# Table of Contents

I. Proprietary Statement ........................................................................................................... 5
II. Trademark Notice .................................................................................................................. 5
III. Preface .................................................................................................................................. 5
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 .......................................................................................................... 16

3. Fueling the CNG System ..................................................................................................... 16
3.1. Fuel Specifications .......................................................................................................... 17
3.2. Fueling Vehicles with CNG ............................................................................................. 17
3.3. Fueling CNG: Pressure and Temperature ....................................................................... 18

4. CNG Fuel System Operation ............................................................................................... 18

5. CNG Fuel System Inspections .............................................................................................. 19
5.1. CNG System Inspection and Interval Recommendations ........................................20
5.2. Inspection Points for All Systems: Decals and Labels ........................................21
5.3. Inspecting System Covers and Framework ..........................................................25
5.4. Pressure Relief Devices (PRDs) ...........................................................................25
5.5. Fuel Lines and Flow Control Components ..........................................................28
5.6. Routing and Clipping – Proximity to Engine Exhaust Components .........................31
5.7. Side Mount Systems, General Inspection Guidelines ..........................................31
5.8. Sliding Block Cylinder Mounts ............................................................................35
6. CNG Fuel Cylinder Inspection and Preparation .....................................................35
7. Fuel System Maintenance and Intervals ...................................................................36
8. CNG Fuel System Maintenance ............................................................................39
8.1. Depressurizing CNG Systems .............................................................................39
8.2. Defueling CNG Systems .....................................................................................40
8.3. Refueling Defueled or New Cylinders ..................................................................46
8.4. Pressure Relief Devices (PRDs) ..........................................................................47
8.5. High Pressure Filter Maintenance ....................................................................49
8.6. Solenoid Valve Maintenance ..............................................................................51
8.7. Pressure Regulator .............................................................................................54
8.8. Valve Maintenance ..............................................................................................54
8.9. Fill Receptacles ....................................................................................................55
8.10. Testing and Finding Leaks ................................................................................55
9. Troubleshooting .....................................................................................................57
9.1. Low Pressure Symptoms and Things to Check ..................................................58
10. References .............................................................................................................59
10.1. Safety Awareness: CNG Fuel Pressure Zones ..................................................60
10.2. Natural Gas Vehicle Cylinder Inspection Record ..............................................61
10.3. Pre-Delivery Inspection (PDI) & Severe Duty Check List ..................................62
10.4. Normal Duty Inspection-Maintainence Check List ..........................................63
10.5. Torque Specifications: Aluminum-Zinc and Zinc Coated ..................................64
10.6. Torque Specifications: 18.8 Stainless Steel ................................................................. 64
10.7. Fitting Torque Specifications ....................................................................................... 65
10.8. Torque Specifications, Side Mount System Straps ..................................................... 66
10.9. CNG Cylinder and System Inspection Regulations, Codes and Guidelines ............. 67
10.10. Glossary ..................................................................................................................... 68
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. 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 +1 949-267-7745.

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 always be considered 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 3600 psi (24821 kPa / 248 bar).
5. Do not smoke or produce an open flame within 30 feet (9 meters) of a CNG vehicle or a CNG dispensing/filling station.
6. Always ground a vehicle prior to defueling.
7. If a CNG vehicle must be out of service for an extended time, turn cylinder valves to the “OFF/CLOSED” position and run the engine until it stalls. This will consume the residual fuel in the lines between the cylinder valves and the engine.

1.5. Welding & Hot Work Precautions

⚠️ WARNING ⚠️ CAUTION

A. Before performing any hot work procedure, make sure the fuel system is leak-free by performing a leak test with a suitable leak detection solution.

B. Before performing any welding on the vehicle chassis or body, ensure the main battery disconnect switch is turned off. Follow OEM or body builders’ manual for welding procedures.

C. Disconnect the CNG fuel system electrical connector at the rear of the FMM box or at the Agility ECU to prevent damage.

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

1. Ensure the vehicle is parked in a well-ventilated area. Do not park the vehicle in an area where natural gas may accumulate.

2. If welding or hot work is performed more than six feet/two meters away from the CNG fuel system, it is not necessary to defuel the system. However, the fuel system should be depressurized.
3. If performing hot work less 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
Europe: ECER110
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 reflective decal on the rear, front and/or sides of the vehicle identifying compressed natural gas (CNG).

*Figure 1. CNG vehicle diamond decal may be blue or green and may appear in multiple places on the vehicle.*

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 (24821 kPa / 248 bar). Agility Fuel Solutions minimizes 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.
NOTICE

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

DANGER

A. CNG storage cylinder pressure can reach 4500 psi (31026 kPa / 310 bar). DO NOT cut fuel supply plumbing.
B. Pressure relief device (PRD) fuel lines always contain full cylinder pressure 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 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.

