2.6 Operation

2.6.1 Labour Requirements

Approximately 20 persons will be employed per shift at the LNG site during normal operations. The facility will operated 24 hrs per day on 12-hour shifts. Additional contractual labour requirements will be required during specific facility operations i.e. vessel berthing and de-berthing, snow clearing etc. It is anticipated that the contractual labour requirements will be between 50 to 80 personnel.

2.6.2 Marine Traffic

By others – NLLNG & MarTrans

2.6.3 Land Based Vehicle Traffic

Land based vehicle traffic will consist of employees, visitors, contractual services (snow clearing, maintenance etc.) and delivery service of parts, equipment and supplies. It is anticipated that between 20 to 30 trips per day will be required to meet facility demands.

LNG will be contained to the facility site and will not be distributed via truck to other locations.

2.6.4 LNG Facilities

2.6.4.2 LNG Transfer Facilities

The three piers will be designed for double berthing of LNG carriers up to 265,000 m^3. This arrangement will allow ship to ship transfer of LNG at any berth and allow additional safe berthing should the need arise. Mooring loads will be based on the ship characteristics and environmental loadings for the project site. Thresholds, such as wind speed, wave height, will be specified for vessel berthing and departure maneuvers. Critical extremes that require the vessels to depart the berths will also be specified.

All approach, berthing and departure criteria and methods will be reviewed with the local Pilotage Authority for acceptance. These criteria will be incorporated into the marine terminal manual.

The berths will each contain four 20” articulated LNG transfer arms that will connect the LNG carrier’s piping system to the onshore piping system. The LNG carrier’s cargo pumps will pump LNG from the ship’s cargo tanks either to another LNG carrier or to onshore LNG storage tanks. The articulated arms will also receive LNG transfers from other ships and one arm, in each case, will be used for vapor balance.

The system design transfer rate will be 15,000 m^3 of LNG per hour. The pump-out time for a 265,000 m^3 LNG carrier will be about 18 hours (not including docking, hookup, and undocking times). The turn-around time, depending on size, for an LNG carrier, will be 24-36 hours. LNG carrier cargo tank pressure will be maintained at about 14 kPa (2 psig).

The LNG carrier unloading/loading and inter-ship transfer operations will follow specific procedures, will be closely monitored, and will utilize automatic monitoring, control, and, if necessary, shutdown systems. This section highlights important steps in the dock-area LNG transfer operations. The process of transferring LNG between carrier and LNG storage tanks or between carriers will include the following broadly categorized phases:

- Docking
- Electronic ship-to-shore systems umbilical connection and testing
- Mechanical connections
- Purging and cool-down
- Transition from no flow to full flow
- Monitoring
- Transition from full flow to no flow
- Purging and depressurization
- Mechanical disconnect
- Electronic disconnect
- Return to non-transfer operating mode
- De-berthing

Many key components will be used to facilitate safe dock-area transfers. Clear and complete written procedures and ample verbal communication between the terminal operators and ship-board crew will be utilized during each dock-area transfer operation. Additionally, electronic monitoring, control, and ESD (emergency shutdown device) systems will be employed to assist operations personnel in the safe operation of the dock facility. The dock's electronic systems will communicate with the ship's electronic systems through an umbilical cord. An emergency shutdown of one will trigger a corresponding shutdown of the other. The key tools to be used for dock-area transfers include:

- Written docking, hookup, communications, and operating procedures
- Electronic process monitoring, process control, ship-to-shore umbilical, process alarm, and process shutdown systems
- Communications equipment
- Hazard detection systems (leak, fire)
- Fire protection systems
- Operator training program

In the event that an emergency shutdown of the dock operation is initiated the following systems will be set to a safe setting for the shutdown scenario:

- LNG transfer arm block-in valves

- Shoreline valves
- Storage tank inlet valves
- Boil-off gas system (blowers and valves)
- LNG-tank internal pumps
- Fuel gas LNG pumps
- LNG vaporizers and inlet/outlet valves
- Emergency depressurization of the vaporization process
- Power generation equipment
- Battery limit valves
- Venting of process equipment and piping where necessary to prevent overpressure

The following discussion lists more detail and illustrates how the systems listed above will be used to ensure safe dock-area operation.

