ACCESS NORTHEAST PROJECT

RESOURCE REPORT 11

LNG Reliability and Safety

Access Northeast LNG Facility

FERC Docket No. PF16-1-000

Pre-Filing Draft

May 2016

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access northeast

RESOURCE REPORT 11 — RELIABILITY AND SAFETY	
Filing Requirement	**Location in Environmental Report**
(1) Describe how the project facilities will be designed, constructed, operated, and maintained to minimize potential hazard to the public from the failure of project components as a result of accidents or natural catastrophes. (§380.12(m))	Section 11.2.2.1 Section 11.3 Section 11.4 Resource Report 13
(2) Provide plot plan drawings of impoundments with cross-sections showing elevations.	Appendix Q.3 of Resource Report 13
(3) Design spills for liquefied natural gas (LNG) storage tanks, marine transfer lines, sendout, and process areas in accordance with Table 2.2.3.5 in the 2001 version of National Fire Protection Association 59A: Standard for the Production, Storage, and Handling of Liquefied Natural Gas (NFPA 59A).	Section 11.6 (Appendix Q.1 of Resource Report 13)
(4) Provide meteorological data supporting the wind speed, atmospheric temperature, and humidity used in all hazard analyses. Also, provide the source of the weather data.	Section 11.6 (Appendix Q.1 of Resource Report 13)
(5) Provide plot plans clearly delineating the entire facility property line as well as the thermal radiation and flammable vapor dispersion exclusion zones. Sufficient data and drawings corroborating the applicant's exclusion zone calculations should be included.	Section 11.6 (Appendix Q.1 of Resource Report 13)
(6) Provide flammable vapor dispersion calculations which are supported drawings indicating the size and location of the line proposed from the design spill.	Section 11.6 (Appendix Q.1 of Resource Report 13)
(7) Provide flammable vapor dispersion calculations which are supported by plan, profile, and cross-section drawings showing the dimensions and configuration of the proposed containment system.	Section 11.6 (Appendix Q.1 of Resource Report 13)
(8) Provide flammable vapor dispersion calculations which are supported by source strength calculations.	Section 11.6 (Appendix Q.1 of Resource Report 13)
(9) Provide flammable vapor dispersion calculations which are supported by DEGADIS program output and results.	Section 11.6 (Appendix Q.1 of Resource Report 13)
(10) Provide flammable vapor dispersion calculations which are supported by a drawing clearly delineating the property line and the resulting exclusion zone.	Section 11.6 (Appendix Q.1 of Resource Report 13)
(11) Describe Agency Coordination regarding the Emergency Response Plan.	Section 11.7.13
(12) Identify all active military installations which may be impacted by the operation of the proposed facility or by LNG vessel transit.	Section 11.3.3
(13) Provide copies of the Letter of Intent (LOI) submitted to the Coast Guard.	N/A
(14) Submit a preliminary waterway suitability assessment to the Coast Guard in accordance with the Coast Guard's Navigation and Vessel Inspection Circular 05-05 (NVIC).	N/A
(15) Provide an analysis that addresses current commercial and recreational waterway traffic and the impact of LNG vessels (address and analyze vessel traffic congestion issues).	N/A
(16) Simulation and modeling studies should take into account various scenarios that include: tides, currents, winds, ice, passing vessels direction, passing vessels sizes, and LNG vessel sizes.	N/A

RESOURCE REPORT 11 — RELIABILITY AND SAFETY	
Filing Requirement	**Location in Environmental Report**
(17) Location of High Consequence Areas crossed by and adjacent to the proposed pipeline route.	See Resource Report 11 for the Access Northeast Project Pipeline and Aboveground Facilities
(18) U. S. Department of Transportation's class locations for off-site pipeline portion by milepost.	See Resource Report 11 for the Access Northeast Project Pipeline and Aboveground Facilities

RESOURCE REPORT 11— RELIABILITY AND SAFETY Information Outstanding for Draft Resource Report 11		
Information	**Resource Report Location**	**Anticipated Submittal Date**
Hazard Identification and Analyses	Section 11.5.1	To be filed with Algonquin's Certificate application in November 2016.
Geotechnical assessment to support the detailed design phase.	Section 11.5.3	Detailed design, if needed.
Summary of Design Spill	Table 11.6-1	To be filed with Algonquin's Certificate application in November 2016.
Results of Toxicity Modeling	Table 11.6-2	To be filed with Algonquin's Certificate application in November 2016.
Results of Jetting and Flashing Vapor Dispersion	Table 11.6-3	To be filed with Algonquin's Certificate application in November 2016.
Results of Overpressure Analysis	Table 11.6-4	To be filed with Algonquin's Certificate application in November 2016.
Results of Jet Fire Analysis	Table 11.6-6	To be filed with Algonquin's Certificate application in November 2016.

ACRONYMS AND ABBREVIATIONS

°F	Degrees Fahrenheit
AEGL	Acute Exposure Guideline Level
Algonquin	Algonquin Gas Transmission, LLC
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
Certificate	Certificate of Public Convenience and Necessity
CFR	Code of Federal Regulations
CO_2	carbon dioxide
DOT PHMSA	U.S. Department of Transportation: Pipeline and Hazardous Materials Safety Administration
EPC	Engineering, Procurement and Construction
ERP	Emergency Response Plan
ESD	Emergency shutdown
Eversource	Energy
LNG Facility	Access Northeast LNG Facility
FERC or Commission	Federal Energy Regulatory Commission
HAZID	Hazard Identification
H_2S	hydrogen sulfide
HDMS	Hazard Detection and Mitigation System
HHC	Heavy Hydrocarbon
lb/ft^3	pounds per cubic foot
LNG	liquefied natural gas
m	meter
m/s	meter per second
m^3	cubic meter
m^3/hr	cubic meters per hour
mph	miles per hour
NFPA 59A	*NFPA 59A: Standard for the Production, Storage, and Handling of Liquefied Natural Gas* (as incorporated by reference in 49 CFR Part 193)
NFPA	National Fire Protection Association
ppm	parts per million
Project	Access Northeast Project
psf	pounds per square foot
psi	pounds per square inch
psia	pounds per square inch absolute
psig	pounds per square inch gauge
WEG	Water Ethylene Glycol

11.0 RESOURCE REPORT 11 – LNG RELIABILITY AND SAFETY

11.1 Project Description

Algonquin Gas Transmission, LLC ("Algonquin") is seeking a certificate of public convenience and necessity ("Certificate") from the Federal Energy Regulatory Commission ("FERC" or the "Commission") pursuant to Section 7(c) of the Natural Gas Act[1] to construct, install, own, operate and maintain the Access Northeast Project[2] ("Access Northeast" or the "Project"). Algonquin also seeks authorization to abandon certain facilities under Section 7(b) of the Natural Gas Act[3]. As part of this Project, Algonquin will upgrade and expand the existing Algonquin pipeline system and construct a liquefied natural gas ("LNG") storage facility in New England to deliver, on peak days, up to an additional 925,000 dekatherms per day of natural gas. The Project is designed to meet the capacity needs of natural gas-fired electric generating units as coal and nuclear electric generating units retire. Access Northeast will be implemented in phases, with the initial phase currently projected to be in-service by November 1, 2018. Phasing Project construction over several years will allow New England's natural gas-fired generators to begin acquiring firm transportation capacity as soon as possible while phasing in the full project capacity and associated costs over a longer period.

The Project includes the construction of approximately 123.22 miles of pipeline facilities, modifications at seven existing compressor stations[4], the construction of one new compressor station, associated pipeline facilities including metering and regulating stations and the construction of an LNG liquefaction, storage and vaporization facility ("Access Northeast LNG Facility" or "LNG Facility"). These proposed Project facilities will be located in New Jersey, New York, Connecticut, Rhode Island and Massachusetts. A more detailed description of the Project is set forth in Draft Resource Report 1.

This Pre-Filing Draft Resource Report 11 describes the reliability and safety of the proposed Access Northeast LNG Facility and addresses the potential hazard from failure of facility components resulting from accidents or natural catastrophes, how these events would affect safety and reliability and the procedures and design features that would be used to reduce potential hazards. A separate Resource Report 11 has been prepared for the Access Northeast Project pipeline and aboveground facilities and is provided under separate cover.

11.2 Proposed Access Northeast LNG Facility

The proposed LNG Facility will be located on a 210-acre site that is owned by Eversource Gas Transmission LLC ("Eversource Energy") in Acushnet, Massachusetts, which is adjacent to an existing Eversource-owned LNG facility. The proposed Access Northeast LNG Facility will provide no-notice supply service to meet an estimated 410,000 dekatherms per day of power plant peaking/backstop demand that is a critical component of the Access Northeast Project proposed service offering. The LNG Facility will be interconnected to Algonquin's G System via the proposed Acushnet 24-inch diameter Connector through which gas will be sent out during times of peak demand and sent in to fill the tanks during low demand periods. The LNG Facility will not be connected to, replace or modify the existing

1 15 U.S.C. § 717f(c) (2012).
2 The Access Northeast Project is being developed by Algonquin, whose members are Spectra Algonquin Holdings, LLC, Eversource Gas Transmission LLC and National Grid Algonquin LLC.
3 15 U.S.C. § 717f(b) (2012)
4 The Weymouth Compressor Station in Norfolk County, Massachusetts, which is being constructed and put into service as part of the Atlantic Bridge Project under CP16-9-000, will be modified in connection with the Access Northeast Project.

Eversource LNG facility located adjacent to the proposed LNG Facility site. Components of the proposed Access Northeast LNG Facility include:

- Two LNG storage tanks with a gross combined capacity of 6.8 billion standard cubic feet (6.5 billion standard cubic feet net);
- Liquefaction and regasification capability;
- A new access road off of Peckham Road to serve both construction and operation of the LNG Facility;
- Electrical service facilities to support LNG operations;
- Ground flare; and
- Other ancillary on-site structures and equipment as required to support the operation and maintenance of the proposed LNG Facility.

