Section X

SUMMARY OF FEDERAL AND STATE REGULATIONS AFFECTING ODORIZATION OF NATURAL GAS IN PIPELINE OPERATIONS

X.1 INTRODUCTION

This section addresses federal and state codes and regulations pertaining to the odorization of natural gas as it is used in pipeline operations. "Pipeline operations," as used in this context, includes natural gas gathering (at production sites), transportation (interstate and intrastate pipelines), and distribution, including "natural gas utility" operations. The scope of the discussion in this section does not include odorization of LNG, LPG, or CNG used as a vehicle fuel. These applications are covered by regulations that are usually separate from pipeline regulations, and they are discussed elsewhere in this report. The purpose of this section is to provide some brief background regarding pipeline natural gas odorization regulations, interpretations, and practices as a context for considering LNG transportation fuel odorization.

X.2 FEDERAL REGULATIONS

The most important regulation affecting the odorization of natural gas used in pipeline operations is the Code of Federal Regulations (CFR) Title 49, Part 192.625, "Transportation of Natural or Other Gas by Pipeline: Minimum Federal Safety Standards Odorization of Gas." This regulation is reproduced as Exhibit X-1.

Note that CFR 192.625 is written in terms of the odorization effect rather than the required odorant chemistry and concentration. Specifically, Subpart (a) states, "A combustible gas in a distribution line must contain a natural odorant or be odorized so that at 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."

Other parts of CFR 192 specify which transmission and distribution lines must be odorized. Details of these regulations will not be reviewed here because they are not pertinent to LNG odorization. However, as a broad generality, pipeline natural gas is usually odorized as it passes through a gate station into distribution lines (sometimes called "mains") where its pressure is reduced to a range between 100 psig and less than 1 psig (Reference X1).

X.3 INTERPRETATION

While CFR 192.625 does not specify the pipeline natural gas odorant type of amount, the natural gas industry routinely odorizes pipeline gas with approximately 0.75 pounds of odorant per million cubic feet of gas (Reference X2). A variety of odorants are used for pipeline natural gas. All are sulfur-containing hydrocarbons, and most are mercaptans and sulfides. Exhibit X-2 lists some commonly used odorants.

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(a) A combustible gas in a distribution line must contain a natural odorant or be odorized so that at 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.

(b) After December 31, 1976, a combustible gas in a transmission line in a Class 3 or Class 4 location must comply with the requirements of paragraph (a) of this section unless:

(1) At least 50 percent of the length of the line downstream from that 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:

(i) An underground storage field;

(ii) A gas processing plant;

(iii) A gas dehydration plant; or

(iv) An industrial plant using as in a process where the presence of an odorant:

(A) Makes the end product unfit for the purpose for which it is intended;

(B) Reduces the activity of a catalyst; or

(C) Reduces the percentage completion of a chemical reaction;

(3) In the case of a lateral line which transports gas to a distribution center, at least 50 percent 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.

(c) In the concentrations in which it is used, the odorant in combustible gases must comply with the following:

(1) The odorant may not be deleterious to persons, materials, or pipe.

(2) The products of combustion from the odorant may not be toxic when breathed nor may they be corrosive or harmful to those materials to which the products of combustion will be exposed.

(d) The odorant may not be soluble in water to an extent greater than 2.5 parts to 100 parts by weight.

(e) Equipment for odorization must introduce the odorant without wide variations in the level of odorant.

(f) Each operator shall conduct periodic sampling of combustible gases to assure the proper concentration of odorant in accordance with this section. Operators of master meter systems may comply with this requirement by-

(1) Receiving written verification from their gas source that the gas has the proper concentration of odorant; and

(2) Conducting periodic “sniff” tests at the extremities of the system to confirm that the gas contains odorant.

[35 FR 13257, Aug. 19, 1970 as amended by Amdt. 192-2, 35 FR 17335, Nov. 11, 1970; Amdt. 192-6, 36 FR 25423, Dec. 31, 1971; Amdt. 192-7, 37 FR 17970, Sept. 2, 1972; Amdt. 192-14, 38 FR 14943, June 7, 1973; Amdt. 192-15, 38 FR 35471, Dec. 28, 1973; Amdt. 192-21, 40 FR 20279, May 9, 1975; Amdt. 192-58, 53 FR 1633, Jan. 21, 1988; Amdt. 192-76, 61 FR 26121, May 24, 1996; Amdt. 192-78, 61 FR 28770, June 6, 1996]

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Exhibit X-1. Code of Federal Regulations Title 49, Part 192.625, "Transportation of Natural or Other Gas by Pipeline: Minimum Federal Safety Standards Odorization of Gas."

ODORANT	REMARKS
Tertiary butyl mercaptan (TBM)	The most commonly used odorant in natural gas blends. Oxidation resistant. Good soil penetration.
Tetrahydrothiophene (THT or thiophane)	Commonly used in LPG and natural gas odorant blends.
Dimethyl sulfide (DMS)	Used in LPG and natural gas odorous blends. Highly oxidant resistant. Best soil penetration characteristics of all odorants.
Methyl ethyl sulfide (MES)	Most recently introduced odorant used in blends for natural gas. Highly oxidation resistant. Good soil penetration.
Isopropyl mercaptan (IPM)	Commonly used natural gas odorant. Frequently blended with TBM to lower freezing point.
Normal propyl mercaptan (NPM)	Occasionally used in natural gas odorant blends. Relatively low oxidation resistance.
Secondary butyl mercaptan	Used in natural gas odorant blends.
Ethyl mercaptan	LPG odorant.

