

# Odorization of Natural Gas

When it comes to vaporization of LNG, the last thing that comes to mind (and is often not even considered) is the odorization of the natural gas after its regasification. In this article, we will dive into the regulations of natural gas odorization, discussing when it is required, and how it is actually implemented.

## When is Odorization Required?

### Regulatory Background and Governing Specifications

Odorization is always nice to have, but when is it actually required and when can it be omitted? As more and more of the masses get into the LNG business, it's common practice for them to dive right into the spec labeled "NFPA59A" whenever a LNG question comes about. NFPA59A is the specification for "Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)" that was created by a committee of the American Gas Association. Since 1960, this document has been revised, resubmitted (to NFPA - National Fire and Protection Agency) and redistributed a number of times, making its last trip through the cycle in 2013. This document will yield nothing other than more questions when it comes to odorization... because simply put, the answer is not in there.

Although NFPA59A is the major specification that governs LNG systems, the odorization of natural gas takes place after the cryogenic liquid has been vaporized and has returned to its gaseous state. Answers regarding odorization will instead best be found in the Code of Federal Regulations (CFR); Title 49, Part 192, Section 625.

### When and Where Odorization is Required

Per Title 49, Part 192, Section 625, odorization of natural gas is required when the natural gas is 'traversing in a distribution or transmission line and in a Class 3 or 4 location'.

### Definitions

That tells us EXACTLY when we need to odorize natural gas... but what is a distribution line? What is a transmission line? And what exactly does Class 3 or 4 location mean?

### Natural Gas Lines to be Considered and What They Are

There are three natural gas lines that come into consideration for odorization: gathering lines, transmission lines and distribution lines. Gathering lines are pipelines that are used to transport natural gas from a production site/facility to a main line (main line is a type of distribution line which is discussed below). Transmission lines are lines other than gathering lines that transport natural gas to a facility for storage or distribution, and operate at a hoop stress of 20% or more of specified minimum yield strength or transports gas within a storage facility. Distribution lines are pipelines other than gathering or transmissions lines. All these are defined in CFR Title 49, Part 192, Section 3.

### Class Locations and What They Are

When dealing with LNG the first thing that comes to mind when we hear the word "class" is hazardous zones. Class I Div. I, Class I Div. II, etc. Although important when dealing with system design, this is not what we're talking about when dealing with odorization. The classes referenced above (Class 3 and Class 4) are not hazardous zones but are instead population density classes. There are 4 class locations in total and these are defined in CFR Title 49, Part 192, Section 5. A class location unit is thus defined as "an onshore area that extends 220 yards (200 meters) on either side of the centerline of any continuous one mile (1.6 kilometers) length of pipe. Classes 1 thru 4 are shown in the table below.

Location Class	Description
Class 1	i) An offshore area; ii) Any class location unit with 10 or less buildings intended for human occupancy per mile within 660' on either side of the pipeline.
Class 2	Ten to 46 buildings intended for human occupancy per mile within 660' on either side of the pipeline.
Class 3	i) Any class location unit with 46 or more buildings intended for human occupancy per mile within 660' on either side of the pipeline; or ii) An area where the pipeline lies within 100 yards of either a building or a small, well-defined outside area (playground, recreation area, etc...) that is occupied by 20 or more persons on at least 5 days a week for 10 weeks in any 12 month period.
Class 4	Any class location unit with 4 story buildings within 660' on either side of the pipeline are prevalent.

If you're in a Class 3 or Class 4 location and your natural gas is in a distribution line or a transmission pipeline, you will need to add an odorizer to your system. Outside of that, odorization is not required, though should be considered.

It is obvious that these regulations were designed for big natural gas pipelines traveling miles and miles. But Class 3 locations have two conditions; the second condition does not depend on the building density but rather the proximity of a building to the pipeline.

