APPENDIX A.22G: Liquid Natural Gas Management Plan

CASINO

CASINO PROJECT

LNG MANAGEMENT PLAN

PRELIMINARY DRAFT

Prepared by:
Casino Mining Corporation
November 2014

EXECUTIVE SUMMARY

The Casino Mine Project is an approximately 22 year mine project owned and operated by Casino Mining Corporation (CMC), that will produce copper and molybdenum concentrates, and gold dore bars via flotation milling and heap leach processing, respectively. The proposed project includes a four year construction period and a 90 year post-closure period. Key project components include the open pit, tailings management facility and waste rock storage area, heap leach facility, mill and associated infrastructure, ore stockpiles, liquefied natural gas power generating infrastructure, and office and accommodation buildings. The project also requires a 120 km access road from the town of Carmacks, YT, and concentrate will be trucked to the port at Skagway, Alaska.

The Casino Mine Project is a proposed 22 year mine project owned and operated by Casino Mining Corporation (CMC), that will produce copper and molybdenum concentrates, and gold dore bars via flotation milling and heap leach processing, respectively. The location of the Casino Project is shown on Figure 1 1. Key project components include the open pit, tailings management facility and waste rock storage area, heap leach facility, mill and associated infrastructure, ore stockpiles, liquefied natural gas power generating infrastructure, and office and accommodation buildings. The project also requires a 120 km access road from the town of Carmacks, YT, and concentrate will be trucked to the port at Skagway, Alaska.

LNG is proposed as the primary fuel supply for power generation and other ancillary uses at the Casino Project. All LNG deliveries to the mine will be by truck transport that will ramp up to an estimated 900 m3/day LNG when at full production. LNG storage is required at the mine to stockpile sufficient inventory to supply natural gas fuel needs during the period where road access is limited due to weather.

A management plan for toxic or hazardous substances is required by the Canadian Environmental Protection Act (CEPA) and through the Environmental Management Act (EMA) Hazardous Waste Regulation. Prior to the start of operation, a comprehensive LNG Management Plan for the Casino Project will be developed to ensure worker safety and to prevent uncontrolled releases to the environment. The LNG Management Plan will be developed in consideration of the principles and standards of practice of the Canadian Standards Association (CSA) standards CSA-Z276, CSA-Z731 and the National Fire Protection Association (NFPA) codes NFPA 59A, as well as other principles and standards of practice related to transportation, handling and storage/use and worker safety and emergency response.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

API .... American Petroleum Institute
ASME .... American Society of Mechanical Engineers
BLEVE .... Boiling Liquid Expanding Vapor Explosion
BOG .... Boil-off gas
CEPA .... Canadian Environmental Protection Act
CMC .... Casino Mining Corporation
CSA .... Canadian Standards Association
EMA .... Environmental Management Act
ESD .... Emergency shut down
LNG .... liquefied natural gas
MDE .... Maximum design earthquake
MSDS .... Material Safety Data Sheets
NEC .... National Electric Code
NFPA .... National Fire Protection Association
PGA .... Peak ground acceleration
psig .... Pounds per square inch gauge
the Plan .... LNG Management Plan
YESAB .... Yukon Environmental and Socio-Economic Assessment Board

1 – INTRODUCTION

The Casino Mine Project is a proposed 22 year mine project owned and operated by Casino Mining Corporation (CMC), that will produce copper and molybdenum concentrates, and gold dore bars via flotation milling and heap leach processing, respectively. The location of the Casino Project is shown on Figure 1-1. Key project components include the open pit, tailings management facility and waste rock storage area, heap leach facility, mill and associated infrastructure, ore stockpiles, liquefied natural gas (LNG) power generating infrastructure, and office and accommodation buildings. The project also requires a 120 km access road from the town of Carmacks, YT, and concentrate will be trucked to the port at Skagway, Alaska.

LNG is proposed as the primary fuel supply for power generation and other ancillary uses at the Casino Project. All LNG deliveries to the mine will be by truck transport that will ramp up to an estimated 900 m^3/day LNG when at full production. LNG storage is required at the mine to stockpile sufficient inventory to supply natural gas fuel needs during the period where road access is limited due to weather.

A management plan for toxic or hazardous substances is required by the *Canadian Environmental Protection Act* (CEPA) and through the *Environmental Management Act* (EMA) Hazardous Waste Regulation. Prior to the start of operation, a comprehensive LNG Management Plan for the Casino Project will be developed to ensure worker safety and to prevent uncontrolled releases to the environment. However, a preliminary plan is provided herein to satisfy the requirements of the Yukon Environmental and Socio-Economic Assessment Board (YESAB).

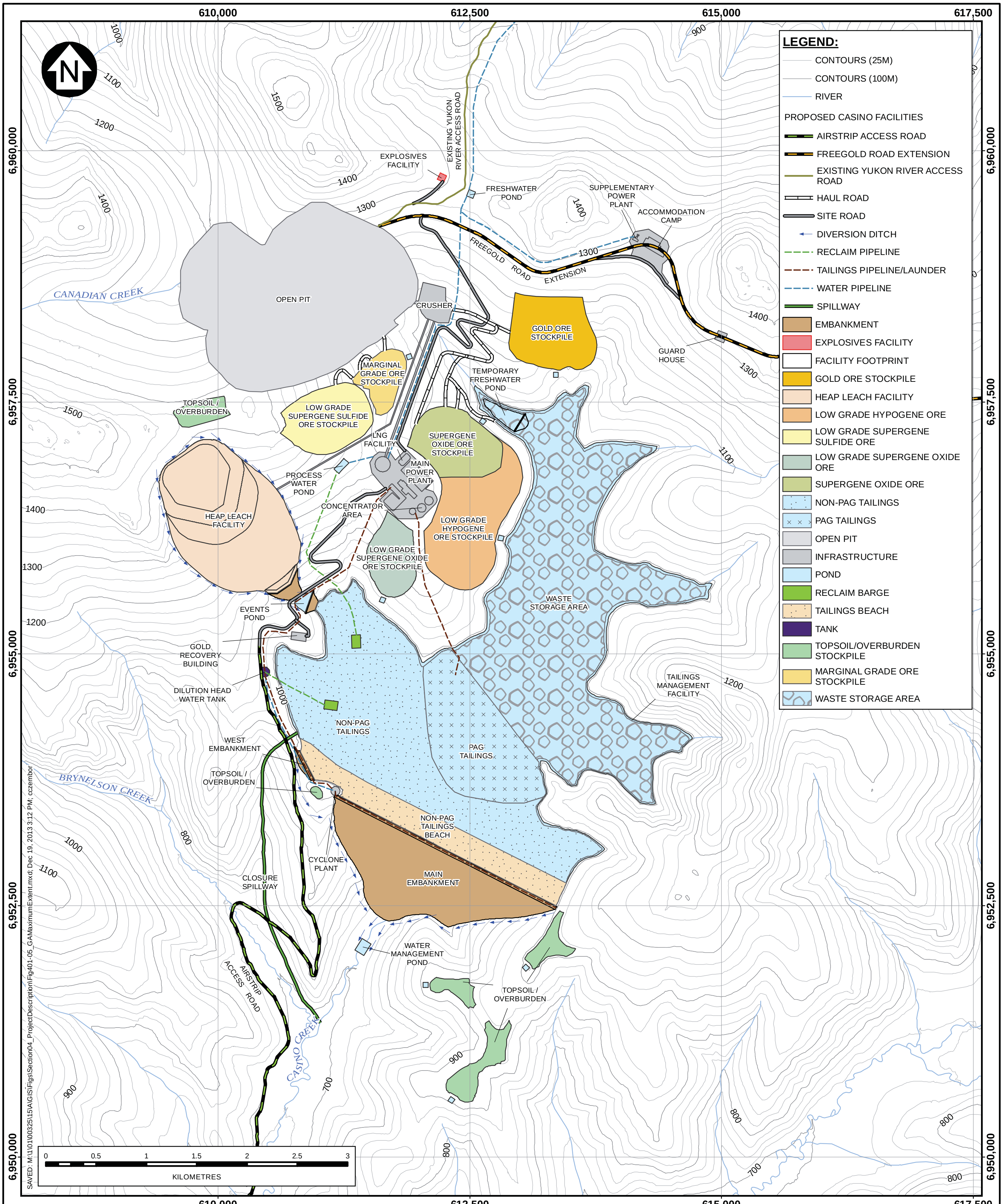
The following subsections provide a preliminary LNG Management Plan, outlining the information and the level of detail that will be provided in the final plan. The plan will include all applicable mitigation and management measures developed through the process and committed to by Casino Mining Corporation.

