UNDERSTANDING FIRE PROTECTION STANDARDS FOR LNG FACILITIES AND THE ROLE OF INDUSTRIAL INSULATION

LNG facilities deal with hazardous, flammable materials that bring with them an increased risk of fire. Because of this, LNG facilities are among some of the most regulated in the nation. Understanding requirements and risk mitigation options is important for everyone in the industry who designs, builds, operates and maintains these facilities.

There are several regulations and requirements that involve fire risk assessment and protection. Frankly, it can be confusing to understand, but this paper will clarify the basic requirements a facility needs to follow and how industrial insulation can play a role in helping to make LNG facilities a safer place to work.

First, we need to understand what the regulating bodies are for each facility and which requirements need to be followed. This is dependent on the facility's location and where the feed gas comes from and to which it is transported.

WHICH AGENCY HAS JURISDICTION?

Most LNG facilities in the United States are regulated by both the Federal Energy Regulatory Commission (FERC) and the Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA).

FERC is responsible for regulating transmission and sale of natural gas for resale in interstate commerce as well as approving the siting of LNG facilities. PHMSA is responsible for regulating and ensuring safe and secure movement of hazardous materials to industry and consumers by all modes of transportation, including pipelines. PHMSA's Office of Pipeline Safety ensures safety in the design, construction, operation, maintenance, and spill response planning of America's 2.6 million miles of natural gas and hazardous liquid transportation pipelines.

A facility is either regulated by FERC, with PHMSA being a cooperating agency, or it is regulated directly by PHMSA or by a state agency.

In the first two scenarios, the facility needs to adhere to PHMSA's regulations found in Title 49 Code of Federal Regulations Part 193 (49 CFR Part 193) Liquefied Natural Gas Facilities. Part 193 is basically the federal "law" when it comes to building LNG facilities in the United States.

If an LNG facility is determined to not be regulated by FERC, it can still be regulated by PHMSA or by a state-level agency. Depending on the state, the facility could still need to meet Part 193 requirements, or it could fall under different requirements adhered to by the state-level jurisdiction. Please check with state and federal bodies to determine which regulatory agencies and requirements your facility is required to follow.

In summary, LNG facilities in the United States will be regulated in one of three scenarios:

- FERC and PHMSA
- Non-FERC but PHMSA
- State-level jurisdiction

MEETING REQUIREMENTS OF PART 193

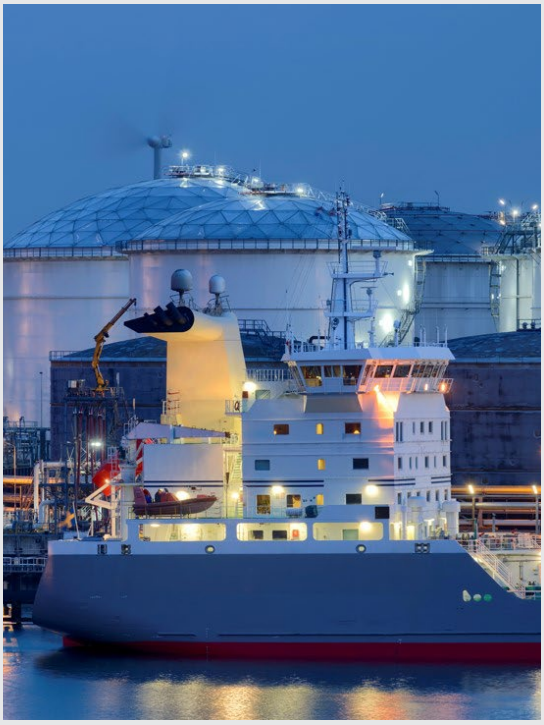
Most LNG facilities are regulated under 49 CFR Part 193. According to PHMSA, exclusions to this include:

1. LNG facilities used by ultimate consumers of LNG or natural gas.
2. LNG facilities used in the course of natural gas treatment or hydrocarbon extraction that do not store LNG.
3. Marine cargo transfer systems and associated facilities, any matter other than siting pertaining to the system or facilities between the marine vessel and the last manifold (or, in the absence of a manifold, the last valve) located immediately before a storage tank.
4. Any LNG facility located in navigable waters.