LNG Transfer Arm Set-up Prior to LNG Transfer

Before LNG can be transferred from the LNG carrier to the facility's storage tanks, the LNG transfer arms must be set-up and tested – the process and procedure are described below:

- if the docking facility has not been used in more that 30 days, Emergency Shutdown Device (ESD) system shall be tested at least 24-hours prior to LNG carrier arrival;
- dust covers are removed and flow of nitrogen begins in unloading arms to displace air;
- vented gas from unloading arm is purged until oxygen content is below (10%);
- communication cables are connected to the LNG tanker;
- LNG tanker & LNG facility go through go-no-go systems check (i.e., communications systems, ESD functionality, etc.);
- after the "all systems check," has been preformed and the "ready for cargo transfer," has been reported, connection of the unloading arms to the LNG tanker shall begin;
- once the transfer arms are connected, the transfer arms are pressured to 345 kPa (50 psi) and checked for leaks;
- the vapor arm is tested at 207 kPa (30 psi) and if no leaks are detected, the arms are depressurized to less than 7 kPa (1 psi);
- the LNG carrier and LNG terminal re-test the ESD system; and
- the systems are now ready for transfer.

Liquid Transfer

Once the transfer arms are safely and securely connected to the LNG carrier, LNG is transferred using the following procedure:

- all boil-off-gas compressors are activated and shall be operating in automatic pressure control mode;

- cool-down procedure is initiated, LNG carrier flows liquid cool-down using stripping pumps (should take approximately 30 minutes);
- after 30 minutes of liquid cool-down flow, the flow can be increased up to 5000 m^3/hr per arm;
- gas chromatograph is set up to automatically monitor the outlet LNG and inlet LNG vapor lines; and
- LNG storage tank pressure and capacity are continually monitored.

This procedure is reversed when LNG is being transferred from the LNG storage tanks to the LNG carrier.

Vapor Return

The LNG carrier is connected to transfer arms that serve two purposes: loading and unloading. During the unloading process, it may be necessary for the LNG carrier to receive vapor (i.e. vapor return). The process and procedure of vapor return are described below:

- the LNG carrier shall inform the LNG terminal once it is available to begin accepting vapor;
- cold gas blower is initiated to begin loading the LNG carrier with vapor; and
- vapor not required by the LNG carrier is directed to Boil-off gas compressors and then on to the fuel gas system or re-liquefaction system.

When loading a LNG carrier with LNG, vapor is transferred back to the storage facility. The same procedure except in reverse will apply. All excess vapors, whether loading or unloading a LNG carrier, will flow to the fuel gas system or to the re-liquefaction system.

Termination of Tanker Transfer

When the LNG storage tanks (on-shore or on tanker) near capacity or transfer nears completion, the transfer flow rate (both LNG and vapor) will be reduced and eventually stopped. After termination of transfer, the LNG facility shall follow the proper shut down procedures listed below:

Liquid Arms

- the shore side block valves are closed;
- the transfer arms are pressured to 345 kPa (50 psi) with nitrogen;
- the by-pass valves around the shore block valves are opened allowing LNG to be displaced into the transfer line;
- process is repeated twice and the by-pass valves are closed;
- the lines are pressurized to 345 kPa (50 psi) and the ship opens the by-pass valves on their block valves; and
- once the transfer arms are disconnected, the LNG circulation in the transfer line is maintained in the cooled down condition.

Vapor Return Arm

- all vapor blowers are stopped;
- the vapor return unloading arm is purged with nitrogen until methane level is below 10% LFL;
- the vapor transfer arm is disconnected; and
- communications cable is disconnected prior to LNG tanker departure.