The LNG Management Plan will be developed in consideration of the principles and standards of practice of the Canadian Standards Association (CSA) standards CSA-Z276, CSA-Z731 and the National Fire Protection Association (NFPA) codes NFPA 59A, as well as other principles and standards of practice related to the following:

- Transportation;
- Handling and storage/use; and
- Worker safety and emergency response.

The LNG Management Plan will be integrated with other relevant Management Plans (e.g., Emergency Response Plan, Spill Contingency Plan) to ensure that worker/public health and safety as well as the environment are protected.

The Plan will be updated as the project is refined, and further details are acquired with regards to the management of LNG at the Casino Project. The final Plan will include a table of proponent commitments made during the environmental assessment process relevant to LNG management, and indicate how the plan addresses the commitments. Terms and conditions of any applicable licences, permits and approvals required for the Project operations will also be included, once acquired.



PREPARED BY:

Knight Piésold
CONSULTING

DESIGNED	GLS/CAH
DRAWN	CC
CHK'D	CAH
APP'D	GLS
REV	0
DATE	16DEC'13

NOTES:
1. BASE MAP: EAGLE MAPPING
2. PROJECTION: NAD 1983 UTM ZONE 7N
3. COORDINATE GRID: METRES

CASINO

GENERAL ARRANGEMENT - MAXIMUM EXTENT

CASINO PROJECT

FIGURE 1-1

REF 1

P/A VA101-325/15

2 – TRANSPORTATION

The final LNG Management Plan will be based on best practices in transporting LNG on public roads, driver communications, vehicle location tracking, maintaining mobile equipment, maintenance record keeping, personnel records, regulatory & enforcement coordination, and to demonstrate compliance to national and local regulations on a long-term, and sustainable basis. The purpose of the plan is to establish standards that all transportation participants will be trained in and measured for conformity.

To ensure the protection of communities and the environment during transport of LNG to the Casino Project, the general guidelines below will be followed:

- Responsibility for safety, security, release prevention, training, and emergency response will be established in written agreements with producers, distributors and transporters.
- Emergency response plans and management measures will be implemented by LNG transporters.

The following practices from CSA-Z276 will be followed in the development of the more detailed transportation plan:

CSA-Z276

13.3.8 Transportation of LNG

13.3.8.1: The driver of each tank vehicle, or the shipper's representative accompanying the driver, shall have readily available written procedures regarding general operating precautions, manual venting, and emergency procedures, including names, addresses, and telephone numbers of individuals to be contacted in an emergency.

13.3.8.2: Stopovers of tank vehicles may occur at safe locations. Under no circumstances shall a tank vehicle be left unattended on a public highway.

13.3.8.3: It can be necessary to blowdown a tank at a remote and safe location. The driver or shipper's representative shall be trained to identify a suitable location and be trained in blowdown procedures.

13.3.8.4: The driver or the shipper's representative accompanying the driver shall be trained in the handling of LNG.

2.1 REQUIREMENTS AND GUIDELINES FOR TRANSPORTATION CONTRACTORS

Casino Mining Corporation will require contractors retained for LNG deliveries to the Project will develop and implement a LNG Transportation Plan that is consistent with the LNG standards mentioned above, and should be integrated with the overall LNG management plan as well as with related management plans (i.e. the Environmental Management Plan). Each contracting firm will be requested to prepare their approach and to submit their proposal based on the following:

- A staffing plan that will support the functional for the LNG trucking fleet. The staffing plan should include general management, drivers, mechanics, and other maintenance and shop personnel, dispatchers, road supervisors, quality assurance staff to handle issues that arise, training including operator and safety training, and office and administrative personnel. Their staffing plan will be used as one of the elements in evaluating their capabilities and space requirements for the proposed LNG unloading and unloading facilities. Driver qualifications and training records are required.

- Trucks, trailers, and other components to be provided in the contract. Trucks and trailers to be a current model, new and unused, under standard production by the manufacturer, and of which parts are stocked at one or more locations in Western Canada. The requirement for parts to be stocked may be waived if the bidder provides an acceptable parts availability plan. All parts utilized on the unit should be new and unused.
- Queuing space allocations at the LNG unloading and unloading facilities for trucks be fueled (either LNG or diesel), LNG transfer to unload tankers, have consumable fluids checked and topped off as necessary, and the interiors cleaned without having to be moved. Bays are to be canopied, and designed to be pull-through able to be accessed at any time regardless of weather conditions.
- Transportation schedules and quantities.
- Carrier should furnish copies of Carrier's permits or authority to transport the products as issued by state or federal regulatory agencies.

The following practices will be described and implemented:

- Vehicles used for the transportation of LNG as well as the associated containers comply with the prescribed safety standards and display all applicable prescribed safety marks in accordance with CSA-Z276.
- Chain of custody documentation including MSDS (Material Safety Data Sheets) to track inventory and LNG movement.
- Use of escort vehicles or convoys for LNG shipments as necessary due to inclement weather and road conditions.
- Regular maintenance of transportation equipment including containers, trucks, loading and unloading machinery, and storage systems.
- Training of all personnel operating LNG handling and transport equipment.
- Emergency Response plans for a potential LNG release during transportation including:
    - Designate appropriate response personnel and commit necessary resources for emergency response;
    - Emergency response training of involved personnel;
    - Descriptions of the specific emergency response duties and personnel responsibilities;
    - A detailed list of all emergency response equipment available during transport or along the transportation route;
    - A detailed list of all emergency response and personal protective equipment during transportation;
    - Initial and periodic refresher training in emergency response procedures;
    - Develop procedures for internal and external emergency notification and reporting; and
    - Periodically evaluate response procedures and capabilities and revise if needed.

During operations, contractors as a minimum will need to provide evidence of compliance to the following:

- On a real time basis, identify limitations, risks and restrictions of conditions that might be encountered along the specific routes to be followed for driver awareness, and prescribed measures to be taken when they occur. Examples include:
  - Highway weight & dimensional limits;
  - Posted speed zones;
  - Bridge regulations;
  - Known traffic hazards;
  - Temporary road hazards;
  - Seasonal and climate related hazards; and
  - Highway impasse due to vehicle accidents, road obstructions, weather;
- Compliance to *LNG Transport Emergency Response Plan* for LNG highway transport operations:
  - Accidents involving LNG transport vehicles (no leaks or spills);
  - Accidents involving LNG transport vehicles (with leaks or spills);
  - LNG transport trailer rollover;
  - Leaks and spills;
  - Fire;
  - Weather related incidents; and
  - Coordination with local, provincial and federal authorities depending on the severity of the accident.
- Personnel policies and training (see Section 2.2).
- A system for real-time communications with drivers in transit.
- A system for tracking the location of vehicles in transit.
- A system to ensure all equipment used is appropriate for the products to be handled and transported. All equipment must comply with the requirements and standards. Equipment must be maintained in good condition and “fit for purpose”.
- A system to capture and report vehicle maintenance:
  - Preventative maintenance;
  - Maintenance problems and defective equipment;
  - Parts and procedures in performing maintenance and repairs;
  - Plan, schedule and record vehicle maintenance history;
  - Demonstrate the vehicle is maintained per the manufacturer recommendations; and
  - Specify tire types, use on specific axle as a minimum, and rules regarding repair and re-treading.

- A system for standard vehicle checklist prior to travel on a daily basis including:
  - A tire policy, tire inspection procedure, tire change and replacement frequency;
  - Regulations of tire pressures;
  - Fluids; and
  - Wiper blades, belts, hoses, etc.