*Figure 2. Typical side (chassis rail) mount CNG fuel system.*
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 (24821 kPa / 248 bar). Every Agility system is housed in a protective structure, and can be found on the roof, at the sides or above the engine compartment in the case of double decker buses.

Each cylinder is protected by one or more pressure relief devices, or PRDs.

![Diagram of CNG fuel system]

*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 depend on engine requirements and may range from a minimum of 60 psi (414 to 483 kPa / 4 to 5 bar) and a maximum of 150 psi (689 to 1034 kPa / 7 to 10 bar).

Note: The CNG fuel system ends at the input side of the low pressure fuel filter, usually located in the engine bay.
Figure 4. CNG fuel flow. Low pressure to most engines: 125 psi (862 kPa / 9 bar) nominal.

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. The following description applies to Agility Fuel Solutions FMMs, your configuration may be different.

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 NGV1 fuel fill receptacle is standard. 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 (3447 kPa / 34.5 bar), maximum pressure is 4,000 psi (27579 kPa / 275.8 bar) and nominal pressure is 3,600 psi (24821 kPa / 248 bar) when full.
5. The manifold is a “plumbing hub” where the gas is distributed to various places in the system.

6. A bleed valve (if equipped) is used to relieve any remaining pressure after the depressurizing process. It is normally closed.

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

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

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.

2.5.1. Fittings

⚠️ CAUTION

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

2.5.2. 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.

2.5.3. 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 engine manufacturer requirements.

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 before the engine cranks and starts.

**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 (24821 kPa / 248 bar).

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 (24821 kPa / 248 bar) 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 when parked, and there are no leaks in the system, so no fuel is consumed. But the pressure gauge indicates 3,000 psi (20684 kPa / 207 bar) instead of 3,600 psi (24821 kPa / 248 bar). Later in the afternoon, the ambient temperature rises to 120°F (50°C), and the gauge indicates 3,600 psi (24821 kPa / 248 bar) 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. This is normal.

Slow (overnight) filling 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.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</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>Emergency/Manual shut off 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 (3447 kPa / 34 bar) min., 3,600 psi (24821 kPa / 248 bar) when full. Re-fuel as needed*</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>If caps are missing, always inspect the PRD lines and the PRD for water entry or corrosion and replace caps.</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>High pressure filter</td>
<td>In or near the FMM*</td>
<td>Change element*</td>
</tr>
<tr>
<td>Low pressure filter</td>
<td>Underhood, at engine</td>
<td>Maintain per engine manufacturer guidelines.</td>
</tr>
</tbody>
</table>

*Trucks only.
5.1. **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 (160,934 km), whichever occurs first.

- Inspect cylinders per the cylinder manufacturer guidelines.

**NOTE:** Inspections must be performed by qualified inspectors. Inspection check lists appear in Section 7 and the Reference Section.

Regardless of which fuel system 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.

5.1.1. **Pre-Delivery Inspection (PDI)**

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.

5.1.2. **Cursory Visual Inspection (Daily Pre- and Post-Drive Checks)**

Visually check items in Table 1 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.

5.1.3. **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.
5.1.4. Detailed Visual Inspection

After every year, or 100,000 miles / 160934 km (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 all 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.

5.2. Inspection Points for All Systems: Decals and Labels

5.2.1. 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 for replacements.

*Figure 5. The CNG cylinder manufacturer’s label must be in place and legible.*
5.2.2. 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.

5.2.3. CNG Diamond Decal

![CNG Diamond Decal](image)

*Figure 6. CNG-fueled vehicle blue diamond decal.*

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

![CNG Diamond Decal](image)

*Figure 7. Left: CNG fueled vehicles are identified by a diamond shape decal. The decal may be blue or green and may be on the side, rear or front of the vehicle.*
5.2.4. 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. Each decal has its own Agility Fuel Solutions part number.

Cabinet Style FMM Face Plate Decal, Part Number 10600030

![Figure 8. Typical FMM front panel decal.]

5.2.5. Danger Venting High Pressure, Part Number 10602108

![Figure 9. This decal is placed near the cylinder and/or the bleed valve.]

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 10. The “Danger venting gas” decal is placed near cylinder and bleed valves.

5.2.6. PRD Vent Line Decal, Part Number 10602234

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.
5.3. 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 (12.7mm to 9.5mm). (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.

5.4. Pressure Relief Devices (PRDs)

A. Remember, fuel lines going to the PRDs are under constant, full cylinder pressure and cannot be isolated. (Vent lines are normally not under pressure.)

B. 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.
The PRD vent tube weep hole is at the lowest portion of the vent tube and 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.

Figure 13. PRD and vent lines, truck side mounted systems.

Figure 14. PRD and vent lines on a bus system. In this view, the upper PRD protecting the upper cylinder is shown. The lower cylinder PRD is on the opposite side.
5.4.1. PRD Vent Tubes and Caps

A. 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.

B. When activated, CNG escapes at full cylinder pressure during a fire and helps prevent cylinders from excessive pressure.

