



## **First Responder Guide: CNG and LNG Vehicle Fuel Systems**

**ENP-084  
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## I. Proprietary Statement

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## II. Preface

This manual is a supplemental guide for public safety first responders to compressed natural gas (CNG) or liquefied natural gas (LNG) vehicle fuel system incidents.

It does not cover response tactics for liquefied petroleum gas (LPG or propane) and does not cover response to vehicle fuel systems using Type 1 or Type 2 CNG cylinders.

This manual is not intended to replace any formal training on the proper response techniques, tactics or procedures for responding to alternative fuel vehicle (AFV) accidents or incidents.

### NOTE

Always consult the National Fire Protection Association (NFPA) and your own training programs for the latest information and best practices for CNG and LNG emergency response.

## III. Warning Statements Used in this Manual



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



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.

**IV. Obtaining Product Support, Service or Parts**

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

Customer Care: support@agilityfs.com

Parts: parts@agilityfs.com

Visit our website for more information, including CNG and LNG fuel system videos. Go to [www.agilityfuelsolutions.com](http://www.agilityfuelsolutions.com)

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Revision	Description	Author	Approved By	Date
--	Initial Release	A. Durrant		
A	Changed format, no information changes	W. Yoshida	Y. Coy	07/09/13
B	Complete re-write	W. Yoshida	C. Forsberg	8/24/15
C	Updated company address and logos, added ANSI Z535 warning icons, updated NFPA training URL, re-formatted manual	W. Yoshida	M. Meyer	7/26/17

## 1. Compressed and Liquefied Natural Gas Facts

Natural gas (methane) is flammable; however, it only burns within a narrow range when mixed with air in a ratio of between 5 and 15 percent. Natural gas is odorless, colorless and tasteless. Natural gas is lighter than air so it rises and diffuses into the atmosphere when released.

Natural gas has unique hazards not found in gasoline and diesel fuel: Natural gas is in a gaseous state at normal temperatures and pressures. In order to be stored efficiently, it must be stored under high pressure (3600 psi) in a compressed natural gas (CNG) system or at an extremely low (cryogenic) temperature (-220°F to -212°F / -140°C to -136°C) in liquid form as liquefied natural gas (LNG).

## 2. Identifying CNG Vehicles

A vehicle equipped with a natural gas fuel system will have a decal on the rear of the vehicle identifying it as a compressed natural gas (CNG) or liquid natural gas (LNG) vehicle.



*Figure 1 Left: CNG fueled vehicles are identified by a blue and white decal on the right rear of the vehicle. Right: A CNG decal may also be on the left front of the vehicle as shown.*

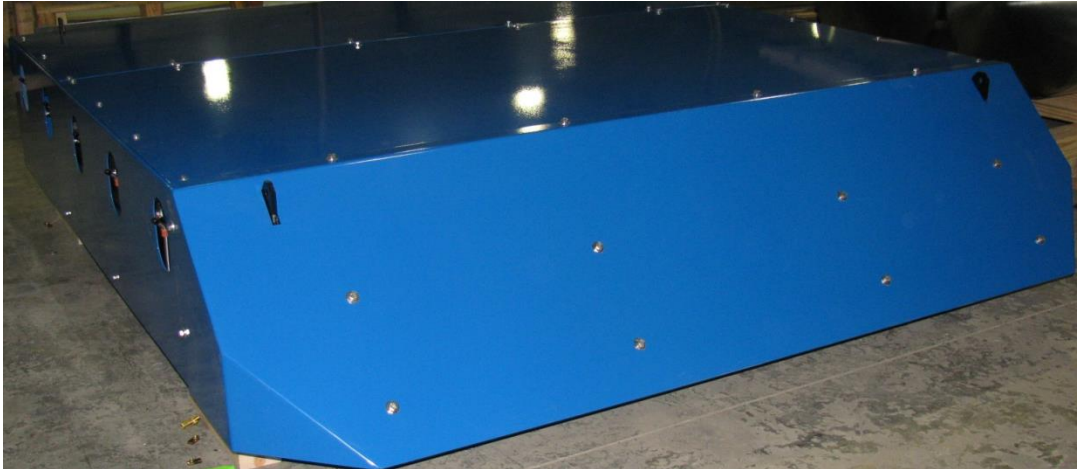


*Figure 2 Popular CNG fuel system configurations offered by Agility Fuel Solutions.*

### 3. CNG Vehicle Cylinders and Fuel Systems

1. There are four types of CNG cylinders:
  - Type 1: All metal construction
  - Type 2: Metal liner with hoop-wrap around cylinder
  - Type 3: Thin metal liner with continuous carbon-fiber over-wrap
  - Type 4: Plastic liner with continuous carbon-fiber over-wrap
2. The CNG fuel cylinder or cylinders are housed in steel or aluminum structures secured to the vehicle body and frame. These structures are engineered to protect the cylinders in a collision.
3. The framework is covered with a composite or metal cover to protect the cylinders from UV exposure and enhances vehicle appearance and aerodynamics.

