-pressure filter and finally to the engine. Low pressure specifications range from a minimum of 60 to 70 psi and a maximum of 100 or 150 psi. Starting in 2018, Agility system regulators are adjusted to approx. 85 to 87 psi to be compatible for all Cummins natural gas engines.

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

![CNG fuel flow diagram]

Fig. 4. CNG fuel flow and nominal pressures. Low pressure to most engines: 125 psi. New Cummins 6.7L, 9L, 12L and Near Zero 12L require lower fuel pressure, see text.

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 to isolate and contain the gas inside the cylinder 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 (if equipped) shows the gas pressure coming out of the regulator and going to the engine.

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

7. A bleed valve (if equipped) 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 (DAP), the engine cannot be started unless all fuel caps (including fuel system doors and auxiliary fill caps) are securely in place. Two types of DAP caps are in use:
   a. Some caps include a sensor trigger (magnet) which closes a reed switch in the FMM panel to send an “OK to crank” signal to the engine control unit (ECU).
   b. Other caps have a spring contact that completes a circuit to ground, providing the OK to crank signal to the FMM.

![Figure 5. Typical integrated FMM used in side mount systems. Note, some parts are hidden in this view.](image-url)
2.5. Tubing and Fittings

All tubing is stainless steel manufactured according to ASTM A269 or ASTM A213. It is cold finished, bright annealed, seamless tube. Tubing can be 316 SS or 304 SS, maximum hardness 80 HRB.

2.6. Fittings

![Diagram of typical cabinet style FMM front panel with cover removed.](image)

Figure 6. Typical cabinet style FMM front panel with cover removed.

### 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. 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. The engine does not run while parked, so no fuel is 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. Table 1 is a list of items to be inspected.

5.1. 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 or 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 natural gas vehicle 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.
Table 1. List of CNG fuel system components to inspect.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description and Location</th>
<th>Observation / Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>System and vehicle decals</td>
<td>Various locations on vehicle and fuel system</td>
<td>Must be in place and legible. Replace if needed.</td>
</tr>
<tr>
<td>Cylinder(s)</td>
<td>Depends on configuration</td>
<td>Inspect cylinder per manufacturer’s instructions. Labels must be in place.</td>
</tr>
<tr>
<td>Cylinder valves and PRDs</td>
<td>Mounted on each cylinder</td>
<td>A) Valves should be fully open. B) Valve should open and close freely by hand. C) If range has reduced, valve may be stuck in the closed position.</td>
</tr>
<tr>
<td>Cylinder shields and covers</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</td>
</tr>
<tr>
<td>Cylinder mounts, side mount systems with straps</td>
<td>Straps, isolators, brackets and fasteners</td>
<td>A) Tighten or replace loose or missing fasteners, displaced or cracked/torn isolators B) Manual valve handle is at 12 o’clock or its original location C) No sign of abnormal fuel line bending</td>
</tr>
<tr>
<td>Cylinder mounts, back of cab, tail gate and similar</td>
<td>Neck blocks and fasteners, isolators between system and vehicle chassis</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>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>Coolant lines</td>
<td>From engine to fuel regulator, in or near FMM</td>
<td>Check for leaks, kinked hoses, worn or loose clamps.</td>
</tr>
<tr>
<td>High pressure gauge</td>
<td>Gauge on or near the FMM</td>
<td>500 psi min., 4,000 psi max. nominal, 3,600 psi when full. Re-fuel as needed.</td>
</tr>
<tr>
<td>Low pressure gauge, if equipped</td>
<td>Gauge on or near the FMM</td>
<td>Turn ignition on or start engine. 115 psi min., 135 psi max., 125 psi nominal. Some systems supply 87 psi.</td>
</tr>
<tr>
<td>Dashboard fuel gauge</td>
<td>In cab dashboard</td>
<td>Should indicate fuel level.</td>
</tr>
<tr>
<td>Leak check</td>
<td>All fittings, PRDs, tubes, hoses and flow control components</td>
<td>Perform leak check with electronic detector or leak detection solution. Leaks to be repaired by qualified technician.</td>
</tr>
<tr>
<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 and replace cap.</td>
</tr>
<tr>
<td>Drive-away prevention (DAP) fill receptacle 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>
<tr>
<td>Low pressure filter</td>
<td>Under hood, at engine</td>
<td>Drain fluid.</td>
</tr>
</tbody>
</table>
5.2. CNG System Inspection and Interval Recommendations

Agility Fuel Solutions Recommends the Following

- Inspect the CNG cylinder(s) and system after every 1 year or after 100,000 miles, whichever occurs first.
- Inspect cylinders per the cylinder manufacturer guidelines.

