

# **EXHIBIT 14**

# PLAQUEMINES

**PLAQUEMINES EXPANSION, LLC  
AND VENTURE GLOBAL PLAQUEMINES LNG, LLC**

**PLAQUEMINES EXPANSION PROJECT**

**Resource Report 11**

**Reliability and Safety**

**Docket No.  
CP26-\_\_\_\_-000**

**November 2025**

**PLAQUEMINES EXPANSION, LLC AND VENTURE GLOBAL PLAQUEMINES LNG, LLC**

**PLAQUEMINES EXPANSION PROJECT  
 RESOURCE REPORT 11 – RELIABILITY AND SAFETY**

<b>Resource Report 11–Reliability and Safety</b>	
<b>Full Filing Requirements</b>	
<b>Information</b>	<b>Report Section Reference</b>
This report is required for applications involving new or recommissioned liquefied natural gas (LNG) facilities. Information previously filed with the Commission need not be refiled if the applicant verifies its continued validity. This report shall address the potential hazard to the public from failure of facility components resulting from accidents or natural catastrophes, how these events would affect reliability, and what procedures and design features have been used to reduce potential hazards. Resource Report 11 must:	
<input type="checkbox"/> (1) Describe measures proposed to protect the public from failure of the proposed facilities (including coordination with local agencies).	11.4
<input type="checkbox"/> (2) Discuss hazards, the environmental impact, and service interruptions which could reasonably ensue from failure of the proposed facilities.	11.2, 11.3
<input type="checkbox"/> (3) Discuss design and operational measures to avoid or reduce risk.	11.4, 11.5
<input type="checkbox"/> (4) Discuss contingency plans for maintaining service or reducing downtime.	11.4, 11.5
<input type="checkbox"/> (5) Describe measures used to exclude the public from hazardous areas. Discuss measures used to minimize problems arising from malfunctions and accidents (with estimates of probability of occurrence) and identify standard procedures for protecting services and public safety during maintenance and breakdowns.	11.3, 11.4, 11.5

Plaquemines Expansion Project  
 Resource Report 11 – Reliability and Safety

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<b>Federal Energy Regulatory Commission Comments dated October 14, 2025 on the Draft Resource Reports 11 and 13</b>		
<b>Number</b>	<b>Comment</b>	<b>Response/Report Section Reference</b>
2	Section 11.2.4 does not discuss the hazards posed on SH 23 by the hazardous pipelines and supporting structures which cross the Project site. Therefore, in the final application, provide discussions and applicable analyses for the vehicle collision protection measures at SH 23 road crossing of the LNG transfer lines to ensure it can withstand impact from the most severe loading, including potential explosion loads from any trucks carrying hazardous materials.	Section 11.2.4 has been updated to include a description of the SH 23 hazards and vehicle impact protection system (and associated analysis).
3	Section 11.2.4 indicates a rail safety and reliability impact study was performed and concluded no impacts from rail activity. However, in 2024, Plaquemines Port Harbor and Terminal District (Plaquemines Port) entered into a letter of intent with APM Terminals to build a new container terminal on the West Bank of Plaquemines Parish, Louisiana, which includes rail that may be routed underneath or adjacent to the marine transfer line pipe rack. Therefore, in addition to the existing facilities, in the final application, provide a discussion of any design considerations (e.g., clearance heights, vibration mitigation or monitoring, etc.) to mitigate potential impacts from railroads within close proximity of the Project site that have pending permits, issued permits, and/or under construction.	The elevation of the marine loading line platform over SH 23 is designed to have sufficient clearance height above the highway and meets LADOT requirements for road crossings. Therefore, it has sufficient clearance height for any future permitted facilities in the area. The Applicants are aware of the potential rail project, and in the event the project moves forward, the Applicants will have a better understanding of the potential rail traffic associated with the project and will implement mitigation features into the design to protect the Plaquemines Expansion Project facilities.

**PLAQUEMINES EXPANSION, LLC AND VENTURE GLOBAL PLAQUEMINES LNG, LLC**

**PLAQUEMINES EXPANSION PROJECT  
RESOURCE REPORT 11 – RELIABILITY AND SAFETY**

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## ACRONYMS AND ABBREVIATIONS

Applicants	Plaquemines Expansion, LLC and Venture Global Plaquemines LNG, LLC
Application	The application to the Federal Energy Regulatory Commission of the Applicants for authorization to site, construct, and operate natural gas liquefaction and export facilities.
ASME	American Society of Mechanical Engineers
CFR	Code of Federal Regulations
CO <sub>2</sub>	carbon dioxide
Commission	Federal Energy Regulatory Commission
COTP	Captain of the Port
CWA	Clean Water Act
DHS	U.S. Department of Homeland Security
DOT	U.S. Department of Transportation
EPA	U.S. Environmental Protection Agency
EPC	Engineering, Procurement, and Construction
ERP	Emergency Response Plan
ESD	Emergency Shutdown
Expansion Facilities	The permanent land- and marine-based Plaquemines Expansion natural gas liquefaction, storage, and export facilities
F&G	Fire and Gas System
FAA	Federal Aviation Administration
FERC	Federal Energy Regulatory Commission
FSP	facility security plan
H <sub>2</sub> S	hydrogen sulfide
HAZID	Hazard Identification and Analysis
HC	hydrocarbon condensate
LDEQ	Louisiana Department of Environmental Quality
LNG	liquefied natural gas
LOI	Letter of Intent
MOU	Memorandum of Understanding
MTPA	million tonnes per annum
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NGA	Natural Gas Act
NVIC	Navigation and Vessel Inspection Circular
°F	degrees Fahrenheit
OSHA	Occupational Safety and Health Administration
PHMSA	Pipeline and Hazardous Materials Safety Administration
Pilots	Crescent River Port Pilots
PIT	Piping Inventory Table
Plaquemines Expansion	Plaquemines Expansion, LLC
Plaquemines LNG	Venture Global Plaquemines LNG, LLC
PPE	personal protective equipment
Project	Plaquemines Expansion Project
PSM	Process Safety Management
RP	Recommended Practice

SIS	Safety Instrumented Systems
USACE	U.S. Army Corps of Engineers
U.S.C.	U.S. Code
USCG	U.S. Coast Guard
WSA	Waterway Suitability Assessment

# PLAQUEMINES EXPANSION, LLC AND VENTURE GLOBAL PLAQUEMINES LNG, LLC

## PLAQUEMINES EXPANSION PROJECT

### 11.0 RESOURCE REPORT 11 – RELIABILITY AND SAFETY

Resource Reports 1 through 13 collectively make up the Environmental Report to be submitted to the Federal Energy Regulatory Commission (“FERC” or “Commission”) as part of the application (the “Application”) of Plaquemines Expansion, LLC (“Plaquemines Expansion”) and Venture Global Plaquemines LNG, LLC (“Plaquemines LNG”), together referred to as the “Applicants” and both wholly owned subsidiaries of Venture Global LNG, Inc. (“Venture Global”), for the proposed expansion (“Project”) of the Plaquemines LNG Terminal that is under construction and commissioning in Plaquemines Parish, Louisiana. The Project will involve permanent land- and marine-based natural gas liquefaction and export facilities (“Expansion Facilities”). The Application is being submitted pursuant to section 3 of the Natural Gas Act (“NGA”), and the Environmental Report is being submitted in accordance with Title 18 of the Code of Federal Regulations (“CFR”) Section 380.12.

On September 30, 2019, the Commission authorized Plaquemines LNG to site, construct and operate a new liquefied natural gas (“LNG”) export terminal and associated facilities along the Mississippi River in Plaquemines Parish, Louisiana.<sup>1</sup> The Authorized Facilities at the Plaquemines LNG export terminal include: (a) one (1) natural gas gate station; (b) six (6) pretreatment facilities; (c) eighteen (18) liquefaction blocks; (d) four (4) full containment above ground LNG storage tanks; (e) two (2) boil-off, flash, and gas relief systems; (f) three (3) LNG loading berths; (g) two (2) 710 megawatt electric power generation plants; (h) safety and security systems; and (i) other appurtenant facilities. The Authorized Facilities are under construction and commissioning, and Plaquemines LNG has commenced the export of commissioning cargos.<sup>2</sup>

As part of this Project, Plaquemines Expansion proposes to build, own, and operate new liquefaction facilities capable of producing an average annual capacity of 27.5 million metric tonnes per annum (“MTPA”) with a peak capacity of up to 31 MTPA of LNG and other facilities detailed below. The Project will be situated on an approximately 587-acre permanent site immediately adjacent to the approximately 632-acre site on which the Authorized Facilities are located. The Applicants provide more detailed information about the Project in Resource Report 1.

Resource Report 11 provides a description and supporting information regarding the reliability and safety of the proposed facilities. This report describes the design, construction, operation, and maintenance measures designed to maximize project reliability and minimize

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<sup>1</sup> *Venture Global Plaquemines LNG, LLC and Venture Global Gator Express, LLC*, 168 FERC ¶ 61,204 (2019) (“2019 Order”). The LNG terminal facilities authorized by the 2019 Order are collectively referred to herein as “Authorized Facilities.” The 2019 Order also authorized Venture Global Gator Express, LLC to construct and operate a new natural gas pipeline system within Plaquemines Parish. The Commission recently authorized the increase in the maximum liquefaction capacity of the Authorized Facilities without any new facilities, construction activities, or facility modifications. *Venture Global Plaquemines LNG, LLC*, 190 FERC ¶ 61,113 (2025).

<sup>2</sup> The Commission approved Plaquemines LNG’s request to load its first LNG export cargo on December 20, 2024. Accession No. 20241220-3027, Delegated Order issued in Docket No. CP17-66-000. Plaquemines LNG files both monthly construction reports and weekly commissioning reports with the Commission in that docket.

potential hazards to the public from intentional acts or failure of project components because of accidents or natural catastrophes. This report includes a summary of potential hazards, measures to protect the public, design features of the facilities as they relate to reliability and safety, procedures for operations and training, and coordination with local fire, police and medical resources. Resource Report 11 complements and is closely tied to Resource Report 13, which provides specific technical details on engineering, design, and materials.

Natural gas pipelines, LNG terminals, and associated infrastructure serve a critical gas supply function requiring a high level of security and reliability. These facilities must be designed to minimize hazards beyond the Project limits that could represent a risk to the public. Both safety and reliability are demonstrated through prudent design, appropriate equipment selection, careful construction, and competent operation and security protocols. Both safety and reliability of operation can be evaluated using the following traditional concepts:

- A hazard is any activity, procedure, plant, process, substance, situation or any other circumstance that could cause, or contribute to causing, a major incident;
- Risk is the sum of the mathematical product of the probability of incidents and the magnitude of the consequences of an incident; and
- Unreliability is the sum of the mathematical product of the probability of malfunctions and the impact on system performance due to such malfunctions.

The Applicants' approach for the Project is to minimize the probability and effects of safety incidents and malfunctions. This approach will be implemented throughout Project design, construction, and operation. The initial step in this process is to recognize potential hazards and malfunctions. This step has been undertaken in the preliminary design of the Project, as described in detail in this Resource Report 11.

The Project facilities have been designed, and will be constructed, operated, and maintained, in accordance with all applicable laws, regulations, codes, standards, and generally recognized practices applicable to the LNG, natural gas processing, and pipeline industries. Complete listings of applicable requirements for the Project facilities are provided in Resource Report 13.

## **11.1 REGULATORY OVERSIGHT**

### **11.1.1 Regulatory Oversight of Reliability and Safety**

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

FERC has the authority to approve the siting and construction of LNG import and export facilities under section 3 of the NGA. FERC is the lead federal agency tasked with ensuring the federal review of a proposed LNG import or export facility complies with the National Environmental Policy Act ("NEPA"). FERC requires applicants to submit information necessary to perform safety and reliability engineering reviews for LNG facilities. FERC's regulations require each applicant to identify how its proposed design complies with the U.S. Department of Transportation's ("DOT") Pipeline and Hazardous Materials Safety Administration's ("PHMSA") minimum federal safety standards for LNG facilities, as codified in 49 CFR Part 193. The Pipeline

Safety Act, 49 U.S. Code (“U.S.C.”) § 60104(d)(2), provides that a certification of 49 CFR 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.

#### **11.1.1.1 The U.S. Department of Transportation’s Pipeline and Hazardous Materials Safety Administration**

PHMSA assists FERC staff by evaluating whether an applicant’s proposed siting meets the requirements of 49 CFR Part 193. If an LNG facility is constructed and becomes operational, the facility is then subject to PHMSA’s inspection program. A final determination of whether a facility complies with the requirements of 49 CFR Part 193 is made by PHMSA staff.