11.2.1 Acushnet 24-inch Connector (Freetown to Acushnet)

The Acushnet 24-inch Connector consists of approximately 2.97 miles of new 24-inch diameter pipeline in the towns of Freetown and Acushnet in Bristol County, Massachusetts. The Acushnet 24-inch Connector will begin (MP 0.00) in the Town of Freetown at the intersection of the Algonquin Line G-8 pipeline. From this starting point, the proposed Acushnet 24-inch Connector extends southwest and parallel to two existing subsurface 48-inch diameter water main structures and an overhead power line for approximately 1.05 miles then deviates in a southerly direction for the remaining 1.95 miles where it terminates at MP 2.97 at the proposed Access Northeast LNG Facility off Peckham Road in Acushnet.

11.2.2 Other Pipeline Information

See Resource Report 11 for the Access Northeast Project Pipeline and Aboveground Facilities.

11.3 LNG Facility Regulatory Oversight

Multiple federal agencies share regulatory authority over the siting, design, construction and operation of the Facility.

The FERC issues Certificates for LNG facilities designed to provide storage and peak service under Section 7(c) of the Natural Gas Act. The FERC will be the lead federal agency for developing the Environmental Impact Statement for the Access Northeast Project, which includes the LNG Facility. The FERC requires standard information to be submitted to perform safety and reliability engineering reviews for LNG facilities. The FERC's filing regulations are codified in 18 CFR 380.12(m) and (o) and require each applicant to identify how its proposed design complies with the U.S. Department of Transportation: Pipeline and Hazardous Materials Safety Administration ("DOT PHMSA") minimum federal safety standards for LNG facilities in 49 CFR 193. The Pipeline Safety Act provides that a certification of Part 193 compliance is binding on FERC unless an appropriate enforcement agency provides timely written notice that an applicant has violated one of PHMSA's safety standards. 49 U.S.C. § 60104(d)(2).

The FERC must ensure that all proposed LNG facilities would operate safely and securely. The design information that must be filed in the application to the Commission is specified by 18 CFR 380.12 (m) and (o). The level of detail necessary for this submittal requires the project to perform substantial front-end engineering of the complete facility. The design information is required to be site-specific and developed to the extent that further detailed design would not result in changes to the siting considerations, basis of design, operating conditions, major equipment selections, equipment design conditions or safety system designs.

In addition, if the Access Northeast LNG Facility is constructed and becomes operational, it will be subjected to FERC reviews during the operational phase.

The DOT PHMSA assists FERC staff in evaluating whether an applicant's proposed siting meets the Part 193 requirements. If a LNG facility is constructed and becomes operational, the facility would be subject to the DOT PHMSA's inspection program. Final determination of whether a facility is in compliance with the requirements of 49 CFR 193 would be made by DOT PHMSA staff.

The DOT PHMSA establishes federal safety regulations for siting, design, construction, operation and maintenance of LNG facilities as detailed in 49 CFR 193. Many of the regulations in Part 193 are based on the provisions in National Fire Protection Association ("NFPA") 59A (2001), "Standard for the Production, Storage, and Handling of Liquefied Natural Gas," a consensus industry standard that is incorporated into DOT PHMSA's regulations by reference. The 2006 edition of NFPA 59A is also incorporated by reference for purposes of certain provisions relating to the design and construction of LNG storage tanks. The regulations in Part 193 prevail in the event a conflict arises with the incorporated provisions in NFPA 59A. In 1985, the FERC and DOT PHMSA entered into a Memorandum of Understanding regarding the execution of each agency's respective statutory responsibilities to ensure the safe siting and operation of LNG facilities. In addition to FERC's existing ability to impose requirements to ensure or enhance the operational reliability of LNG facilities, the Memorandum of Understanding specified that FERC may, with appropriate consultation with DOT PHMSA, impose more stringent safety requirements than those in Part 193.

11.3.1 Impact to Nuclear Facilities

The closest nuclear facility in operation is the Pilgrim Nuclear Power Station located in Plymouth, Massachusetts, which is approximately 23 miles northeast from the LNG Facility. Therefore, no nuclear facilities will be impacted by the LNG Facility construction or operation or by transportation to or from the LNG Facility.

11.3.2 Impact to Aeronautical Operations

The closest airport to the LNG Facility is the New Bedford Regional Airport located in New Bedford, Massachusetts, which is approximately 4 miles southwest of the LNG Facility. The LNG Facility's design does not include any structure over approximately 160 feet, and Algonquin does not anticipate any hazard to air travel from structures or ground flare operation during startup, shutdown or upset conditions. Therefore, no aeronautical operations will be impacted by LNG Facility construction or operation or by transportation to or from the LNG Facility.

11.3.3 Impact to Military Operations

The closest military installation is the Naval Station Newport located in Newport, Rhode Island, which is approximately 25 miles southwest of the LNG Facility. Therefore, no military operations will be impacted by the LNG Facility construction or operation or by transportation to or from the LNG Facility.

11.4 LNG Facility Hazards

11.4.1 Description of Hazardous Materials

11.4.1.1 LNG

Liquefied natural gas is natural gas in its liquid state that has been cooled at atmospheric pressure to 260 Degrees Fahrenheit ("°F") below zero. Similar to natural gas in its vapor state, LNG is odorless, colorless, non-corrosive and nontoxic. With a density of approximately 26.5 pounds per cubic foot ("lb/ft^3"), LNG is neither flammable nor explosive.

Liquefied natural gas vaporizes rapidly on contact with any surface that is at a temperature greater than the LNG itself. The LNG vapors are flammable to air ratios of 5 to 15 percent. Unlike heavier hydrocarbons (such as propane), natural gas and LNG vapors do not have the potential for the explosion of unconfined vapor clouds. LNG vapors at high concentrations can displace oxygen, resulting in oxygen levels that are too low for safe human exposure, potentially causing asphyxiation if a person were to enter a high concentration area.

The primary component of LNG is methane. Table 11.4-1 summarizes the properties of methane:

Table 11.4-1: Properties of Methane

Property	Value			Notes
Melting Temperature	-296.46 °F[a]			At normal pressure (14.7 psia)
Boiling Temperature	-258.68 °F[a]			At normal pressure (14.7 psia)
Flash Point	-306.7°F[b]			Closed Cup
Lower Flammability Limit	5.0%[a]			In air by percent volume
Upper Flammability Limit	15.0%[a]			In air by percent volume
Auto-Ignition Temperature	548.6°F[b]			--
Heat of Combustion	55.5 MJ/kg[a]			At 60°F
Property	**Min**	**Normal**	**Max**	**Notes**
Operating Temperatures in Process	-258.49°F	varies	110.92°F	Includes LNG and natural gas
Operating Temperatures in Storage	-258.49°F	-257.99°F	-257.99°F	
Operating Pressures in Process	40psig	varies	864.7psig	LNG
	0.31psig	varies	864.7psig	Natural gas
Operating Pressures in Storage	-0.07psig	0.5 psig	4.2psig	LNG
Operating Densities in Process	25.96lb/ft^3	varies	27.38lb/ft^3	LNG
	0.112lb/ft^3	varies	5.684lb/ft^3	Natural gas
Operating Densities in Storage	27.0lb/ft^3	27.02lb/ft^3	27.38lb/ft^3	LNG
	0.118lb/ft^3	0.119lb/ft^3	0.123lb/ft^3	Natural gas
Property	**Details**			
Asphyxiant and Toxic Properties	Simple asphyxiant, non-toxic[c]			
Maximum Concentration of Toxic Component in Process	N/A			
Asphyxiation Concentration	Below 6% Oxygen[c]			
Corrosion Rate of Skin	N/A			
Corrosion Rate of Metal Surfaces	N/A			

[a] Gas Processors Association. (1977) *Engineering Data Book*.
[b] Airgas Material Safety Data Sheet, Methane. https://www.airgas.com/msds/001033.pdf
[c] Haz-Map, Simple Asphyxiation. https://hazmap.nlm.nih.gov/category-details?id=350&table=tbldiseases
ppm = parts per million; psia = pounds per square inch absolute; psig = pounds per square inch gauge.

11.4.1.2 Nitrogen

The LNG Facility will use a nitrogen liquefaction system. Nitrogen is a non-toxic, odorless, colorless, non-corrosive and nonflammable material. Nitrogen vaporizes rapidly on contact with any surface that is at a temperature higher than the nitrogen itself. Nitrogen vapors at high concentrations can displace oxygen, resulting in oxygen levels that are too low for safe human exposure, potentially causing asphyxiation if a person were to enter a high concentration area.

Table 11.4-2 summarizes the properties of Nitrogen.

Table 11.4-2: Properties of Nitrogen

Property	Value			Notes
Melting Temperature	-346.0°F[a]			At normal pressure (14.7 psia)
Boiling Temperature	-320.4°F[a]			At normal pressure (14.7 psia)
Flash Point	N/A			Closed Cup
Lower Flammability Limit	N/A			In air by percent volume
Upper Flammability Limit	N/A			In air by percent volume
Auto-Ignition Temperature	N/A			--
Heat of Combustion	N/A			--
Property	**Min**	**Normal**	**Max**	**Notes**
Operating Temperatures in Process	N/A	varies	N/A	Vendor confidential information, refer to heat and material balances
Operating Temperatures in Storage	-320°F	-260°F	-240°F	stored as liquid
Operating Pressures in Process	N/A	varies	N/A	Vendor confidential information, refer to heat and material balances
Operating Pressures in Storage	200psig	220psig	N/A	stored as liquid
Operating Densities in Process	N/A	varies	N/A	Vendor confidential information, refer to heat and material balances
Operating Densities in Storage	37lb/ft^3	34lb/ft^3	31lb/ft^3	stored as liquid
Property	**Details**			
Asphyxiant and Toxic Properties	Simple asphyxiant, non-toxic[b]			
Maximum Concentration of Toxic Component in Process	N/A			
Asphyxiation Concentration	Below 6% Oxygen[b]			
Corrosion Rate of Skin	N/A			
Corrosion Rate of Metal Surfaces	N/A			

[a] Gas Processors Association. (1977) Engineering Data Book.
[b] Haz-Map, Simple Asphyxiation. https://hazmap.nlm.nih.gov/category-details?id=350&table=tbldiseases
ppm = parts per million; psia = pounds per square inch absolute; psig = pounds per square inch gauge.