*Figure 15. PRD vent caps must always be in place to prevent moisture and debris entry. The PRD vent tube caps are heat shrinkable and must be installed with a heat gun.*
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 (9.5 to 12.7mm) PRD vent tubes. The caps are heat-shrinkable and must be installed using a hot air gun.

5.5. 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 17. The FMM covers have been removed for this view. Most flow control components are in or near the FMM.

5.5.1. 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.

Parker Parflex® - Fiber Reinforced Hoses

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.

Figure 18. Parflex fiber reinforced CNG hose feature a crimped collet, coiled spring strain relief and red outer jacket.
5.5.2. 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.

5.6. 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 shielding)</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.

5.7. Side Mount Systems, General Inspection 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 21. 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 22. 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.*

### 5.7.1. 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.

### Strap and Isolator Inspection Guidelines

- Maximum crack / tear length should not exceed 1/2-inch (12.7mm) past the (inside) edge of bracket, see Figure 23.
- Cracks and tears over 1/2-in. (12.7mm) should be removed and replaced.
- Isolators that are displaced (moved) away from their mating surfaces by more than one inch (25.4mm), must be replaced. Isolators may be displaced up to 1/4-inch (6.35mm) during normal assembly procedures.
- Isolators with excessive compression must be replaced: minimum remaining thickness should be 1/16-inch or greater.

![Figure 23. New rubber isolators between the brackets and cylinder. At right is an example of an “allowable split” on a bracket isolator.](image-url)
Figure 24. When applying torque to the Grade 9 bolt and Belleville washer stacks, make sure to observe cylinder pressure.
5.8. Sliding Block Cylinder Mounts

CNG fuel systems using sliding block cylinder mounts (part number 240105-01 engraved on the block), commonly used with 16-in. and 21-in. (406.4mm and 533.4mm) 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.

![Image of CNG cylinder with sliding block highlighted]

*Figure 25. The Delrin bushing inside the sliding block (mounted on the valve end) should be replaced if there is evidence of excessive movement or play.*

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

Note: Not all items may be present on your vehicle. Ignore items that do not apply.

<table>
<thead>
<tr>
<th>Items to Check</th>
<th>PDI</th>
<th>Daily Visual Check</th>
<th>2-Month Run-In/Annual Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel leaks use hand-held methane detector or Snoop</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Coolant leaks</td>
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</tr>
<tr>
<td>Frame/system fastener torque check*</td>
<td>x*</td>
<td></td>
<td>x*</td>
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<tr>
<td>Cylinder strap fastener torque check (side mount)</td>
<td>x</td>
<td>x</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>x</td>
</tr>
<tr>
<td>Manual cylinder valves operation</td>
<td>x</td>
<td></td>
<td>x</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>System and vehicle decals</td>
<td></td>
<td>x</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>x</td>
<td>x</td>
</tr>
<tr>
<td>PRD and components for corrosion</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Manual cylinder valves operation</td>
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<td></td>
<td></td>
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<tr>
<td>Emergency/Manual Shutoff valve</td>
<td></td>
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<td></td>
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<tr>
<td>Replace high pressure filter element***</td>
<td></td>
<td></td>
<td>x**</td>
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<tr>
<td>Replace solenoid valve coil***</td>
<td>***</td>
<td>***</td>
<td>***</td>
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<tr>
<td>High pressure gauge</td>
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<tr>
<td>Dashboard fuel gauge</td>
<td>x</td>
<td></td>
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<tr>
<td>Pressure test/coolant leak check</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Rubber isolators condition/displacement check****</td>
<td>x****</td>
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<td></td>
</tr>
<tr>
<td>Cylinder inspection, per manufacturer guidelines</td>
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<tr>
<td>Check cylinder shields and covers for damage****</td>
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<tr>
<td>Cylinder bracket mounts****</td>
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<tr>
<td>Cylinder isolator displacement****</td>
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<tr>
<td>PRDs, visual and leak check</td>
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<td></td>
<td></td>
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<tr>
<td>Leak check</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*Visual check of torque seal indicator acceptable.