PHMSA has established federal safety regulations for siting, design, construction, operation, and maintenance of LNG facilities, as detailed in 49 CFR Part 193. Many of these regulations are based on the provisions in the National Fire Protection Association (“NFPA”) 59A (2001 Edition), “Standard for the Production, Storage, and Handling of Liquefied Natural Gas,” (“NFPA 59A”), which is a consensus-based industry standard that has been incorporated into PHMSA’s regulations by reference.

The Project does not include any new LNG storage tanks. Instead, the Project will interconnect with the Authorized Facilities and share the use of Plaquemines LNG’s previously authorized and constructed LNG storage tanks and other appurtenant facilities. Therefore, provisions of 49 CFR Part 193 and incorporated standards such as the 2006 edition of NFPA 59A, applicable to the design and construction of LNG storage tanks, do not apply to any new facilities proposed in this Application. The regulations in 49 CFR Part 193 prevail in the event a conflict arises with the incorporated provisions in NFPA 59A.

On August 14, 2018, FERC and PHMSA entered an updated Memorandum of Understanding (“MOU”) to improve coordination throughout the LNG permit application process for FERC-jurisdictional LNG facilities. FERC is the lead federal agency tasked with ensuring the federal review of a proposed LNG import or export facility complies with NEPA. PHMSA is responsible for ensuring compliance with 49 CFR Part 193. As a means of coordination between the agencies, PHMSA issues a Letter of Determination (“LOD”) representing PHMSA’s determination that the proposed LNG facility will comply with the requirements of 49 CFR Part 193, Subpart B - Siting Requirements.

#### **11.1.1.2 U.S. Coast Guard**

The U.S. Coast Guard (“USCG”) has authority over the safety of an LNG facility’s marine transfer area (“MTA”) and LNG marine traffic, as well as authority over security plans for the entire LNG facility and LNG marine traffic. The USCG regulations applicable to LNG facilities are codified in 33 CFR Parts 105 and 127. The USCG is a cooperating agency in the FERC-led permitting process for LNG terminal facilities. As defined in 33 CFR § 127.007 and 18 CFR § 157.21, the USCG requires LNG terminal applicants to submit a Letter of Intent (“LOI”), Preliminary Waterway Suitability Assessment (“WSA”) and a Follow-on WSA to the USCG Captain of the Port (“COTP”). The WSA is USCG’s review of the marine traffic on the waterway associated with an LNG facility and addresses the suitability of the waterway for LNG carrier

marine traffic associated with the facility. The USCG regulations require that full consideration be given to safety and security of the port, the waterway, the vessels transporting LNG, and the LNG carrier at berth.

In February 2004, the USCG, DOT, and FERC entered into an Interagency Agreement to ensure greater coordination among these three agencies in addressing the full range of safety and security issues at LNG terminals, including terminal facilities and tanker operations, and maximizing the exchange of information related to the safety and security aspects of the LNG facilities and related marine operations. Under the Interagency Agreement, FERC is the lead federal agency responsible for the preparation of the analysis required under NEPA for impacts associated with LNG facility construction and operation. The DOT and USCG participate as cooperating agencies but remain responsible for enforcing their regulations covering LNG facility design, construction, and operation.

#### **11.1.1.3 U.S. Environmental Protection Agency**

Under the Clean Water Act (“CWA”), Congress authorized state environmental agencies to issue water quality certifications (section 401 of the Clean Water Act [“CWA”]); in Louisiana, water quality certifications are issued by the Louisiana Department of Environmental Quality (“LDEQ”). The U.S. Environmental Protection Agency (“EPA”) oversees the LDEQ’s issuance of a National Pollutant Discharge Elimination System permit for the point-source discharge of used water into waterbodies (section 402 of the CWA). As discussed in Resource Report 1, storm water associated with the Project will be discharged to the drainage ditch located on the south side of the Authorized Facilities. The EPA shares responsibility for administering and enforcing section 404 of the CWA with the U.S. Army Corps of Engineers (“USACE”) and has authority to veto USACE permit decisions.

The EPA has jurisdictional authority under the Clean Air Act of 1970 (42 U.S.C. § 85) to control air pollution by developing and enforcing rules and regulations for all entities that emit pollutants into the air. Under this authority, the EPA has adopted regulations for major sources of air pollution and source categories and has established general conformity applicability thresholds. The EPA has delegated the following jurisdictional authority under the Clean Air Act of 1970 to the LDEQ for sources located in Louisiana, unless the source would be located within Native American lands:

- Title 1, Part A, Section 111 – New Source Performance Standards;
- Title 1, Part A, Section 112 – National Emission Standards for Hazardous Air Pollutants; and
- Title I, Part C – Prevention of Significant Deterioration.

#### **11.1.1.4 U.S. Occupational Safety and Health Administration**

The Project is not under the jurisdiction of the Occupational Safety and Health Administration’s (“OSHA”) Process Safety Management (“PSM”) program.

#### **11.1.1.5 U.S. Department of Transportation Federal Aviation Administration**

The DOT's Federal Aviation Administration ("FAA") is the federal agency responsible for civil aerospace travel, including regulation and development of civil aviation, air traffic control, and regulation of U.S. commercial space transportation.

The Air Safety and Reliability Impact Study, included in Appendix 13.G.6 of Resource Report 13, lists and characterizes the nearby airports.

Due to the height of facilities associated with the Project, the Applicants will provide a Notice of Proposed Construction or Alteration of Objects that may affect the Navigable Airspace and ensure that marking and lighting of all elevated structures follows FAA standards in accordance with 14 CFR Part 77.

The Applicants will install a helipad within Expansion Facilities. The Applicants will file a determination request with the FAA for the proposed helipad location, and the helipad design will be in accordance with applicable FAA regulations and guidance. The FAA determination will address potential airspace impacts and confirm that the helipad design meets relevant safety requirements.

The Applicants do 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 the Expansion Facilities' construction or operation or by transportation to or from the Expansion Facilities.

#### **11.1.1.6 U.S. Department of Defense**

The Energy Policy Act of 2005 amended Section 3 of the NGA to require FERC to consult with the Department of Defense ("DOD") Siting Clearinghouse to determine whether there would be any impacts associated with the Project on military training or activities on any military installations.

The closest military installation to the Project is the Naval Air Station Joint Reserve Base in New Orleans, which is approximately 18 miles northwest of the proposed Expansion Facilities. Therefore, no military installations will be impacted by the Expansion Facilities' construction or operation or by transportation to or from the Expansion Facilities.

#### **11.1.1.7 U.S. Nuclear Regulatory Commission**

The closest nuclear power plant is the Waterford 3 Steam Electric Station, which is approximately 45 miles northwest of the proposed Expansion Facilities. Therefore, no nuclear plants will be impacted by the Expansion Facilities' construction or operation or by transportation to or from the Expansion Facilities.

### **11.1.1.8 State and Local Agencies**

The Applicants are consulting with state and local agencies on various topics related to the Project. Results of those ongoing consultations and discussions are presented in Resource Report 1.

## **11.2 HAZARD IDENTIFICATION**

### **11.2.1 Hazardous Materials**

#### **11.2.1.1 Liquefied Natural Gas**

LNG is natural gas in its liquid state, which occurs when the gas has been cooled to 260 degrees Fahrenheit (“°F”) below zero. Similar to natural gas in its vapor state, LNG is odorless, colorless, non-corrosive, and non-toxic. LNG has a density of approximately 26.5 pounds per cubic foot and is neither flammable nor explosive. LNG vaporizes on contact with any surface that is at a temperature greater than the LNG itself. Vapor resulting from the vaporization of LNG has a specific gravity of 1.5 and will initially behave as a liquid such that it will seek the lowest point (i.e., settle close to the ground) near the LNG vaporization source (i.e., a 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. Cold vapor quickly becomes buoyant as it contacts the surrounding air and the water vapor in the air becomes lighter than air at approximately -100 °F.

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 and low storage temperature of the LNG. The principal hazards associated with LNG result from its cryogenic temperature (-260 °F), the flammability of natural gas vapors, the dispersion characteristics of the natural gas vapors, and the potential loss of containment during catastrophic events.

Due to its cryogenic temperature, LNG spills, if touched by human skin, could result in frostbite and injuries to operations personnel. In addition, brittle fracture and structural damage could occur if LNG spills were to contact materials incompatible with cryogenic temperatures.

Unlike heavier hydrocarbons such as propane, natural gas and LNG do not have the potential for the explosion of unconfined vapor clouds. However, while LNG in its liquid state is not flammable, LNG vapors resulting from a release or spill are flammable at air-to-gas concentrations of 5-15 percent. Initial vaporization following a release of LNG produces a flow of rich concentration vapor. As the cloud spreads, it mixes with air and begins to warm and dilute. A relatively narrow region near the outer edges of the cloud will have flammable air-to-gas concentrations between approximately 5 to 15 percent; beyond this region, an unconfined cloud is non-flammable. The distance 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, and atmospheric temperature and humidity. Although LNG is not toxic, LNG vapors at high concentrations can displace oxygen, resulting in oxygen levels that are too low for safe human exposure. Thus, if a person were to enter a high concentration area resulting from an LNG spill,

asphyxiation could occur. These high concentration areas would be limited to the Expansion Facilities.

Table 11.2.1-1 summarizes the properties of methane considered for the Project.

TABLE 11.2.1-1				
Plaquemines Expansion Project Properties of Methane				
Property	Value			Notes
Melting temperature	-305.7 °F <sup>a</sup>			
Boiling temperature	-258 °F <sup>a</sup>			
Flash point	-155.2 °F <sup>a</sup>			Closed cup
Lower flammability limit	5.0% <sup>a</sup>			In air by % volume
Upper flammability limit	15.0% <sup>a</sup>			In air by % volume
Auto-ignition temperature	548.6 °F <sup>a</sup>			
Heat of combustion	-50.0 MJ/kg <sup>a</sup>			
Property	Min	Normal	Max	Notes
Storage Volume	N/A	N/A	N/A	N/A – no storage as part of this project
Operating temperatures in process	-259 °F	--	155 °F	Includes LNG and natural gas
Operating temperatures in storage	N/A	N/A	N/A	N/A – no storage as part of this project
Operating pressures in process	--	--	1250 psig	LNG
	0.5 psig	--	1218 psig	Natural gas
Operating pressures in storage	N/A	N/A	N/A	N/A – no storage as part of this project
Operating densities in process	2.0 lb/ft <sup>3</sup>	3.6 lb/ft <sup>3</sup>	4.0 lb/ft <sup>3</sup>	Natural Gas
	N/A	N/A	N/A	N/A – no storage as part of this project
Operating densities in storage	N/A	N/A	N/A	N/A – no storage as part of this project
Property	Details			
Asphyxiant and toxic properties	Simple Asphyxiant, non-toxic <sup>b</sup>			
Maximum concentration of toxic component in process	N/A			
Asphyxiation concentration	Below 18% oxygen <sup>a</sup>			
Corrosion rate of skin	N/A			
Corrosion rate of metal surfaces	N/A			
<sup>a</sup>	Safety Data Sheet, Airgas Methane. Issue date 05/08/2025.			
<sup>b</sup>	National Center for Biotechnology Information, 2025a			

### 11.2.1.2 Refrigerant

Propane, ethylene, and isopentane will be used as refrigerants and will be imported and stored in vessels prior to use in the liquefaction trains of the Project. Nitrogen will be used as a refrigerant and will be produced by the High Purity Nitrogen system as part of the Project. Methane will be added to the refrigerant mixture and taken from the boil off gas system. All individual components will be combined upstream of the 1st Stage Suction Scrubber. Tables 11.2.1-2 through 11.2.1-5 summarize the refrigerant properties considered for the Project. Information listed as “TBD” will be developed during detailed design.