11.4.1.3 Heavy Hydrocarbons

Heavy Hydrocarbons ("HHC") are present in the feed gas and will be removed during the liquefaction process and burned as fuel gas at the LNG Facility. Similar to natural gas in its vapor state, HHC are odorless, colorless and non-corrosive. HHC composition changes as the feed gas composition changes; therefore, its exact density and flammability ranges are variable. The HHC are flammable and may have the potential for overpressures if ignited in a confined area.

The HHC vaporize rapidly on contact with any surface that is at a temperature higher than the HHC itself. HHC vapors at high concentrations can displace oxygen, resulting in oxygen levels that are too low for safe human exposure, potentially causing asphyxiation if a person were to enter a high concentration area.

HHC streams may contain Ethane, Propane, Butane, Pentane, Hexane, Heptane, Octane, Nonane, Decane, Benzene, Toluene and Xylene. Of these components, Benzene, Toluene and Xylene are toxic although the feed gas composition analysis shows they will be present in very small quantities. Table 11.4-3 lists the properties of the HHC stream.

Table 11.4-3: Properties of Heavy Hydrocarbon Stream

Property	**Value**			**Notes**	
Melting Temperature	varies			At normal pressure (14.7 psia)	
Boiling Temperature	varies			At normal pressure (14.7 psia)	
Flash Point	varies			Closed Cup	
Lower Flammability Limit	varies			In air by percent volume	
Upper Flammability Limit	varies			In air by percent volume	
Auto-Ignition Temperature	varies			--	
Heat of Combustion	varies			--	
Property	**Min**	**Normal**	**Max**	**Notes**	
Operating Temperatures in Process	N/A	varies	N/A	Vendor confidential information, refer to heat and material balances	
Operating Temperatures in Storage	N/A	N/A	N/A	No HHC storage	
Operating Pressures in Process	N/A	varies	N/A	Vendor confidential information, refer to heat and material balances	
Operating Pressures in Storage	N/A	N/A	N/A	No HHC storage	
Operating Densities in Process	N/A	varies	N/A	Vendor confidential information, refer to heat and material balances	
Operating Densities in Storage	N/A	N/A	N/A	No HHC storage	
Property	**Details**				
Asphyxiant Properties	Simple asphyxiant[b]				
Maximum Concentration of Benzene in Process	0.0332				
Maximum Concentration of Toluene in Process	0.0249				
Maximum Concentration of Xylene in Process	0.0083				
Asphyxiation Concentration	Below 6% Oxygen[b]				
Corrosion Rate of Skin	N/A				
Corrosion Rate of Metal Surfaces	N/A				
AEGLs	**10 min**	**30 min**	**60 min**	**4 hr**	**8 hr**
Benzene AEGL-1	130 ppm[c]	73 ppm[c]	52 ppm[c]	18 ppm[c]	9.0 ppm[c]
Benzene AEGL-2	2,000 ppm[c]	1,100 ppm[c]	800 ppm[c]	400 ppm[c]	200 ppm[c]
Benzene AEGL-3	9,700 ppm[c]	5,600 ppm[c]	4,000 ppm[c]	2,000 ppm[c]	990 ppm[c]
Toluene AEGL-1	67 ppm[c]	67 ppm[c]	67 ppm[c]	67 ppm[c]	67 ppm[c]
Toluene AEGL-2	1,400 ppm[c]	760 ppm[c]	560 ppm[c]	310 ppm[c]	250 ppm[c]
Toluene AEGL-3	10,000ppm[c]	5,200 ppm[c]	3,700 ppm[c]	1,800 ppm[c]	1,400 ppm[c]
Xylene AEGL-1	130 ppm[c]	130 ppm[c]	130 ppm[c]	130 ppm[c]	130 ppm[c]
Xylene AEGL-2	2,500 ppm[c]	1,300 ppm[c]	920 ppm[c]	500 ppm[c]	400 ppm[c]
Xylene AEGL-3	7,200 ppm[c]	3,600 ppm[c]	2,500 ppm[c]	1,300 ppm[c]	1,000 ppm[c]

[b] Haz-Map, Simple Asphyxiation. https://hazmap.nlm.nih.gov/category-details?id=350&table=tbldiseases
[c] http://www.epa.gov/aegl/access-acute-exposure-guideline-levels-aegls-values#chemicals
ppm = parts per million; psia = pounds per square inch absolute; psig = pounds per square inch gauge.

11.4.1.4 Hydrogen Sulfide

Hydrogen Sulfide (“H_2S”) is present in the feed gas and is removed using amine based absorber and regeneration columns. Acid gas from the regeneration column is sent to a thermal oxidizer for disposal. While it can only be anticipated in very small quantities within the process, H_2S is classified as a toxic material.

Table 11.4-4 summarizes the acute exposure guideline levels (“AEGLs”) for H_2S.

Table 11.4-4: AEGLs for Hydrogen Sulfide

AEGL	10 min	30 min	60 min	4 hr	8 hr
AEGL-1	0.75 ppm	0.60 ppm	0.51 pm	0.36 ppm	0.33 ppm
AEGL-2	41 ppm	32 ppm	27 ppm	20 ppm	17 ppm
AEGL-3	76 ppm	59 ppm	50 ppm	37 ppm	31 ppm

[a] http://www.epa.gov/aegl/hydrogen-sulfide-results-aegl-program
ppm = parts per million.

11.4.1.5 Amine Solution

A set of absorber and regeneration columns designed by BASF using their propriety OASE Purple (an MDEA-containing solution) technology removes H_2S and carbon dioxide (“CO_2”) from the feed gas as a part of the pretreatment process. The amine solution is considered an environmental health hazard. Table 11.4-5 lists the properties of amine solution.

Table 11.4-5: Properties of Amine Solution

Property	Value			Notes
Melting Temperature	< -14°F[a]			At normal pressure (14.7 psia)
Boiling Temperature	> 212°F[a]			At normal pressure (14.7 psia)
Flash Point	~ 244°F[a]			Closed Cup
Auto-Ignition Temperature	265°F[a]			
Property	**Min**	**Normal**	**Max**	**Notes**
Operating Temperatures in Process	97.32°F	varies	243°F	
Operating Temperatures in Storage	--	100°F	--	Min. and max. TBD by vendor
Operating Pressures in Process	7.1psig	varies	634.6psig	
Operating Pressures in Storage	--	0.5psig	--	Min. and max. TBD by vendor
Operating Densities in Process	0.073lb/ft^3	varies	66.571lb/ft^3	
Operating Densities in Storage	--	63.18 lb/ft^3	--	Min. and max. TBD by vendor
Property	**Details**			
Asphyxiant and Toxic Properties	Skin and respiratory sensitizer[a]			
Asphyxiation Concentration	N/A[a]			
Corrosion Rate of Skin	Non-corrosive[a]			
Corrosion Rate of Metal Surfaces	Non-corrosive[a]			

[a] Safety Data Sheet OASE purple, BASF.
ppm = parts per million; psia = pounds per square inch absolute; psig = pounds per square inch gauge.

11.4.1.6 Diesel

Diesel will be used to fuel the spare firewater pump in the event that the electric-driven firewater pump fails. Diesel will also be used to fuel the black start generator. Diesel is considered a combustible material. Table 11.4-6 summarizes the properties of diesel.

Table 11.4-6: Properties of Diesel

Property	Value	Notes
Boiling Temperature	338 °F[a]	At normal pressure (14.7 psia)
Flash Point	125°F[a]	Closed Cup
Lower Flammability Limit	0.6%[a]	In air by percent volume
Upper Flammability Limit	7.5%[a]	In air by percent volume
Auto-Ignition Temperature	494°F[a]	--
Heat of Combustion	46 MJ/kg[b]	--
Property	**Details**	
Asphyxiant and Toxic Properties	Harmful if swallowed.[a]	
Asphyxiation Concentration	N/A	
Corrosion Rate of Skin	Irritant (Category 2)[a,b]	
Corrosion Rate of Metal Surfaces	Non-corrosive[1]	

[a] Material Safety Data Sheet, Diesel.
[b] *Biomass Energy Data Book*. (2012). U.S. Department of Energy
ppm = parts per million; psia = pounds per square inch absolute; psig = pounds per square inch gauge.

11.4.1.7 Hot Oil System

A hot oil system will be used to provide heat to the amine stripper reboiler and the regeneration gas heater. The high operating temperature presents hazards to the LNG Facility. The hot oil system is considered an environmental health hazard. Table 11.4-7 summarizes the properties of the hot oil.

Table 11.4-7: Properties of Hot Oil System

Property	Value			Notes
Melting Temperature	< -11°F[a]			At normal pressure (14.7 psia)
Boiling Temperature	648°F[a]			At normal pressure (14.7 psia)
Flash Point	338°[a]F			Closed Cup
Lower Flammability Limit	N/A[a]			In air by percent volume
Upper Flammability Limit	N/A[a]			In air by percent volume
Auto-Ignition Temperature	705°F			
Heat of Combustion	N/A			
Property	**Min**	**Normal**	**Max**	**Notes**
Operating Temperatures in Process	258.67°F	varies	610°F	
Operating Temperatures in Storage	N/A	N/A	N/A	
Operating Pressures in Process	64.7psig	varies	114.7psig	
Operating Pressures in Storage	N/A	N/A	N/A	
Operating Densities in Process	49.55lb/ft^3	varies	58.23lb/ft^3	
Operating Densities in Storage	N/A	N/A	N/A	
Property	**Details**			
Asphyxiant and Toxic Properties	Toxic[a]			
Asphyxiation Concentration	N/A[a]			
Corrosion Rate of Skin	Non-corrosive[a]			
Corrosion Rate of Metal Surfaces	Non-corrosive[a]			

[a] Safety Data Sheet, Therminol® 66 Heat Transfer Fluid, Eastman.
ppm = parts per million; psia = pounds per square inch absolute; psig = pounds per square inch gauge.