Operators should assume an LNG facility used in the transportation of gas by a 49 CFR Part 192 pipeline is regulated under 49 CFR Part 193 unless specifically exempted in Section 193.2001(b).

Once you've determined that your facility needs to follow Part 193, it is also required to follow the 2001 version of the National Fire Protection Association (NFPA) 59A, Standard for the Production, Storage and Handling of Liquified Natural Gas (LNG). If a facility is determined to not be required to follow Part 193, a particular state may require the facility to follow a different and possibly newer version of NFPA 59A. Again, check into the specifics of your facility.

When looking at Part 193, pay special attention to Part 193 Sub-Part B that covers "Siting Compliance." There are two sections to review that cover Thermal Radiation Protection and Flammable Vapor-Gas Dispersion Protection.



Thermal Radiation Protection (193.2057)
Each LNG container and LNG transfer system must have a thermal exclusion zone in accordance with section 2.2.3.2 of NFPA–59A–2001.

This states you must demonstrate a thermal radiation reduction at 1600 BTU/hr*ft2 at the property line of the facility (or up to a property that cannot be built upon) from the impoundment (this is referred to as an "exclusion zone").

Flammable Vapor-Gas Dispersion Protection (193.2059)
Each LNG container and LNG transfer system must have a dispersion exclusion zone in accordance with sections 2.2.3.3 and 2.2.3.4 of NFPA–59A–2001.

For this, you must demonstrate that you can achieve 50% of the lower-flammability-limit at the property line (or property that cannot be built upon).

In addition to Part 193, NFPA 59A (2001) Section 9.1.2 states:
Fire protection shall be provided for all LNG facilities. The extent of such protection shall be determined by an evaluation based on sound fire protection engineering principles, analysis of local conditions, hazards within the facility, and exposure to or from other property. The evaluation shall determine the following, as a minimum: (1) The type, quantity, and location of equipment necessary for the detection and control of fires, leaks, and spills of LNG, flammable refrigerants, or flammable gases (2) The type, quantity, and location of equipment necessary for the detection and control of potential nonprocess and electrical fires (3) The methods necessary for protection of the equipment and structures from the effects of fire exposure (4) Fire protection water systems (5) Fire extinguishing and other fire control equipment (6) The equipment and processes to be incorporated within the emergency shutdown (ESD) system, including analysis of subsystems, if any, and the need for depressurizing specific vessels or equipment during a fire emergency (7) The type and location of sensors necessary to initiate automatic operation of the ESD system or its subsystems (8) The availability and duties of individual plant personnel and the availability of external response personnel during an emergency (9) The protective equipment, special training, and qualification needed by individual plant personnel as specified by NFPA 600, Standard on Industrial Fire Brigades, for his or her respective emergency duties.*

The language above is vague and "The extent of such protection shall be determined by an evaluation based on sound fire protection engineering principles, analysis of local conditions, hazards within the facility, and exposure to or from other property" in particular provides a "catch-all" for each facility to determine the hazards and best way to mitigate them. Once you complete the fire-risk assessment, state and city (or other municipalities) fire marshals will review and approve the assessment.

Later versions of NFPA have added provisions.For example, in NFPA 59A (2019), Section 10.3.1.3 states:
Piping insulation used in areas where the mitigation of fire exposure is necessary shall have a maximum flame spread index of 25 when tested in accordance with ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials, or ANSI/UL 723, Standard for Test for Surface Burning Characteristics of Building Materials, and shall maintain those properties that are necessary to maintain physical and thermal integrity during an emergency when exposed to fire, heat, cold, or water.