TABLE 11.2.1-2

**Plaquemines Expansion Project  
Properties of Propane**

Property	Value			Notes
Melting temperature	-305.7 °F <sup>a</sup>			At normal pressure (14.7 psia)
Boiling temperature	-258.7 °F <sup>a</sup>			At normal pressure (14.7 psia)
Flash point	-155.2 °F <sup>a</sup>			Closed cup
Lower flammability limit	1.8% <sup>a</sup>			In air by % volume
Upper flammability limit	8.4% <sup>a</sup>			In air by % volume
Auto-ignition temperature	842 °F <sup>a</sup>			
Heat of combustion	46.0 MJ/kg <sup>a</sup>			
Property	Min	Normal	Max	Notes
Storage Volume	TBD	Varies	TBD	
Operating temperatures in process	TBD	Varies	TBD	
Operating temperatures in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Operating pressures in process	TBD	Varies	TBD	
Operating pressures in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Operating densities in process	TBD	Varies	TBD	
Operating densities in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Property	Details			
Asphyxiant and toxic properties	Simple Asphyxiant, non-toxic <sup>b</sup>			
Maximum concentration of toxic component in process	N/A			
Asphyxiation concentration	Below 6% oxygen <sup>b</sup>			
Corrosion rate of skin	N/A			
Corrosion rate of metal surfaces	N/A			
<sup>a</sup> Safety Data Sheet, Airgas Propane. Issue date 04/14/2025.				
<sup>b</sup> National Center for Biotechnology Information, 2025b				

TABLE 11.2.1-3

**Plaquemines Expansion Project  
Properties of Ethylene**

Property	Value			Notes
Melting temperature	-272.5 °F <sup>a</sup>			At normal pressure (14.7 psia)
Boiling temperature	-154.8 °F <sup>a</sup>			At normal pressure (14.7 psia)
Flash point	-212.5 °F <sup>a</sup>			Closed cup
Lower flammability limit	2.7% <sup>a</sup>			In air by % volume
Upper flammability limit	36% <sup>a</sup>			In air by % volume
Auto-ignition temperature	842 °F <sup>a</sup>			
Heat of combustion	47.2 MJ/kg <sup>a</sup>			
Property	Min	Normal	Max	Notes
Storage Volume	TBD	Varies	TBD	
Operating temperatures in process	TBD	Varies	TBD	
Operating temperatures in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Operating pressures in process	TBD	Varies	TBD	
Operating pressures in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Operating densities in process	TBD	Varies	TBD	
Operating densities in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Property	Details			
Asphyxiant and toxic properties	Simple Asphyxiant, non-toxic <sup>b</sup>			
Maximum concentration of toxic component in process	N/A			
Asphyxiation concentration	Below 6% oxygen <sup>b</sup>			
Corrosion rate of skin	N/A			
Corrosion rate of metal surfaces	N/A			
<sup>a</sup> Safety Data Sheet, Airgas Ethylene. Issue date 01/09/2024.				
<sup>b</sup> National Center for Biotechnology Information, 2025c				

TABLE 11.2.1-4				
Plaquemines Expansion Project Properties of Isopentane				
Property	Value			Notes
Melting temperature	-255.6 °F <sup>a</sup>			At normal pressure (14.7 psia)
Boiling temperature	-82 °F <sup>a</sup>			At normal pressure (14.7 psia)
Flash point	-59.8 °F <sup>a</sup>			Closed cup
Lower flammability limit	1.4% <sup>a</sup>			In air by % volume
Upper flammability limit	7.6% <sup>a</sup>			In air by % volume
Auto-ignition temperature	788 °F <sup>a</sup>			
Heat of combustion	44.9 MJ/kg <sup>a</sup>			
Property	Min	Normal	Max	Notes
Storage Volume	TBD	Varies	TBD	
Operating temperatures in process	TBD	Varies	TBD	
Operating temperatures in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Operating pressures in process	TBD	Varies	TBD	
Operating pressures in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Operating densities in process	TBD	Varies	TBD	
Operating densities in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Property	Details			
Asphyxiant and toxic properties	Simple Asphyxiant, non-toxic <sup>b</sup>			
Maximum concentration of toxic component in process	N/A			
Asphyxiation concentration	Below 6% oxygen <sup>b</sup>			
Corrosion rate of skin	N/A			
Corrosion rate of metal surfaces	N/A			
<sup>a</sup> Safety Data Sheet, Airgas Isopentane. Issue date 02/23/2021.				
<sup>b</sup> National Center for Biotechnology Information, 2025d				

TABLE 11.2.1-5				
Plaquemines Expansion Project Properties of Mixed Refrigerant				
Property	Min	Normal	Max	Notes
Operating temperatures in process	--	Varies	--	Vendor Confidential. See Heat & Material Balances
Operating pressures in process	--	Varies	--	Vendor Confidential. See Heat & Material Balances
Operating densities in process	--	Varies	--	Vendor Confidential. See Heat & Material Balances

### 11.2.1.3 Nitrogen

The Expansion Facilities will use nitrogen for refrigerant make-up and utility purposes. Nitrogen is a non-toxic, odorless, colorless, non-corrosive, and nonflammable material. Liquid 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 11.2.1-6 summarizes the properties of nitrogen considered for the Project. Information listed as “TBD” will be developed during detailed design.

TABLE 11.2.1-6				
Plaquemines Expansion Project Properties of Nitrogen				
Property	Value			Notes
Melting temperature	-346 °F <sup>a</sup>			At normal pressure (14.7 psia)
Boiling temperature	-320.8 °F <sup>a</sup>			At normal pressure (14.7 psia)
Flash point	N/A			
Lower flammability limit	N/A			
Upper flammability limit	N/A			
Auto-ignition temperature	N/A			
Heat of combustion	N/A			
Property	Min	Normal	Max	Notes
Storage Volume	TBD	Varies	TBD	
Operating temperatures in process	TBD	Varies	TBD	
Operating temperatures in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Operating pressures in process	TBD	Varies	TBD	
Operating pressures in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Operating densities in process	TBD	Varies	TBD	
Operating densities in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Property	Details			
Asphyxiant and toxic properties	Simple Asphyxiant, non-toxic <sup>b</sup>			
Maximum concentration of toxic component in process	N/A			
Asphyxiation concentration	Below 6% oxygen <sup>b</sup>			
Corrosion rate of skin	N/A			
Corrosion rate of metal surfaces	N/A			
<sup>a</sup>	Safety Data Sheet, Airgas Nitrogen. Issue date 03/28/2025.			
<sup>b</sup>	National Center for Biotechnology Information, 2025e			

#### 11.2.1.4 Hydrocarbon Condensate

Heavy hydrocarbons are present in the feed gas and will be removed during the liquefaction process. Hydrocarbon condensate (“HC”) will be stored on site and trucked out. Similar to natural gas in its vapor state, HC is odorless, colorless, and non-corrosive. HC composition changes as the feed gas composition changes; therefore, its exact density and flammability ranges are variable. HC is flammable and may have the potential for overpressure if ignited in a confined area.

HC will vaporize rapidly on contact with any surface that is at a temperature higher than the HC boiling temperature. HC 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.

HC streams may contain ethane, propane, butane, pentane, hexane, benzene, toluene, and xylene. Of these components, hexane, benzene, toluene, and xylene are toxic; however, the feed gas composition analysis shows they will be present in very small quantities. Table 11.2.1-7 lists the properties of the HC stream. Information listed as “TBD” will be developed during detailed design.

TABLE 11.2.1-7				
Plaquemines Expansion Project Properties of Hydrocarbon Condensate				
Property	Value			Notes
Melting temperature	Varies			
Boiling temperature	Varies			
Flash point	Varies			
Lower flammability limit	Varies			
Upper flammability limit	Varies			
Auto-ignition temperature	Varies			
Heat of combustion	Varies			
Property	Min	Normal	Max	Notes
Storage Volume	TBD	Varies	TBD	
Operating temperatures in process	TBD	Varies	TBD	
Operating temperatures in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Operating pressures in process	TBD	Varies	TBD	
Operating pressures in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Operating densities in process	TBD	Varies	TBD	
Operating densities in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Property	Details			
Asphyxiant and toxic properties	Simple Asphyxiant, non-toxic			
Toxic Properties	Certain components have toxic properties			
Asphyxiation concentration	Below 6% oxygen			
Corrosion rate of skin	N/A			
Corrosion rate of metal surfaces	N/A			

### 11.2.1.5 Acid Gas

Hydrogen sulfide (“H<sub>2</sub>S”) and carbon dioxide (“CO<sub>2</sub>”) will be present in the feed gas and will be removed using the amine-based absorber and regeneration columns. Acid gas from the regeneration column will be sent to the H<sub>2</sub>S scavenger unit. Table 11.2.1-8 summarizes the properties of the acid gas stream.

TABLE 11.2.1-8	
Plaquemines Expansion Project Properties of Acid Gas	
Property	Details
Asphyxiant and toxic properties	Simple Asphyxiant, non-toxic <sup>a</sup>
Toxic properties	Certain components have toxic properties <sup>a</sup>
Asphyxiation concentration	Below 6% oxygen <sup>a</sup>
Corrosion rate of skin	N/A
Corrosion rate of metal surfaces	N/A

<sup>a</sup> National Center for Biotechnology Information, 2025f, National Center for Biotechnology Information, 2025g

### 11.2.1.6 Amine Solution

The acid gas removal unit is designed to treat feed gas containing up to 2 percent mole CO<sub>2</sub> and any remaining traces of H<sub>2</sub>S that remain after the H<sub>2</sub>S removal unit process. After treatment in the acid gas removal unit, the feed gas would contain no more than 50 parts per million by volume CO<sub>2</sub> and no more than 1 part per million by volume H<sub>2</sub>S. Activated methyldiethanolamine technology would be used primarily due to its ability to remove CO<sub>2</sub> to very low levels and, with respect to comparative technologies, fewer corrosion issues, and lower foaming tendencies. Table 11.2.1-9 lists the properties of amine (OASE purple) solution. Information listed as “TBD” will be developed during detailed design.

TABLE 11.2.1-9				
Plaquemines Expansion Project Properties of Amine Solution				
Property	Value			Notes
Melting temperature	< -6 °F <sup>a</sup>			At normal pressure (14.7 psia)
Boiling temperature	>477 °F <sup>a</sup>			At normal pressure (14.7 psia)
Flash point	~ 280 °F <sup>a</sup>			Closed cup
Auto-ignition temperature	536 °F <sup>a</sup>			
Property	Min	Normal	Max	Notes
Operating temperatures in process	TBD	Varies	TBD	
Operating temperatures in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Operating pressures in process	TBD	Varies	TBD	
Operating pressures in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Operating densities in process	TBD	Varies	TBD	
Operating densities in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Property	Details			
Asphyxiant and toxic properties	Skin and respiratory sensitizer <sup>a</sup>			
Asphyxiation concentration	N/A			
Corrosion rate of skin	N/A			
Corrosion rate of metal surfaces	N/A			
<sup>a</sup> Safety Data Sheet, OASE purple, BASF				

### 11.2.1.7 Diesel

Diesel will be used to fuel the emergency power generators. Diesel is a combustible material. Table 11.2.1-10 summarizes the properties of diesel considered for the Project.

TABLE 11.2.1-10		
Plaquemines Expansion Project Properties of Diesel		
Property	Value	Notes
Boiling temperature	540-640 °F <sup>a</sup>	
Flash point	125 °F <sup>a</sup>	
Lower flammability limit	0.4% <sup>b</sup>	
Upper flammability limit	8% <sup>b</sup>	
Auto-ignition temperature	495 °F	
Property	Details	
Asphyxiant and toxic properties	Harmful if swallowed <sup>a</sup>	
Asphyxiation concentration	N/A	
Corrosion rate of skin	Irritant (Category 2) <sup>a, b</sup>	
Corrosion rate of metal surfaces	Non-corrosive	
<sup>a</sup> OSHA Occupational Chemical Database, 2025		
<sup>b</sup> Safety Data Sheet, Valero Diesel Fuels, Issue date 05/23/2014.		

### 11.2.1.8 Hot Oil

A hot oil system will be used to provide heat to the amine reboiler and condensate system. The hot oil, at high temperatures, is considered an environmental health hazard. Table 11.2.1-11 summarizes the properties of the hot oil. Information listed as “TBD” will be developed during detailed design.

TABLE 11.2.1-11				
Plaquemines Expansion Project Properties of Hot Oil				
Property	Value <sup>a</sup>			Notes
Freezing point	-13 °F			
Melting point	Not applicable to liquids			
Boiling point	298 °F			
Flash point	260.1 °F			Martens Closed Cup ASTM D 93 ethylene glycol
Auto-ignition temperature	801 °F			
Property	Min	Normal	Max	Notes
Operating temperatures in process	TBD	Varies	TBD	
Operating temperatures in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Operating pressures in process	TBD	Varies	TBD	
Operating pressures in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Operating densities in process	TBD	Varies	TBD	
Operating densities in storage	TBD	Varies	TBD	Min/Max to be determined by vendor
Property	Details			
Asphyxiant and toxic properties	Toxic <sup>a</sup>			
Asphyxiation concentration	N/A			
Corrosion rate of skin	Brief contact is essentially nonirritating to skin. Prolonged contact may cause slight skin irritation with local redness. Repeated contact may cause skin irritation with local redness. <sup>a</sup>			
Corrosion rate of metal surfaces	N/A			
<sup>a</sup> Safety Data Sheet, DOWTHERM™ RP Heat Transfer Fluid. Issue date 06/24/2025.				