2.6.4.3 LNG Storage

The LNG storage tanks will be designed to hold, receive and discharge LNG. LNG carriers will unload LNG into the storage tanks. The storage tanks will hold LNG until other smaller or specialized LNG carriers arrive and load the LNG from the storage tanks for transport to re-gasification terminals.

Up to eight (8), single-containment, double wall, 160,000 – 200,000 m^3 LNG storage tanks will be installed on shore. These tanks will have a steel-nickel alloy inner tank suitable for LNG service, an insulated annular space to limit heat in-leak, and a carbon steel outer tank.

Much of the LNG tank's operation will be automated or automatic. Some systems will be electronic and some will be mechanical. Ultimately, the goal of the storage tank and all process systems is containment of the process. Therefore, where warranted, redundancy is incorporated into the design and operation of the systems. For example, level instruments will report level readings to the distributed control system (DCS), which will alarm if the level exceeds normal operating limits. Further, pressure safety valves, PSV's, a mechanical system, will vent overpressure if the tank's electronically-controlled pressure control system malfunctions. Finally, the ultimate, and most failsafe, process system will be the dike impoundments that will surround each tank.

The tanks will have no below-liquid-level penetrations. Pumps will be column-mounted, internal, and submerged in the tanks. The pump columns will each have a foot valve at the bottom and nitrogen purge capability that will enable pump removal without the need for emptying the entire LNG tank.

Stratification of LNG due to composition, and therefore density differences, can lead to rollover. Density variation can be caused by two things: the first is the tendency of light components like methane to preferentially boil off near the top of the liquid and the second is the filling of a partially filled LNG tank with significantly higher or lower density LNG. Either can make the top layer heavy relative to the bottom layer, which does not boil off as much of its light components due to increased pressure at locations well below the liquid surface. Rollover can result in high vapor generation rates. This project will install liquid level, temperature, and density monitoring devices to prevent, detect, and mitigate LNG stratification inside the LNG storage tanks. Also, the tanks will be equipped with top and bottom filling capability as well as mixing/circulation capability.

Heat in-leak will be removed by boil-off-gas which will be collected by the boil-off-gas vent system and forwarded to either the liquefaction system or to the plant's gas turbine-driven power generation equipment. If the boil-off-gas vent system is down or overloaded (it will be designed for foreseeable loads) excess boil-off-gas will be vented to the atmosphere via a heated vent system.

LNG storage tanks, like all large low-pressure tanks, cannot withstand vacuum (negative gauge pressure). The per-square-foot force on a tank under vacuum is very large and can cause tank damage and partial collapse. Therefore each tank will have a vapor make-up system and vacuum breaker valves to protect the tanks from vacuum conditions.

2.6.4.3.1 Exclusion Zones

Exclusion zones are required by CSA-Z276 to provide protection of the general public and property adjacent to an LNG facility. These zones depict boundaries beyond which thermal radiation levels or vapor concentrations associated with "design spill scenarios" are acceptable per CSA-Z276. The exclusion zones are determined based on vapor dispersion and thermal radiation models. Environmental conditions such as temperature, relative humidity and wind speed and the proposed LNG facility layout are considered. Design cases, such as, malfunctions and unplanned events, are modeled using techniques specified by CSA-Z276-01. The following release scenarios are required to be analyzed by CSA-Z276:

- 10-minute LNG storage tank release of the largest flow from any single line that could be pumped into the impounding area with the container withdrawal pump(s) considered to be delivering the full rated capacity if surveillance and shutdown is demonstrable; or for the time needed to empty a full container where surveillance and shutdown is not approved;
- 10-minute release for impounding areas serving only vaporization, process or LNG transfer areas; or less based on demonstrable surveillance and shutdown exists;
- Loss of LNG storage tank contents into its impoundment area.

Thermal flux levels (5,000 W/m^2; 9,000 W/m^2; 30,000 W/m^2) are also defined by CSA-Z276-01 for different spill scenarios that are used to calculate the exclusion zone.