**Replace element every 15,000 miles / 24140 km / 1,000 hours or 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.

***See “Solenoid Valve Maintenance” section.

****Side mount only
## Normal Duty

<table>
<thead>
<tr>
<th>Items to Check</th>
<th>1st 8,000 Mi. 12,875 km 6 Mo.</th>
<th>Daily Visual Check</th>
<th>Every 75,000 Mi. 120,700 km</th>
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</thead>
<tbody>
<tr>
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<td>x</td>
<td></td>
</tr>
<tr>
<td>Frame/system fastener torque check*</td>
<td>x*</td>
<td>x</td>
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<tr>
<td>Cylinder strap fastener torque check (side mount)</td>
<td>x</td>
<td>x</td>
<td></td>
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<tr>
<td>PRD vent caps check</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Fuel gauge operation check</td>
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</tr>
<tr>
<td>Manual cylinder valves operation</td>
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<tr>
<td>Shut-off valve operation</td>
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<tr>
<td>Fill receptacle inlet O-rings check</td>
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<td>Rubber isolators condition/displacement check</td>
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<td>System and vehicle decals</td>
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<tr>
<td>Fuel and coolant leaks</td>
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<tr>
<td>Cylinder mounts</td>
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<tr>
<td>Cylinder strap fastener torque check (side mount)</td>
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<td>PRD vent caps check</td>
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<td>Emergency/manual shutoff valve</td>
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<tr>
<td>Fill receptacle inlet O-rings check</td>
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<tr>
<td>Replace high pressure filter element**</td>
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<tr>
<td>Replace solenoid valve coil***</td>
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<td>High pressure gauge</td>
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<td>Low pressure filter - drain</td>
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<td>Dashboard fuel gauge</td>
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<td>PRD and components for corrosion</td>
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<tr>
<td>Drive-away prevention caps</td>
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<td>Pressure test/coolant leak check</td>
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<td>Rubber isolators condition/displacement check</td>
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<td>Cylinder inspection</td>
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<td>All fuel and coolant hoses and tubes</td>
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<tr>
<td>Check cylinder shields and covers for damage</td>
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<tr>
<td>Cylinder bracket mounts</td>
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<tr>
<td>Cylinder isolator displacement</td>
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<td>Cylinder valves and PRDs</td>
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<td>BTC isolator mounts</td>
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</tr>
<tr>
<td>Leak check</td>
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</table>

*Visual check of torque seal indicator acceptable.

**Replace element every 35,000 miles / 56327 km / 1,000 hours or 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.

***See “Solenoid Valve Maintenance” section.
8. CNG Fuel System Maintenance

Figure 26. A general guide to determine whether to depressurize or to defuel. Low pressure to engine depends on engine requirements.

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.
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.

**Figure 27. A bleed valve is typically located in a manifold in the FMM. “Box type” FMM shown.**

### 8.2. Defueling CNG Systems

**NOTE:** The information in this section is a general overview of typical Agility Fuel Solutions CNG fuel systems and may not apply to your specific installation. The exact procedure will vary according to your vehicle configuration, fittings and control valves used.

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.
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), including eye and ear protection.
- 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 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 (3447 kPa / 34 bar) will leave about 4.2 DGE in the cylinder.

Remaining fuel should be removed following the defueling procedures below.

Table 2. Cylinder pressure and CNG fuel system capacities. The green cells indicate “OK to drive” a short distance to the service shop.

<table>
<thead>
<tr>
<th>Storage Pressure psi / kPa / bar</th>
<th>60 DGE (730 L)</th>
<th>80 DGE (1030 L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 / 6895 / 69</td>
<td>12.5</td>
<td>15.6</td>
</tr>
<tr>
<td>900 / 6205 / 62</td>
<td>10.8</td>
<td>13.5</td>
</tr>
<tr>
<td>800 / 5516 / 55</td>
<td>9.2</td>
<td>11.5</td>
</tr>
<tr>
<td>700 / 4826 / 48</td>
<td>7.5</td>
<td>9.4</td>
</tr>
<tr>
<td>600 / 4137 / 41</td>
<td>5.8</td>
<td>7.3</td>
</tr>
<tr>
<td>500 / 3447 / 34</td>
<td>4.2</td>
<td>5.2</td>
</tr>
<tr>
<td>400 / 2758 / 28</td>
<td>2.5</td>
<td>3.1</td>
</tr>
<tr>
<td>300 / 2068 / 21</td>
<td>0.8</td>
<td>1.0</td>
</tr>
<tr>
<td>200 / 1379 / 14</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 29. Other regulations may apply. Check with your local authority having jurisdiction (AHJ).

1. A steel vent pipe, typically two-inches (51mm) in diameter attached to a support structure. The pipe must extend a minimum of two feet (.61 meters) higher than the support structure and at least 10 feet (3 meters) above ground. There should be no ignition sources near the pipe.
2. An electrical ground connection with a minimum 3 AWG (5.8mm diameter) 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.

---

*Figure 29. A typical venting facility includes all these safety features. Check local building codes and authorities for requirements.*
8.2.4. General Defueling Procedures

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

Fuel transfer hoses must be made with approved, CNG-compatible conductive hose and couplings that match the defuel fittings on the vehicle fuel system. Check with your local dealer for more information.

Preparing vehicle systems equipped with an NGV1-style defuel receptacle, 1/4-turn valve and 3-way defuel valve. (Figure 28, left.)

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 gauge on 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 an NGV1-style defuel receptacle, 1/4-turn valve and 2-way ball defuel valve. (Figure 28, right.)