2.2 PERSONNEL POLICIES AND TRAINING

Contractors who are evaluated for LNG transportation services will be requested to develop a training plan to ensure that training needs and effectiveness are reviewed on a regular basis. A training matrix should be prepared to determine what training will be delivered, by whom, and what frequency, etc. Training must take account of any statutory regulations, and should also reflect industry codes or standards relevant to the work. A designated person within the transportation services company is to coordinate and manage the provision of training and maintain appropriated training records. For employee qualification, training, and certification, detailed classroom study, testing, and safety training. Safety training that is expected to be included in the training syllabus matrix includes:

- Induction and Orientation
- Properties of LNG and Natural Gas
- LNG Transfer (unloading and loading) Operations
- LNG Fueling
- Fatigue & Tiredness
- Drug & Alcohol Abuse
- Vehicle Roll Over Awareness Training
- Personnel Protective Equipment
- Fire Prevention and Suppression
- Management Planning for the Specific Route
- Checklists, Logs, and Documentation
- Near Miss and Incident Reporting
- Tire inspections
- Journey Risks, Transportation Routes and Consideration of the Constraints and Risks Associated with the Routes
- Approved Rest Areas and Prominent Land Marks Along The Routes
- Emergency Response Plan

3 – HANDLING, STORAGE AND USE

The proposed LNG facility, storage and secondary containment infrastructure is shown in Figure 3-1. Delivery and unloading of LNG on site will take place at the LNG storage and receiving facility. The storage tank will include 110% secondary containment. The unloading and storage areas will be designed to allow safe maneuvering of plant vehicles. The LNG containment areas will be designed at 110% of the total volume held in the delivery container.

Measures implemented during LNG handling, storage, and use at the Casino project will be in accordance with the principles of CSA-Z276 – mainly to protect workers and the environment during LNG handling and storage. The relevant CSA-Z276 guidelines are summarized below.

CSA-Z276

13.3.9 LNG transfer

13.3.9.1: Where making bulk transfers into stationary storage containers,

(a) the LNG being transferred shall be compatible in composition and temperature or in density with the LNG already in the container; or

(b) means shall be employed to manage stratification and to prevent rollover and an excessive rate of vapor evolution where the compositions and temperatures or the densities are not compatible. If a mixing nozzle or agitation system is provided, it shall be designed to have sufficient energy to accomplish its purpose.

7.1.4 Basic design considerations

7.1.4.1: Those parts of LNG containers that normally are in contact with LNG and all materials used that are in contact with LNG or cold LNG vapor (vapor at a temperature below –29 °C [–20°F]) shall be physically and chemically compatible with LNG and intended for service at –168 °C (–270°F).

7.1.4.3: All LNG tank systems shall be designed to accommodate both top and bottom filling, unless other positive means are provided to prevent stratification.

7.1.4.4: Any portion of the outer surface area of an LNG container and any external members whose failure could result in loss of containment from accidental exposure to low temperatures resulting from leakage of LNG or cold vapor from flanges, valves, seals, or other non-welded connections shall be designed to withstand such temperatures or otherwise protected from the effects of such exposure.

7.1.4.5: Where two or more containers are situated in a common dike, the container foundations shall be capable of withstanding contact with LNG or shall be protected against contact with an accumulation of LNG that could endanger their structural integrity.

7.1.4.6 The density of the liquid shall be assumed to be the actual mass per unit volume at the minimum storage temperature; however, the assumed density shall not be less than 470 kg/m3 (29.3 lb/ft3).

Handling, storage and use of the LNG at the Casino Project will comply with the following best management practices:

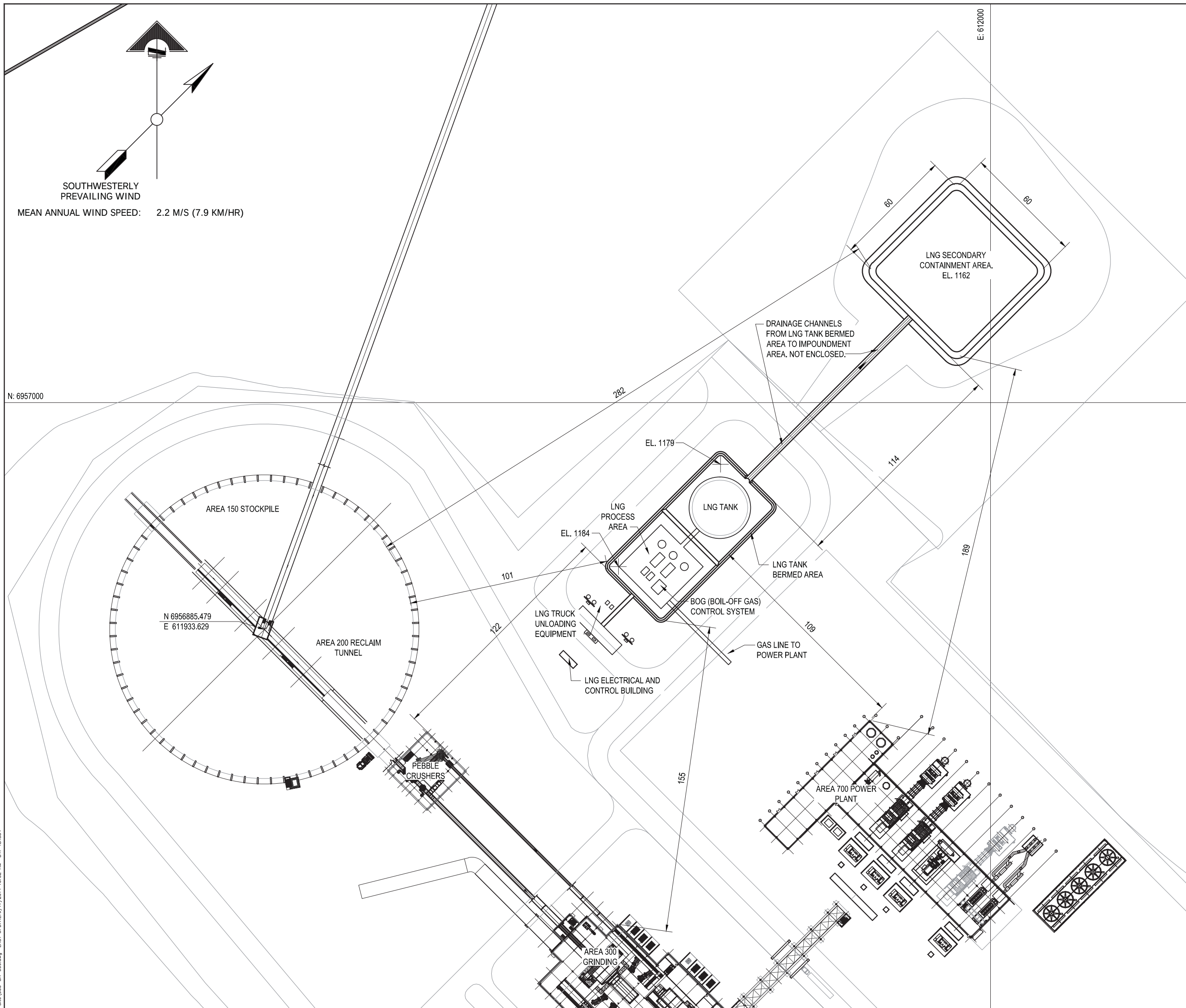
- Design and construct unloading and storage facilities consistent with sound, accepted engineering practices and quality control/assurance procedures, spill prevention and spill containment measures.
- Operate unloading and storage facilities using inspections, preventive maintenance and contingency plans to prevent or contain releases, and control and respond to worker exposures.
- Provide spill prevention or containment measures for associated tanks, pipelines, and associated process equipment.

3.1 LNG TRANSFER OPERATIONS

LNG transfer, storage and process equipment is a closed loop system such that during normal operations there should be no routine or significant releases to the atmosphere from plant equipment and processes. The exceptions are for extremely small releases during truck loading arm connection and disconnection operations. Operating procedures require that piping and transfer arms or hoses are to be purged with nitrogen prior to opening to the atmosphere to prevent an internal flammable mixture from occurring. The design, operating procedures, and are intended to eliminate the potential for:

- Unplanned or unsafe release of LNG or flammable vapors to the atmosphere;
- Flammable mixtures with air in piping, containers and other enclosed spaces;
- Hazards to personnel and equipment from improper valve isolations; or
- Hazards from improper cooldown and warm-up of LNG liquid and vapor lines.

Releases of flammable gas to the atmosphere may occur during certain planned maintenance activities, emergencies and abnormal operating conditions. “Hot Work” permits are required during truck loading/loading, arm/hose connection and disconnection operations where a potential for release of their contents to the atmosphere is possible. Transfer operations will comply with CSA Z276.



