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2013 NFPA 52

Vehicular Gaseous Fuel Systems

Code Analysis

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2322 West Third Street • Los Angeles, California 90057-1906 • Phone: 213-381-7891 • Fax: 213-381-1517

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Introduction

Overview

Clean Energy is constructing Liquefied Natural Gas (LNG) fueling facilities located throughout the United States.

The proposed improvements consist of:

- Two above ground storage tank
- LNG pump skid
- Off-Load Transfer pump
- Vaporizer
- Fueling Canopy with two islands

Codes and Standards

The National Fire Protection Association (NFPA)

The National Fire Protection Association (NFPA) has prepared a specific code that addresses the use of Liquefied Natural Gas as a motor vehicle fuel.

NFPA 52 - Vehicular Gaseous Fuel Systems Code includes:

- Chapter 10 - LNG Fueling Facilities
- Chapter 12 - LNG Fire Protection
- Chapter 13 - Installation Requirements for ASME Tanks for LNG

The following analysis has been prepared to identify the applicable code sections and describe how the Clean Energy LNG Fueling Facility design has addressed the applicable sections of 2013 NFPA 52.

NFPA 52 - Chapter 10 - LNG Fueling Facilities

[redacted]

		NFPA 52 - Chapter 10 - LNG Fueling Facilities	
	Section		**Compliance**
	10.1 Application.		
		10.1.1 This chapter applies to the design, siting, construction, installation, spill containment, and operation of containers, pressure vessels, pumps, vaporization equipment, buildings, structures, and associated equipment used for the storage and dispensing of LNG and L/CNG as engine fuel for vehicles of all types.	
		10.1.2 All dispensing of LNG, including mobile refueling, into vehicle onboard fuel systems shall comply with the requirements of a permanent LNG refueling installation at the point of dispensing fuel.	
	10.2 Facility Design.		
		10.2.1 General.	
		10.2.1.1 LNG fueling facilities that are permitted to be unattended shall be designed to secure all equipment from tampering.	All storage tanks, vaporizers, pumps and electrical control equipment is located in secured areas.
		10.2.1.2 Storage and transfer equipment at unattended facilities shall be secured to prevent tampering.	The transfer equipment is secured behind a locked access gate.
		10.2.1.3 Operating instructions identifying the location and operation of emergency controls shall be posted conspicuously in the facility area.	Operating instructions are provided.
		10.2.1.4 LNG fueling facilities transferring LNG during the night shall have permanent, adequate lighting at points of transfer and operation.	Lights are provided around the containment area to illuminate the LNG tanker offload station, as shown on Drawing FP-1.0. Additional lights are provided under the canopy that covers the dispenser islands
		10.2.1.5 Designers, fabricators, and constructors of LNG fueling facilities shall be competent in the design, fabrication, and construction of LNG containers, cryogenic equipment, loading and unloading systems, fire protection equipment, methane detection, and other components of the facility.	The LNG fueling station is designed and fabricated by NorthStar, Inc., Evanston, WY. NorthStar has built over 60 similar facilities and has a licensed mechanical PE on staff. Civil and electrical drawings will be PE stamped by Fiedler Group engineers with experience in the design of LNG fuel stations and other fueling facilities.
		10.2.1.6 Supervision shall be provided for the fabrication, construction, and acceptance tests of facility components to the extent necessary to ensure that facilities are structurally sound, suitable for the service, and otherwise in compliance with this code.	All fabrication and construction will be supervised by NorthStar, Inc
		10.2.1.7 LNG refueling sites utilizing or dispensing saturated LNG with personnel in the immediate vicinity shall provide barrier walls or equal protection in order to protect the refueling operator and vehicle.	The LNG storage tank and pumping equipment is surrounded by a containment wall with a minimum height of 3'-3". The LNG dispenser cabinets enclose all LNG fueling piping with the exception of the fueling hose itself.
		10.2.1.8 All facility piping other than the refueling hose to the vehicle shall be behind a barrier, which in the case of an equipment or device malfunction deflects the saturated LNG upward.	The containment wall is higher than the LNG pump skid, preventing any horizontal sprays from leaving the containment area.
	10.2.2 Siting.		
		10.2.2.1 LNG tanks and their associated equipment shall not be located where exposed to failure of overhead electric power lines operating over 600 volts.	LNG tanks and associated equipment is not in the immediate vicinity of overhead electric power lines operating over 600 volts.
		10.2.2.2 Vaulted or underground installations shall be deemed to provide engineered protection from overhead power lines.	Not applicable. Tanks are above ground.
		10.2.2.3 If other combustible or hazardous liquids are able to encroach on the LNG fueling facility, means shall be provided to protect the LNG facility.	The LNG equipment is protected from encroachment of hazardous liquids by the containment wall.
		10.2.2.4 Fired equipment shall be located in accordance with Table 10.2.2.4 from any impounding area or container drainage system.	There is no fired equipment associated with the LNG fueling station. Fired equipment not associated with the fuel station will comply with Table 10.2.2.4.
		10.2.2.5 Points of transfer shall be located not less than 25 ft (7.6 m) from the nearest important building not associated with the LNG facility, from the line of adjoining property that is able to be built upon, or from fixed sources of ignition.	The point of transfer for LNG dispenser number 1 and 2 is more than 25' from the nearest building, including the effect of the full length of the 10' long refueling hose, and is greater than the required 25' separation from the property boundary. The points of transfer for the LNG tanker offload connection is more than 25' from the nearest building, including the full length of a 15' long offload hose, and is greater than the required 25' separation from the property boundary
	10.2.3 Spill Containment.		

		10.2.3.1 Site preparation shall include provisions for retention of spilled LNG within the limits of plant property and for surface water drainage.	The facility plan includes primary spill containment for the LNG storage tank. Primary spill containment for the LNG storage tank is provided by the 3'-3" high containment wall. The LNG dispensers are protected by fail closed valves that are operated by the safety systems. Water drainage from the primary containment area is provided by a manual drain.
		10.2.3.1.1 Saturated LNG in an ASME container [50 psi (345 kPa) and above] shall only have to meet the requirements of 10.2.3.1 with respect to construction of the impounding area.	The containment area is designed to meet the requirements of paragraph 10.2.3.1.
		10.2.3.2 Enclosed drainage channels for LNG shall be prohibited.	Not Applicable - Enclosed drainage channels are not included in this facility design
		10.2.3.3* Impounding areas, if provided to serve LNG transfer areas, shall have a minimum volumetric capacity equal to the greatest volume of LNG or flammable liquid that could be discharged into the area during a 10-minute period from any single accidental leakage source or a lesser time period based on demonstrable surveillance and shutdown provisions acceptable to the AHJ.	The spill containment for the LNG offload area is designed to contain a 10 minute spill at a flow rate of 250 gallons per minute .
		10.2.3.4 Flammable liquid storage tanks shall not be located within an LNG container impounding area.	No flammable liquids are stored within the LNG impoundment area.
		10.2.3.5* Impounding areas serving LNG containers shall have a minimum volumetric holding capacity, V, including any useful holding capacity of the drainage area and with allowance made for the displacement of snow accumulation, other containers, and equipment, in accordance with 10.2.3.5.1 and 10.2.3.5.2.	The containment area for the LNG storage tank is sized to contain 100% of the tank contents, after allowing for liquid displacement by the LNG equipment.
		10.2.3.5.1 For impounding areas serving one or more than one container with provisions made to prevent low temperature or fire exposure resulting from the leakage from anyone container served from causing subsequent leakage from any other container served, the volume of the dike shall be the total volume of liquid in the largest container served, assuming the container is full.	The impounding area serves two LNG storage tank. The tank legs are protected by a concrete-based fireproofing product, Carboline Pyrocrete 241, which also insulates the tank legs against cold temperatures from an LNG spill, as demonstrated in a UL test report.
		10.2.3.5.2 For impounding areas serving more than one container without provisions made in accordance with 10.2.3.5.1, the volume of the dike shall be the total volume of liquid in all containers served, assuming all containers are full.	The impounding area serves two LNG storage tanks.
		10.2.3.6 The containment design shall include calculations and shall be installed to prevent overflow due to spill wave action.	The containment area calculations are shown on Drawing CS-1.0. The containment area is oversized by 10% to account for wave action.
		10.2.3.7 The containment design shall prevent projecting LNG or cold gas beyond the containment area.	The containment is oversized by 10% to account for wave action and to help prevent cold gas from leaving the containment area. Since the containment area does not have a roof it is impossible to contain cold vapor under all conditions.
		10.2.3.8 Provisions shall be made to clear rain or other water from the impounding area.	Rain water is cleared from the LNG storage tank containment area by a drain valve.
		10.2.3.8.1 Automatically controlled sump pumps shall be permitted if equipped with an automatic cutoff device that prevents their operation when exposed to LNG temperatures.	Not applicable - The facility does not include an automatically controlled sump pump.
		10.2.3.8.2 Piping, valves, and fittings whose failure permits liquid to escape from the impounding area shall be designed for continuous exposure to LNG temperatures.	All piping which can be exposed to LNG will be stainless steel.
		10.2.3.8.3 If gravity drainage is employed for water removal, provisions shall be made to prevent the escape of LNG by way of the drainage system.	The drain valve is an air operated valve. The valve is cycled open and closed under the control of the PLC. In the event of an ESD the drain valve is automatically closed along with all other air operated valves.
	10.2.4 Indoor Fueling.		Not applicable. Fueling is outdoors.
		10.2.4.1 Building Construction.	Not applicable. Fueling is outdoors.
		10.2.4.4 A gas detection system shall be provided in all buildings containing LNG.	Not applicable. Fueling is outdoors.
		10.2.4.4.1 The gas detection system shall activate a latched alarm when a maximum of 20 percent of the LFL is reached.	Not applicable. Fueling is outdoors.