NOTE: Inspections must be performed by qualified inspectors.

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

5.2.1. Pre-Service Visual Inspection

The first inspection begins before the vehicle is put into service. It is an examination of all surfaces, components, mounting systems and fuel cylinders. This inspection should confirm the delivered vehicle matches the vehicle specifications and complies with all codes, regulations and best practices. Shields and covers are removed to ensure complete examination of all surfaces, components, fittings, framework and fasteners. This inspection should be performed by a qualified or certified CNG system inspector.

5.2.2. 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. This check can be performed by the vehicle operator. If anything is wrong, a certified or qualified CNG system technician shall make the necessary repairs.

5.2.3. General Visual Inspection

A general visual inspection is performed by a certified or qualified 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.

5.2.4. Detailed Visual Inspection
After every year, or 100,000 miles (whichever occurs first), a detailed visual check is to be performed on the vehicle by a certified or qualified CNG inspector. The checks are detailed examinations 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.

**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 qualified CNG fuel system inspector.

5.3. Inspection Points for All Systems: Decals and Labels

5.3.1. 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 cylinder labels are damaged or missing, contact Agility Customer Care.
5.3.2. 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.

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.

5.3.3. Blue Diamond CNG Decal, Part Number 10602105

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.
5.3.4. 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.

Cabinet Style FMM Face Plate Decal, Part Number 10600030

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.

Figure 10. Typical cabinet style FMM front panel decal.
One Piece Aluminum Side Mount FMM Face Plate Decal, Part Number 10602176

![Image of one piece aluminum cover side mount system with integrated FMM decal.](image1)

*Figure 11. One piece aluminum cover side mount system with integrated FMM decal.*

Composite Cover Side Mount FMM Face Plate Decal, Part Number 10602146

![Image of side mount 237 and other similar series composite cover FMM decal.](image2)

*Figure 12. Side mount 237 and other similar series composite cover FMM decal.*
Composite Cover Side Mount Auxiliary Fill Panel Decal, Part Number 10602114

5.3.5. Danger Venting High Pressure, Part Number 10602108

DANGER

Venting of pressure from this system requires the use of special instructions and tools that can be obtained from Agility Fuel Solutions, 949-267-7745, support@agilityfs.com, www.agilityfs.com. Failure to follow the proper procedure could result in serious personal injury or death.

Figure 13. When equipped with an auxiliary fill panel, this decal is required.

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.
5.3.6. PRD Vent Line Decal, Part Number 10602234

![Warning Decal](image)

**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.

![Decal Placement](image)

**Figure 17. PRD vent line decal locations shown in yellow.**
5.3.7. CNG Vent Line Cap Decal, Part Number 10602021

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.
5.3.8. CNG PRD Venting Hazard Decal, Part Number 10602253

![CNG PRD Venting Hazard Decal](image1)

**WARNING**

CNG Vent Hazard
During vehicle fire:
Keep people away
Prepare for large flame
Let fire burn
Gas vents here
Failure to comply may injure or kill.

*Figure 20. The CNG Vent Hazard decal is to be placed near each PRD vent outlet area.*

5.3.9. Natural Gas Filter, Part Number 10602239 (L) or 10602240 (R)

![Natural Gas Filter](image2)

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

5.3.10. 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.
5.3.11. Maximum Height, Part Number 10602304

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.

5.4. 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.
5.5. 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 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

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

Figure 27. Side mount point PRD system.

PRD Vent Tubes and Caps

⚠️ 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 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.
5.6. 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.

5.6.1. 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**

![Titeflex CNG flexible fuel line](image)

*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.*
Figure 33. Titeflex paper tag (may or may not be present). Right: Outer jacket includes Titeflex brand and other markings.

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.

Figure 35. Parfelx hoses include a manufacturer’s metal tag, and the outer jacket is marked with the company name and hose ratings.