11.4.1.8 Water Ethylene Glycol

A Water Ethylene Glycol ("WEG") system will be used to provide heat to the LNG vaporizers. The high operating temperature presents a hazard at the LNG Facility. The WEG system is considered an environmental health hazard. Table 11.4-8 summarizes the properties of Ethylene Glycol.

Table 11.4-8: Properties of Ethylene Glycol

Property	Value			Notes
Melting Temperature	9°F[a]			At normal pressure (14.7 psia)
Boiling Temperature	387°F[a]			At normal pressure (14.7 psia)
Flash Point	232°F[a]			Closed Cup
Lower Flammability Limit	N/A[a]			In air by percent volume
Upper Flammability Limit	N/A[a]			In air by percent volume
Auto-Ignition Temperature	784°F[a]			
Heat of Combustion	N/A			
Property	**Min**	**Normal**	**Max**	**Notes**
Operating Temperatures in Process	120°F	varies	190°F	
Operating Pressures in Process	64.7psig	varies	104.7psig	
Operating Densities in Process	64.16lb/ft^3	varies	66.56lb/ft^3	
Property	**Details**			
Asphyxiant and Toxic Properties	Toxic[a]			
Asphyxiation Concentration	N/A[a]			
Corrosion Rate of Skin	Non-corrosive[a]			
Corrosion Rate of Metal Surfaces	Non-corrosive[a]			

[a] Safety Data Sheet, Ethylene Glycol – Industrial Grade, BASF.
ppm = parts per million; psia = pounds per square inch absolute; psig = pounds per square inch gauge.

11.4.1.9 Mercury

Mercury may be present in very small quantities in the feed gas and will be removed via a mercury guard bed during the pretreatment process. Mercury is considered an environmentally hazardous material.

11.4.2 Description of Potential Events

11.4.2.1 LNG

The principal hazards of LNG result from its cryogenic temperature (-260°F), flammability of vapors, loss of containment and vapor dispersion characteristics. Natural gas is one of the most desirable sources of clean energy and has an excellent safety record; however, specific aspects of LNG safety must be taken into account. The inherent safety advantages of natural gas, such as buoyancy, a narrow range of flammability limits and high ignition temperature, are partially offset by the large storage volumes, potential releases and low storage temperature of the LNG.

Vapor resulting from the vaporization of LNG has a specific gravity of 1.5 and will initially behave as a liquid in that it will seek the lowest point in the vicinity of the LNG vaporization source (e.g., a release or spill). When warmed to approximately -160°F, LNG vapors become buoyant and will rise and rapidly disperse into the atmosphere. Initial vaporization following a release of LNG produces a large flow of vapor for a short period of time as the LNG temperature elevates to levels above -160°F. The distance that the vapor will travel depends on many variables, including the volume of the initial release or spill, its duration, the wind velocity and direction, terrain, atmospheric temperature and humidity. Flammable mixtures of LNG vapor will initially extend downwind for a short period of time. Therefore, the zone of flammability will be confined to the immediate vicinity of the release or spill. Although LNG vapor has no odor or color, its low temperature will cause condensation of water vapor in the air, forming a visible white cloud.

The LNG presents a low temperature hazard in the event of an LNG spill, which could result from failure of connected process lines, flanged joint leaks and pipe breaks on equipment containing LNG. All piping for the LNG Facility will be designed for cryogenic service and LNG process and transfer systems will minimize the potential for leaks and failures. Equipment which may be in contact with pooled LNG will be designed to withstand the cold contact or protected by cryogenic insulation to prevent embrittlement. A spill containment system will be provided to route spills away from process equipment and to an impoundment basin. Any LNG in the spill containment system will warm over time and vaporize, producing a cold vapor cloud above or around the spill containment system. The insulated concrete design of the spill containment system decreases this vaporization rate. High expansion foam is provided at impoundment basins, which also works to decrease the vaporization rate. Firewater monitors located at strategic places around the LNG Facility can help control vapor cloud movement. Exceedance of the spill containment area could result in the spread of LNG to areas not designed for cryogenic temperatures. In order to mitigate this hazard, LNG impoundment basins are sized to contain the greatest flow capacity from a single pipe for ten minutes in the local area plus piping inventory and pump runout or the largest piece of equipment containing LNG.

Vapor cloud migration may result in ingestion of the gas into the air intake of an enclosed building. At high concentrations (<6 percent Oxygen), this may present an asphyxiation hazard. While LNG vapors do not pose an overpressure hazard in an unconfined space, if the ingested vapor cloud—now in a confined space—reaches a concentration within the flammability limits and contacts an ignition source, an overpressure could occur. The overpressure event can create a pressure wave that can damage buildings, structures and process equipment. Most equipment is located outdoors to prevent the accumulation of gas, and air intakes for fired equipment and building ventilation are spaced away from sources of vapor. Process overpressures will be mitigated by having equipment designed in accordance with American Society of Mechanical Engineers ("ASME") codes and designing relief equipment to operate below design pressures. Additionally, gas detection at the air intakes will shut down affected equipment. These measures prevent the escalation of events associated with a spill of LNG.

When a pressurized leak occurs, the liquid jet will vaporize and, depending on the operating condition, a portion of the jet could rainout and pool on the ground. The vapor cloud formation associated with a spill of LNG presents a radiant heat hazard if the concentration falls within the flammability range and an ignition source is encountered. Radiant heat from a jet fire or pool fire could impact nearby equipment or personnel. A flash fire could also occur if there is a delayed ignition of the vapor cloud in an open area. This can result in a brief, high heat release that could ignite secondary fires or impact nearby equipment or personnel. The spill containment system channels spills away from process equipment, and the impoundment basins are located away from equipment, structures and buildings. A high expansion foam system at the impoundment basins decreases the vaporization rate of LNG, which can help keep the vapor concentration over the impoundment basin below the lower flammability limit. Dry chemical systems provided around the LNG Facility can be used to extinguish LNG fires, and water spray systems can be used to cool adjacent equipment. Fireproofing on equipment and structures that are designed to withstand contact with radiant heat further reduces risk and prevents cascading failures.

Cascading events, including the failure of critical equipment or structures, may introduce a hazard to the LNG Facility. However, the mitigation features presented above minimize the potential for the escalation of an event. As an additional measure of protection, the Emergency Response Plan ("ERP") developed for the LNG Facility and further described in Resource Report 13 ensures that any emergency situations are handled quickly and efficiently.

11.4.2.2 Nitrogen

Nitrogen's principal hazard results from its cryogenic temperatures. An inherent safety advantage of nitrogen as a liquefaction technology is that nitrogen is not flammable; therefore, it does not present any vapor dispersion, overpressure or radiant heat hazards. Additionally, nitrogen does not pose a threat to the environment, because nitrogen composes 78 percent of the air.

Nitrogen presents a low temperature hazard in the event of a leak of cryogenic nitrogen. However, nitrogen has a boiling point of -320°F, so even if the leak is of the liquid phase, it will vaporize rapidly and mix with the surrounding air. Curbing around the nitrogen storage tank will keep spills local and allow for a more controlled vaporization and dispersion. Any piping containing cryogenic nitrogen will be designed for cryogenic service.

While nitrogen is non-toxic, it is classified as a simple asphyxiant and can cause asphyxiation when concentrations are sufficient to reduce oxygen levels below 6 percent. Curbing around the nitrogen storage tank will keep spills local and allow for a more controlled vaporization and dispersion, preventing the asphyxiation hazard from extending beyond the secondary containment. Adequate ventilation will be provided in the Compressor building to prevent an asphyxiation hazard in the event of a leak in that area.

Cascading events, including the failure of critical nitrogen equipment or structures, may introduce a hazard to the LNG Facility. However, the mitigation features presented above minimize the potential for the escalation of an event. As an additional measure of protection, the ERP developed for the LNG Facility ensures that any emergency situations are handled quickly and efficiently.

11.4.2.3 Heavy Hydrocarbons

Principal hazards associated with HHC result from its flammability, loss of containment, vapor dispersion characteristics and potential for overpressures if ignited.

The HHC presents a low temperature hazard in the event of an HHC spill, which could result from failure of connected process lines, flanged joint leaks and pipe breaks on equipment containing HHC. All HHC piping for the LNG Facility will be designed for cryogenic service and HHC process and transfer systems will minimize the potential for leaks and failures. Equipment which may be in contact with pooled HHC will be designed to withstand the cold contact or protected by cryogenic insulation to prevent embrittlement. A spill containment system will be provided to route spills away from process equipment and to an impoundment basin. Any HHC in the spill containment system will warm over time and vaporize, producing a cold vapor cloud above or around the spill containment system. The insulated concrete design of the spill containment system decreases this vaporization rate. High expansion foam is provided at impoundment basins, which also works to decrease the vaporization rate. Firewater monitors located at strategic places around the LNG Facility can help control vapor cloud movement. Exceedance of the spill containment area could result in the spread of HHC to areas not designed for cryogenic temperatures. In order to mitigate this hazard, impoundment basins are sized to contain the greatest flow capacity from a single pipe for ten minutes in the local area plus piping inventory and pump runout or the largest piece of equipment containing LNG, which exceeds the HHC flow rates.

Vapor cloud migration may result in ingestion of the gas into the air intake of an enclosed building. At high concentrations (<6 percent Oxygen), this may present an asphyxiation hazard. HHC vapors may pose an overpressure hazard if it reaches a concentration within the flammability limits and contacts an ignition source. The overpressure event can create a pressure wave that can damage buildings, structures and process equipment. Most equipment is located outdoors to prevent the accumulation of gas, and air intakes for fired equipment and building ventilation are spaced away from sources of vapor. Process overpressures will be mitigated by having equipment designed in accordance with ASME codes and designing relief equipment to operate below design pressures. Additionally, gas detection at the air intakes will shut down affected equipment. These measures prevent the escalation of events associated with a spill of HHC.