		10.2.4.5 Dispensing equipment located inside or attached to buildings used for other purposes shall comply with the following: (1) The dispensing room shall have a minimum of one external wall. (2) Interior walls or partitions shall be continuous from floor to ceiling, be anchored in accordance with the building code, and have a fire resistance rating of at least 2 hours. (3) The interior finish of the dispensing room shall be constructed of noncombustible or limited-combustible materials. (See Section 4.5 for noncombustible or limited-combustible.) (4) In the interior walls of the dispensing room, doors shall be listed as 1-hour self-closing fire doors that are installed in accordance with NFPA 80, Standard for Fire Doors and Other Opening Protectives. (5) A ventilation system for a dispensing room within or attached to another building shall be separated from any ventilation system for the other building. (6) Access to the dispensing room shall be from outside the primary structure only.	Not applicable. Fueling is outdoors.
		10.2.4.5.1 Access from within the primary structure shall be permitted where such access is made through a barrier space having two vapor-sealing, self-closing fire doors having a fire resistance rating equal to that of the wall.	Not applicable. Fueling is outdoors.
		10.2.4.6 Access doors or fire doors shall be kept unobstructed at all times.	Not applicable. Fueling is outdoors.
		10.2.4.7 Signs and markings and the words “WARNING — NO SMOKING” shall be in red letters at least 1 in. (25 mm) high on a white background.	Not applicable. Fueling is outdoors.
		10.3.1 Section 10.3 shall apply to the transfer of LNG between cargo transport containers and fueling facility containers.	The requirements for cargo transport unloading apply to this facility.
		10.3.2 When transfers are made into fueling facility containers, the LNG shall be transferred at a pressure that does not overpressurize the receiving tank.	Offloading is accomplished with a dedicated offload LNG pump and is controlled by the PLC control system. This control system includes monitoring of tank pressure and pump discharge pressure to prevent over-pressurizing the LNG storage tank. If tank pressure or pump discharge pressure exceeds pre-programmed limits a control alarm will be initiated and the LNG pump will be shut down. The LNG pump can generate sufficient discharge pressure to overcome tank pressure, so it is not necessary to vent the LNG storage tank during offloading except under extreme conditions.
		10.3.2.1 Venting of on-site containers shall be done only under emergency conditions and in a manner acceptable to the authority having jurisdiction.	Venting of on-site containers shall be done only under emergency conditions and in a manner acceptable to the authority having jurisdiction.
		10.3.3 Isolation Valves.	emergency conditions and in a manner acceptable to the
		10.3.3.1 The transfer piping shall have isolation valves at both ends.	authority having jurisdiction.
		10.3.3.2 On facility containers with a capacity greater than 2000 gal (7.6 m3), one remotely operated valve, automatic closing valve, or check valve shall be used to prevent backflow.	Check valves are provided on the pump discharge and fill circuits on the LNG storage tank to prevent back flow, as well as an automatic valve between the offload pump and offload hose.
		10.3.4 If the fueling facility tank or transfer equipment is located in a remote area, operating status indicators, such as those that indicate container level, shall be provided in the unloading area.	The offload transfer equipment is mounted directly adjacent to the LNG storage tank. Pressure and level gauges are provided on the LNG storage tank and are visible at the offloading station.
		10.3.5 At least one qualified person shall be in continuous attendance with an unobstructed view of the transfer point while unloading is in progress.	The LNG transport drivers are required to be trained in the correct offload and safety procedures. This person is required to be present at all times during the offload process.
		10.3.6 Sources of ignition shall not be permitted in the unloading area while transfer is in progress.	Sources of ignition are prohibited from the offload area. Signage on the LNG containment wall notify personnel of this policy
		10.3.7 Methane Detection.	
		10.3.7.1 Offloading site methane detection and fire protection shall be provided.	Methane detectors and UV/IR flame detectors are provided for protection of the offload area. The locations are illustrated on Drawing FP-1.0.

		10.3.7.2 The methane detection system shall be capable of detection at multiple locations beyond the full radius of the transfer hose, measured at each point of transfer and receipt of LNG.	Methane detectors are provided for the facility, at each LNG dispenser, at the transfer skid, and the LNG pump skid. The locations are illustrated on Drawing FP-1.0.
		10.3.8 Bleed Connections.	
		10.3.8.1 Bleed or vent connections shall be provided so that loading arms and hoses can be drained and depressurized prior to disconnection if necessary.	A manual bleed valve for the hose is provided near the offload connection.
		10.3.8.2 The connections shall relieve to a safe area.	The bleed valve directs liquid and vapor from the offload hose to the LNG storage tank vent stack.
		10.3.9 Prior to connection, a cargo transport vehicle's wheels shall be rendered immobile.	The offloading procedure requires chocking the wheels before offloading. In addition, the design of the standard LNG transport tanker releases air from the trailer air brakes when the piping cabinet is opened, rendering the transport tanker immobile.
		10.3.10 The cargo transport vehicle's engine shall be shut off while the transfer hose or piping is being connected or disconnected.	The offloading procedure requires turning off the transport vehicle’s engine.
		10.3.11 If required for LNG transfer, the engine shall be permitted to be started and used during the liquid transfer operations.	The transfer pump is built into the LNG fuel station system. It is not necessary to operate a transfer engine on the transport, even if present. The majority of LNG transports does not have a transfer engine and pump.
		10.3.12 The LNG cargo transport unloading connection shall be at least 1.5 ft (0.46 m) from a storage container.	The LNG transport unloading connection is approximately 10 feet from the LNG storage tank, exceeding the minimum distance of 1.5 feet.
	10.4 Vehicle Fuel Dispensing Systems.		
		10.4.1 The dispensing device shall be protected from vehicle collision damage.	The LNG dispensers will be protected by concrete islands and concrete filled pipe bollards.
		10.4.2 An ESD shall be provided that includes a shutoff valve for stopping liquid supply and shutting down transfer equipment.	Each LNG dispenser includes a built-in emergency shut down button. Activation of any emergency shut down button on the entire facility will turn off the dispensing pump and close all automatic valves.
		10.4.3 An ESD actuator, distinctly marked for easy recognition with a permanently affixed, legible sign, shall be provided within 10 ft (3.1 m) of the dispenser and also at a safe, remote location.	An emergency shut down button is mounted on each LNG dispenser. There are also emergency shut down buttons located on the main control cabinet, at the offload location, and on the wall of the existing office building.
		10.4.4 The maximum delivery pressure at the fueling nozzle shall not exceed the maximum allowable pressure of the vehicle fuel tanks.	The fuel delivery pressure is monitored and controlled by the PLC control system. Pump speed is varied in order to maintain dispenser pressure at a safe level below the maximum allowable working pressure of the vehicle tanks. Safety relief valves also protect the piping from being exposed to excessively high pressures.
		10.4.5 Hose and arms shall be equipped with a shut-off valve at the fuel end and a breakaway device to minimize release of liquid and vapor in the event that a vehicle pulls away while the hose remain connected. Such a device shall be installed and maintained in accordance with the OEM component manufacturer's maintenance/ safety instructions.	An automated valve is mounted near the dispenser end of the dispensing hose. This valve is closed automatically by the emergency shut down system in an emergency. A breakaway device is located where the dispense hose is attached to the dispenser piping. This breakaway is configured to actuate the emergency shut down system through loss of control air pressure in a drive away event. In addition, the fueling nozzle incorporates a self-closing valve that closes when the fueling nozzle is released from the vehicle tank.
		10.4.5.1 Such a device shall be installed and maintained in accordance with the OEM component manufacturer’s maintenance/safety instructions.	All equipment will be maintained in accordance with the manufacturers' recommendations.
		10.4.6 When not in use, hose shall be secured to protect it from damage.	The hose is suspended by a retractable hose cable when not in use.
		10.4.7 Where a hose or arm of nominal 3 in. (76 mm) diameter or larger is used for liquid transfer or where one of nominal 4 in. (100 mm) diameter or larger is used for vapor transfer, an emergency shut-off valve shall be installed in the piping of the transfer system within 10 ft (3.1 m) from the nearest end of the hose or arm.	The LNG dispensing hose is 1 in. nominal diameter. The emergency shut off valve is located approximately 18” from the inlet to the dispensing hose. It is possible that this paragraph is intended to apply to the offloading system, even though it falls under the heading of Vehicle Fuel Dispensing Systems. The offloading hose is 3” nominal diameter, and is equipped with an emergency shut off valve approximately 5 feet from the nearest end of the offloading hose.

