



Compressed Natural Gas Vehicle Fuel System Inspection Guidance

Prepared by
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Development Committee
Fuel System Inspection
Working Group

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Natural Gas Vehicles for America

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Purpose and Scope

This document is intended to provide guidance for the inspection of vehicular Compressed Natural Gas (CNG) fuel systems.

Introduction

Natural gas is the cleanest burning alternative transportation fuel available today that can economically power light, medium, and heavy-duty vehicle applications. Whether in the form of compressed natural gas (CNG) or liquefied natural gas (LNG), natural gas is a proven alternative fuel that significantly improves local air quality and reduces greenhouse gases (GHG).

Relevant Codes & Standards

Federal Motor Vehicle Safety Standard (FMVSS) 571.304
CSA/ANSI NGV 2-2016

Code or Standard	Section	Requirement
FMVSS 304	7.4 Labeling	Each fuel container shall have a label that states "This container should be visually inspected after a motor vehicle accident or fire and at least every 36 months or 36,000 miles; whichever comes first, for damage and deterioration."
CSA/ANSI NGV 2-2016	4.1.4 Periodic In-Service Inspections	"As a minimum, each container shall be visually inspected at least every 36 months, or at the time of any re-installation, for external damage and deterioration."

FMVSS 304 was intended to be used by light-duty vehicle manufacturers and the 36 months or 36,000 mile recommendation was tied to warranty timeframes. The standard is written that the fuel container must (shall) have a label that states the cylinder should be inspected every 36 months or 36,000 miles; however, this is merely a labeling requirement and the interval suggested by it does not provide a requirement for the inspection. Additionally, neither FMVSS 304 nor CSA/ANSI NGV2 address the entire fuel system; they are both limited to the fuel containers only.

Many commercial vehicles are running over 100,000 miles per year, which by today's standards requires the CNG container(s) to be thoroughly inspected multiple times per year. These multiple inspections per year were not the intention of FMVSS 304, and may introduce unnecessary harm to the CNG fuel system by removing access panels and mounting systems. Therefore, NGV America has submitted a petition to the United States Department of Transportation to modify FMVSS 304 inspection label requirements. The requested modification would remove the mileage requirement and change the timeframe from every three years to once a year. This change in timeframe lines up with the required annual inspection of commercial motor vehicles, including fuel systems, per 49 CFR Part 396.

CNG Fuel System Visual Inspection Considerations

What?

It is recommended that fleets and maintenance providers apply four levels of visual inspection to the fuel system of CNG-powered vehicles.

The first level of inspection is a **Pre-Service Visual Inspection**. This is a thorough inspection of the entire CNG fuel system and should be completed before the vehicle is placed into service. For fleets that have a detailed vehicle specification, this would be the time to compare the delivered vehicle with the vehicle specification, and to ensure that there are no omissions, modifications, or installation code violations. This is the first detailed visual inspection of the entire fuel system and includes removal of all shielding or covering. Cameras, bore-scopes, mirrors, etc. may be used to visually inspect the complete fuel system – every surface, component, and fitting.

The second level of inspection is a pre-trip and post-trip **Cursory Visual Inspection** of the exposed surfaces of the fuel system. During this visual inspection, the shields/enclosures of the fuel system should be observed for any damage including dents, gouges, scrapes, cuts, abrasions, discoloration, heat damage, etc.; and any readily accessible system components should be observed for signs of damage or leakage. Pressure relief device (PRD) vent lines should be inspected to ensure that vent lines are capped to prevent water from getting in the PRD outlet tubes. It is important to note that this Cursory Visual Inspection does not include the removal of any shielding, enclosures, coverings or opening of any system access panels.

The **General Visual Inspection**, which is the third level of inspection and should be completed during preventative maintenance events, includes a close examination of all system shielding and readily accessible system components. During this general inspection, the shields and enclosures of the CNG fuel system should be inspected for any damage including dents, gouges, scrapes, cuts, abrasions, discoloration, heat damage, etc. and the readily accessible system components should be inspected for signs of wear, damage, or leakage. It is important to note that the General Visual Inspection does not include the removal of any shielding beyond system access panels.

