TERMPOL REVIEW REPORT

ON THE GOLDBORO LNG PROJECT

TP 15412 E
June 16 2020

Transport Canada Transports Canada

Canada

Responsible Authority	Approval
The Director General, Marine Safety and Security is responsible for this document, including any changes, corrections, or updates.	**"Original signed by Julie Gascon"** **Julie Gascon** **Director General** **Marine Safety and Security** **Transport Canada** **Date signed: August 27, 2020**

Cette publication est aussi disponible en français sous le titre [insert French title of publication].

TP No. 15412 E

PDF

Cat. No. T29-153/2019E

ISBN 978-0-660-30738-1

TC-1006307

FOREWORD

The TERMPOL Review Report on the Goldboro LNG Project was prepared by representatives from the following departments and authorities:

Transport Canada:

Marine Safety & Security [1]

Environment and Climate Change Canada:

Environmental Assessment and Marine Programs

Department of Fisheries and Oceans:

Canadian Coast Guard

Canadian Hydrographic Service

Oceans and Coastal Management

Atlantic Pilotage Authority

County of Guysborough

Please note that this TERMPOL Review Report is not a statement of government policy. Do not assume that the government endorses the proposed project in whole or in part. This report reflects the opinions of the TERMPOL Review Committee (TRC) who reviewed the project proposal and prepared the report.[2]

TERMPOL Review Report conclusions and recommendations do not relieve Pieridae Energy Limited, Goldboro LNG Limited and the vessels associated with the project from an obligation to fully follow all current legislative and regulatory requirements, amended from time to time, that apply to shipping safety and to the protection of the environment.

Julie Gascon

Director General
Marine Safety and Security
Transport Canada

---

[1] *The TERMPOL process is limited to a technical review of the safety aspects of terminal systems and transshipment sites. The security aspects are addressed outside of the TERMPOL process through security assessments by Marine Security, a division of TC Marine Safety and Security.*

[2] *TERMPOL Review Process TP 743, 2014* https://www.tc.gc.ca/media/documents/marinesafety/tp743e.pdf

CONTENTS

EXECUTIVE SUMMARY

Pieridae Energy (Canada) Ltd. (Pieridae, the Proponent) wants to develop and operate a Liquefied Natural Gas (LNG) facility for storage and export at a site in Country Harbour, in Guysborough County, near Goldboro, NS.

Pieridae's design for the facility will berth LNG vessels with a cargo capacity of up to 266,000 m^3 [3]. The operation will result in the export of about 9.6 million tonnes per annum (MTPA) of LNG [4], with in a maximum 206 LNG vessels entering Country Harbour every year (7 to 13 shipments per month)[5]. Pieridae does not expect changes to existing shipping routes or expect to have LNG vessels that hold more than 266,000 m^3.

Transport Canada (TC) provides a voluntary, technical review process of marine terminal systems and transshipment sites known as TERMPOL[6]. It measures the navigational risks associated with placing and operating marine terminals for tankers carrying bulk oil, chemicals, liquefied gas and other dangerous cargoes. A TERMPOL Review Committee (TRC) uses the review process to evaluate proposed projects.

In 2014, after obtaining an environmental assessment approval under the province of Nova Scotia's environmental review regime, Pieridae asked TC for a TERMPOL review. The NS approval was subject to meeting conditional requirements which included undergoing a TERMPOL review and implementing all recommendations.

A TRC was set up with members from TC, Fisheries and Oceans Canada (DFO), Environment and Climate Change Canada (ECC), the Atlantic Pilotage Authority (APP) and the County of Guysborough. They determined the scope of the review and asked Pieridae to submit studies that could help demonstrate how it could carry out the marine transportation components of the project safely, taking into account current Canadian laws and regulations, industry best practices, marine programs and services.

In 2016, Pieridae provided a study[7] prepared by Amec Foster Wheeler, as a part of its submission. To help prepare other studies for the submission, Pieridae commissioned HR Wallingford Ltd. to conduct a General Risk Analysis and Ship Manoeuvering Simulations.

On July 26, 2018, Pieridae submitted the Information Report to Satisfy the Requirements of TERMPOL for the Goldboro LNG Export Facility to the TRC[8]. The submission contained the following information:

3.1 Introduction
3.2 Marine Traffic Survey
3.3 Route Analysis, Approach Characteristics and Navigability Survey
3.4 Special Under keel Clearance Survey
3.5 Transit Time and Delay Survey
3.6 Casualty Data Survey
3.7 Vessel Specifications
3.8 Site Plans and Technical Data
3.9 Cargo Transfer and Transshipment Systems
3.10 Channel, Manoeuvring and Anchorage Element.
3.11 Berth Procedures and Provisions
3.13 General Risk Analysis and Intended Methods of Reducing Risk

---

[3] *Pieridae TERMPOL Submission 3.7 – Vessel Specifications – Table 1-1 Terminal Characteristics.*
[4] *Pieridae TERMPOL Submission 3.3 – Route Analysis –1.1 General Project Description.*
[5] *Pieridae TERMPOL Submission 3.2 – Marine Traffic Survey –4.2 Operational Phase.*
[6] *TC publication TERMPOL Review Process, TP 743*
[7] *TERMPOL Review Report Submission 1*
[8] *Pieridae Energy's TERMPOL Submission Cover Letter.*

3.14 Outline of Port Information Book
3.15 Outline of Terminal Operations Manual
3.16 Contingency Planning
3.18 Hazardous and Noxious Substances Considerations

Members of the TRC also participated in the vessel manoeuvring simulations in Howbery Park, Wallingford, United Kingdom. The last report, *Goldboro LNG, Navigation Simulation Study*, was submitted to the TRC on April 2, 2019.

The committee studied Pieridae's proposal from the point of view of their respective mandates, regulatory authorities, responsibilities and expertise.

The committee expects the project to follow all current legal and regulatory requirements that apply to marine safety and protection of the environment. Canada has several regulatory safety measures in place to help make sure large vessels that enter Canadian waters follow both international and Canadian requirements, and do not pose a risk to safety or the environment. Under these requirements, marine terminals, LNG vessels and their operations, including those planned for Pieridae's Goldboro facility, must meet the safety and environmental protection requirements of international agreements and Canada's marine safety regulatory regime while in waters of Canadian jurisdiction.

Canadian and international requirements deal with areas including:

- Safe vessel design and construction, including requirements for safe manning
- Crew qualifications and training
- Working conditions
- Safety management systems
- Radio communications equipment
- Equipment for safe navigation, including electronic chart display and information systems (ECDIS) and automatic identification systems (AIS)
- Voyage planning
- Vessel reporting
- Rules to prevent collisions

LNG carriers will also have to follow Pieridae's vessel acceptance process and terminal procedures.

Although any project can pose some degree of risk, the TRC has not identified any major concerns for Pieridae's LNG carriers, operations, the proposed route, navigability, other waterway users or the marine terminal operations. After reviewing Pieridae's submission, the TRC has made 52 recommendations and proposed actions for Pieridae Energy Ltd. to undertake before the proposed terminal becomes operational. In combination with Pieridae's commitments, they will provide a higher level of safety for LNG vessel operations.

While the TRC does not consider the increase in marine traffic levels to be a safety issue, it supports additional measures that are consistent with the best practices of fully operational LNG terminals, including the LNG facility in Saint John, NB. These include:

- Applying thorough vetting and compatibility criteria before allowing a vessel at the terminal
- Using tugs with the right characteristics to escort the LNG carriers to and from their berths
- Setting limiting environmental criteria for arrivals, departures and cargo transfer
- Updating CHS charts and nautical publications for the area before terminal operations begin
- Having all licensed marine pilots for the area go through simulation or manned model training before terminal operations begin

- Considering safety zones around the LNG carriers and the terminal for an improved level of safety for the vessels, lives and nearby property. This is consistent with best practices at similar, fully operational LNG terminals.

All of the TRC's findings and recommendations are listed in **Appendix 1**.

1.0 INTRODUCTION

1.1 Project background and description

In 2014, after reviewing Pieridae's environmental assessment[9] submitted, Nova Scotia's Minister of the Environment, approved the Goldboro LNG Project, subject to several conditions.

Condition 2.11 of the environmental assessment states:

"Completion of the TERMPOL Review Process in consultation with TC, Marine Safety and Security (MSS), to adequately assess the risks associated with the Goldboro LNG Marine Terminal.

The Approval Holder must implement and adhere to all recommendations of the TERMPOL Review Process unless otherwise approved by NSE."

Pieridae started a TERMPOL Review Process with TC in November 2013 and agreed on the scope and depth of the studies. Pieridae provided the final portion of the submission on April 2, 2019.

On October 31, 2018, the Nova Scotia Utility and Review Board issued a permit to construct a Liquefied Natural Gas (LNG) export facility in Goldboro, Nova Scotia, subject to conditions including providing copies of permits and approvals from other authorities.

Through the Goldboro LNG Project (the Project), Pieridae is proposing to build and operate a facility and marine terminal, for the storage and export of LNG.

LNG is natural gas in its liquid state. It's mostly made of methane, but also includes heavier hydrocarbons and traces of other compounds. When cooled to about -160°C, at atmospheric pressure, natural gas becomes a clear, colourless, and odourless liquid. LNG is cryogenic, non-corrosive and non-toxic. The process to turn LNG into a liquid removes the water, oxygen, carbon dioxide and sulfuric compounds from the natural gas. As a liquid, the volume of natural gas is reduced by 600 times, which makes it easier to transport overseas. After shipping, the LNG is re-heated and turned back into gas[10].

The International Maritime Organization (IMO) classifies LNG as a hazardous and noxious substance (HNS). The IMO defines HNS as any substance other than oil that, if released into the marine environment, would likely harm humans, living resources and marine life or interfere with other use of the sea[11]. TC has applied the definition of LNG as a hazardous and noxious substance in this report.

If the project goes ahead, the Goldboro LNG facility will export up to 10 MTPA of LNG and be able to load vessels between 125,000 m^3 to 266,000 m^3. Goldboro LNG will:

- Receive natural gas by a dedicated pipeline.
- Liquefy the gas.
- Store the LNG on site.
- Load it onto carriers (LNGCs).
- Ship it around the world.

The LNGCs docking at the Goldboro facility will be chartered tankers, owned by independent owners. The LNGC owners will be responsible for making sure the vessels are safe.

---

[9] https://novascotia.ca/nse/ea/goldboro-lng.asp
[10] http://www.nrcan.gc.ca/energy/natural-gas/5679
[11] *IMO HNS Convention and the 2010 Protocol,* http://www.hnsconvention.org/

When operating in waters under Canadian jurisdiction, LNGCs must also follow all regulations. In addition, LNGCs will have to follow Pieridae's own vessel acceptance process and terminal procedures.

The proposed terminal layout, as detailed in the submission, will be made up of a causeway from the shore to two berths. The berths are designed to handle two LNGCs:

- Berth 1 (north) can moor vessels with 125,000 m3 to 266,000 m3 capacity.
- Berth 2 (south) can moor vessels with 125,000 m3 to 220,000 m3 capacity.

You can find the proposed layout in **Section 3.3.1** and **Appendix 4**.

1.2 TERMPOL Review Process

TERMPOL refers to the Technical Review Process of Marine Terminal Systems and Transshipment Sites. TERMPOL guidelines are described in *TERMPOL Review Process,* 2014 Edition (TP 743).[12]

TERMPOL is a voluntary review process for companies (proponents) that want to build and operate marine terminal for bulk handling of oil, chemicals and liquefied gases. The review focuses on the marine transportation parts of a project (i.e. when a vessel enters Canadian waters, navigates through channels, approaches berths at a marine terminal, and loads or unloads bulk oil, gas or chemicals).

The goal of this process is to improve those parts of a proposal that could, in certain circumstances, damage a vessel's hull while navigating or during cargo transfer at the terminal.

A proponent will submit TERMPOL studies set out in the *TERMPOL Review Process,* 2014 Edition, TP 743, to:

- Identify major hazards in the context of the proposed operation.
- Evaluate the risks from these hazards.
- Identify ways to reduce the risks to an acceptable level using the best available technology and practices.

Through the technical review process, a proponent works with a TRC chaired by TC and made up of members from departments and authorities with relevant expertise or responsibilities.

The TRC examines the proposal and considers:

- Studies, surveys and technical data provided in support of TP 743.
- Current and anticipated national and international regulations to make sure vessels are safely operated.
- Current marine transportation activities along the proposed shipping route.

The proponent considers a range of subjects, including:

- Navigational safety of the vessel's route(s)
- Services that help with safe navigation, such as
    - fixed and floating aids
    - vessel traffic services
    - electronic position fixing systems
- Requirements for pilotage, tug escort and radio communications along the route(s)
- If the vessel is well suited to navigating the proposed route(s) and docking at the berth

[12] *TERMPOL Review Process, 2014 Edition (TP 743)*
https://www.tc.gc.ca/media/documents/marinesafety/tp743e.pdf

- Operational safety of the vessel's cargo containment and handling
- Whether the vessel's berth and related terminal service requirements are adequate
- Possible effects of increased shipping on regional shipping networks, including fishing, recreational boating and vessels that don't need to carry an automatic identification system (AIS)
- Pollution concerns related to the additional vessels
- Risks to communities along the route(s)
- Pollution prevention, contingency planning and emergency response

The Committee reviews the TERMPOL submission and provides a report that includes:

- An executive summary, analysis, findings and recommendations
- Reports on specific topics to address any site-specific circumstances

The success of the TERMPOL Review Process depends on the proponent following the procedures in TP 743 and the quality of the data submitted to the TRC. The proponent is responsible for making sure that the studies meet industry and international standards.

The TRC "**recommendations**" are proposed actions to improve safety beyond existing regulations. As such, they relate to areas that the proponent can control. "**Findings**" are observations made to capture, reinforce or comment on key commitments made by the proponent. They are sometimes used to highlight actions underway or to note something related to a particular program or regulation.

The TERMPOL Review Process does not replace the safety, security, and environmental requirements of any Acts or Regulations that are in effect, nor is it a process to approve or reject a project. It should be noted for the purpose of this document that the referred to legislation and regulations may have changed since the implementation of the Goldboro terminal and therefore, it is expected that the proponent adhere to the most updated acts and regulations pertaining to this project.

The TERMPOL process is not a regulatory instrument. No approvals or permits are issued as a result of the TERMPOL review or report. As such, the TERMPOL report should not be interpreted as a statement of government policy or federal government endorsement. Although TERMPOL report findings and recommendations are not binding, a proponent may integrate the suggested improvements into their engineering, planning and design.

The Environmental Assessment[13] approval issued by the Nova Scotia Environment Department (NSE) included several conditions. Condition 2.11 requires the proponent to complete a TERMPOL Review Process to evaluate the project's risks and then carry out any recommendations, unless otherwise approved by NSE.

Notes:

1. Recommendations cannot reduce the regulatory requirements of the *Canada Shipping Act, 2001 (CSA, 2001)* and any other applicable legislation.
2. No approvals or permits are issued as a result of a TERMPOL Review. However, government authorities and other agencies can use the TERMPOL Review Report to identify:
   - Problems and opportunities to improve maritime safety
   - Any impact on marine services and programs

[13] https://novascotia.ca/nse/ea/goldboro-lng.asp

3. The TRC and its relevant departments and organizations are not responsible for enforcing the conditions put in place by the environmental assessment.

1.3 Scope of a TERMPOL review

The scope of a TERMPOL Review Process will vary according to the nature and location of each project.

The proponent, in consultation with the TRC, will select the most appropriate scope for the project to determine the geographic area, studies, surveys, technical data and timelines for the review. The proponent must also keep in mind pre-existing shipping activities and unique circumstances in the area.

Other considerations include:

- Will the terminal handle bulk oil, chemicals, liquefied gases, or other noxious and hazardous cargo?
- Is the project a new or existing terminal?
- Is the project proposed for an area that is not already a well-established shipping route?
- Are the project vessels larger than vessels currently in the area?
- Is this new cargo, not currently shipped out of the area?
- Is the project located outside the limits of a Canada Port Authority?
- Is this the first TERMPOL review for the region? If so, are the operations, vessels or cargo different from the previous review?
- Will the project result in a significant increase in vessel traffic?
- Have the safety risks been properly assessed in the scoping area of the project?

The TERMPOL review is a stand-alone process, separate from any environmental assessment. It does not look at the environmental impacts of a project, including those caused by accidents or malfunctions.

TERMPOL reviews do not determine standards for the terminal's site, design, construction or operation nor do they examine land infrastructures like natural gas receiving and LNG production facilities.

TERMPOL reviews are separate from the requirements under the *Canadian Navigable Waters Act* (CNWA)[14]. Under the CNWA, proponents must apply for an approval if they want to construct, place, alter, repair, rebuild, remove or decommission a major work in, on, over, under, through or across any navigable water. The project must not affect the safety of navigation in that waterway.

In contrast, the TERMPOL review process looks at the marine transportation parts of a project within the context of the existing marine regulations, programs, and services, and considers new measures that could be put in place when the project begins operations.

1.4 Methodology for the Review of the Goldboro LNG Project

Pieridae Energy Ltd (Pieridae) formally requested a TERMPOL Review in a letter to TC on November 4, 2013. After the request was accepted, representatives from Pieridae and the TRC met to decide on the right scope for the surveys and studies.

The TRC members represented:

- TC MSS

[14] *The Navigation Protection Act was renamed to the Canadian Navigable Waters Act. Amendments came into force, June 21, 2019.* https://www.tc.gc.ca/eng/programs-632.html

- DFO Canada: CHS, Oceans and Coastal Management, Canadian Coast Guard (CCG) - Navigational Programs, Incident Management, and Integrated Business Management Services.
- ECC: Environmental Assessment and Marine Programs
- APA
- County of Guysborough

Pieridae prepared its submission according to the *TERMPOL Review Process TP 743, 2014 Edition*[15]. The Technical Review Committee evaluated the documents to identify information gaps and to provide feedback.

As set out in the TERMPOL Review Guidelines, Pieridae submitted the studies, surveys and technical data identified in the *Table 1.3-1* for TRC review and analysis:

Table 1.3-1 List of documents submitted to TRC for review

Number	Title of the TERMPOL Study
3.2	Marine Traffic Survey
3.3	Route Analysis, Approach Characteristics and Navigability Survey
3.4	Special Under keel Clearance Survey
3.5	Transit Time and Delay Survey
3.6	Casualty Data Survey
3.7	Vessel Specifications
3.8	Site Plans and Technical Data
3.9	Cargo Transfer and Transshipment Systems
3.10	Channel, Manoeuvre and Anchorage Elements
3.11	Berth Procedures and Provisions
3.13	General Risk Analysis and Intended Methods of Reducing Risks
3.14	Port Information Book (outline)
3.15	Terminal Operations Manual (outline)
3.16	Contingency Planning
3.18	Hazardous & Noxious Substances Considerations

Pieridae and the TRC agreed to omit two studies that do not apply to the project:

- *3.12 - Single Point Mooring Provisions*
- *3.17 - Oil Handling Facilities Requirements*

Pieridae worked with HR Wallingford Ltd. in Howbery Park, Wallingford, UK, to conduct LNGC ship manoeuvring simulations to:

[15] *It should be noted that the review of this project commenced prior to the 2019 revised TERMPOL Review Process Manual, and therefore, the reference to the 2014 version applies.*

- Validate its terminal design and configuration.
- Validate tug characteristics and composition.
- Test environmental limits for safe operation.
- Evaluate the adequacy of existing aids to navigation.

The simulations were performed in November, 2018 by a team from the APA, TC MSS, Pieridae and HR Wallingford Ltd. More information on the simulation report can be found in Section 3.2.3.2.

The TRC reviewed the draft surveys and studies between July 2018 and May 2019 and provided feedback to Pieridae for amendments/additions to their submission information.

The results of the TRC's review are presented in the Analysis section of this report under the following five sections:

1. *Vessel information*
2. *Route information*
3. *Terminal operations*
4. *Risk assessment and contingency planning*
5. *LNG and oil spill preparedness and response*

The TRC based the analysis and commentary in this report on the information, documentation, and technologies available at the time it was written. There may be a need to re-evaluate some aspects of this analysis if there is a long delay in the start of operations or if Pieridae makes changes to the proposal.

This TERMPOL Review Report recommendations and findings apply specifically to the marine safety elements of Pieridae's proposed Goldboro LNG Project and are intended to reduce risks, using the best available technology and practices.

Please read this report along with the *TERMPOL Review Process*, 2014 Edition (TP 743) and the studies submitted by the proponent. For a copy of the proponent's studies, contact:

Pieridae Energy Ltd
1718 Argyle St, Suite 730
Halifax NS, B3J 3N6
Tel: 902-492-4044
Fax: 902-492-5200
Email: info@pieridae.com
https://pieridaeenergy.com/goldboro-lng

2.0 INDIGENOUS ENGAGEMENT

Several communities and Indigenous organizations may be affected by or have a direct interest in the Goldboro LNG Project. The scoping area is used for traditional activities including hunting, fishing and gathering.

In their proposal, Pieridae detailed their engagement with local Indigenous groups between 2013 and 2018. They've also committed to continue these conversations as the project moves forward and reaches key milestones. Although the *Duty to Consult* was initially triggered by the requirements from Nova Scotia's environmental assessment, parts of the TERMPOL Review also factored into Pieridae's consultation.

As part of the completed environmental assessment, Pieridae has committed to work proactively with Indigenous groups to define and agree to a Collaboration Benefits Agreement, which the proponent claims will aim to ensure the active involvement of First Nations in the development and operation of the project.

During the TERMPOL review process, TC provided regular updates to local Indigenous groups as well as other provincial and federal departments. TC will make Pieridae's *TERMPOL Review Report on the Goldboro LNG Project* available to the public.

TC may hold technical briefings with Indigenous groups and local waterway users to:

- Give them an overview of the TERMPOL report.
- Provide an opportunity for questions and answers.
- Explain how the review committee reached its conclusions.

3.0 ANALYSIS

3.0 Introduction

The TERMPOL Report reflects the TRC's analysis of Pieridae's plans and management of risk. The "safety enhancements" Pieridae has committed to were important parts of the TRC's assessment of the Project's safety. The TRC expects the proponent to manage these risks.

The report includes recommendations and findings that apply to LNG carriers, proposed routes and terminal safety. The TRC encourages the proponent to act on the recommendations included in this report. While the proponent can implement some recommendations, others will involve speaking to various authorities. Pieridae should make sure to give themselves enough lead time in case discussions are needed before acting on some recommendations.

If Pieridae changes any parts of the project, operational parameters, or characteristics, it is important to notify the right authorities to give them enough time for their review.

The Project's LNGCs and their operations must follow all Canadian and International laws that apply, including:

- *The Canada Shipping Act, 2001* (CSA, 2001); which is the main law that governs safety in marine transportation and protects the marine environment from vessel-source pollution in Canada. The *CSA, 2001* applies to all vessels operating in Canadian waters, Canadian vessels worldwide and in some cases, to foreign vessels within the Exclusive Economic Zone.
- The *Atlantic Pilotage Regulations (APR)* under the *Pilotage Act,* which created compulsory pilotage areas along Canada's Atlantic Coast.
- The *Marine Transportation and Security Act (MTSA)* manages marine transportation security and applies to vessels, ports and marine facilities in Canada, Canadian vessels outside of Canada, and marine installations and structures.

Finding 1. The TRC recognizes that Pieridae will have to discuss timelines with all relevant authorities for acting on the recommendations outlined in this report.

Recommendation 1. The TRC recommends that Pieridae notify the relevant authorities if it wishes to alter any parts of the project, operational criteria, or characteristics, so the authorities can review any safety impacts that would result from the changes.

3.1 Vessel information

3.1.1 General

Specialized LNG carriers (LNGC) will transport LNG from the Goldboro terminal to market. According to Pieridae[16], its marine terminal will handle vessels ranging from 125,000 m^3 to 266,000 m^3. The LNGCs will be chartered, foreign-flagged vessels and they must follow all international, flag state and Canadian Acts, Regulations and Conventions that apply to the vessel at the time of inspection. Based on the smallest vessel expected, they will have to meet the full range of requirements with no size-related exemptions.

Canada has incorporated parts of two international agreements, the International Convention for the Safety of Life at Sea (SOLAS) and International Convention for the Prevention of Pollution from Ships (MARPOL) into the *CSA, 2001*, and require vessels to follow them. For example:

- Critical shipboard systems like steering, power and navigation systems must have back-ups available on board so that the failure of one system does not jeopardize the safety of the vessel. (SOLAS, Chapter IV and V).
- SOLAS requires a full set of navigational equipment for safe and accurate navigation.
- All LNGCs must have enough lifesaving equipment made up of lifeboats, life rafts, lifejackets, life rings and distress signals, etc. They must also have a fire plan on board with details of essential firefighting equipment.[17]
- SOLAS requires vessels to have an emergency towing arrangement on board.[18]
- All LNGCs must carry a shipboard oil pollution emergency plan approved by the Administration.[19]
- Air Emissions: Goldboro is located in the North American Emissions Control Area (NA-ECA), which requires that the marine fuel used by vessels within the NA-ECA cannot contain more than 0.1% Sulphur. The 0.1% Sulphur limits came into effect on January 1, 2015.[20]

The construction of a LNGC must comply with the requirements of the Flag State as well as the appropriate instruments of IMO conventions and codes. LNGCs must also comply with the version of the International Code for Construction and Equipment of Ships Carrying Liquid Gases in Bulk (IGC Code) in force at the time of their construction, and the guidelines of classification societies. Guidelines and recommendations are also issued by the Oil Company International Marine Forum (OCIMF) and the Society of International Gas Tanker and Terminal Operators (SIGTTO).

IGC Code includes requirements for the following items and controls:

- Cargo containment construction materials•
- Cargo pressure and temperature control
- Environmental control
- Fire protection and extinguishment
- Personnel protection
- Capacity limits for cargo tanks

---

[16] *Pieridae TERMPOL Review 3.7—Vessel Specifications, chapter 1.2*
[17] *SOLAS, Chapter II-2 and Chapter III*
[18] *SOLAS, Chapter II-1/R 3–4*
[19] *MARPOL Annex 1—Chapter V—Regulation 37*
[20] *Vessel Pollution and Dangerous Chemicals Regulations, Division 6 and MARPOL, Annex 6*

The membrane system uses insulation built directly into the hull of the vessel, along with a membrane covering inside the tanks to maintain their integrity. The ship's hull directly supports the pressure of the LNG cargo. The membrane system uses the entire volume of a ship's hull and is cheaper to build. These vessels have better visibility from the bridge windows than the spherical design and will not be as affected by wind.

Independent, self-supporting tanks, such as the Kvaerner-Moss system, use free-standing, insulated spherical tanks supported at the equator by a continuous cylindrical skirt. The tank and the hull of the vessel are two separate structures. They are not affected by possible damage to vessel's hull. The Kvaerner-Moss design is generally found on smaller LNGCs.

Pieridae submitted data for four sizes of vessel that may call at Goldboro[21]:

Table 3.1.1-1 Design vessel specifications

Vessel Capacity	125,000 m^3	177,000 m^3	216,000 m^3	266,000 m^3
Containment	Spherical	Spherical/ Membrane	Membrane	Membrane
LOA (m)	285.3	300	315	345
LBP (m)	273.4	286.5	302	332
Beam (m)	43.7	52	50	53.8
Moulded Depth (m)	25	28	27	27
Loaded Draft (m)	11.5	11.7	12	12
Ballast Draft (m)	10	9.5	9.4	9.6
Loaded Displacement (mt)	102,804	128,533	146,054	178,564
Ballast Displacement (mt)	82,500	98,887	111,900	141,990
Loaded Longitudinal Wind Area (m2)	6450	9918	7130	8759
Loaded Transverse Wind Area (m2)	783	1943	1510	1612
Ballast Longitudinal Wind Area (m2)	6865	10,478	8000	9552
Ballast Transverse Wind Area (m2)	850	2055	1650	1741

Recommendation 2. The TRC recommends that Pieridae identify all specific Canadian requirements that are not currently part of International Conventions, Codes or standards. Pieridae should emphasize these requirements within the *Port Information Book* for vessels calling at the Goldboro LNG terminal.