10.4.7.1 Where the flow is away from the hose, a check valve shall be permitted to be used as the shut-off valve.	A check valve is not provided in the LNG dispensing piping, although a check valve is included in the vehicle tank piping. An air actuated ball valve is used as the shutoff valve.
10.4.7.2 Where either a liquid or vapor line has two or more legs, an emergency shut-off valve shall be installed either in each leg or in the feed line before the legs.	The LNG dispensing hose is a single leg design.
10.4.8 Bleed Connections.	
10.4.8.1 Bleed or vel1l connections shall be provided so that loading arms and hose can be drained and depressurized prior to disconnection if necessary.	An automatic bleed circuit is provided for the LNG dispensing hose. This circuit bleeds the dispensing hose back to the LNG storage tank, depressurizing the dispensing hose to the same pressure as the LNG storage tank.
10.4.8.2 Bleed or vent connections shall lead to a safe point of discharge.	The bleed circuit for the LNG dispensing hose is routed back into the LNG storage tank.
10.4.9 A fueling connector and mating vehicle receptacle shall be used for reliable, safe, and secure transfer of LNG or gas vapor to or from the vehicle with minimal leakage.	A JC Carter fueling nozzle and vehicle receptacle are provided, which are the most common type used in the industry. The manufacturer rates the amount of venting upon disconnection of the fueling coupling as less than 1 cubic centimeter of liquid or vapor volume.
10.4.10 The fueling connector either shall be equipped with an interlock device that prevents release while the line is open or have self-closing ends that automatically close upon disconnection.	The fueling nozzle includes an interlock device with self-closing end on both the fueling nozzle and vehicle tank receptacle.
10.4.11 The transfer of LNG into vehicular onboard fuel containers shall be performed in accordance with the onboard tank and refueling component OEM manufacturer's instructions.	Refueling instructions are posted on each dispenser cabinet.
10.4.11.1 The OEM manufacturer's instructions shall be posted at the dispensing device.	Instructional signage is included at the dispensing area.
10.4.12 The spacing of LNG dispensing equipment relative to other equipment, activities. Nearby property lines, and other exposures in a fuel dispensing forecourt shall be approved by the AHJ.	The dispensing equipment is sited in accordance with Table 10.2.2.4 and other requirement in NFPA 52.
10.4.13 The provisions of Section 10.4 shall not apply to dispensing from vehicle-mounted tanks located at commercial and industrial facilities used in connection with their business where the following conditions are met:	Not applicable. Dispensing will not occur from vehicle mounted tanks.
(l) An inspection of the premises and operations shall have been made and approval granted by the AHJ	
(2) The vehicle-mounted container shall comply with requirements of DOT.	
(3) The dispensing hose shall not exceed 50 ft (15 m) in length.	
(4) Nighttime deliveries shall be made only in lighted areas.	
10.5 Piping Systems and Components. Piping shall be in accordance with Chapter 16.	Piping shall be in accordance with Chapter 16, Installation Requirements for ASME Tanks for LNG.
10.6 Safety and Relief Valves.	
10.6.1 Pressure relieving safety devices shall be so arranged that the possibility of damage to piping or appurtenances is reduced to a minimum.	Each section of piping is protected by a pressure safety device of the appropriate size, type, and pressure rating. Flow ratings are based on assumed fire conditions.
10.6.2 The means for adjusting relief valve set pressure shall be sealed.	All pressure safety valves are sealed and non-adjustable except by an authorized safety valve repair technician.
10.6.3 Stationary LNG containers shall be equipped with pressure relief devices in accordance with CGA S- 1.3, Pressure Relief Device Standards - Part 3 - Stationary Storage Containers for Compressed Gases.	The LNG storage tank is equipped with relief valves and rupture discs by the tank manufacturer. These safety devices are provided by the tank manufacturer in accordance with CGA S-1.3 as required.
10.6.4 A thermal expansion relief valve shall be installed as required to prevent over pressure in any section of a liquid or cold vapor pipeline that can be isolated by valves.	Each piping section that can be isolated by either manual or automatic valves is protected by a relief valve.
10.6.4.1 Thermal expansion relief valves shall be set to discharge above the maximum pressure normally expected in the line but less than the rated test pressure of the line it protects.	Thermal expansion relief valves are set to the MAWP rating of the piping they protect. The pressure is higher than the normal operating pressure of the piping and less than the test pressure of the piping, which is 1.5 times the MAWP for a hydrostatic test and 1.1 times the MAWP for a pneumatic test in accordance ASME B31.3.
10.6.4.2 Discharge from thermal expansion relief valves shall be directed so as to minimize hazard to personnel and other equipment.	The discharge from the thermal expansion relief valves is directed to the vent stack on the LNG storage tank.