When a pressurized leak occurs, the liquid jet will vaporize and, depending on the operating condition, a portion of the jet could rainout and pool on the ground. The vapor cloud formation associated with a spill of HHC presents a radiant heat hazard if the concentration falls within the flammability range and an ignition source is encountered. Radiant heat from a jet fire or pool fire could impact nearby equipment or personnel. A flash fire could also occur if there is a delayed ignition of the vapor cloud in an open area. This can result in a brief, high-heat release that could ignite secondary fires or impact nearby equipment or personnel. The spill containment system channels spills away from process equipment, and the impoundment basins are located away from equipment, structures and buildings. A high expansion foam system at the impoundment basins decreases the vaporization rate of HHC, which can help keep the vapor concentration over the impoundment basin below the lower flammability limit. Dry chemical systems provided around the LNG Facility can be used to extinguish HHC fires, and water spray systems can be used to cool adjacent equipment. Fireproofing on equipment and structures that are designed to withstand contact with radiant heat further reduces risk and prevents cascading failures.

Cascading events, including the failure of critical equipment or structures, introduce a hazard to the LNG Facility. However, the mitigation features presented above minimize the potential for the escalation of an event. As an additional measure of protection, the Emergency Response Plan developed for the LNG Facility and described in Resource Report 13 ensures that any emergency situations are handled quickly and efficiently.

11.4.2.4 Hydrogen Sulfide

The acid gas stream produced during the regeneration phase of the amine system is the source of concentrated hydrogen sulfide at the LNG Facility. Hydrogen sulfide is buoyant and will quickly disperse upon release. Gas detectors will be provided around pretreatment equipment containing concentrations of hydrogen sulfide that could present a hazard. Toxicity modeling is performed as a part of the Hazard Analysis (15505-TR-000-006) to ensure a release will not pose a hazard to the public.

11.4.2.5 Amine Solution

The equipment in the amine pretreatment area will have adequate curbing underneath to keep spills local. In the event of a spill, the bund will be manually drained to the amine drain tank and disposed of properly. In addition, local spill cleanup kits will be provided at the LNG Facility to ensure spills are cleaned up and minimize environmental impacts.

11.4.2.6 Diesel

Diesel is used onsite for fueling the firewater pumps and the black start diesel generator. Diesel storage associated with the backup diesel firewater pump will be contained within a building, and diesel storage associated with the black start diesel generator will be contained in a double walled container within an enclosure. The diesel equipment is located away from the major process area to reduce the potential for cascading events. Any diesel leaks or spills in the LNG Facility will be contained and disposed of properly. These measures ensure that there is no hazard posed to the public.

11.4.2.7 Hot Oil

A hot oil system is used to provide heat to the amine stripper reboiler and the regeneration gas heater areas. The equipment in the pretreatment area will have adequate curbing underneath to keep spills local. In the event of a spill, a vacuum truck can be sent to site, if necessary, to clean up the contained spill. In addition, local spill cleanup kits will be provided at the LNG Facility to ensure spills are cleaned up and minimize environmental impacts. Radiant fire modeling is performed as a part of the Hazard Analysis (15505-TR-000-006) to ensure a release will not pose a hazard to the public.

11.4.2.8 Water Ethylene Glycol

The equipment in the vaporizer area will have adequate curbing underneath to keep spills local. In the event of a spill, a vacuum truck can be sent to site, if necessary, to clean up the contained spill. In addition, local spill cleanup kits will be provided at the LNG Facility to ensure spills are cleaned up and minimize environmental impacts.

11.4.2.9 Mercury

Mercury is removed from the feed gas with a mercury guard bed, which chemically absorbs the mercury to form mercury sulfide. This stable compound remains in the guard bed. The guard bed is disposed of and replaced properly at the end of its life by qualified personnel. These steps ensure that the mercury on site does not have potential for a release and does not pose a hazard to the public.

11.5 LNG Facility Hazard Identification

11.5.1 Process Hazard Identification and Analyses

A Hazard Identification and Analyses ("HAZID") will be performed on the LNG Facility engineering design by a group of qualified individuals prior to submitting the Certificate application in November 2016. The objective of a HAZID is to perform a high-level, systematic analysis to identify potential hazards in the early stage of a project design that can produce undesirable consequences through the occurrence of an incident by evaluating the materials, system, process and plant design.

The HAZID will be based on the LNG Facility's plot plan, process flow diagrams and heat and material balances, which are included in Appendix U of Resource Report 13. The results of the HAZID will be included in Appendix G.1 of Resource Report 13. As a result of the HAZID, recommendations will be made to improve the engineering design to minimize the potential for a hazardous event. The recommendations from the HAZID and their implementation will be included in Appendix G.2 of Resource Report 13.

11.5.2 Security Threat and Vulnerability Assessments

A preliminary security specification has been developed to identify the security measures that will be included in the design to mitigate potential security threats. The specification is included in Resource Report 13, Appendix T. In addition, security drawings are provided in Resource Report 13, Appendix U to illustrate the location of the proposed security measures for the LNG Facility. Additional security assessments will be performed during detailed design.

11.5.3 Natural Hazard Assessments

A site specific seismic evaluation has been performed to determine the potential for natural hazards to occur at the site. The seismic assessment contains the development of design ground motions and assessment of liquefaction and tsunami hazards. The full seismic evaluation is included in Appendix I of Resource Report 13.

A site specific geotechnical assessment has been performed to determine the potential for natural hazards to occur at the site. The geotechnical assessment developed preliminary geotechnical recommendations for the front end engineering design level design. Additional investigations will be performed to support the detailed design phase. However, final location of specific structures, anticipated dimensions, loading conditions and serviceability requirements (i.e., settlement limitations etc.) will not be finalized until detailed design is completed and will be included in Algonquin's Certificate application to be filed in November 2016. The full geotechnical assessment is included in Appendix J of Resource Report 13.

11.6 LNG Facility Hazard Analysis

11.6.1 Design Spill Selection

In accordance with 49 CFR Part 193.2059, each LNG container and LNG transfer system must have a vapor dispersion exclusion zone in accordance with Sections 2.2.3.3 and 2.2.3.4 of The NFPA 59A (2001 Edition). The design spill selection for determining the exclusion zone is provided in Section 2.2.3.5 and Table 2.2.3.5 of NFPA 59A.

The NFPA 59A Table 2.2.3.5 requires containers with over-the-top fill, with no penetrations below the liquid level, to contain a design spill of the largest flow from any single line that could be pumped into the impounding area with the container withdrawal pumps(s) considered to be delivering the full rated capacity. This design spill is required for 10 minutes based on the LNG Facility's surveillance and shutdown equipment.

The NFPA 59A Table 2.2.3.5 requires impounding areas serving only vaporization, process or LNG transfer areas to contain a spill of LNG for 10 minutes from a single accidental leakage source. However, since a "single accidental leakage source" is not defined in either NFPA 59A (2001 edition) or 49 CFR 193, DOT PHMSA has developed a criteria detailed in their Frequently Asked Questions webpage to calculate design spill rates associated with such single accidental leakage sources[5]. The resulting design spill rates are then used to calculate exclusion zones for impounding areas serving these areas.

Although not an exclusion zone by code, other hazards, such as hydrogen sulfide or HHC potential releases will also be considered and analyzed in a manner similar to LNG.

[5] http://primis.phmsa.dot.gov/lng/faqs.htm

The LNG Facility is currently developing a Design Spill Package including a Piping and Equipment Inventory Database, which will be submitted to DOT PHMSA for review. This Design Spill Package details the LNG Facility's methodology and selection of design spills. The full Piping and Equipment Database will be included in Resource Report 13, Appendix Q.1.

A summary of the bounding design spills used for hazard analysis modeling will be included in Table 11.6-1, below.

11.6.1 Hot and Cold Temperature Analysis

The materials used at the LNG Facility could present hot and cold temperature hazards if unmitigated. These hazards could affect plant personnel and, to a significantly lesser extent, adjacent landowners.

The insulation specification provided in Appendix T of Resource Report 13 provides the requirements for insulation thickness on process piping. Insulation provides protection for heat leak from the environment into the piping and also provides protection for plant personnel from cold touch hazards. Plant personnel will also have Personal Protective Equipment requirements to further mitigate touch hazards.

Areas where cryogenic spills could occur are provided with curbing, grating, and sloping to pull spills away from equipment and direct spills into impoundment basins. Spill containment systems are designed for a range of temperatures and will ensure that cold hazards associated with a spill do not affect plant personnel or adjacent equipment.

Material selection for piping and equipment is based on industry experience and the use of recognized accepted materials for cryogenic and high heat service.

When hot or cold materials are released to the environment, they immediately begin to warm up or cool down based on the temperature differences between atmospheric conditions and the fluid condition. The passive physically installed spill containment systems keep spills localized and allow them to warm up or cool down away from plant personnel, equipment and property lines.

As illustrated on the LNG Facility plot plan in Appendix A.3 of Resource Report 13, there is a large buffer area between the property line and the LNG Facility security fence line. There is additional area between the security fence line and process equipment and spill containment systems. As such, process spills will have no hot or cold temperature impact at the property lines.

Table 11.6-1: Summary of Design Spills										
Scenario Number	**Hazardous Fluid**	**Hole Size**	**Equipment Size**	**Location**	**Release Height**	**Release Temp**	**Equilibrium Pressure**	**Release Flow Rate**	**Release Duration**	**Liquid Rainout**
TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

11.6.2 Asphyxiant and Toxic Vapor Dispersion Analysis

Although not an exclusion zone, Section 2.1.1.d of NFPA 59A (2001) states that "*other factors applicable to the specific site that have a bearing on the safety of plant personnel and the surrounding public shall be considered. The review of such factors shall include an evaluation of potential incidents and safety measures incorporated in the design or operation of the facility.*"

Therefore, toxic vapor dispersion analysis associated with jetting and flashing releases has been performed. As NFPA 59A and Part 193 do not provide recommended thresholds for analyzing toxicity, FERC has required applicants to consider toxicity levels based on the AEGL-1, -2, and -3 maintained by the U.S. Environmental Protection Agency.

Toxicity modeling was performed on hydrogen sulfide, benzene, toluene and xylene. Dispersion analysis was also performed on the liquid nitrogen storage in order to determine the presence of an asphyxiation hazard. The Phast v6.7 model was used to perform the analysis. A safety factor of 2 was applied to the toxicity modeling. Atmospheric conditions used were stability F, wind speed of up to 2 meters per second ("m/s"), temperature of 51.4°F, relative humidity of 50 percent and surface roughness factor of 0.03 meter ("m") for all wind directions.