3.1.2 Tanker vetting procedures

All foreign tankers calling at a Canadian port are subject to inspections. TC inspects tankers during their first call to a Canadian port, and at least once each year afterwards.

---

[21] *Pieridae TERMPOL Review 3.7—Vessel Specifications, 5—Design vessels*

Inspectors make sure they follow Canadian requirements and relevant international conventions. Canada considers LNGCs as tankers for inspection purposes.

Classification societies (like Lloyd's Register, American Bureau of Shipping, DNV-GL, etc.) have the expertise to inspect, verify and certify that vessels are built, maintained and operated according to recognized rules, regulations and standards.

The Port State Control program is an international regime that allows foreign vessels to be boarded and inspected to make sure that major international maritime conventions are respected[22]. TC uses the program to enforce the *CSA, 2001*, the *Marine Transportation and Security Act* and other international conventions.

The Oil Companies International Marine Forum (OCIMF) provides guidance for a tanker inspection program's content and application under the Ship Inspection Report (SIRE), a voluntary inspection process. Member companies ask for vessel inspections by an accredited SIRE inspector. There is a cascading division of responsibility in SIRE for ensuring compliance with the applicable regulations. The shipper vets the ship owner before nominations. The marine terminal operator will then vet the nominated tankers to make sure they are compatible with the terminal layout, facilities and equipment. Industry members' adherence to the SIRE programme promotes continuous improvement.

OCIMF's Tanker Management Self-Assessment (TMSA) encourages companies to measure their safety management systems against key performance indicators and provides a minimum expectation (level 1) plus three increasing levels of best practice guidance. Self-assessment results can be used to develop improvement plans to support continuous improvement of their vessel management systems. Companies are encouraged to regularly compare their self-assessment results against the TMSA key performance indicators and create plans for improvement. Making sure that their policies and procedures align with industry best practices helps companies improve their performance and reach high standards of safety and pollution prevention.

Since the TMSA is generally accepted by the tanker sector, many Protection and Indemnity Associations (P&I Clubs) and terminals have begun to request the TMSA from other types of vessels. The self-assessment covers the following[23]:

1. *Leadership and the Safety Management System*
2. *Recruitment and Management of Shore-Based Personnel*
3. *Recruitment Management and Wellbeing of Vessel Personnel*
4. *Vessel Reliability and Maintenance including Critical Equipment*
5. *Navigational Safety*
6. *Cargo, Ballast, Tank Cleaning, Bunkering, Mooring and Anchoring Operations*
7. *Management of Change*
8. *Incident Reporting, Investigation and Analysis*
9. *Safety Management*
10. *Environmental and Energy Management*
11. *Emergency Preparedness and Contingency Planning*
12. *Measurement, Analysis and Improvement*
13. *Maritime Security*

---

[22] *Inspection of non-Canadian commercial vessels* https://www.tc.gc.ca/eng/marinesafety/oep-inspection-psc-menu-1120.htm

[23] *Tanker Management Self-Assessment, Loss Prevention Briefing* https://www.ocimf.org/sire/about-tmsa.aspx

The Chemical Distribution Institute—Marine (CDI-M) provides annual inspection reports on the world's fleet of chemical and liquid petroleum gas tankers. In 2018, over 600 ship owners and 5400[24] chemical and gas carriers participated in this effort. There are over 70 CDI-M accredited inspectors that conduct inspections in ports around the world. Vessels that have a CDI-M report on the active database are listed in the European Quality Ship Information System (EQUASIS). Port State Control members participating in EQUASIS have access to the database that lets them get information from ship inspection reports.

Pieridae has stated that it will establish a vetting and approval process that evaluates an LNG carrier's ability to call and load at the Goldboro LNG terminal safely and efficiently. [25] This procedure is divided into two different activities:

- "Compatibility with the Terminal" - checks of the physical aspects of the LNGC against the terminal's requirements.
- "Quality Assurance of the LNGC and LNGC Operator" - assesses the ability of the LNGC to comply with safety and environmental standards.[26]

The vetting procedure would also cover:

- Safety and security at the berth.
- LNG carrier verification prior to berth.
- Details of the cargo and carrier during loading.
- Crew qualifications.
- Terminal safety and operational procedures.

The Society of International Gas Tanker and Terminal Operators (SIGTTO) has developed a Ship-Shore Compatibility Questionnaire to make sure that tankers are appropriately configured for the terminal.[27] Pieridae has stated that all vessels calling at Goldboro will meet all relevant International and Canadian vetting requirements and will have a valid Ship Inspection Report programme (SIRE) certificate.[28]

Finding 2. Tanker vetting, the Ship Inspection Report Programme and Chemical Distribution Institute-Marine processes are generally accepted tools that terminals and LNG companies use to check compliance and improve safety.

Recommendation 3. The TRC recommends that Pieridae introduce and apply vetting standards, ensure all vessels calling at its terminal have an up-to-date Ship Inspection Report Programme certificate (SIRE) and meet the terminal's compatibility criteria. Pieridae should incorporate its vetting standards within the *Port Information Book* .

Recommendation 4. The TRC recommends that Pieridae requires all vessels calling at their marine terminal to follow the Tanker Management Self-Assessment program from the Oil Companies International Marine Forum (OCIMF).

Recommendation 5. The TRC recommends that Pieridae use the Ship-Shore Compatibility Questionnaire as published by the Society of International Gas Tanker and Terminal Operators (SIGTTO) at the pre-fixing stage to see if a vessel can be safely berthed at the terminal.

---

[24] *Chemical Distribution Institute—Year Book 2018, p.22. Published by Chemical Distribution Institute*
[25] *Pieridae TERMPOL Review 3.7—Vessel Specifications, section 4.3*
[26] *Pieridae TERMPOL Review 3.7—Vessel Specifications, section 4.3*
[27] *http://www.sigtto.org/publications/publications-and-downloads*
[28] *Pieridae TERMPOL Review 3.7—Vessel Specifications, section 4.1*

3.1.3 Ballast water management

The Goldboro LNG project will involve LNGCs up to 266,000 m^3, which will likely carry sea water as ballast. Every foreign vessel must follow Canada's *Ballast Water Control and Management Regulations* as well as the *International Convention for the Control and Management of Ships' Ballast Water and Sediments*.[29]

Vessels that take on ballast water outside Canada must have a ballast water management plan in place. They cannot release foreign ballast water into Canadian waters unless it has been managed by:

- Exchanging it at sea.
- Treating it onboard.
- Pumping it ashore for treatment; or
- Retention on board.

Canadian regulations go beyond the International Convention by asking that ballast be exchanged at least 200 nm from shore and in water that is at least 2000 metres deep. IMO convention on ballast requires the exchange of ballast water at least 200 nm from shore but only 200 metres depth.

A vessel must send a "Ballast Water Reporting Form" to TC as soon as the ballast water management is completed and before entering waters under Canadian jurisdiction. Vessels can be inspected by TC MSS to make sure they are following the *Ballast Water Control and Management Regulations,* as amended from time to time.

3.1.4 Vessel and crewing standards

All LNGCs must meet the *Standards of Training, Certification and Watch Keeping Convention* (STCW), Classification Society and Flag State surveys, and follow all international and Canadian laws.

The STCW Convention sets the minimum international qualification standards for any person working on board a vessel. It includes certification and training requirements for all jobs aboard a vessel, including:

- Hours of rest for seafarers
- Certificates of Competency for able seafarers, for both deck and engine departments
- Training and refreshing requirements
- Required security training
- Additional medical standards
- Specific blood or breath alcohol limits

The *Marine Personnel Regulations* (*MPR*) are regulations made under the *CSA, 2001*. Part 2 of *MPR* applies to Canadian vessels and foreign vessels in Canadian waters. It requires:

- Senior officers (master, chief mate, chief engineer or second engineer) on board an LNGC to have a *Specialized Liquefied Gas Tanker Training* certificate/endorsement.
- Any crew member with specific duties in liquefied gas transfer operations to have a *Liquefied Gas Tanker Familiarization* certificate/endorsement.

Pieridae needs to make sure carriers meet all required elements of the *MPR* under the *CSA, 2001*, including any future updates.

[29] *The new Ballast Water Regulations are expected to come into force in 2020.*

The *Safety of Life at Sea Convention* (SOLAS) requires that all "vessels shall be sufficiently and efficiently manned."[30] When the minimum safe manning of a vessel is determined, several principles are applied to make sure the safety is not compromised at any time.

SIGTTO has published two documents about crew qualifications:

- *SIGTTO LNG and LPG Experience Matrix Guidelines for Use*[31], to help with the safety management of crews on board LNG and LPG vessels
- *LNG Shipping Competency Standards*

The proponent will need to ensure that crews of the LNGCs that call at the proposed Goldboro terminal are experienced and trained for the specific cargo and vessel they operate. [32] As such, all applicable shipboard personnel should have the training required to meet the SIGTTO *LNG Shipping Competency Standards* and the *SIGTTO LNG and LPG Experience Matrix Guidelines for Use*.

Finding 3. Pieridae did not include any *Marine Personnel Regulations* requirements for crews training and qualification in its submission.

Recommendation 6. The TRC recommends that all shipboard personnel be trained to meet SIGTTO's *LNG Shipping Competency Standards* and the *SIGTTO LNG and LPG Experience Matrix Guidelines for Use*.

3.2 Route information

3.2.1 Overall route

The proposed Goldboro LNG terminal would be located on the eastern shore of Nova Scotia at the entrance of Country Harbour and Isaacs Harbour. It is only accessible from deep sea so no alternative routes were considered. Most LNG carriers calling at the proposed facility would arrive from Europe (Belgium, Spain and France are key markets.[33]) Maritime access to the proposed terminal is safe and unrestricted for all the design vessels, with the approach and departure routes generally 20m or deeper. You can find additional information in Appendix 4.

The scoping area of the proposed facility extends from Dover, NS (61° west longitude) to Sherbrooke, NS (62 ° west longitude) for a total of 76 km (47 nm) along the coast, and out to the boundary of the Canadian Territorial Sea (to a distance of 12 nautical miles).

[30] *SOLAS, Chapter V, regulation 14*
[31] http://www.sigtto.org/media/7568/sigtto-experience-matrix-guidance-document.pdf
[32] *Pieridae TERMPOL Review 3.13—General Risk Assessment, Section 2.3.5*
[33] http://goldborolng.com/project/project-site/

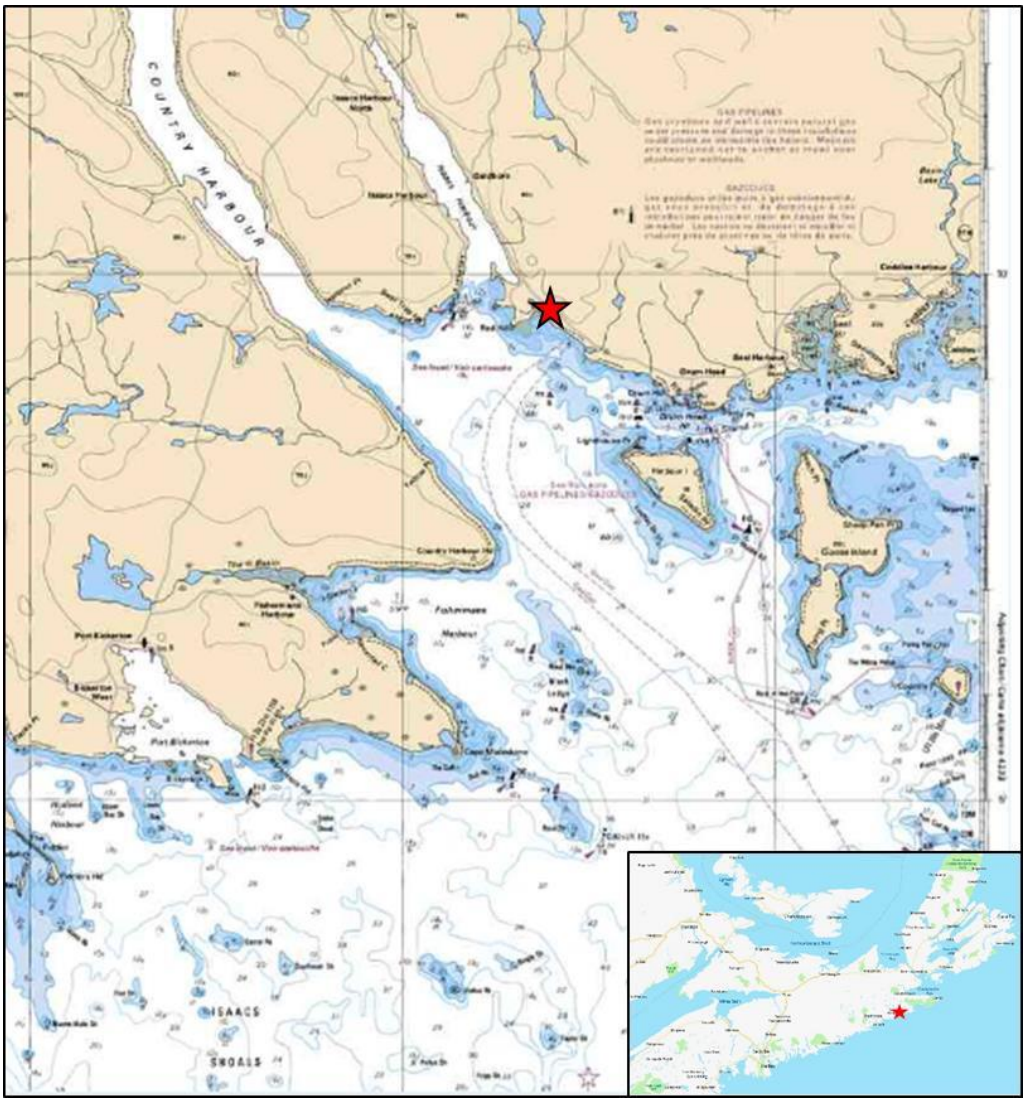


Image: Proposed location of Goldboro LNG project

In April 2016, Pieridae submitted a study [34] prepared by Amec Foster Wheeler, as a part of its submission. The study was not updated but relevant sections were added to an Annex in module *3.3 Route Analysis, Approach Characteristics and Navigability Survey*, submitted to the TRC on July 26, 2018.

Pieridae also submitted a Manoeuvring Simulations Report in module 3.10—*Channel and Manoeuvring and Anchorage Elements* and *Goldboro LNG— Navigation Simulation Study* conducted by HR Wallingford Ltd.

In the immediate area of the proposed terminal, there are two sub-sea natural gas pipelines that are no longer in operation:

- The Sable Offshore pipeline, owned by ExxonMobil
- The Deep Panuke Offshore pipeline, owned by Encana Corporation

[34] *TERMPOL Review Report Submission 1 – Summary*

ExxonMobil, the main operator of the Sable Offshore Energy Project, stopped shipping natural gas ashore on December 31, 2018[35]. Encana Corporation stopped shipping gas ashore on May 7, 2018, for their activities at Deep Panuke. These pipelines should be fully decommissioned by 2021[36] and will reduce the risk associated with the passage and berthing of the LNGCs.

Pieridae's studies do not take the decommissioning of the sub-sea pipelines into account. The end of operations for Sable Offshore and Deep Panuke will have an effect on the proposed mitigations that vessels would have to take while navigating in the area. Pieridae will need to re-evaluate the risks associated with the navigation in the area and the risk mitigation measure as well. For example, Pieridae has proposed that all LNG vessels should have the anchor up and secured, once the pilot is on board and one tug has been made fast. This measure might not be necessary if the pipelines are not in use.

Finding 4. The two existing offshore pipelines that moved natural gas to the former Goldboro Gas Plant will likely remain. Both Encana Corporation and ExxonMobil have submitted applications to the Canada Energy Regulator[37] to abandon the pipelines and have started decommissioning them. Both companies have explained that the pipelines would be pigged and flushed, filled with seawater, and left inert on the seafloor.

Recommendation 7. The TRC recommends that Pieridae evaluate the proposed risk mitigation measures related to the abandoned Encana and ExxonMobil sub-sea gas pipelines located near the terminal; in particular, the risks associated with a LNG carrier dropping anchor over the sub-sea pipelines and make the related updates to its *Port Information Book* and *Terminal Operational Manual*.

3.2.2 Navigation and safety

3.2.2.1 General

Like all vessels entering Canadian waters, LNGCs bound for the proposed Goldboro LNG terminal must meet all navigation safety requirements found in the *CSA, 2001, and the CMA* and their regulations. They must comply with the regulations for the entire time they are in waters under Canadian jurisdiction.

These regulations require the Master of the vessel to:

- Have the proper navigational charts, nautical publications, and navigation and communications equipment on board.
- Develop a passage plan that takes into account the available water depth over the entire transit to make sure there is enough under keel clearance at all times.
- Before arriving at the pilot boarding station and departing from the berth, check that the vessel's navigation, control and propulsion systems are fully functional, by: [38]
    - Running engine(s) astern
    - Checking the steering (testing the full arc of swing of the rudder[s]); and
    - Testing:
        - Communication systems

[35] http://soep.com/decommissioning/decommissioningtimeline.html
[36] https://www.neb-one.gc.ca/pplctnflng/mjrpp/ncndppnk/index-eng.html
[37] https://www.cer-rec.gc.ca/bts/bllc69/index-eng.html
[38] http://www.imo.org/en/About/Conventions/ListOfConventions/Pages/International -Convention-for-the-Safety-of-Life-at-Sea-(SOLAS),-1974.aspx

- RADARs
- Other electronic navigation equipment
- Other wheelhouse equipment
- Anchor
- Mooring equipment
- Emergency towing system available for escort tug operations

LNGCs would approach the terminal from deep sea without much interaction with other vessels except for manoeuvring to follow the *Convention on the International Regulations for Preventing Collisions at Sea* (COLREGs) until it reaches the anchorage or pilot station (if the harbour is to be deemed a mandatory pilotage area).

3.2.2.2 Vessel Traffic Services

All Goldboro LNGCs will need to report to CCG's Marine Communications and Traffic Services (MCTS):

- **When 96 hours away from Canadian Waters**, as set out in *Marine Transportation Security Regulations* (SOR/2004-144)[39] provisions. Among other security enquiries, the vessel must declare any deficiencies in its security equipment and systems, including its communications systems.
- **When 24 hours away from Canadian Waters**, as set out in *Eastern Canada Vessel Traffic Services Zone Regulations* (SOR/89-99)[40] provisions. Vessels must declare, in addition to details about statutory certification and liability coverage, any defects in the ship's hull, main propulsion or steering systems, RADARs, compasses, radio equipment, anchors or cables.

MCTS centres also monitor shipping within Vessel Traffic Services (VTS) zones under the *Vessel Traffic Services Zones Regulations.* Every ship of 20 metres or more in length and every ship engaged in towing or pushing any vessel must report to an MCTS officer. The vessel must comply with the reporting requirements set out in the regulations. The exchange of information between vessels and a shore-based centre helps promote safe and efficient navigation and increases environmental protection.

Currently, there is no vessel traffic routing system in the Goldboro LNG project scoping area (such as a traffic separation scheme), nor is there any VTS monitoring (including RADAR coverage and VHF working frequency radio coverage), as the traffic density does not require such measures.

The HR Wallingford *General Risk Analysis* produced several intended measures and procedures to reduce any risks to an acceptable level. Vessel traffic management was one of the measures suggested in the study. This is discussed further in Section 3.4.2.

3.2.2.3 Aids to navigation

Aids to navigation are devices or systems, external to a vessel, that:

- Help mariners determine the vessel's position and course.
- Warn of dangers or obstacles.
- Indicate the best or preferred route.

The Canadian aids to navigation system[41] is made up of visual, aural and electronic aids to navigation. Visual aids include buoys, day beacons, day marks and lights. Aural aids are sound producing devices that warn mariners of danger in low visibility conditions. These include fog signals on shore and buoy

[39] http://laws-lois.justice.gc.ca/eng/regulations/SOR-2004-144/
[40] http://laws-lois.justice.gc.ca/eng/regulations/SOR-89-99/
[41] http://www.ccg-gcc.gc.ca/aids/home

mounted bells and whistles that are activated by wave action. Most aural aids operate when visibility is reduced to less than two nautical miles. Electronic aids include radar reflectors, radar beacons, the Differential Global Positioning System, "virtual" aids to navigation and the Automatic Identification System (AIS).

The CCG is mandated, though not required, to provide aids to navigation in Canadian waters, with the exception of waterways served by Parks Canada.

The existing aids to navigation system in Country Harbour and Isaacs Harbour meet the needs of current marine traffic. Aids are not provided for the benefit of a single user or to mark access to a private facility. As this is considered a single user, any costs related to additional aids would be at the expense of Pieridae.

Finding 5. The TRC notes that the harbour is well marked with buoys and meets the needs of the current marine traffic. Any proposed changes, or additions, to the aids to navigation system requires input from the CCG, Aids to Navigation Program, to make sure that the level of service is maintained for existing users in the area.

3.2.2.4 Pilotage

Around the world, many maritime countries use specialized marine pilots to navigate ships through their waterways. Licensed pilots conduct vessels to make sure that ships are navigated and berthed safely in challenging areas. They are familiar with the coastlines, inland waters, shoals, harbours, ports, weather, tides, shipping regulations and restrictions of the pilotage area in which they are licensed. Pilots are also familiar with the different propulsion systems, hull design, and rudder characteristics of different vessels and how they react at various speeds and weather conditions.

The four Pilotage Authorities in Canada responsible for setting requirements for, and providing marine pilotage services in, all geographic areas of the country are the Atlantic Pilotage Authority (APA), the Great Lakes Pilotage Authority, the Laurentian Pilotage Authority, and the Pacific Pilotage Authority. They regulate the requirements for compulsory pilotage within which certain classes of vessels, including oil tankers, must take a marine pilot with local knowledge on board before entering a harbour or busy waterway.

The APA continues to monitor and assess all areas within its mandate to determine any change in factors and circumstances that may have an impact on safety. If such a change is determined to warrant closer review, the Authority will employ an outside facilitator to conduct a Pilotage Risk Management Methodology (PRMM).

Pieridae explained that vessels would approach the terminal location under the conduct of a pilot by passing the fairway buoy "TT" on the vessel's port side. The vessel would keep its heading until the vessel begins its turn to approach the jetty, with help from tugs. During the manoeuvring simulations, pilots suggested a set of range light/leading lights be placed for the transit of the narrows at approaches to the proposed terminal location (Refer to the Section 3.2.3.3 and Appendix 5 for more details.)

The proposed Goldboro LNG terminal is not situated in a compulsory pilotage area. Pieridae has recommended that Goldboro be included as a mandatory pilotage area. This is discussed further in section 3.4.2.5

Finding 6. The proposed Goldboro LNG terminal is not located in a compulsory pilotage area.

Recommendation 8 The TRC recommends that Pieridae request a Pilotage Risk Management Methodology review prior or during construction of the terminal.

3.2.2.6 Nautical charts

Vessels calling at the proposed Goldboro terminal would use CHS charts 4234, 4321 and 4227 or equivalent chart recognized by the International Hydrographic Organization (IHO). CHS is the federal government agency in charge of marine charting. CHS is responsible for producing and maintaining charts and other products that support safe navigation in Canadian waters.[42] The *Goldboro LNG Navigation Simulation Study* recommended that charts should be updated so that Country Harbour is centered, instead of its current location at the edge of the chart. CHS stated that they need to chart any proposed anchorages, berths, exclusion zones and any changes/additions to aids to navigation related to the proposed facility. Given the nature and scope of the project, the chart revision could take up to four years. CHS would have to reassess the existing chart schemes. A new large-scale "docking" inset may be needed to support navigation at the LNG terminal. Electronic charts and nautical publications would also have to be updated to support navigation at the terminal, once the terminal design, lighting, exclusion zones and aids to navigation are finalized.

If the Goldboro LNG project is confirmed, Pieridae must officially notify CHS. All proposed and as-built plans should be forwarded to the CHS at Pieridae's earliest opportunity. Notifications and proposed plans can be sent to:

CHS Atlantic
Attention:
Hydrographic Data Centre
1 Challenger Drive
Dartmouth, NS, B2Y 4A2

Finding 7. CHS would be impacted by a large new marine terminal.

Finding 8. The TRC recognizes that the present charts of the area are inadequate for the safe navigation of the predicted increase and type of vessel traffic.

Recommendation 9. The TRC recommends that Pieridae consult with CHS to prepare and submit the charting survey data at the earlier stage possible as the process for charting could take 3 to 4 years.

3.2.2.7 Environmental conditions

The Chicago Bridge & Iron Company (CB&I) commissioned a metocean study[43], on behalf of Pieridae Energy for the Goldboro project in 2015, to document the average and extreme local weather and sea conditions that could be expected at the proposed terminal location. The study area extends up to 20 km from the proposed terminal location in all directions. Pieridae has included the 2015 study results in their 2018 submission.

[42] http://www.charts.gc.ca/help-aide/about-apropos/index-eng.asp#los
[43] *Pieridae TERMPOL Review 3.3—Route Analysis, Approach Characteristics and Navigability Survey*

Waves, tides and currents

The area's highest tide can reach 2.2 metres and the lowest tide 0.2 metres [44]. Table 3.2.2.7-1 is a sample from the tide table for Isaacs Harbour, showing the highest high and lowest low tides for 2019.

Table 3.2.2.7-1 Extract from 2019 Tide Table for Isaacs Harbour

Day	*Time*	*Height (m)*
January 22, 2019	9:12 PM	2.2
January 23 2019	9:51 PM	2.2
March 21, 2019	8:33 PM	2.2
March 22, 2019	9:07 PM	2.2
August 3, 2019	9:28 AM	2.2
August 4, 2019	10:06 AM	2.2
August 31, 2019	8:32 AM	2.2
September 1, 2019	3:05 AM	0.2
September 1, 2019	9:08 AM	2.2
September 2, 2019	9:43 AM	2.2
September 29, 2019	8:09 AM	2.2
September 30, 2019	8:44 AM	2.2

The average sea level in the area rises at a rate of about 3.15 mm/year, roughly 0.315 m in 100 years. CB&I determined that the worst case scenario, for a 100 year return period would be +3.3 m above chart datum (+2.2 m of astronomical high tide, +0.3 sea level rise and +0.8 m of storm surge event).

Wave heights outside the entrance to Country Harbour, by Goose Island, average 1.35 m from the south and can be as high as 8.24 m (5 cases reported in 61 years)[45]. Wave conditions near the proposed Goldboro LNG terminal are smaller and shorter due to the sheltering effect of the land surrounding the berth. The southern berth is more affected than the northern berth; although, in general the wave height is less than 1 metre, with rare cases above 1 m and a maximum of 3 m (0.03%). In summer, waves are smaller and from the south-southwest; in the colder months waves are bigger and from the south.