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

5.6.2. 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 of hose end]

*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.*
5.7. 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>6-in. (152mm)</td>
<td>Above</td>
</tr>
<tr>
<td></td>
<td>5-in. (127mm)</td>
<td>Beside</td>
</tr>
<tr>
<td></td>
<td>4-in. (101.5mm)</td>
<td>Below</td>
</tr>
<tr>
<td>Hoses, tubing, harnesses and cables protected by reflective heat shielding</td>
<td>3-in. (76mm)</td>
<td>Above</td>
</tr>
<tr>
<td></td>
<td>2.5-in. (63.5mm)</td>
<td>Beside</td>
</tr>
<tr>
<td></td>
<td>2-in. (51mm)</td>
<td>Below</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.
5.8. Fuel System Mounts

5.8.1. 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 is not used in current systems.

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.
Figure 39. There should be no metal-to-metal contact between the vehicle chassis and fuel system cabinet.

5.8.2. BTC Ring and Bushing Type Isolators

Figure 40. Ring and bushing isolator part number is 10712233.

Ring and bushing isolators are used to secure behind the cab (BTC) and tail gate fuel systems to the vehicle chassis. 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 cabinet and make sure it is square. If there are no signs of damage, remove and replace the isolators.
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.

5.8.3. BTC Cylinder Block Mounts – 203 Series Systems

Cylinder mounting blocks on 203 series BTC systems should be inspected for loose fasteners or excessive movement.


5.8.4. Side Mount Systems, General Guidelines

Because of normal cylinder expansion and contraction, side- or rail-mount system straps and brackets may loosen over time and can lead to cylinder (tank) spin or other preventable damage that is not covered under warranty.

Although some cylinder movement is normal, excessive movement must be corrected as soon as it is observed.

The front and the bottom covers should be removed from the system for proper access. If the rubber isolators are loose, displaced, damaged or missing they must be replaced.

Loose cylinders can be observed visually and include:

1) Changes in cylinder valve position.
2) Changes in tube routing connected to the cylinder valve.
3) Loose, displaced, 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 to the cylinder.
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.

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

5.8.5. Side Mount Bracket, Straps and Isolators

⚠️ 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.

The isolator is a maintenance item, but vehicle duty cycle, use/application and road conditions vary significantly.
Since 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 contact between the cylinder and the metal bracket are acceptable. Some isolator movement is considered normal.

Excessive push-out or compression, contact between the cylinder and the metal bracket, and cracks are indications that an isolator must be replaced.

**General Guidelines**

- Cracks and tears 1/2-inch or smaller are acceptable.
- Cracks and tears over 1/2-inch should be removed and replaced.
- Isolators that are displaced (moved) away from their mating surfaces by more than 1 inch, must be replaced. Isolators may be displaced up to 1/4-inch during normal assembly procedures.
- Isolators with excessive compression must be replaced: minimum remaining thickness should be 1/16-inch or greater.

*Figure 44. New rubber isolators between the brackets and cylinder.*
Figure 45. New rubber isolator material.

Figure 46. When applying torque to the Grade 9 bolt and Belleville washer stacks, make sure to observe cylinder pressure.
5.8.6. **Sliding Block Cylinder Mounts**

CNG fuel systems using sliding block cylinder mounts (part number 240105-01 engraved on the block), commonly used with 16-inch and 21-inch cylinder families should be checked periodically for Delrin bushing wear as shown below to prevent cylinder damage. The opposite end of the cylinder uses a fixed block and is not normally subjected to wear.

![Delrin bushing replacement](image)

*Figure 47. The Delrin bushing inside the sliding block (mounted on the valve end) should be replaced if there is evidence of excessive movement or play.*

5.9. **Roof Mount and Front of Body Systems**

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.

![Roof mount CNG system](image)

*Figure 48. Roof mount CNG system on a refuse vehicle.*
6. CNG Fuel Cylinder Inspection and Preparation

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.

Cylinders manufactured by Agility Fuel Solutions (TUFFSHELL™ hybrid composite Type 4 and Agility all carbon fiber Type 4 cylinders) have additional inspection details. Refer to the Agility publication “CNG Fuel Cylinder Inspection Manual,” ENP-558.

**NOTICE**


**CAUTION**

Cylinder inspections must be performed by a certified or qualified CNG cylinder inspector.