### 11.2.1.9 Mercury

Mercury may be present in very small quantities in the feed gas. Mercury is reactive with aluminum, which will be used as the material of construction for the heat exchangers in the liquefaction system. Therefore, mercury will be removed via mercury removal units during the pretreatment process. Mercury is an environmentally hazardous material.

### 11.2.1.10 Aqueous Ammonia

Aqueous ammonia will be used for reduction of nitrogen dioxide emissions from the burners and turbines through use of a selective catalytic reduction (“SCR”) system. The aqueous ammonia will be a 19% solution in water. Aqueous ammonia vapors are toxic and irritating to humans. Table 11.2.1-12 summarizes the properties of aqueous ammonia considered for the Project.

TABLE 11.2.1-12		
Plaquemines Expansion Project Properties of Aqueous Ammonia		
Property	Details	
Maximum concentration of toxic component in process	19% ammonia, 79% water	
Asphyxiation concentration	AEGL-1 (60 minute) for pure ammonia	30 ppm
	AEGL-1 (60 minute) for pure ammonia	160 ppm
	AEGL-1 (60 minute) for pure ammonia	1,100 ppm
Flash point	Not Applicable	
Auto-ignition temperature	1204 °F (for pure ammonia)	
Corrosivity of skin	Aqua ammonia is a severe irritant of the skin	
Reactivity with water	Does not react, water spray can be used to disperse vapors	
Reactivity with other materials	Stable material. Contact with calcium hypochlorite, bleaches, gold, mercury, and silver may form highly explosive products. Contact with iodine, bromine or chlorine may cause violent spattering.	
<sup>a</sup> Safety Data Sheet, CF Industries Aqua Ammonia 19%. Issue date 06/04/2025.		

## **11.2.2 Process Hazards**

### **11.2.2.1 Hazard Identification and Analysis**

A Hazard Identification and Analysis (“HAZID”) has been performed on the Expansion Facilities engineering design. The objective of a HAZID is to perform a high-level, systematic analysis to identify potential hazards in the early stage of a project’s design that can produce undesirable consequences through the occurrence of an incident, by evaluating the materials, systems, processes, and plant design.

The Expansion Facilities will include a pipe rack system that crosses through portions of the Authorized Facilities and interconnects with the Authorized Facilities of Plaquemines LNG. This pipe rack forms part of the Expansion Project infrastructure and has been included in hazard identification, hazard analysis, and reliability considerations. The HAZID is based on the Expansion Facilities’ plot plan, process flow diagrams, and preliminary heat and material balances, which are included in Appendix 13.E to Resource Report 13. The results of the HAZID are included in Appendix 13.G to 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 during detailed design.

Sections 11.2.2.2 to 11.2.2.10 address the materials evaluated in the HAZID.

### **11.2.2.2 Liquefied Natural Gas**

The principal hazards of LNG result from its cryogenic temperature (e.g., -260 °F), flammability of vapors, potential for 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 considered. 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 for releases, and low storage temperature of LNG.

Vapor resulting from the vaporization of LNG has a specific gravity of approximately 1.4 and will initially behave as a liquid in that it will seek the lowest point near 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 as the LNG temperature rises 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. 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 that 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 sump. 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 blocks will be provided at the impoundment sumps, which also works to decrease the vaporization rate. Firewater monitors located at strategic places around the Expansion Facilities will help control vapor cloud movement.

An exceedance of the volume of the spill containment area could result in LNG spreading to areas not designed for cryogenic temperatures. To mitigate this risk, LNG impoundment sumps have been sized to contain the greatest flow capacity from a single pipe for a duration of ten minutes in the local area, plus piping inventory and pump runout or the largest piece of equipment containing LNG. Low temperature detectors will be installed in the impoundment sumps which will set off an alarm upon low temperature detection and will also inhibit the operation of the storm water removal pumps.

Vapor cloud migration may result in the intrusion of the gas into the air intake of an enclosed building. When methane concentrations are sufficient to reduce oxygen levels below 6 percent, this scenario may present an asphyxiation hazard. While LNG vapors do not pose an overpressure hazard in an unconfined space, if an ingested vapor cloud 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 Project equipment will be located outdoors to prevent the accumulation of gas, and air intakes for fired equipment and building ventilation has been located away from sources of vapor. Process overpressures will be mitigated by having equipment designed in accordance with the 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, if they could pose a threat. These measures will prevent the escalation of events associated with a spill of LNG. If 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 affect nearby equipment or personnel. A flash fire could also occur if there is a delayed ignition of the vapor cloud in an open area. A flash fire can produce a brief, high heat release that could ignite secondary fires or impact nearby equipment or personnel. The spill containment system will channel spills away from process equipment, and the impoundment sumps will be located away from equipment, structures, and buildings. Dry chemical systems will be provided in applicable locations around the Expansion Facilities, which can be used to extinguish LNG fires. In addition, water spray systems will be provided throughout the Expansion Facilities, which can be used to cool adjacent equipment. Fireproofing on applicable equipment and structures are designed to withstand contact with radiant heat and will further reduce risk and prevent cascading failures.

Cascading events, including the failure of critical equipment or structures, may introduce a hazard into the Expansion Facilities. However, the mitigation features presented above minimize the potential for the escalation of such an event. In addition, a Marine Emergency

Manual will be developed during detail design for the marine transfer area of the Expansion Facilities in accordance with USCG requirements prescribed in 33 CFR Part 127.

### **11.2.2.3 Refrigerant**

The principal hazards of the refrigerants result from their cryogenic temperature, flammability of vapors, potential loss of containment and vapor dispersion characteristics. Vapor resulting from the vaporization of a liquid mixed refrigerant or refrigerant component spill has a higher specific gravity than air. Refrigerant vapor will initially behave as a liquid in that it will seek the lowest point near the refrigerant vaporization source (e.g., a release or spill). When warmed, refrigerant vapors become buoyant and will rise and rapidly disperse into the atmosphere. Initial vaporization following a release of liquid refrigerant produces a large flow of vapor for a short period as the refrigerant temperature rises to levels above cryogenic temperatures. 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. Although refrigerant vapor has no odor or color, its low temperature will cause condensation of water vapor in the air, forming a visible white cloud.

Refrigerant presents a low temperature hazard in the event of a liquid refrigerant spill, which could result from failure of connected process lines, flanged joint leaks, and pipe breaks on equipment containing liquid refrigerant. All liquid refrigerant piping for the Expansion Facilities will be designed for cryogenic service and the refrigerant process, along with its associated transfer systems, to minimize the potential for leaks and failures. Equipment that may be in contact with pooled refrigerant 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 to an impoundment basin or sump. Any liquid refrigerant 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 will decrease this vaporization rate. Firewater monitors will be located at strategic places around the Expansion Facilities to help control vapor cloud movement, if necessary.

An exceedance of the volume of the spill containment area could result in liquid refrigerant spreading to areas not designed for cryogenic temperatures. To mitigate this hazard, spill containment impoundment sumps will be 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 or refrigerants, which is larger than any potential spill of refrigerant.

Vapor cloud migration may result in the intrusion of the gas into the air intake of an enclosed building. When refrigerant concentrations are sufficient to reduce oxygen levels below 6 percent, this scenario may present an asphyxiation hazard. While vapors do not pose an overpressure hazard in an unconfined space, if the ingested vapor cloud in a confined space reaches a concentration within the flammability limits and contacts an ignition source, an overpressure could occur. The overpressure event could create a pressure wave that could damage buildings, structures, and process equipment. Most Project equipment will be 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 will prevent the escalation of events associated with a spill of refrigerant.

When a pressurized refrigerant leak occurs, the liquid jet will vaporize and, depending on the operating conditions, a portion of the refrigerant jet could rainout and pool on the ground. The vapor cloud formation associated with a spill of liquid refrigerant 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 affect nearby equipment or personnel. A flash fire could also occur if there is a delayed ignition of the vapor cloud in an open area. A flash fire can produce a brief, high heat release that could ignite secondary fires or impact nearby equipment or personnel. The spill containment system will channel spills away from process equipment, and the impoundment sumps will be located away from equipment, structures, and buildings. Dry chemical systems will be provided in applicable locations around the Expansion Facilities, which can be used to extinguish refrigerant fires. In addition, water spray systems will be available to cool adjacent equipment. Fireproofing on applicable equipment and structures will be designed to withstand contact with radiant heat will further reduce the risk and prevent cascading failures. Low temperature detectors will be installed in the impoundment sumps, which will set off an alarm upon low temperature detection and will also inhibit the operation of the storm water removal pumps.

Cascading events, including the failure of critical equipment or structures, may introduce a hazard to the Expansion Facilities. However, the mitigation features presented herein minimize the potential for the escalation of an event.

#### **11.2.2.4 Nitrogen**

Nitrogen presents a low temperature hazard in the event of a cryogenic nitrogen leak. However, nitrogen has a boiling point of -320 °F, so even if a leak occurs in the liquid phase, it will vaporize rapidly and mix with the surrounding air.

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. Low temperature detectors will be present in the trenches around the nitrogen package to detect any leak and alert personnel.

Cascading events, including the failure of critical nitrogen equipment or structures, may introduce a hazard to the Expansion Facilities. However, the mitigation features presented above will minimize the potential for the escalation of an event.

#### **11.2.2.5 Hydrocarbon Condensates**

Principal hazards associated with HC result from its flammability, potential loss of containment, vapor dispersion characteristics, and potential for overpressures if ignited. A spill containment system will be provided to route spills away from process equipment and to a local impoundment sump. Any HC in the spill containment system may warm due to ambient temperatures and vaporize, producing a vapor cloud above or around the spill containment

system. Firewater monitors located at the impoundment sumps will help control vapor cloud movement. Impoundment sumps will be 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 HC, which exceeds the HC flow rates.

Vapor cloud migration may result in the intrusion of the gas into the air intake of an enclosed building. When HC concentrations are sufficient to reduce oxygen levels below 6 percent, this may present an asphyxiation hazard. HC vapor 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 will be located outdoors to prevent the accumulation of gas, and air intakes for fired equipment and building ventilation will be 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 will prevent the escalation of events associated with a spill of HC.

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 HC 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 affect nearby equipment or personnel. A flash fire could also occur if there is a delayed ignition of the vapor cloud in an open area. A flash fire can produce a brief, high-heat release that could ignite secondary fires or affect nearby equipment or personnel. The spill containment system channels spills away from process equipment, and the impoundment sumps are located away from equipment, structures, and buildings. Foam blocks will be provided in impoundment sumps to decrease the vaporization rate. Dry chemical systems will be provided at appropriate locations around the Project to extinguish HC fires. In addition, water spray systems can be used to cool adjacent equipment. Fireproofing on appropriate equipment and structures will be designed to withstand contact with radiant heat to further reduce risk and prevent cascading failures.

Cascading events, including the failure of critical equipment or structures, introduce a hazard to the Expansion Facilities. However, the mitigation features presented above minimize the potential for the escalation of an event.

#### **11.2.2.6 Acid Gas**

The acid gas stream produced during the regeneration phase of the amine system will be the source of concentrated H<sub>2</sub>S and CO<sub>2</sub> at the Expansion Facilities. Gas detectors will be provided around pretreatment equipment containing concentrations of H<sub>2</sub>S which could present a hazard. Refer to the Hazard Analysis in Appendix 13.H to Resource Report 13 for dispersion modeling performed to ensure that such releases will not pose a hazard to the public.

#### **11.2.2.7 Amine Solution**

The Amine Drain Tank and Amine Storage Tank will be located in a paved curbed area sloped towards a spill trench in the pretreatment area. The trench will gravity drain towards a collection basin. In addition, local spill cleanup kits will be provided at the Expansion Facilities to ensure spills are cleaned appropriately to minimize environmental impacts.

#### **11.2.2.8 Diesel**

Diesel will be used to fuel the emergency power generators. 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 Expansion Facilities will be contained and disposed of properly. These measures will ensure that no hazard is posed to the public.

#### **11.2.2.9 Hot Oil**

A hot oil system is used to provide heat to the feed gas heaters, PTS Hybrid Units, fuel gas heaters, condensate superheaters, condensate vaporizers and PTS AGRU units. The hot oil storage tank will be in a paved curbed area sloped towards a spill trench in the pretreatment area. The equipment in the pretreatment area will have adequate curbing underneath to direct spills to the spill trench in the pretreatment area. The trench will gravity drain towards a collection basin. In the event of a spill, a vacuum truck can be sent to the site, if necessary, to clean up the contained spill. In addition, local spill cleanup kits will be provided at the Expansion Facilities to ensure spills are cleaned appropriately to minimize environmental impacts. These measures will ensure a release will not pose a hazard to the public.

