TABLE OF CONTENTS

Page No.

3.0 RISK ASSESSMENT SUMMARY

3.1 Introduction

The proposed site of the Terminal is in the vicinity of Bear Head on the Strait of Canso. The facility will include equipment to transport LNG from an ocean-going LNG tanker to large LNG storage tanks, move the LNG from the storage tanks to high pressure booster pumps, vaporize the LNG to produce high pressure natural gas, and meter the natural gas before introduction into a natural gas pipeline. The proposed LNG Terminal is designed to receive LNG from several possible LNG production facilities. Where the LNG received does not meet the pipeline specification in respect of gross heating value, the Terminal will be provided with stripping units designed to separate the ethane and propane plus heavy components from the LNG before it is sent to the vaporizers. The ethane and propane plus heavy components thus separated will be sent in liquid form via pipelines to be used as feedstock. Where the LNG received does not meet the pipeline specification because it is too light, the specification will be corrected by dilution with nitrogen. In this case, the Terminal will be provided with suitably designed nitrogen production units.

The Canadian Standard, Liquefied Natural Gas (LNG) – Production, Storage, and Handling (CSA Z26-01 (2003**)**) specifies design codes followed by the design engineers, constructors, and operators of LNG facilities in Canada. These codes contain requirements related to siting, design, construction, fire protection, and safety. This section provides an overview of the properties of natural gas and LNG as well as a summary of the Risk Assessment Component Study including the methodology, analysis of results and principal conclusions. The complete Risk Assessment Component Study is included in this report as Appendix C.

3.2 What is Natural Gas & LNG?

Natural gas in its natural state is composed primarily of methane, ethane, propane and heavier hydrocarbons including small quantities of nitrogen, oxygen, carbon dioxide, sulfur compounds, and water. Natural gas is normally lighter than air (due to its content make-up of mostly methane gas) but is dense if released at its boiling point of !160^{o} C (LNG density = 424.5 kg/m^3 and water density = 1041.2 kg/m^3).

LNG is the name given to natural gas when it has been liquefied. Natural gas is liquefied for shipping using refrigerants to a temperature of approximately !160EC. LNG is a clear, odourless, non-corrosive, non-toxic cryogenic liquid at a temperature of !160EC, at atmospheric pressure. LNG is routinely transported, stored, and used in applications throughout the world. Last year (2003), approximately 133 billion cubic metres of LNG was transported by sea without incident. Natural gas is not poisonous;

however, as with any gaseous material besides air and oxygen when vaporized, LNG can cause asphyxiation in an unventilated confined area.

If there is an accidental release of LNG, a methane vapour cloud will rapidly form. The gas cloud is non-toxic, but is an asphyxiant at concentrations above 50% methane. It becomes flammable when mixed with air only between concentrations of 5% and 15%; outside of this range, the methane cloud will not ignite.

3.3 Component Study Methodology

The codes referenced in the Bear Head LNG Terminal - Risk Assessment Component Study are CSA Z276-01 (2003), and NFPA 59A (2001), Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG). These codes contain requirements related to siting, design, construction, fire protection, and safety for LNG installations. The CSA Z276-01 (2003) is the predominant code, the NFPA 59A (2001) provides supporting information on compliance requirements raised by the CSA.

The primary objective of the Component Study (Appendix C) is to demonstrate through analysis, that for the plant siting proposal, the consequences of a release under specified scenarios have been duly identified and considered. To satisfy the objectives, the scope of analysis for the study is required to cover the jetty, LNG storage, and vaporization areas, as well as any related impounding or drainage systems.

The Component Study report has been structured around the requirements of CSA Z276-01, in particular the following:

- Impounding Systems, Clause 4.2.2.2;
- Design Spills, Clause 4.2.3.4;
- Vapour Dispersion Scenarios, Clause 4.2.3.3;
- LNG Pool Fire Scenarios, Clause 4.2.3.2.3;
- Tanker Grounding Events;
- Tsunami & Earthquake Events;
- External Fire Threat Hazards; and
- Aircraft Collision Risk.

Fire and gas dispersion consequence modelling has been undertaken using the atmospheric conditions specified in CSA clause 4.2.3.2.2 in respect of wind speed (0 m/s), air temperature (21EC), and relative humidity (50%). For the consequence modelling hazard endpoints, CSA clause 4.2.3.2.2 specifies the maximum thermal radiation flux levels of 30, 9 and 5kWm^{-2} that are acceptable at specific locations.

In respect of duration, the CSA design spill of 10 minutes has been adopted for the LNG containers and impounding areas based on the provision of demonstrable surveillance and shutdown provisions. Fire and gas dispersion modelling has been undertaken using Trinity Consultants' BREEZE HAZ Professional suite of consequence models (which includes amongst others DEGADIS for dense gas dispersion) and where appropriate Shell FRED. The various hazard contours developed by BREEZE HAZ Professional have been combined with the site plot plan images to give a visualization of the fire and gas dispersion hazard ranges.