The **Detailed Visual Inspection** of the fuel system is the fourth level of inspection, and requires a thorough inspection of the entire CNG fuel system. This inspection will likely require the removal of shielding and/or the use of mirrors and cameras to visually access all components. A sample list of inspection items includes:

1. Fill receptacle and cap
2. Check valve
3. CNG storage system – including the fuel storage container, container valves, container manufacturer label, frame and enclosures
4. CNG container and mounting elements
5. Valve protection
6. Pressure Relief Device and vent system
7. Manual shut-off valve (Fuel system isolation valve)
8. Pressure regulator
9. Coolant lines to/from pressure regulator
10. Filtration – high and low pressure coalescing filters and particle filter(s)
11. Fuel lines and hoses – including routing, fittings, retention devices, and protection
12. Component mounting brackets
13. Pressure measurement devices
14. System Labels
15. Defueling valve and receptacle (if equipped)
16. Shutoff solenoid(s)

CNG Fuel System Visual Inspection Considerations

When?

It is recommended to follow the CNG fuel container manufacturer or CNG fuel system installer guidelines for fuel system inspection intervals, including following the manufacturer's recommended break-in period. Absent recommendations from either of these two entities, the following inspection levels are recommended:

- The **Pre-Service Visual Inspection** of the CNG fuel system on every new vehicle. This would be the first Detailed Visual Inspection of the fuel system.
- The driver performs a **Cursory Visual Inspection** of the CNG fuel system during each pre-trip and post-trip vehicle inspection.
- A **General Visual Inspection** should be performed at each preventative maintenance inspection.
- A **Detailed Visual Inspection** of the fuel system is to be performed on an annual interval, in the event of a thermal event or accident, and/or if damage or evidence of a leak is noted during the general visual inspection. Some fleets may elect to perform a complete Detailed Visual Inspection of the fuel system during the FHWA annual inspection.

Who?

The Cursory Visual Inspection can be completed by the vehicle operator, and the General Visual Inspection can be completed by a trained vehicle technician.

For the Detailed Visual Inspection, the fuel system inspector should be "**certified**" by either an outside entity or "**qualified**" by the fleet operator. The inspector must be knowledgeable of the CNG fuel system components, the types of fuel containers used, and damage allowances for each type. The inspector **must** also have an understanding of the inspection requirements, tests, and procedures.

APPENDIX A:

Recognized CNG Fuel System Inspector Training & Certification Programs

Most CNG fuel system installers and CNG container manufacturers offer specific product training for their customers. For more information, contact your manufacturer/installer.

CNG Fuel System Inspector training and certification is available from these recognized organizations.

- Natural Gas Vehicle Institute (NGVi) - http://ngvi.com/cng_inspector.html
- CSA Group - <http://shop.csa.ca/en/canada/personnel-certification-programs/compressed-natural-gas-cng-fuel-system-inspector-certification/inv/2703393>
- There are also several colleges that offer CNG fuel system inspection training programs.

APPENDIX B: Inspection Documents

- The fuel container manufacturer maintenance and inspection manual – this is the primary inspection document for the container and its installation, container valve, and container PRDs. In the absence of this document, the inspector is to use CGA C-6.4 as the inspection document.
- NFPA 52 Vehicular Natural Gas Fuel System Code – this is the fuel system installation code in the United States. NFPA 52 is only relevant to the version of NFPA 52 in affect at the time the vehicle was built.
- CGA C-6.4 Methods for External Visual Inspection of Natural Gas Vehicle (NGV) and Hydrogen Vehicle (HGV) Fuel Containers and Their Installations – this is the fuel system inspection standard in the United States

APPENDIX C: Cursory Visual Inspection

The driver conducts an inspection of the CNG fuel system during pre-trip and post-trip inspections. Without removing access panels, the driver should look for the following:

- Damage to CNG fuel system components.** Dents, dings, cuts, gouges, scrapes, etc. to the CNG cylinder covers/enclosures and visible CNG fuel lines and components.
- Signs of gas leaks.** Leaks can be detected by a rotten egg smell, visible damage to CNG fuel system, and a hissing sound of leaking natural gas.
- CNG fill receptacle and cap.** The fill receptacle cap should be in place. The fill receptacle o-ring should be in place and there should be no marring on the face of the receptacle.

If signs of damage to the CNG fuel system are identified during the cursory visual inspection, the vehicle should be put out of operation until a more in depth investigation is performed.

APPENDIX D: General Visual Inspection

A trained technician conducts an inspection of the CNG fuel system during preventative maintenance (PM) events, such as oil changes, filter changes, scheduled maintenance, etc. The technician should look for the following:

- Damage to CNG fuel system components.** Dents, dings, cuts, gouges, scrapes, etc. to the CNG cylinder covers/enclosures and visible CNG fuel lines and components.
- Signs of gas leaks.** Leaks can be detected by a rotten egg smell, visible damage to CNG fuel system, and a hissing sound of leaking natural gas.
- CNG fill receptacle and cap.** The fill receptacle cap should be in place. The fill receptacle o-ring should be in place and there should be no marring on the face of the receptacle.
- Debris around the CNG cylinders.** Remove all debris and check for any damage to the cylinders
- Pressure relief device (PRD) vent tubes, caps, and labels.** PRD vent tubes should not have any crimps in the routing or cuts. PRD vent caps and labels must be in place.
- CNG fuel tubes, hoses, clamps and piping.** CNG hose routings should be in place as designed. Clamps, where applicable, should be in place.
- CNG cylinder mounting.** Inspect the neck clamping blocks for loose bolts or signs of wear or damage. For strap-mounted tanks, inspect the condition of the rubber isolator for cracks, signs of wear, or movement.