[44] *Fisheries and Oceans Canada, Water Levels, Isaacs Harbour NS, 2019 tide tables,* http://www.waterlevels.gc.ca/Eng/data/table/2019/wlev_sec/535

[45] *Pieridae TERMPOL Review 3.3—Route Analysis, Approach Characteristics and Navigability Survey*

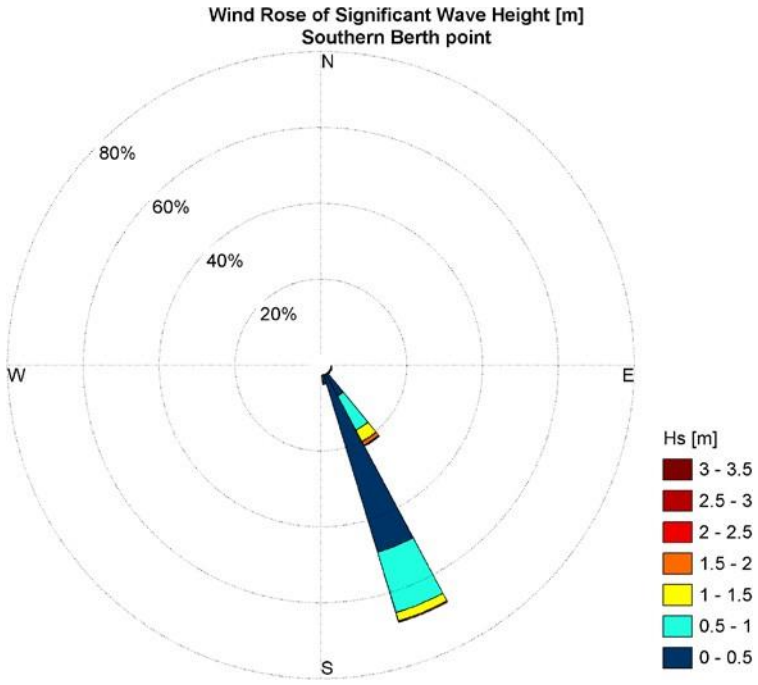


Figure 3.2.2.7-2 Wind rose representing the significant wave height at the southern berth

The study also detailed the currents expected at the terminal location. Through modelling post-construction, Pieridae has calculated the maximum current expected at the Causeway South to be 0.44 m/s[46], which is highest current velocity predicted at the proposed terminal location. Figure 3.2.2.7-3 shows the directional frequency of the currents at six points:

A. Southern berth, maximum expected current 0.21 m/s (0.4 Kts)
B. Northern berth, maximum expected current 0.34 m/s (0.66 Kts)
C. Material Offloading Facility (MOF) Structure, maximum expected current 0.18 m/s (0.35 Kts)
D. Causeway south, maximum expected current 0.44 m/s (0.86 Kts)
E. Point "S1", maximum expected current 0.19 m/s (0.37 Kts)
F. Causeway north, maximum expected current 0.17 m/s (0.33 Kts)

[46] *Pieridae TERMPOL Review 3.3—Route Analysis, Approach Characteristics and Navigability Survey*

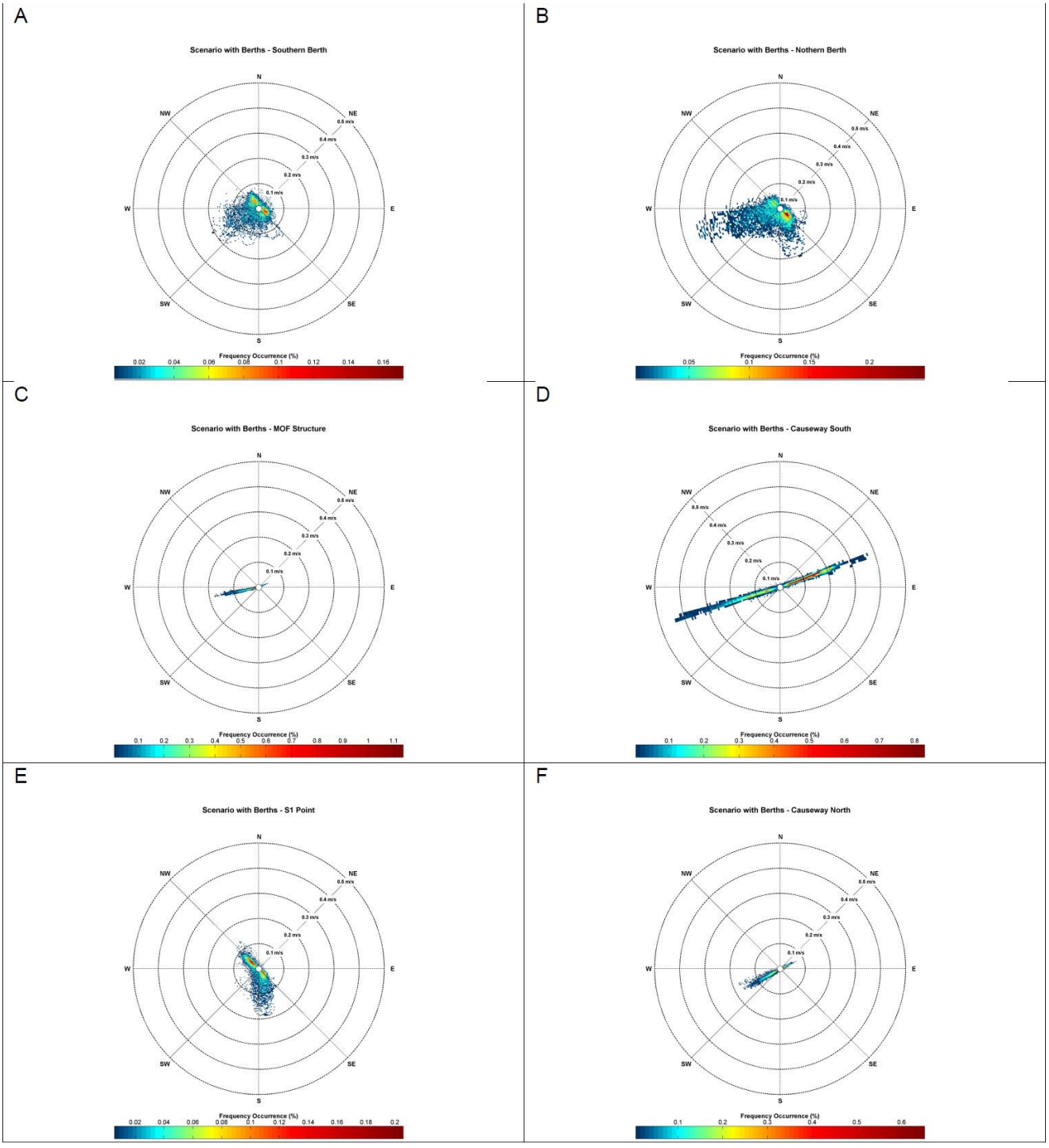


Figure 3.2.2.7-3 Current's directional frequency diagram for post-construction scenarios

Winds and storm events

The prevailing winds in the area are westerly — southwesterly in the warmer months and northwesterly in cold months. At the project site, the direction of wind varies from southwest and west-southwest. The maximum wind velocity in the 61 years covered by the study was 26 m/s (93.6 km/h), which occurred in spring.

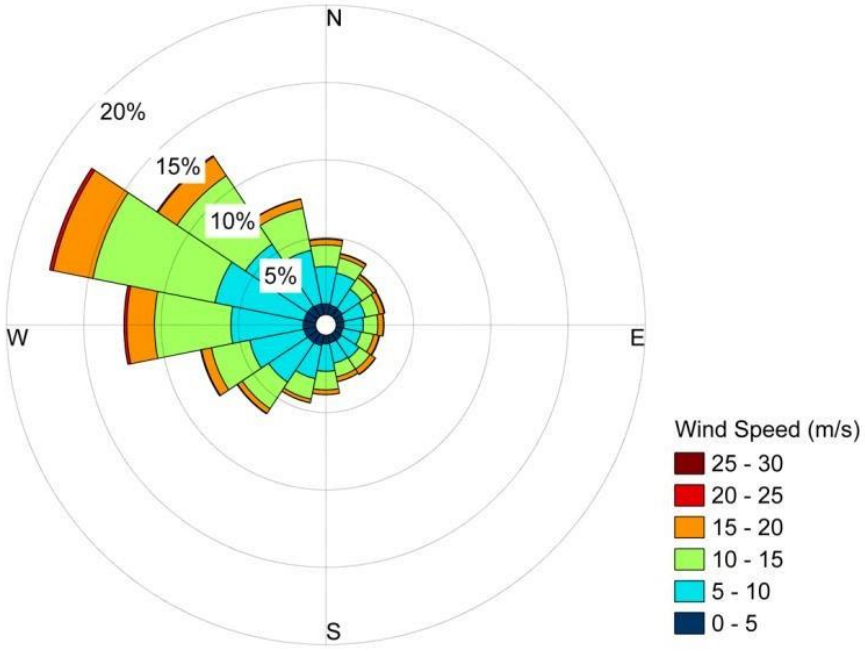


Figure 3.2.2.7-4 Wind rose representing the predominant wind speed in winter

According to records for seasonal wind conditions, the strongest average wind speeds occur in winter. The average speed is 9.71 m/s (35 km/h) compared to 5.13 m/s (18.5 km/h) in summer. In general, storms with winds over 12.86 m/s (46 km/h) are more frequent during winter and can last up to 5 days.

Fog

The project site lies in an area that is often affected by fog. Fog is more common during the warmer months and will reduce visibility which can cause delays to the terminal's shipping activities. According to Environment and Climatic Change Canada, close to half of mornings in June and July have reduced visibility due to fog in the area. This figure drops drastically in the winter with an average of 16% foggy days.

Finding 9. The TRC believes that installing a smart buoy [Ocean Data Acquisition System (ODAS) / weather buoy)] near the proposed pilot station would provide a real-time analysis of metocean conditions.

Recommendation 10. Pieridae should decide on funding sources for the smart buoy [Ocean Data Acquisition System (ODAS buoy/weather buoy)], in consultation with Environment and Climate Change Canada.

Recommendation 11. Pieridae should confirm the metocean limiting conditions, including factors affecting visibility that would affect operations and include them in the *Port Information Book* and *Terminal Operations Manual*.

3.2.2.8 Winter Conditions

Freezing spray

Freezing spray is an environmental risk during the cold winter months when temperatures can drop to -10°C and wind-chill values can drop below -25°C[47]. Freezing spray can create ice build-up on marine infrastructure such as the vessel's hull, decks, guy wires, cables, anchors, deck equipment, etc. that may affect the vessel's stability or deck operations. A freezing spray warning is issued when ice build-up from freezing spray is expected to reach **moderate** levels, between 0.7 and 2 centimetres per hour (cm/h), or **severe** levels of more than 2 cm/h.[48]

Sea ice

According to the Canadian Ice Service, sea ice in the area is highest from January to March. The highest likelihood of sea ice in the area is 15% for March, with a maximum likely thickness of 30 cm. The odds decrease to 10% for January and February. When sea ice is present, the coverage would be 50% or less. Figure 3.2.2.8-1 shows the frequency (%) of sea ice over 30 years.

In the past, there have been extreme ice events that fall outside the expected conditions. In February 2003 sea ice up to 120 cm was seen in the area. In April 1987 pack ice was carried by currents along the coast of Nova Scotia, then strong southerly winds sent the 2 - 2.5 meter thick ice into the coastal ports. This impacted commercial shipping significantly.

[47] https://www.yr.no/place/Canada/Nova_Scotia/Goldboro/statistics.html
[48] https://www.canada.ca/en/environment-climate-change/services/general-marine-weather-information/publications/guide-forecasts/chapter-8.html

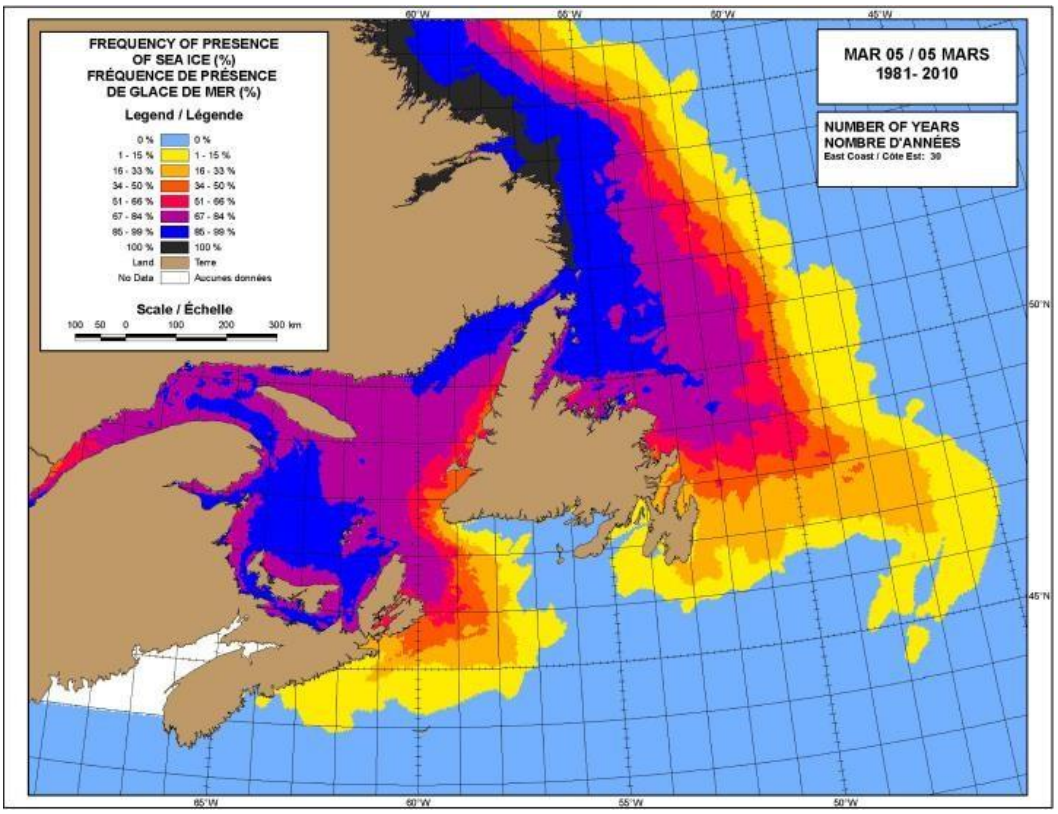


Figure 3.2.2.8-1 Ice Chart showing the % of sea ice over a 30 year span

During the winter of 2019, ice concentration in the area was heavier than average. On February 25th, the total ice concentration was 7/10 in area "Y", with 4/10 covered with grey ice (10 cm to 15 cm thick) in medium-sized floes (100 to 500 metres wide) and 3/10 of new ice (under 10 cm thick). Figure 3.2.2.8-2 shows an excerpt of the ice chart with its ice egg codes.

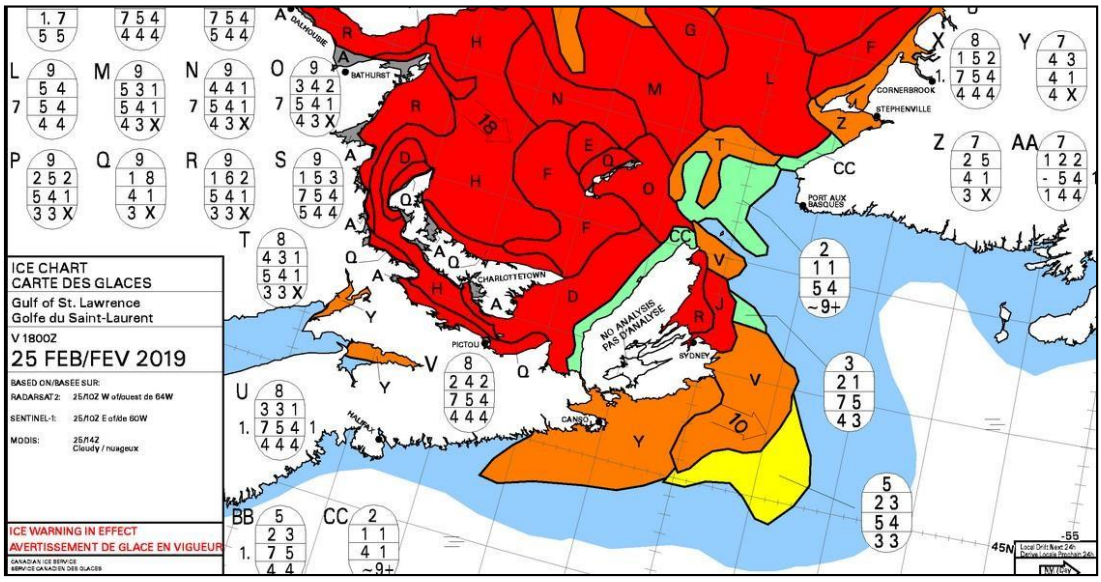


Figure 3.2.2.8-2 Excerpt of the Ice Chart for the Gulf of St. Lawrence (Goldboro is located in the "Y" orange area)

Risk of ice damage exists on the east coast of Canada during winter and spring. As this can affect the safety of marine personnel, the marine environment and vessels sailing in ice-covered waters, TC developed the *Joint Industry-Government Guidelines for the Control of Oil Tankers and Bulk Chemical Carriers in Ice Control Zones of Eastern Canada*, TP 15163, in November 1979[49].

These guidelines do not apply to LNG carriers, only to laden oil tankers and bulk chemical carriers. However, the TRC recommends that LNGCs calling at the proposed terminal follow the guidelines, to lower the risk of ice damage.

Eastern Canadian waters south of Latitude 60º N are divided into Ice Control Zones. The Canadian Coast Guard Ice Operations Centre declares an Ice Control Zone "active" when it finds that ice conditions in a zone are dangerous to shipping.

In 2012, the guidelines were changed to include Ice Control Zone "X1" for Chedabucto Bay and the Strait of Canso. Zone "X1" is defined as all waters in Zone X between Latitude 45 30'N and 45°00'N, running eastwards from the shoreline. Country Harbour, Isaacs Harbour and Goldboro are located in Ice Control Zone "X1".

Ice Control Zone "X1" was active from February 25 to March 27, 2019 so all oil tankers and chemical carriers had to carry an "Ice Advisor" on board when travelling through the zone.

[49] *Joint Industry—Government Guidelines for the Control Of Oil Tankers and Bulk Chemical Carriers in Ice Control Zones of Eastern Canada, 2015, TP 15163*
https://www.tc.gc.ca/media/documents/marinesafety/TP15163.pdf

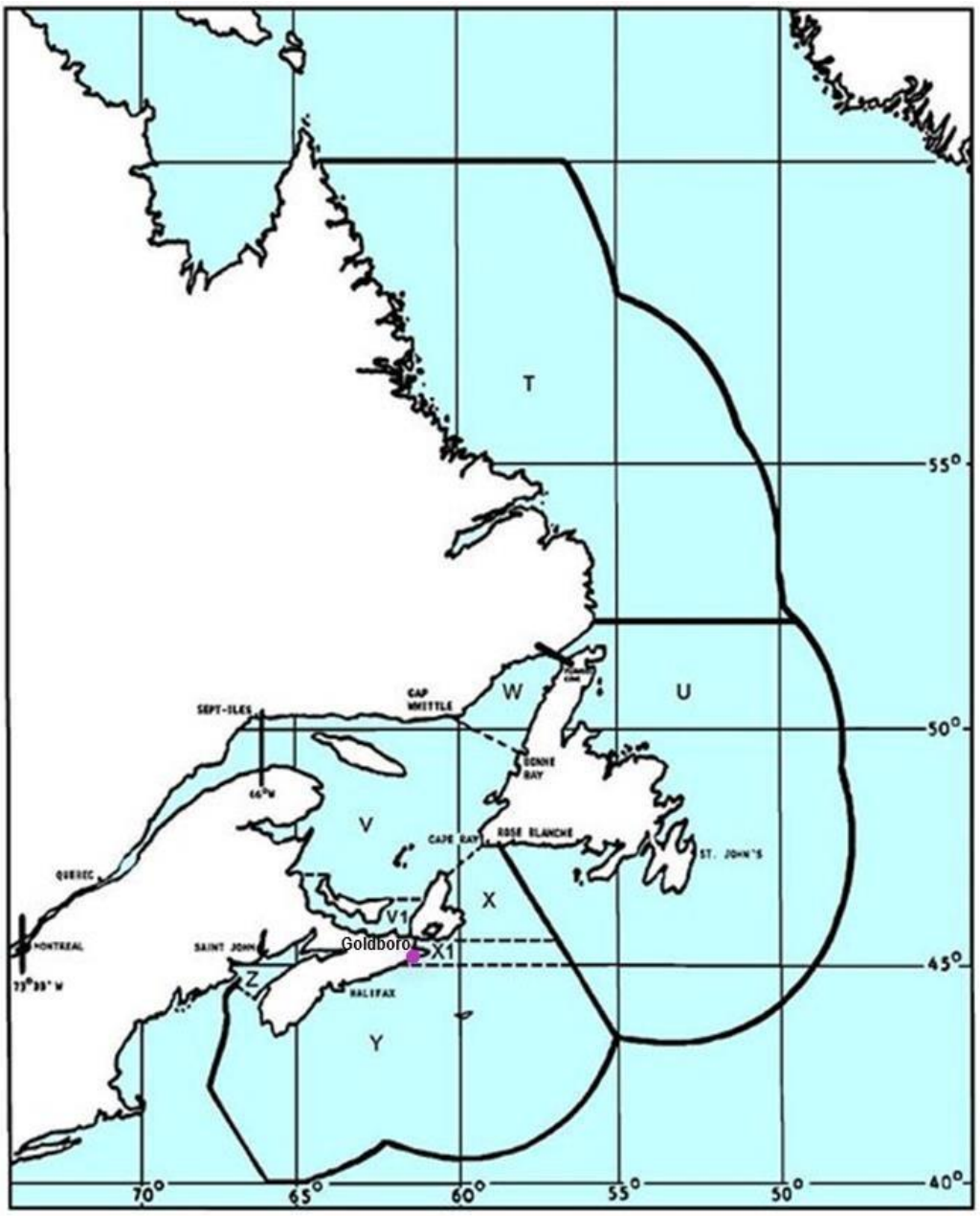


Figure 3.2.2.8-3 Ice Control Zones of Eastern Canada

The TRC noted that Pieridae does not agree that LNGCs visiting the Goldboro Terminal should be required to follow the guidelines. "*We note that these guidelines are applicable to oil tankers and bulk chemical carriers. It is our view that an LNG carrier is not, as declared by the IBC Code, a chemical carrier nor is it an oil tanker, therefore the JIGs do not apply. However, Pieridae agrees that it would be prudent to include provisions in the Port Information Booklet advising the procedures to be followed in the event that ice is reported in the area that a LNG carrier is due to traverse. We intend to develop these procedures in the next phase of the project development and we would welcome TC's involvement during this process."*[50]

[50] *Pieridae's response after the TRC's initial comments during the TERMPOL review*

Finding 10. The TRC believes that LNG carriers would be safer if they have an "Ice Advisor" on board when travelling in ice covered waters.

Recommendation 12. The TRC recommends that Pieridae require all LNG carriers that call at the proposed terminal to follow the *Joint Industry-Government Guidelines for the Control of Oil Tankers and Bulk Chemical Carriers in Ice Control Zones of Eastern Canada* in an active ice control zone as if the vessels were laden oil tankers.

3.2.3 Navigability and vessel operations

3.2.3.1 Transit Time and Delay Survey

In the December 2015 submission, Pieridae presented the *LNG Berth Utilisation and Down Time Analysis*. The study used a mathematical model to:

- Examine the potential down time for marine operations (vessel arrival, loading and departure) due to local weather (visibility, wind, waves and sea ice).
- Estimate the yearly down time for marine operations.

The TRC noted the following limiting conditions were included in the mathematical model, which used base data from metocean and other studies [51]:

- Vessel inbound transit and berthing:
  - Off shore waves < 3.0m
  - Waves at berth < 2.0m
  - Wind speed < 25kts
  - Visibility > 1.0nm
  - Sea ice <25%, thickness <15cm
- Vessel un-berthing and outbound transit:
  - Off shore waves < 3,0m
  - Waves at berth < 2,0m
  - Wind speed < 30kts
  - Visibility > 1,0nm
  - Sea ice <25%, thickness <15cm
- Cargo transfer – stop loading:
  - Waves at berth >2,0m
  - Wind speed >30kts
- Cargo transfer – disconnect marine loading arm:
  - Waves at berth >2,0m
  - Wind speed >35kts

The following table shows results from the *LNG Berth Utilisation and Down Time Analysis* . Large vessels would use the berths less often than smaller vessels so the number of transits would be lower. Large vessels can load more LNG per call and would be more efficient.

---

[51] *This criteria may need to be adjusted when Pieridae determines the actual metocean limiting criteria for Goldboro LNG operations*

The smaller vessels spend more time at each berth as the time spent includes non-LNG product loading operations such as government clearances, safety checks, tank gauging, etc.

Table 3.2.3.1-1 – Summary of Utilisation Results

Annual Utilization	Design Vessel		
	Small vessel (120,000 m³)	**Medium vessel (175,000 m³)**	**Large vessel (266,000 m³)**
Minimum number of vessels per year	190	128	84
Maximum number of vessels per year	206	137	91
Annual use (% of year)	63%	50%	42%

.

3.2.3.2 Navigation Simulation Study

Pieridae's submission included a report on vessel manoeuvring simulations provided by HR Wallingford Ltd. The *Goldboro LNG Navigation Simulation Study*[52], performed during November 19–24, 2018 looked at:

- The safety aspects of LNGCs (up to 266,000 m^3 in capacity) navigating to and from the proposed terminal and vessel berth.
- The safety aspects when using 4 azimuth stern drive (ASD) tugs with 70 tons bollard pull capacity, using industry standard tethered escort techniques.

In particular, the study aimed to:

1. *Confirm the Goldboro LNG terminal design and configuration for the proposed LNGCs.*
2. *Make sure there are enough tug with tractor abilities/bollard pulls to perform escort and berthing operations.*
3. *Confirm the upper environmental limits (wind speed/direction, tidal current conditions and restricted visibility) for transit and berthing/un-berthing operations.*
4. *Identify tug reserve power requirements during LNGC accidents and or tug failures .*
5. *Evaluate the adequacy of existing navigation aids and propose new aids or the relocation of existing aids.*

HR Wallingford created a geographic model of the terminal and surrounding area, using the layout which was developed during the Front End Engineering Design Phase (FEED) studies completed in 2015.[53] The FEED studies were also used for other base data like wind, current, wave, etc.

The simulation team was made up of representatives from Pieridae, two marine pilots from the APA, two representatives from TC MSS and HR Wallingford representatives (including one marine pilot and one tug master).

---

[52] *Goldboro LNG—Navigation Simulation Study, H.R. Wallingford, Wallingford, UK, March 2019*
[53] *Pieridae TERMPOL Review 3.10—Channel and Manoeuvring and Anchorage Elements (188479-400-MA-RP-00003 Proof of Concept Manoeuvring Simulations Report).*

Accident scenarios are critical in choosing the best tug configuration for Goldboro terminal section and were included in the simulations runs. Some of the emergencies that were part of the simulation included:

- Aborted arrival
- Accelerated departure
- Outbound voyage with rudder failure
- Arrival berth with failure of vessel's engine
- Dead ship departure
- Arrival berth with tug failure

During the session, HR Wallingford conducted 41 simulations, including 28 completed standard manoeuvres, covering 13 arrivals and 15 departures. Of the 28 manoeuvres, 21 were successful, 6 were rated as marginal and one was considered a fail. The "fail" was due to the combination of tugs being unable to push the LNGC off the north berth due to significant wave heights (2 meters).