LNG FACILITY DATA :

LNG STORAGE TANK AND SECONDARY CONTAINMENT AREA, INCLUDING THE CHANNEL CROSSING THE ROAD AND TO THE IMPOUNDMENT AREA, DESIGNED TO THE SPECIFIC REQUIREMENTS OUTLINED IN THE FOLLOWING STANDARDS:

A. CSA Z276;
B. API 620 APPENDIX Q;
C. NFPA 59A.

LNG SECONDARY CONTAINMENT AREA
- SIZE (INSIDE EDGE OF BERM): 60 M X 60 M
- CONTAINMENT AREA: 3,600 SQUARE METERS (MAXIMUM AREA FOR POOL SIZE / RADIATION CALCULATION)
- CONTAINMENT VOLUME: 11,000 CUBIC METERS (110% OF LNG TANK VOLUME)

LNG TANK
- TANK SIZE: 28 M DIAMETER X 17.5 M HIGH (INTERIOR DIMENSIONS)
- TANK VOLUME: 10,000 CUBIC METERS
- LNG TANK BERM: 2 M WIDE, .75 M HIGH (AREA PROTECTION BERM. NOT THE CONTAINMENT BERM.)

LNG UNLADING PUMPS
- NUMBER: 4
- CAPACITY: 90 M³/HR. EACH (LNG)

LNG TANK PUMPS
- NUMBER: 2
- CAPACITY: 45 M³/HR. EACH (LNG)

LNG BOOSTER PUMPS (SUBMERGED)
- NUMBER: 3
- CAPACITY: 23 M³/HR. EACH (LNG)

LNG GLYCOL/WATER CIRCULATION PUMPS
- NUMBER: 2
- CAPACITY: 185 M³/HR. EACH (LNG)

LNG VAPORIZERS
- NUMBER: 2
- CAPACITY: 45 M³/HR. EACH (LNG)

LNG BOG (BOIL-OFF GAS) COMPRESSORS
- NUMBER: 2
- CAPACITY: 1,171.6 M³/HR. EACH (GAS)

PRELIMINARY
NOT FOR CONSTRUCTION

LNG FACILITY LAYOUT
SCALE: 1:1000

25 12.5 0 25 50
SCALE IN METERS
DO NOT SCALE 11x17 DRAWINGS

CASINO MINING CORPORATION

CASINO FEASIBILITY STUDY

CASINO PROJECT OVERALL SITE GENERAL ARRANGEMENT LNG FACILITY LAYOUT

REFERENCES		REFERENCES		REVISIONS						REVISIONS					
DWG. NO.	TITLE	DWG. NO.	TITLE	NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT	NO.	DESCRIPTION	BY	APP'D	DATE	CLIENT

SCALE:	1:2000	DATE
DESIGNED BY	TFB	JUL 14
DRAWN BY	TFB	JUL 14
CHECKED BY		
PROJECT MGR		
CLIENT APPR.		

m3 ARCHITECTURE ENGINEERING CONSTRUCTION MANAGEMENT
Tucson, Arizona
Chandler, Arizona
Hermosillo, Sonora Mexico
www. m3eng.com

PROJECT NO. M3-PN 120001
DWG NO. **000-GA-009**
REV NO. P1
DATE 17 SEP 14

3.1.1 LNG Truck Loading and Unloading

LNG supply to truck loading is from the LNG supplier's LNG tank transfer pumps. LNG unloading is from the highway trailer to the LNG storage tank using stationary LNG unloading transfer pumps. There is a common 'cold retention' liquid recirculation line for the two truck loading bays to retain LNG temperature in piping between LNG truck loadings. 'Cold retention' recirculation LNG is returned to the LNG tank zero send-out recirculation line.

For LNG code compliance for secondary containment, the loading and unloading bays are provided with a spill collection system to lead spills to an impoundment basin sized for 10 minute spill at max loading rate. A drain pot is provided to drain the LNG arms/hoses on completion of loading (for coupling disconnection, ease of handling and prevention of ice build-up during periods of no loading). Drained liquid is returned to the LNG recirculation line with nitrogen pressure.

Truck Loading and Unloading Bay Components:

- LNG unloading manifold
- LNG supply piping manifold
- Vapor return piping manifold
- Canopied Cover for loading bay and weighbridge (weather protection)
- Driver shelter
- Man-machine interface (MMI) for "load recognition and verification"
- Weighbridge
- Articulated liquid and vapor arms or hoses to connect Terminal piping to truck (arms or hoses will be determined during detailed engineering)
- Drain vessel for draining articulated arms/hoses
- Nitrogen supply for arms/hoses blow-down and drain-vessel blow-casing

Hazard detection, CCTV monitoring, and automatic and manual emergency shutdown is included in the truck loading design and includes the following truck loading and unloading area emergency shutdown initiators:

- ESD Hand Switch - Truck loading/unloading
- ESD Hand Switch - Truck loading/unloading perimeter (15m from bays)
- ESD Hand Switch– Main control room
- ESD (Automatic) truck loading fire, gas, spill hazard detection
- Instrument Air pressure: low-low, close truck loading ESDV's
- LNG tanker high liquid level (Alarm)
- LNG tanker high-high liquid level (ESD)

To contain potential LNG releases from loading/unloading areas and transfer piping, secondary containment curbs and transfer trenches will be installed in process areas and adjacent to LNG pipe racks to drain potential releases of LNG to impoundment basin.

Truck access to the Terminal Site is via an automatic gate. Only trucks and drivers with advance authorization and valid ID are admitted onto the Terminal Site. The truck loading operation is performed by trained truck drivers, who will remain in attendance throughout the loading procedure.

3.1.2 LNG Highway Tanker Loading Operational Steps

LNG highway tanker loading/unloading is accomplished by performing a sequence of operational steps:

1. Trucks access the facility via an automatic gate. Only approved trucks and drivers with valid ID are admitted.
2. The truck/tanker parks on the weighbridge
3. The driver secures the truck, chalk wheels, and steps away from the weighbridge
4. Driver identity, Truck/tanker identity, and weight are validated as accurate
5. The truck loading/unloading operation is performed by trained drivers who will remain in attendance throughout the loading procedure.
6. An umbilical cord is connected to LNG highway tanker to monitor truck/tanker safety systems and provide earthen grounding to the tanker.
7. Truck keys are removed and secured
8. LNG loading and vapor hoses are connected between the tanker and the loading manifold
9. Vapor pressure is equalized between the tanker and facility vapor system
10. The LNG loading valve is opened to provide cooldown of the LNG loading arm/hose
11. The LNG facility loading or unloading pump is started that provides the drive force for transfer of LNG from storage tanks to highway tankers (loading) or from highway tankers to the LNG storage tank (unloading).
12. LNG loading/unloading continues until the tanker is near 90% full of liquid, and 10% or more vapor space is retained (loading) or until the tanker is near empty of liquid (unloading). A suction drum is located before the LNG transfer pump that has a liquid level indicator that automatically stops the unloading pump when liquid level drops below the setpoint in the suction drum. By design, a small heel of LNG is retained in the highway tanker to keep the tank cold for the return trip.
13. Vapor and LNG valves on the loading manifold are closed.
14. Hoses are depressurized, and purged of LNG and flammable vapor to the LNG drain vessel.
15. Hoses/arms are disconnected
16. The umbilical cord is disconnected
17. The LNG tanker loaded/unloaded quantity validation is completed in the facility measurement system
18. The driver departs with the LNG tanker load and vapor space pressure of approximately 2 psig.

3.1.3 LNG Highway Tanker Loading Safety Features

The LNG highway tanker loading/unloading facility will incorporate a number of safety features to prevent unsafe conditions:

- Hazard detectors will be installed in the LNG highway tanker loading area where potential of LNG spills, gas leaks, flame, excess heat and cryogenic temperature indicate unsafe conditions. Logic in hazard detection control systems will automatically trigger an emergency shutdown (ESD) for specific events.
- Manual ESD activation hand-switches are provided at multiple locations in the tanker loading area.
- Emergency manual call points are provided, as well as sirens and beacons to alert personnel of emergency situations.
- A terminal-to-truck umbilical cable is connected to the LNG highway tanker that ensures that truck engine is off, LNG highway tanker is earthed, and truck & tanker braking systems are set before loading is permitted. Loading and vapor return hoses are vulnerable to “drive-off” with hoses connected. Cryogenic hoses are not provided with breakaway couplings to provide a “weak point” and to be avoided as a serious incident.
- Barriers protect pipe work from truck impact as practical.
- Fire suppression and firewater with remote activation and control in the event of fire is provided.