If signs of damage to the CNG fuel system are identified during the general visual inspection, the vehicle should be put out of operation until a more in depth investigation is performed.

APPENDIX E: Detailed Visual Inspection

A certified or qualified CNG fuel system inspector conducts an inspection of the CNG fuel system once a year, before the vehicle is placed in service, and after any thermal event or accident. The inspector should inspect the complete high pressure CNG fuel system, cameras and/or mirrors can be used. Fleets will typically have a checklist and form for the detailed visual inspection. CGA C-6.4 provides a comprehensive inspection checklist, and a generic sample checklist is provided below:

Checked?	Item	Detail
	Signs of natural gas leaks	<ul style="list-style-type: none"> • rotten egg smell and/or a hissing sound • detection of methane from a methane leak detector
	CNG fill receptacle and cap	<ul style="list-style-type: none"> • fill receptacle cap in place • fill receptacle o-ring in place • no marring on the face of the receptacle • no signs of brinelling of receptacle
	Check valve(s)	<ul style="list-style-type: none"> • no leaks at the connections to check valves • valve does not have signs of impact
	CNG storage system	<ul style="list-style-type: none"> • no dents, dings, cuts, gouges, scrapes, etc to the CNG containers • no signs of leakage at the inlet/outlet of the tank valves • tank straps intact • no indentations or cuts on the CNG tanks under the straps • CNG cylinder mounts intact • fasteners torqued to manufacturer specifications • solenoid valve electrical line and connector, if applicable, intact without any signs of abrasion
	CNG storage system covers and shields	<ul style="list-style-type: none"> • CNG storage system covers and shields in place without contact to surrounding components
	Valve protection	<ul style="list-style-type: none"> • valve shielding in place without contact to surrounding components
	Manual shut-off valve (Fuel system isolation valve)	<ul style="list-style-type: none"> • able to open and close the manual valve • valve intact without any signs of impact damage
	Pressure regulator	<ul style="list-style-type: none"> • regulator intact without any signs of impact damage • no signs of leakage at the inlet/outlet of the regulator • electrical line and connector, if applicable, intact without any signs of abrasion

Checked?	Item	Detail
	Coolant lines to/from pressure regulator	<ul style="list-style-type: none"> • no abrasion, cuts, or gouges to lines or protective coating
	Filtration	<ul style="list-style-type: none"> • no signs of leakage around the coalescing filter bowl • no signs of leakage at the inlet/outlet of the filters • check that filters have been changed, if necessary
	Fuel lines and hoses	<ul style="list-style-type: none"> • routing of fuel lines and hoses meets design intention • no abrasion, cuts, or gouges to lines or protective coating
	Component mounting brackets	<ul style="list-style-type: none"> • mounting brackets are intact without contact to surrounding components • fasteners torqued to manufacturer specifications
	System labels	<ul style="list-style-type: none"> • appropriate labels in place • CNG cylinder label visible • CNG cylinder within service timeframe listed on cylinder label
	Defueling valve and receptacle	<ul style="list-style-type: none"> • defueling receptacle cap in place • defueling receptacle o-ring in place • no marring on the face of the receptacle • no signs of brinelling of receptacle
	Shutoff solenoid	<ul style="list-style-type: none"> • solenoid intact without any signs of impact damage • electrical line and connector intact without any signs of abrasion

APPENDIX F: CNG Cylinder Types

- Type 1 CNG cylinders are all metal tanks made either from aluminum or steel.
- Type 2 CNG cylinders are manufactured with a metal liner reinforced by glass or carbon fiber composite wrap around the middle, also referred to as “hoop wrap”. The liner and composite each receive 50% of the stress caused by internal pressurization.
- Type 3 CNG cylinders, like Type 2, are manufactured using a metal liner, however are reinforced with a full composite wrap covering the entire cylinder. The full composite wrap absorbs most of the gas pressure.
- Type 4 CNG cylinders are manufactured using a plastic gas-tight liner reinforced by a full composite wrap around the entire tank.

For more information contact

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