	10.7 Corrosion Control.		
		10.7.1 Underground and submerged piping shall be protected and maintained in accordance with the principles of NACE RP0169. Control of External Corrosion of Underground or Submerged Metallic Piping Systems.	There is no underground or submerged LNG piping in this facility. The piping to the LNG dispensers is placed in a covered trench and provided with a sump pump to prevent immersion.
		10.7.2 Austenitic stainless steels and aluminum alloys shall be protected to minimize corrosion and pitting from corrosive atmospheric and industrial substances during storage, construction, fabrication, testing, and service.	Austenitic steels perform well in LNG service. No chlorides are used in the fabrication process. Insulation used on piping is chloride free to prevent corrosion under insulation.
		10.7.2.1 These substances shall include, but not be limited to, chlorides and compounds of sulfur or nitrogen.	No chlorides or sulfur or nitrogen compounds are used in fabrication or in service.
		10.7.2.2 Tapes or other packaging materials that are corrosive to the pipe or piping components shall not be used.	No corrosive materials will be used.
		10.7.2.3 Where insulation materials cause corrosion of aluminum or stainless steels, inhibitors or waterproof barriers shall be utilized.	Only chloride free corrosion resistant insulation will be used.
		10.7.3 Corrosion protection of all other materials shall be in accordance with the requirements of SSPGPA I, Shop, Field and Maintenance Painting; SSPC;.PA 2, Measurement of Dry Paint Thickness with Magnetic Gages; and SSPC-SP 6. Commercial Blast Cleaning.	The paint systems used on the LNG storage tank comply with the listed requirements.
	10.8 Stationary Pumps and Compressors.		
		10.8.1 Valves shall be installed such that each pump or compressor can be isolated for maintenance.	Manual isolation valves allow maintenance or replacement of the LNG pump.
		10.8.2 Where pumps or centrifugal compressors are installed for operation in parallel, each discharge line shall be equipped with a check valve.	Only a single LNG pump is used in this facility.
		10.8.3 Foundations and sumps for cryogenic pumps shall be designed and constructed to prevent frost heaving.	The pump is installed in a stainless steel ASME code stamped, vacuum jacketed sump. This sump is installed above ground and is mounted on a steel frame. Frost heaving will not occur because the sump is not in direct contact with the ground.
		10.8.4 Operation of all pumps and compressors shall cease when the facility's ESD system is initiated.	The ESD system immediately stops the pump from operating and removes power from the pump and all electrical equipment.
		10.8.5 Each pump shall be provided with a vent or relief valve that prevents overpressurizing of the pump case under all conditions, including the maximum possible rate of cool down.	The pump sump is equipped with a vent circuit to route boil off gas back to the storage tank. The sump is also equipped with a pressure safety valve that is sized for the boil off that occurs during fire conditions.
		10.8.6 Compression equipment handling flammable gases shall be provided with vent line connections from all points, including distance pieces of packing for piston rods, where gases escape.	Compression equipment is not a part of this facility
		10.8.7 Vents shall be piped outside of buildings to a point of safe disposal.	Not applicable. This facility is not indoors.
	10.9 Vaporizers.		
		10.9.1 Multiple vaporizers shall be manifolded such that both inlet and discharge block valves are installed on each vaporizer.	A single vaporizer is included in this facility. This vaporizer is only used to raise the saturation temperature of the LNG, not to generate warm vapor.
		10.9.2 If the intermediate fluid used with a remote heated vaporizer is flammable, shut-off valves shall be provided on both the hot and cold lines of the intermediate fluid system.	The vaporizer utilizes ambient air as the heat source. There is no intermediate fluid. A fan powered by an explosion proof motor circulates air to improve the efficiency of the vaporizer.
		10.9.3 A low temperature switch or other accepted means shall be installed on the vaporizer discharge to eliminate the possibility of LNG or cold natural gas entering LNG containers and other equipment not designed for LNG temperatures.	The warmed LNG from the vaporizer is returned to the LNG storage tank. A low temperature switch is not needed since there is no downstream equipment that could be damaged by low temperatures.
		10.9.4 Relief valves on heated vaporizers shall be located so that they are not subjected to temperatures exceeding 140"F (60"C) during normal operation unless they are designed to withstand higher temperatures.	Not applicable. The vaporizer is not heated.

		10.9.5 The combustion air required for the operation of integral heated vaporizers or the primary heat source for remote heated vaporizers shall be taken from outside an enclosed structure or building.	Not applicable. The vaporizer does not use a combustion heat source.
		10.9.6 Vaporizers for purposes other than pressure building coils or LNG-to-CNG (L/CNG) systems shall be in accordance with NFPA 59A, Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG).	The purpose of the saturation vaporizer is to increase tank pressure by adding heat to the tank contents. Since the discharge of the vaporizer is returned to the storage tank its function is very similar to a pressure building coil. For this reason the requirement to comply with NFPA 59A is not applicable.
		10.9.7 Installation of internal combustion engines or gas turbines shall conform to NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.	Not applicable. Internal combustion engines and gas turbines are not used on this facility.
		10.9.8 The vaporizer shall be anchored and its connecting piping shall be sufficiently flexible to provide for the effect of expansion and contraction due to temperature change.	The vaporizer is anchored to the concrete slab that makes up the floor of the containment area. Flexible piping elements and expansion loops are used to minimize pipe stress and loads on the vaporizer due to thermal contraction.
	10.10 LNG-to-CNG (L/CNG) Systems.		
		10.10.1 Section 10.10 shall apply to the design, construction, installation, and operation of equipment used to produce CNG from LNG.	
		10.10.2 The process shall be permitted to be accomplished by pumping LNG to high pressure and vaporizing it or by compressing vapor from an LNG tank.	
		10.10.3 In addition to the emergency shutdown systems described in Section 10.4, the emergency shutdown system also shall shut off the liquid supply and power to the LNG transfer equipment necessary for producing CNG from LNG.	The odorant dispensing system has a level transmitter installed on the odorant reservoir. This transmitter allows the PLC control system to monitor odorant level. There is a low odorant level parameter (typically set to 1%) that triggers an administrative alarm when this level is reached. Currently we do not stop CNG fueling when this alarm is active, because it is our experience that the CNG systems become saturated with odorant and the CNG remains odorized for a long period of time if the odorant is depleted. However, if a local jurisdiction requires it, we can
		10.10.4 Compressors, vaporizers, and CNG storage cylinders shall not be located inside the facility impounding area.	Compressors, vaporizers, and CNG storage cylinders will not be located inside the impounding area.
		Exception: Ambient and remotely heated vaporizers shall be permitted to be located inside the facility impounding area.	
		10.10.4.1 Ambient and remotely heated vaporizers shall be permitted to be located inside the facility impounding area.	
		10.10.5 Transfer piping, pumps, and compressors shall be protected from vehicle collision damage.	All equipment is protected by steel bollards.

		10.10.6 L/CNG natural gas refueling site and automotive applications shall not be required to utilize an odorant if an engineered and validated methane detection system is in place.	Not applicable. Odorant will be added for LCNG applications.
		10.10.7 Unodorized L/CNG natural gas shall not be dispensed at public refueling stations.	Not applicable. Odorant will be added for LCNG applications.
		10.10.8 Refueling stations dispensing odorant shall have safety measures in place to automatically and completely shut down all dispensing of L/CNG if the odorant supply is inadequate.	
		10.10.9 Refueling station odorant dispensing equipment shall be certified by the dispenser OEM for automotive refueling station applications.	NorthStar as the manufacturer and Clean Energy as the owner/operator need to take responsibility for the design and operation of the LCNG system.
		10.10.10 Dispensing of odorant for automotive natural gas applications shall conform to the federal standards for natural gas pipeline percentages of odorant within the gaseous mixture.	NorthStar is not aware of a consistent standard for the odorant concentration of pipeline gas. In our experience we have been asked to odorize LCNG to between 12 and 50 ppm. We have found that the LCNG tends to be heavily odorized at the upper end of this range so we have used 12 ppm with good results on several recent projects. The odorant injection pump stoke rate is adjustable so that we can operate at any target odorant concentration that is required.
		10.10.11 Onboard methane detection shall be required for vehicles that utilize unodorized natural gas or that do not meet the federal standards for pipeline gas odorization.	Not applicable. Odorant will be added for LCNG applications.
	10.11 Instrumentation.		
		10.11.1 Pressure Gauging. Pressure gauges shall be installed on each pump and compressor discharge.	A pressure gauge is installed on the pump discharge piping.
		10.11.2 Temperature Instruments.	
		10.11.2.1 Vaporizers and heaters shall be provided with instrumentation to monitor outlet temperatures.	Vaporizers are required to have a temperature sensor on the discharge, except when the vaporizer is an ambient type heat exchanger and the vapor discharge is returned to the storage tank. This is true for this facility and is therefore exempt from the requirement for a temperature sensor.
		Exception: Ambient pressure-building coil vaporizers that are fed with liquid from, and return vapor to, a container.	
		10.11.2.1.1 Ambient pressure–building coil vaporizers that are fed with liquid from, and return vapor to, a container shall not be subject to 10.11.2.1.	
		10.11.2.2 Temperature monitoring systems shall be provided where the foundations supporting cryogenic containers and equipment are subject to adverse effects by freezing or frost heaving of the ground.	The foundations for the tank and equipment are isolated from cryogenic temperatures. The tank and equipment are vacuum jacketed and raised off the concrete by structural steel supports. The foundation therefore will not be subject to frost heaving from the cryogenic equipment and a temperature monitoring system for the foundation is not necessary.
		10.11.3 Emergency Shutdown Device (ESD).	
		10.11.3.1 Instrumentation for LNG fueling facilities shall be designed so that, in the event of a power or instrumentation failure, the system goes into a fail-safe condition until the operators either reactivate or shut down the system.	Upon activation of the ESD system the pump is turned off and all actuated valves are closed. The system will stay in this state until the condition that triggered the ESD is corrected and the ESD system is reset.
		10.11.3.2 All ESDs shall be manually reset.	Resetting the ESD system requires the operator to press the manual reset button. The condition that caused the ESD, e.g. methane detection, must be corrected before the ESD system will be allowed to reset.
	10.12 Electrical Equipment.		
		10.10.1 Electrical equipment and wiring shall be as specified by and installed in accordance with NFPA 70, National Electrical Code, meeting the requirements of Class I, Group D, Division or Zone as specified in Table 10.2.2.4.	All electrical equipment shall comply with the requirements of NFPA 70, National Electrical Code.
		Exception: Electrical equipment on internal combustion engines installed in accordance with NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines.	