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.
7. Fuel System Maintenance and 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 Visual Check</th>
<th>Every 15,000 Mi. 1000 Hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel and coolant leaks</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame/system fastener torque check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder strap fastener torque check (side mount)</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRD vent caps check</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Fuel gauge operation check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual cylinder valves operation</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shut-off valve operation</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fill receptacle inlet O-rings check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber isolators condition/displacement check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>System and vehicle decals</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel and coolant leaks</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder mounts</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder strap fastener torque check (side mount)</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRD vent caps check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual cylinder valves operation</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency/Manual Shutoff valve</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fill receptacle inlet O-rings check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replace high pressure filter element*</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replace solenoid valve coil**</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High pressure gauge</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low pressure gauge</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dashboard fuel gauge</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRD and components for corrosion</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive-away prevention caps</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame/system fastener torque check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure test/coolant leak check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber isolators condition/displacement check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder inspection</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All fuel and coolant hoses and tubes</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check cylinder shields and covers for damage</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder bracket mounts</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder isolator displacement</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder valves and PRDs</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BTC isolator mounts</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leak check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</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.
## Normal Duty

<table>
<thead>
<tr>
<th>Items to Check</th>
<th>1st 8,000 Mi. 6 Mo.</th>
<th>Daily Visual Check</th>
<th>Every 75,000 Mi.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel and coolant leaks</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Frame/system fastener torque check</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Cylinder strap fastener torque check (side mount)</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRD vent caps check</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Fuel gauge operation check</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Manual cylinder valves operation</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Shut-off valve operation</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Fill receptacle inlet O-rings check</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Rubber isolators condition/displacement check</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>System and vehicle decals</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel and coolant leaks</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder mounts</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder strap fastener torque check (side mount)</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRD vent caps check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual cylinder valves operation</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency/Manual Shutoff valve</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fill receptacle inlet O-rings check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replace high pressure filter element*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Replace solenoid valve coil**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High pressure gauge</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low pressure filter - drain</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low pressure gauge</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dashboard fuel gauge</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRD and components for corrosion</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive-away prevention caps</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame/system fastener torque check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure test/coolant leak check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber isolators condition/displacement check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder inspection</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All fuel and coolant hoses and tubes</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check cylinder shields and covers for damage</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder bracket mounts</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder isolator displacement</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder valves and PRDs</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BTC isolator mounts</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leak check</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</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.
8. CNG Fuel System Maintenance

Figure 49. 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.

8.1. Depressurizing CNG Systems

Always close each cylinder valve to isolate and contain the gas inside the cylinder when depressurizing the system.
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 or bottom of the fill panel to access the Defuel valve and open the valve to Defuel or Open.
8. Relieve the remaining pressure by slowly opening the bleed valve. Regardless of vehicle or fuel system configuration, the bleed valve is installed in a manifold inside the FMM. See figures below for typical locations.

Figure 50. A bleed valve is typically located in a manifold in the FMM. “Box type” FMM shown.

Figure 51. In behind the cab systems equipped with an FMM, the bleed valve is installed in a manifold behind the control panel.
Figure 52. The bleed valve in side mount systems can be accessed by removing the D- or oval-shape cover plate on the FMM and valve side of the system.

9. Close the 1/4-turn manual shut-off valve as a secondary precaution.

10. 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.

8.2. 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.

Defueling requires access to the appropriate valves and receptacles on or near the FMM. Since there are a wide variety of FMM configurations, valve and receptacle locations may vary. However, the valve names and functions are the same.

This procedure covers the two defueling procedures for FMMs currently in use.

Determining which defuel procedure to use depends on the FMM control valves and not system configuration:

1. Quarter-turn manual shutoff valve and 3-way defuel valve, see Figure 53.
2. Two 1/4-turn valves (manual shutoff and defuel) and a Mani-Filter™, see Figure 54.
Figure 53. Examples of 1/4-turn valve with 3-way defuel valve FMMs. At left, side mount system FMM with 1/4-turn valve. The 3-way defuel valve is inside the housing, near the low pressure gauge. At center, box style FMM with 1/4-turn valve. The 3-way defuel valve is accessed from the bottom of the FMM chassis box. At right, a behind the cab FMM. The 3-way defuel valve is inside the cabinet.

Figure 54. FMMs equipped with manual shutoff and defuel 1/4-turn valves. At left, both 1/4-turn valves are on the front panel. At right, a back of cab FMM with panel-mounted shutoff valve. The 1/4-turn defuel valve is inside the fuel system cabinet.

8.2.1. Defueling Preparation and Procedures

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.

Here are the general rules for safe defueling:

- 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.