"Marginal" outcomes were for the following scenarios:

- Aborted arrival to the north berth mooring starboard side to
- Accelerated departure from port side on the north berth using one tug
- Accelerated departure from port side on the north berth using 2 tugs
- Accelerated departure from starboard side on the north berth using 2 tugs

Overall, the simulations showed that there was enough space and tug power available to allow the berthing manoeuvre to be stopped with the vessel under control, and for the vessel to move to a temporary anchorage area with tug assistance.[54]

Based on the simulations, the team reached the following conclusions:

1. *Tests confirmed that access to and from the proposed terminal is safe and unrestricted. There is enough space for vessels to be moved onto and off a berth, without interacting with a moored vessel on the next berth. There is enough, naturally deep space available to allow the ship handler to swing to port or starboard on arrival, for either berth.*
2. *The jetty berthing line is reasonably aligned with the dominant wave direction but tugs operating in push mode at the vessel's hull are fully exposed to waves. As expected, the key constraint on marine operations was found to be the performance of tugs in higher wave conditions, particularly when tugs were operating in push mode.*
3. *The 70 ton bollard pull ASD tugs were found to be effective in push mode up to 1 metre wave height conditions, particularly when combined with tugs working on lines using render recovery winches.*
4. *Tests also showed that, when tugs were operating in appropriate wave conditions and steady wind speeds of 25 knots or less, the wind direction was unimportant.*
5. *No additional floating aids to navigation were needed. Although, tests clearly showed that leading lights (range lights or sector lights) would be helpful so recommendations were made to improve the aids to navigation.*

See Appendix 5 for the full list of conclusions and recommendations of the *Goldboro LNG Navigation Simulation Study* report which were supported by the simulation team.

[54] *Goldboro LNG—Navigation Simulation Study, H.R. Wallingford, Wallingford, UK, March 2019*

The TRC considered each recommendation from the *Goldboro LNG Navigation Simulation Study* and developed findings and recommendations for Goldboro terminal, which are included in section 3.4.2 Intended Methods of Reducing Risks.

Finding 11. The TRC agrees that the overall conclusions, recommendations and supplementary considerations of HR Wallingford's *Navigation Simulation Study* would improve the safety of marine navigation in the TERMPOL scoping area.

3.2.4 Marine traffic considerations

Pieridae submitted their *Marine Traffic Survey* using data from the Atlantic Pilotage Authority 2017 Annual Report, Statistics Canada, Oceans and Coastal Management (Fisheries & Oceans Canada), the US Department of Defense, National Geospatial Intelligence Agency and the marine traffic website "marinetraffic.com". The traffic study did not include vessels not required to carry AIS.

Traffic from the Goldboro project will develop in two phases — the construction phase and the operational phase. The construction phase will have additional vessel traffic. As of the writing of this document, Pieridae had not yet decided on the terminal's construction method, land-based, sea-based, or both. The TRC expects construction will require tugs, work boats, barges and project cargo vessels, but exact details are not yet available.

The operational phase of the project is expected to see, at maximum, 206 vessel calls (412 vessel movements), assuming that the carriers have a 125,000 m^3 capacity. The design vessels for this project are up to 266,000 m^3, and as such, would create fewer vessels calls, which would in turn reduce any increase of vessel traffic. The number of vessel movements in the area is directly related to the size of the LNGCs that will call at the terminal. The proposed design vessels are listed in Appendix 3.

The *Marine Traffic Survey* showed that there is not a lot of vessel traffic in the scoping area of the project. It also noted the absence of ports with any significant marine traffic between Halifax and Port Hawkesbury.[55]

For the offshore "Scotian Shelf" portion of the LNGC transits, the TRC expects that project LNGCs can be easily be absorbed in the existing network. LNGCs are subject to strict vetting processes by charterers so the TRC were not concerned that the project vessels would increase the risk to the network.

Most of the Atlantic coastal traffic is located well offshore to avoid any natural hazards. This would give enough room for any vessels the LNGCs might encounter. While the exact routing has yet to be confirmed, LNGCs will generally avoid busy areas (like Halifax and the Strait of Canso).

[55] *Pieridae TERMPOL Review 3.2—Marine Traffic Survey, Section 3*

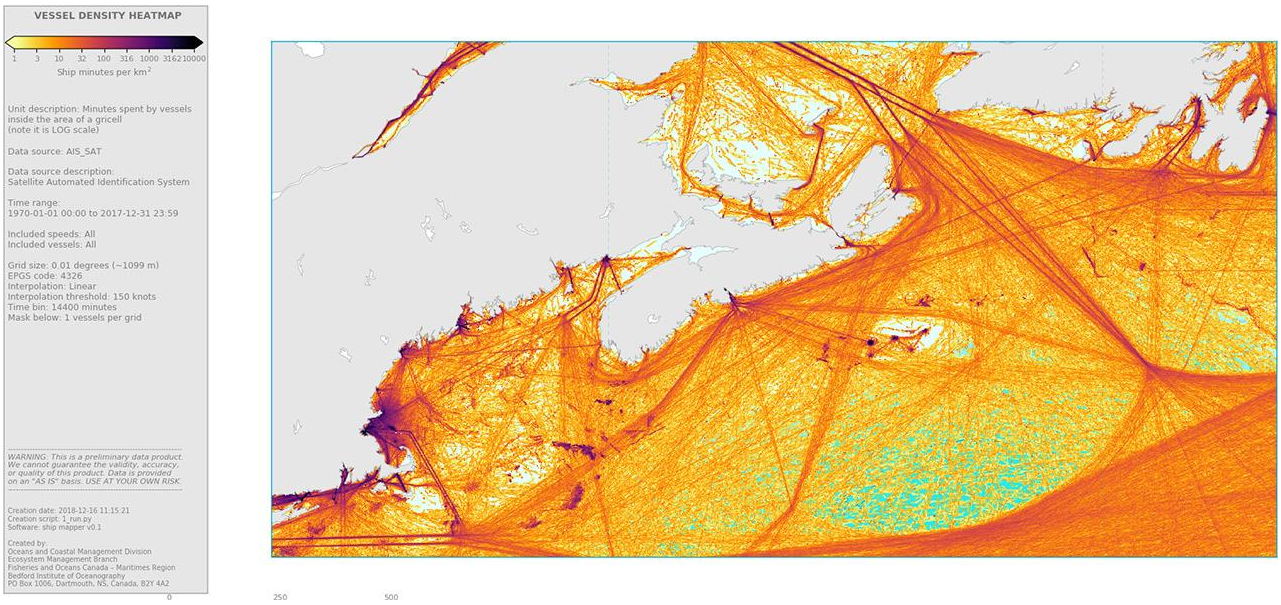


Figure 3.2.4-1 – Commercial traffic density off the Atlantic Coast. Source: DFO 2019

The Nova Scotia inshore coast will have more traffic than the offshore part. The inshore data collection is not as robust as the offshore portion, as not all inshore traffic needs to carry Automatic Identification Systems (AIS), and the area is in the range of recreational boaters and fishing vessels.

Recreational traffic is expected to be low as there are no big population centres in the area. There are a few small fishing harbours but none have a large number of vessels. Nevertheless, this portion of the transit will have seasonal changes in traffic density, directly related to the local fishing seasons, mainly lobster and snow crab. This traffic will be a combination of local fishing vessels and fishing vessels from other ports.

Pieridae's proposal did not address the impact of the project on local communities. However, they have an ongoing communication plan, local engagement activities and a working group set up with local fishermen that will continue throughout the LNG plant's operational life.

There are no special operational areas that need to be considered for this project, other than the charted military exercise areas, which extend along much of the Nova Scotia coast. Whenever the Royal Canadian Navy has exercises within those areas, there will be a Navigational W arning (NAVWARN) issued via the eNavigation web portal and broadcast over the MCTS radio network. The TRC recommends that the proponent make sure that all LNGCs calling at the proposed terminal have all relevant Navigational Warnings prior entering Canadian waters.

All vessels must follow *Navigation Safety Regulations,* pursuant to the Canada Shipping Act 2001. These regulations govern the carriage of Automatic Identification Systems (AIS).

TC is considering changing AIS carriage requirements to improve vessel monitoring by Canadian authorities and by other nearby vessels through the amendments to the *Navigation Safety Regulations, 2020*[56] The TRC recognizes this will also improve the situational awareness for vessels travelling around the project area, given the expected increase in project-related traffic.

Finding 12. The TRC recognizes that not all vessels operating in the area are required to be fitted with AIS.

[56] *The amendments to the Navigation Safety Regulations are expected to come into force in 2020*

Finding 13. For the offshore part of the LNG carrier's transit, the additional vessels can be easily absorbed in the existing network. LNGCs are subject to a strict vetting process by charterers so the TRC is not concerned that the project vessels will increase the risk to the network.

Finding 14. Pieridae has an ongoing communication plan and is engaging with local communities, including all water users. There is also a working group with local fishermen which will continue throughout the plant's operational life.

Recommendation 13. The TRC recommends that Pieridae investigate the "non-AIS" vessels that travel in the scoping area and pay close attention to seasonal fishing operations.

Recommendation 14. The TRC recommends that Pieridae expands its study on the impact to coastal communities.

Recommendation 15. The TRC recommends that Pieridae continue its engagement through the working group with the local fishermen.

Recommendation 16. The TRC recommends that Pieridae make sure that vessels calling Goldboro terminal have all relevant Navigational Warnings before they enter Canadian waters. This will make sure there are no conflicts with any Royal Canadian Navy exercises or other activities in the area.

3.3 Terminal Operations

3.3.1 Marine terminal

The marine facilities associated with the Project will include an LNG jetty made up of a single marine trestle spanning from the causeway structure to a t-head with two LNG loading platforms. They will also include a Material Offloading Facility (MOF), which will be used for delivery of construction materials and equipment for the construction of the terminal. Once the construction phase is complete, the MOF will be converted into a support vessel berth, mooring the necessary support vessels for the operation of the terminal.

The cargo loading berths will be able to accommodate vessels ranging in size from 125,000m³ to 266,000m³ capacity, which is the most likely vessels to call at the terminal on a regular basis. Table 3.3.1-1 lists the proposed Terminal Characteristics.

Description	Value
Berth 1 - vessel sizes	125,000 - 266,000m^3
Berth 2 - vessel sizes	125,000 - 220,000m^3
Minimum distance of flange face to side of vessel	2.8m
Maximum distance of flange face to side of vessel	3.8m
Transverse drift perpendicular from berth (away/towards)	+3.0m/-1.8m
Total drift parallel to the berth (fore/aft)	+/-3.0m
Minimum flange spacing on vessel manifold	3.0m
Maximum flange spacing on vessel manifold	4.0m
Minimum rail height	1.0m
Minimum distance of vessel flange axis to deck	4.2m
Maximum distance of vessel flange axis to deck	5.6m

Manifold	16-20 1"/ASME CL150/SS

Table 3.3.1-1 Proposed Terminal Characteristics

The two jetty loading platforms will have sufficient space for all topsides needed for the LNG loading operation. This includes features like the marine loading arms, piping, valves and other equipment, a vessel access structure, a service crane, vehicular manoeuvring and parking, fire lighting equipment, area lighting, LNG containment and general drainage. Pictured below is a diagram of the proposed facility footprint submitted by Pieridae in July 2018.

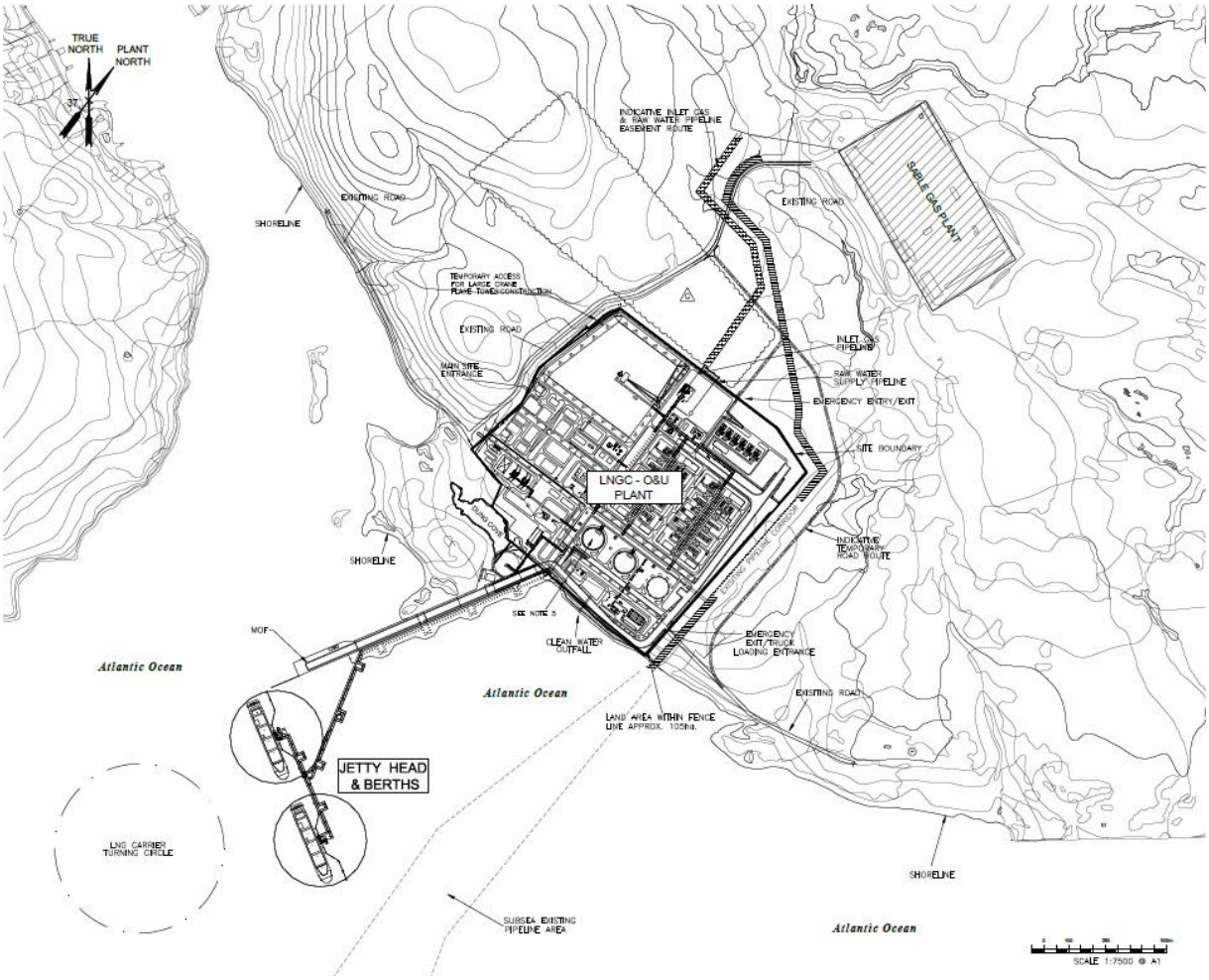


Figure 3.3.1-1 Footprint of the Proposed LNG Facility in Goldboro, NS

The jetty loading platforms will be pile-supported breasting and mooring dolphin structures. A total of four breasting dolphins and six mooring dolphins are anticipated for each jetty.

The piles (columns) of the unloading platform will be located to maintain at least one metre clearance on the berthing vessel's hull when the vessel is subject to three degrees roll under the maximum compression of the fenders.

The height of the jetty loading platforms will allow the crests of design waves to pass clearly under the structural elements of the platform's main deck, preventing uplift loads from being imposed on the

structure. All structural steel elements of the jetty will be coated with corrosion protection to appropriate marine standards.

The breasting dolphins will be fitted with:

- A suitable fender system to hold the berthing loads and wind loads on the vessels .
- Quick release mooring hooks with an integrated capstan to help with handling lines.

Although the project is meant to be an export terminal, all berthing energy calculations were done with the masses of loaded vessels, to account for any scenario that might require a loaded vessel to be berthed at the terminal. This is a recommendation from "*Guidelines for Design of Fender Systems: 2002*" by the World Association for the Waterborne Transport infrastructure, formerly known as Permanent International Association of Navigation Congresses (PIANC).

A vessel access structure should be provided on the loading platform for safe access to and from the LNGC. Catwalks will be provided to connect all of the mooring and berthing dolphins to the respective loading platform.

The berths will include fender panels to reduce the berthing loads on the vessels' hulls when securing alongside.

Cargo transfer equipment will be made up of two liquid arms, one vapor return arm and one hybrid (primary liquid, secondary vapor) arm. The four arms should be installed on each jetty loading platform to help load the full range of design vessels in all operating conditions. The design will be such that it can operate with any vessel designed to OCIMF Guidelines.

Firefighting equipment, including fire monitors and dry chemical systems will be installed on the jetty loading platform. The main way to fight fires and provide cooling will be by remote controlled firefighting systems. These help to reduce risk to personnel by minimizing the need for manual fire-fighting.

The fire-fighting system design will be based on the following assumptions [57]:

- Only one major fire will happen at a time
- Quick detection of fire or flammable gas is expected inside the protected buildings and areas with detection systems
- Fires will be extinguished or controlled with fixed extinguishing systems, monitors, hydrants, hose reels and/or other mobile means
- The main way to control fires will be to isolate the fuel source through automatic Emergency Shutdown and manual depressurization
- The main way to fight fires will be by fixed water spray and monitor systems
- Small fires will be extinguished with portable/wheeled fire extinguishers
- The Goldboro plant fire brigade will fight fires using the right kind of equipment
- Fires on LNG carriers during loading will be controlled using the firefighting systems and equipment on the vessel
- Jetty fire-fighting facilities will only be used for cooling the Product Loading Facility and prevent the fire spreading to the facility
- Depending on the fire, the following methods will be used in the facility:
    - water based Automatic Fire Protection systems will use fresh water as the primary fire water supply
    - sea water will be used as a back-up supply and;

[57] Pieridae *TERMPOL Review 3.8 – Site Plans and Technical Data*

    - Low expansion foam is required to control fire involving flammable and combustible liquid hydrocarbons having a flash point below 65°C.
- There will be a tug on site equipped for firefighting.

The design and construction of the facility will meet the latest versions of internationally recognized standards, like the National Building Code of Canada, Design of Steel Structures, Design of Concrete Structures, etc.

A 200-metre exclusion zone around each loading jetty is also included in diagram 3.3.1-1. Creating an exclusion zone around a LNG terminal loading arm would help prevent accidental ignition in the event of a spill during LNG transfer operations.

Since 2001 in Nova Scotia, any new LNG facility must follow the *Energy Resources Conservation Act, Gas Plant Facility Regulations* and *Nova Scotia Code of Practices for LNG Plants* . The *Gas Plant Facility Regulations* incorporate by reference:

- The *Code of Practices* which includes requirements and guidance on the design, construction, operation and abandonment of land-based LNG plants and their jetty and marine terminal.
- *Liquefied Natural Gas (LNG) – Production, Storage, and Handling* (CAN/CSA-Z276-18), from the Standards Council of Canada "For facilities that load or unload LNG from a marine vessel, this Standard contains requirements for the interconnecting piping between the loading/unloading arm flange and the storage tank(s), and other piping and appurtenances on the pier of jetty itself."[58]

The TRC did not have any findings or recommendations for this Section (3.3.1).

3.3.2 Berthing and mooring

In their 2016 submission, Pieridae used simulations to study berthing and mooring arrangements, to determine if the design components could withstand expected loads from the full range of vessels expected to call the terminal. Static and dynamic mooring analyses were done using metocean criteria. The study looked at historical wind, wave, and meteorological and astronomical tides expected at the site for the proposed Goldboro LNG berths.

The berthing and mooring study referred to relevant standards, recommendations and guidelines produced by various international authorities like those produced by OCIMF and PIANC. The engineering standards that will govern the design and installation will include those listed in the table below.

Table 3.3.2-1 Engineering standards that govern the design and installation

Reference	*Title*
NBCC 2010	National Building Code of Canada 2010
CSA S16-09	Design of Steel Structures
CSA A23.3-04	Design of Concrete Structures
CSA A23.1-09 / A23.2-09	Concrete Materials and Methods of Concrete Construction / Test Methods and Standard Practices for Concrete
G40.20-13	General Requirements for Rolled or Welded Structural Quality Steel / Structural Quality Steel - Seventh Edition; Update No 1: May 2014

[58] http://www.scc.ca/en/standardsdb/standards/29572

G30.18-09	Carbon steel bars for concrete reinforcement - Second Edition Update No 1: August 2012
CSA W48-14	Filler metals and allied materials for metal arc w elding
CSA W59-13	Welded steel construction (metal arc w elding)
Canadian Institute of Steel Construction	CISC Code of Standard Practice for Structural Steel 2009 - 7th Edition
CSA S6	Canadian Highw ay Bridge Design Code
CSA S9	Design of Highw ay Bridges
NSTIR	Nova Scotia Transportation and Infrastructure Renew al Requirements
Canadian Institute of Steel Construction	CISC Code of Standard Practice for Structural Steel 2012 -10th Edition
Reinforcing Steel Institute of Canada	RSIC Reinforcing Steel Manual of Standard Practice
CSA Z276-15	Liquefied Natural Gas (LNG) - Production, Storage and Handling
ACI SP-66	ACI Detailing Manual
API RP 2A	American Petroleum Institute - Recommended Practice for Planning, Design, and Constructing Fixed Offshore Platforms
API Spec 2B	American Petroleum Institute - Specification for Fabricating Structural Steel Pipes
API Spec 2C	American Petroleum Institute - Specification for Offshore Cranes
BS 6349-1-1	British Standard – Maritime Structures – Part 1: Code of Practice for Planning and Design for Operations
BS 6349-1-3	British Standard – Maritime Structures – Part 1: General – Code of Practice for Geotechnical Design
BS 6349-1-4	British Standard – Maritime Structures – Part 1: General – Code of Practice for Materials
BS 6349-2	British Standard – Maritime Structures – Part 2: Design of Quay Walls, Jetties and Dolphins
BS 6349-4	British Standard – Maritime Structures – Part 4: Code of Practice for Design of Fendering and Mooring Systems
BS 6349-7	British Standard – Maritime Structures – Part 7: Guide to Design and Construction of Breakw aters
RSNS 1989, C. 49	Nova Scotia Building Code Regulations
NACE RP 01.76	National Association of Corrosion Engineers – Recommended Practice – Corrosion Control of Steel, Fixed Offshore Platforms associated w ith Petroleum Production
NFPA 59A	NFPA 59A: National Fire Protection Association - Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)
NS DEPT ENERGY	Code of Practice – Liquefied Natural Gas Facilities (Nova Scotia Department of Energy)

In addition to having enough water depth and maneuverability, the berth and jetty facilities must meet the specifications for the carriers intended to call at the terminal. The Masters and Pilots must be certain that the carrier can maneuver around the facilities safely and efficiently.

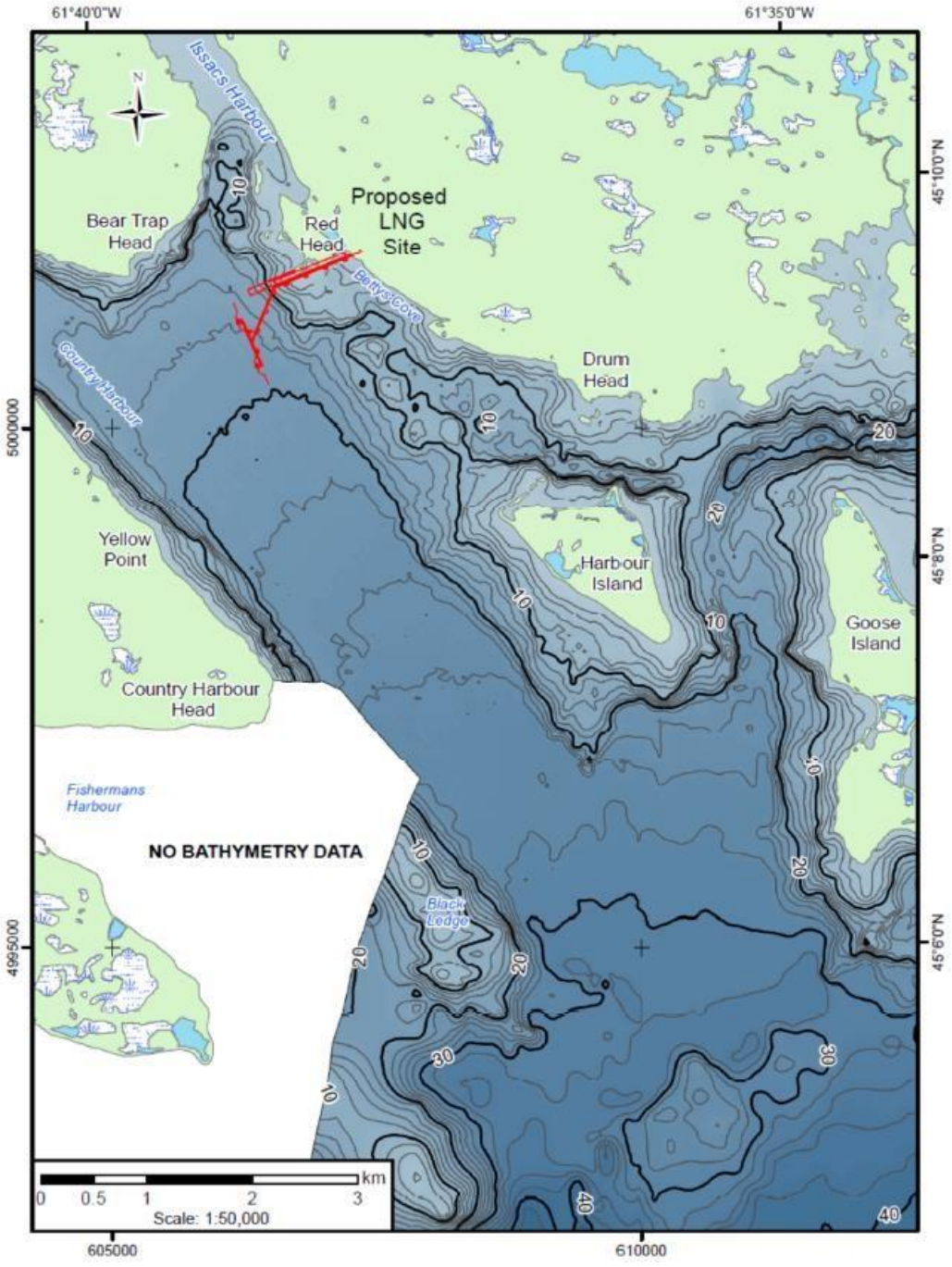


Figure 3.3.2-2 Goldboro Approach Channel Bathymetry

The manoeuvering and berthing strategy was described in *TERMPOL Study 3.10 'Channel Manoeuvring and Anchorage Elements'*. The *Under Keel Clearance* study showed that the berth

location has enough under keel clearance for carriers and construction support vessels. As such, the placement of the berths would not require dredging.

The *Navigation Simulation Study* shows that it is best to secure the vessels port-side to the berth. Mooring port-side to the berth is preferred because the vessels will enter the bay from the south with the terminal to the east. If the vessels tie up with their starboard side to the dock, they would need to turn around at departure, fully loaded, instead of turning the vessel around in ballast when it arrives and securing port-side to the berth, allowing the vessel to proceed directly to sea. This scenario will also reduce the loads on the vessel related to turning it around, and reduce the power needed by the tugs to turn the vessel.

Lighting plans are key to making sure that the lighting scheme does not interfere with the bridge's field of vision on an arriving or departing LNGC. As the lighting plan was not yet confirmed at the time of writing this report, Pieridae should submit the proposed lighting plans to the TRC for review as soon as the plans are available and no later than 6 months before operations begin.

A vessel approach monitoring system with a suitable display panel will be provided, located on the inner aft mooring dolphin at each berth, clearly visible from the vessel's bridge wing during berthing manoeuvers.[59] TRC members that helped with the simulations by HR Wallingford have suggested that "jetty docking boards" would help pilots to determine their distance off the jetty and speed of approach towards the berth.

Figure 3.3.2-3 Image of a Jetty Docking Board. Source: Goldboro LNG Presentation to the TRC

The design of the terminal allows worker to access the berthing dolphin catwalks, and provide enough access for vehicles, fire trucks or mobile cranes.

There is value in having an on-site, fully-staffed and trained control room dedicated to monitoring terminal operations. Consistent communication between vessel crew, terminal operators, tug crew, and all parties involved in loading or unloading of cargo is critical while a carrier is at berth.