		10.10.1.1 Electrical equipment on internal combustion engines installed in accordance with NFPA 37, Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines, shall not be subject to 10.10.1.	The LNG storage tank, pump skid, control panel, dispensers, and all other equipment will be connected to the grounding grid.
		10.10.2 Each interface between a flammable fluid system and an electrical conduit or wiring system, including process instrumentation connections, integral valve operators, foundation heating coils, canned pumps, and blowers, shall be sealed or isolated to prevent the passage of flammable fluids to another portion of the electrical installation.	Electrical seals are built into each electrical device that is connected to an electrical conduit.
		10.10.3 Each seal, barrier, or other means used to comply with 10.10.2 shall be designed to prevent the passage of flammable fluids or gases through the conduit, stranded conductors, and cables.	Electrical seals are designed to prevent the passage of flammable vapors.
		10.10.4* A primary seal shall be provided between the flammable fluid and gaseous systems and the electrical conduit wiring system.	Primary seals are included as components of devices exposed to system pressure where needed.
		10.10.4.1 If the failure of the primal)' seal would allow the passage of flammable fluids and gases to another portion of the conduit or wiring system, an additional approved seal, barrier, or other means shall be provided to prevent the passage of the flammable fluid beyond the additional device or means in the event that the primary seal fails.	Dual pressure seals are utilized for entry into the pump sump for the LNG pump power wiring.
		10.10.5 Each primary seal shall be designed to withstand the service/ice conditions to which it is expected to be exposed.	Primary seals are rated appropriately for the intended duty.
		10.10.5.1 Each additional seal or barrier and interconnecting enclosure shall meet the pressure and temperature requirements of the condition to which it could be exposed in the event of failure of the primary seal, unless other approved means are provided to accomplish this purpose.	Seals are appropriate for the intended duty per NFPA 70.
		10.10.6 Unless specifically designed and approved for the purpose, the seals specified in 10.10.2 through 10.10.4 shall not be permitted to replace the conduit seals required by 501.15 of NFPA 70, National Electrical Code.	Conduit seals are provided on each conduit in the locations required by NFPA 70.
		10.10.7 Where primary seals are installed, drains, vents, or other devices shall be provided for monitoring purposes to detect flammable fluids and leakage.	A vent port is provided between the dual primary seals used on the pump power wiring.
		10.10.8 Static protection shall not be required when cargo transport vehicles or marine equipment are loaded or unloaded by conductive or nonconductive hose, flexible metallic tubing, or pipe connections through or from tight (top or bottom) outlets where both halves of metallic couplings are in contact.	The offload hose and couplings metallic, conductive, and in direct contact. Static protection is not required for unloading LNG transports.
	10.13* Maintenance.		
		10.13.1 A preventive maintenance program consistent with the OEMs' recommendations shall be in place and include a written regular schedule of procedures for test and inspection of facility systems and equipment.	The maintenance plan will be finalized and placed into effect when the facility commences operation.
		10.13.1.1 The maintenance program shall be carried out by a qualified representative of the equipment owner.	The maintenance plan includes inspections and maintenance procedures to be performed at 3 month intervals.
		10.13.1.2 The refueling site shall have a maintenance program or process safety analysis program in place.	The maintenance plan includes the refueling site.
		10.13.1.3 Maintenance records shall be kept for the duration of the refueling site's operation.	Maintenance records will be kept for the duration of the refueling site's operation.
		10.13.2 Each component in service, including its support system, shall be maintained in a condition that is compatible with its operation or safety purpose by repair, replacement, or other means as determined by the equipment OEM.	The maintenance plan includes all components requiring maintenance.

NFPA 52 - Chapter 12 - LNG Fire Protection

[redacted]

		NFPA 52 - Chapter 12 - LNG Fire Protection	
		Section	**Compliance**
	12.1 Application		
		This chapter applies to LNG fire protection, personnel safety, security, LNG fueling facilities and training for LNG vehicles, and warning signs.	This section is applicable to the LNG fuel station.
	12.2 Fire Protection, Safety, and Security.		
		12.2.1 Fire protection shall be provided for all LNG fueling facilities.	Fire protection is required for all LNG facilities.
		12.2.1.1 The extent of such protection shall be determined by n evaluation based on sound fire protection and methane detection engineering principles, analysis of local conditions, vehicle operations, hazards within the facility, exposure to or from other property, and the size of the LNG containers.	The extent of fire protection is described below.
		12.2.1.2 Guidance factors for making such an evaluation include the following:	The development of the fire protection system is based on an analysis of the listed factors.
		(l) Type, quantity, and location of equipment necessary for the detection and control of fires, leaks, and spills of LNG, flammable refrigerants, and flammable gases or liquids	
		(2) Methods necessary for the protection of vehicles, equipment, and structures from the effects of fire exposure	
		(3) Equipment and processes to be incorporated within the ESD system	
		(4) Type, quantity, and location of sensors necessary to initiate automatic operation of the ESD system	
		(5) Availability and duties of individual facility personnel and the availability of external response personnel during an emergency	
		(6) Protective equipment and special training required by personnel for emergency duties	
		12.2.2 The planning for emergency response measures shall be coordinated with the appropriate local emergency agencies.	The planning for emergency response measures will be the responsibility of Clean Energy.
		12.2.3* An emergency response plan shall be prepared to cover foreseeable emergency conditions.	Development of an emergency response plan will be the responsibility of Clean Energy.
		12.2.4 The fire protection and methane detection equipment shall be maintained in accordance with the manufacturer's instructions and the AHJ.	A maintenance plan will be provided by upon request.
	12.3 Ignition Source Control.		
		12.3.1 Smoking and ignition sources shall be prohibited, except in accordance with 12.3.2.	Smoking will be prohibited near the LNG facilities. Signage will be posted notifying users of this fact.
		12.3.2 Welding, oxygen-acetylene cutting, and similar operations shall be conducted only when and where specifically authorized and in accordance with the provisions of NFPA 51B, Standard for Fire Prevention During Welding, Cutting, and Other Hot Work.	Welding and other similar operations shall be performed using appropriate hot work procedures.
		12.3.3 Vehicles and other mobile equipment that constitute a potential ignition source shall be prohibited except where specifically authorized and under constant supervision or when at a transfer point specifically for the purpose of transfer.	This facility is manned 24 hours per day. Vehicle traffic past the containment area to reach the LNG dispensers and truck scale is permitted.
		12.3.4 Vehicles delivering LNG to the facility or vehicles being fueled from the facility shall not be considered sources of ignition.	LNG transports and vehicles being refueled are not considered sources of ignition.
		12.3.5 Vehicles containing fuel-fired equipment (e.g., recreational vehicles and catering trucks) shall be considered a source of ignition unless all sources of ignition such as pilot lights, electric igniters, burners, electrical appliances, and engines located on the vehicle being refueled are shut off completely before entering an area where ignition sources are prohibited.	Vehicles with fuel-fired equipment are considered sources of ignition, but are permitted for manned facilities per 12.3.3.
	12.4 Personnel Safety and Training.		
		12.4.1 Qualification of Personnel. All persons employed in handling and dispensing LNG shall be trained in handling and operating duties and procedures.	All persons that handle and dispense LNG shall be trained.
		12.4.2 Protective clothing, face shield/goggles, and gloves shall be provided for all operators dispensing and handling LNG. Exception: Where equipment is demonstrated to operate without release of LNG or cold gases.	Protective clothing and equipment shall be required for all operators of the LNG fueling facility.
		12.4.2.1 Requirements, as specified in 12.4.2, shall be permitted to be excluded where equipment is demonstrated to operate without exposing operators to release of LNG or cold gases.	All persons that handle and dispense LNG shall be trained.
		12.4.3"' Training shall be conducted upon employment and every 2 years thereafter.	The training plan will require training all new LNG equipment operators and retraining every 2 years.
		12.4.4 Training shall include the following:	The training program will address the items in this paragraph.
		(1) Information on the nature, properties, and hazards of LNG in both the liquid and gaseous phases	
		(2) Specific instructions on the facility equipment to be used	
		(3) Information on materials that are compatible for use with LNG	
		(4) Use and care of protective equipment and clothing	
		(5) Standard first aid and self-aid instruction	