### 8.2.2. 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.

#### If You Must Drive Away from a Defueling Station

Refer to the table below. If you must drive the vehicle away from a defueling station, watch the high pressure gauge carefully and stay within the “OK to Drive” zone shown in green.

For example, defueling a 60 DGE system to 500 psi will leave about 4.2 DGE in the cylinder.

Remaining fuel should be removed following the defueling procedures below.

<table>
<thead>
<tr>
<th>Storage Pressure (PSI)</th>
<th>60 DGE</th>
<th>75 DGE</th>
<th>100 DGE</th>
<th>120 DGE</th>
<th>160 DGE</th>
<th>175 DGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>12.5</td>
<td>15.6</td>
<td>20.8</td>
<td>25.0</td>
<td>33.3</td>
<td>36.5</td>
</tr>
<tr>
<td>900</td>
<td>10.8</td>
<td>13.5</td>
<td>18.1</td>
<td>21.7</td>
<td>28.9</td>
<td>31.6</td>
</tr>
<tr>
<td>800</td>
<td>9.2</td>
<td>11.5</td>
<td>15.3</td>
<td>18.3</td>
<td>24.4</td>
<td>26.7</td>
</tr>
<tr>
<td>700</td>
<td>7.5</td>
<td>9.4</td>
<td>12.5</td>
<td>15.0</td>
<td>20.0</td>
<td>21.9</td>
</tr>
<tr>
<td>600</td>
<td>5.8</td>
<td>7.3</td>
<td>9.7</td>
<td>11.7</td>
<td>15.6</td>
<td>17.0</td>
</tr>
<tr>
<td>500</td>
<td>4.2</td>
<td>5.2</td>
<td>6.9</td>
<td>8.3</td>
<td>11.1</td>
<td>12.2</td>
</tr>
<tr>
<td>400</td>
<td>2.5</td>
<td>3.1</td>
<td>4.2</td>
<td>5.0</td>
<td>6.7</td>
<td>7.3</td>
</tr>
<tr>
<td>300</td>
<td>0.8</td>
<td>1.0</td>
<td>1.4</td>
<td>1.7</td>
<td>2.2</td>
<td>2.4</td>
</tr>
<tr>
<td>200</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>
8.2.3.  **Defueling (Venting) Facilities and Equipment**

Defueling stations must include the following features as shown in Figure 53. Other state or local regulations may apply. Check with your local authority having jurisdiction (AHJ).

1. 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.
2. An electrical ground connection with a minimum 3 gauge 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.
3. A high pressure electrically conductive flexible hose.
4. A hand valve to control the flow of gas.

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

1. 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.
2. Large signage indicating “NO SMOKING” and “FLAMMABLE GAS.”
3. A flame arrestor downstream of the hand valve.

**NOTICE**

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.
A. Freestanding cylinders must be restrained prior to venting. Cylinders will contract and move if gas is released at a rapid rate.
B. Some Type 4 cylinders used in Agility fuel systems may be sensitive to rapid defueling and require a specific procedure be followed to avoid damage to the plastic liner. Cylinders manufactured by Agility have no such restriction.

8.2.4. General Defueling Procedures

WARNING
A passive fuel transfer process like this does not completely remove fuel. There will always be some fuel left in the system. This fuel pressure must be vented into the atmosphere.

8.2.4.1. Defueling / Fuel Transfer Hoses

A fuel transfer hose, made with approved, CNG-compatible conductive hose and couplings is available from Agility Fuel Solutions, see Figure 56.

Figure 56. The Agility Fuel Solutions CNG transfer hose, part number 20100021, is 35 feet long and can be used to transfer CNG from one vehicle to another.

Preparing Vehicle Systems Equipped with an NGV1-style defuel receptacle, 1/4-turn valve and 3-way defuel valve.

1. The manual valves on all fuel cylinders must be open.
2. Connect a ground wire from the vehicle to the vent stack system.
3. Attach the defuel hose to the vent stack system.
4. Turn the 3-way defueling valve handle to the “Vent” position. This relieves pressure to allow hose connection.
5. Attach the defuel nozzle to the defuel receptacle on the FMM.
6. Ensure the manual shutoff valve is open.
7. Slowly open the defuel valve (to the Defuel position) 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.
   b) Watch the high pressure gauge during the defuel process.
c) When gas stops flowing, the high pressure gauges of both vehicles should be nearly equal.

d) Turn the 3-way valve from the Defuel position to the Vent position and disconnect the hose from the defuel receptacle.

e) Turn the 3-way valve from the Vent position to the “Off” position.