Note that operators will be trained to know when to apply fire water. Fire water is not an appropriate response for all fires.

3.1.4 LNG Highway Tanker Weighing During Loading/Unloading

A weighbridge is provided for each of the two LNG highway tanker loading and unloading bays. The truck and highway tanker is parked on the weighbridge the entire duration of loading and serves three primary purposes during loading:

1. Overfill protection is provided where the tanker has a maximum weight that when reached will stop loading. If exceeded, there will be an overfill alarm on high level. For high-high level, a safety interlock trip will stop loading. For high-high-high level, an ESD trip will stop loading.
2. For custody transfer measurement, loaded LNG quantities are automatically recorded in the LNG facility measurement system and based on the weight of LNG loaded. This is determined from the difference in starting weight to ending weight when loading is complete.
3. Prior to loading, a weight trip (pre-loaded set point for all truck/tanker) prevents the tanker from being loaded if not within expected weight range. The truck/tanker should weigh the same prior to the start of loading as the truck/tanker weighed after truck/tanker loading at Casino, less truck fuel consumed, or added en-route. A management override is required to document and explain any discrepancies.

And two primary purposes during unloading:

1. For custody transfer measurement, unloaded LNG quantities are automatically recorded in the LNG facility measurement system and based on the weight of LNG unloaded. This is determined from the difference in starting weight to ending weight when unloading is complete.
2. Prior to unloading, a weight trip (pre-unloaded set point for all truck/tanker) prevents the tanker from being unloaded if not within expected weight range. The truck/tanker should weigh the same prior to the start of unloading as the truck/tanker weighed after truck/tanker loading in Fort Nelson, less truck fuel consumed, or added en-route. A management override is required to document and explain any discrepancies.

4 – WORKER SAFETY AND EMERGENCY RESPONSE

The following principles for worker safety are of the utmost importance and must be followed at all times:

- Protect workers' health and safety from exposure to LNG/natural gas evaporating from the LNG.
- Protect communities and the environment through the development of emergency response strategies and capabilities.
- Train workers and emergency response personnel to manage LNG in a safe and environmentally protective manner.

This section of the LNG Management Plan will be implemented in conjunction with the Occupational Health and Safety Management Plan as well as with the Emergency Response Plan. The relevant CSA-Z276 safety and emergency response guidelines include:

CSA-Z276

4.5 Safety and loss management system

4.5.1: For each LNG facility, the operating company shall develop, implement, and maintain a documented safety and loss management system that provides for the protection of people, the environment, and property.

4.5.2: The safety and loss management system shall include the following elements:

(a) clearly articulated policy;

(b) leadership commitment;

(c) a suitable organizational structure with well-defined responsibilities and authorities;

(d)a process for the management of resources, including the establishment of competency requirements and an effective training program;

12.8 Personnel safety

12.8.1: Protective clothing that provides protection against the effects of exposure to LNG shall be available and readily accessible at the facility. Note: Protective clothing for normal liquid transfer operations should include cryogenic gloves, safety glasses, face shields, and coveralls or long-sleeve shirts.

12.8.2: Those employees who are involved in emergency activities, as determined in accordance with Clause 12.1.2, shall be equipped with the necessary protective clothing and equipment and shall be qualified in accordance with NFPA 600.

12.8.3: Written practices and procedures shall be developed to protect employees from the hazards of entry into confined or hazardous spaces. Note: Information concerning confined entry practices and procedures can be found in the U.S. Code of Federal Regulations, Title 29, Subtitle B, Chapter XVII, Part 1910.46, the Canada Labour Code, Part II, and any local, state, or provincial/territorial regulations and standards that apply.

12.8.4: At least three portable flammable-gas indicators shall be readily available. Note: Natural gas, LNG, and hydrocarbon refrigerants within the process equipment are usually not odorized, and the sense of smell cannot be relied upon to detect their presence. Two portable detectors should be available for monitoring when required, with a third detector for backup. This provides a spare detector in the event of failure of one of the primary detectors and also allows verification if the two primary detectors provide different readings.

13.3.3 Emergency procedures

13.3.3.1: The types of emergencies referred to in Clause 13.3.2(k) shall include, at a minimum, emergencies that arise from an operating malfunction, structural collapse of part of the LNG plant, personnel error, forces of nature, and activities carried out adjacent to the plant. Emergency procedures shall include:

(a) procedures for responding to controllable emergencies, including notifying personnel, the use of equipment that is appropriate for handling of the emergency, the shutdown or isolation of various portions of the plant, and other applicable steps to ensure that the escape of gas or liquid is promptly cut off or reduced as much as possible;

(b) procedures for recognizing an uncontrollable emergency and for taking action that will

(i) minimize harm to the personnel at the LNG plant and to the public; and

(ii) provide prompt notification of the emergency to the appropriate local officials, including notification of the possible need to evacuate persons from the vicinity of the LNG plant; and

(c) procedures for coordinating with the appropriate local officials an emergency evacuation plan that sets forth the steps necessary to protect the public in the event of an emergency.

13.3.3.2: The procedures and steps in Clause 13.3.3.1(c) shall include methods of advising the appropriate local officials of the

(a) quantity and location of fire equipment throughout the LNG plant;

(b) potential hazards at the LNG plant;

(c) communication and emergency control capabilities of the LNG plant; and

(d) status of each emergency.

13.3.3.3: Normally, gas fires (including LNG fires) should not be extinguished until the fuel source has been shut off, unless the fire would create more of a hazard than the gas dispersion.

The following principles will be implemented to meet the CSA-Z276 code requirements:

- Identify potential LNG spill scenarios and measures necessary to eliminate, mitigate and control, and minimize worker exposure. The scenarios will include vapor dispersion/thermal radiation from potential spills, and the layers of protection associated (i.e. a spill impoundment).

- Prepare detailed emergency response plans for potential LNG spills as they may cause fires if not contained. The plans will outline the potential scenarios and specific response actions including clearing the site, personnel, and the public as necessary.
- Develop and implement emergency response plans to respond to worker exposure to LNG/natural gas.
- Involve site personnel and stakeholders in the planning process.
- Periodically evaluate response procedures and capabilities and revise them as needed.
- Train appropriate personnel to operate the LNG receiving and unloading facility according to systems and procedures that protect human health, the community, and environment.
- Train workers to understand the hazards associated with LNG/natural gas.
- Train workers and personnel to respond to LNG/natural gas exposure and environmental releases, including use of first aid measures.
- Designate personnel and commit equipment and resources for emergency response as necessary.
- Develop internal and external procedures for emergency notification and reporting.

4.1 GENERAL HAZARDS

General hazards from the handling, storage and transportation of LNG include potential hazards during loading and unloading, during transit and during storage and from day-to-day operations. These hazards are discussed further below. Fire hazards from LNG and from the gasified natural gas are also outlined.

4.1.1 Hazards of LNG and Natural Gas

LNG liquid itself is not flammable – only the vapors emanating from the liquid can be lit. Natural gas and LNG vapor fires in the open atmosphere may flash and burn hot, but are not explosive because the flame propagation speed is much less than required to have an explosive pressure wave when the ignition is not within an enclosed space. In an unconfined space, the flame propagation speed of natural gas and LNG vapor increases with the temperature of the gas, but is significantly lower than other flammable hydrocarbons such as propane or gasoline vapors which can explode in an unconfined space.

Potential hazards from LNG, natural gas, explosion and from improper handling techniques are summarized below.

4.1.1.1 Hazards from LNG

The design, operations and maintenance procedures for handling, storage, and transfer of LNG are intended to eliminate the potential for LNG liquid from being released in the atmosphere or on the ground at all times. General hazards from LNG include:

- LNG vapor is flammable when in a 5 to 15% concentration in air. Please note that this is a fairly narrow concentration range in comparison to other hydrocarbons.
- Skin exposure by personnel to LNG (or bare metal surfaces chilled by LNG) will cause external dermal frost burns also called cryogenic “burns” or frostbite due to the -161 °C temperature of LNG. Cryogenic burns can cause serious skin injury in the form of skin discoloration, loss of skin layers and blistering dependent on the quantity and duration of exposure that requires immediate medical attention.