		(6) Response to emergency situations such as fires, leaks, and spills	
		(7) Good housekeeping practices	
		(8) Emergency response plan as required in 12.2.3	
		(9) Evacuation and fire drills	
		12.4.5 Each operator shall provide and implement a written plan of initial training to instruct all designated operating and supervisory personnel in the characteristics and hazards of LNG used or handled at the site, including low LNG temperature, flammability of mixtures with air, odorless vapor, boil-off characteristics, and reaction to water and water spray; the potential hazards involved in operating activities; and how to carry out the emergency procedures that relate to personnel functions and to provide detailed instructions on mobile LNG	The training program will address the items in this paragraph.
	12.5 Security.		
		12.5.1 The LNG fueling facility shall provide protection to minimize unauthorized access and damage to the facility.	The LNG equipment is surrounded by a 3'-3"high containment wall and 8' high fencing to minimize access to the LNG equipment. The LNG dispensers include lockable panels to obtain access to the internal piping. The LNG control system requires a key to open the doors to gain access to the PLC and control system components. The facility is unmanned and open to the public for fueling.
		12.5.2 Security procedures shall be posted in readily visible areas near the fueling facility.	There are no security procedures required beyond normal securing of the equipment doors and panels.
	12.6 Hazard Detection.		
		Gas leak detection and fire detection shall be installed based on the evaluation required in 12.2.1.1.	The facility includes methane and UV/IR flame detectors.
	I2.7 Parking of LNG Vehicles.		
		LNG vehicles shall be permitted to be parked indoors, provided such facilities or vehicles are equipped to prevent an accumulation of gas in a combustible mixture or the onboard fuel storage tank and fuel system are drained of LNG and purged with inert gas or depressurized.	Not applicable. There is no indoor parking at this facility.
	12.8 Warning Signs.		
		For all LNG fueling facilities, the following signs shall be displayed in bright red letters on a white background,	Appropriate warning signs will be posted at several locations around the facility.
		(1) "No Smoking" or "No Smoking within 25ft (7.6 m) "	
		(2) "Stop Motor"	
		(3) "No Open Flames Permitted"	
		(4) "Cryogenic Liquid or Cold Gas"	
		(5) "Flammable Gas"	
		(6) "Unodorized Gas"	

NFPA 52 - Chapter 13 - Installation Requirements for ASME Tanks for LNG

		NFPA 52 - Chapter 13 - Installation Requirements for ASME Tanks for LNG	
	Section		**Compliance**
	13.1 Application		
		13.1* Application. This chapter provides requirements for the installation, design, fabrication, and siting of LNG containers of 100,000 gal (378,000 L) capacities and less and their associated equipment for use in applications such as vehicle refueling facilities that are designed and constructed in accordance with ASME Boiler and Pressure Vessel Code.	This section is applicable for this facility since the LNG storage tanks have a total capacity of 36,000 gallons and is ASME code stamped.
		13.1.1 The maximum aggregate storage capacity at a single fueling facility shall be 280,000 U.S. gal (1060 m3).	The maximum aggregate storage capacity at a the site is 36,00 U.S. gal.
	13.2 General.		
		Storage and transfer equipment at unattended facilities shall be secured to prevent tampering. [59A: 13.2.3]	The storage and transfer equipment is secured with an 8' high chain link fence.
	13.3 Containers.		
		13.3.1 All piping that is part of an LNG container, including piping between the inner and outer containers, shall be in accordance with either the ASME Boiler and Pressure Vessel Code, Section VIII, or ANSI/ ASME B31.3, Process Piping. [59A:l3.3.1]	The vessel piping was manufactured in accordance with ASME B31.3.
		13.3.2 Compliance with 13.3.1 shall be stated on or appended to the ASME Boiler and Pressure Vessel Code, Appendix W, Form U-1, "Manufacturer's Data Report for Pressure Vessels." [59A:13.3.2]	Compliance with ASME B31.3 will be documented by the tank manufacturer.
		13.3.3 Internal piping between the inner tank and the outer tank within the insulation space shall be designed for the maximum allowable working pressure of the inner tank, with allowance for the thermal stresses. [59A:13.3.3]	The piping is designed as a standard practice for the maximum allowable working pressure plus consideration of thermal stress.
		13.3.4 Bellows shall not be permitted within the insulation space. [59A:13.3.4]	There are no bellows in the annular space.
		13.3.5 Containers shall be double-walled, with the inner tank holding LNG surrounded by insulation contained within the outer tank. [59A:l3.3.5]	The LNG storage tank is double walled and the inner vessel is insulated with multiple layers of paper and foil cryogenic insulation.
		13.3.6 The inner tank shall be of welded construction and in accordance with the ASME Boiler and Pressure Vessel Code, Section VIII, and shall be ASME-stamped and registered with the National Board of Boiler and Pressure Vessel Inspectors or other agency that registers pressure vessels. [59A:l3.3.6]	The inner tank is of welded construction and is registered with the National Board.
		13.3. 7 The inner tank supports shall be designed for shipping, seismic, and operating loads. [59A:l3.3.7]	The inner vessel supports are designed for seismic, shipping, and operating loads as a standard practice by the tank manufacturer.
		13.3.8 The support system to accommodate the expansion and contraction of the inner tank shall be designed so that the resulting stresses imparted to the inner and outer tanks are within allowable limits. [59A: 13.3.8]	Thermal contraction is accounted for as a standard practice.
		13.3.9 The outer tank shall be of welded construction using any of the following materials:	The outer tank is of welded construction. The outer vessel is constructed of Type A36 carbon steel. The cryogenic piping is isolated from the carbon steel outer vessel by stainless steel sleeves.
		(1) Any of the carbon steels in Section VIII, Part UCS of the ASME Boiler and Pressure Vessel Code at temperatures at or above the minimum allowable use temperature in Table lA of the ASME Boiler and Pressure Vessel Code, Section II, Part D	
		(2) Materials with a melting point below 2000°F (1093°C) where the container is buried or mounded [59A:1 3.3.9]	
		13.3.10 Where vacuum insulation is used, the outer tank shall be designed by either of the following:	The outer tank is designed to CGA 341.
		(1) The ASME Boiler and Pressure ~Vessel Code, Section VIII, Parts UG-28, UG-29, UG-30, and UG-33, using an external pressure of not less than 15 psi (100 kPa)	
		(2) Paragraph 3.6.2 of CGA 341, Standard for Insulated Cargo Tank Specification for Cryogenic Liquids [59A: 13.3.1 0] Tank Specification for Cryogenic Liquids [59A: 13.3.1 0]	
		13.3.11 Heads and spherical outer tanks that are formed in segments and assembled by welding shall be designed in accordance with the ASME Boiler and Pressure ~Vessel Code, Section VIII, Parts UG-28, UG-29, UG-30, and UG-33, using an external pressure of 15 psi (100 kPa). [59A:13.3.11]	The outer heads are of one piece construction. This paragraph is not applicable.
		13.3.12 Any portion of the outer tank surface exposed to LNG temperatures shall be designed for such temperatures or protected from the effects of such exposure.	The carbon steel outer tank is protected from cryogenic temperatures by stainless steel sleeves.
		13.3.13 The outer tank shall be equipped with a relief device or other device to release internal pressure. [59A:l3.3.12]	The outer tank is equipped with a lift plate to relief internal pressure, if necessary.