The plant control system will control the following activities which can be monitored locally at the jetty:

- Mooring hook quick release

[59] *Pieridae Energy TERMPOL Review 3.8 — Site Plan and Technical Data, section 8.3*

- Mooring line tension monitoring
- Vessel docking aids & fender monitoring; and
- Environmental and ocean condition monitoring

Berthing and mooring procedures should be developed at least 6 months before operations begin and reflected in the PIB and TOM (Sections 3.3.4 and 3.3.5). The procedures should specify:

- Methods for berthing and un-berthing LNG carriers and the number of tugs required.
- The number of mooring launches and personnel required for mooring.
- Berthing velocity.
- Limiting environmental and operational limits/criteria for berthing, un-berthing.
- Available berthing aid systems:
    - jetty docking board which measures the speed of approach and distance to the jetty, displaying the information to the design vessels ; and
    - Portable Pilot Unit (PPU) a handheld device with electronic navigation chart display, GPS, AIS, metocean data and other important information.

Finding 15. The TRC agrees with HR Wallingford's conclusion that there is enough sea room for manoeuvring in the transit waterway.

Finding 16. Pieridae will refer to and incorporate relevant standards, recommendations and guidelines of various international authorities like those produced by OCIMF and PIANC for berthing and mooring procedures.

Finding 17. The lighting plan was not completed at the time of writing this report. Lighting plans are key to making sure that the lighting scheme does not block the field of vision from the bridge of an arriving or departing LNG carrier.

Finding 18. Berthing and mooring procedures will help the TRC to review the *Port Information Book* and *Terminal Operations Manual* when the documents are submitted.

Recommendation 17. The TRC recommends that Pieridae include references to OCIMF and PIANC checklists and guidelines in Goldboro LNG's *Port Information B*ook and *Terminal Operations Manual*.

Recommendation 18 The TRC recommends that Pieridae implement the recommendation from the *Goldboro LNG Navigation Simulation Study*.

Recommendation 19. The TRC recommends that Pieridae submit its proposed terminal lighting plan to the TRC to assess interactions with existing lights in the area. The plan should be submitted as soon as it is available and at least 6 months before operations begin.

Recommendation 20. The TRC recommends that Pieridaeestablish berthing and mooring procedures before submitting the *Port Information Book* and *Terminal Operations Manual* to TC so the department can take them into account when reviewing the documents.

Recommendation 21. The TRC recommends that Pieridae incorporate docking boards into the final design in order to assist pilots in determining their distance off the jetty and speed of approach towards the berth.

3.3.3 Cargo transfer operations

While in Canadian waters, vessels transferring LNG must follow *Canadian Vessel Pollution and Dangerous Chemicals Regulations* (*VPDCR)*, the International Code for the Construction and Equipment of Ships carrying Liquefied Gases in Bulk (IGC Code), industry guidelines and other best practices. The *VPDCR* include strict environmental standards that help prevent deliberate, negligent and accidental discharge of ship-source pollutants into Canadian waters.

The Goldboro marine terminal is designed to have six LNG loading pumps in operation with a flow rate of 2,000 m^3/hr for a maximum continuous rate of 12,000 m^3/hr for each LNGC. Two liquid arms and one hybrid (liquid or vapor return) arm will have a design loading rate of 4,000 m^3/hr.

In their submission, Pieridae included transfer procedures and check lists that will be part of their *Cargo Transfer Manual/Terminal Operations Manual* based on recommendations from the SIGTTO. The construction of transfer systems should follow all applicable standards, codes and best practices.

Pieridae will need to make sure that all operations and maintenance personnel working at Goldboro are trained to properly and safely perform their work including:

- LNG safety
- Cryogenic operations
- Vessel loading procedures
- Proper operation of all terminal equipment and;
- Emergency procedures

Pieridae should develop operating procedures and training material after the final terminal design is completed and provide enough training to make sure that Goldboro operational personnel understand the safety procedures. These procedures should:

- Form part of the terminal's contingency plans.
- Address LNG carrier operations, such as safe start-up, shutdown, cool-down, purging, regular operation and monitoring.
- Pay particular attention to coordination with local emergency management and response officials for emergency scenarios.

The Marine Terminal Operator Competences and Training (MTOCT) guide from OCIMF helps marine terminal managers make sure the people operating the ship/shore interface have all the necessary skills and experience. The guide identifies key competences and knowledge requirements for different roles.

Recommendation 22. The TRC recommends Pieridae develop operating procedures and make sure that all staff are trained for safe cargo transfer operations.

Recommendation 23. The TRC recommends that Pieridae ensure that all terminal personnel are trained to the OCIMF recommended standard found in the *'Marine Terminal Operator Competence and Training Guide.'*

Recommendation 24. Pieridae should incorporate the SIGTTO Ship/Shore Safety Check List in their *Terminal Operations Manual*.

Recommendation 25. Once the cargo transfer system design is finalized and before submitting the *Terminal Operations Manual,* Pieridae should advise TC of any changes to the plans. This will help TC to decide if further reviews are necessary.

3.3.4 Port information book

The *Port Information Book* (PIB) gives vessel personnel details about the marine terminal and the route to it. As per the TERMPOL Review Process, 2014 Edition (TP 743), the TRC wants Pieridae to submit the PIB, at least six months before operations begin.

This will help the TRC make sure that any mitigation measures are in place before the start of operations. A copy of the PIB must be provided to all LNGCs before they call at the Goldboro LNG terminal.

The *Port Information Book* should include:

- Pilot boarding instructions and operational limits
- Tug information and assistance requirements
- Port entry information
- Reporting instructions
- Terminal description
- Relevant charts and nautical publications
- Site specific berthing instructions
- Upper limits of berthing operations
- Security and industrial health and safety matters
- Emergency measures
- Policies, procedures and checklists

Refer to the *TERMPOL Review Process* (TP 743) for a full list of PIB requirements.

Recommendation 26. The TRC recommends that Pieridae provide them with a copy of the *Port Information Book* (PIB) at least 6 months before the terminal begins operations. This will allow for a speedy review and help make sure that all procedures and mitigation measures are in place before operations begin. The PIB must be carried on board any LNGC calling at the Goldboro terminal.

3.3.5 Terminal operations manual

The *Terminal Operations Manual* (TOM) informs the LNGC's personnel about the factors affecting the safety and efficiency of the vessels, terminal and cargo transfer operations.

Pieridae should complete the TOM and submit it to TC at least six months before operations begin. TC will make sure the manual covers all the relevant items, including:

- Pre-arrival and pre-departure checklists
- SIGTTO Ship/Shore safety check list
- Cargo transfer procedures, including pre-transfer inspections, checklists and meetings
- Vessel and terminal communications, and chain of authority
- Terminal cargo transfer equipment, including information on inspections, testing and preventative maintenance
- Emergency procedures, emergency response and contingency plans
- Upper limit of all atmospheric factors that would require cargo transfer operations to stop or the marine loading arm to disconnect.
- Procedures that manage access to the vessel during transfer operations

Refer to the TERMPOL Review Process (TP 743) for a full list of TOM requirements.

Recommendation 27. Pieridae should make sure that all policies and procedures based on the HR Wallingford Goldboro LNG *Navigation Simulation Report* are completed in time to be included in the *Port Information Book* and *Terminal Operations Manual*.

Recommendation 28. The TRC recommends that Pieridae provide them with a copy of the *Terminal Operations Manual* at least 6 months before terminal operations begin, so that TC can make sure that all procedures and contingency plans are in place before operations begin.

3.4 Risk assessment and contingency planning

3.4.1 Risk assessment

The HR Wallingford Risk Assessment was structured using the IMO Formal Safety Assessment (FSA)[60]. The FSA has five steps:

1. *Identify hazards, including a list of all relevant accident scenarios with potential causes and outcomes. What might go wrong?*
2. *Assess risks. How bad could an accident be and how likely could it occur?*
3. *Decide ways to control or reduce the risks. How can things be improved?*
4. *Determine the cost and effectiveness of each option.*
5. *Recommend actions that should be taken.*

The scoping area of the proposed facility extends from Dover, NS (61° west longitude) to Sherbrooke, NS (62 ° west longitude) for a total of 76 km (47 nm) along the coast, and out to the boundary of the Canadian Territorial Sea (to a distance of 12 nautical miles).

According to the proponent's risk assessment[61], the proposed project and associated LNGCs will likely increase the risk of accidents and spills in the study area. Once built, Pieridae estimates 206 carrier calls at the terminal each year, which would result in less than one inbound and one outbound carrier transit per day.

As the study focused on Country Harbour, where only one LNGC will be travelling at a time, the risk assessment did not use marine traffic modelling method. Possible hazards were identified in three scenarios:

- LNGCs entering and leaving the Country Harbour area
- LNGCs arriving at and leaving the berth, and
- Other traffic arriving at and leaving the Country Harbour area

Finding 19. The TRC noted that the risk assessment submitted by Pieridae did not include the following risks in their analysis, as per TP 743. [62]

---

[60] *http://www.imo.org/en/OurWork/safety/safetytopics/pages/formalsafetyassessment.aspx*
[61] *Pieridae TERMPOL Review 3.13 — General Risk Analysis and Intended Methods of Reducing Risks* http://goldboroIng.com/project/pieridae/
[62] *TERMPOL Review Process TP 743, 2014* https://www.tc.gc.ca/media/documents/marinesafety/tp743e.pdf

- Likelihood of a major cargo transfer incident at the terminal dock
- Geographical boundaries of an uncontrolled release of LNG
- Weaknesses of the LNGC's LNG containment system following a collision, allision or grounding in the area
- Likelihood of a large scale, uncontrolled LNG release in the area
- Nearness of the local population to any vapour clouds and possible ignition sources
- Risk analysis of the offshore area (including but not limited to severe electrical storms, deliberate acts and spills incidents during cargo operations)

Recommendation 29. The TRC recommends that Pieridae conduct an additional risk assessment on the components listed in Finding 19.

3.4.2 Gas cloud risks

LNG is natural gas, cooled to -160°C, at atmospheric pressure, and reduced to a liquid state. Materials that cannot stand cold temperatures can crack if they come in contact with LNG. As a result, handling LNG requires special equipment and facilities.

As a liquid, LNG cannot explode and is not flammable[63]. However, if LNG is released and warmed, it can become a flammable gas. This gas can ignite in the presence of an ignition source, only at a range of 5% (Lower Flammable Limit) to 15% (Upper Flammable Limit) vapour in the air by volume. While this narrow range reduces the overall risk, safe handling and transfer of LNG is key to public safety.

An exploding vapour cloud can cause death and property damage within its range. Radiation burns can also happen near an ignited vapour cloud. Detonations with lethal overpressure are possible if vapour collects in confined spaces before ignition. Evaluating these risks is a complex process but a good approach would be to calculate the number of potential deaths from an explosion. [64]

Transport Publication TP 743, Section 3.13.1, requires the proponent to conduct a risk analysis study to:

1) *Analyze the navigation and operational risks that could lead to the release of pollutants and hazardous and noxious substances either enroute or at a terminal*
2) *Find ways to reduce these risks*

The TP 743 includes special considerations for vessels carrying LNG, including:

- *The vulnerability of the liquefied natural gas carrier's cargo containment system following a collision or a grounding in the area*
- *The probability of a large scale, uncontrolled liquefied gas release within the area*
- *The "nominal" quantity, rate and duration of released liquefied gas bulk cargo and the dimensions of the resulting vapour cloud*
- *The proximity of populations to vapour cloud boundaries and the distribution of possible ignition sources*
- *Consequences impact radius for pool fire ignitions, vapour cloud overpressures and rapid phase transition explosions*
- *Consequences impact radius for asphyxiation due to oxygen displacement and exposure to direct dermal contact resulting in frostbite or potential mortality from freez ing*

---

[63] *Natural Resources Canada web page:* http://www.nrcan.gc.ca/energy/natural-gas/5681
[64] *TERMPOL Review Process TP 743, 2014* https://www.tc.gc.ca/media/documents/marinesafety/tp743e.pdf

- *The vulnerability of adjacent storage tanks to being compromised and their cumulative volumes of explosive substances potentially contributing to additional fires and explosions, and thus, to larger consequences impact radii.*

Finding 20. The TRC has noted that Pieridae did not analyze the risks and mitigation measures related to a gas cloud release.

Recommendation 30. The TRC recommends that Pieridae update the risk analysis with the likelihood of a gas cloud release as required by TERMPOL TP 743. This analysis should include the geographical boundaries of an uncontrolled release of cargo. Any mitigations should be included in Goldboro *Contingency Plan.*

3.4.3 Intended methods of reducing risks

The HR Wallingford risk assessment identified the following key mitigation measures to reduce risks:[65]

- Always make sure four tugs are available for any inbound and outbound LNGC.
- Make sure only one vessel manoeuvres at a time.
- Create procedures and train pilots and tug crews, to make sure they know what to do in an emergency.
- Do not carry out manoeuvres in poor visibility.
- Make sure tugs are equipped with appropriate firefighting capability for LNG carriers .
- Do not manoeuvre LNGCs in wind speeds >25 knots or another limiting wind speed to be determined.
- Make sure guard vessels are available during manoeuvres if the other berth is occupied.
- Stop cargo transfer operations on adjacent berth.
- Develop instructions to lower the possibility of a gas cloud igniting if a vessel nears the LNGC at the dock, such as to stop transferring LNG.

In addition, Pieridae suggested a marine exclusion zone of 200 metres from the vessel at the berth, as it is a common best practice.

Pieridae also identified emergency provisions and procedures in case of a fire on board the LNGC while alongside the terminal. For example:

- ISGOTT recommendations will be followed, so the vessel would remain at berth during a fire when possible.
- All tugs will be equipped with fire response. At least one of the four tugs should be available in less than 10 minutes and the three others in less than 30 minutes.
- A vessel's main engines and related systems will be ready for an emergency departure with tug assistance.
- No vessel maintenance, specifically no repairs to the vessel's engines will be allowed alongside.

The risk assessment was submitted in July 2018. The *Navigation Simulation Study* submitted in March 2019, included additional recommendations for aids to navigation and the use of tugs to reduce the

[65] *Pieridae TERMPOL Review 3.13 — General Risk Analysis and intended Methods of Reducing Risks*

consequences of engine failure, tug failures, loss of steering, etc. (Refer to Section 3.2.3 and Appendix 6.)

3.4.3.1 Aids to navigation

In April 2016 the *Proof of Concept Maneuvering Simulations Report*, Section 3.3 Aids to Navigation, referred to "four additional floating aids to navigation to be considered for the project". The *Goldboro LNG Navigation Simulation Study* found that no additional floating aids to navigation were needed, although pilots thought that a leading line (set of range lights or sector lights) would be helpful.

> ***Recommendation 31.*** The TRC recommends that Pieridae work with the Canadian Coast Guard to discuss any proposed changes or additions to the aids to navigation system to ensure that a continued level of service is maintained for the existing users in the area.

3.4.3.2 Metocean and operational limiting criteria

The TRC noted that metocean limiting criteria for the operations was not clearly identified in the conclusion or recommendations of the *Navigation Simulation Study*. A smart buoy, also known as a weather or Ocean Data Acquisition System (ODAS) buoy, in the vicinity of the pilot station would provide a real-time measure of metocean conditions. Pieridae should confirm the metocean limiting conditions for Goldboro LNG operations.

> ***Recommendation 32.*** Pieridae should consult with Environment and Climate Change Canada to discuss the requirements and funding sources for a smart buoy (Ocean Data Acquisition System buoy/weather buoy) at the pilot boarding station.
>
> ***Recommendation 33.*** Pieridae should confirm the metocean limits identified in the simulations and include them in the *Port Information Book* and *Terminal Operations Manual*.

3.4.3.3 Vessel Traffic Services

There are currently no Vessel Traffic Services (VTS) zones in the area of the project, nor is there any RADAR or VTS working frequency radio coverage. Having a VTS zone in the Goldboro area would help restrict other vessel traffic where necessary, when LNG carriers are underway, as is the case of the LNG terminal in Saint John, New Brunswick.

Establishing a routeing measure, for example, a precautionary area at the entrance to Country Harbour, might be worth considering. However, the IMO recommends that other solutions be considered before those measures are implemented[66]. There is minimal traffic in the area so a study would need to be done to determine these requirements.

Proponents who request vessel traffic services for a single user system are responsible for the initial capital costs to establish the infrastructure needed to support the service. It is important for Pieridae to engage the CCG early to have a thorough needs analysis of any new service and equipment requirements in the Goldboro area. This review would make sure any new systems work well in the existing MCTS centre's equipment. Ongoing operating and maintenance costs for the new systems would be part of a consultative process with the proponent.

---

[66] *General Provisions on Ships' Routeing, adopted Nov. 20, 1985, IMO Resolution A.572(14)*

Personnel operating communication equipment must also follow the *CSA, 2001*'s *VHF Radiotelephone Practices and Procedures Regulations*, *Ship Station (Radio) Regulations*, and *Ship Station (Radio) Technical Regulations*.[67]

Finding 21. There are no Vessel Traffic Services (VTS) in the Goldboro scoping area. If Pieridae wants VTS coverage for Country Harbour, any costs associated with this would be at their expense as the port would be for a single user.

Finding 22. The TRC noted that MCTS could support either the establishment of a new vessel traffic services zone, or an extension of the existing Canso Vessel Traffic Services Zone.

Recommendation 34. For VTS and RADAR coverage, the TRC recommends that Pieridae request a study from CCG MCTS. The range and site location for VTS, RADAR and radio coverage would need to be discussed by Pieridae and the MCTS. As the new service would be for a single user, Pieridae would need to pay any associated fees.

Recommendation 35. The TRC recommends that Pieridae, in addition to looking into establishing a precautionary area, look into other solutions as per IMO Resolution A.572(14). Pieridae should speak with TC's regional office if the risk analysis shows the needs for such a measure.

3.4.3.4 Tugs

Based on the results from the *Goldboro LNG Navigation Simulation Study*, Pieridae has proposed that 4 tugs be available from seaward of fairway buoy "TT" for escort, when required.

Within the harbour there is ample sea room (over one nautical mile from the terminal to the opposite shore) for tug-assisted manoeuvres.

Tugs must meet every *CSA, 2001,* requirement for registration, crewing and certification. Tug operators need to maintain certificates for Near Coastal Class 2 (can navigate up to 25 nm from shore) or higher voyage classification requirements to conform to TC's registration, crewing and inspection regime. Tug owners can do this directly through TC MSS or via the Delegated Statutory Inspection Program from a recognized organization.

Strong communication between tugs Masters and project carriers is key. The STCW Convention, through Regulation VIII/2, outlines the requirements for watch-keeping arrangements and principles for Masters and all personnel. Following these will ensure safe, continuous watches are maintained on vessels at all times.

[67] *These regulations will be consolidated into the new Navigation Safety Regulations, 2020, expected to come into force in 2020.*

Finding 23. The TRC agrees with Pieridae's proposal and HR Wallingford's simulations of having four tugs to escort LNGCs.

Finding 24. The TRC agrees that, based on the simulations, using escort tugs will help to reduce the risk of grounding.

Finding 25. The TRC noted that Pieridae has committed to providing escort tugs with a robust firefighting capability.

Recommendation 36. The TRC recommends that tugs have load cells so they can measure the pulling forces on the line when they are tethered to a vessel.

Recommendation 37. The TRC recommends that tug design be standardized to allow for seamless tug substitutions and interchangeable parts and equipment to make sure there are enough tugs available at all times.

Recommendation 38. The TRC recommends that all tugs be equipped with render/recover winches to increase capabilities for escort duties and berthing.

Recommendation 39. The TRC recommends that all escort tugs be fitted with rescue equipment to assist LNGCs, including equipment for emergency towing. Carriers should also have equipment that allows towing gear to connect quickly and safely. It is critical that LNGCs and escort tugs are compatible.

Recommendation 40. The TRC recommends Pieridae has all tugs fitted with the latest industry standard firefighting equipment.

Recommendation 41. The TRC recommends Pieridae make sure all project carriers meet the Emergency Towing Procedures requirements of SOLAS Regulation 11-1/3-4 (IMO Resolution 258 [84]).

3.4.3.5 Pilotage

Pieridae has indicated that they expect a pilot on board during any LNGC movements, with a pilot boarding station seaward of the fairway buoy "TT". In order for the proposed terminal to become a compulsory pilotage area with a "Pilot Boarding Station", the APA would need to complete a Pilotage Risk Management Methodology (PRMM) assessment [68] used to:

- Identify or revise compulsory pilotage areas.
- Decide on the size and type of vessels subject to compulsory pilotage; and
- Adopt or change key policies or practices like double pilotage or the use of waivers.

If the PRMM assessment concludes that it does not need to be a compulsory pilotage area, Pieridae should make sure that any Goldboro LNG operational procedures have the Master contract a local marine expert to assist the vessel to the berth.

The APA makes arrangements for the pilots and apprentice pilots to attend simulator training to ensure good bridge management. The IMO Resolution A960 leaves pilot training up to the Authorities to define and manage. **All licensed pilots for the area would need simulation training (virtual or manned models). The Chief Executive Officer of the APA also agreed that pilots should have training before operations begin."**

[68] *Pilotage Risk Management Methodology (PRMM), TP 13741, 05/2010. Published by TC*

Finding 26. The TRC agrees it would be prudent to have APA pilots for safe berthing and un-berthing at the proposed terminal.

Finding 27. The TRC recognizes that there are many ways to reduce risk when travelling to and from the terminal. The vessel's bridge management team and the pilots use RADAR and electronic aids to monitor the vessel's position, speed and rate of turn to safely direct the vessel. The APA can also restrict a vessel from receiving a pilot if there is less than 2 nm of visibility.

Recommendation 42. The TRC recommends that all licensed pilots for the area have simulation or manned model training before the terminal begins operating.

Recommendation 43. Pieridae should ensure that all LNG carriers have a local marine expert to assist the vessel to the berth, if the APA decides that Goldboro does not need to be a compulsory pilotage area.

3.4.3.6 Port Authority

The risk assessment study has suggested that a port authority with appropriate powers should be established for Country Harbour.[69]

The *CMA* was created in 1996 and provides a governance model to manage federally-run ports and facilities. These include ports that were previously operated as a Harbour Commission, a "Canada Ports Corporation" or a federal public harbour. Country Harbour is not a port listed under the Act, so it cannot be recognized as a Canada Port Authority or as a public port.

After consulting the National Advisor on Port Operation, it was made clear that Goldboro Terminal is a private entity and is not subject to the *CMA.* While it may be regulated by other federal legislation like the *CSA, 2001*, the *CMA* is not applicable to this port. Pieridae should avoid any reference to a Canadian Port Authority in any Goldboro LNG terminal documentation.

Finding 28. The TRC noted the consistent use of TC's registered trademark term "Port Authority/ Administration portuaire" to describe Goldboro in the submission documentation. As Goldboro is not a recognized public port under the *CMA*—the use of the term Port Authority/Administration portuaire" could be misconstrued by the public and would be an infringement of Sections 7 and 9 of the *Trademark Act.*

Recommendation 44. As per *Finding 28* in this report, the TRC recommends that Pieridae change all references to the trademark term "Port Authority/Administration portuaire" in all Goldboro related documentation to read "Port Management" or the generic position of the Harbour Master as the designated person/employee in charge of port operations.

3.4.3.7 Exclusion or Safety Zones

Exclusion zones are created to protect the public from the consequences of an accidental release of LNG. Operators are legally required to control all activities around an LNG facility that could be affected by radiant heat from a fire or vapor.

Pieridae has identified the need for a marine exclusion zone around the terminal of 200 meters during LNG carrier loading. It is the area that would be affected by a loss of containment during loading. The

---

[69] *Pieridae TERMPOL Review 3.13 — General Risk Analysis and Intended Methods of Reducing Risks*

restrictions would be in place to avoid ignition sources in that area during loading (e.g. no vessels or vehicles in the zone, limited personnel, permitted zone).

Pieridae did not include any studies related to the marine exclusion or safety zone. The SANDIA report "*Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water*"[70] can be used to decide the need for safety zones. The process can be used for gas plume modeling to determine thermal effect distances from a LNG pool fire from various size tank releases considering wind, current and topography. It would also help to determine the risk to populations along the transit route and while berthed at Goldboro.

The International Maritime Organization (IMO) and International Convention for the Safety of Life at Sea (SOLAS) do not have standards for marine exclusion or safety zones. In Canada, there are few ways to create safety zones around vessels. The *CMA* allows Port Authorities to create safety zones in port limits, with their port procedures and systems. The Saint John Port Authority has created safety measures at the fully operational Canaport LNG terminal in the Port of Saint John[71]:

- Security screenings of the vessel crew by TC
- Tethered tug support
- A safety exclusion zone of 0.5 nautical miles (925 m) around the LNG carrier while underway
- No anchoring in 1.5 nautical miles (2.7 km) of the LNG carrier
- No overtaking of the LNG carrier while underway in the harbour
- A 0.3 nautical mile (620 m) radius from the centre of the terminal is off-limits to all marine traffic except tugs and service craft assisting the LNG carrier during LNG unloading operations

As Goldboro is not in a Port Authority, it would not be possible to create a safety zone in the harbour under the *CMA*.

TC is conducting an international research project on marine control zones. The research is focused on learning:

- If existing marine control zones lower the risk of marine accidents that cause harm to the environment.
- How to design marine control zones.
- How they could be created and enforced with the Canadian legal and regulatory framework.
- The cost of creating marine control zones and who would bear those cost of enforcing them.

The TRC understands the need for further work to review the issue of safety zones for LNG terminals with the aim of creating an approach that takes into account the unique circumstances of each marine terminal.

Finding 29. The TRC recognizes the SANDIA Report as an internationally recognized reference document that identifies the creation of exclusion zones as a way to manage risks relating to thermal hazards, in the event of an accidental or deliberate LNG release.

Finding 30. The TRC noted that Pieridae's analysis of the exclusion zone around the LNG carrier at berth is based on existing zones from other jurisdictions.

---

[70] *Sandia Report. Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water. Sandia National Laboratories, 2004. Albuquerque, New Mexico*

[71] *Saint John Port Authority. (2015). Practices and Procedures. p. 9-10, 13-17, 36*

Recommendation 45. With respect to the 200 metres exclusion zone, the TRC recommends that Pieridae conduct a study using methods like SANDIA. The study should consider local conditions and include input from waterway users, as a way to justify the need for, and size of, a safety zone. Information regarding the safety zone is to be included in the Port Information Book and the Terminal Operations Manual.

3.4.3.8 Incident Management

The TRC suggests that incidents occurring at Goldboro terminal be managed under the Incident Command System (ICS) at Goldboro LNG terminal to help with emergency response. The system is an all-hazards incident management system that is based on international best practices. It has been adopted by many organizations around the world, including the Canadian Coast Guard and TC.

It features a standardization which allows organizations to work together under a single structure with a consolidated response plan. ICS requires formal training and certification. Terminal managers and other key staff should have ICS certification.

Recommendation 46. The TRC recommends that Pieridae make sure that all Goldboro LNG terminal personnel are well trained for LNG emergencies.

Recommendation 47. The TRC recommends that Pieridae make sure that LNG terminal personnel have formal accredited Incident Command Systemtraining before operations begin.

3.4.4 Contingency Planning

A contingency plan gives guidelines and instructions that help with quick responses to emergencies. The success of any contingency plan depends on personnel practicing their roles and responsibilities in pre-planned exercises.

As of the writing of this report, Pieridae had not created a terminal contingency plan, although it has committed to develop and submit the plan to TC and the Canadian Coast Guard at least six months before operations begin.[72] The review will allow Pieridae to:

- combine the contingency plan with existing emergency procedures.
- plan a coordinated response with other local authorities.