8. Close the cylinder valve.

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

### Preparing vehicle systems equipped with two 1/4-turn valves and a Mani-Filter™

1. The manual valves on all fuel cylinders must be open.
2. Connect the ground wire from the vehicle to the vent stack system.
3. The manual valves on all fuel cylinders should be open.
4. Close the 1/4-turn manual shutoff valve. Watch the high pressure gauge during the defuel process.
5. Open the defuel valve.
   a. The low pressure gauge should read a nominal pressure of about 125 psi.
   b. Note: Low pressure for Cummins Near Zero and other engines should be 85 psi.
6. Open the bleed valve in Mani-Filter™. This relieves pressure in the manifold.
7. Close the Mani-Filter bleed valve when pressure is relieved.
8. Connect an approved, electrically-conductive defuel hose to the defuel receptacle.
9. Open the 1/4-turn defuel shutoff valve on the FMM and commence defueling.
   a. The high pressure gauge should indicate pressure is decreasing.
   b. Adjust for a slow and steady flow to avoid freezing and static build-up.
   c. If the valve freezes, stop the process and wait until the valve thaws. Water from a garden hose may be used to thaw the defueling valve. Never use tools to chip away ice.
10. Once defueling is complete, close 1/4-turn shut off valve on the FMM.
11. Next, open the bleed valve in the Mani-Filter to relieve manifold pressure. This will allow safe removal of the defueling hose.
12. Close the bleed valve.
13. Disconnect the defuel hose.
14. Close the defuel valve and open the 1/4-turn shut off valve on the FMM, making the system ready for normal operation (re-fueling).

### 8.2.5. The Venting Process

1. There are no flow restrictions during venting (defueling) an Agility cylinder that affects its performance or suitability for service.
2. Rapid venting of natural gas normally causes a significant temperature reduction inside natural gas vehicle fuel cylinders. Internal temperatures lower than -100°F (-73°C) have been measured.

3. CNG should be vented slowly to avoid freezing plumbing components which will decrease flow.

4. The residual gas in the container after initial venting expands as the cylinder warms to its surrounding temperature. This causes a buildup of pressure if the cylinder is not allowed to vent throughout the defuel process.
   a. Keep the manual cylinder valve open during this warming stage to ensure the cylinder is defueled as completely as possible.
   b. Since the liner in the Agility Type 4 cylinder can get very cold during the defuel process, it is important to wait 4 hours after venting before re-pressurizing the cylinder to prevent liner damage.

5. Do not allow a vacuum to form in the cylinder at any time. If a vacuum occurs, the cylinder should be opened to atmosphere and conditioned at a temperature above 60°F (16°C) for 8 hours before being pressurized.

8.2.6. Refueling Defueled or New Cylinders

There are no fill flow restrictions for Agility cylinders when:

1. The ambient temperature is greater than 10°F (-12°C), or

2. The cylinder is in natural gas vehicle service with a residual pressure greater than 100 psi (649 kPa / 7 bar), or

3. The cylinder has been conditioned, see below.

8.2.7. Conditioning Cold Cylinders: A Special Condition

Agility fuel cylinders at less than 100 psi (649 kPa / 7 bar) and at an ambient temperature of 10°F (-12°C) or less are called “cold cylinders.”

This condition could occur after maintenance work is performed on the fuel system, or during the installation of new cylinders in cold climates.

There are no restrictions when time (slow) filling a cold cylinder.

After a cylinder is in service and a minimum pressure of 100 psi is maintained, the liner is seated and there is no restriction regardless of fill rate or temperature.

These procedures can be applied to any Type 4 cylinder, regardless of manufacturer.

⚠️ CAUTION

A. No Type 4 CNG fuel cylinder (regardless of manufacturer) is compatible with liquid methane. Liquid methane can form at the filling station from an extremely cold, high pressure cascade.
B. Procedures for filling a cold cylinder must prevent damage to the plastic liner by filling at a slow rate to a pressure that seats the liner.

If a cold cylinder is to be transit (fast) filled, the steps below should be performed.

1. Partially fill the cylinder, wait for a few minutes, and then re-fuel as follows:
2. Fill to 450 psi ± 50 psi (3103 kPa ± 345 kPa, 31 bar ± 3 bar) directly from a compressor (not from a cascade or compressor-less transfer station).
3. Wait 1 hour.
4. Re-fuel normally.