		13.3.13.1 The discharge area shall be at least 0.00024 in.2/lb (0.34 mm2/kg) of the water capacity of the inner tank, but the area shall not exceed 300 in.2 (0.2 m2). [59A:13.3.12.1]	This tank is an 18,007 gallon gross capacity . The water capacity is 18,007 gallons times 8.64 lb/gal, or 155,580 lb of water. Therefore the required flow capacity of the outer jacket relief device is 155,580 lb times 0.00024 in^2/lb, or 37.34 in^2. The tank is equipped with two vacuum lift plates to protect the outer jacket from pressurization. The lift plates have an inside diameter of 5.125". Therefore the flow area of each lift plate is 20.63 in^2, and the total flow area for two lift plates is 41.26 in^2.
		13.3.13.2 The relief device shall function at a pressure not exceeding the internal design pressure of the outer tank, the external design pressure of the inner tank, or 25 psi (172 kPa), whichever is least. [59A:l3.3.12.2]	The lift plate is designed to open at a pressure of 25 psi or less.
		13.3.14 Thermal barriers shall be provided to prevent the outer tank from going below its design temperature. [59A:13.3.13]	Stainless steel thermal barriers are provided for the piping penetrations. Composite thermal barriers are provided for internal supports.
		13.3.15 Seismic Design.	The ASME storage tank is designed for the applicable seismic loads.
		13.3.15.1 Shop-built containers designed and constructed in accordance with the ASME Boiler and Pressure Vessel Code and their support systems shall be designed for the dynamic forces associated with horizontal and vertical accelerations as follows: (1) For horizontal force: $V = Z_c \times W$ (2) For vertical force: $P = \frac{2}{3} Z_c \times W$ where: Z_c = seismic coefficient equal to 0.60 SDS where SDS is the maximum design spectral acceleration determined in accordance with the provisions of ASCE 7, Minimum Design Loads for Buildings and Other Structures, using an importance factor, I, of 1.0 for the site class most representative of the subsurface conditions where the LNG facility is located W = total weight of the container and its contents [59A:13.3.14.1]	
		13.3.15.2 Usage.	
		13.3.15.2.1 The method of design described in 13.3.15.1 shall be used only where the natural period, T, of the shop built container and its supporting system is less than 0.06 second. [59A:13.3.14.2(A)]	
		13.3.15.2.2 If the natural period T is 0.06 or greater, 7.4.4.1 and 7.4.4.2 of NFPA 59A, Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG), shall apply. [59A:13.3.14.2(B)]	
		13.3.16 Each container shall be identified by the attachment of a nameplate(s) in an accessible location marked with the information required by the ASME Boiler and Pressure Vessel Code and the following:	The required information is displayed on a second data plate next to the ASME data plate. Additionally the minimum temperature for which the container was designed to is listed on the plate.
		(1) Builder's name and date container was built	
		(2) Nominal liquid capacity	
		(3) Design pressure at the top of the container	
		(4) Maximum permitted liquid density	
		(5) Maximum filling level	
		(6) Minimum design temperature [59A:13.3.15]	
		13.3.17 All penetrations of storage containers shall be marked with the function of the penetration. [59A:13.3.16]	All penetrations on the storage tank can be identified by tags installed on the manual shut off valves on each line.
		13.3.18 Markings shall be legible under all conditions.	All tags are etched and filled in order to be legible under all conditions.
		13.3.19 Container Filling. Containers designed to operate at a pressure in excess of 15 psi (100 kPa) shall be equipped with a device(s) that prevents the container from becoming liquid-full or the inlet of the relief device(s) from becoming covered with liquid when the pressure in the container reaches the set pressure of the relieving device(s) under all conditions. [59A:13.4]	
	13.4 Container Foundations and Supports.		

		13.4.1 LNG container foundations shall be designed and constructed in accordance with NFPA 5000, Building Construction and Safety Code. [59A:13.5.1].	The container foundations are designed to the current version of the IBC as described on the foundation calculations.
		13.4.1.1 The design of saddles and legs shall include shipping loads, erection loads, wind loads, and thermal loads. [59A:13.5.2]	The container supports are designed in accordance recognized design standards are described on the support calculations.
		13.4.1.2 Foundations and supports shall have a fire resistance rating of not less than 2 hours and shall be resistant to dislodgment by hose streams. [59A:13.5.3]	Foundations and supports have a fire resistance rating of not less than 2 hours and will be resistant to dislodgment by hose streams.
		13.4.1.3 If insulation is used to achieve this requirement, it shall be resistant to dislodgment by fire hose streams.	Insulation is not applied to the foundation.
		13.4.2 LNG storage containers installed in an area subject to flooding shall be secured to prevent the release of LNG or flotation of the container in the event of a flood. [59A:13.5.4]	The area of installation is not prone to flooding. Flotation analysis has not been performed.
		13.5 Container Installation. LNG containers of 1000 gal (3.8 m_3) and smaller shall be located as follows: (1) 125 gal (0.47 m_3) or less, 0 ft (0 m) from property lines that can be built upon (2) Larger than 125 gal (0.47 m3) to 1000 gal (3.8 m_3), 10 ft (3.0 m) from property lines that can be built upon [59A:13.6.1]	Not applicable. Tank size is greater than 1,000 gal.
		13.5.1 The minimum distance from the edge of an impoundment or container drainage system serving aboveground and mounded containers larger than 1000 gal (3.8 m3) shall be in accordance with Table 13.5.1 for each of the following: (1) Nearest offsite building (2) The property line that can be built upon (3) Spacing between containers [59A:13.6.2.1]	The layout of the above ground tanks is per table 13.5.1.
		Exception: 'With the approval of the authority having jurisdiction, such equipment shall be permitted to be located at a lesser distance from buildings or walls constructed of concrete or masonry, but at least 10 ft from any building openings.	
		13.5.1.1 The distance from the edge of an impoundment or container drainage system to buildings or walls of concrete or masonry construction shall be reduced from the distance in Table 13.5.1 with the approval of the authority having jurisdiction with a minimum of 10 ft (3 m). [59A:13.6.2.2]	The layout of the above ground tanks is per table 13.5.1.
		13.5.1.2 Underground LNG tanks shall be installed in accordance with Table 13.5.1.2. [59A:13.6.3]	Not applicable. The storage tank is mounted above ground.
		Table 13.5.1 Distances from Containers and Exposures	Facility designed in accordance with Table 13.5.1
		Table 13.5.1.2 Distances from Underground Containers and Exposures	Not applicable. Containers are not located underground.
		13.5.2 Buried and underground containers shall be provided with means to prevent the 32 degree F isotherm from penetrating the soil.	Not applicable. The storage tank is mounted above ground.
		13.5.3 Where heating systems are used, they shall be installed such that any heating element or temperature sensor used for control can be replaced. [59A:13.6.5]	Not applicable. The facility does not have a heating system.
		13.5.4 All buried or mounded components in contact with the soil shall be constructed from material resistant to soil corrosion or protected to minimize corrosion. [59A:13.6.6]	The electrical conduit will be the only buried component for the facility. Underground electrical conduits will be PVC. All bends will be rigid galvanized steel and wrapped in tape to minimize corrosion. The LNG piping to the dispenser will be installed up through the canopy and drop down to the dispenser.
		13.5.5 A clear space of at least 3ft (0.9 m) shall be provided for access to all isolation valves serving multiple containers. [59A:l 3.6.7]	A clear space is provided to access all isolation valves.
		13.5.6 LNG containers of greater than 125 gal (0.5 m3) capacity shall not be located in buildings. [59A:13.6.8]	Not applicable. There are no indoor LNG containers at this facility.
		Exception: we vehicle fuel tanks permanently installed on vehicles.	
		13.5.7 LNG vehicles shall be permitted to be located in buildings.	
	13.6 Automatic Product Retention Valves.		
		13.6.1 All liquid and vapor connections, except relief valve and instrument connections, shall be equipped with automatic failsafe product retention valves. [59A:l3.7.1]	Each liquid and vapor connection, except relief valve and instrument connections, is equipped with an air-to-open, spring-to-close, fail safe product retention valve.
		13.6.2 Automatic failsafe product retention valves shall be designed to close on the occurrence of any of the following conditions:	All automatic fail safe valves will close upon methane detection, fire detection, or activation of an emergency stop button. These safety systems are hard wired in a way that allows them to operate even if the event of a failure of the PLC.
		(1) Fire detection or exposure	

