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To: Gaseous fueled vehicle owners, operators, and service facilities

From: TTP's Technology & Development Committee

Date: October 15, 2025

Subject: **Technology Bulletin – Cold Weather Notice for Natural Gas and Hydrogen PRD Vents and Other Best Practices for Engine Operation**

Owners and operators of vehicles powered by natural gas and hydrogen—and the associated service and maintenance personnel as well—should be aware that the occurrence of colder temperatures necessitates additional precautions for vehicles' pressure relief systems, fire safety systems, and the vent pipe outlets.

Frozen Moisture in PRD Systems

The potential for moisture to collect, freeze, and cause damage in thermally-activated and pressure-activated pressure relief devices (PRDs), and in the associated vent lines, requires special attention when the temperature drops below freezing. In fact, water can cause problems even without freezing, potentially resulting in damage and the following unintended consequences:

1. unexpected activation of the PRD, resulting in the release of the fuel container contents,
2. PRD leaks, or
3. delayed activation or complete failure to reduce tank or cylinder pressure when required (e.g. during a thermal event).

PRDs are intended to be used as a safety device for gaseous fueled vehicles (GFVs), stationary fuel storage containers, and mobile transportation equipment for bulk gas (i.e., virtual pipelines) by releasing the high-pressure fuel container contents when exposed to fire. The location of PRDs can vary, but they are typically located at one or both ends of the fuel containers. In cases where multiple fuel containers are used, the devices may exist in a manifold configuration, typically connected to a vent port.

Incidents have shown that moisture from rainwater and vehicle washes may enter the PRD vent systems through accessible openings. Vent outlets that are open due to missing moisture caps are a common point of entry for water; however, loose fitting caps can also allow moisture to enter the PRD vent system. Pressure washing and truck washing pose a

particular threat to the unintended removal of loose or damaged caps and can also result in water ingress through holes inherent to the design of some vent systems. Moisture collected in a PRD system can cause distortion of the internal components when it freezes and expands, resulting in premature activation and release of fuel storage contents. This potential failure mode exists on any gaseous fuel system or container with a PRD vent system.

Manufacturers of GFVs and virtual pipeline equipment typically recommend routine inspection of PRD vent systems to verify the integrity of the vent lines and to ensure that all vent caps are in place. The interval of this inspection varies between different manufacturer specifications. Owners and operators of GFVs and virtual pipeline equipment are encouraged to consult their O&M manual and/or the manufacturer for appropriate inspection procedures. If vent caps are discovered to be missing or damaged, or there are other signs of moisture present in the PRD vent system, the owner/operator should contact the manufacturer or provider of the fuel system or equipment immediately for recommended actions.

> **NOTE**: inspections, maintenance, and repairs of GFV fuel systems and virtual pipeline equipment should only be conducted by qualified personnel that have received the proper training and/or certification required by the local authority having jurisdiction, the OEM of the vehicle or equipment, and/or the manufacturer or provider of the fuel system or equipment.

Other inspection guidance for PRD vent systems is available from codes and standards such as the following:

1. **CSA/ANSI NGV 6.1** – *Compressed natural gas (CNG) fuel storage and delivery systems for road vehicles* – 2024 edition
2. **CGA C-6.4** – *Methods For External Visual Inspection of Natural Gas Vehicle and Hydrogen Gas Vehicle Fuel Containers and Their Installations* – Edition 4
3. **CGA G-19.2** – *Standard for Natural Gas Transportation and Transfer* – 2019 edition
4. **NFPA 52** – *Vehicular Natural Gas Fuel Systems Code* – 2026 edition

Engine Operating Tips in Cold Weather

Derived from the September 2020 edition of Cummins' Natural Gas Engine Tech Talk, best practices for operating natural gas engines in below freezing conditions are as follows:

1. **Do not use cold starting aids** with natural gas vehicles (NGVs). Testing natural gas engines in extremely cold weather has shown spark-ignited natural gas engines have better starting performance compared to equivalent diesel engines that rely on cold starting aids.

2. **Do not use fuel system heaters**. Cold weather accessories such as fuel tank heaters and fuel filter heating elements may have their place with diesel vehicles, but fuel system heaters are not recommended or necessary with NGVs.
3. **Allow the engine to warm up**. For better performance and to eliminate the chance of fuel system components freezing, start and allow the engine to idle at low RPM for 5 minutes. This idle time may not allow enough time to heat the cab, but it is enough time to warm the engine's major components, including fuel regulators and various sensors.
4. **Avoid excessive engine idle time**. Natural gas engines that experience periods of idling in excess of 15 consecutive minutes are more prone to excessive bearing wear, piston ring wear, and oil dilution. The same adverse effects apply to diesel engines as well, and additional detrimental effects on diesel exhaust aftertreatment systems and their performance can also be expected with excessive idle time. Regardless of the vehicle's fuel type, an auxiliary power unit (APU) should always be utilized instead of the vehicle's primary propulsion engine for climate control in an unoccupied cab or managing the hotel loads in a sleeper cab.
5. **Engine shutdown protocol following excessive idle time should include a short period of high idle**. If it is necessary to idle your natural gas engine for an extended period, occasionally operate the engine at high idle to help clear moisture that may have accumulated in your engine's CCV and EGR systems.
6. **Reference Cummins Service Bulletin 5579487**, "Operation and Troubleshooting of Closed Crankcase Ventilation (CCV) Systems for Automotive Natural Gas Engines". Available on QuickServe Online or through your local Cummins representative, this bulletin contains guidance for addressing oil emulsion and signs of water in the crankcase, both of which can freeze during cold weather and lead to blockages.
7. **Reference Cummins Service Bulletin 4332709**, "Operation of Automotive Natural Gas Engines in Cold Climates". Available on QuickServe Online or through your local Cummins representative, this bulletin contains detailed guidelines to ensure successful operation of Cummins natural gas engines in cold conditions.
8. **Ensure that batteries are in good operating condition.** Batteries are an often-overlooked component of vehicle starting systems. The batteries cranking capacity is reduced in cold weather as the required cranking power is increased. Ensure that batteries are kept charged and parasitic draws are kept to a minimum. Check battery connections for signs of corrosion and poor connections. Check the health and age of your batteries before winter and replace batteries that are weak or damaged. In artic conditions battery heaters can be used to help maintain battery temperature and ensure optimum performance.

Refueling Impacts

Fuel stations use temperature compensated filling algorithms to prevent overfilling of CNG fuel containers. Because natural gas density increases as the temperature drops, a fuel station that dispenses the same amount of gas regardless of ambient temperature may result in the perception of insufficient refueling. For example, if 100 diesel-gallon-equivalent (DGE) of fuel dispensed at 70 °F results in 3,600 PSI vehicle fuel system pressure, dispensing the same 100 DGE of fuel at -30 °F may result in an effective pressure of 2,000 PSI, with the dispenser considering the fuel containers full. The table below illustrates this example of effective refueling pressure in a vehicle's fuel system at a few different ambient temperatures.

Temperature (°F)	Pressure (PSI)
70	3,600
32	3,000
0	2,500
-30	2,000

For more detailed information on this topic, consult the associated provider or manufacturer of the CNG refueling equipment or dispenser to confirm compliance and a reliable temperature compensation refueling strategy for proper CNG vehicle safety.

Supporting New GFV Fleets

Experienced providers within the transportation industry that are involved with natural gas and hydrogen refueling, service, and maintenance operations are encouraged to spread word of this information and educate newly transitioned fleets they are working with on the importance of these best practices.