- If inhaled, LNG vapor is non-toxic to breathe the same as nitrogen or carbon dioxide but can act as an asphyxiate by displacing oxygen in the air.
- If inhaled, LNG vapor may be very cold and cause internal frost burns to the throat and lungs and may require immediate medical attention.
- When LNG liquid is confined in a pipe, container, or tank, the LNG will begin to absorb heat from the atmosphere that initiates vapor creation (boiling) of the LNG with a 1-to-615 of liquid (at atmospheric pressure) to vapor expansion ratio. Unless the pressure is released at an equal or greater rate, the container could be exposed to rapid and/or extremely high internal pressure buildup. The potential pressure buildup due to this effect could quickly exceed the containment pressure design rating that could cause a sudden failure of the container or other serious failures that may or may not include ignition.
- LNG vapor can be lighter or heavier than air based on the LNG vapor temperature with a specific gravity range of 1.7 when cold to 0.55 when warmed to ambient temperature. This characteristic results in the vapor having potential to collect in low places when cold, and high place when warm.
- LNG is an odorless, colorless, non-corrosive, and non-toxic clear liquid, where the presence of LNG or LNG vapor is not necessarily apparent to the human senses of smell and sight. When exposed to the atmosphere LNG produces a visible vapor cloud (fog) as moisture in the air condenses. Once the gas vapor temperature equalizes with the surrounding atmosphere, the vapor cloud fades away. Instruments for gas detection are to be relied upon for detecting the presence of natural gas and LNG vapor.
- LNG is very cold and therefore materials selected for storage and transfer of LNG need to be fully considered to be sure they are suitable for the application. Materials such as plastic and carbon steel become very brittle and will fail if exposed to the cryogenic temperatures of LNG liquid where stainless steel and aluminum materials retain their strength properties at cryogenic temperature.
- LNG is very cold that results in materials LNG comes into contact with to become smaller (contract) due to thermal contraction and expand upon warm-up. This effect needs to be considered to allow for movement where expansion and contraction occurs.

4.1.1.2 Hazards from Natural Gas

The design, operations and maintenance procedures for handling, storage, and transfer of natural gas are intended to eliminate the potential for natural gas from being released in the atmosphere at all times. General hazards from natural gas include:

- Natural gas is flammable when mixed with air and ignited.
- Natural gas is explosive when mixed with air and ignited in an enclosed space.
- Exposure of personnel to natural gas vented at high velocity can cause serious skin and eye injury that requires immediate medical attention.
- If inhaled, natural gas can act as an asphyxiate by displacing oxygen but is non-toxic to breathe the same as nitrogen or carbon dioxide.
- Natural gas is lighter than air and can collect in high place if confined.
- Natural gas is an odorless, colorless, non-corrosive, and non-toxic clear gas where the presence of natural gas is not necessarily apparent to the human senses of smell and sight. Instruments for gas detection are to be relied upon for detecting the presence of natural gas and LNG vapor.

4.1.1.3 Explosion Hazard Description of Natural Gas and LNG Vapors

Natural gas and LNG vapors are not explosive in an open space, and volatility of ignition decreases with colder ambient temperature. When natural gas and LNG vapor are ignited in a flammable mixture with air in an open space, the flame propagation speed is well below the speed of sound. When ignited, natural gas and LNG vapor will produce a flame and heat until the fuel is consumed, but no meaningful pressure wave will occur. Lower ambient temperature will further reduce the volatility of natural gas and LNG vapor where the intensity of the initial ignition is further reduced.

An explosion can occur with natural gas and LNG vapor, but only when combined with air in an enclosed space (pipe, containers, tanks, and buildings) and ignited. This is a far more serious hazard than fire in the open atmosphere. In addition to the effects of the fire, an explosion can be generated that has considerably more destructive power from the combined effects of fire and rapidly expanding vapor within an enclosed space structure. An explosion is caused when the initial ignition and fire causes a pressurization impulse wave that is initially contained by the enclosed space that further compresses the confined gases which also increases the gas temperature. The ignited gas burns behind a shockwave and releases energy that supports supersonic (faster than the speed of sound) shock propagation. This self-sustained detonation wave is different than an open fire as this can propagate at a supersonic speed and high temperature causing a significant and sudden pressure change and flashback (sonic boom). Because detonations generate rapid pressure changes and higher temperature they are generally much more destructive than subsonic fires. In all cases, an explosion will exceed the pressure containment rating of the enclosed space (pipe, containers, tanks, sumps and buildings) that results in complete loss of containment and failure of the enclosure and structure that further amplifies the destructive power of the blast. Other potential effects include flash fire, high temperature, supersonic pressure waves, domino failures, flying projectiles, burns, debilitating injury-death, hearing loss, asphyxiation, etc.

4.1.1.4 Hazards from Improper Purge, Isolation, and Ignition Sources

Hazards created by improper purge, improper isolations, the presence of ignition sources, and improper cooldown can be serious events. The following procedures will be included in the final LNG Management Plan to prevent such occurrences:

- Hazards from Improper Purge, Isolation, and Ignition Sources
- Purging
    - Purge-Into-Service
    - Leak Check and Pressurization Into Service
    - Purging-Out-of-Service
- Isolations for LNG and Natural Gas
- Cooldown-Into-Service
- Cooldown of LNG Piping
- Warm-up of LNG Piping and Containers

4.1.2 Potential Hazards at an LNG Loading / Unloading Facility

Hazards listed below are identified as potential safety hazards that will be addressed and managed in detail during facility design and development of safe operating procedures for LNG transfer operations of an LNG highway tanker at an LNG loading/unloading facility. The transfer phase of operations includes arrival at the LNG transfer facility, arm/hose connection, preparing for the LNG transfer, LNG transfer operations, arm/hose disconnection, and departure from the LNG transfer facility. Hazards during LNG transfer operations of an LNG highway tanker include:

- Unconstrained flammable gases in the atmosphere;
- Accidental spills or releases involving LNG liquid or vapor;
- Arms or hoses beyond their safe operating limits due to LNG tanker movement during transfer operations. (arms or hoses will be determined during detailed engineering) This could be caused by improper wheel chalking or improper drive off;
- Overfill the tanker with LNG during loading;
- Overpressure the LNG tanker;
- Vacuum pressure the LNG tanker;
- Accidents caused by vehicle movement in the transfer area;
- Fire in the transfer area;
- Flammable mixtures in piping, containers and other enclosed spaces;
- Hazards to personnel and equipment from improper isolations;
- Hazards from fueling the transit vehicle;
- Potential ignition sources for accidental ignitions of unconfined flammable gases in the atmosphere;
- Potential hazards from improper cooldown and warm-up of LNG liquid and vapor lines;
- Slips and falls by drivers during LNG transfer and fueling in inclement winter weather; and
- Personnel exposure to lightning hazards during storms.

By design, during normal LNG transfer operations, there should be no flammable gas or LNG in the atmosphere from transfer equipment and processes except small releases during trailer arm/hose connection and disconnection processes when the arms/hoses are purged and inerted. Releases to the atmosphere may also occur during certain planned maintenance activities, emergencies and abnormal operating conditions. Maintenance should be avoided during transfer operations, however, if necessary, “Hot Work” permits are required for maintenance during transfer operations, and when the arms are purged and inerted and planned maintenance activities during which flammable gases may be present. The design of the transfer facility includes operability, potential ignition source management, maintainability requirements, and mitigations to all potential hazards listed above.

4.1.3 Potential Hazards of LNG during Transit

Hazards listed below are identified as potential safety hazards that will be addressed and managed in detail during LNG transit operating procedures development, LNG transportation contractor selection, LNG driver training, and routine operations for safe LNG transit operations of an LNG highway tanker. This phase of operations includes all the activities during the roundtrip transit after departing an LNG transfer facility to arrival at an LNG transfer facility. Hazards during LNG transit operations of an LNG highway tanker include:

- Driver fatigue or inattention;
- Vehicle accident during transit;
- Driver unsafe driving practices;
- Accidental spills or releases involving LNG liquid or vapor resulting in unconstrained flammable gases in the atmosphere;
- Overpressure the LNG tanker due to boil-off gas buildup;
- Vehicle fire during transit;
- Potential ignition sources from the transit vehicle, other vehicles, other activities en-route that present sources of accidental ignitions of unconstrained flammable gases in the atmosphere; and
- Slips and falls due to LNG transfer during inclement winter weather.