		(2) Uncontrolled flow of LNG from the container	
		(3) Manual operation from a local and remote location [59A:l3.7.2]	
		13.6.3 Connections used only for flow into the container shall be equipped with either two backflow valves, in series, or an automatic failsafe product retention valve. [59A:1 3.7.3]	Dual check valves are not used in the design of this facility.
		13.6.4 Appurtenances shall be installed as close to the container as practical so that a break resulting from external strain shall occur on the piping side of the appurtenance while maintaining intact the valve and piping on the container side of the appurtenance. [59A:13.7.4)	The automatic fail safe valves are installed as close to the LNG storage tank as possible.
	13.7 Inspection.		
		13.7.1 Prior to initial operation, containers shall be inspected to ensure compliance with the engineering design and material, fabrication, assembly, and test provisions of this chapter. [59A:13.9.1]	NorthStar will inspect the LNG storage tank for compliance with requirements and general condition prior to being placed into service.
		13.7.2 Inspectors shall be qualified in accordance with the code or standard applicable to the container and as specified in NFPA 59A, Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG). [59A:13.9.2]	The inspection of the ASME storage tank will be carried out by employees of NorthStar, Inc. NorthStar has an ASME U and R stamp and is therefore qualified to inspect ASME pressure vessels. In addition, NorthStar also has over 15 years experience in the construction of LNG fueling facilities. No other requirements for the inspector are apparent in NFPA 59A, Para. 7.2.
		13.7.3 Performance of any part of the inspection shall be permitted to be delegated to inspectors who are employees of the operator's own organization, an engineering or scientific organization, or a recognized insurance or inspection company	
	13.8 Testing and Purging of LNG Containers.		
	13.8.1 Shop Testing of LNG Containers.		LNG containers are leak tested at the factory. In the field the integrity of the inner vessel can be verified by checking vacuum levels in the insulation space. External piping will be leaked checked after assembly when the facility piping is leak tested.
		13.8.1.1 The outer tank shall be leak tested. [59A:13.10.1]	The original testing of the ASME pressure vessel is in accordance with ASME code. No additional testing is required by ASME code.
		13.8.1.2 Piping between the inner container and the first connection outside the outer container shall be tested in accordance with ASME B 31.3, Process Piping. [59A:13.10.2]	The inner vessel was hydrostatic tested prior to shipment, as verified by the ASME U-1 form. The outer vessel is helium mass spectrometer tested for leaks. The annular piping is required to be inspected in accordance with Chapter 16 of NFPA 59A. There is no Chapter 16 in the current version of NFPA 59A (2009). However, paragraph 13.14.1 specifies that the piping on the LNG storage tank shall be in accordance with ASME B31.3.The annular piping is pressure tested at the same time as the inner vessel. Welding and materials are to be in accordance with ASME B31.3.
		13.8.1.3 Shipment of LNG Containers. Containers shall be shipped under a minimum internal pressure of 10 psi (69 kPa) inert gas. [59A:13.11]	Containers will be shipped under a minimum internal pressure of 10 psi (69 kPa) inert gas.
13.8.2 Field Testing of LNG Containers.			
		13.8.2.1 Containers and associated piping shall be leak tested prior to filling with LNG. [59A:13.12.1]	Containers and associated piping will be leak tested with nitrogen prior to filling with LNG.
		13.8.2.2 After acceptance tests are completed, there shall be no field welding on the LNG containers. [59A:13.12.2]	
13.8.3 Welding on Containers.			No field welding will be performed on the ASME pressure vessel for this project. This section is not applicable.
		13.8.3.1 Field welding shall be done only on saddle plates or brackets provided for the purpose. [59A:13.13.1]	No field welding will be performed on the ASME pressure vessel for this project. This section is not applicable.
		13.8.3.2 Where repairs or modifications incorporating welding are required, they shall comply with the code or standard under which the container was fabricated. [59A:13.13.2]	No field welding will be performed on the ASME pressure vessel for this project. This section is not applicable.
		13.8.3.3 Retesting by a method appropriate to the repair or modification shall be required only where the repair or modification is of such a nature that a retest actually tests the element affected and is necessary to demonstrate the adequacy of the repair or modification. [59A:13.13.3]	No field welding will be performed on the ASME pressure vessel for this project. This section is not applicable.
		13.8.4 Container Purging Procedures. Prior to placing an LNG container into or out of service, the container shall be inerted by an approved inerting procedure.	The container will be purged with nitrogen gas before being placed into service.

13.9 Piping.	
13.9.1 All piping that is part of an LNG container and the facility associated with the container for handling cryogenic liquid or flammable fluid shall be in accordance with ASME B 31.3, Process Piping, and the following: (1) Type F piping, spiral welded piping, and furnace buttwelded steel products shall not be permitted. (2) All welding or brazing shall be performed by personnel qualified to the requirements of ASME B 31.3, Subsection 328.2, Welding Qualifications, and ASME Boiler and Pressure Vessel Code, Section IX, as applicable. (3) Oxygen–fuel gas welding shall not be permitted. (4) Brazing filler metal shall have a melting point exceeding 1000°F (538°C). (5) All piping and tubing shall be austenitic stainless steel for all services below −20°F (−29°C). (6) All piping and piping components, except gaskets, seals, and packing, shall have a minimum melting point of 1500°F (816°C). (7) Aluminum shall be used only downstream of a product retention valve in vaporizer service. (8) Compression-type couplings used where they can be subjected to temperatures below −20°F (−29°C) shall meet the requirements of ASME B 31.3, Process Piping, Section 315. (9) Stab-in branch connections shall not be permitted. (10) Extended bonnet valves shall be used for all cryogenic liquid service, and they shall be installed so that the bonnet is at an angle of not more than 45 degrees from the upright vertical position. [59A:13.14.1]	All piping for this facility will be constructed in accordance with ASME B31.3.
13.9.2 The level of examination of piping shall be specified. [59A:13.14.2]	
13.10 Container Instrumentation.	
13.10.1 General. Instrumentation for LNG facilities shall be designed so that, in the event of power or instrument air failure, the system will go into a failsafe condition that can be maintained until the operators can take action to reactivate or secure the system. [59A:l3.15.1]	In the event of power or instrument air failure all automatic valves will close and the LNG pump will be stopped. The system will remain in this safe mode until power and air pressure are restored, and all other alarms corrected and acknowledged.
13.10.2 Level Gauging. LNG containers shall be equipped with liquid level devices as follows: (1) Containers of 1000 gal (3.8 m3) or larger shall be equipped with two independent liquid level devices. (2) Containers smaller than 1000 gal (3.8 m3) shall be equipped with either a fixed length dip tube or other level devices. (3) Containers of 1000 gal (3.8 m3) or larger shall have one liquid level device that provides a continuous level indication ranging from full to empty and that is maintainable or replaceable without taking the container out of service. [59A:13.15.2]	The LNG storage tank is provided with a fixed length dip tube (full trycock), a mechanical differential pressure gauge, and differential pressure sensor and transmitter.
Exception: Containers smaller than 1000 gal (3.8 m3) shall be permitted to be equipped with a fixed-length dip tube only.	
13.11 Pressure Gauging and Control.	
13.11.1 Each container shall be equipped with a pressure gauge connected to the container at a point above the maximum liquid level that has a permanent mark indicating the maximum allowable working pressure (MAWP) of the container. [59A:13.15.3.1]	Dual pressure safety relief valves and rupture discs are provided for the LNG storage tank, in accordance with ASME code. These devices are sized for fire conditions with loss of vacuum by the tank manufacturer.
13.11.2 Vacuum-jacketed equipment shall be equipped with instruments or connections for checking the pressure in the annular space. [59A:13.15.3.2]	The safety relief valves are piped to the vent stack, where they discharge to atmosphere.
13.11.3 Safety relief valves shall be sized to include conditions resulting from operational upset, vapor displacement, and flash vaporization resulting from pump recirculation and fire. [59A:13.15.3.3]	Safety relief valves have been sized to include conditions resulting from operational upset, vapor displacement, and flash vaporization resulting from pump recirculation and fire.
13.11.4 Safety relief valve discharge stacks or vents shall be designed and installed to prevent an accumulation of water, ice, snow, or other foreign matter and, if arranged to discharge directly into the atmosphere, shall discharge vertically upward. [59A:l3.15.8]	The vent stack is equipped with a manual drain valve at the bottom to allow draining rain water. The vent stack vents directly upward.
13.11.5 Pressure relief valves shall be sized in accordance with 7.3.6.5 of NFPA 59A, Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG), or with CGA S-1.3, Pressure Relief Device Standards—Part 3—Compressed Gas Storage Containers. [59A:13.15.5]	Pressure relief valves is sized in accordance with 7.3.6.5 of NFPA 59A

		13.11.6 Inner container pressure relief valves shall have a manual full-opening stop valve to isolate it from the container. [59A:13.15.6]	
		13.11.6.1 The stop valve shall be lockable or sealable in the fully open position. [59A:13.15.6.1]	
		13.11.6.2 The installation of pressure relief valves shall allow each relief valve to be isolated individually for testing or maintenance while maintaining the full relief capacities determined in 7.3.6.5 of NFPA 59A, Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG). [59A:13.15.6.2]	