#### **11.2.2.10 Mercury**

Mercury will be removed from the feed gas with mercury removal units, which chemically absorbs the mercury to form mercury sulfide. This stable compound will remain in the guard bed. The guard bed will be disposed of and replaced properly at the end of its life by qualified personnel in accordance with applicable Federal, State, and local regulations. These steps will ensure that the mercury on site does not have potential for a release and does not pose a hazard to the public.

### **11.2.3 Marine Transportation Hazards**

The USCG has jurisdiction under 33 CFR Part 127 for the “marine transfer area” of every waterfront LNG terminal facility. The “marine transfer area” is defined as the part of the facility handling LNG between the vessel, or where the vessel moors, and the last manifold or valve immediately before the receiving tanks. The regulations provide detailed requirements for safety and security design features, operations and emergency planning, operator training, and maintenance.

The Energy Policy Act of 2005<sup>5</sup> also requires an applicant to prepare an ERP in consultation with USCG, as well as state and local agencies, and that such plan be approved by FERC prior to any approval to begin construction of the facilities. The Plaquemines LNG ERP will be expanded to include the Project.

The Plaquemines LNG security assessment will be updated to account for the proposed Plaquemines Expansion marine berth, as required under 33 CFR Part 105, prior to facility startup. In accordance with 33 CFR § 105.410, the owner or operator of an LNG facility shall submit a facility security plan (“FSP”) for review and approval to the COTP 60 days prior to beginning marine transfer operations. An amendment to the Plaquemines LNG FSP will include the Plaquemines Expansion project. Once approved, an FSP is valid for five years. Details related to development of an FSP are provided in 33 CFR Part 105, Subpart D.

A prospective applicant seeking to site, construct, and operate an LNG import or export facility is required by USCG and FERC regulations (33 CFR § 127.007 and 18 CFR § 157.21) to submit a Preliminary WSA, along with the LOI, to the COTP at or before the time the applicant begins the pre-filing period with the FERC.

### **11.2.3.1 Results of the Ship Simulation Studies**

The LNG carrier dock will be located along the Mississippi River on the northern boundary of the Expansion Facilities. The dock within the berthing area will feature a concrete surface loading platform, which will be supported by steel pipes. The platform will support three loading arms and one vapor return arm to allow LNG transfer to berthed carriers. LNG carriers will access the Expansion Facilities from the Gulf of America, formerly known as the Gulf of Mexico, through the existing navigation channel in the Mississippi River.

The size, location, and orientation of the loading berth has been designed to optimize a number of safety criteria, including safe navigable approach and departure conditions, a safe mooring environment, proximity to the channel, and safe distance from the influence of passing vessels. Other influences on the ultimate design of the loading berths include water depth and optimization of the cryogenic piping arrangement. A variety of hazard detection and mitigation systems, as discussed in Resource Report 13, will also be included within the Expansion Facilities.

During construction, the Applicants anticipate that a significant portion of materials, equipment, and modular plant components (including the liquefaction trains) will be brought to the site by barge, which will require several utility docks to allow barge visits during construction.

The LNG carrier dock will include the following:

- One (1) LNG carrier berthing area—featuring:

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<sup>5</sup> Public Law 109-58—Aug. 8, 2005, Energy Policy Act of 2005.

- One (1) jetty
- One (1) loading platform
- One (1) river water intake platform
- One (1) LNG spill collection sump
- Three (3) bow mooring dolphins
- Three (3) stern mooring dolphins
- Four (4) berthing dolphins
- The loading platform will be equipped with:
  - Hydraulic gangway
  - Lighting
  - Cathodic protection
  - LNG trough leading to a separate platform-mounted spill-sump
  - Three (3) LNG loading arms
  - One (1) vapor return arm

The design pumping rate from the existing tanks is roughly 12,000 cubic meters (“m<sup>3</sup>”) per hour. The Applicants anticipate that the marine loading berth will accommodate LNG carriers with a capacity ranging from 120,000 m<sup>3</sup> to 210,000 m<sup>3</sup>.

The Mooring, Berthing, and Passing Ship Analyses report are provided in Appendix 13.G to Resource Report 13.

### **11.2.3.2 Depictions of the Marine Hazard Zones**

USCG Navigation and Vessel Inspection Circular (“NVIC”) 01-11 Enclosure 9 discusses “Zones of Concern.” As stated therein,

The 2004 Sandia Labs Report (SAND2004-6258) identified three concentric, circular “Zones of Concern” for intentional spills from LNG tankers. That report, coupled with a Sandia study conducted in 2007 for larger volume LNG tankers (SAND2008-3153), indicated the hazard zone sizes described below can be used for LNG vessels with a cargo carrying capacity of up to 265,000 m<sup>3</sup>. COTP may find the hazard zone size information and data particularly useful when reviewing an applicant’s Follow-on Waterway Suitability Assessment and in making a recommendation to FERC on the suitability of a waterway to support LNG marine traffic associated with a proposed project.

Enclosure 9 further defines the zones as follows:

Zone 1: This is the area with the most severe consequences around the LNG tanker, where an LNG spill could pose a severe public safety and property hazard and could damage or significantly disrupt critical infrastructure and key assets located within this area. Zone 1 is considered to extend about 500 meters (0.3 mile) for an intentional breach of an LNG tanker. Risk management strategies should address vapor cloud dispersion and fire hazards. The most rigorous deterrent measures should be considered when major critical infrastructure elements, such as population or commercial centers, lie within Zone 1. These measures should include such things as vessel security zones, waterway traffic management, and establishment of positive control over vessels. Coordination among all port security stakeholders is essential. Incident management and emergency response measures should be carefully evaluated to ensure adequate resources (i.e., firefighting, salvage) are available for consequence and risk mitigation.

Zone 2: This is an area with less severe consequences than Zone 1 and is considered to extend from 500 meters (0.3 mile) to 1,600 meters (1 mile) for an intentional breach of an LNG tanker. Risk management strategies should address vapor cloud dispersion and fire hazards. When major critical infrastructure elements occur within Zone 2, risk management strategies that should be considered include incident management and emergency response measures that ensure areas of refuge (enclosed areas, buildings) are available, the development of community warning procedures, and education programs to ensure that communities are aware of precautionary measures.

Zone 3: This is an area with the least likelihood of severe consequences and is considered to extend from 1,600 meters (1 mile) to a conservative maximum of 3,500 meters (2.2 miles) from the LNG tanker, in the unlikely event that 3 cargo tanks were breached and a vapor cloud disperses without an initial ignition. Risk management strategies should address the vapor cloud dispersion hazard. When major critical infrastructure elements occur within Zone 3, risk management strategies that should be considered include incident management and emergency response measures that ensure areas of refuge are available and community education programs should be considered to ensure that people know what to do in the unlikely event of the release of a vapor cloud without initial ignition.

A graphic depiction of the Zones of Concern for the Project is provided in figure 11.2.3.2-1 below.

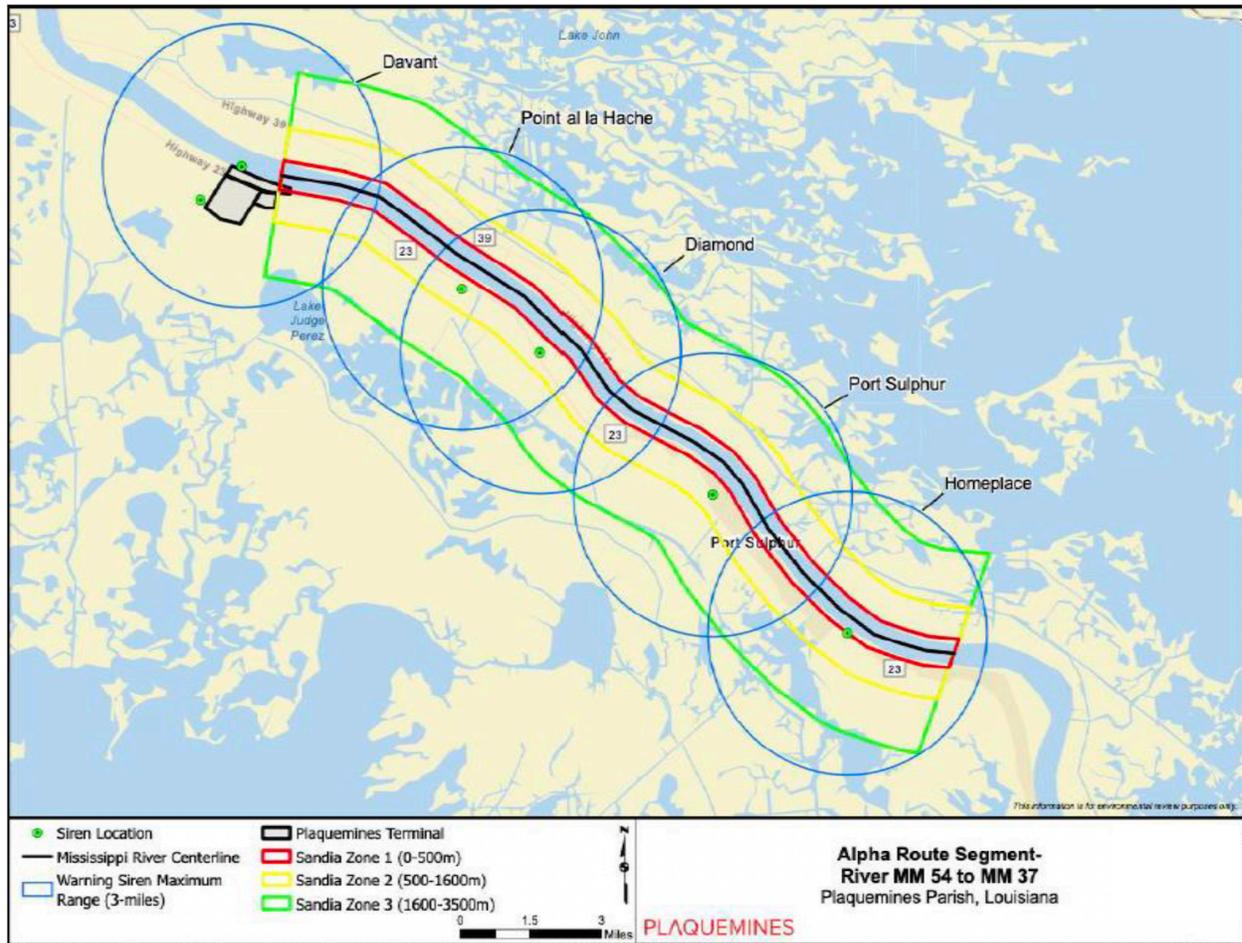


Figure 11.2.3.2-1  
Zones of Concern

### 11.2.3.3 Areas Impacted by the Marine Hazard Zones

The Follow-on WSA is a more detailed version of the Preliminary WSA and identifies credible security threats and safety hazards related to the transportation of LNG from the LNG Carrier's entrance into U.S. territorial waters, LNG Carrier transit to/from the marine berth, and operations at the vessel/facility interface. The results of the WSA provide the local COTP the information necessary to inform the permitting process that the proposed Expansion Facilities and associated facilities are appropriate for the specific waterway. The results of the Follow-on WSA also provide the basis for developing safety and security plans for LNG Carrier transits and Expansion Facilities operations within this waterway.

The WSA process is conducted in accordance with NVIC 01-2011 "Guidance Related to Waterfront LNG Facilities" (NVIC 01-2011; USCG, 2011). This guidance sets forth a systematic and robust process for reviewing safety and security issues specific to the waterway and includes appropriate technical expertise and stakeholder involvement. NVIC 01-2011 calls for the involvement of a cross-section of public officials and industry responsible for the safe transit of

LNG vessels inbound for or outbound from a U.S. port. The COTP may also involve existing ad-hoc committees, such as the Area Maritime Security Committee, which is made up of law enforcement and other port stakeholders, to participate in the process.

The WSA process considers potential infrastructure vulnerabilities and evaluates specific accidental and security threat scenarios, potential consequences of an LNG release, and existing safety systems and security countermeasures, as well as the need for additional risk management measures for the Expansion Facilities. A primary objective of the WSA process is to identify the federal, state, local, and private sector resources needed to carry out the mitigation measures developed during the assessment. The WSA identifies resources currently available and the mechanism by which funding will be provided for additional public resources needed for safe and secure LNG Carrier transit.