An LNG tanker trailer is a tight, double wall insulated tank, where all LNG tank interfaces are valved off and capped, except for pressure relief valves. During normal LNG transit operations there should be no ignitable flammable gas or LNG vapors in the atmosphere from the tanker or vehicle fuel system. Pressure in the LNG tank vapor space is normally maintained at low pressure, and significantly below the pressure relief valve setpoint. Releases to the atmosphere during transit are an exception, and considered an abnormal or emergency operating condition.

4.2 ACCIDENTS AND MALFUNCTIONS

All facilities, including LNG facilities, will be designed and constructed in accordance with applicable Federal and Territorial codes and regulations. Applicable permits will also be obtained prior to operation of the facility to fulfil compliance.

Incident scenarios involving uncontrolled release from vaporization, process pipework, and fuel gas systems may include an abnormal temperature or pressure. Potential releases will be prevented by following engineering best practices for LNG and requirements from CSA Z276. By design, during normal LNG facility operations, there should be no flammable gas or LNG in the atmosphere from process equipment, storage and transfer areas except small releases during trailer arm/hose connection and disconnection when the arms/hoses are purged and inerted. Releases that could cause flammable gas mixture build-up in a congested region of the plant are considered an abnormal and potentially emergency condition. Gas, fire, and LNG spill detection are provided as the first line of defense in detecting unsafe releases, and will provide audible alarms, and in some cases, an automatic process shutdown.

Mitigation measures have been incorporated into the design of the LNG and natural gas facility and distribution network. Mitigation measures implemented to avoid impacts from the environment on the project (e.g., seismic events, extreme weather, wildfire) are summarized in Table 4-1.

Table 4-1 Mitigation Measures to Avoid Disturbance from Environmental Events

Environmental Event	Mitigation Measure
Earthquake or seismic event	The LNG storage tank will be designed for MDE corresponding to 1 in 2,500 year earthquake with a mean PGA of 0.13g and a design earthquake magnitude of 8.0.
Terrain stability	The LNG tank is expected to be founded on bedrock with no possibility of permafrost being present. There is no prospect of terrain instability where these facilities are to be located.
Extreme weather (e.g., snow, wind, etc.)	The LNG tank and related facilities will be designed to withstand all site conditions including snow, wind, etc. as required by code and sound engineering practice.
Unstable areas	Detailed geotechnical studies and seismic analysis will be performed during detailed engineering to confirm the stability of the LNG tank soil conditions, and areas in proximity of the LNG facility that could potentially be unstable.
Wildfire	The LNG storage and related facilities are isolated from other site facilities and activities to preclude potential ignition sources for the LNG impoundment area.

Additionally, a hazard detection system for the facility will serve as the first line of defense for detection of gas, LNG releases and fire. The system is based on the following strategies:

- Continuous monitoring of areas that store, transfer, process flammable fluids by remote hazard detectors (flame, gas, and low temperature);
- Manual local emergency hand switches at strategic locations to manually activate the Hazard Detection System;
- Remote visual monitoring through closed circuit television (CCTV);
- Hazard detection system audible alarms and visual beacons to alert personnel of a potential hazard and abnormal operations in the immediate area of the detection and in the local & Main Control Room;
- Automatic trips of ESD system zones for certain events.

A fire suppression system may be employed which will detect, extinguish, and control the flame.

4.2.1 Seismic Events

The process equipment and piping will be designed to comply with the CSA-Z276 standards for site specific seismic conditions. The LNG storage tank will be designed for MDE corresponding to 1 in 2,500 year earthquake with a mean PGA of 0.13g and a design earthquake magnitude of 8.0. Table 4-2 describes the potential consequences if a foundation or structural failure occurs for various associated piping and equipment.

Table 4-2 Potential effects of seismic events on the LNG storage tank, other equipment, and pipelines carrying natural gas

Equipment	Seismic Event	Potential Effect
LNG Storage Tank	Foundation Failure/Structural Failure	Failure of the LNG storage tank foundation can affect the integrity of the LNG container, the impounding system and system components required to isolate the LNG container. An LNG spill can occur and if a source of ignition is present a pool fire can occur which can lead to a vapor cloud ignition.
Natural Gas Pipeline	Foundation Failure/Structural Failure	This can lead to a leak or rupture of the pipeline. If this occurs there is a potential for a flash fire if an ignition source is present. This can cause damage to other pieces of nearby equipment (i.e. BOG compressor) and personnel can suffer thermal injuries and fatalities. External incidents can occur from the flash fire as other pieces of nearby equipment may become compromised.
LNG Vaporizers	Foundation Failure/Structural Failure	This can lead to an accumulation of flammable products of combustion. If the accumulated gas is near an ignition source and there is between 5-15% of air in the mixture, an ignition will occur causing severe property damage and potential for personnel injury.
LNG Pumps	Foundation Failure/Structural Failure	This can lead to overstressed material which can fatigue or rupture the pump. The pump seal can fail and the LNG can vaporize through the seal and if it reaches an ignition source, can cause a flash fire or vapor cloud ignition.
Booster Pumps	Foundation Failure/Structural Failure	This can lead to overstressed material which can fatigue or rupture the pump. The pump seal can fail and the natural gas can leak through the seal and if it reaches an ignition source, can cause a flash fire or vapor cloud ignition
BOG Compressors	Foundation Failure/Structural Failure	This can lead to potential overpressure, vibration, and seal leakage. The gas leakage can lead to a flash fire or vapor cloud ignition
Heat Exchanger Gas/Glycol Water	Foundation Failure/Structural Failure	This can lead to potential overpressure and overheating of the gas. This hot gas can leak if the exchanger has been ruptured and reach an ignition source. As a result a vapor cloud ignition.

4.2.2 LNG Tank Rupture

A catastrophic failure of an LNG storage tank although unlikely, has the ability to create a long range flammable gas cloud, which will flash, but not explode as it reaches an ignition source. The consequences to personnel and the facility will be severe as there will be property damage and potential injuries and fatalities. LNG liquid itself is not flammable – only the vapors emanating from the liquid can be lit. Natural gas and LNG vapor fires in the open atmosphere may flash and burn hot, but are not explosive because the flame propagation speed is much less than required to have an explosive pressure wave when the ignition is not within an enclosed space.

If there is an uncontrolled release, a pool of LNG can form between the primary and secondary containment. If an ignition source is reached, the combustion of the material evaporating from the pool of liquid can occur. The larger the evaporative vapor cloud from the pool of LNG is, the more severe the potential damages could be to the facility and personnel. This is why it is important to use materials with low density, heat capacity, and thermal conductivity in order to minimize the vaporization rate, which determines the size of the vapor cloud.

Although both of these events are unlikely, the consequences of these events occurring are severe and must be treated with high importance. During detailed design a pool fire model will be created utilizing the programs approved by CSA-Z276 and NFPA 59A.

4.2.3 Uncontrolled Release

Uncontrolled releases may occur from process pipework, or from the LNG storage tank. These two scenarios are discussed below.

4.2.3.1 Uncontrolled Release from Process Pipework

Uncontrolled release from process pipework will be prevented as a primary design consideration to prevent unsafe conditions. LNG and vapor pipework will be designed and installed to meet or exceed LNG design standards. Hoop stress, thermal stress caused by expansion and contraction, corrosion potential, thermal shock cooling and heating, and location specific conditions will be considered during detailed design to apply and demonstrate best engineering practices. Non-destructive testing and pressure tests will be utilized to confirm and record the integrity of installed systems fit for purpose, and compliance to LNG regulations.

4.2.3.2 Uncontrolled release from LNG storage tank

The design standard that is the primary guideline is CSA-Z276. The particular sections that discuss the process instrumentation and controls for the prevention and monitoring of uncontrolled releases from the storage tank are shown below. This includes a variety of scenarios to prevent LNG overflow and uncontrolled release of LNG from the tank:

- LNG tank overfill;
- LNG tank overpressure;
- Leaks or releases from process piping associated with the LNG tank; and
- LNG tank integrity impacts from external forces, wind, snow, and seismic.

A combination of redundant high integrity liquid level devices, alarms if the set points are reached, and automatic shutdown for flow device, and operator monitoring will be employed in order to prevent and monitor tank LNG releases and other unsafe conditions.