The calculations and resulting toxic dispersion analysis for the LNG Facility will be detailed in the Hazard Analysis included in Appendix Q.1 of Resource Report 13.

Results of the asphyxiant and toxic vapor dispersion analysis will be included in a subsequent revision of this report.

Table 11.6-2: Asphyxiant and Toxic Vapor Dispersion Results

Scenario #	AEGL Level	Distance (ft)
TBD	½ AEGL-1	TBD
	½ AEGL-2	TBD
	½ AEGL-3	TBD
TBD	½ AEGL-1	TBD
	½ AEGL-2	TBD
	½ AEGL-3	TBD

11.6.3 Flammable Vapor Dispersion Analysis

In accordance with the requirements of Sections 2.2.3.3 and 2.2.3.4 of NFPA 59A, 49 CFR Part 193.2059 and written interpretations issued by DOT PHMSA in July 2010, provisions have been made within the design of the LNG Facility to minimize the possibility of flammable vapors reaching a property line that can be built upon and that would result in a distinct hazard. Specifically, in accordance with the requirements of 49 CFR Part 193.2059, dispersion distances have been calculated for one half the lower flammability limit of natural gas and flammable hydrocarbon vapors. These distances have been calculated for jetting and flashing releases and also the conveyance and impoundment of a design spill of LNG and flammable refrigerants calculated in accordance with Section 2.2.3.5 of NFPA 59A (2001).

Atmospheric conditions used in the modeling are in compliance with the requirements of 49 CFR Part 193. The Phast v6.7 model was used to perform the analysis. A safety factor of 2 was applied to the dispersion modeling. Atmospheric conditions used were stability F, wind speed of up to 2m/s, temperature of 51.4°F, relative humidity of 50 percent and surface roughness factor of 0.03m for all wind directions.

The calculations and resulting vapor dispersion exclusion zones for the LNG Facility will be detailed in the Hazard Analysis included in Appendix Q.1 of Resource Report 13.

Results of the LNG jetting and flashing vapor dispersion analysis will be included in a subsequent revision of this report.

Table 11.6-3: LNG Jetting and Flashing Vapor Dispersion Results

Scenario #	Bounding Scenario Hole Size (inch)	Distance to ½ Lower Flammability Limit (feet)	Total Vapor Mass Flow Rate (lb/hr)
TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD

Results of the LNG conveyance vapor dispersion analysis will be included in a subsequent revision of this report.

Table 11.6-4: LNG Conveyance Vapor Dispersion Results

Scenario #	Bounding Scenario Hole Size (inch)	Distance to ½ Lower Flammability Limit (feet)	Discharge Mass Flow Rate (lb/hr)
TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD

11.6.4 Overpressure Analysis

Although not an exclusion zone, Section 2.1.1.d of NFPA 59A (2001) states that *"other factors applicable to the specific site that have a bearing on the safety of plant personnel and the surrounding public shall be considered. The review of such factors shall include an evaluation of potential incidents and safety measures incorporated in the design or operation of the facility."*

Therefore, vapor cloud overpressure analysis associated with HHC releases has been performed for the LNG Facility. As NFPA 59A and Part 193 do not provide recommended thresholds for analyzing overpressures, FERC has required applicants to consider an overpressure value of 1 psi to determine the potential impacts on the public. The Phast v6.7 model was used to perform the analysis. Atmospheric conditions used were stability F, wind speed of up to 2m/s, temperature of 51.4°F, relative humidity of 50 percent and surface roughness factor of 0.03m for all wind directions.

The calculations and resulting overpressure analysis for the LNG Facility will be detailed in the Hazard Analysis included in Appendix Q.1 of Resource Report 13.

Results of the overpressure analysis will be included in a subsequent revision of this report.

Table 11.6-5: Overpressure Results			
Scenario #	**Bounding Scenario Hole Size (inch)**	**Distance to 1 psi (ft)**	**Total Vapor Mass Flow Rate (lb/hr)**
TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD

11.6.5 Fire Hazard Analysis

11.6.5.1 LNG Pool Fire

Exclusion zone and hazard distances for various flux levels for flammable hydrocarbon pool fires have been calculated in accordance with 49 CFR Part 193.2057 and Section 2.2.3.2 of NFPA 59A, using the "LNGFIRE III" computer program model developed by the GRI. Atmospheric conditions used in the modeling are in compliance with the requirements of 49 CFR Part 193. Atmospheric conditions used were wind speed of up to 24 miles per hour ("mph"), temperature of 14°F and relative humidity of 25 percent for all wind directions.

The calculations and resulting LNG pool fire analysis for the LNG Facility are detailed in the Hazard Analysis included in Appendix Q.1 of Resource Report 13. The results of the modeling show that all thermal radiation hazards associated with pool fires remain within the LNG Facility property line and therefore meet the exclusion zone requirements detailed in 49 CFR Part 193. Table 11.6-5 summarizes the thermal exclusion zones.

Table 11.6-5: LNG Thermal Exclusion Zones			
Basin:	**Distance (ft) to:**		
	10,000 Btu/ft^2-hr	**3,000 Btu/ft^2-hr**	**1,600 Btu/ft^2-hr**
Process Area (S-830)	140	180	211
Trucking Area (S-832)	73	91	105
LNG Storage Tanks	467	781	1003

11.6.5.2 LNG Jet Fire

The Phast v6.7 model was used to calculate the jet fire thermal radiation distances for the bounding design spill scenarios. Atmospheric conditions used were wind speed of up to 24mph, temperature of 14°F and relative humidity of 25 percent for all wind directions.

The calculations and resulting LNG jet fire analysis for the LNG Facility will be detailed in the Hazard Analysis included in Appendix Q.1 of Resource Report 13.

Results of the LNG jet fire analysis will be included in a subsequent revision of this report.

Table 11.6-6: LNG Jet Fire Thermal Distances					
Material	**Scenario Number**	**Hole Size (in)**	**Distance to 1,600 Btu/ft^2-hr: (ft)**	**Distance to 3,000 Btu/ft^2-hr: (ft)**	**Distance to 10,000 Btu/ft^2-hr: (ft)**
TBD	TBD	TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD	TBD	TBD
TBD	TBD	TBD	TBD	TBD	TBD

11.6.5.3 Diesel Pool Fire

Diesel storage associated with the backup diesel firewater pump will be contained within a building, and diesel storage associated with the black start diesel generator will be contained in a double walled container within an enclosure. In the highly unlikely event of a diesel pool fire, the resultant thermal radiation would be contained within the building or enclosure that is within the Facility property. Therefore, there would be no impact on the public.

11.7 LNG Facility Layers of Protection

The design of the LNG Facility includes multiple layers of protection to reduce the risk of a potentially hazardous scenario developing into an event which could impact off-site infrastructure. The layers of protection are considered independent of one another, i.e., each layer would perform its designed function regardless of the function of other layers.

11.7.1 Structural Design

The structural design of the LNG Facility complies with the requirements detailed in 49 CFR Part 193 and NFPA 59A (2001). The LNG Facility is designed to meet the loading requirements for wind speed and the seismic hazards that could occur at the LNG Facility. The LNG Facility would be designed to withstand a sustained wind of 150 mph, which converts to 183 mph at a 3-second gust per 49 CFR 193.2067. The ground surface of the LNG Facility would be at an elevation of about 122 feet North American Vertical Datum of 1988. The LNG storage tanks would be 120 feet North American Vertical Datum of 1988.

A listing of the Codes and Standards to which the LNG Facility would be designed is included in Appendix D of Resource Report 13. Demonstration of Code Compliance is available in Resource Report 13 Appendix F. Further details are included in Resource Report 13 Appendix I – Seismic, Appendix J – Geotechnical Investigation, Appendix T – Specifications and Appendix C – Basis of Design.

11.7.2 Mechanical Design

The mechanical design of the LNG Facility complies with the requirements detailed in 49 CFR Part 193 and NFPA 59A (2001). The design of the LNG Facility includes the use of suitable materials of construction. LNG storage tanks are designed with 9 percent nickel steel and process piping is designed for cryogenic temperatures. Material selection for process components is compatible with the operational and design limits (pressure, temperature etc.) of the systems. Piping will be designed in accordance with ASME B31.3. LNG piping will consist of welded connections on the majority of the piping connections to minimize the possibility of flange leaks. Pressure vessels will be designed in accordance with ASME Section VIII. LNG storage tanks would be designed in accordance with American Petroleum Institute ("API") Standard 620 and NFPA 59A (2001 and 2006) per the requirements of 49 CFR 193.

Critical equipment necessary to support continued sendout operation (in-tank pumps, high pressure ("HP") pumps, WEG pumps, WEG heaters etc.) are installed as spares to ensure reliability if the LNG Facility is called upon during high demand times.

A listing of the Codes and Standards to which the LNG Facility would be designed is included in Appendix D of Resource Report 13. Demonstration of Code Compliance is available in Resource Report 13 Appendix F. Further details are included in Resource Report 13 Appendix T – Specifications, Appendix C – Basis of Design and Appendix L – Storage Tank.

11.7.3 Operations and Maintenance Plans

The design of the LNG Facility will include Operations and Maintenance Plans as required by 49 CFR Part 193. Measures, such as operating control system tools, procedures and training, address the potential for human error and incorrect operation. Procedures for operation and maintenance of the LNG Facility will comply with NFPA standards as specified in the following sections of the NFPA 59A (2001):

- Chapter 11—Operating, Maintenance and Personnel Training.
    - The procedure will include policies for operating procedures, monitoring of operations, emergency procedures, personnel safety, failure investigations, communication systems and operating records.
    - The procedure will include policies for maintenance procedures, fire protection, isolating and purging, repairs, control systems, inspection of LNG storage tanks, corrosion control and maintenance records.
    - Recruitment of the Operations and Maintenance Team will commence during the construction period, and personnel involved in the day-to-day operation and maintenance of the Terminal will receive required training.
- Appendix C—Security. This procedure will include policies for security procedures, protective enclosures, security communications, security monitoring and warning signs.