**NOTE:** Agility Fuel Solutions uses Type 3 and Type 4 cylinders.



*Figure 3 Typical refuse roof mount CNG storage system. Aluminum covers protect the cylinders from overhead objects.*



*Figure 4 Five Type 3 or Type 4 CNG cylinders reside inside the housing. PRDs are located at each manual valve and centered along the length of the cylinder for a total of 10 PRD and vent locations.*

4. CNG cylinders may be mounted on the side rails of the vehicle, on the roof or behind the cab.
5. Fuel storage capacity can be increased by combining systems.
6. Each cylinder in a CNG system has a valve at one end to allow fuel to be isolated from the rest of the system. During normal operation, all cylinder valves should be open.

## 4. Pressure Relief Devices (PRDs)

### **⚠ WARNING ⚠ CAUTION**

- A. CNG PRDs vent with full cylinder pressure, nominally 3600 psi or more.**
- B. Vehicle damage and position may modify venting gas direction.**
- C. Venting gas may ignite, become a jet fire and can re-ignite several times.**

1. The cylinders are protected with one or more **thermally-activated** pressure relief devices (PRDs).
2. PRDs activate (vents gas) between 212°F to 220°F (100°C to 104°C).
3. Typical PRD locations and venting directions are shown in Figures 5 through 8.
  - a) For side mount systems, PRD venting is routed up to a vent stack behind the cab.
  - b) For roof-mounted refuse vehicle systems, a vent stack at the rear vents upward.
  - c) Conventional cab vehicles (trucks and tractors) have a vent stack routed up and away from the back of the cab.
  - d) Some older systems vent downward as shown in Figure 6.
4. Remember, unlike a structure or utility fire, a natural gas vehicle will have a limited amount of fuel on board, so let the gas vent and watch for secondary exposures and hazards.



