

USA PRO Shoreline Technology LLC

AUTOMOTIVE GASEOUS FUELS SAFETY INFORMATION

1.0 School Bus and Commercial Vehicle Safety - Gaseous Fuels: Natural gas (CNG-LNG), Natural Gas \ Hydrogen, Propane, Hydrogen

Use of gaseous automotive fuels deserves serious safety consideration for all commercial and school bus applications to insure the highest levels of public safety. Alternate fuels for automotive applications as a group show a history of slow regulatory development, and implementation of safety measures are often left to less than fully informed individual buyers. Meeting "letter of the law" mandates may not satisfy the safety demands of specific applications. Each gas must meet requirements specific to its gas type, onboard location of fuel system storage tanks, system piping, and engine location. As an example, each gaseous fuel poses significant safety challenges related to weight of the gas; that is, whether or not it is lighter or heavier than air.

Safety challenges arise because gaseous fuels are significantly different than liquid fuels, such as diesel and gasoline. For instance, some released gases instantly rise, while others cling to lowest levels and may not rise instantaneously. All automotive gases are considered migratory. Therefore, gas migration presents a wide range of potential ignition sources, and automotive electrical standards lack the same level of wiring safety as that found at gas refueling stations. Engine compartment or storage tank areas are not sealed; thus, gas releases can migrate to passenger compartments or other areas with relative ease.

Odorants are not guaranteed to act effectively as single warning agents as vehicle drivers may not be able to detect or define dangerous levels of gas treated with odorants. For all commercial and school bus applications, leak detection, and proper education should be first levels of safety employed.

2.0 Lack of Onboard Safety Equipment

For CNG, propane and hydrogen there appears that no safety criteria has been developed that addresses gas detection systems for transit, school buses and commercial vehicles. Contrary to conventional engineering, there are bus and commercial operators that do not provide any vehicle safety systems whatsoever. Neglecting this aspect of safety assumes that: an automotive gas odorant has been added; the possibility of gas leaks is nonexistent; regular maintenance practices are being performed; there is no probability of an accident; drivers possess flawless olfactory senses; refueling stations have gas detectors; there are no sources of ignition; and so on. This is totally opposite to the standard practices of major transits within the United States. Without a doubt, the first line of defense—prior to a fire or explosion—is detection/notification of gas leaks that may find sources of ignition.

3.0 Odorants

A number of school bus and commercial vehicle operators have embraced a safety program that utilizes a natural gas odorant to singularly satisfy all safety requirements for vehicles and their passengers. These operators, therefore, have chosen to rely on the human sense of smell by not including gas detection or fire suppression. Odorized gas should not be considered a stand alone safety measure, as this method does not provide adequate safety assurances in the event of an accident or equipment malfunction. Dependence on human factors for smelling gas is a safety concern and lacks individual application validation. In addition, this practice is in opposition to transit industry practices which endorse gas detection and fire suppression systems. Please note the following safety information related to commercial and school bus automotive gaseous fuels:

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1. For school bus and commercial vehicles one is hard pressed to provide adequate safety without implementing vehicle gas detection and fire suppression. Safe use of automotive gaseous fuel begins with gas detection, combined with fire suppression, to form a unified safety plan.
2. Safety reviews place great importance on risk management. To focus solely on fire suppression ignores the opportunity to prevent fire and explosion occurrences with early warning gas detection.
3. Automotive gaseous fuel leaks are a high risk that may find a source of ignition prior to or after fire suppression has been instituted.
4. Quality training, proper maintenance and comprehensive safety programs are extremely important to reliable, long-term gaseous fuel vehicle and passenger safety.

Please note challenges listed (5.0) within Natural Gas Odorization Corporation (NGO) review and history of odorants.

4.0 Fire Suppression

Fire suppression should be complimentary to early warning gas detection. School bus buyers/owners, as an example, have focused on a single fire suppression system to encompass all safety concerns, or, in the worst case, have no safety systems at all. Fundamentally, neither premise provides a first line of safety, which is to lessen the chance of fire/explosions and to provide the highest level of safety, which is through gas detection. Prevention, combined with adequate training, should at a minimum include the following:

- ❖ Gas detection: engine, storage area, and passenger-driver compartment
- ❖ Fire suppression

It is a fallacy to assume that, once a gaseous fuel-related fire has been suppressed, continuous gas leakage will not find the same or new opportunities for ignition. Early gas detection/warning safety systems should be considered as the first line of defense: vehicle onboard gas detection working in concert with fire suppression is recommended.

5.0 Natural Gas Odorization Corporation (NGO) Literature Review

There is widespread confidence in the use of odorants for pipeline applications. However, odorant manufacturers point out that there are variables in their use. Therefore, odorants should not be the only means of alerting the presence of gas leaks in automotive applications. Specifically, the following information supplied by Natural Gas Odorization Corporation (NGO), excerpted directly from their literature, supplies us with insights into automotive gaseous fuels applications, which can be related to gaseous odorant uses as follows:

1. **No one odorant or no one rate of odorization will be 100% effective in warning of the presence of natural gas.**
2. **Loss or diminished odor intensity can be caused by chemical reactions including oxidation, adsorption and/or absorption, and masking by other components in pipes and distribution systems carrying odorized natural gas.**
3. **Adsorption: Odorant can adhere to surfaces of solid structures or liquids with which it is in contact, thus reducing the amount of odorant remaining in the gas stream.**
4. **Extremely cold weather can affect the amount of odorant in natural gas and, thus, may reduce odorant effectiveness.**
5. **The physical condition and state of mind of an individual, as well as the surroundings and the individual's attentiveness can affect the ability to detect odors including, but not limited to, natural gas odorants (i.e., natural gas odorants and/or an individual sulfur compound).**

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6. Absence of an odor must not be taken to mean the absence of natural gas. Nor should a judgment of the concentration of natural gas be made by the intensity of the odor.
7. There is no odorant that will be effective in all situations.
8. Some people have an impaired sense of smell that results in reduced sensitivity to all odors or, alternatively, results in no sense of smell for only certain odors (i.e., natural gas odorants and other sulfur compounds).
9. Some people have no sense of smell and can detect no odors. Common colds, allergies, and smoking can also decrease an individual's ability to smell.
10. Other odors in the area, such as those present in a musty basement, may mask or cover the natural gas odor.
11. In some cases, natural gas odor is not detected simply because people are concentrating on something else; their minds are distracted from detecting the odor.
12. It should be established that all persons expected to be in contact with odorized natural gas, including customers' age, are adequately warned in advance about the properties, characteristics, propensities, and limitations of odorants when used as warning agents.
13. Olfactory fatigue caused by exposure to other odorous products may reduce an individual's ability to detect natural gas odorant.
14. Olfactory adaptation to the odorant can occur if an individual does not quickly and immediately respond to the presence of the natural gas odorant.
15. Since loss of the distinctive odor of odorized natural gas can occur under some conditions, periodic testing by all persons handling natural gas, before sale to the ultimate consumer, is advisable to determine that the rate of odorization is adequate to comply with all regulatory requirements and safety considerations.

NGO does not have access to your customers. NGO provides this warning to educate you and strongly suggests that you educate your customers. You should confirm that all persons having contact with the product, including your customers, are adequately warned about the properties, characteristics, propensities, and limitations of natural gas, and natural gas odorants when used as a warning agent in natural gas. For instance, persons having contact with natural gas should know that natural gas vapor is lighter than air.

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