A listing of the codes and standards to which the LNG Facility would be designed is included in Appendix D of Resource Report 13. Demonstration of Code Compliance is available in Resource Report 13 Appendix F. Further details are included in Resource Report 13 Appendix T – Specifications and Appendix C – Basis of Design.

11.7.4 Control Systems

The design of the LNG Facility includes state-of-the-art control systems. These control systems include monitoring systems, process alarms and control and isolation valves which can be monitored in the control room. The LNG Facility will also develop operating procedures in accordance with 49 CFR Part 193, which will ensure the facility stays within the established operating and design limits. Alarms would have visual and audible notification in the control room, as well as in the field, to warn operators that process conditions may be approaching design limits. Operators would have the capability to take action from the control room to mitigate an upset. As required by 49 CFR Part 193, all operators will undergo extensive training prior to operating the LNG Facility.

Alarm and shutdown setpoints, where available, are shown on the P&IDs included in Appendix U of Resource Report 13. Cause and effect matrices showing logic are provided in Appendix N of Resource Report 13. Finalized operating limits for flows, pressures and temperatures will be dependent on the final vendor selection for major process systems which will be determined during final design.

A listing of the codes and standards to which the LNG Facility will be designed is included in Appendix D of Resource Report 13. Demonstration of Code Compliance is available in Resource Report 13 Appendix F. Further details are included in Resource Report 13 Appendix N – Instrumentation, Appendix U – P&IDs and Appendix C – Basis of Design.

11.7.5 Safety Instrumented Systems

The design of the LNG Facility includes safety-instrumented prevention systems that include safety control valves and emergency shutdown systems designed to prevent a release if design limits are exceeded during operation. The exclusive purpose of this system is to bring the LNG Facility to a safe state. The system will be designed in accordance with International Society of Automation 84.01, Application of Safety Instrumented Systems for the Process Industry. Safety valves and instrumentation would be installed to monitor, alarm, shutdown and isolate equipment and piping during process upsets or emergency conditions. The inherently fail-safe safety instrumented system will isolate process areas from incoming feed gas, sectionalize and isolate inventories to limit materials in release event, isolate potential ignition sources and depressurize equipment handling flammable materials. The control room will initiate emergency shutdowns or depressurizations. The system power is provided with a backup un-interruptible power supply systems to maintain control operation. Through its features detailed above, the safety instrumented system provides protection for equipment, personnel and the surrounding environment.

A listing of the Codes and Standards to which the LNG Facility would be designed is included in Appendix D of Resource Report 13. Demonstration of Code Compliance is available in Resource Report 13 Appendix F. Further details are included in Resource Report 13 Appendix N – Instrumentation, Appendix U – P&IDs and Appendix C – Basis of Design.

11.7.6 Security Systems and Plans

The security requirement for the LNG Facility is governed by 49 CFR 193, Subpart J - Security. This subpart includes requirements for conducting security inspections and patrols, liaison with local law enforcement officials and design and construction of protective enclosures, lighting, monitoring, alternative power sources and warning signs. The design of the LNG Facility includes state-of-the-art systems to help maintain and operate the LNG Facility in a safe, secure and reliable environment. Advances in monitoring systems, alarm systems and communication systems have allowed LNG facilities to continue to have an impeccable security record. Security measures included in the design of the Project to control access include: perimeter security including inspections and patrols, access points into/out of the LNG Facility, restrictions and prohibitions applied at the access points, intrusion detection, security and safety Closed Circuit Television monitoring with digital video feed and recording capabilities, identification systems, screening procedures, response procedures to security breaches and liaison with local law enforcement officials. Lighting will be provided in locations to allow personnel to reach a place of safety in the event of a main power outage.

A listing of the Codes and Standards to which the LNG Facility would be designed is included in Appendix D of Resource Report 13. Demonstration of Code Compliance is available in Resource Report 13 Appendix F. Further details are included in Resource Report 13 Appendix C – Basis of Design, Appendix T and Appendix U.

11.7.7 Physical Protection Devices

The pressure relief and flare system will be designed to safely and reliably dispose of streams which are released during start-up, shutdown, cool down, plant upsets and emergency conditions. The design of the LNG Facility includes relief valves for process piping that physically protect the piping systems from operating beyond the design limits. The relief valves are connected to a closed flare system where any process upsets are sent to a ground flare for disposal. The safety relief valves would be designed to handle process upsets and thermal expansion within piping, per NFPA 59A and ASME Section VIII. The flare system will be designed such that the vent and drain systems are segregated from each other, the ground flare operates with minimal smoke generation and a highly reliable ignition system, and the thermal radiation will be in accordance with API RP 521.

The LNG storage tanks include both relief valves and vacuum relief valves to protect the LNG storage tank from both over and under pressure events.

Relief valves which discharge to atmosphere will be minimized.

A listing of the Codes and Standards to which the LNG Facility would be designed is included in Appendix D of Resource Report 13. Demonstration of Code Compliance is available in Resource Report 13 Appendix F. Further details are included in Resource Report 13 Appendix L – LNG Storage Tank, Appendix U – P&IDs and Appendix C – Basis of Design.

11.7.8 Ignition Controls

The design of the LNG Facility includes ignition controls as specified in 49 CFR Part 193 and NFPA 59A (2001). The LNG Facility would include equipment that is electrically classified in accordance with NFPA 59A, NFPA 497 and API RP 500 to mitigate potential ignition sources. The electrical design of the LNG Facility includes grounding of equipment, as necessary. The LNG Facility procedures will also include the requirements for hot work permits to be obtained prior to work activities, smoking restrictions at the LNG Facility and other measures to minimize potential ignition sources at the LNG Facility. The LNG Facility has been designed such that areas likely to contain flammable gas mixtures will be isolated from ignition sources in accordance with NFPA 70 and the National Electric Code. Electrical equipment used within these designated areas will be housed in enclosures approved for this service and application.

A listing of the Codes and Standards to which the LNG Facility would be designed is included in Appendix D of Resource Report 13. Demonstration of Code Compliance is available in Resource Report 13 Appendix F. Further details are included in Resource Report 13 Appendix O –Electrical and Appendix C – Basis of Design.

11.7.9 Spill Containment Systems

The design of all spill containment system meets the requirements of 49 CFR Part 193 and NFPA 59A (2001). All spill containment systems would be equipped with detection devices that would activate an automated alarm alerting the operator in the unlikely event of a spill.

A listing of the Codes and Standards to which the LNG Facility would be designed is included in Appendix D of Resource Report 13. Demonstration of Code Compliance is available in Resource Report 13 Appendix F. Further details are included in Resource Report 13 Appendix P –Spill Containment Drawing, Appendix U – Piping Layout and Section Drawings, Appendix C – Rainfall Design Basis, Appendix C – Basis of Design and Appendix D – Design Codes and Standards.

11.7.9.1 LNG Storage Tanks

Part 193.2181 of 49 CFR specifies that the impoundment system serving a single LNG storage tank must have a volumetric capacity of 110 percent of the LNG storage tank's maximum liquid capacity. The two LNG storage tanks designed for the LNG Facility are full-containment tanks with a primary inner container and a secondary outer container. The tanks have been designed and will be constructed so that the self-supporting primary container and the secondary container will be capable of independently containing the LNG. The primary, inner container has been designed and will be constructed in accordance with the requirements of API Standard 620 Appendix Q, and will contain the LNG under normal operating conditions. The secondary container will be capable of containing the LNG (110 percent capacity of inner tank) and controlling the vapor resulting from the unlikely occurrence of product leakage from the inner container. Each insulated tank is designed to store a net volume of 152,700 m^3 (960,454 barrels) of LNG at a temperature of -260°F. As part of its full containment design, each inner storage tank is surrounded by an outer concrete wall with an inner diameter of approximately 265 feet and a height of approximately 125.3 feet. In addition, an earthen berm would be constructed around both of the LNG storage tanks as a tertiary containment.

Table 11.7-1 summarizes the dimensions of the secondary containment.

Table 11.7-1: LNG Storage Tank Containment Sizing

Containment	Diameter (ft)	Height (ft)	Capacity (ft^3)	Capacity (m^3)
LNG Storage Tank	265	125.3	6,910,870	195,694

To increase the safety of the tanks, there are no penetrations through the inner container or outer container sidewall or bottom. Piping into and out of the inner and outer containers will enter from the top of the tank. The full containment design prevents water ingress into annular spaces and therefore there are no water removal requirements for this tank design. Further details are included in Resource Report 13, Appendix L.

11.7.9.2 LNG Impoundment Basins

The design of the LNG Facility includes insulated concrete impoundment basins described as follows:

- Process Area (S-830). This impoundment basin will collect spills originating in the LNG liquefaction area, tank area and associated piping.
- Truck Loading Area (S-832). This impoundment basin will collect spills originating at the truck loading area and associated piping systems.

The locations of the impoundment basins are illustrated on plot plan included in Appendix U.1 of Resource Report 13. The flow of LNG spills into the impoundment basins is illustrated on the LNG Spill Containment Drawing 15505-DG-600-101, which is included in Appendix Q.3 of Resource Report 13.

In accordance with the requirements of Section 2.2.2.2 of NFPA 59A, impounding areas that serve only vaporization, process or LNG transfer areas will have a minimum volumetric capacity equal to the greatest volume of LNG that can be discharged into the area during a 10 minute period from any single accidental leakage source or during a shorter time period based on demonstrable surveillance and shutdown provisions acceptable to the authority having jurisdiction. Each impoundment basin has been sized to contain the largest design LNG spill that could occur from a single accidental leakage source within its respective area for a period of 10 minutes, plus pump runout and pipe inventory. The calculations are further described in the hazard analysis included in Appendix Q.1 of Resource Report 13. Table 11.7-2 summarizes the dimensions of the impoundment basins.