Remember, after a cold cylinder is in service and a minimum pressure of 100 psi is maintained, the liner is seated and there is no restriction regardless of fill rate or temperature.

8.2.8. 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. Make sure all manual cylinder valves are fully open.
7. 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. Refer to “Service Facility Fuel Handling Equipment,” ENP-380 for Pony Tank information and the operation manual for your Pony Tank.

More information on the defueling process and related subjects can be found in the following Agility Fuel Solutions publications:

“Safely Working on CNG Fuel Systems,” ENP-391
“Venting (Defueling) and Re-Filling Agility Fuel Solutions Cylinders,” ENP-649
“Pony Tank Operation Manual,” ENP-005
“Type 2 Pony Tank Operation Manual,” ENP-249
“Service Facility Fuel Handling Equipment,” ENP-380
8.3. 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.

8.3.1. Draining PRD 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. The part number is 10712383 and 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 57. 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.)](image-url)
Figure 58. Typical example of roof mounted PRD and vent line cap.

### 8.4. High Pressure Filter Maintenance

**WARNING**

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

**NOTICE**

Draining the high pressure filter is no longer necessary.

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.

**CAUTION**

**DO NOT allow lubricants to contaminate the filter or filter element.**

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.
High Pressure Filter Assembly 20100008

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

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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Qty.</th>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>10200266</td>
<td>9/16-in. hex plug (O-ring part number 10500014)</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>20100107</td>
<td>Filter bowl</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>10500022</td>
<td>Filter bowl O-ring</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>20100110</td>
<td>Element base</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>10500017</td>
<td>O-ring</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>20100109</td>
<td>Filter element**</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>20100108</td>
<td>Element housing</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>20100106</td>
<td>Filter housing</td>
</tr>
</tbody>
</table>

**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

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

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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Qty.</th>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>10200266</td>
<td>9/16-in. hex plug</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>20100107</td>
<td>Filter bowl</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>10500022</td>
<td>Filter bowl O-ring</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>20100110</td>
<td>Element base</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>20100109</td>
<td>Filter element**</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>20100108</td>
<td>Element housing</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>10500017</td>
<td>O-ring</td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>20100402</td>
<td>ManiFilter, exit LHS</td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>10500014</td>
<td>Hex plug O-ring</td>
</tr>
</tbody>
</table>

**A high pressure 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.**
### 8.5. Solenoid Valve Maintenance

**DANGER** **WARNING**

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

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

**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 are used in Agility Fuel Solutions CNG systems. To ensure maximum system reliability, we recommend the following preventative measure, depending on solenoid valve type and voltage.

This preventative maintenance procedure applies only to 12V solenoid valves made by AFC.

### 8.6. AFC Solenoid Valve with Molded-In Connector

![AFC valve with molded-in connector (with or without internal diode).](image)

**Figure 59. AFC valve with molded-in connector (with or without internal diode).**

<table>
<thead>
<tr>
<th>Solenoid Valve with Molded-In Connector, 12V</th>
<th>Complete Valve Part Number</th>
<th>Coil Only Repair Kit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10300441</td>
<td>10300463</td>
</tr>
</tbody>
</table>

NOTE: For Freightliner only, an additional wire harness is needed, part number 10400183
Preventative Maintenance Recommendation

For 12V AFC solenoid valves only: Remove and replace the solenoid valve coil every two years, regardless of mileage.

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

8.7. 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 60. 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.

![Solenoid Valve]

**Figure 61. Typical solenoid valve location: between the high pressure filter and regulator.**

### 8.8. 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.
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>

8.9. 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.

8.10. 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.

8.11. Fill Receptacles

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. Receptacle surfaces must always be kept clear of contaminants and debris. 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 disassemble the receptacle, or any component connected to the receptacle.

8.12. Testing and Finding Leaks

![Figure 62. 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 Swagelok Snoop®.

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.
8.13. 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 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.
7. Torque specifications are in the Reference section.
8. If the leak cannot be repaired, the component and stainless steel line 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 for assistance.

8.13.1. 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.
8.13.2. Tightening Fitting Nuts

For new fittings, Swagelok recommends the 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 snug.

When re-using fittings, nuts should be tightened to no more than 1/2-turn from snug.