*Figure 5 CNG PRD venting locations and direction, refuse roof mount systems.*



*Figure 6 CNG PRD venting locations and direction, side mount systems.*



*Figure 7 CNG PRD venting locations and direction, front of body refuse system.*

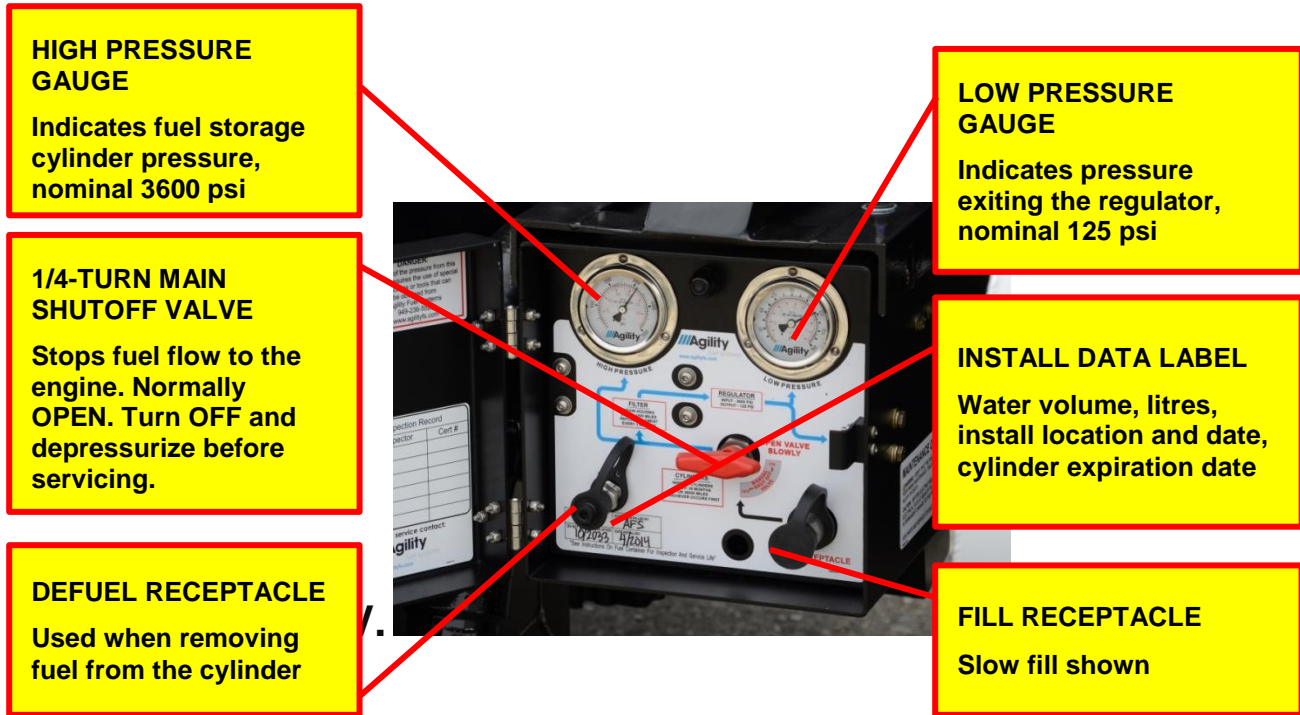




*Figure 8 CNG PRD venting locations and direction, transit bus.*

## 5. Fuel Management Module (FMM)

Refer to Figures 9 and 10. The fuel management module (FMM) is equipped with a 1/4-turn shut off valve which isolates the fuel storage system from the engine for maintenance or emergency situations. Although the location and arrangement of valves and gauges may vary, all FMMs are functionally the same.



*Figure 9 CNG system fuel management module (FMM) gauges and controls.*



*Figure 10 CNG FMM mounted on a side mount system.*

## 6. Emergency Response – CNG



CNG pressures are nominally 3600 psi or more when full. **Do not** cut fuel supply tubing.

## 7. If the Vehicle Has Sustained Damage or a Gas Leak Is Discovered

1. Eliminate all sources of ignition such as fire, sparks, electronics, lights, or electrostatic charges. No smoking near the vehicle and do not light road flares.
2. Turn the ignition switch off (this will close the solenoid valve), set parking brake and turn off battery at main battery disconnect.
3. If it is safe to do so, close the manual shutoff valve, close the cylinder valves and check the fuel system near the damaged area for leaks using smell, sight and sound. CNG is odorized and can be detected by smell.
4. Keep people and traffic away from the area.
5. Open the doors of the vehicle to introduce fresh air.
6. If the vehicle is indoors, open windows and doors to allow ventilation and avoid turning on any lights or electronics which may create a spark. Pay particular attention to any sources of ignition overhead because natural gas will rise to the ceiling.
7. Beware that residual gas may still leak from the storage system even after the ignition switch is off and the manual shut off valves are closed.
8. Advise towing and wreckage storage operators the vehicle is fueled with CNG.
9. Have a qualified natural gas vehicle service technician make necessary repairs.

## 8. In Case of a Vehicle Fire – CNG



- A. **DO NOT** apply water to the cylinders because this will prevent the PRDs from activating and can result in a catastrophic cylinder failure (high pressure gas rupture).
- B. After 5-10 minutes in a fire without PRD activation, the cylinder pressure can increase to 5000 psi or more.
- C. Burst pressure of an intact CNG cylinder is 8000 to 9000 psi.

1. Establish a safety area of 80 to 100 feet.
2. **If the cylinders are not involved** in the fire, the fire on the vehicle can be extinguished with normal response tactics.
3. **If fire is impinging on the cylinders, or if the cylinders are on fire**, it is best to let the vehicle burn and watch for secondary hazards, such as other vehicles or structures.
4. When a PRD activates, the result is often a jet fire – and may go out and re-ignite several times.
  - a. A typical PRD on a CNG tank will require 2-5 minutes to activate. Total vent-down time is approximately 5 minutes from activation but may vary depending on the amount of fuel in the system.
  - b. The cylinder could survive in a fire for up to a total of 20-30 minutes.
5. Advise towing and wreckage storage operators the vehicle is fueled with CNG.

## 9. General Information – LNG



- A. LNG is stored at cryogenic temperatures (-220°F to -212°F / -140°C to -136°C) and is odorless. PPE should include gloves and face shields to prevent frostbite, a methane/flammable gas detector and self-contained breathing apparatus (SCBA).
- B. LNG fuel is a multi-phase mixture of liquid and gas at cryogenic temperatures: The fuel pressure inside the LNG tank is not indicative of fuel level. A full tank could read zero pressure, and an empty tank could read 230 psi.