### Exemptions for Odorization

There are a number of exemptions for odorization spelled out in CFR Title 49, Part 192, Section 625, which are listed below:

- 1) At least 50% of the length of the line downstream from a Class 3 or Class 4 location is in a Class 1 or Class 2 location.
- 2) The line transports gas to any of the following facilities which received gas without an odorant from that line before May 5, 1975;
  - a. An underground storage facility:

- b. A gas processing plant;
- c. A gas dehydration plant; or
- d. An industrial plant using gas in a process where the presence of an odorant:
  - i. Makes the end product unfit for the intended purpose
  - ii. Reduces the activity of the catalyst, or
  - iii. Reduces the percentage completion of a chemical reaction;
- 3) A lateral line which transports gas to a distribution center, at least 50% of the length of that line is in a Class 1 or Class 2 location; or
- 4) The combustible gas is hydrogen intended for use as a feedstock in a manufacturing process. Note that this last exemption is not applicable to natural gas.

### What do we put in, how do we put it in and how much do we use?

So now that we've discussed when and where to odorize natural gas, what is the odorant? How do we put the odorant in? And how much are we supposed to put in?

### What do we put in?

When you use your stove at home and it doesn't light, you'll catch a little whiff of something that smells like bad eggs. That smell is the odorant that is put into the natural gas. It's actually a chemical called Mercaptan. This is the primary odorant used for odorizing natural gas. Note that there are other odorants used throughout the world (natural gas in America might not smell the same as natural gas in India), a list of typical odorants is below.

### Types of Odorants

- Tert Butyl Mercaptan - The primary odorant used (egg-like smell)
- Tert butyl thiol
- Tetrahydrothiophene (THT)
- Ethanethiol (ethyl mercaptan)
- Dimethyl sulfide (DMS; garlic-like smell)
- Diethyl sulfide (DES)
- Methylethyl sulfide (MES)
- N-Propyl mercaptan (NPM)
- Isopropyl mercaptan (IPM)

### How do we put it in?

There are a number of ways to put the odorant into the natural gas: bypass odorizing, wick odorizing, pulse bypass odorizing, drip odorizing, injection odorizing and bourdon tube odorizing. In this article we will focus on bypass mixing and injection mixing.

### Bypass Mixing

Also called an Absorption Bypass Odorizer. Bypass Mixing Odorizers operate by taking a slip stream of the natural gas, running it through a container with odorant inside where the odorant is absorbed into the gas, then feeding it back into the main line. Typically, a pressure regulator between the bypass loop and the main line drives the natural gas through the odorizer, though this can be omitted with the use of a needle valve on the odorizer inlet line.

### Liquid Injection Odorizer

In this process, the natural gas does not have to bypass anything or go through any tanks. The odorizer tank is hooked up with a pump. Odorant is pressurized and shot into the natural gas line. The amount is based on how much flow of natural gas is moving through the pipeline, measured with a flow meter.

These systems are much more complex than Bypass Mixing systems and involve more components and technology. They require a flow meter and a control panel or other forms of control. Being more complex, there's much more that can be monitored with these systems such as the level of odorizer left in the odorizer tank, amount of odorant being put into the natural gas, flow of natural gas, etc. This technology does come at a cost, and this type of system is considerably more expensive than a Bypass Mixing system.

### How much do we put in?

This is a question that does not have a straightforward answer. If we look at the CFR Title 49, Part 192, Section 625, it states that enough odorant needs to be put into the natural gas where "a concentration in air of one-fifth of the lower explosive limit, the gas is readily detectable by a person with a normal sense of smell". One-fifth the explosive limit is 1% natural gas in the air (natural gas is combustible in the concentration range of 5-15% relative to air). But how do we define a person with a normal sense of smell, and how detectable is readily detectable? Also in CFR Title 49, Part 192, Section 625, it states that this is to be tested by the operator using a device that is capable of determining the level of gas in air at which the odor becomes readily detectable, and that a periodic "sniff" test is needed. As a general rule of thumb, 1 #/MMSCFH odorant to natural gas is the amount that should be added by the odorizer.

Even if your system is not in a high-populated, required area, you may still want to have an odorization system just as a safety factor for personnel working around the system. Per NFPA59A specifications, there are a lot of safety fall backs put into LNG systems including: hydrocarbon sensors, flame detectors, emergency shutdown protocols, fail safe equipment, etc, put there for safety reasons. But if something starts leaking downstream of all this equipment and odorant in the gas could be your last line of defense.

For more information, visit [cryoquip.com](http://cryoquip.com).