The WSA outlines information on the density and character of marine traffic required in 33 CFR § 127.007; it also includes information regarding commercial, military, and recreational vessel use, and marine events and seasonal use.

#### **11.2.3.4 Safeguards and Security Necessary to Mitigate Impacts**

It is the mission of the Crescent River Port Pilots (“Pilots”), per their “Standards of Care,” to safely navigate vessels to and from the ports along the Mississippi River, as authorized by Louisiana Statutes and U.S. federal regulations.

The “Standards of Care” are essentially “best practices” that have been developed over time by the Pilots and are published as a guideline to the shipping industry of the Pilots’ general practices and recommendations for safely handling vessels on the Mississippi River.

Additional safeguards implemented by the Pilots for the handling of large LNG carriers include a minimum number of 4 tugs of sufficient bollard pull (about 50 to 70 tons).

Waterway use and recreation on and along the waterway may be affected by any safety and security zones that may be established by the USCG for the Expansion Facilities and LNG carriers during transit and while berthed. The Expansion Facilities will be a restricted area with access restricted to personnel authorized by the Applicants. The restricted area may include the shoreline within the Expansion Facilities’ property limits along the west bank of the Mississippi River.

Although commercial and recreational vessels may be prohibited from entering Plaquemines Expansion’s fixed safety and security zone (if the USCG at its discretion establishes one), the Mississippi River will remain open to commercial and recreational use, even when an LNG carrier is moored at the marine berth.

#### **11.2.4 Other Transportation Hazards**

A Road Safety and Reliability Impact Study was performed for the Plaquemines LNG facility, which concluded that the location poses manageable risk for roadway impacts. Safety

prevention/mitigation measures and security countermeasures detailed in the study are sufficient, and no significant gaps were identified.

A Rail Safety and Reliability Impact Study was performed for the Plaquemines LNG facility, which concluded there are no safety or reliability impacts from rail activity at or near the site, based on the distance from the site to any external railroad system and the fact that the facility does not use rail transportation.

An Air Safety and Reliability Impact Study was performed for the Plaquemines LNG facility, which concluded that the site location poses a low risk of public impacts from accidental or intentional aircraft incidents. Safety prevention/mitigation measures and security countermeasures detailed in the study are sufficient, and no significant gaps were identified.

The State Highway 23 (SH23) pipe bridge, which transports LNG over the highway to the new loading berth, is exposed to potential accidental and/or intentional damage due to vehicular collision. Therefore, an impact protection system, in compliance with the Louisiana Department of Transportation and Development (LADOTD) regulations, will be installed to protect the bridge support structure. Additionally, trucks carrying flammable materials (i.e., propane and other liquefied petroleum gases) in pressure vessels may transit along SH23 resulting in a potential Boiling Liquid Expanding Vapor Explosion (BLEVE) scenario in the unlikely event of an accident occurring near the bridge. An appropriate analysis of a BLEVE scenario, including a structure blast analysis, will be performed during detailed design to validate the integrity of the bridge crossing as well as the LNG transfer lines within the structure. Details of the impact protection system and the supporting analyses described above will be developed during detailed design.

Further details are included in Resource Report 13, Appendix 13.G.

### **11.2.5 Crane and Lifting Hazards**

During construction, workers may be exposed to crane and lifting hazards due to the potential for objects to be dropped at height. With minor exception, construction would occur within the Expansion Facilities property line and these hazards are not expected to impact the public off the site. However, lifting and placement of the pipe trestle spanning State Highway 23 will occur in a public area, although mitigation measures will be in place to prevent public access into a hazardous area.

During construction, the Engineering, Procurement, and Construction (“EPC”) contractor will develop safety procedures to mitigate hazards associated with crane and object lifting. Typically, these procedures include (1) development of a lifting plan identifying when in the schedule critical lifts would occur, (2) development of safety procedures to be implemented during lifting operations, and (3) establishment of exclusion zones around lifting areas. Lifting operations will also be scheduled with the LADOTD and located in the safest possible areas to minimize impacts to existing ground level equipment and personnel.

Lifting large equipment not only poses a hazard to construction workers but also creates the potential for schedule delays from issues with lifting, which can occur with critical long lead equipment items. Therefore, extreme precaution and planning goes into lifting operations to

ensure that construction is performed safely and reliably. If applicable, all cranes required during the construction phase which exceed 200 feet in height will abide by FAA regulations.

### **11.2.6 Adjacent Hazards**

The Expansion Facilities will be constructed on the western shore of the Mississippi River adjacent to the Plaquemines LNG facility. The Applicants have not identified any other adjacent facilities handling hazardous materials. The closest facilities to the Project that handle hazardous materials are the Elmwood Marine Services and International Marine Terminals, which are both more than one mile from the Expansion Facilities. Given the distance and position of these facilities, they do not pose a hazard to the Project.

### **11.2.7 Natural Hazards**

The Expansion Facilities have been designed to mitigate against natural disasters to ensure the safety of the public, facility staff, and ensure reliable energy supply for customers. Flooding/sea-level rise, hurricanes and storm surge, and seismic events may create situations that threaten the operational safety of the Expansion Facilities, if the Expansion Facilities are not adequately prepared for such events.

Refer to the Storm Surge Analysis in Appendix I.3 of Resource Report 13 for a full and detailed site-specific discussion of hurricanes and other regional weather events. Refer to Appendices 13.I and 13.J in Resource Report 13 for results of the Seismic and Geotechnical investigations. At minimum, natural disaster design considerations will be incorporated into the design to comply with DOT PHMSA requirements prescribed in 49 CFR Part 193 or USCG 33 CFR Part 127 obligations.

### **11.2.8 Security Threats and Vulnerability Assessments**

The security requirements for the onshore components of the Expansion Facilities are governed by 49 CFR Part 193, Subpart J – Security, which incorporates NFPA 59A (2001 Edition). 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.

Additional security requirements are contained in the USCG regulations in 33 CFR Parts 127 and 105, respectively. The USCG is also responsible for the security of shipping in waters of the U.S.

The U.S. Department of Homeland Security's ("DHS") Chemical Facility Anti-Terrorism Standards program identifies and regulates high-risk chemical facilities to ensure they have security measures in place to reduce the risks associated with the chemicals stored at each facility. These requirements are detailed in 6 CFR Part 127.

Security threats and vulnerabilities will be incorporated into the Project's Facility Security Plan as required by, and in accordance with, 33 CFR Parts 127 and 105. Additionally, onshore security requirements described in 49 CFR Part 193, will be incorporated into the Project's Facility Security Plan.

## **11.3 HAZARD ANALYSES**

### **11.3.1 Hazardous Releases**

In accordance with 49 CFR § 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 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 (2001 Edition).

The NFPA 59A (2001 Edition) 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 Part 193, PHMSA has developed criteria detailed in its Frequently Asked Questions webpage to calculate design spill rates associated with such single accidental leakage sources. The resulting design spill rates are then used to calculate exclusion zones for process and transfer areas.

Although not an exclusion zone by code, other hazards, such as acid gas, condensate, and refrigerant potential releases will also be considered and analyzed in a manner similar to the analysis applied to potential releases of LNG.

Refer to Resource Report 13, appendix 13.H for the Hazard Analysis, including a Piping Inventory Table (“PIT”), which will be submitted to PHMSA for review. The Hazard Analysis details the Expansion Facilities’ methodology and selection of design spills.

### **11.3.2 Hot and Cold Fluid Temperature Hazard Analysis**

The materials used at the Expansion Facilities may present hot and cold temperature hazards if unmitigated. These hazards could affect plant personnel and, to a significantly lesser extent, adjacent landowners if left unmitigated. The Project will mitigate hot and cold temperature hazards as further described herein.

The insulation specifications provided in appendix 13.F to Resource Report 13 provides the requirements for insulation thickness of applicable process piping. Insulation provides protection for heat leak from the environment into the piping and provides protection for plant personnel from cold touch hazards. Plant personnel will be provided appropriate Personal Protective Equipment (“PPE”) to mitigate touch hazards further.

Areas where cryogenic spills could occur are provided with curbing, grating, and sloping to channel spills away from equipment and direct spills into impoundment basins or sumps. 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. Spill containment drawings are included in appendix 13.S to Resource Report 13.

Material selection for piping and equipment is based on industry experience, best practices, or as required by regulations, such as 49 CFR Part 193 or 33 CFR Part 127, and the use of recognized accepted materials for cryogenic and high heat service. Material selection is detailed in the piping specification provided in appendix 13.F of Resource Report 13.

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.

Mitigation features, beyond what has been described herein, to reduce cascading impacts include instrumentation and control systems, hazard detection devices, hazard control devices, firewater systems, impoundment systems, and emergency shutdown (“ESD”) systems have been considered. Details regarding these systems are included in Resource Report 13.

### **11.3.3 Asphyxiant and Toxic Vapor Dispersion Hazard Analysis**

Section 2.1.1.d of NFPA 59A (2001 Edition) 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.”

Refer to Resource Report 13, appendix 13.H for the results of the toxic vapor dispersion analysis associated with jetting and flashing releases. Because NFPA 59A (2001 Edition) and 49 CFR Part 193 do not provide recommended thresholds for analyzing toxicity, PHMSA has required applicants to consider toxicity levels based on the Acute Exposure Guideline Levels -1, -2, and -3 maintained by the EPA. Refer to Resource Report 13, appendix 13.H for detailed Specific Acute Exposure Guideline Levels for each component in the Hazard Analysis.

Toxicity modeling is performed on toxic components. Dispersion analysis is also performed on the liquid nitrogen storage to determine the presence of an asphyxiation hazard. The Phast model is used to perform the analysis. Atmospheric conditions used are described in the Hazard Analysis in Resource Report 13, appendix 13.H.

Refer to the Hazard Analysis in Resource Report 13, appendix 13.H for the calculations and resulting toxic dispersion analysis results for the Expansion Facilities.

Mitigation features to reduce cascading impacts include instrumentation and control, hazard detection devices, hazard control devices, firewater systems, impoundment systems, and ESD systems have been considered. Details regarding these systems are included in Resource Report 13.

### **11.3.4 Flammable Vapor Dispersion Hazard Analysis**

In accordance with the requirements of Sections 2.2.3.3 and 2.2.3.4 of NFPA 59A (2001 Edition), 49 CFR § 193.2059 and written interpretations issued by PHMSA in July 2010, provisions have been made within the design of the Expansion Facilities 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 § 193.2059, dispersion distances are calculated for one-half the lower flammable limit of natural gas and flammable hydrocarbon vapors. These distances have been calculated for jetting and flashing releases of a

design spill of LNG, HC, and flammable refrigerants calculated in accordance with Section 2.2.3.5 of NFPA 59A (2001 Edition).

Atmospheric conditions used in the modeling comply with the requirements of 49 CFR Part 193. The Phast model was used to perform the analysis. Atmospheric conditions used are described in the Hazard Analysis in Resource Report 13, appendix 13.H.

Refer to the Hazard Analysis in Resource Report 13, appendix 13.H for the calculations and resulting vapor dispersion exclusion zones for the Expansion Facilities.

Mitigation features to reduce cascading impacts include instrumentation and control, hazard detection devices, hazard control devices, firewater systems, impoundment systems, and ESD systems have been considered. Details regarding these systems are included in Resource Report 13.

### **11.3.5 Vapor Cloud Overpressure Hazard Analysis**

Section 2.1.1.d of NFPA 59A (2001 Edition) 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.”

Refer to the Hazard Analysis, provided in Resource Report 13, appendix 13.H, for vapor cloud overpressure analysis associated with HC and refrigerant releases for the Expansion Facilities. Because NFPA 59A (2001 Edition) and 49 CFR Part 193 do not provide recommended thresholds for analyzing overpressures, PHMSA has required applicants to consider an overpressure value of 1 pound per square inch to determine the potential impacts on the public. Refer to the Hazard Analysis for models, safety factors, atmospheric conditions and results.

Refer to the Hazard Analysis in Resource Report 13, appendix 13.H for the calculations and resulting overpressure analysis for the Expansion Facilities.

Mitigation features to reduce cascading impacts include instrumentation and control, hazard detection devices, hazard control devices, firewater systems, impoundment systems, and ESD systems have been considered. Details regarding these systems are included in Resource Report 13.