- 5-kW/sq m (1,600 Btu/hr-sq. ft) – nearest point used by group assemblies of 50 or more persons and not under direct control of the terminal Owner.
- 9-kW/sq m (3,000 Btu/hr-sq. ft) – nearest point of a building outside the property line that is a school, hospital, church, jail, residence (does not include industrial property)
- 30-kW/sq m (10,000 Btu/hr-sq. ft) – nearest point on property or on adjacent property that is or can be built upon, i.e. can fall upon open water, game lands, farmlands that is not built on.

With this information the worst-case scenario shall be identified and used for determination of the exclusion zone.

Dispersion of flammable mixtures of vapor shall be modeled for design spills. As described in CSA Z276, “Consideration shall be given to controlling the possibility of a flammable mixture of vapors from a ‘design spill’ of reaching a property line that may be built upon at an elevation above grade, which would result in a distinct hazard.” A flammable zone will exist where the natural gas vapor concentration is 5-15%. The vapor exclusion zone limits are at the boundary where flammable concentrations of vapor cease to exist, at the lower flammability limit of 5% natural gas.

For further details, the modeling procedure and results are showed in section **xx.xx.- Quest to provide input**.

2.6.4.4 Re-liquefaction

Boil-off gas that is not used for fuel or returned to a vessel as displacement vapor, is compressed by the boil-off gas compressors and sent to a plate-fin heat exchanger, in which the boil-off gas is cooled and condensed to LNG. The LNG then goes through a pressure reduction and into the transfer line to the LNG storage tanks or to a LNG carrier. The refrigeration for the re-liquefaction system is provided by a nitrogen refrigerant system, which consists of a three-stage nitrogen compressor operating at ambient temperature and an expander operating at the cold end. Nitrogen passes through the plate-fin exchanger so that the plate-fin exchanger effectively has three zones:

- a warm zone in which warm nitrogen is cooled down against cold nitrogen returning to the compressor suction;
- a zone in which hydrocarbon gas (boil-off vapors) and nitrogen are both cooled (in separate passages), against cold nitrogen; and
- a cold zone in which hydrocarbon gas (boil-off vapor) is cooled and condensed against cold nitrogen, which typically will enter with a small amount of liquid present.

2.6.5 Emissions & Waste

2.6.5.1 Marine Tankers

The standard propulsion system for LNG Carriers was the steam turbine combined with a medium voltage switchboard system. However LNG carriers are now being equipped with duel-fuel technology (diesel and natural gas). The natural gas is sourced from the boil off gas (BOG) from the carriers LNG tanks.

Inbound voyages to the facility would rely on LNG BOG as the fuel source and thus would have low emissions. While at berth and during the outbound voyage diesel fuel would be used.

Two tugboats equipped with 4,500 horsepower diesel engines would be used to assist with berthing and de-berthing maneuvers.

For the basis of this analysis it will be assumed that eight LNG carriers will visit the facility each week and will remain at the berth for a total of 36 hours. The two tugs will assist with berthing and de-berthing for a total of 8 hours.

Estimated emissions are summarized in the following table.

Vessel	Emission Type (tonnes/yr)				
	NO_x	SO_2	CO	PM	CO_2
LNG Carrier					
Tugboat					
Total					

2.6.5.2 Electrical Supply

Electrical power for the facility will come from the provincial power grid and from on site generation from LNG boil-off gas.

In the event of a power outage most facility operations would be temporarily terminated. With the combined effect of the large LNG volume and the tank insulation it is anticipated that power outages up to 12 hours would have minimal effect on the LNG storage. Should a power outage go beyond 12 hours then a back up power supply would be required to power blowers and compressors required to handle vapor losses. It is anticipated that in stand-by mode, with an eight tank configuration, a total of 21 MW will be required as back up power requirements. This back up power would be provided by a combination of diesel generator and LNG generation. The diesel generator would power the pumps, compressors etc. required to start the LNG power plant that provides power to the facility during LNG transfer operations.

Fire protection will be provided by means of a diesel fire pumps.