Exhibit X-2. Commonly Used Gas Odorants.

The selection of odorants and their concentrations strongly depends on the local conditions. This includes the gas composition, pipeline and surrounding conditions, and what the local community is used to. Gas composition issues include moisture and heavy hydrocarbon contents. Higher odorant concentrations are required for natural gas with high levels of moisture and/or heavy hydrocarbons. The gas temperature is important as it relates to freezing and vapor pressure. Pipeline and surrounding conditions can also promote odorant oxidation, adsorption, and absorption(which are discussion in Section X.5) and different odorants have different susceptibilities to these effects. Personnel involved in pipeline gas odorization also emphasize that the odorant should produce a smell that is readily identified by lay people as "leaking gas," and this smell may differ slightly in different local communities depending on what odorants have been used historically.

The odorant chemicals and concentrations summarized here are based on almost a century of experience, product development work by chemical and odorant injection equipment companies, and

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laboratory research. A wealth of gas odorization technical literature exists. For example, presentations from the annual International Conference and Exposition on Natural Gas and LP Odorization, which is organized by the Institute of Gas Technology (IGT, which is now combined with the Gas Research Institute, GRI, and the new entity is the Gas Technology Institute, GTI), are available (Reference X3).

X.3 State Regulations

Most states have additional codes and regulations (i.e., in addition to CFR 192.625) pertaining to natural gas in pipelines. In many cases, these regulations are part of the State Utility Commission's rules or orders. In most cases, the states' regulations do not contradict or supercede CFR 192.625 with respect to basic pipeline natural gas odor detect ability requirements.

For example, in California, regulations pertaining to pipeline natural gas are contained in California Public Utilities Commission (PUC) General Order No. 112-E, "Rules Governing Design, Construction, Testing, Maintenance, and Operation of Utility Gas Gathering, Transmission and Distribution Piping Systems." Section101.2 of this order states:

> These rules are incorporated in addition to the Federal Pipeline Safety Regulations, specifically, Title 49 of the Code of Federal Regulations (49 CFR), Parts 190, 191, 192, 193, and 199, which also govern the Design, Construction, Testing, Operations, and Maintenance of Gas Piping Systems in the State of California. These rules do not supercede the Federal Pipeline Safety Regulations, but are supplements to the Federal Regulations.

The rules in California PUC General Order 112-E contain no pipeline natural gas odorization requirements separate from CFR 192.625. However, the California Code of Regulations (CCR) includes specific requirements for odorizing natural gas and LPG contained and transported pressure vessels.

To complete the California example, the primary pipeline natural gas odorants and concentrations used by the State's two largest natural gas utilities (Southern California Gas, and Pacific Gas and Electric) are (Reference X4):

50% tertiary butyl mercaptan, plus
50% tetrahydrothiophene,
at 0.4 Lb/MMscf

X.5 Effectiveness Issues

A variety of physical factors and effectiveness issues must be considered in selecting the most appropriate odorant chemistry and concentration to meet the provisions of CFR 192.625, specifically so that "at 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." These well-recognized factors and issues are documented in the technical literature as well as odorant product information (e.g., Reference X2).

The following physical factors are important relative to the odorization of pipeline natural gas:

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- Oxidation Contact with oxidizing agents (including rust) can convert the odorant to its corresponding disulfide, which has a weaker odor.
- Absorption Odorants can dissolve into liquids.
- Adsorption Odorants can attach to solid structures.
- Temperature Very low temperatures can reduce the amount of effective odorant in natural gas.

The condition of the individual potentially smelling the gas leak can also influence the effectiveness of natural gas odorants. Important factors include:

- State of mind E.g., attentiveness, distractions.
- Permanently impaired sense of smell Some individuals have a reduced sensitivity to certain odors, and a few individuals have no sense of smell at all.
- Temporarily impaired sense of smell E.G., due to colds, allergies, smoking.
- Olfactory fatigue Caused by exposure to other strong odors.
- Olfactory adaptation Over time, an individual can become accustomed to odors, including odorized natural gas.
- Other odors present May mask natural gas odorants.

Federal and state regulations require periodic testing at various pipeline locations to address the above physical factors. Variations associated with individuals must also be considered, and these factors often arise during litigation associated with natural gas pipeline accidents (e.g., Reference X5).

REFERENCES

X1. American Gas Association, www.aga.org

X2. Natural Gas Odorizing, Inc., OxyChem, www.oxychem.com/products/ natural_gas_odorants, and www.oxychem.com/plants/Baytown

X3. International Conference and Exposition on Natural Gas and LP Odorization, proceedings are available at www.gri.org/pub/abstracts

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X4. Personal communications: Michael Eaves, Southern California Gas Co., and Brian Stokes, Pacific Gas and Electric Co., May, 2001.

X5. Schlee, D. R., "Natural Gas Odor Fade Verdict Affirmed in Wyoming." *Butane-Propane News,* p. 20.

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