1. The defuel hose must include a vent function to allow disconnection from the defuel receptacle.
2. The manual valves on all fuel cylinders must be open.
3. Connect a ground wire from the vehicle to the vent stack system.
4. Remove the FMM bottom cover to access the defuel (ball) valve.
5. Attach the defuel hose to the vent stack system.
6. Attach the other end of the defuel hose to the defuel receptacle on the FMM.
7. Ensure the manual shutoff valve is open.
8. Slowly open the defuel valve (to the Defuel position).
9. Watch the high pressure gauge during the defuel process.
10. When gas stops flowing, turn the defuel valve to the closed position.
11. Relieve pressure in the defuel hose by turning the valve to the Vent position.
12. Disconnect the hose from the defuel receptacle.
13. Replace the FMM bottom cover.

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

8.2.4.2. 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.
8.3. Refueling Defueled or New Cylinders

There are no fill flow restrictions for Agility cylinders when:

1. The ambient temperature is greater than 100°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.

8.3.1. Conditioning Cold Cylinders: A Special Condition

Agility fuel cylinders at less than 100 psi (649 kPa / 7 bar) and at an ambient temperature of 100°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 (689 kPa / 7 bar) is maintained, the liner is seated and there is no restriction regardless of fill rate or temperature.

8.3.2. 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.
   (5.4 N m to 6.8 N m)
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
“Service Facility Fuel Handling Equipment,” ENP-380

8.4. 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.

PRDs are a safety device and are thermally activated at 219°F (104°C), not pressure activated. Their purpose is to relieve cylinder pressure in case of fire to help prevent rupturing. They are usually mounted at the cylinder ends and inside the fuel system cabinet.
8.4.1. 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 (9.5mm to 12.7mm) PRD vent tubes. The caps are heat-shrinkable and must be installed using a hot air gun.

3. Corroded PRDs cannot be repaired and must be replaced with the same, approved PRD.

*Figure 30. PRD vent line caps must always be in place. If they are missing or loose, examine the vent lines and the PRD for damage or corrosion. There are two pairs of PRD vent lines in the system shown, all covered with heat-shrink caps.*
8.5. High Pressure Filter Maintenance

**WARNING**

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

**NOTICE**

The following information applies to the Agility Fuel Solutions high pressure filter. If your system is equipped with a different filter, follow the manufacturer’s recommendations.

1. High pressure filter element replacement intervals:
   a) Severe Duty: 15,000 mi. (24140 km), 1,000 hours or 9 months, whichever occurs first
   b) Normal Duty: 35,000 mi. (56327 km), 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 (54 N m) 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 (54 N m)
Hex Plug: 25 ft-lbs to 30 ft-lbs (34 N m to 41 N m)
In/Out Ports: 25 ft-lbs to 30 ft-lbs (34 N m to 41 N m)

**Element Replacement**
Severe Duty: 15,000 miles (24140 km), 1,000 hours or 9 months, whichever occurs first.
Normal Duty: 35,000 miles (56327 km), 1,000 hours or 9 months, whichever occurs first.

*Figure 31. Agility Fuel Solutions high pressure coalescing filter.*
8.6. Solenoid Valve Maintenance

**NOTICE**

The following information applies to the Agility Fuel Solutions solenoid valve in the Agility FMM. If your system is equipped with a different FMM, follow the manufacturer’s maintenance recommendations.

**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.

---

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

**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.**
8.6.1. AFC Solenoid Valve with Molded-In Connector

![Image of AFC valve with molded-in connector](image)

*Figure 32. AFC valve with molded-in connector (with or without internal diode).*

Preventative Maintenance Recommendation

For **24V solenoid valves**: Remove and replace the solenoid valve coil every 200,000 miles (320,000 km).

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

8.6.2. 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.

![Diagram of high pressure filter, solenoid and regulator subassembly](image)

*Figure 33. High pressure filter, solenoid and regulator subassembly.*

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](image)

*Figure 34. Typical solenoid valve location: between the high pressure filter and regulator.*

**8.6.3. 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 ft-lbs to 30 ft-lbs (34 N m to 41 N m).

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 in-lbs to 55 in-lbs. (4.9 N m to 6.2 N m).

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 (24821 kPa / 248 bar).

10. Fix any leaks.

11. If no leaks are found, the vehicle may be returned to service.

![CAUTION]

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

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

8.7. 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.

8.8. 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.
8.9. Fill Receptacles

⚠️ CAUTION ⚠️

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

1. 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.

8.10. Testing and Finding Leaks

![Image](image.png)

*Figure 35. If you smell gas, locate leaks using leak detection solution.*

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.

8.10.1. Leak Repair

⚠️ WARNING ⚠️

A. Ensure the system is depressurized (or defueled if necessary) 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.

8.10.2. 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.

8.10.3. 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. (1.6mm, 3.2mm and 4.8mm) 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 fuel systems; however, issues concerning other onboard systems may influence or directly cause problems with the CNG storage system.