Table 11.7-2: LNG Impoundment Basin Sizing				
Basin	**Length (ft)**	**Width (ft)**	**Depth (ft)**	**Capacity (ft^3)**
Process Impoundment Basin	35	35	11	100,800
Trucking Impoundment Basin	15	15	13	21,881

LNG will flow into the impoundment basins along insulated concrete troughs located alongside or beneath LNG pipelines and equipment as illustrated on the LNG Spill Containment Drawings that are included in Appendix Q.3 of Resource Report 13. The troughs are sized to contain the largest design LNG spill that could occur from a single accidental leakage source within its respective area. The troughs will be constructed of insulated concrete and designed to minimize vapor formation during LNG spills.

The LNG impoundment basins will be of an insulated concrete design. The concrete insulates the LNG from the sump walls and floor, reducing the vaporization rate. Additionally, in accordance with the requirements of Section 2.2.2.8 of NFPA 59A, the insulation system used for the impounding surfaces will be noncombustible and suitable for the intended service.

In accordance with the requirements of Section 2.2.2.7 of NFPA 59A, each LNG impoundment basin will include a sump to collect rainwater from the containment area. A water removal system will be installed and will have the capacity to remove water at a minimum of 25 percent of the rate from a storm of a 10-year frequency and 1-hour duration. In accordance with the requirement of Section 2.2.2.7 of NFPA 59A, automatically controlled sump pumps will be installed in the sump to remove water from the LNG impoundment basin sumps. The sump pumps will be fitted with an automatic cutoff device that prevents their operation when exposed to LNG temperatures.

11.7.9.3 Amine Containment

Amine-containing equipment will be individually bunded to keep spills local. Spills will be manually drained to the amine drain tank and disposed of properly. Rainwater falling in this area will collect in the Amine Drain Tank Sump and can be manually drained to the oily water treatment package (L-848). Table 11.7-3 summarizes the dimensions of the amine spill containment basin.

Table 11.7-3: Amine Impoundment Basin Sizing				
Basin	**Length (ft)**	**Width (ft)**	**Depth (ft)**	**Capacity (ft^3)**
Amine Containment Basin	30	12	6	2,160

11.7.9.4 Diesel Containment

Diesel storage associated with the backup diesel firewater pump will be contained within a building, and diesel storage associated with the black start diesel generator will be contained in a double walled container within an enclosure.

11.7.10 Passive Protection

The design of the LNG Facility includes additional passive protection measures which goes beyond equipment layout and includes proper process design to minimize hydrocarbon inventory, isolate inventory segments and move flammable inventory out of the area of hazard to the flare in the shortest practical time, where applicable. Vessel and equipment spacing was designed in accordance with 49 CFR

Part 193 and NFPA 59A (2001) between each other, buildings, from ignition sources and to the property line. The design of the LNG Facility also complies with the exclusion zone requirements for thermal radiation and vapor dispersion detailed in 49 CFR Part 193. All process areas will be designed to be as open as possible to minimize the potential for enclosed spaces leading to overpressures.

In addition to proper layout and process design, fire proofing and cryogenic protection is provided to structures, as needed. Fireproofing design will be in accordance with the recommendations of API 2218. Any fireproofing material used in areas where there is a risk for LNG splashing, will be designed to handle the cold contact without losing its structural integrity or fireproofing ability.

Personnel heat protection via insulation or guarding will be provided for all equipment and piping with a potential external skin temperature above than 140 °F. Cryogenic protection will be provided for cold equipment to prevent personnel injury. Protection against falling ice will be considered and implemented, as needed, during detailed design.

A listing of the codes and standards to which the LNG Facility will be designed is included in Appendix D of Resource Report 13. Demonstration of Code Compliance is available in Resource Report 13 Appendix F. Further details are included in Resource Report 13 Appendix P – NFPA 59A Evaluation and Appendix U – Unit Plot Plans.

11.7.11 Hazard Detection Systems

The LNG Facility is designed to minimize the occurrence of events that could result in the release of LNG and other flammable materials and to mitigate potential impacts to the public and facility personnel. In the unlikely event that a release does occur, a Hazard Detection and Mitigation System ("HDMS") emergency shutdown ("ESD") will be in place. Elements of this system include the following:

- Flammable gas detectors;
- Low oxygen detectors (nitrogen, hydrogen sulfide);
- High and low temperature detectors;
- Smoke detectors;
- Flame detectors;
- Manual local ESD activation push buttons; and
- Automatic ESD activation features.

The HDMS will provide the means to monitor for and alert operators of hazardous conditions throughout the LNG Facility resulting from fire, combustible gas leaks and low temperature LNG spills. The detection of these hazardous conditions by the HDMS will result in local audio and visual (e.g., strobe lights) signals with various alarms and colors depending on the detected hazard. The HDMS system will be independent of the process control system. When appropriate, the HDMS system will have the capability to initiate automatic shutdown of specific equipment and systems and may activate the wider ESD system response. Firewater and fire suppression/extinguishing systems will be provided to protect personnel, the public and facility equipment in the event of a fire.

An NFPA 59A Fire Protection Evaluation has been performed to ensure that the design of the HDMS is sufficient and meets the requirements of Section 9.1.2 of NFPA 59A (2001). This evaluation is included in Appendix P of Resource Report 13.

A listing of the Codes and Standards to which the LNG Facility would be designed is included in Appendix D. Demonstration of Code Compliance is available in Resource Report 13 Appendix F. Further details are included in Resource Report 13 Appendix C – HDMS Philosophy and Appendix U.

11.7.12 Hazard Control Equipment

In the unlikely event that the HDMS detects an event, the LNG Facility is designed with hazard control equipment to minimize the impact of the event. Elements of this system include the following:

- Dry chemical systems;
- Firewater systems;
- High expansion foam systems;
- Clean agent systems; and
- CO_2 extinguishers.

Portable, fixed and wheeled dry chemical extinguishers are strategically located around the LNG Facility and provide a means to extinguish hydrocarbon fires. The LNG Facility design includes a firewater system that includes monitors and hoses, which can provide firewater to cool adjacent equipment and minimize impacts from an incident. High expansion foam systems will be provided at all impoundment basins to reduce vaporization rate of LNG being contained and provide additional protection by decreasing the rate of vaporization. Clean agent systems, which fill a room with a gaseous agent to suppress fires where water is not a desirable suppression agent, are provided for electrical equipment that is critical to LNG Facility operation or to maintenance of control in an emergency. CO_2 extinguishers will be provided in the control room, motor control consol/field auxiliary room buildings, electrical and power substations, switchgear rooms and other rooms/buildings where electrical hazards are present. The layout and design of the hazard control equipment meets the requirements of 49 CFR Part 193 and NFPA 59A (2001).

A NFPA 59A Fire Protection Evaluation has been performed to ensure that the design of the HDMS is sufficient and meets the requirements of Section 9.1.2 of NFPA 59A (2001). This evaluation is included in Appendix P of Resource Report 13.

A listing of the Codes and Standards to which the LNG Facility would be designed is included in Appendix D of Resource Report 13. Demonstration of Code Compliance is available in Resource Report 13 Appendix F. Further details are included in Resource Report 13 Appendix C – HDMS Philosophy, Appendix P and Appendix U.

11.7.13 Emergency Response

A draft ERP has been developed in accordance with FERC's *Draft Guidance for LNG Terminal Operator's Emergency Response Plan* dated September 21, 2006, and the requirements of 49 CFR 193.2509. A draft ERP is included in Resource Report 13, Appendix P.3. The ERP establishes the procedures for responding to specific emergencies that may occur at the LNG Facility as well as procedures for emergency situations that could affect the public.

In accordance with FERC's *Draft Guidance for LNG Terminal Operator's Emergency Response Plan* (FERC, 2006), Algonquin will consult with local, state and Federal agencies to prepare a final version of the ERP for FERC's approval prior to the start of construction.

The ERP will include a cost-sharing plan describing any cost reimbursements that the applicant agrees to provide to any state and local agencies with the responsibility for security and safety of the LNG Facility. The ERP will be reviewed with community stakeholders and aforementioned authorities.

Algonquin will work with state and local emergency response organizations to develop and implement the ERP. Guidelines for response training required of appropriate personnel will be included in the ERP.

A listing of the Codes and Standards to which the LNG Facility would be designed is included in Appendix D of Resource Report 13. Demonstration of Code Compliance is available in Resource Report 13 Appendix F. Further details are included in Resource Report 13 Appendix C – HDMS Philosophy and Appendix P.

11.8 LNG Facility Reliability

The design of the LNG Facility includes numerous measures to ensure its overall reliability throughout its more than 25+ year design life. The LNG Facility will incorporate only proven design and technology and be built to the design codes and standards listed in the Design Codes and Standards document (15505-TS-000-003) in Appendix D of Resource Report 13.

The design is further aimed at giving "state-of-the-art" levels of operability, reliability, availability and maintainability. Only cryogenic equipment from vendors who have a proven record of operation in LNG service will be used in this LNG Facility. This equipment will include but not be limited to LNG storage tanks, refrigerant and boiloff gas compressors, refrigerant companders, pressure vessels, pumps, heat exchangers, valves, piping and instrumentation. The use of different manufacturers or types of vendor-supplied equipment for similar applications will be minimized in order to improve the operability and maintainability of the LNG Facility and to consolidate and therefore minimize the holding of spare parts required.

The LNG Facility will be designed to permit unconstrained operation over the absolute range of ambient conditions referred to in the Design Basis. It will be provided with suitable weather protection to enable all operation and maintenance procedures to be undertaken under all design weather conditions.

Except in the case of a total power outage, the LNG Facility will be designed for continuous natural gas liquefaction during the liquefaction season as well as quick startup and continuous LNG sendout operations during peak gas demand periods. Sufficient sparing and equipment isolation will be included such that normal maintenance and inspection can be accomplished while sustaining the design liquefaction, LNG sendout or LNG vaporization rates.

The LNG Facility is designed for a 130 day liquefaction season assuming the LNG storage tanks are fully empty (minus tank heel) at the start of the liquefaction season. Critical spare parts and components will be kept in the warehouse to minimize overall downtime and increase reliability. As the LNG Facility will need to send out natural gas when called upon, an N+1 installed sparing philosophy is implemented in the design of the sendout system.