LNG cannot be odorized because of its very cold temperature, so methane detection systems are mandatory. One sensor is located in the engine compartment and one inside the cab.

1. LNG is extremely cold, and if spilled, will vaporize and dissipate into the air.
2. LNG fuel storage containers are highly insulated stainless steel tanks to keep the cryogenic fuel cold.
3. Systems are usually mounted on the vehicle sides, but can be located in similar locations as CNG systems, such as the vehicle roof.
4. Pressure relief devices for LNG are not thermally activated, so there is no danger of defeating or damaging the relief valves with water.
5. Manual valves are located on one end of the fuel tank, as shown in Figures 12 and 13.

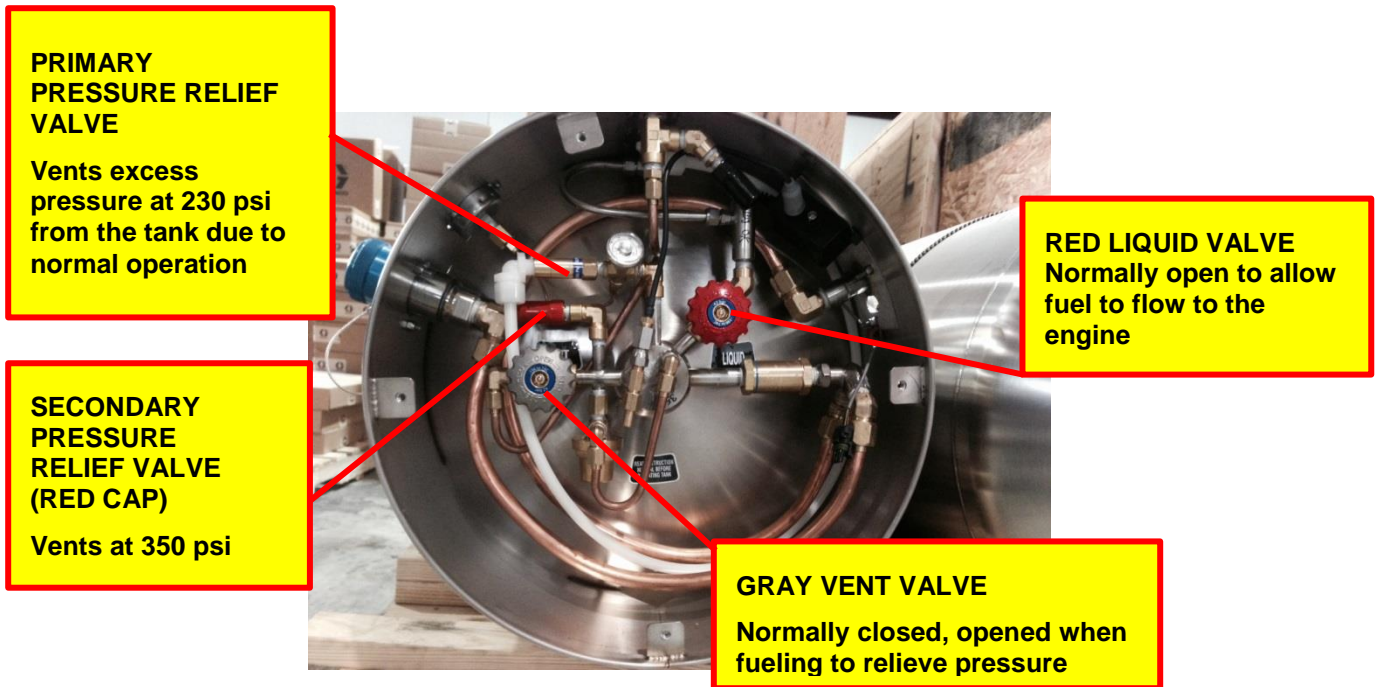
6. An LNG fuel system may **normally** vent (via the primary relief valve) when the pressure inside the tank rises above 230 psi due to normal reaction (expansion) to ambient temperatures.
  - a. The relief valve will automatically reset when the pressure decreases to 230 psi.
  - b. LNG venting is considered normal, but excessive venting may indicate a problem.
7. Remember, unlike a structure or utility fire, a natural gas vehicle will have a limited amount of fuel on board, so let the gas vent and watch for secondary hazards, such as other vehicles or structures.