### **11.3.6 Fire Hazard Analysis**

#### **11.3.6.1 Pool Fire**

Exclusion zone and hazard distances for various flux levels for flammable hydrocarbon pool fires have been calculated in accordance with 49 CFR § 193.2057 and Section 2.2.3.2 of NFPA 59A (2001 Edition), using the “LNGFIRE III” computer program model developed by the Gas Research Institute. Atmospheric conditions used in the modeling comply with the requirements of 49 CFR Part 193. Atmospheric conditions used were wind speed of up to 29 miles per hour (“mph”), temperature of 37 °F and relative humidity of 27 percent for all wind directions.

Refer to the Hazard Analysis in Resource Report 13, appendix 13.H for the calculations and resulting LNG pool fire analysis for the Expansion Facilities.

Although not exclusion zones, thermal radiation modeling has been performed on other impoundments to determine the hazards associated with pool fires from those impoundments. Refer to the Hazard Analysis in Resource Report 13, appendix 13.H for the calculations and resulting pool fire analysis for the Expansion Facilities. Refer to Resource Report 13 for the thermal radiation results.

Mitigation features to reduce cascading impacts include instrumentation and control, hazard detection devices, hazard control devices, firewater systems, impoundment systems, and ESD systems have been considered. Details regarding these systems are included in Resource Report 13.

#### **11.3.6.2 LNG Jet Fire**

Section 2.2.3.2(a)(1) of NFPA 59A (2001 Edition) states that “provisions shall be made to prevent thermal radiation flux from a fire from exceeding ... 1,600 British thermal units per square foot per hour at a property line that can be built upon for ignition of a design spill....” The Phast v8.22 model is used to perform the analysis. For atmospheric conditions, a wind speed of up to 29 mph, temperature of 37 °F and relative humidity of 27 percent are considered for all wind directions.

Refer to the Hazard Analysis in Resource Report 13, appendix 13.H for the calculations and resulting jet fire results for the Expansion Facilities.

Mitigation features to reduce cascading impacts include instrumentation and control, hazard detection devices, hazard control devices, firewater systems, impoundment systems, and ESD systems have been considered. Details regarding these systems are included in Resource Report 13.

#### **11.3.6.3 Refrigerant Jet Fire**

Section 2.1.1.d of NFPA 59A (2001 Edition) 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.”

Refer to the Hazard Analysis in Resource Report 13, appendix 13.H for details of jet fires associated with condensate and refrigerant releases for the Expansion Facilities. As NFPA 59A (2001 Edition) and 49 CFR Part 193 do not provide recommended thresholds for analyzing jet fires, PHMSA has required applicants to consider thermal flux endpoints of 1,600 British thermal units per square foot per hour to determine the potential impacts on the public. Refer to the Hazard Analysis in Resource Report 13, appendix 13.H for models, safety factors, atmospheric conditions and results.

Refer to the Hazard Analysis in Resource Report 13, appendix 13.H for the calculations and resulting jet fire results for the Expansion Facilities.

Mitigation features to be implemented in the design to reduce cascading impacts include instrumentation and control, hazard detection devices, hazard control devices, firewater systems, impoundment systems, and ESD systems. Details regarding these systems are included in Resource Report 13.

### **11.3.7 Vessel Overpressure Hazard Analysis**

Section 2.1.1.d of NFPA 59A (2001 Edition) 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.”

Mitigation features to be implemented in the design to reduce cascading impacts include instrumentation and control, hazard detection devices, hazard control devices, firewater systems, impoundment systems, and ESD systems. Details regarding these systems are included in Resource Report 13.

In the unlikely event of a pool fire, hazard control systems can be used to put out the pool fire while firewater systems can be used to cool any vessels exposed to heat fluxes. The firewater system design and coverage area drawings are included in appendix 13.S to Resource Report 13, which demonstrates overlapping coverage for all applicable areas.

In the unlikely event of a jet fire, hazard detection systems and instrumentation systems will be able to detect the release. Those devices would send a signal to activate ESD valves in the applicable area or systems, which would stop the flow of fuel to the jet fire. Further, the Project has incorporated passive and active mitigation measures, described herein, as well as Resource Report 13, to put out the jet fire. Further, firewater systems can be used to cool any vessels exposed to heat fluxes. The firewater system design and coverage area drawings are included in appendix 13.S to Resource Report 13, which demonstrates overlapping coverage for all applicable areas.

Based on the layout of the firewater system, hazard detection system, and hazard control system, no vessels associated with the Project would be subjected to sufficient heat fluxes for an extended period, which could, if unmitigated, result in a boiling liquid expanding vapor explosion.

### **11.3.8 Fog or Steam Hazard Analysis**

Section 2.1.1.d of NFPA 59A (2001 Edition) 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.”

Based on the current design, there are not any expected fog or steam hazards.

### **11.3.9 Other Hazard Analysis**

Based on the current design, the Applicants have not identified any other hazard analysis required to demonstrate safety for plant personnel and the public.

### **11.3.10 Hazardous Material Disposal**

Section 2.1.1.d of NFPA 59A (2001 Edition) 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.”

Mercury will be removed from feed gas prior to liquefaction in mercury removal units. The guard bed will absorb the mercury from the feed gas stream and is included in the design as a preventative measure to prevent mercury from impacting the exchangers in the Main Cryogenic Heat Exchanger. Based on the feed gas design parameters, no mercury is expected in the feed gas.

However, if mercury is present and is collected in the closed guard bed, a specialized vendor would be contracted to safely remove the mercury, dispose of the mercury, and replenish the guard bed. Any waste containing mercury will be managed and disposed of in accordance with Federal, State, or local laws and regulations.

The guard bed is a closed bed, which would prevent any accidental release which could impact plant personnel. Plant personnel would be trained to visually inspect the guard bed for abnormal signs to preventatively mitigate the risk of a release.

## **11.4 LAYERS OF PROTECTION**

### **11.4.1 Layers of Protection**

The design of the Expansion Facilities includes multiple layers of protection to reduce the risk of a potentially hazardous scenario developing into a cascading event, which could affect off-site persons and 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).

#### **11.4.1.1 Structural Design of the Facilities and Components**

The structural design of the Expansion Facilities complies with the requirements detailed in 49 CFR Part 193 and NFPA 59A (2001 Edition). In addition to the equipment dead weight loads, the foundations at the Expansion Facilities are designed to meet the dynamic loads associated with wind pressure and ground motion due to seismic hazards that could occur at the Expansion Facilities. The Expansion Facilities will be designed to withstand a sustained wind of 150 mph, which converts to 183 mph at a 3-second gust in accordance with the requirements of 49 CFR § 193.2067.

A listing of the Codes and Standards to which the Expansion Facilities will be designed is included in Appendix 13.D to Resource Report 13. A Regulatory Compliance Matrix is available in Resource Report 13, appendix 13.C. Further details are included in Resource Report 13 appendix 13.I – Natural Hazard Design Investigations and Forces; appendix 13.J – Site Investigation and Conditions, and Foundation Design; appendix 13.F – Specifications and appendix 13.B – Design Basis, Criteria, and Philosophies.

#### **11.4.1.2 Mechanical Design of the Facilities and Components**

The mechanical design of the Expansion Facilities complies with the requirements detailed in 49 CFR Part 193 and, as included by reference, NFPA 59A (2001 Edition), when applicable, as well as 33 CFR Part 127 and, as included by reference, NFPA 59A (2019 Edition), when applicable. The design of the Expansion Facilities includes the use of suitable materials for construction. Material selection for the process components is compatible with the operational and design limits (pressure, temperature, etc.) of the systems. Process piping will be designed in accordance with ASME B31.3. Applicable piping for the power island systems will be designed in accordance with ASME B31.1.

In general, applicable systems that include critical equipment required to support continuous operation of the Expansion Facilities will be designed to include two 100% equipment items for full redundancy.

Additionally, the marine transfer area of the Expansion Facilities will comply with the requirements described in 33 CFR Part 127 and NFPA 59A (2019).

A listing of the Codes and Standards to which the Expansion Facilities will be designed is included in Resource Report 13, appendix 13.D. A Regulatory Compliance Matrix is available in Resource Report 13, appendix 13.C. Further details are included in Resource Report 13, appendix 13.F – Specifications; and appendix 13.B – Design Basis, Criteria, and Philosophies.

#### **11.4.1.3 Operations and Maintenance Plans**

When applicable, the Expansion Facilities will be integrated into the Plaquemines LNG facility's Operations and Maintenance Plans as required by 49 CFR Part 193 and 33 CFR Part 127. Measures such as operating control system tools, procedures, and training address the potential for human error and incorrect operation. Refer to Resource Report 13, appendix 13 for plans and procedures for the Expansion Facilities.

A list of the codes and standards to which the Expansion Facilities will be designed is included in Resource Report 13, appendix 13.D. A Regulatory Compliance Matrix is available in Resource Report 13, Appendix 13.C. Further details are included in Resource Report 13, appendix 13.F – Specifications, and appendix 13.B – Design Basis, Criteria, and Philosophies.

#### **11.4.1.4 Basic Plant Control Systems**

The design of the Expansion Facilities includes state-of-the-art control systems. These control systems include monitoring systems, process alarms, and control and isolation valves that can be monitored in the main control room. The Applicants will develop operating procedures

during detailed design for the Expansion Facilities, similar to the existing operating procedures for the Plaquemines LNG facility. Alarms will have visual and audible notification in the main control room, as well as in the field, in accordance with 49 CFR Part 193, to warn operators that process conditions may be approaching design limits. Operators will have the capability to act from the main control room to mitigate an upset; however, the control systems will be designed so that operator intervention will not be required. As such, the Expansion Facilities will be designed to safely shutdown, and placed in a safe operating state, in the event operator intervention is not realized. As required by 49 CFR Part 193, all operators will undergo extensive training prior to operating the Expansion Facilities.

Alarm and shutdown setpoints, where currently available, are shown on the piping and instrumentation diagrams included in Resource Report 13, appendix 13.E. Cause and effect matrices showing logic are provided in Resource Report 13, appendix 13.Q. 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 detailed design.

A list of the codes and standards to which the Expansion Facilities will be designed is included in Resource Report 13, appendix 13.D. A Regulatory Compliance Matrix is available in Resource Report 13, appendix 13.C. Further details are included in Resource Report 13, appendix 13.P – Process Control and Instrumentation; appendix 13.E – Engineering Design Information; and appendix 13.B – Design Basis, Criteria, and Philosophies.

#### **11.4.1.5 Safety Instrumented Systems**

The design of the Expansion Facilities includes safety-instrumented prevention systems that include safety control valves and ESD systems designed to prevent a release if design limits are exceeded during operation. The exclusive purpose of this system is to bring the Expansion Facilities to a safe state during an unlikely emergency event. The system will be designed in accordance with International Society of Automation 84.01, Application of Safety Instrumented Systems (“SIS”) for the Process Industry. Safety valves and instrumentation will be installed to monitor, alarm, shut down, and isolate equipment and/or piping during process upsets or emergency conditions. During an unlikely emergency event, the inherently fail-safe SIS will appropriately isolate process areas from incoming feed gas, sectionalize and isolate inventories to limit materials in a release event, isolate potential ignition sources, and depressurize equipment handling flammable materials. The main control room will then manually or automatically initiate ESDs or depressurizations. The system power includes a backup un-interruptible power supply system to maintain control operation, in accordance with, and as required by, 49 CFR Part 193, as applicable. Through these features, the SIS will provide protection for equipment, personnel, and the surrounding environment.

A list of the Codes and Standards to which the Expansion Facilities will be designed is included in Resource Report 13, appendix 13.D. A Regulatory Compliance Matrix is available in Resource Report 13, appendix 13.C. Further details are included in Resource Report 13, appendix 13.P – Process Control & Instrumentation; appendix 13.E – Engineering Design Information; and appendix 13.B –Design Basis, Criteria, and Philosophies.

#### **11.4.1.6 Security Systems and Plans**

The USCG and DOT PHMSA have authority over certain aspects of the security plans for the entire Expansion Facilities. A facility security assessment will be prepared during detailed design for the marine transfer area as required by, and in accordance with, 33 CFR Part 105. In addition, a Facility Security Plan (“FSP”) will be prepared as required by, and in accordance with, 33 CFR Part 105. This FSP will be submitted for review and approval to the USCG COTP at a minimum of 60 days prior to commencing operations in the marine transfer area. Once approved, the FSP is revalidated every five years. Additional security requirements for the LNG Facility are provided by 49 CFR Part 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. Security procedures that are active for the Plaquemines LNG facility will be revised to include the Expansion Facilities.

The design of the Expansion Facilities includes state-of-the-art systems to help maintain and operate the Expansion Facilities 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, but are not limited to, the following: perimeter security including inspections and patrols, controlled access points into/out of the Expansion Facilities, 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. Emergency backup lighting will be provided in applicable locations to allow personnel to reach a place of safety in the event of a main power outage.