3.4 Analysis Results

There are impounding sumps for each of the LNG tanks, process area and the LNG jetty. For the 10 m by 10 m LNG storage tank dike sumps, the LNG thermal flux hazard range from the perimeter of the sump to the $5kWm^{-2}$ contour is 42.46 m. For the 6 m by 3 m process and jetty sumps, the thermal flux hazard range from the perimeter of the sump to the $5kWm^{-2}$ contour for LNG is 16.24 m, ethane is 16.64 m and propane is 17.28 m. For the gas plume dispersion hazard, the hazard range from the plume centre to one half LFL for the LNG storage sump is 252.116 m, and for the process and jetty sumps is 107.068 m. All sump fire and gas plume dispersion scenarios have no impact offsite.

For the LNG tanker grounding scenarios the LNG release from a 0.5 m diameter hole has been modelled. The scenario represents a large penetration of the bottom hull caused by the grounding of an errant vessel. Plume distances from the release to one half LFL has been analyzed at 773.4 m. The radiated heat from a grounded ship release will reach a value of 30 kWm^{-2} at a distance of 100 m from the perimeter of the pool fire and 400 m to the 5 kWm^{-2} heat release contour. There are no industrial premises or communities close enough to the Terminal to be affected by the heat radiation level from the ignited cloud of a grounded ship.

Paragraph 1.5 of the CSA Standard indicates that the Standard does not cover marine transportation (*i.e.*, analysis of grounding is not required by the Standard). Grounding of an LNG vessel involving a release of LNG (as noted in Section 8.2 and Appendix C), either at the Terminal or elsewhere, is considered remote.

The LNG transfer pipeline from the jetty to the tanks pool fire and gas dispersion scenarios have been analyzed for the area located between the jetty ESD valve and the ESD valve prior to the first LNG storage tank. Three dispersion scenarios, including full bore, have been modelled. For the full bore, the distance to one half LFL is estimated at 2.13 km. Two pool fire scenarios, including full bore have been modelled. For the full bore the $5kWm^{-2}$ contour is 135.48 m from the pipeline.

The tank impounding system fire models have been modelled in relation to the deliberate attack scenarios. For the tank dike pool fire, the $5kWm^{-2}$ contour is 486.2 m from the three outward facing dike walls closest to the Terminal perimeter.

For the LNG vaporization areas, pressurized releases were also modelled for the four major equipment groups within the regasification train, the HP pumps, S/T Exchangers, BO Gas Compressors and the export pipeline part within the plant. The maximum distances to LFL was estimated at 438 m corresponding to the high pressure low temperature equipment. As the Terminal's detailed sizing of equipment and exact product parameters have to be finalized, the data for the release scenarios were based on a typical onshore LNG regasification plant.

3.5 Discussion Relating to Acceptability of Bear Head Terminal Site

Based on the modelling results, the proposed Bear Head LNG facility siting and layout meets the CSA required thermal radiation protection distances for LNG releases in sumps and drainage trenches, for unconfined pools within the transfer pipeline areas, and for releases within the vaporization area. For confined releases within the dikes, the 9 and 5kWm$^{!2}$ contour is at 351.4 m and 486.2 m respectively from the perimeter of each dike and therefore, they would extend beyond the Terminal boundaries, while the 30 kWm$^{!2}$ contour is within the boundary of the proposed site at 154.1 m from each dike perimeter. However, the 9 and 5 kWm$^{!2}$ contours outside the Terminal site do not have any offsite significance as there are no populated areas near the boundaries, and is thus acceptable.

The dispersion distance requirements are met for LNG releases in sumps and drainage trenches, the vaporization area and typical operational releases transfer pipeline. Only two scenarios have shown that an LNG plume may extend over the Terminal's boundary; ship grounding near the jetty and full bore rupture of the transfer pipeline.

The maximum plume distance from the ship grounding event would be approximately 554 m to LFL and 773 m to one half LFL. This event does not constitute a hazard to any populated areas which are situated about 5 km to the east of the Terminal and to the southwest towards Guysborough County. More importantly, taking into account the established operational procedures which prohibit tanker approach without the assistance of tugs, the scenario for an errant tanker grounding within the plant's shoreline is considered a non credible event. Tanker grounding scenarios outside the terminal bordering shoreline are not required by the CSA plant siting studies.

The dispersion contours of a full bore pipeline release have a shorter duration and impact, and the maximum plume distance would be approximately 1.2 km to LFL and 2.13 km to the one half LFL. The modelling of full bore rupture scenario is considered a very conservative approach as it is extremely unlikely to take place on any part of the pipeline within the controlled terminal environment under normal operating conditions.

All thermal and gas dispersion modelling results are presented in the Risk Assessment Component Study (Appendix C).

Tsunami and earthquake events have been identified as potential initiating events for catastrophic releases at the Bear Head Terminal. Although potentially very damaging, tsunamis events on the Scotian Shelf and earthquakes are considered to be non credible events with a likelihood of occurrence of around 1 in 10,000 years and with no history of soil liquefaction or landslide movement in the area.

Forest fire risks external to the LNG Terminal are considered to be a potentially serious risk. Forest fires in the area will be rapidly responded to and suppressed by local fire fighting forces as discussed in Section 8.2.6.4. The facility Emergency Response and Contingency Plan will include provisions for fire protection.

Similarly, the aircraft collision risk is not considered credible given the improved security provided at the airports after the September 11, 2001 attack in the USA. Even if it were to happen, the results would be not worse than the tank dike on fire as per section 4.4 of the Risk Assessment Component Study and referred to in section 3.4 of this summary.