*Figure 11 Left: LNG blue diamond decal location at the lower right rear of the cab on vehicles without bodies such as a roll-off refuse hauler. Right: LNG decal on the right end of the fuel tank.*



*Figure 12 Left: LNG decal on the right rear of a transit bus. Right: The “valve end” of an LNG fuel tank.*



*Figure 13 LNG system valves. A larger pressure gauge is usually located on the side of the tank for easy viewing.*



*Figure 14 LNG vehicle, rear view. The LNG tank is on the lower left and the vent line runs from the tank and up the rear of the cab, terminating above the cab. LNG vent tubes look like their CNG counterparts – but beware that LNG vehicles may vent in normal operation. See text for more details.*

## 10. Emergency Response – LNG



- A. LNG is stored at cryogenic temperatures (-220°F to -212°F / -140°C to -136°C) and is odorless. PPE should include gloves and face shields to prevent frostbite, a methane/flammable gas detector and self-contained breathing apparatus (SCBA).
- B. LNG fuel is a multi-phase mixture of liquid and gas at cryogenic temperatures: The fuel pressure inside the LNG tank is not indicative of fuel level. A full tank could read zero pressure, and an empty tank could read 230 psi.

## 11. If the Vehicle Becomes Damaged or a Gas Leak is Found

Use caution when handling an LNG leak. LNG is stored at temperatures below -260°F and can cause first degree burns and frostbite if it comes in contact with skin. It is best to remove sources of ignition and allow leaking LNG fuel to vaporize and disperse into the atmosphere.

1. Establish a safety area of 80 to 100 feet.
2. Small LNG leaks can be seen as vapor escaping from the leak, usually at fittings.
3. Large liquid leaks may spill, but will vaporize and rise almost immediately. Be aware of the extreme cold and make sure PPE is in place for any exposed skin.
4. Turn the ignition switch off (this will close the solenoid valve), set parking brake and turn off battery at main battery disconnect.
  - a. If it is safe to do so, turn off the main battery switch.
5. If it is safe to do so, close the red liquid valve and check the fuel system near the damaged area for frost, ice or condensation. This is an indicator of an LNG leak.
6. If the tank is damaged or there is frost on the tank, and the sound of fuel escaping can be heard, the gas will vaporize and rise into the air.
7. Be aware the pressure gauges may indicate zero, but some residual liquid may still be in the tank.
8. Keep people and traffic away from the area.
9. Open the doors of the vehicle to introduce fresh air.
10. If the vehicle is indoors, open windows and doors to allow ventilation and avoid turning on any lights or electronics which may create a spark. Pay particular attention to any sources of ignition overhead because natural gas will rise to the ceiling.
11. Beware that residual gas may still leak from the storage system even after the ignition switch is off and the manual valves are closed.

12. Advise towing and wreckage storage operators the vehicle is fueled with LNG.
13. Have a qualified natural gas vehicle service technician make necessary repairs.

## 12. In Case of a Vehicle Fire - LNG

1. Establish a safety area of 80 to 100 feet.
2. **If the LNG tanks are not involved** in the fire, the fire on the vehicle can be extinguished with normal response tactics.
3. **If fire is impinging on the LNG tanks**, it is best to let the vehicle burn and watch for and protect secondary hazards and exposures, such as other vehicles and structures.
4. Water can be used to extinguish the fire because LNG tanks are well insulated.
  - a. LNG tanks are well insulated so temperature and pressure rise should be small.
  - b. The LNG pressure relief valve will open and the gas will vent.
  - c. LNG pressure relief valves are self-resetting (resets when pressure is below about 230 psi).
5. If it is safe to do so, turn off the main battery switch.
6. Advise towing and wreckage storage operators the vehicle is fueled with LNG.

## 13. References and Additional Information

The following resources and publications will help increase your understanding of CNG and LNG fuel systems.

NFPA offers a free Alternative Fuel Vehicles Training Program to US Emergency Responders:

<http://www.nfpa.org/training-and-events/by-topic/alternative-fuel-vehicle-safety-training>

Go to the Agility Fuel Solutions website – Product Support Group page to download or view these publications:

<http://www.agilityfuelsystems.com/product-support-contact-info.html>

- Agility Fuel Solutions, “Truck and Tractor CNG Fuel System Operation Manual,” ENP-007
- Agility Fuel Solutions, “CNG System Users’ Manual,” ENP-314
- Agility Fuel Solutions, “Safely Working on CNG Fuel Systems,” ENP-391
- Agility Fuel Solutions, “Dual Tank LNG System Operation Manual,” ENP-064
- Agility Fuel Solutions, “LNG System Users’ Manual,” ENP-334
- CNG and LNG Fuel System Videos