Section 10.3.1.4 states:
In addition to 10.3.1.3, pipe insulation assemblies used in areas where the mitigation of fire exposure is necessary shall be one of the following: Comprised of noncombustible materials per ASTM E136, Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C (see Section 4.10) covered by an outer protective stainless steel jacket at least 0.02 in. (0.51 mm) thick covered by an outer aluminum jacket at least 0.032 in. (0.81 mm) thick determined to meet the conditions of acceptance in B.3 of NFPA 274.

THE ROLE OF INDUSTRIAL INSULATION

While Part 193 and NFPA 59A don't state specific requirements or provide "credit" for using specific insulation systems, there are several ways in which using a nonflammable insulation and/or a pool fire suppression system can help protect your LNG facilities with structural steel as well as process piping and equipment.

Among the many benefits of industrial insulation are passive fire protection, energy efficiency, sound isolation, personnel protection, mitigation of corrosion and condensation control.

Insulation can protect against rising temperatures of the substrates including piping, equipment and structural elements. This helps to maintain structural integrity. Did you know that steel alloys may lose 50% or more of load-bearing capacity when heated to 1000°F? In the case of a fire, insulation can provide time to allow for the safe, controlled shutdown of equipment and time for firefighting personnel to arrive.

A couple of the insulation types that are used in LNG facilities include:

Mineral Wool Insulation
Composed of inorganic fibers from rock and recycled slag. This provides sound absorption properties, is flame resistant up to 2000+°F, and its maximum service temperature is 1200°F.

Cellular Glass Insulation
A lightweight rigid material composed of millions of completely closed glass cells. It is inorganic, 100% closed cell, impermeable to liquids and moisture and non-flammable. Service temperature range is -450°F to +800°F.

THE NEED FOR AND VALUE OF A POOL FIRE SUPPRESSION SYSTEM

Most issues at an LNG facility are the result of a cryogenic liquid spill. When cryogenic LNG is exposed to air, many problems can occur.

The priorities are to provide thermal shock protection of support steel and concrete. Sudden exposure to cryogenic temperatures can negatively impact the load-bearing capacity of structural materials like concrete and steel. Also, vaporization of liquid hydrocarbons needs to be reduced because LNG gives off invisible, flammable vapors when allowed to boil off.

Lastly, radiant heat during fires needs to be reduced because it further increases vaporization, leading to a self-propagating reaction. As part of your risk assessment and plan you need to be able to show a pool fire will not cause unacceptable temperature levels of 1600 BTUs at your property line. A pool fire suppression system is a good solution for this.

The patented FOAMGLAS® Pool Fire Suppression (PFS) System Gen 2 leverages the properties of FOAMGLAS® cellular glass insulation for a low-maintenance, reliable protection that complements any safety program at an LNG facility.

For this system, modules of cellular glass insulation are wrapped in a silicone adhesive coating and cladded in stainless steel. They are fastened together during installation in order to form an interconnected system of modules within a containment pit.

When LNG pools, the highly buoyant modules rise immediately to the surface of the LNG, providing an insulating cap that can aid in reducing vaporization. In the event of ignition, the modules mitigate the burn rate and quickly limit thermal radiation and flame height. The system works in conjunction with fire-fighting foams and chemical extinguishing systems.

The system is proven to reduce vaporization of liquid hydrocarbons and reduce radiant heat during fires.

Sources

1. Pipeline and Hazardous Materials Safety Administration (PHMSA)Title 49 Code of Federal Regulations Part 193 Liquefied Natural Gas Facilities.

2. National Fire Protection Association (NFPA) 59A, Standard for the Production, Storage, and Handling of Liquified Natural Gas (LNG) 2001 Edition.

Some other resources you may want to consider include:

- NFPA 551 (2022) Guide for the Evaluation of Fire Risk Assessments
- UL 1709 Standard for Rapid Rise Fire Tests of Protection Materials for Structural Steel Owens Corning has decades of historical test data for various insulation systems tested to UL 1709
- ISO 22899-1 Determination of the Resistance to Jet Fires of Passive Fire Protection Materials

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