The contingency plan should have two parts - vessels and terminal operations when a vessel is alongside. The plan should include various scenarios for events like fire on board, improper cargo transfer, emergency at the terminal, etc.[73]

Pieridae has also committed to prepare a study showing the impact of an accident on a third party that includes remediation and compensation.

Recommendation 48. The TRC recommends that Pieridae consider the results of emergency scenarios in the HR Wallingford *Goldboro LNG Navigation Simulation Study* to include safety strategies in a contingency plan.

[72] *Pieridae TERMPOL Review 3.16 — Contingency Planning*

[73] *TERMPOL Review Process TP 743, 2014* https://www.tc.gc.ca/media/documents/marinesafety/tp743e.pdf

Recommendation 49. The TRC recommends that Pieridae develop and submit the *Contingency Plan* to TC at least 6 months before operations begin.

Recommendation 50. The TRC recommends that Pieridae work with the local community and regulatory agencies to address any gaps in the facility's emergency response plans. Pieridae should submit the *Emergency Response Plan* for the Goldboro LNG project to the TRC at least 6 months prior to operation for review.

Recommendation 51. TRC recommends that Pieridae have safe evacuation and sheltering procedures for emergencies. They should be included in the *Contingency Plan*, *Port Information Book* and *Terminal Operations Manual*.

3.5 LNG and oil spill preparedness and response

In their 2018 submission, Pieridae committed to developing a safety and loss management program before operations begin. This will align with the Canadian Standards Association *CSA Z276 LNG—Production, Storage, and Handling*.

Pieridae will also develop an Emergency Response Plan for the Goldboro project that will cover marine oil spill response (for the release of bunker fuel from LNG carriers) and marine rescue response for the waters near the terminal.

Pieridae's vessel vetting procedures will make sure that LNGC owners follow the 2010 HNS Convention.[74]

3.5.1 LNG release

If a release occurs, the LNG will vaporize and disperse. People and animals in the immediate area can suffocate and develop frostbite due to the extremely low temperature of the gas (LNG changes back to gas at about -160 °C). Vapour clouds will disperse as water and air warm the natural gas. If the vapour cloud is exposed to an ignition source and is ignited, there is potential for direct human and animal deaths. If ignited, the vapour cloud would not expand or explode, but would burn back to its source, resulting in a localized pool fire that could harm people or aquatic life in the thermal radiance zone.

Steps to ensure the integrity of shipboard LNG tanks are included in the IGC Code. The IGC Code provides an international standard for the safe carriage by sea of liquefied gases and certain other substances listed in chapter 19 of the Code, by including the requirements to:

- The design and construction standards of vessels transporting LNG.
- The equipment they should carry to minimize risk to the vessel, its crew and the environment, having regard to the nature of the products involved.

A severe collision, allision, or stranding could lead to cargo tank damage, which could result in uncontrolled release of the product. The release could cause the cargo to evaporate and disperse; the extreme cold could cause brittle fracture of the vessel's hull. The aim of the IGC Code is to minimize this risk as much as possible, based on current knowledge and technology.

The Hazardous and Noxious Substances (HNS) Convention—IMO

[74] *Pieridae TERMPOL Review 3.18 — Hazardous and Noxious Substances*

The HNS Convention was adopted by the IMO in May 1996. It is based on the highly successful Civil Liability and Fund Conventions, which cover pollution damage caused by spills of persistent oil from tankers. In accordance with the original oil pollution compensation regime, the HNS Convention has a two-tier system for paying fines in case of accidents at sea that involve hazardous and noxious substances.

Tier one will be covered by vessel owners' insurance, who would be able to limit their liability. In cases where the insurance does not cover an incident, or is not enough to satisfy the claim, a second tier of compensation will be paid from a Fund, made up of contributions from the receivers of HNS. Contributions will be calculated according to the amount of HNS received in each Member State in the preceding calendar year.

By 2009, the HNS Convention had not entered into force due to a lack of member state ratifications. A second International Conference, held in April 2010, used a Protocol to the HNS Convention (2010 HNS Protocol) to address problems that had prevented many States from approving the original Convention. As of April 2019, 4 states have ratified the 2010 HNS Protocol and eight other states are required to have it enter into force.[75]

Once the 2010 HNS Protocol enters into force, the 1996 Convention, updated by the 2010 Protocol, will be called the "International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea, 2010" (OPRC-HNS).[76]

Transport Canada developed the *Marine Liability and Information Returns Regulations*,[77] which entered into force on December 2, 2016. This was the final step in Canada's implementation of the HNS Convention, requiring receivers of bulk HNS to report for the 2017 calendar year. Canada ratified the Convention in April 2018.

Limitation of Liability

When a release of bulk HNS causes damage, the vessel owners can normally limit their financial liability between 10 million and 100 million Special Drawing Rights (SDR) of the International Monetary Fund (current exchange rate to be calculated), depending on the gross tonnage of the vessel.

The HNS Fund will provide an additional tier of compensation up to a maximum of 250 million SDR (current exchange rate to be calculated), including any amount paid by the vessel owner and his insurer. The IMO HNS Convention sets limits of liability in Articles 9 and 10 of the convention[78].

3.5.2 Oil release

Canada's Marine Oil Spill Preparedness and Response Regime[79] is industry-funded and managed under the National Oil Spill Preparedness and Response Regime. It was designed to make sure that industry has the ability to clean up their own spills.

Under the regime, industry must maintain a 10,000 tonne response capability, covering marine regions south of 60° N latitude. *CSA, 2001,* requires prescribed vessels and oil-handling facilities to have arrangements in place with a TC certified response organization. [80]

As a complement to the industry regime, the CCG can:

- Provide immediate response where required.

---

[75] *IMO HNS Convention and the 2010 Protocol,* http://www.hnsconvention.org/status/
[76] *IMO HNS Convention and the 2010 Protocol* http://www.hnsconvention.org/the-convention/
[77] https://laws-lois.justice.gc.ca/eng/regulations/SOR-2016-307/page-1.html
[78] *IMO HNS Convention Art 9 & 10,* http://www.hnsconvention.org/the-convention/
[79] *TC website* https://www.tc.gc.ca/eng/marinesafety/oep-ers-regime-menu-1780.htm
[80] *Marine Oil Spill and Preparedness Regime — TP 14539/ August 2014*

- Provide help with offshore spills.
- Respond to marine spills north of 60° N latitude.

TC is responsible for:

- Making sure that emergency planning standards and regulations are adequate.
- Making sure that response organizations and oil handling facilities meet standards and regulations.
- Monitoring the effectiveness of the regime and the diligence of response organizations and oil handling facility operations.

Regulatory Requirements for Vessels

The Environmental Response Regulations (SOR/2019-252) require that the following classes of vessels are prescribed for the purposes of subsection 167(1) of the *CSA, 2001:*

(a) oil tankers of 150 gross tonnage or more

(b) vessels, other than oil tankers, of 400 gross tonnage or more that carry oil as cargo or as fuel, and

(c) vessels that carry oil as cargo or as fuel and that are engaged in towing or pushing at least one other vessel that carries oil as cargo or as fuel, if the combined gross tonnage of the vessels is 150 gross tonnage or more.

These vessels are required to have on board an arrangement with a Canadian certified Response Organization and a declaration in the form specified by the Minister, when operating in Canadian waters, as required by subsection 167 (1) of the *CSA, 2001*.

The Eastern Canada Vessel Traffic Services Zones Regulations[81] require vessels to report on a number of items, including the date of expiration of:

- The certificate of insurance or other financial security in respect to the International Convention on Liability for Oil Pollution Damage, 1969.
- The International Oil Pollution Prevention Certificate.
- The International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk; and
- The Certificate of Fitness and the Certificate of Compliance, if any, issued to the ship.

TC MSS Inspectors also check that foreign vessels follow a range of safety requirements, including the need for an arrangement with a certified response organization.

The Goldboro terminal in Country Harbour is in the geographic area of response (GAR) for the certified response organization Point Tupper Marine Services (PTMS), which has the capacity to respond to respond to a spill up to an oil spill up to 10,000 tons.

Canadian Compensation Regime [82]

The Canadian regime of liability and compensation for ship sources of oil pollution consists of both national and international rules that Canada has agreed to. Both are implemented under Part 6 of the *Marine Liability Act* (*MLA).* A key feature of the Canadian regime is the Ship-Source Oil Pollution Fund (SSOPF). The rules setting up the SSOPF and managing it are in Part 7 of the *MLA*. The regime is

[81] https://laws-lois.justice.gc.ca/eng/regulations/SOR-89-99/

[82] http://www.ssopfund.ca/en/international-conventions/the-canadian-compensation-regime

based on the fundamental principle that the ship owner is liable for oil pollution damage caused by the ship — that is, the polluter pays principle.

National Rules

Under the national rules, ship owners are liable for oil pollution damage caused by their vessels up to a limit of liability based on the tonnage of the vessel. For these claims, the rules that limit the liability of ship owners are contained in Part 6 of the *MLA*. The liability of the owner is strict, meaning that they can only avoid liability based on a limited number of defences listed in subsection 77 (3) of the *MLA*. If compensation from the owner is inadequate or not available, claimants can submit their claims to the Administrator of the SSOPF for any amount they cannot recover from the owner, as set out in Part 7 of the *MLA*.

International Rules

The international rules governing the liability of the ship owners for oil spills caused by tankers carrying bulk oil as cargo are:

- 1992 Convention on Civil Liability for Oil Pollution Damage (CLC)
- 1992 Convention on the Establishment of an International Fund for Oil Pollution Damage (Fund Convention).

There is a strict liability regime for bunker spills. Bunker fuel is considered to be any fuel a vessel uses for propulsion or its operations. Canada is a party to the 2001 *International Convention on Civil Liability for Bunker Oil Pollution (Bunkers Convention)*. This means a ship owner can only avoid liability based on a few defences, similar to those under the national and international rules listed in Article 3.3 of the *Bunkers Convention* and Schedule 8 of the *MLA*[83]. The owner may limit liability based on the tonnage of the vessel in accordance with the rules contained in Part 3 of the *MLA*.

Area Response Planning Initiative

Following recommendations of the Tanker Safety Panel's report "*A Review of Canada's Ship Source Oil Spill Preparedness and Response Regime*"[84], Port Hawkesbury and the Strait of Canso were in one of four pilot project areas under the Area Response Planning Initiative. The pilot project goal was to help find the best way to adopt a regional, risk-based preparedness and response system for ship source oil pollution spills across Canada. Using a risk management framework, regional task forces piloted the development of Area Response Plans that allow regulatory flexibility for regional differences and level of risk. The Lessons Learned report for the Area Response Planning is now available. [85]

Fisheries Compensation

With the existing regulatory regime in Canada and around the world, the accidental release of a large quantity of oil from LNG carriers is highly unlikely and would be limited to the vessel's fuel oil. Collisions with oil tanker traffic trading between the Strait of Canso and Halifax are potential sources of oil spills.

If it does happen, the bunker oil could interact with fish and fish habitat, marine mammals, aquatic birds and shoreline habitat, fisheries, aquaculture and marine navigation. Pieridae should develop a Fishery Compensation Plan to make sure that fishers and aqua-culturists are compensated for damage to equipment or loss of access to fishing grounds.

---

[83] *Marine Liability Act* http://laws-lois.justice.gc.ca/eng/acts/M-0.7
[84] *Tanker Safety Expert Panel* www.tc.gc.ca/eng/tankersafetyexpertpanel/menu.htm
[85] *Area Response Planning* https://www.tc.gc.ca/eng/marinesafety/lessons-learned-report-area-response-planning.html

Recommendation 52. The TRC recommends that Pieridae develop a Fishery Compensation Plan in consultation with the local fishing industry, to make sure that fishers and aqua-culturists are compensated for damage to equipment or loss of access to fishing grounds.

4.0 CONCLUSION

This TERMPOL Review focused on marine safety and accident prevention. Its goal was to make sure Pieridae Energy and Goldboro LNG can carry out the marine transportation components of its proposed project in a way that manages risk to a level consistent with Canada's regulatory regime, International Conventions and Codes, safety standards and industry best practices.

Canada has many tools in place to make sure that vessels entering Canadian waters follow international and domestic requirements and do not pose a risk to safety or the environment. In addition to existing marine laws, regulations and international frameworks, Pieridae's proposed safety measures will support safer shipping for the proposed Goldboro Project.

With Pieridae's vetting and acceptance process, operators of LNG carrier must make additional safety improvements. As the terminal operator, Pieridae has the authority to grant or deny permission for vessels to berth. This is a significant tool that can be used to compel vessels to follow the vetting process and terminal procedures.

The proposed route provides enough clearance for vessel maneuvers and allow LNG carriers to navigate safely. The channel depth and width exceeds those required for the LNG carriers that the terminal will accommodate.

The TRC understands the importance of keeping community and stakeholders up-to-date with the project development. Pieridae should continue to engage communities, Indigenous groups and marine stakeholders to build awareness of the project's impacts.

While the TRC does not see the increase in marine traffic levels to be a safety issue, it does support additional measures that would promote safe shared use of the project's shipping route. These measures include:

- Applying thorough vetting and compatibility criteria before allowing a vessel at the terminal.
- Using tugs with the right characteristics to escort the LNG carriers to and from their berths.
- Setting limiting environmental criteria for arrivals, departures and cargo transfer.
- Updating CHS charts and nautical publications for the area before terminal operations begin.
- Having all licensed marine pilots for the area go through simulation or manned model training before terminal operations begin.
- Consider creating safety zones around the LNG carriers and the terminal for an improved level of safety for the vessels, lives and nearby property. This is consistent with best practices at similar, fully operational LNG terminals.

In closing, any project can pose some degree of risk but, after reviewing Pieridae's studies and its commitments, the TRC has not identified any major concerns for the LNG carriers, proposed route, navigability, other waterway users, cargo transfer operations or marine terminal operations.

The TRC has developed 30 findings and 52 recommendations in response to Pieridae's submission for Goldboro terminal. This includes proposed actions for Pieridae to undertake. With Pieridae's commitments, this will provide a higher level of safety for LNGC operations and the potential increase in traffic.

If the project goes ahead, the TRC expects Pieridae to fully implement the commitments detailed in the TERMPOL submission for the Goldboro LNG terminal. However, if at any time Pieridae changes the project's operational criteria or characteristics, or needs to adjust its commitments, the relevant authorities might need to do further review and analysis.

A complete list of the findings and recommendations from the TRC is included in Appendix 1.

APPENDIX 1: FINDINGS AND RECOMMENDATIONS

Findings are statements or observations from the TRC that capture, reinforce or comment on Pieridae's own recommendations and key commitments. They may highlight actions currently underway by a department or authority related to a particular marine service program or regulated area.

Recommendations are proposed actions for Pieridae that would improve marine safety beyond the current regulatory regime.

Findings

Finding 1. The TRC recognizes that Pieridae will have to discuss timelines with all relevant authorities for acting on the recommendations outlined in this report.(Section 3.0)

Finding 2. Tanker vetting, the Ship Inspection Report Programme and Chemical Distribution Institute-Marine processes are generally accepted tools that terminals and LNG companies use to check compliance and improve safety. (Section 3.1.2)

Finding 3. Pieridae did not include any *Marine Personnel Regulations* requirements for crew training and qualification in its submission. (Section 3.1.4)

Finding 4. The two existing offshore pipelines that moved natural gas to the former Goldboro Gas Plant will likely remain. Both Encana Corporation and ExxonMobil have submitted applications to the Canada Energy Regulator to abandon the pipelines and have started decommissioning them. Both companies have explained that the pipelines would be pigged and flushed, filled with seawater, and left inert on the seafloor. (Section 3.2.1)

Finding 5. The TRC notes that the harbour is well marked with buoys and meets the needs of the current marine traffic. Any proposed changes, or additions, to the aids to navigation system requires input from the Canadian Coast Guard, Aids to Navigation Program, to make sure that the level of service is maintained for existing users in the area. (Section 3.2.2.3)

Finding 6. The proposed Goldboro LNG terminal is not located in a compulsory pilotage area. (Section 3.2.2.4)

Finding 7. CHS would be impacted by a large new marine terminal.(Section 3.2.2.6)

Finding 8. The TRC recognizes that the present charts of the area are inadequate for the safe navigation of the predicted increase and type of vessel traffic. (Section 3.2.2.6)

Finding 9. The TRC believes that installing a smart buoy [Ocean Data AcquisitionSystem (ODAS) / weather buoy)] near the proposed pilot station would provide a real-time analysis of metocean conditions. (Section 3.2.2.7)

Finding 10. The TRC believes that LNG carriers would be safer if they have an "Ice Advisor" on board when travelling in ice covered waters. (Section 3.2.2.8)

Finding 11. The TRC agrees that the overall conclusions, recommendations and supplementary considerations of HR Wallingford's *Navigation Simulation Study* would improve the safety of marine navigation in the TERMPOL scoping area. (Section 3.2.3.2)

Finding 12. The TRC recognizes that not all vessels operating in the area are required to be fitted with AIS (Section 3.2.4)

Finding 13. For the offshore part of the LNG carrier's transit, the additional vessels can be easily be absorbed in the existing network. LNGCs are subject to a strict vetting process by charterers so the TRC is not concerned that the project vessels will increase the risk to the network. (Section 3.2.4)

Finding 14. Pieridae has an ongoing communication plan and is engaging with local communities, including all water users. There is also a working group with local fishermen which will continue throughout the plant's operational life. (Section 3.2.4)

Finding 15. The TRC agrees with HR Wallingford's conclusion that there is enough sea room for manoeuvring in the transit waterway. (Section 3.3.2)

Finding 16. Pieridae will refer to and incorporate relevant standards, recommendations and guidelines of various international authorities like those produced by OCIMF and PIANC for berthing and mooring procedures. (Section 3.3.2)

Finding 17. The lighting plan was not completed at the time of writing this report. Lighting plans are key to making sure that the lighting scheme block the field of vision from the bridge of an arriving or departing LNG carrier. (Section 3.3.2)

Finding 18. Berthing and mooring procedures will help the TRC to review the *Port Information Book* and *Terminal Operations Manual* when the documents are submitted. (Section 3.3.2)

Finding 19. The TRC noted that the risk assessment submitted by Pieridae did not include the following risks in their analysis, as per TP 743. [86] (Section 3.4.1)

Finding 20. The TRC has noted that Pieridae did not analyze the risks and mitigation measures related to a gas cloud release. (Section 3.4.2)

Finding 21. There are no Vessel Traffic Services (VTS) in the Goldboro scoping area. If Pieridae wants VTS coverage for Country Harbour, any costs associated with this would be at their expense as the port would be for a single user. (Section 3.4.2.3)

Finding 22. The TRC noted that MCTS could support either the establishment of a new vessel traffic services zone or an extension of the existing Canso Vessel Traffic Services Zone. (Section 3.4.2.3)

Finding 23. The TRC agrees with Pieridae's proposal and HR Wallingford's simulations of having four tugs to escort LNGCs. (Section 3.4.2.3)

Finding 24. The TRC agree that, based on the simulations, using escort tugs will help to reduce the risk of grounding. (Section 3.4.2.4)

---

[86] *TERMPOL Review Process TP 743, 2014* https://www.tc.gc.ca/media/documents/marinesafety/tp743e.pdf

Finding 25. The TRC noted that Pieridae has committed to providing escort tugs with a robust firefighting capability. (section 3.4.2.4)

Finding 26. The TRC agrees it would be prudent to have APA pilots for safe berthing and un-berthing at the proposed terminal. (Section 3.4.2.5)

Finding 27. The TRC recognizes that there are many ways to reduce risk when travelling to and from the terminal. The vessel's bridge management team and the pilots use RADAR and electronic aids to monitor the vessel's position, speed and rate of turn to safely direct the vessel. The APA can also restrict a vessel from receiving a pilot if there is less than 2 nm of visibility. (Section 3.4.2.5)

Finding 28. The TRC noted the consistent use of TC's registered trademark term "Port Authority/ Administration portuaire" to describe Goldboro in the submission documentation. As Goldboro is not a recognized public port under the *CMA*—the use of the term Port Authority/Administration portuaire" could be misconstrued by the public and would be an infringement of Sections 7 and 9 of the *Trademark Act*. (Section 3.4.2.6)

Finding 29. TRC recognizes the SANDIA Report[87] as an internationally recognized reference document that identifies the creation of exclusion zones as a way to manage risks relating to thermal hazards, in the event of an accidental or deliberate LNG release. (Section 3.4.2.7)

Finding 30. The TRC noted that Pieridae's analysis of the exclusion zone around the LNG at berth is based on existing zones from other jurisdictions. (Section 3.4.2.7)

Recommendations

Recommendation 1. The TRC recommends that Pieridae notify the relevant authorities if it wishes to alter any parts of the project, operational criteria, or characteristics, so the authorities can review any safety impacts that would result from the changes. (Section 3.0)

Recommendation 2. The TRC recommends that Pieridae identify all specific Canadian requirements that are not currently part of International Conventions, Codes or standards. Pieridae should emphasize these requirements within the *Port Information Book* for vessels calling at the Goldboro LNG terminal. (Section 3.1.1)

Recommendation 3. The TRC recommends that Pieridae introduce and apply vetting standards, ensure all vessels calling at its terminal have an up-to-date Ship Inspection Report Programme certificate and meet the terminal's compatibility criteria. Pieridae should incorporate its vetting standards within the *Port Information Book* . (Section 3.1.2)

Recommendation 4. The TRC recommends that Pieridae requires all vessels calling their marine terminal to conform to the Tanker Management Self-Assessment program from the Oil Companies International Marine Forum (OCIMF). (Section 3.1.2)

Recommendation 5. The TRC recommends that Pieridae use the Ship-Shore Compatibility Questionnaire as published by the Society of International Gas Tanker and Terminal Operators (SIGTTO) at the pre-fixing stage to see if a vessel can be safely berthed at the terminal (Section 3.1.2)

---

[87] *Sandia Report. Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water. Sandia National Laboratories, 2004. Albuquerque, New Mexico*

Recommendation 6. The TRC recommends that all shipboard personnel be trained to meet SIGTTO's *LNG Shipping Competency Standards* and the *SIGTTO LNG and LPG Experience Matrix Guidelines for Use*. (Section 3.1.4)

Recommendation 7. The TRC recommends that Pieridae evaluate the proposed risk mitigation measures related to the abandoned Encana and ExxonMobil sub-sea gas pipelines located near the terminal; in particular, the risks associated with a LNG carrier dropping anchor over the sub-sea pipelines and make the related updates to its *Port Information Book* and *Terminal Operational Manual*. (Section 3.2.1)

Recommendation 8. The TRC recommends that Pieridae request a Pilotage Risk Management Methodology review prior or during construction of the terminal. (Section 3.2.2.4)

Recommendation 9. The TRC recommends that Pieridae consult with CHS to prepare and submit the charting survey data at the earlier stage possible as the process for charting could take 3 to 4 years. (Section 3.2.2.6)

Recommendation 10. Pieridae should decide on funding sources for the smart buoy [Ocean Data Acquisition System (ODAS buoy/weather buoy)], in consultation with Environment and Climate Change Canada. (Section 3.2.2.7)

Recommendation 11. Pieridae should confirm the metocean limiting conditions, including factors affecting visibility that would affect operations and include them in the *Port Information Book* and *Terminal Operations Manual*. (Section 3.2.2.7)

Recommendation 12. The TRC recommends that Pieridae require all LNG carriers that call at the proposed terminal to follow the *Joint Industry-Government Guidelines for the Control of Oil Tankers and Bulk Chemical Carriers in Ice Control Zones of Eastern Canada* in an active ice control zone as if the vessels were laden oil tankers (section 3.2.2.8)

Recommendation 13. The TRC recommends that Pieridae investigate the "non-AIS" vessels that travel in the scoping area and pay close attention to seasonal fishing operations. (Section 3.2.4)

Recommendation 14. The TRC recommends that Pieridae expands its study on the impact to coastal communities. (Section 3.2.4)

Recommendation 15. The TRC recommends that Pieridae continue its engagement through the working group with the local fishermen. (Section 3.2.4)

Recommendation 16. The TRC recommends that Pieridae make sure that vessels calling Goldboro terminal have all relevant Navigational Warnings before they enter Canadian waters. This will make sure there are no conflicts with any Royal Canadian Navy exercises or other activities in the area. (Section 3.2.4)

Recommendation 17. The TRC recommends that Pieridae include references to OCIMF and PIANC checklists and guidelines in Goldboro LNG's *Port Information B*ook and *Terminal Operations Manual*. (Section 3.3.2)

Recommendation 18. The TRC recommends that Pieridae implement the recommendation from the *Goldboro LNG Navigation Simulation Study*. (Section 3.3.2)

Recommendation 19. The TRC recommends that Pieridae submit its proposed terminal lighting plan to the TRC to assess interactions with existing lights in the area. The plan should be submitted as soon as it is available and at least 6 months before operations begin. (Section 3.3.2)

Recommendation 20. The TRC recommends that Pieridae establish berthing and mooring procedures before submitting the Port Information Book and Terminal Operations Manual to TC so the department can take them into account when reviewing the documents. (Section 3.3.2)

Recommendation 21. The TRC recommends that Pieridae incorporate docking boards into the final design in order to assist pilots in determining their distance off the jetty and speed of approach towards the berth. (Section 3.3.2)

Recommendation 22. The TRC recommends Pieridae develop operating procedures and make sure that all staff are trained for safe cargo transfer operations. (Section 3.3.3)

Recommendation 23. The TRC recommends that Pieridae ensure that all terminal personnel are trained to the OCIMF recommended standard found in the *'Marine Terminal Operator Competence and Training Guide.* (Section 3.3.3)

Recommendation 24. Pieridae should incorporate the SIGTTO Ship/Shore Safety Check List in their *Terminal Operations Manual*. (Section 3.3.3)

Recommendation 25. Once the cargo transfer system design is finalized and before submitting the *Terminal Operations Manual,* Pieridae should advise TC of any changes to the plans. This will help TC to decide if further reviews are necessary. (Section 3.3.3)

Recommendation 26. The TRC recommends that Pieridae provide them with a copy of the *Port Information Book* (PIB) at least 6 months before the terminal begins operations. This will allow for a speedy review and help make sure that all procedures and mitigation measures are in place before operations begin. The PIB must be carried on board any LNGC calling at the Goldboro terminal. (Section 3.3.4)

Recommendation 27. Pieridae should make sure that all policies and procedures based on the HR Wallingford Goldboro LNG *Navigation Simulation Report* are completed in time to be included in the *Port Information Book* and *Terminal Operations Manual*. (Section 3.3.5)

Recommendation 28. The TRC recommends that Pieridae provide them with a copy of the *Terminal Operations Manual* at least 6 months before terminal operations begin, so that TC can make sure that all procedures and contingency plans are in place before operations begin. (Section 3.3.5)

Recommendation 29. The TRC recommends that Pieridae conduct an additional risk assessment on the components listed in Finding 19 (section 3.4.1)

Recommendation 30. The TRC recommends that Pieridae update the risk analysis with the likelihood of a gas cloud release as required by TERMPOL TP 743 as per section 3.5.2.2 Hazardous and noxious substances. This analysis should include the geographical boundaries of an uncontrolled release of cargo. Any mitigations should be included in Goldboro's *Contingency Plan*. (Section 3.4.2)

Recommendation 31. The TRC recommends that Pieridae work with the Canadian Coast Guard to discuss any proposed changes or additions to the aids to navigation system to ensure that a continued level of service is maintained for the existing users in the area. (Section 3.4.2.1)

Recommendation 32. Pieridae should consult with Environment and Climate Change Canada to discuss the requirements and funding sources for a smart buoy (Ocean Data Acquisition System buoy/weather buoy) at the pilot boarding station. (Section 3.4.2.2)

Recommendation 33. Pieridae should confirm the metocean limits identified in the simulations and include them in the *Port Information Book* and *Terminal Operations Manual*. (Section 3.4.2.2)