Indications of trouble in the fuel system are related to pressure: Difficulty in starting, engine does not run or low engine performance.

If the vehicle is equipped with DriveAway™ Protection, the engine will not crank.

NOTICE

For any issues not addressed in this manual, contact Agility Fuel Solutions Customer Care for assistance.
9.1. Low Pressure Symptoms and Things to Check

- Partially closed valves
  - Open all cylinder valves
  - Open 1/4-turn valve

- High pressure filter
  - Service HP filter

- Fuel regulator
  - Remove, inspect / repair
  - Check coolant lines

- Restricted flow
  - Leak test, kinked lines, blocked components

- Solenoid valve restriction
  - Bad coil or valve
  - Intermittent operation
  - Inspect, test, replace as needed

- Low pressure filter
  - Drain or replace

Figure 36. Things to check when fuel pressure seems low.
10. References

Information in this section applies to Agility Fuel Solutions cylinders, systems, components and equipment and may not be applicable to other manufacturers’ products.

These pages may be printed or saved electronically and used as inspections and maintenance chores are performed.

More details on Agility Fuel Solutions cylinder inspection criteria and condition assessment can be found in the “CNG Fuel Cylinder Inspection Manual,” ENP-558, available from the Agility Fuel Solutions website.
10.1. Safety Awareness: CNG Fuel Pressure Zones

**Cannot Isolate Pressure:**
*MUST DEFUEL*

- Cylinders
- Manual Valves
- PRDs
- PRD Lines

**Items in RED Always Under Pressure**

- Blue Fuel Lines can be isolated w/cylinder valve

**Can Isolate Pressure:**
*DEPRESSURIZE*

- Ball Valve
- Filter
- Solenoid Valve
- Regulator

*High Pressure up to 4,500 psi (31026 kPa / 310.26 bar)*

*Low Pressure to Engine 125 psi or 87 psi (862 kPa / 8.6 bar or 600 kPa / 6 bar)*
### 10.2. Natural Gas Vehicle Cylinder Inspection Record

Note: Leave items blank and insert “N/A” if not applicable.

<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. (25.5mm) 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>
### 10.3. Pre-Delivery Inspection (PDI) & Severe Duty Check List

<table>
<thead>
<tr>
<th>Items to Check</th>
<th>PDI</th>
<th>Daily Visual Check</th>
<th>2-Month Run-In Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel leaks use hand-held methane detector or Snoop</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Coolant leaks</td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Frame/system fastener torque check*</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Cylinder strap fastener torque check (side mount)</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>PRD vent caps check</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Fuel gauge operation check</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual cylinder valves operation</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Shut-off valve operation</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Fill receptacle inlet O-rings check</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>System and vehicle decals</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Cylinder mounts</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Cylinder strap fastener torque check (side mount)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRD vent caps check</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>PRD and components for corrosion</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Manual cylinder valves operation</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Emergency/Manual Shutoff valve</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Replace high pressure filter element**</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Replace solenoid valve coil***</td>
<td>***</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>High pressure gauge</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Dashboard fuel gauge</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Pressure test/coolant leak check</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Rubber isolators condition/displacement check****</td>
<td></td>
<td></td>
<td>x****</td>
</tr>
<tr>
<td>Cylinder inspection, per manufacturer guidelines</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Check cylinder shields and covers for damage****</td>
<td></td>
<td></td>
<td>x****</td>
</tr>
<tr>
<td>Cylinder bracket mounts****</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Cylinder isolator displacement</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>PRDs, visual and leak check</td>
<td></td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Leak check</td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

*Visual check of torque seal indicator acceptable.

**Replace element every 15,000 miles / 24140 km / 1,000 hours or 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.

***See “Solenoid Valve Maintenance” section.

****Side mount only
### 10.4. Normal Duty Inspection-Maintainence Check List

<table>
<thead>
<tr>
<th>Items to Check</th>
<th>1st 8,000 Mi. 12,875 km 6 Mo.</th>
<th>Daily Visual Check</th>
<th>Every 75,000 Mi. 120,700 km</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>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></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></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></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder strap fastener torque check (side mount)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRD vent caps check</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manual cylinder valves operation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency/Manual shutoff valve</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fill receptacle inlet O-rings check</td>
<td></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></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low pressure filter - drain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low pressure gauge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dashboard fuel gauge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRD and components for corrosion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive-away prevention caps</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frame/system fastener torque check</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure test/coolant leak check</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubber isolators condition/displacement check</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder inspection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All fuel and coolant hoses and tubes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check cylinder shields and covers for damage</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder bracket mounts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder isolator displacement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cylinder valves and PRDs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BTC isolator mounts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leak check</td>
<td></td>
<td></td>
<td>x</td>
</tr>
</tbody>
</table>

*Visual check of torque seal indicator acceptable.