A list of the Codes and Standards to which the Expansion Facilities will be designed is included in Resource Report 13, appendix 13.D. A Regulatory Compliance Matrix is available in Resource Report 13, appendix 13.C. Further details are included in Resource Report 13, appendix 13.B – Design Basis, Criteria, and Philosophies and appendix 13.E – Engineering Design Information.

#### **11.4.1.7 Physical Protection Devices**

The pressure relief and flare system will be designed to safely and reliably dispose of streams that are released during start-up, shutdown, cool down, plant upsets, and emergency conditions. The design of the Expansion Facilities includes relief valves for process piping that physically protect the piping systems from operating beyond their design limits. The relief valves will be connected to a closed flare system by which any process upset gases will be sent to an elevated flare for disposal. The safety relief valves will be designed to handle process upsets and thermal expansion within piping, per NFPA 59A (2001 Edition) and ASME Section VIII. The flare system will be designed such that the vent and drain systems are segregated from each other, the elevated flare will operate with minimal smoke generation and a highly reliable ignition system, and the thermal radiation will be in accordance with API Recommended Practice (“RP”) 521.

A list of the Codes and Standards to which the LNG Facility will be designed is included in Resource Report 13, appendix 13.D. A Regulatory Compliance Matrix is available in Resource Report 13 appendix, 13.C. Further details are included in Resource Report 13 appendix 13.E – Engineering Design Information; and appendix 13.B – Design Basis, Criteria, and Philosophies.

#### **11.4.1.8 Ignition Controls**

The design of the Expansion Facilities includes ignition controls as specified in 49 CFR Part 193 and NFPA 59A (2001 Edition). The Expansion Facilities will include equipment that is electrically classified in accordance with NFPA 59A (2001 Edition, where applicable, and 2019 Edition for the marine transfer area), NFPA 70, NFPA 497 and API RP 500 to mitigate potential ignition sources. The electrical design of the Expansion Facilities includes grounding of equipment, as necessary. The Expansion Facilities procedures will also include requirements for hot work permits, to be obtained prior to work activities, smoking restrictions at the Expansion Facilities and other measures to minimize potential ignition sources at the Expansion Facilities. The Expansion Facilities have 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 list of the Codes and Standards to which the Expansion Facilities will be designed is included in Resource Report 13, appendix 13.D. A Regulatory Compliance Matrix is available in Resource Report 13, appendix 13.C. Further details are included in Resource Report 13 appendix 13.N – Electrical Design Information and appendix 13.B – Design Basis, Criteria, and Philosophies.

#### **11.4.1.9 Spill Containment System**

The Expansion Facilities spill containment systems have been designed to convey spills away from process equipment into remotely located impoundment basins or sumps. The design of all spill containment systems will meet the requirements of 49 CFR Part 193 and NFPA 59A (2001 Edition), where applicable, as well as 33 CFR Part 127 and NFPA (2019 Edition), where applicable. All spill containment systems will be equipped with detection devices that will activate

an automated alarm alerting the operator in the unlikely event of a spill. All hazardous fluids will be contained within spill containment systems.

A list of the Codes and Standards to which the Expansion Facilities will be designed is included in Appendix D of Resource Report 13. Regulatory Compliance Matrix is available in Resource Report 13, appendix C. Further details are included in Resource Report 13, appendix S – Spill, Toxic, Fire, and Explosion Protection and Calculations; appendix E – Engineering Design Information; appendix I – Natural Hazard Design Investigations and Forces; and appendix B – Design Basis, Criteria, and Philosophies.

#### **11.4.1.10 Passive Protection for Cryogenic Fluids, Overpressures, Projectiles, and Fires**

The design of the Expansion Facilities includes additional passive protection measures that go 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. The spacing of vessels and equipment, separation from ignition sources, and setbacks from property lines were determined in accordance with 49 CFR Part 193 and NFPA 59A (2001 Edition). The design of the Expansion Facilities 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, fireproofing and cryogenic protection will be 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 of LNG splashing will be designed to handle the cold contact without losing its structural integrity or fireproofing ability.

Cryogenic protection will be provided for cold equipment to prevent personnel injury, where necessary.

A list of the codes and standards to which the Expansion Facilities will be designed is included in Resource Report 13, appendix 13.D. A Regulatory Compliance Matrix is available in Resource Report 13, appendix 13.C. Further details are included in Resource Report 13, appendix 13.S – Passive Fire Protection Plans and appendix 13.E – Engineering Design Information.

#### **11.4.1.11 Hazard Detection and Mitigation System**

The Expansion Facilities have been 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 plant personnel. The integrated control and safety system will consist of field instrumentation, field mounted remote I/O panels distributed throughout the facility, control processors located in the main control building, and communication interfaces with the control systems of other specific process licensor units and packaged equipment units. The control system types will consist of a Basic Process Control System, SIS and Fire & Gas System (“F&G”).

The SIS is an independent high integrity system, separate from the basic process control system. It is comprised of dedicated input devices (e.g., sensors, selector switches, and push buttons installed in the field, substations and main control room), logic solvers, and output devices (final elements). The SIS shall be based on a redundant programmable system with fail safe design, having high reliability, high availability, and fault tolerant equipment complete with redundant communication and redundant processor architecture.

The F&G system will be an independent, stand-alone, high integrity system that will continuously monitor and alert facility operating personnel to spills, fires, or flammable gas leaks. The F&G system will be designed to meet or exceed recognized industry standards, such as the performance standards described in NFPA 72. The facility system will be fault-tolerant and self-supervising to alert operating personnel of faulty conditions. Elements of the F&G systems include the following:

- Flammable gas detectors;
- High and low temperature detectors;
- Smoke detectors;
- Flame detectors;
- Pressure switches for confirmation of deluge valves discharge;
- Push buttons for manual operation of deluge valves;
- Smoke and heat detectors (indoors applications); and
- Automatic self-contained extinguishing systems (dry chemical, clean agents, deluge).

The control system will provide the means to monitor and alert operators of hazardous conditions throughout the Expansion Facilities resulting from fire, combustible gas leaks, and LNG spills. The detection of these hazardous conditions by the F&G system will result in local audio and visual (e.g., strobe lights) signals with various alarms and colors depending on the detected hazard. The control 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 Expansion Facilities' equipment in the event of a fire.

An NFPA 59A (2001 Edition) Fire Protection Evaluation has been performed to ensure that the design of the Hazard Detection and Mitigation System for the Expansion Facilities is sufficient and meets the requirements of Section 9.1.2 of NFPA 59A (2001 Edition). This evaluation is included in Resource Report 13, appendix 13.S.

A list of the Codes and Standards to which the Expansion Facilities will be designed is included in Resource Report 13, appendix 13.D. A Regulatory Compliance Matrix is available in Resource Report 13, appendix 13.C. Further details are included in Resource Report 13, appendix 13.E – Engineering Design Information.

#### **11.4.1.12 Hazard Control Equipment**

The Expansion Facilities have been designed with hazard control equipment which will operate to minimize the impact of a hazardous event. Elements of this system include, but are not limited to, the following:

- Dry chemical systems;
- Firewater systems;
- Foam block systems;
- Clean agent systems; and
- CO<sub>2</sub> and ABC extinguishers.

Portable, fixed, and wheeled dry chemical extinguishers are strategically located around the Expansion Facilities in accordance with NFPA 10 and provide a means to extinguish hydrocarbon fires. The Expansion Facilities' design incorporates a firewater system that includes monitors, hydrants, and hoses, which can provide firewater to cool adjacent equipment and minimize impacts from an incident. Foam block systems will be provided in LNG impoundment sumps/basins to reduce the vaporization rate of LNG being contained and provide additional protection by decreasing the rate of vaporization. CO<sub>2</sub> extinguishers will be provided in the main control room, the data rooms, the transformer and motor control center, and other rooms/buildings where electrical hazards are present. ABC fire extinguishers will be provided in the maintenance building, the warehouse, the administration office, the guard house, and other buildings/rooms where non-process fire hazards could be present. The layout and design of the hazard control equipment meets the requirements of 49 CFR Part 193 and NFPA 59A (2001 Edition).

A NFPA 59A (2001 Edition) Fire Protection Evaluation has been performed to ensure that the design of the Hazard Detection and Mitigation System for the Expansion Facilities is sufficient and meets the requirements of Section 9.1.2 of NFPA 59A (2001 Edition). This evaluation is included in Resource Report 13, Appendix 13.S.

A list of the Codes and Standards to which the Expansion Facilities will be designed is included in Resource Report 13, appendix 13.D. A Regulatory Compliance Matrix is available in Resource Report 13, appendix 13.C. Further details are included in Resource Report 13, appendix 13.B – Design Basis, Criteria, and Philosophies; appendix 13.S – Spill, Toxic, Fire, and Explosion Protection; and appendix 13.E – Engineering Design Information.

#### **11.4.1.13 Emergency Response**

An ERP establishes the procedures for responding to specific emergencies that may occur at the Terminal Site and Expansion Facilities as well as procedures for emergency situations that could affect the public along the LNG Carrier transit routes. The Plaquemines LNG facility ERP will be revised to incorporate the Expansion Facilities during detailed design. The ERP revisions will be in accordance with the latest guidance from FERC.

The Applicants will coordinate with local port authorities, fire, police, and public officials regarding the ERP. The Applicants will incorporate comments and suggestions of these local agencies, as appropriate. During implementation of the Project and throughout its operation, the Applicants will maintain liaison and awareness programs with these agencies to exchange information about the resources and responsibilities of each organization that may respond to accidents or natural catastrophes, and to coordinate mutual assistance.

The ERP will include a cost-sharing plan describing any cost reimbursements that the Project agrees to provide to any state and local agencies with the responsibility for security and safety of the Expansion Facilities. The Applicants will review the ERP with community stakeholders and the aforementioned authorities.

The Project 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.

## **11.5 RELIABILITY**

### **11.5.1 Description of Reliability**

The design of the Expansion Facilities includes numerous measures to ensure its overall reliability throughout its design life. The Expansion Facilities will incorporate proven design and technology and be built to the Codes and Standards listed in the Codes and Standards document in Resource Report 13, appendix 13.D.

The Project 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 the Expansion Facilities. This equipment will include, but is not limited to, refrigerant and boil-off gas compressors, pressure vessels, pumps, heat exchangers, valves, piping, and instrumentation. The Applicants will minimize the use of different manufacturers or types of vendor-supplied equipment, where possible, for similar applications to improve the operability and maintainability of the Expansion Facilities and to consolidate and therefore minimize the holding of required spare parts.

The Expansion Facilities will be designed to permit unconstrained operation over the range of ambient conditions referred to in the Design Basis included in Resource Report 13, appendix 13.B. The Expansion Facilities will be designed with suitable weather protection to enable operation and maintenance procedures to be undertaken under all design weather conditions.

### **11.5.1.1 Equipment Redundancies**

The Expansion Facilities will be designed for continuous natural gas liquefaction except in the case of a total power outage or a natural disaster necessitating plant shutdown. Necessary equipment redundancies will be included, such that normal maintenance and inspection can be accomplished while sustaining the design liquefaction and loading rates.

### **11.5.1.2 Sparing Philosophy**

The sparing philosophy for specific equipment and utilities will be developed during the detailed design engineering process.

### **11.5.1.3 Warehouse Philosophy**

Critical equipment and components to be stored in the warehouse will be determined in detailed design. The warehouse philosophy will ensure that the plant will have necessary equipment and components stored to ensure that minimum availability requirements will be met.

### **11.5.1.4 Anticipated Plant Reliability and Availability**

The liquefaction systems that will be installed at the Expansion Facilities will be designed to operate with a worst-case reliability/availability of 93 percent. A Reliability, Availability, and Maintainability Study confirmed that 93 percent availability is achievable with the Project design. In general, systems with critical equipment required to support continuous operation of the Expansion Facilities will be designed to include redundant equipment items.

The plant reliability, availability, and maintainability (RAM) information will be developed during detailed design.

### **11.5.1.5 Contingency Plans**

Contingency plans for failure of or impacts to major plant assets or operations due to accidental or natural disasters will be developed in detailed design.

### **11.5.1.6 Design Life**

The design life of the Expansion Facilities is 30 years. After the initial design life, further life expectancy can be accomplished through a system of operations and maintenance inspections. The facility will follow all operational and maintenance requirements detailed in 49 CFR Part 193 for the PHMSA jurisdictional areas, and 33 CFR Part 127 for USCG jurisdictional areas of the Expansion Facilities.

## 11.6 REFERENCES

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