Recommendation 34. For VTS and RADAR coverage, the TRC recommends that Pieridae request a study from CCG MCTS. The range and site location for VTS, RADAR and radio coverage would need to be discussed by Pieridae and the MCTS. As the new service would be for a single user, Pieridae would need to pay any associated fees. . (Section 3.4.2.3)

Recommendation 35. The TRC recommends that Pieridae, in addition to looking into establishing a precautionary area, look into other solutions as per IMO Resolution A.572(14). Pieridae should speak with TC's regional office if the risk analysis shows the needs for such a measure. (Section 3.4.2.3)

Recommendation 36. The TRC recommends that tugs have load cells so they can measure the pulling forces on the line when they are tethered to a vessel. (Section 3.4.2.4)

Recommendation 37. The TRC recommends that tug design be standardized to allow for seamless tug substitutions and interchangeable parts and equipment to make sure there are enough tugs available at all times. (Section 3.4.2.4)

Recommendation 38. The TRC recommends that all tugs be equipped with render/recover winches to increase capabilities for escort duties and berthing (Section 3.4.2.4)

Recommendation 39. The TRC recommends that all escort tugs be fitted with rescue equipment to assist LNGCs, including equipment for emergency towing. Carriers should also have equipment that allows towing gear to connect quickly and safely. It is critical that LNGCs and escort tugs are compatible. (Section 3.4.2.4)

Recommendation 40. The TRC recommends Pieridae have all tugs fitted with the latest industry standard firefighting equipment (Section 3.4.2.4)

Recommendation 41. The TRC recommends Pieridae make sure all project carriers meet the Emergency Towing Procedures requirements of SOLAS Regulation 11-1/3-4 (IMO Resolution 258 [84]). (Section 3.4.2.4)

Recommendation 42. The TRC recommends that all licensed pilots for the area have simulation or manned model training before the terminal begins operating.(Section 3.4.2.5)

Recommendation 43. Pieridae should ensure that all LNG carriers have a local marine expert to assist the vessel to the berth, if the APA decides that Goldboro does not need to be a compulsory pilotage area (Section 3.4.2.5)

Recommendation 44. As per Finding 28 in this report, the TRC recommends that Pieridae change all references to the trademark term "Port Authority/Administration portuaire" in all Goldboro related documentation to read "Port Management" or the generic position of the Harbour Master as the designated person/employee in charge of port operations. (Section 3.4.2.6)

Recommendation 45. With respect to the 200 metres exclusion zone, the TRC recommends that Pieridae conduct a study using methods like SANDIA. The study should consider local conditions and include input from waterway users, as a way to justify the need for, and size of, a safety zone. Information regarding the safety zone is to be included in the Port Information Book and the Terminal Operations Manual. (Section 3.4.2.7)

Recommendation 46. The TRC recommends that Pieridae make sure that all Goldboro LNG terminal personnel are well trained for LNG emergencies. (Section 3.4.2.8)

Recommendation 47. The TRC recommends that Pieridae ensure carrier and terminal personnel receive formal accredited Incident Command System training before operations begin. (Section 3.4.2.8)

Recommendation 48. The TRC recommends that Pieridae consider the results of emergency scenarios in the HR Wallingford *Goldboro LNG Navigation Simulation Study* to include safety strategies in a contingency plan. (Section 3.4.3)

Recommendation 49. The TRC recommends that Pieridae develop and submit the *Contingency Plan* to TC at least 6 months before operations begin. (Section 3.4.3)

Recommendation 50. The TRC recommends that Pieridae work with the local community and regulatory agencies to address any gaps in the facility's emergency response plans. Pieridae should submit the *Emergency Response Plan* for the Goldboro LNG project to the TRC at least 6 months prior to operation for review. (Section 3.4.3)

Recommendation 51. TRC recommends that Pieridae have safe evacuation and sheltering procedures for emergencies. They should be included in the *Contingency Plan*, *Port Information Book* and *Terminal Operations Manual.* (Section 3.4.3)

Recommendation 52. The TRC recommends that Pieridae develop a Fishery Compensation Plan in consultation with the local fishing industry, to make sure that fishers and aqua-culturists are compensated for damage to equipment or loss of access to fishing grounds. (Section3.5.2)

APPENDIX 2: DOCUMENTS SUBMITTED FOR TERMPOL REVIEW PROCESS

May 05, 2016, Submission			
Document Title	**Document Number**	**Revision**	**Issue Date**
Meteorological Data Report	13-1250-0139-014-Rev0	Rev 0	2016-02
Goldboro LNG Project – Bathymetry Survey Report	13-1250-0139-CSR-REP-0009	Rev 0	2015-06-16
Metocean Study Final Data Report	13-1250-0139-GAL-REP-0011	Rev 0	2015-09-04
Jetty Marine Structures Basis of Design	188479-400-MA-BD-00001	C	2015-12-07
Material Offloading Facility Marine Structures – Basis of Design	188479-400-MA-BD-00002	C	2015-12-07
LNG Berth Utilization and Down Time Analysis	188479-400-MA-RP-00001	B	2015-12-18
Berthing and Mooring Analyses	188479-400-MA-RP-00002	B	2015-11-25
Proof of Concept Manoeuvring Simulations Report	188479-400-MA-RP-00003	B	2015-12-10
Updated Metocean Report	188479-400-MA-RP-00005	B	2015-12-10
Specifications - Mooring Hardware	188479-400-MA-SP-00007	D	2016-01-05
TERMPOL Report Review Submission, Submission 1 - Summary	GPL-PEL-TNO-0002_00		2016-04
July 26, 2018, Submission			
3.2 Marine Traffic Survey	DJR5960-RT101- R02-00	Rev 1	2018-07-18
3.3 Route Analysis, Approach Characteristics & Navigability Surrey	GPL-PEL-MAR-RPT-0008	Rev 0	2018-07-06

3.4 Special Underkeel Clearance	DJR5960-RT102- R02-00	Rev 1	2018-07-18
3.5 Transit Time & Delay Survey	GPL-PEL-MAR-RPT-0001	Rev 0	2018-07-06
3.6 Casualty Data Survey	DJR5960-RT103- R02-00	Rev 1	2018-07-16
3.7 Vessel Specifications	GPL-PEL-MAR-RPT-0002	Rev 0	2018-07-06
3.8 Site Plans & Technical Data	GPL-PEL-MAR-RPT-0003	Rev 0	2018-07-06
3.9 Cargo Transfer Manual	GPL-PEL-MAR-RPT-0004	Rev 0	2018-07-06
3.10 Channel & Manoeuvring & Anchorage Elem ents (Proof of Concept Manoeuvring Simulations Report)	188479-400-MA-RP-00003	B	2015-12-10
3.11 Berth Procedures & Provisions	GPL-PEL-MAR-RPT-0005	Rev 0	2018-07-06
3.13 General Risk Analysis & Intended Methods of Reducing Risks	DJR5960-RT104- R02-00	Rev 1	2018-07-16
3.14 Port Information Book & 3.15 Terminal Operations Manual	GPL-PEL-MAR-RPT-0006	Rev 0	2018-07-24
3.16 Contingency Planning	GPL-PEL-MAR-RPT-0007	Rev 0	2018-07-06
3.18 Hazardous & Noxious Substances Considerations	DJR5960-RT105- R02-00	Rev 1	2018-07-16
Goldboro LNG – Navigation Simulation Study	DJR5960-RT001- R02-00	Rev 2	2019-03-08

APPENDIX 3: DESIGN VESSELS

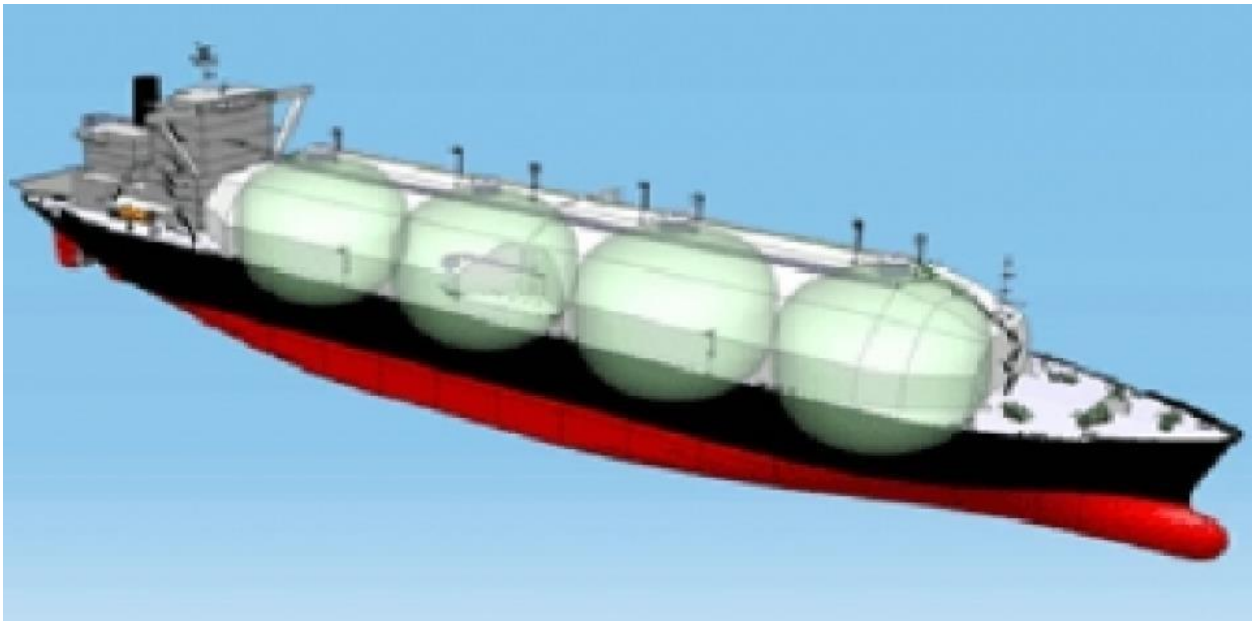
According to Pieridae, the Goldboro LNG facility will include a jetty with two loading platforms that can berth LNG carriers ranging from 125,000 m3 to 266,000 m3."[88] There will be two types of LNGCs calling at Goldboro, with either spherical tanks or membrane tanks. These project vessels are detailed below.

Table A3-1 Design Vessel Specifications

Vessel Capacity	125,000 m ^{3}	177,000 m ^{3}	216,000 m ^{3}	266,000 m ^{3}
Containment	Spherical	Spherical/ Membrane	Membrane	Membrane
LOA (m)	285.3	300	315	345
LBP (m)	273.4	286.5	302	332
Beam (m)	43.7	52	50	53.8
Moulded Depth (m)	25	28	27	27
Loaded Draft (m)	11.5	11.7	12	12
Ballast Draft (m)	10	9.5	9.4	9.6
Loaded Displacement (mt)	102804	128533	146054	178564
Ballast Displacement (mt)	82500	98887	111900	141990
Fore Fender Limit (m)	38.8	60.1	59.6	60
Aft Fender limit	81.7	95.8	98.4	104
Type of Line	Steel Wire	HMPE*	HMPE*	HMPE*
Strength of Line - BL (t)	132	137	137	137
Line Diameter (mm)	44	44	44	44
Max Number of Lines/Side	16	18	20	20
Tail Type of Line	Nylon	Nylon	Nylon	Nylon
Tail Strength (t)	188	188	188	188
Tail Diameter (mm)	110	110	110	110
Tail Length (m)	11	11	11	11
Loaded Longitudinal Wind Area (m 2)	6450	9918	7130	8759
Loaded Transverse Wind Area (m 2)	783	1943	1510	1612
Ballast Longitudinal Wind Area (m 2)	6865	10478	8000	9552
Ballast Transverse Wind Area (m 2)	850	2055	1650	1741
Manifold Vertical Above Deck (m)	4.2	4	4.9	5.2
Manifold Horizontal from bow (m)	123	137.2	156.9	172.5
Manifold Horizontal from stern (m)	162.4	162.8	158.1	172.5

[88] *Pieridae TERMPOL Review 3.7 - Vessels Specifications*

* HMPE - high-modulus polyethylene. Commonly used for ships' hawsers and cables as a lighter alternative to steel wires.

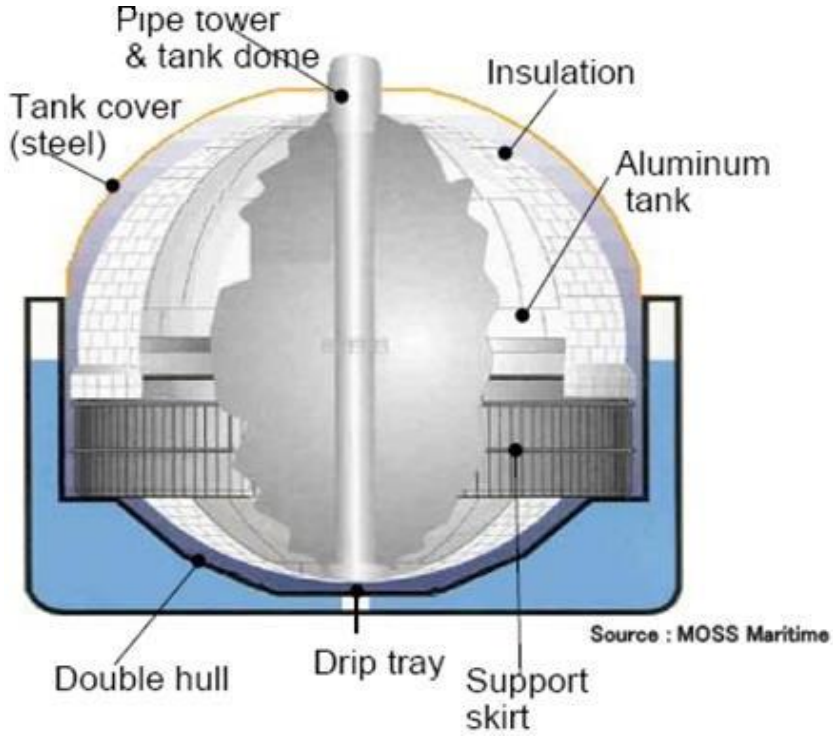


Typical 125,000 m³ LNGC with Spherical Containment Tanks

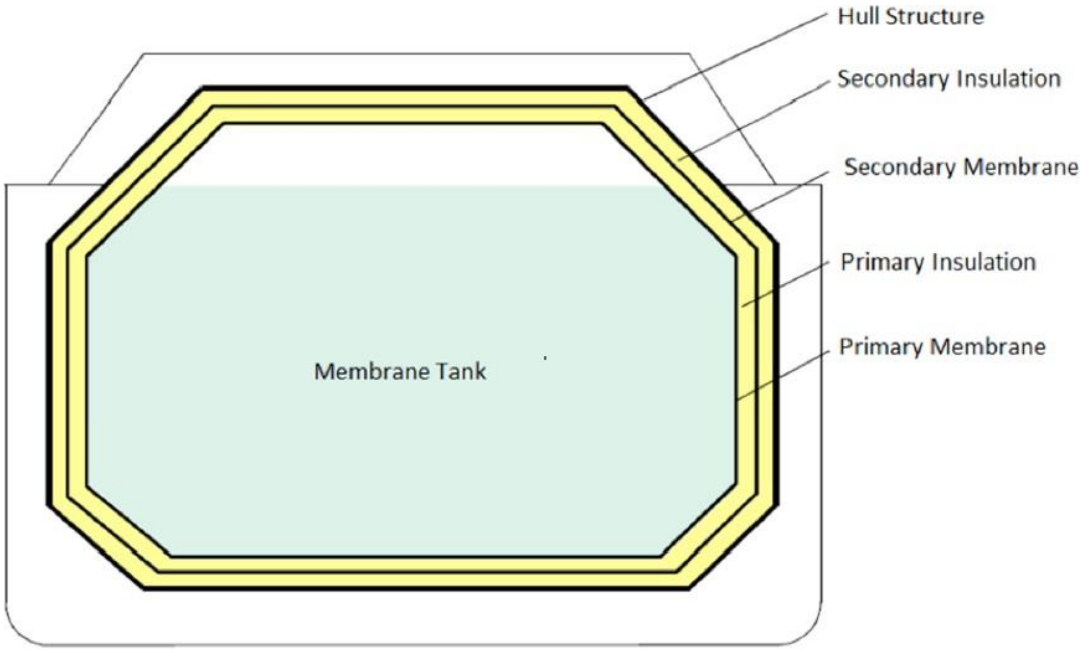
Typical 125,000 m³ LNGC in Operation

Typical 216,000 m³ LNGC with Membrane Type Containment

The spherical, or Moss type, tanks will be fitted on smaller carriers, and the membrane type on larger vessels. Below are cross-section images of both tanks.



Representation of Moss Tank Cargo Containment System



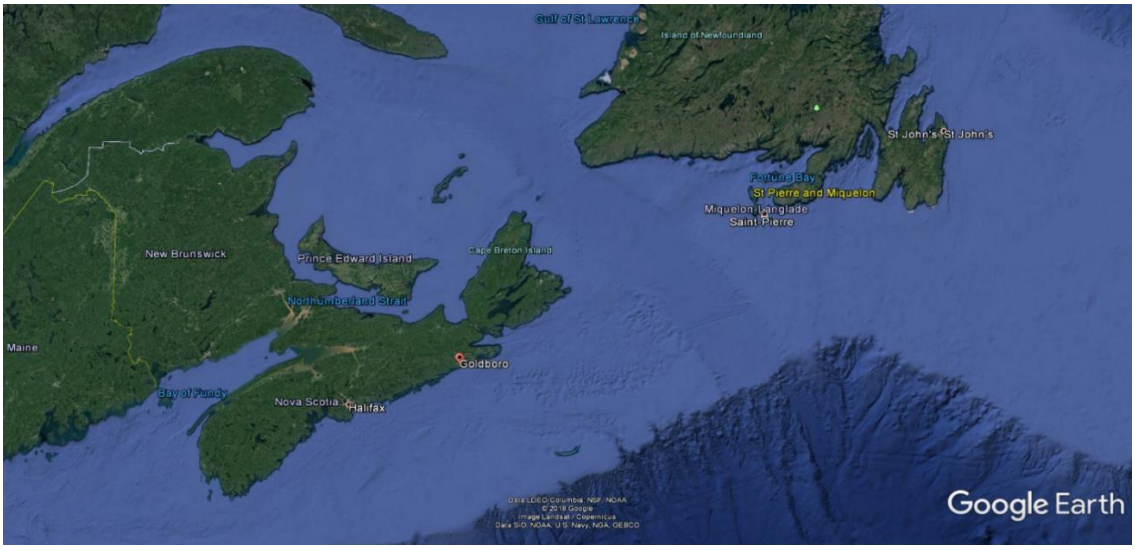
Representation of Membrane Tank Cargo Containment System [89]

Inside the membrane tank of a typical 266,000 m3 LNG carrier

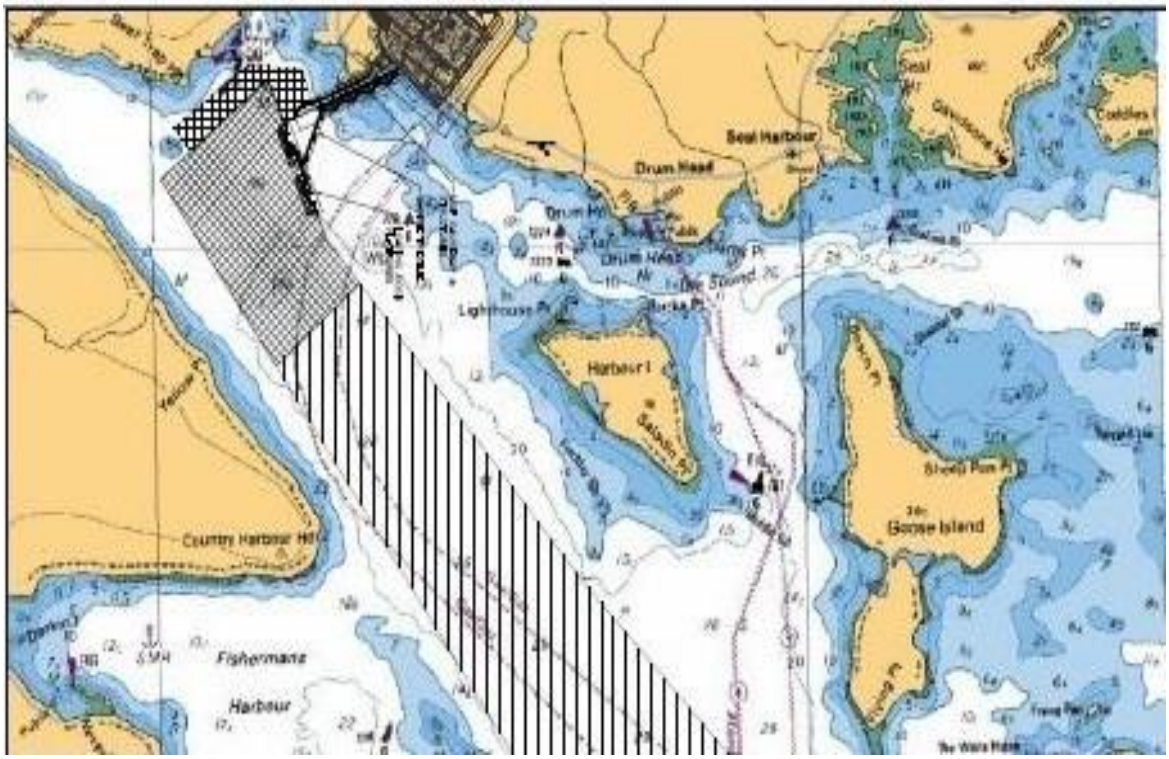
[89] *TERMPOL 3.7*

APPENDIX 4: TERMINAL AND NAVIGATION INFORMATION

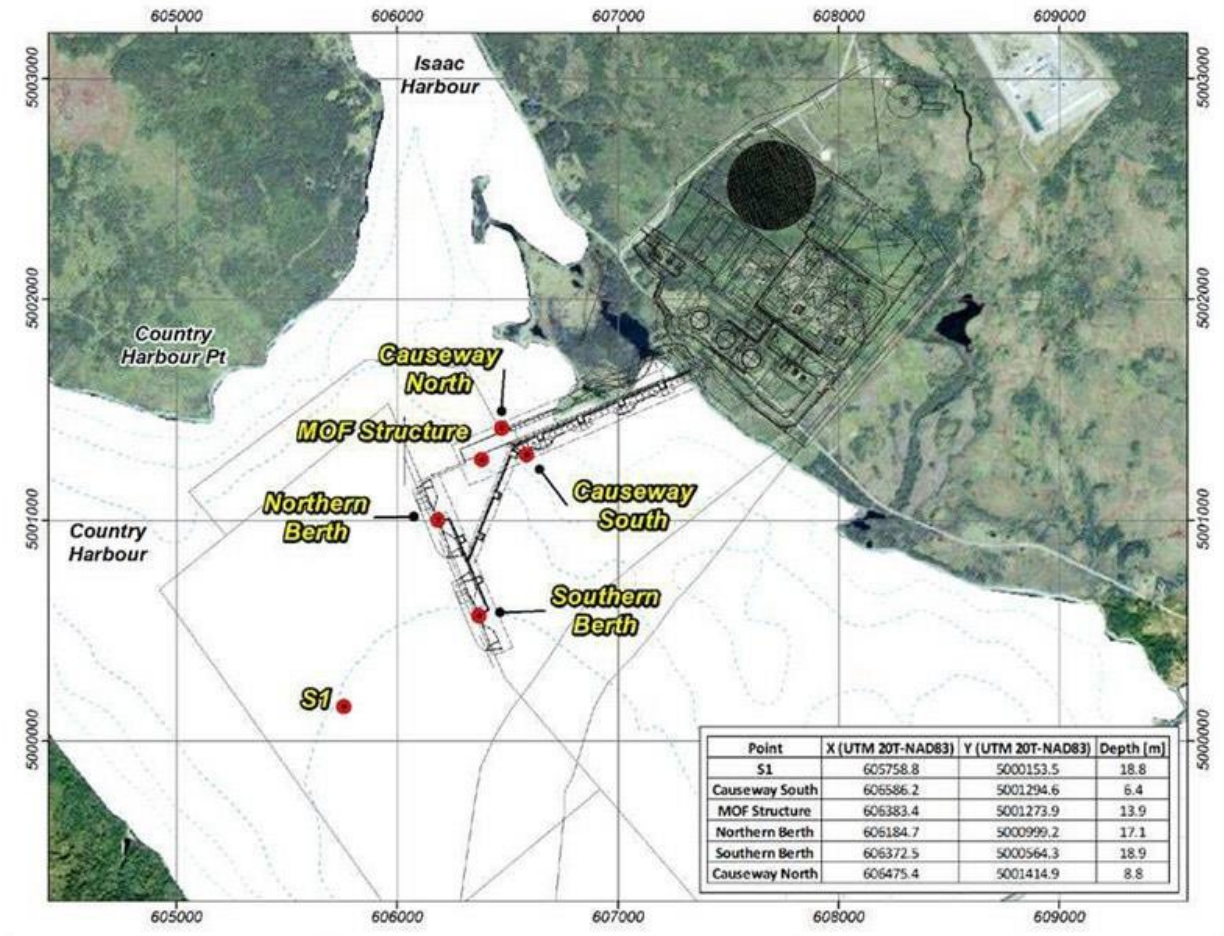
The proposed project site is located on the Eastern Shore of Nova Scotia, approximately 160 kilometres northeast of Halifax, in the community of Goldboro.