Snug is defined as the point at which the tube cannot be rotated freely in the pre-set swaging tool or fitting body. Swagelok fittings employ a two-ferrule design, the front ferrule provides the seal and the rear ferrule provides a firm grip on the tubing.

In any case, any time fittings and components are replaced or re-installed, a leak check using approved liquid leak detector is necessary.

9. 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.
## 9.1. 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 63. Things to check when fuel pressure related fault codes are present.
9.2. 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>

*Low pressure should be approx. 87 psi for Cummins 6.7L, 9L, 12L and Near Zero 12L natural gas engines.

<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>
<tr>
<td></td>
<td>Debris in fill receptacle</td>
<td>1. Depressurize fill manifold</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Remove receptacle from the manifold</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Inspect for blockage or damage</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Reinstall or replace as needed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. Test for leaks</td>
</tr>
<tr>
<td>2</td>
<td>Valve seats are worn or debris is not allowing the valve to fully close</td>
<td>1. Depressurize system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Remove the main shutoff valve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. Replace valve seats per valve manufacturer instructions or replace the valve</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. Test for leaks</td>
</tr>
<tr>
<td>3</td>
<td>Regulator not working properly</td>
<td>1. Depressurize system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Remove and replace the regulator</td>
</tr>
<tr>
<td>4</td>
<td>High pressure or low pressure filter is clogged</td>
<td>Replace filter element</td>
</tr>
</tbody>
</table>

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.
  - Low pressure should be approx. 87 psi for Cummins 6.7L, 9L, 12L and Near Zero 12L natural gas engines.
- 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 64. A shop-built regulator test jig.
10. References

10.1. 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>
10.2. 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>Maximum 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>

10.3. Torque Specifications: 18.8 Stainless Steel

<table>
<thead>
<tr>
<th>Lock Nuts</th>
<th>Minimum Torque</th>
<th>Desired Torque</th>
<th>Maximum 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>
10.4. 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>Maximum 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>Maximum 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>
## 10.5. Fitting Torque Specifications

<table>
<thead>
<tr>
<th>Fitting</th>
<th>Minimum Torque</th>
<th>Desired Torque</th>
<th>Maximum 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>Valve/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>Maximum 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>
10.6. Torque Specifications, Side Mount System Straps

Since Type 3 and Type 4 cylinders normally expand and contract depending on pressure, mounting system fastener torque must be adjusted. For cylinders mounted with stainless steel straps and a Belleville washer stack, the following torque specs should be followed.

Although several strap mount configurations are in use, the torque specs and cylinder pressures indicated below should be used for all side mount Agility Fuel Solutions CNG fuel systems.

**CAUTION**

Observe cylinder pressure and torque when re-assembling cylinder strap brackets.

![Diagram of side mount system bracket and strap torque guidelines]

**Figure 65. Side mount system bracket and strap torque guidelines.**
10.7. Torque Specifications, Behind the Cab Systems

Two behind the cab (BTC) fuel system cabinet to vehicle chassis mounts are currently in use: The “flat rubber” and the “ring and bushing” isolator mounting systems.

10.7.1. Flat Isolators

![Figure 66. BTC systems with flat isolators require multiple torque sequences.](image)

1. Initial torque: 200 Ft-Lbs for Yellow-Zinc fasteners (150 Ft-Lbs for Aluminum-Zinc).
2. Four hours after initial torque: 200 Ft-Lbs for Yellow-Zinc (150 Ft-Lbs for Aluminum-Zinc).
3. Torque should be the same after a minimum of 4 hours after second torque. If not, re-torque in the same sequence.
   a. Settled torque range for Yellow Zinc: 159 Ft-Lbs to 185 Ft-Lbs
   b. Settled torque range for Aluminum-Zinc: 120 Ft-Lbs to 135 Ft-Lbs

**NOTICE**

Yellow zinc fasteners are no longer used in Agility systems. Aluminum-zinc or zinc coated finish is preferred.
10.8. 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.

a. NGVAmerica Technology & Development Committee Fuel System Inspection Working Group, “Compressed Natural Gas Vehicle Fuel System Inspection Guidance”


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

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

e. ANSI NGV 3.1/CSA 12.3, “Fuel System Components for Compressed Natural Gas Powered Vehicles”


h. 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”

i. Cylinder manufacturer guidelines
10.9. 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.

Drive Away Protection (DAP): Vehicle engine cannot be started unless all fuel caps (including fuel system doors and auxiliary fill caps) are securely in place.

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.