**Replace element every 35,000 miles / 56327 km / 1,000 hours or 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.

***See “Solenoid Valve Maintenance” section.
10.5. 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.

<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 / 9.5 N m</td>
<td>8 ft-lbs / 10.8 N m</td>
<td>9 ft-lbs / 12.2 N m</td>
</tr>
<tr>
<td>5/16-18</td>
<td>17 ft-lbs / 23 N m</td>
<td>18 ft-lbs / 24.4 N m</td>
<td>20 ft-lbs / 27.1 N m</td>
</tr>
<tr>
<td>3/8-16</td>
<td>26 ft-lbs / 35.3 N m</td>
<td>30 ft-lbs / 40.7 N m</td>
<td>34 ft-lbs / 46.1 N m</td>
</tr>
<tr>
<td>7/16-14</td>
<td>38 ft-lbs / 51.5 N m</td>
<td>45 ft-lbs / 61 N m</td>
<td>52 ft-lbs / 70.5 N m</td>
</tr>
<tr>
<td>1/2-13</td>
<td>60 ft-lbs / 81.3 N m</td>
<td>69 ft-lbs / 93.6 N m</td>
<td>79 ft-lbs / 107.1 N m</td>
</tr>
<tr>
<td>9/16-12</td>
<td>85 ft-lbs / 115.2 N m</td>
<td>95 ft-lbs / 128.8 N m</td>
<td>105 ft-lbs / 142.4 N m</td>
</tr>
<tr>
<td>5/8-11</td>
<td>120 ft-lbs / 162.7 N m</td>
<td>135 ft-lbs / 183 N m</td>
<td>150 ft-lbs / 203.4 N m</td>
</tr>
<tr>
<td>3/4-10</td>
<td>210 ft-lbs / 284.7 N m</td>
<td>240 ft-lbs / 325.4 N m</td>
<td>270 ft-lbs / 366.1 N m</td>
</tr>
<tr>
<td>7/8-9</td>
<td>350 ft-lbs / 474.5 N m</td>
<td>380 ft-lbs / 515.2 N m</td>
<td>410 ft-lbs / 555.9 N m</td>
</tr>
<tr>
<td>1-8</td>
<td>490 ft-lbs / 664.4 N m</td>
<td>550 ft-lbs / 745.7 N m</td>
<td>610 ft-lbs / 827 N m</td>
</tr>
<tr>
<td>1/2-13 Neck Bolts</td>
<td>60 ft-lbs / 81.3 N m</td>
<td>69 ft-lbs / 93.6 N m</td>
<td>79 ft-lbs / 107.1 N m</td>
</tr>
</tbody>
</table>

10.6. 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 (through nut clip)</td>
<td>75 in.-lbs / 8.5 N m</td>
<td>78 in.-lbs / 8.8 N m</td>
<td>82 in.-lbs / 9.3 N m</td>
</tr>
<tr>
<td>Metric 8-1.25 (through nut clip)</td>
<td>169 in.-lbs / 19.1 N m</td>
<td>169 in.-lbs / 19.1 N m</td>
<td>169 in.-lbs / 22.1 N m</td>
</tr>
<tr>
<td>Metric 8-1.25 (Grade 8.8)</td>
<td>169 in.-lbs / 19.1 N m</td>
<td>202 in.-lbs / 23 N m</td>
<td>225 in.-lbs / 25.4 N m</td>
</tr>
<tr>
<td>Metric 8-1.25 (Grade 8.8)</td>
<td>169 in.-lbs / 19.1 N m</td>
<td>202 in.-lbs / 23 N m</td>
<td>225 in.-lbs / 25.4 N m</td>
</tr>
<tr>
<td>Metric 6-1 (Grade 8.8)</td>
<td>70 in.-lbs / 7.9 N m</td>
<td>84 in.-lbs / 9.5 N m</td>
<td>92 in.-lbs / 10.4 N m</td>
</tr>
<tr>
<td>Metric 8-1.25 (Grade 8.8)</td>
<td>169 in.-lbs / 19.1 N m</td>
<td>202 in.-lbs / 22.8 N m</td>
<td>225 in.-lbs / 25.4 N m</td>
</tr>
</tbody>
</table>
### 10.7. 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 / 149.1 N m</td>
<td>140 ft-lbs / 189.8 N m</td>
<td>160 ft-lbs / 216.9 N m</td>
</tr>
<tr>
<td>Valve/PRD/End Plug into Quantum cylinder (1.125-12 thread)</td>
<td>110 ft-lbs / 149.1 N m</td>
<td>115 ft-lbs / 156 N m</td>
<td>120 ft-lbs / 162.7 N m</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 / 14.9 N m</td>
<td>15 ft-lbs / 20.3 N m</td>
<td>18 ft-lbs / 24.4 N m</td>
</tr>
<tr>
<td>3/8-in. JIC</td>
<td>18 ft-lbs / 24.4 N m</td>
<td>25 ft-lbs / 33.9 N m</td>
<td>31 ft-lbs / 42 N m</td>
</tr>
<tr>
<td>1/2-in. JIC</td>
<td>36 ft-lbs / 48.8 N m</td>
<td>45 ft-lbs / 61 N m</td>
<td>59 ft-lbs / 80 N m</td>
</tr>
<tr>
<td>5/8-in. JIC</td>
<td>57 ft-lbs / 77.3 N m</td>
<td>70 ft-lbs / 95 N m</td>
<td>85 ft-lbs / 115.2 N m</td>
</tr>
<tr>
<td>3/4-in. JIC</td>
<td>79 ft-lbs / 105.8 N m</td>
<td>90 ft-lbs / 122 N m</td>
<td>118 ft-lbs / 160 N m</td>
</tr>
</tbody>
</table>