Overview of Country Harbour and proposed terminal location

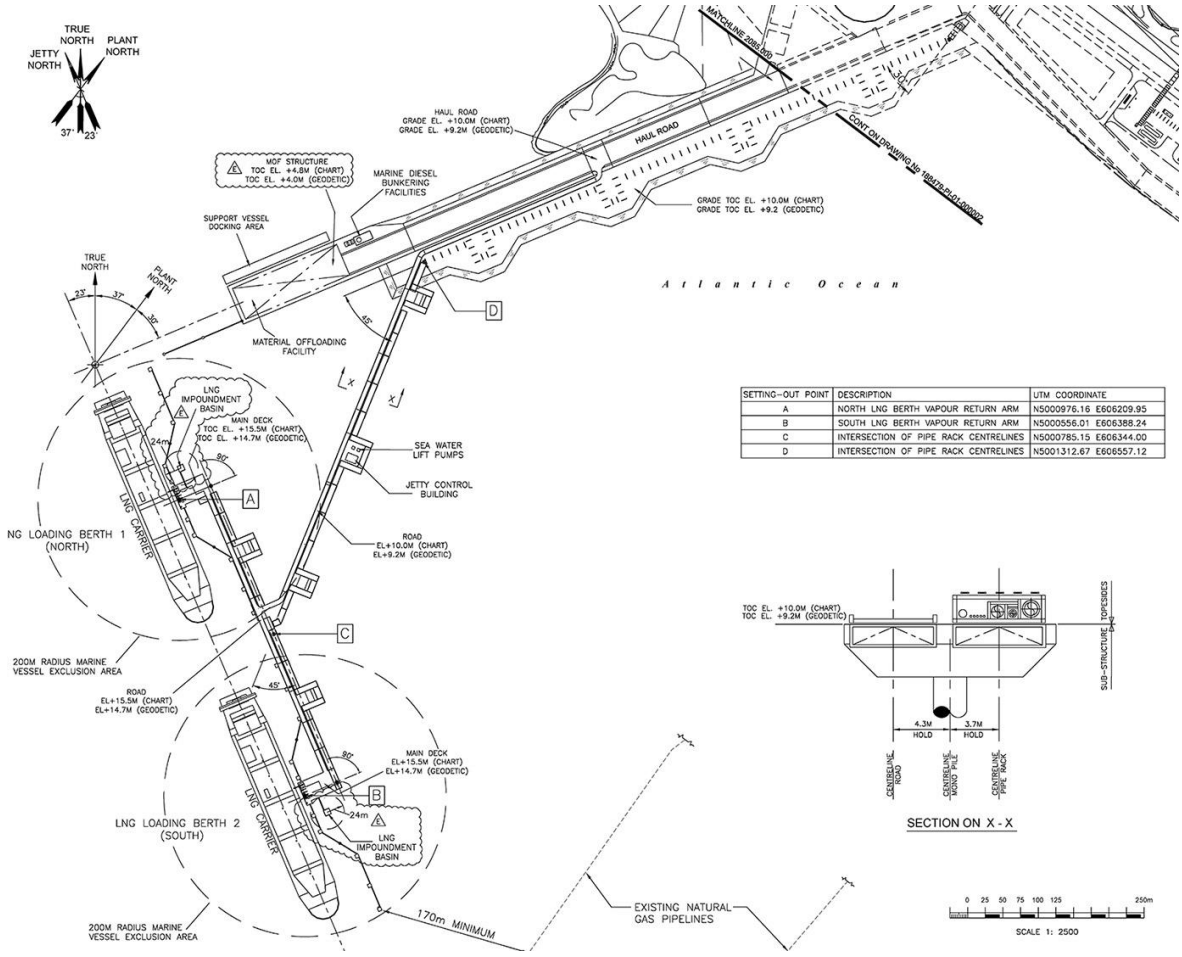


Proposed footprint of the jetty, submitted by Pieridae [90]



Point	X (UTM 20T-NAD83)	Y (UTM 20T-NAD83)	Depth [m]
S1	605758.8	5000153.5	18.8
Causeway South	606586.2	5001294.6	6.4
MOF Structure	606383.4	5001273.9	13.9
Northern Berth	606184.7	5000999.2	17.1
Southern Berth	606372.5	5000564.3	18.9
Causeway North	606475.4	5001414.9	8.8

[90] *Source: Pieridae Energy TERMPOL Review, 3.8 – Site Plans and Technical Data*



SETTING-OUT POINT	DESCRIPTION	UTM COORDINATE
A	NORTH LNG BERTH VAPOUR RETURN ARM	N5000976.16 E606209.95
B	SOUTH LNG BERTH VAPOUR RETURN ARM	N5000556.01 E606388.24
C	INTERSECTION OF PIPE RACK CENTRELINES	N5000785.15 E606344.00
D	INTERSECTION OF PIPE RACK CENTRELINES	N5001312.67 E606557.12

APPENDIX 5: GOLDBORO LNG NAVIGATION SIMULATION STUDY

Conclusions and Recommendations

As mentioned in in the section 3.2.3, to support submission, Pieridae commissioned HR Wallingford to conduct a *General Risk Analysis* and to produce a *Navigation Simulation Study*. From November 19–24, 2018, members of the TRC participated in the simulations in Howbery Park, Wallingford, United Kingdom. The final report, *Goldboro LNG Navigation Simulation Study*, was submitted to the TRC on April 2, 2019.

HR Wallingford created a geographic model of the proposed terminal and surrounding area, with the proposed marine terminal layout that was developed during the Front End Engineering Design Phase (FEED) studies completed in 2015.[91]

The simulations included the FEED berth alignments that factored in the prevailing weather, wind, sea conditions, tides & currents, with seasonal variations for the safe berthing and un-berthing of vessels at the terminal. HR Wallingford conducted 41 simulations including 28 completed standard manoeuvres, made up of 13 arrivals and 15 departures.

The TRC considered each HR Wallingford recommendation from the *Goldboro LNG Navigation Simulation Study* and developed findings and recommendations for Goldboro terminal which are discussed in section 3.4.2 Intended Methods of Reducing Risks.

Below is an extract of the conclusions and recommendations from Pieridae's *Navigation Simulation Study*:

Conclusions

The simulations confirmed that maritime access to and from the proposed terminal is safe and unrestricted for all the simulated vessels, with minimum natural depths along the approach and departure routes generally in excess of 20m.

Adequate manoeuvring space was found to be available to enable vessels to be manoeuvred on to and off the relevant berth without interacting with a moored vessel on the adjacent berth. Adequate, naturally deep, manoeuvring space was found to be available to provide flexibility for the ship handler to swing to port or starboard on arrival, for either berth.

Access to the South Berth was confirmed as being more straightforward, but there were no significant difficulties were encountered in operation to and from the North Berth.

[91] *Pieridae Energy TERMPOL Review – Module 3.10 Channel and Manoeuvring and Anchorage Elements (188479-400-MA-RP-00003 Proof of Concept Manoeuvring Simulations Report)*

Limiting environmental conditions

The jetty berthing line is aligned with the dominant, incident wave direction; however, assisting tugs operating in push mode at the vessel's hull are fully exposed to waves. As expected, the key potential constraint on marine operations was found to be the performance of tugs in higher wave conditions, particularly when tugs were operating in push mode.

The simulations demonstrated that operations with tugs in push mode become more difficult above significant wave height of 1m, with a peak period of about 8 to 9 seconds. In such cases, all parties involved in the manoeuvring operations should be made aware of possible issues prior to commencing any arrival or departure manoeuvres.

Although it was found possible to complete arrival and departure manoeuvres in higher wave conditions, these operations were effectively carried out with 2 tugs working on lines. The tugs operating in push mode were largely ineffective and therefore there was no reserve tug power available in the event of a tug failure.

The simulations also demonstrated that provided that tugs were operating in appropriate wave conditions and steady wind speeds of 25 knots or less, the wind direction was found to be largely immaterial.

Tug power

The 70t bollard pull ASD tugs were found to be effective in push mode in a 1m significant wave height condition, particularly when combined with tugs working on lines using render recovery winches.

Aids to navigation

No requirement for any additional floating aids to navigation was identified during the simulations. The simulations clearly demonstrated that a leading line (set of range lights) was beneficial, as may be seen from the track plots.

Recommendations

Tugs

The simulations clearly demonstrated that a fleet of 4 tugs is required to provide the necessary reserve power. The minimum requirements for the tugs should include the following:

- All tugs should be capable of delivering 70t bollard pull in the expected environmental conditions
- All tugs should be equipped with render recovery winches, with double drums

Aids to navigation

A leading line should be provided to assist a ship handler to follow a central track through Country Harbour on arrival and departure.

The front and rear structures should be designed to ensure that the leading line is visible from the pilot boarding area during the hours of darkness and daylight.

Particular attention will need to be paid to ensuring that the leading line is visible in different visibility conditions, including rainfall, snow and sleet, fog and mist.

Jetty Berthing Line as a clearing line

The pilots found that the LNG terminal jetty acts as a clearing line for the wreck near Buoy TT6 and therefore, any fixed lights on the jetty should take this into account.

Real time environmental monitoring

Real time environmental monitoring should be provided to ensure that the following minimum info provide:

- Fog sensors at the pilot boarding area and at the terminal
- Wind, wave and current sensors at the pilot boarding area and at the terminal

Supplementary considerations

Canadian Hydrographic Office Chart 4234

Chart 4234 requires revision, or a new chart is required, to show the approach to Country Harbour centrally within the sheet, so that the approaches to Country Harbour from seaward and the relevant offshore hazards are provided on a single sheet. At present, it is necessary to also consult other charts, such as Chart 4233, to obtain an overall view of the approach. This is a key safety requirement.

Other revisions that may be required include the following:

- The chart may need to be updated to take account of the bathymetric survey(s) carried out for the Goldboro LNG project.
- The charted wreck near Buoy TT6 may require a wreck buoy and Buoy TT6 may require removal.
- A "no anchoring" may be required to better define the Deep Panuke and Sable submarine pipelines on a suitable scale, inset chart plan.

Existing aids to navigation

Further consideration is required as to whether there is any potential for any of the existing floating aids to mislead ship handlers approaching and departing from the LNG terminal. For example, certain lateral marks, such as buoy TT4 may be better replaced with cardinal marks.

Remote pilotage transfer

The possibility of pilot boarding and disembarking operations taking place in Chedabucto Bay (Canso) should be considered if such operations cannot take place off Country Harbour.

APPENDIX 6: GLOSSARY

Aids to Navigation – Devices or systems that:

- Help mariners find their position and course;
- Warn of dangers or obstacles; or
- Often show the best route through a waterway.

Automatic Identification System (AIS) – AIS automatically provides information to equipped shore stations, other vessels and aircraft. This information can include a vessel's identity, type, position, course, speed, navigational status and other safety-related information.

Ballast Water –Water, with suspended matter, taken on board a ship from a body of water to:

- Control its trim or list
- Increase its draught
- Regulate its stability
- Keep stress loads within acceptable limits

Ballast Water Control and Management Regulations – Under the *Canada Shipping Act, 2001*, these regulations govern how to manage ballast water on all ships arriving in Canada from beyond the Canadian exclusive economic zone.

Canada Shipping Act, 2001 (CSA, 2001) – The *CSA, 2001,* is the main law that governs safety in marine transportation and protection of the marine environment. It:

- Balances shipping safety and marine environmental protection while encouraging maritime commerce.
- Applies to all vessels operating in Canadian waters and Canadian vessels worldwide. In some instances such as pollution, it also applies to foreign vessels within the Exclusive Economic Zone of Canada.

Canadian Waters - the territorial sea of Canada and the internal waters of Canada

Classification Societies – these organizations help make sure vessels are safe. For example, Lloyd's Register (LR), the American Bureau of Shipping (ABS) and Det Norske Veritas-Germanischer Lloyd (DNV-GL) inspect, check and certify that vessels are built, maintained and operated according to established rules, regulations and standards.

Code of Practice - is a guideline prepared or adopted by the Minister of Energy or Administrator and, with respect to a LNG plant, means the Nova Scotia Code of Practice for LNG Plants, as amended, published by the Nova Scotia Department of Energy and Mines.

Collision Regulations – Under the *CSA, 2001*, rules based on the Convention on the International Regulations for Preventing Collisions at Sea that vessels must follow to prevent collisions in Canadian waters.

Convention on the International Regulations for Preventing Collisions at Sea (COLREG) – are published by the International Maritime Organization (IMO) and set out, among other things, the "rules of the road" or navigation rules to be followed by ships and other vessels at sea to prevent collisions between two or more vessels.

Electronic Chart Display and Information System (ECDIS) – A computer-based navigation information system, with adequate back-up arrangements, that meets International Maritime Organization standards. It displays information from electronic navigational charts or digital nautical charts and integrates position information from the Global Navigation Satellite System and other

navigational sensors, such as RADAR and automatic identification systems (AIS). It assists the mariner in route planning and route monitoring, and by displaying additional navigation-related information if required.

Escort Tug – A vessel that assists and accompanies another vessel. Some escort tugs can fasten to another vessel to provide a different level of service.

Flag State – Country of registry of a vessel, often a seagoing one. A flag state sets the safety standards and pollution prevention requirements that apply to the vessels flying its flag.

Goldboro LNG Project (Goldboro) – Goldboro LNG Project is a LNG processing facility with storage tanks and marine works located at the Goldboro Industrial Park in Guysborough County, Nova Scotia, Canada.

Incident Command System (ICS) – a standardized, on-scene, all-hazards incident management system that gives users an integrated organizational structure to match the complexities and demands of single or multiple incidents without being hindered by jurisdictional boundaries.

International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) - An international standard that allows safe transport of bulk liquefied gases and other substances (listed in Chapter 19 of the Code) by sea. The Code explains the design and construction standards of ships involved in such carriage and the equipment they should carry to minimize the risk to the ship, to its crew and to the environment, based on the nature of the products involved.

International Convention for the Control and Management of Ships' Ballast Water and Sediments – Adopted in 2004, this Convention aims to prevent the spread of harmful aquatic organisms from one region to another, by:

- Creating standards and procedures for managing and controlling ships' ballast water and sediments.
- Requiring all ships in international traffic to manage their ballast water and sediments to a certain standard, according to a ship-specific ballast water management plan.
- Requiring all ships to carry an International Ballast Water Management Certificate.

International Convention on Civil Liability for Bunker Oil Pollution Damage (Bunkers Convention) – The IMO adopted the Bunkers Convention in March 2001, which created strict liability for ship owners (backed by mandatory insurance) to provide coverage for bunker oil spills from their ship. Bunker fuel is any fuel a ship uses for its propulsion or in its operations. Changes to the *Marine Liability Act* to apply the *Bunker Convention* received Royal Assent in June 2009. Canada has since ratified the *Bunkers Convention* and it came into force in January 2010.

International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea (HNS Convention) – Adopted by the IMO in 2010. This agreement is based on the model for pollution damage caused by persistent oil spills from tankers. Once in force, it will create a two-tiered system for compensating claimants in cases of ship-source accident at sea that involve HNS.

International Convention for the Prevention of Pollution from Ships (MARPOL) – The main international agreement aimed at preventing marine pollution by ships.

International Convention on Oil Pollution Preparedness, Response and Co-operation (OPRC Convention) – Adopted in 1990, the OPRC agreement aims to provide a global international co-operation framework to deal with major incidents or threats of marine pollution. Countries that signed this Convention, which include Canada, must create processes for dealing with pollution incidents, either nationally or in co-operation with other countries.

International Convention on Standards of Training, Certification and Watch keeping for Seafarers (STCW) – This agreement sets minimum standards for the training, certification and watch keeping of vessel crews that countries must meet or exceed.

International Maritime Organization (IMO) – Established in 1948 at an international conference in Geneva, the IMO Convention entered into force in 1958 and the new organization met for the first time the following year. The IMO's main task has been to develop and maintain a comprehensive regulatory framework for shipping. Today its work includes safety, environmental concerns, legal matters, technical co-operation, maritime security and shipping efficiency. Canada is one of 174 IMO member States.[92] When the IMO reaches an agreement, member States (like Canada) create domestic regulatory frameworks for the shipping industry. There are over 50 IMO conventions covering a range of topics. The conventions are reflected in Canada's marine safety and security system, including the *CSA, 2001*.

Liquefied Natural Gas (LNG) – LNG is natural gas in a liquid state. When chilled to roughly -160° C (-260° F) at atmospheric pressure, natural gas becomes a clear, colourless, and odourless liquid. LNG is non-toxic, cryogenic and is classified as a hazardous and noxious substance by the IMO. In liquid form, LNG is about 1/600th the volume of natural gas, which allows for efficient transport in purpose-built ocean carriers.[93]

Marine Communications and Traffic Services (MCTS) – A CCG program that provides safety radio-communication services, vessel traffic information and a commercial marine telephone call service on a 24/7 basis. The *CSA, 2001* makes the Minister of DFO responsible for MCTS management and operations.

Marine Liability Act (MLA) – In force since August 2001, the *MLA* is the main law dealing with ship owners and operator liability around passengers, cargo, pollution and property damage. It sets limits of liability and creates uniformity by balancing the interests of ship owners and other parties. The *MLA* gives many IMO international conventions the force of law.

Metocean – Meteorological and oceanographic data

National Oil Spill Response and Preparedness Regime – Established in 1995 as a partnership between government and industry. As the lead federal regulator, TC sets the guidelines and regulatory structure for the preparedness and response to marine oil spills.

Canadian Navigable Waters Act – The law that authorizes and regulates works and obstructions that risk interfering with the public right of navigation in the navigable waters listed on the schedule to the Act.

Navigational Warning (NAVWARN) Service – Launched in 2019, the new Navigational Warning (NAVWARN) service replaces the Notices to Shipping (NOTSHIP) service offered by the CCG. The service informs the marine community of hazards, current activities and other relevant information like changes to navigational aids, fishing zones, military exercises, dredging, or other marine hazards.

Oil Companies International Marine Forum (OCIMF): Formed in 1970, this voluntary association includes every major oil company in the world and most national oil companies. The OCIMF:

- Promotes the safe design and operation oftankers and terminal operations related to crude oil, oil products, petrochemicals and gas.
- Aims to be the authority on the safe and environmentally responsible operation of oil tankers and terminals.
- Regularly represents the views of industry at the IMO; and

---

[92] http://www.imo.org/en/About/Membership/Pages/Default.aspx
[93] *Natural Resources Canada, Liquefied Natural Gas,* https://www.nrcan.gc.ca/energy/natural-gas/5679

- It is a strong advocate for marine safety standards and regulations.

Paris Memorandum of Understanding (MOU) – An international agreement of 27 maritime Administrations, including Canada. The agreement covers the waters of coastal Europe and the North Atlantic basin from North America to Europe. Its aim is to:

- Prevent substandard ships from operating through a consistent Port State Control system that makes sure that all ships meet international safety, security and environmental standards.
- Make sure crew members have decent living and working conditions.

Pieridae Energy (Canada) Ltd. – Pieridae Energy (Canada) Ltd. (Pieridae) is the Proponent for the Goldboro LNG project. It is a publicly traded Canadian corporation based in Calgary, Alberta with offices in Quebec City and Halifax. Founded in 2011, they are a company that develops Liquefied Natural Gas (LNG) infrastructures, from exploration and production of crude oil and natural gas to the development and operation of a complete LNG terminal[94].

Pilotage Regulations (Atlantic Pilotage Authority Regulations) – Regulations that require vessels operating in specific waters to bring a marine pilot with local knowledge on board to help guide the vessel safely to its destination.

Pilotage Act – Created in 1972 and updated in 1998, this law established four Pilotage Authorities that operate, maintain and administer the pilotage service in their respective regions. Among other things, the Act allows Pilotage Authorities to establish, with the approval of the Governor in Council, mandatory pilotage areas where ships must bring pilots on board.

Port State Control – A vessel inspection program created under the IMO, where countries that share waters, agree to inspect foreign vessels to check that they meet international agreements related to their condition, equipment, crew and operations. Port State Control is TC's main method for making sure that ships follow the *CSA, 2001*, the *Marine Transportation Security Act* and other relevant international agreements.

Proponent – the person, body, federal authority or government that proposes the carrying out of a designated project. (promoteur)

Response Organizations and Oil Handling Facilities Regulations – Under the *CSA, 2001,* rules related to response organizations' and handling facilities' procedures, equipment and resources during an oil pollution incident.

Ship Inspection Report Programme (SIRE) – Launched in 1993 by the Oil Companies International Marine Forum to deal with concerns about substandard shipping, it acts as a tanker risk assessment for charterers, vessel operators, terminal operators and government bodies concerned with vessel safety. The program operates a very large database of up-to-date information about tankers and barges.

Society of International Gas Tankers and Terminal Operators (SIGTTO) - This non-profit company was registered in Bermuda in October 1979. The Society has more than 170 full and associate members who represent nearly all the world's LNG business and more than half of global LPG business. The Society:

- It is the authoritative voice of the liquefied gas shipping and terminal industries.
- Defines and promotes standards and best practices among global industry members, to maintain confidence in the safety of liquefied gas industries and support their acceptance as responsible industrial partners.

---

[94] https://pieridaeenergy.com//what-we-do

- Has observer status at the International Maritime Organization (IMO).
- Has a reputation for integrity and being bias-free when addressing operational and safety matters.

SOLAS (International Convention for the Safety of Life at Sea) – This international maritime safety treaty requires flag states to make sure their ships meet minimum construction, equipment and operational standards. It was first adopted in 1914, in response to the Titanic disaster.

Special Drawing Rights - Special drawing rights, currency code XDR, or SDR are supplementary foreign-exchange reserve assets defined and maintained by the International Monetary Fund[95].

TERMPOL – "Technical Review Process of Marine Terminal Systems and Transshipment Sites." It dates from the late 1970s, when an interdepartmental committee reviewing marine pollution issues identified the need for a reliable way to measure the navigational risks associated with placing and operating marine terminals for large tankers. TERMPOL is a voluntary review process that can be requested by a proponent involved in building and operating a marine terminal system for bulk handling of oil, chemicals and liquefied gases. It focuses on the marine transportation aspects of a proposed project.[96]

TERMPOL Review Committee (TRC) – With TC as its chair, TRC members come from departments and authorities with marine regulatory, programs and services responsibilities. The Goldboro LNG Project TRC has representatives from TC, MSS, DFO, CCG, CHS and Ecosystems Management, ECC, County of Guysborough and the APP.

Territorial Sea of Canada – In general, *Canadian waters extend to 12 nautical miles from shore. The official definition can be found in the Interpretation Act* and *Oceans Act*.

Tonne - Also known as a metric ton (mt), a unit of measurement equal to 1,000 kilograms.

Vessel Pollution and Dangerous Chemicals Regulations – Under the *CSA, 2001*, the rules set standards to reduce greenhouse gas emissions as well as oil, sewage, garbage and air pollution from vessels.

Vessel Traffic Services(VTS) – A way of exchanging information between vessels and a shore-based center. Canada's VTS system is operated by the CCG. The operators are designated Marine Communications and Traffic Services (MCTS) Officers who monitor vessel movements using a network of VHF (very high frequency) radio, surveillance RADAR, Automatic Identification System (AIS), direction-finding equipment and a vessel traffic management and information system tracking computer network.

Vessel Traffic Services Zones Regulations – Under the *CSA, 2001,* they outline the requirements for Canadian and foreign vessels to report information before entering, operating in, and leaving Canadian waters.

VHF Radiotelephone Practices and Procedures Regulations – Under the *CSA, 2001,* they set out the on board procedures for the use bridge-to-bridge VHF radiotelephones to help safe navigation.

Waters Under Canadian Jurisdiction – Canadian waters and the waters in the exclusive economic zone of Canada, set out in the *Oceans Act* and the *Arctic Waters Pollution Prevention Act*.

***Note:** You can find full text of Canadian Acts and Regulations at http://www.laws-lois.justice.gc.ca.

Simply enter the name of the Act or Regulation in the search box at the top right corner of the screen.

---

[95] *Special drawing right (SDR), www.imf.org.*

[96] *TERMPOL Review Process TP 743, 2014 https://www.tc.gc.ca/media/documents/marinesafety/tp743e.pdf*

APPENDIX 7: ACRONYMS AND ABBREVIATIONS

AIS – Automatic Identification Systems

APA – Atlantic Pilotage Authority

COLREG – Convention on the International Regulations for Preventing Collisions at Sea

CSA, 2001 – *Canada Shipping Act*, *2001*

EA – Environmental Assessment

EAC – Environmental Assessment Certificate

GIIGNL – International Group of Liquefied Natural Gas Importers

HAZID – Hazard Identification

HNS – Hazardous and Noxious Substance

IACS – International Association of Classification Societies

IGC – International Code for Construction and Equipment of Ships Carrying Liquefied Gases in Bulk

IMO – International Marine Organization

KPI – Key Performance Indicators

LNG – Liquefied Natural Gas

LNGC – Liquefied Natural Gas Carrier

MARPOL – International Convention for the Prevention of Pollution from Ships

MCTS – Marine Communications and Traffic Services

MLA – Marine Liability Act

MOF - Material Offloading Facility

MSRA – Marine Safety Risk Assessment

mt - metric ton (tonne)

MTPA – Million Tonnes per Annum

NAVWARN – Navigational Warning Service (replaced Notices to Shipping (NOTSHIP)

nm – Nautical Mile

NSE – Nova Scotia Environment (Ministry)

OCIMF – Oil Companies International Marine Forum

PIANC – The World Association for Waterborne Transport Infrastructure (previously known as Permanent International Association of Navigation Congresses)

PRMM – Pilotage Risk Management Methodology

RO – Response Organization

SDR – Special Drawing Right, also known as XDR

SIGTTO – Society of International Gas Tanker and Terminal Operators

SIRE – Ship Inspection Report Programme

SOLAS – International Convention for the Safety of Life at Sea

SOPEP – Shipboard Oil Pollution Emergency Plan

SSOPF – Ship-Source Oil Pollution Fund

STCW – Standards for Training, Certification and Watch Keeping Convention

TERMPOL – Technical Review Process of Marine Terminal Systems and Transshipment Sites

TMSA – Tanker Management Self-Assessment

TRC – TERMPOL Review Committee

UKC – Under Keel Clearance

VHF – Very High Frequency

VTS – Vessel Traffic Services

XDR – Special Drawing Rights, also known as SDR

APPENDIX 8: LIST OF REFERENCES

Canada Marine Act, Statutes of Canada (1998, c.10) http://laws-lois.justice.gc.ca/eng/acts/C-6.7/index.html

Canada Shipping Act, 2001, Statutes of Canada (2001, c.26) http://laws-lois.justice.gc.ca/eng/acts/c-10.15/

Eastern Canada Vessel Traffic Services Zone Regulations (SOR/89-99) http://laws-lois.justice.gc.ca/eng/regulations/SOR-89-99/index.html

Environmental Assessment for the Goldboro LNG Project, Nova Scotia Environment https://novascotia.ca/nse/ea/goldboro-lng.asp

Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water. Sandia National Laboratories, 2004. Albuquerque, New Mexico

Fisheries and Oceans Canada, Water levels, Isaac`s Harbour NS, 2019 Tide Tables http://www.waterlevels.gc.ca/Eng/data/table/2019/wlev_sec/535

International Maritime Organization. *Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, 1983 Edition*. London: International Maritime Organization, 1983.

International Maritime Organization. *Code for Existing Ships Carrying Liquefied Gases in Bulk*. London: International Maritime Organization, 1976.

International Maritime Organization. *International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code), 1993 Edition*. London: International Maritime Organization, 1993.

International Maritime Organization. *International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea, 2010 (2010 HNS Convention)* http://www.hnsconvention.org/

International Maritime Organization. *Protocol on Preparedness, Response and Co-ordination to Pollution Incidents by Hazardous and Noxious Substances, 2000* (OPRC-HNS Protocol). London: 2000.

International Maritime Organization. *International Convention for the Prevention of Pollution from Ships (MARPOL)*

International Maritime Organization. *International Convention for the Safety of Life at Sea (SOLAS)*

Liquefied Natural Gas (LNG) – Production, Storage, and Handling, CSA Z276-15, January 2015 CSA Group, Toronto, Canada

Marine Liability Act, Statutes of Canada (2001, c. 6) https://laws-lois.justice.gc.ca/eng/acts/M-0.7/

Natural Resources Canada, Liquefied Natural Gas, https://www.nrcan.gc.ca/energy/natural-gas/5679

Navigation Safety Regulations (SOR/2005-134) http://laws-lois.justice.gc.ca/eng/regulations/SOR-2005-134

Radio Aids to Marine Navigation 2019, (Atlantic, St. Lawrence, Great Lakes, Lake Winnipeg, Arctic and Pacific), published under the Authority of Director General, Operations, DFO, CCG

Tanker Safety Expert Panel. *A Review of Canada's Ship-Source Spill Preparedness and Response: Setting the Course for the Future, Phase II, Requirements for the Arctic and for Hazardous and Noxious Substances Nationally* (2014).

The Royal Society of Canada Expert Panel: The Behaviour and Environmental Impacts of Crude Oil Released into Aqueous Environments, Ottawa November 2015 http://www.cepa.com/wp-content/uploads/2014/01/OIW-Report.compressed.pdf

TC. *Joint Industry - Government Guidelines for the Control of Oil Tankers and Bulk Chemical Carriers in ice Control Zones of Eastern Canada*, 2015, TP 15163 http://www.tc.gc.ca/eng/marinesafety/tp-tp15163-menu-4025.htm

TC. Pilotage Risk Management Methodology (PRMM), TP 13741 http://publications.gc.ca/site/eng/9.693193/publication.html

TC. *TERMPOL Review Process* 2014 (TP 743) (12/2014) https://www.tc.gc.ca/media/documents/marinesafety/tp743e.pdf

Vessel Pollution and Dangerous Chemicals Regulations (SOR/2012-69) http://laws-lois.justice.gc.ca/eng/regulations/SOR-2012-69/index.html

Vessel Traffic Services Zone Regulations (SOR/89-98) http://laws-lois.justice.gc.ca/eng/regulations/SOR-89-98/index.html