2.6.5.3 Noise

During operations, noise will be generated from a number of sources including:

- Vehicle traffic
- Marine traffic
- Process equipment

Process equipment (i.e. compressors) will be enclosed in buildings that will be constructed to minimize noise transmission. Isolated pieces of equipment not enclosed in buildings will be covered with enclosures to reduce noise levels. Vehicles operating on the site will be equipped with mufflers or other noise suppression equipment.

2.6.5.4 Liquid Waste

The liquid wastes to be generated at the facility are limited to the sanitary wastewater from operations staff and heated process water from the seawater cooling system. There are no other processes at the facility that contribute wastewater to the effluent stream.

The wastewater from the operations of the plant is limited to that produced by the domestic use from a staff of a total of approximately 40 persons. The total flow is approximately 7600 litres/day (0.000088 m^3/s). This flow will be directed into a primary settling chamber or septic tank for removal of solids and the effluent will be discharged through the seawater outfall back to the marine environment. Concentrations of the effluent will be in accordance with Schedule A of the provincial “Environmental Control Water and Sewage Regulations, 2003”. Domestic wastewater that may be generated from potentially hydrocarbon-contaminated operations will be channeled as necessary through oil/water separators. This will apply to garage and equipment areas where drains may be a source of hydrocarbon contamination. The effluent from the separators will be directed into the primary settling chamber for primary treatment and eventual discharge. The oily fraction will be removed by an approved contractor using appropriate liquid handling equipment and vehicles, and treated off-site at an approved facility.

Process wastewater will be limited to that from the seawater cooling system. This water will have no net chemical changes from the intake water, only a thermal change will occur. The discharge seawater will be limited to a maximum temperature of 32°C in accordance with the stipulations of Schedule A of the provincial “Environmental Control Water and Sewage Regulations, 2003.” To provide for adequate mixing and rapid dissipation of the additional thermal energy, a diffused outfall will be used to discharge the seawater into the marine water column in a minimum depth of 15 m below LNT.

2.6.5.5 Solid Waste

Solid wastes will be sorted at the facility and material not deemed acceptable for re-use or recycling will be disposed of in an acceptable manner at an approved landfill site. Certified contractors will be retained for the safe transportation of sold waste to the approved facility.

Waste management strategies for both construction and operations for the project will be outlined in a Waste Management Plan that will be prepared for review by regulatory authorities. The Plan will be prepared in accordance with the new provincial Waste Management strategy. During operations, waste minimization will be a prime objective to prevent the generation of waste wherever possible and reduce the need for waste diversion and landfilling.

Non-hazardous solid wastes that are may be generated during operations include:

- Domestic refuse
- Food waste
- Clean tanks, drums and containers
- Packaging materials

- Used oil filters
- Broken fittings and tools
- Plastic, metal, concrete, asphalt and wood
- Non-Hazardous Electronics
- Uncontaminated soils, rock and vegetation
- Bulk items including structures and machinery

2.6.5.6 Hazardous Waste

Similarly to the solid waste objective, a program of careful product selection will be used during operations to minimize the generation of hazardous waste for the project. As part of the routine operations, however, hazardous materials will be used and hazardous waste will consequently be generated. All hazardous materials will be handled and stored on site in accordance with WHMIS regulations. All hazardous waste generated on site during operations will be disposed of in accordance with regulatory requirements. Personnel training will be an important aspect of the waste management plan for hazardous wastes and all workers will be trained in safe management practices. Training and worker awareness will result in minimizing accidents such as spills, improper storage of waste materials and inappropriate disposal techniques.

Hazardous solid wastes that are may be generated during operations include:

- Used oil, lubricants and coolants
- Contaminated or expired fuels
- Waste batteries
- Chemical solvents and additives
- Light bulbs that contain mercury
- Electronics
- Oiled materials
- Wastewater treatment sludge
- Fungicides, herbicides and pesticides
- Materials such as soils and debris that contain hazardous substances
- Parts from machinery
- Contaminated soils, rock and vegetation