*The valve or PRD manufacturer specifies the torque value: For OMB products, the torque is 70 ft-lbs to 96 ft-lbs (95 N m to 130 N m).

#### 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 / 9.5 N m</td>
<td>7.5 ft-lbs / 10.2 N m</td>
<td>9 ft-lbs / 12.2 N m</td>
</tr>
<tr>
<td>7/16-20 SAE straight</td>
<td>14.5 ft-lbs / 19.7 N m</td>
<td>15 ft-lbs / 20.3 N m</td>
<td>17 ft-lbs / 23 N m</td>
</tr>
<tr>
<td>1/2-20 SAE straight</td>
<td>18 ft-lbs / 24.4 N m</td>
<td>18.5 ft-lbs / 25.1 N m</td>
<td>20 ft-lbs / 27.1 N m</td>
</tr>
<tr>
<td>9/16-18 SAE straight</td>
<td>25 ft-lbs / 34 N m</td>
<td>26 ft-lbs / 35.3 N m</td>
<td>30 ft-lbs / 41 N m</td>
</tr>
<tr>
<td>3/4-16 SAE straight</td>
<td>51 ft-lbs / 69.1 N m</td>
<td>52 ft-lbs / 70.1 N m</td>
<td>58 ft-lbs / 79 N m</td>
</tr>
<tr>
<td>7/8-14 SAE straight</td>
<td>73 ft-lbs / 99 N m</td>
<td>74 ft-lbs / 100.3 N m</td>
<td>81 ft-lbs / 110 N m</td>
</tr>
<tr>
<td>1-1/16-12 SAE straight</td>
<td>122 ft-lbs / 165.4 N m</td>
<td>125 ft-lbs / 169.5 N m</td>
<td>138 ft-lbs / 187.1 N m</td>
</tr>
<tr>
<td>1-3/16-12 SAE straight</td>
<td>155 ft-lbs / 210.2 N m</td>
<td>158 ft-lbs / 214.2 N m</td>
<td>175 ft-lbs / 237.3 N m</td>
</tr>
<tr>
<td>1-5/16-12 SAE straight</td>
<td>195 ft-lbs / 264.4 N m</td>
<td>199 ft-lbs / 270 N m</td>
<td>220 ft-lbs / 298.3 N m</td>
</tr>
<tr>
<td>1-5/8-12 SAE straight</td>
<td>206 ft-lbs / 279.3 N m</td>
<td>210 ft-lbs / 284.7 N m</td>
<td>231 ft-lbs / 313.2 N m</td>
</tr>
<tr>
<td>1-7/8-12 SAE straight</td>
<td>268 ft-lbs / 363.4 N m</td>
<td>273 ft-lbs / 370.1 N m</td>
<td>300 ft-lbs / 407 N m</td>
</tr>
</tbody>
</table>
10.8. 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.

---

**Top Plate Torque**
- 160 ft-lbs to 180 ft-lbs
- (216.9 N m to 244.0 N m)
- 3 Bolts, 2 Places

---

**Cylinder Strap Torque, Belleville Washer Stack Bolt**
- 50 ft-lbs to 60 ft-lbs when cylinder pressure is between 500 psi to 1500 psi
- 60 ft-lbs when cylinder pressure is above 1500 psi
- 67.8 N m to 81.3 N m between 3447 kPa / 34.5 bar to 10342 kPa / 103.4 bar
- 81.3 N m when cylinder pressure is above 10342 kPa / 103.4 bar

---

*Figure 37. Side mount system bracket and strap torque guidelines.*
10.9. 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
10.10. 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 all composite Type 4 cylinders. It is a registered trademark (encircled R). The cylinders are made with a polymer liner, metallic bosses and a high strength composite wall. The composite wall comes in the following construction types:

- **TUFFSHELL® ACF:** All-Carbon Fiber reinforced in an epoxy resin. The all-carbon fiber cylinders may or may not have an external coating (paint).
- **TUFFSHELL®:** Hybrid composite cylinders consisting of carbon and glass fibers reinforced in an epoxy resin.

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