LNG tank overpressure could cause uncontrolled release of LNG vapor from LNG tank pressure relief valves on the tank roof as an overpressure protection of last resort. Overpressure and relief valve discharge will be prevented by process controls, facility BOG recovery systems, and continuous monitoring to respond in advance to conditions that could create high tank pressure and avoid them before they occur. For overfill/flow scenarios for LNG tank the following alarms/trips are used:

- Liquid Level High Alarm;
- Liquid Level High-High Trip;

- Redundant Mechanical Liquid Level High-High Trip;
- LNG Tanker Unloading Trip;
- Unloading Pumps Trip; and
- Secondary Containment for LNG Tank Spills and Releases.

4.2.4 Downwind Ignition Sources

The design and layout of the LNG facility considers minimizing controllable ignition sources within proximity of the facility. During detailed engineering, an electrical hazardous area drawing will be prepared to designate hazardous areas, and electrical area classifications. Buffer zones will be created and designated by the LNG security fence. Isolating downwind ignition sources – other ignition sources which may be downwind of the facility include high temperature sources (flames), electrical sources, and physical sources such as compression energy. There are unlikely to be chemical sources as there are no chemical reactions that will occur at this facility. Recommendations to minimize ignition sources through isolation include:

- Electrical area classification (NEC 70);
- Reducing the combustible concentration by isolation; and
- Detecting and eliminating ignition sources.

Finally, trucks and other LNG transfer vehicles must remain at least 15 m away from equipment containing LNG and natural gas. In addition, these vehicles must not enter the impoundment area, unless authorized and under constant supervision.

4.3 EMERGENCY RESPONSE

A detailed emergency response plan will be developed during the detailed design phase of the project; however, a preliminary emergency response plan is provided herein. The Casino LNG receiving facility uses a closed loop process where the release of LNG to the environment is not expected, and considered an abnormal operating condition. Best practices are followed, and the use of flanged joints has been kept to an absolute minimum and all welded piping is used whenever possible to avoid potential leak sources.

General guidelines for cryogenic burns, vapor cloud ignition/explosions, jet fires, flash fires, pool fires and boiling liquid expansion are provided below for LNG and natural gas. The mitigation measures detailed below will be employed at all times during the transportation, handling and storage of LNG and natural gas.

4.3.1 Cryogenic Burns

Mitigation Measures: Proper Personal Protective Equipment (PPE) should be worn at all times when in close proximity to cryogenic equipment. This should consist of special cryogenic gloves, long sleeve shirts, long pants, leather steel toed boots, and a face shield to protect the face from any splashing liquid.

Emergency Response Procedures: Exposure to LNG or direct contact with metal at cryogenic temperatures can damage skin tissue more rapidly than when exposed to vapor. It is also possible for personnel to move away from the cold gas before injury. In addition, moist skin coming in contact with cryogenic parts will freeze instantly and may adhere to the part. If this occurs, treat the burned or frostbitten skin by flushing or immersing the affected area(s) in lukewarm water. Do not rub the area or remove clothing that may have adhered to the area from freezing. After sensation to the affected area has returned, keep the skin warm, dry, and clean. If blistering of the skin occurs, apply a sterile dressing. Seek medical attention as soon as possible.

4.3.2 Vapor-Cloud Ignition/Explosion

The Casino LNG receiving facility design includes strict guidelines to prevent potential ignition sources within the LNG facility boundaries, and safety setbacks from non-LNG operations in accordance with CSA Z276 section 13.3.4.

Mitigation Measures: In order to be ignited, LNG must first be vaporized and mixed with air between 5-15% concentration, and an ignition source must be present. Only the outer area of the LNG vapor cloud is ignitable. LNG, LNG vapor, and natural gas will not explode, provided the release is in an open environment. For an explosion to occur, LNG needs to vaporize, mix with 5-15% air, collect in a confined space, and be ignited. The design of the Casino LNG facility excludes confined space within the LNG facility area, except for buildings, which are monitored and protected to prevent migration of gas indoors at doors and fresh air intakes. Mitigation measures need to prevent the above conditions from occurring, and hence prevent the explosion itself. The suppression system will include:

- *Detection* – using flammable gas detectors, LNG spill detectors, or optical flame detectors that are configured to perform automatic shutdown of equipment.
- *Extinguishment* – high rate discharge containers with the suppressing agent for Type B and C fires (flammable gas, liquids, electrical fires). Extinguishing agents can be dry chemical formulations or foam. Firewater is not recommended for a polar climate, and for suppression of LNG and natural gas fires.
- *Control and supervision* – continue to monitor the appropriate detection monitors as the extinguishing agent is released until normal levels have been reached.
- *Isolation* – Emergency shutdown valves will isolate the plant sections to minimize quantities released.

Emergency Response Procedures:

1. *Assess the situation* – determine the wind direction and park vehicles in an upwind position. Eliminate sources of ignition such as cars and trucks (i.e. do not leave engines running or start stalled engines).
2. *Protect the area* – secure the area around the leak to limit non-essential personnel to a safe distance from the leak. Enter with caution, erect barricades, and evacuate people if needed. Establish a command site at the area to ensure proper communications between emergency response personnel. Try to prevent the spread of the fire itself. Avoid forced ventilation of structures and excavations as that can increase the likelihood of a flammable atmosphere.
3. *Contact Emergency Responders* – to secure the area.
4. *Work together* – ensure that the local, the operator, and emergency responders have proper communications and are working to resolving the emergency.

4.3.3 Jet Fire Following a Leak from Piping

Mitigation Measures: Piping will be designed using practices from ASME B31.3 for natural gas process facilities. The mitigation strategy should be incorporated to prevent a leak at a pipe joint and the rupture or loss of containment during a fire of surrounding piping systems. As a result, piping design will incorporate the following best practices:

- The pipe will exceed minimum code requirements and will meet the criteria of material compatibility, pressure, and temperature pertinent to that particular pipe. Relevant standards include API 607, FM-

7440, and BS-6755-2. Pipe will be welded as much as possible, and the use of flanged joints will be minimized.

- Fire safe rated valves meeting the requirements of API 607 will be designed, tested, and used to assure the prevention of fluid leakage internally along the valve flow path, and externally through the steam packing and seals.
- The basic design conditions will incorporate the following in order to remove natural gas from the pipeline: remote shut-off of the flow supply line; sealing of the flow path at the drain and vent valves; and ensuring the external path through the stem packing as well as the body seals remain intact during a fire.

Emergency Response Procedures: A jet fire is typically associated with the release of natural gas and is dependent upon the diameter of the pipe as well as the leak size. A jet fire occurs if a pipeline has a leak at a certain point in its path AND if an ignition source is present. An alarm should be activated, notifying personnel that there is a fire and the area should be evacuated. After the evacuation, emergency response teams should isolate the fuel source by closing the pipe as close to the leak as possible. The fire will be extinguished by removing the fuel source, and if needed, through the use of extinguishing agents such as dry chemical formulations.

4.3.4 Flash Fire Following a Release

Mitigation Measures: These measures are the same as for the vapor cloud ignitions (Section 4.3.2) in terms of equipment design, but additional mitigation measures should include the use of fire-retardant PPE to reduce and prevent thermal injury. Normal clothing will provide partial protection, but thermal injuries can still occur.

Emergency Response Procedures: A flash fire occurs due to a sudden intense fire caused by ignition of flammable materials. It is characterized by high temperature, short duration, a rapidly moving flame front, and considerable shock waves. This type of fire occurs due to a leak rather than a rupture. According to NFPA 2113, a flash fire may have a heat flux of up to 84 kW/m^2 for short periods of time (<3 seconds). If there is no confinement, a flash back will burn back towards the source relatively quickly. As flash fire flames spread at subsonic velocity, the overpressure damage is negligible and most of the damage is a result of thermal radiation and secondary fires. Therefore, the emergency response procedures are the same as for the vapor cloud fires (Section 4.3.2).

4.3.5 Pool Fire in the Secondary Containment Following a Release

Mitigation Measures: The main goal during a pool fire is to limit the distance of the ½ LFL vapor cloud and thermal radiation impacts if ignited. The liquid normally spills on concrete between the tank wall and secondary containment. Therefore, the concrete mixture selected should have a low density, low heat capacity, and low thermal conductivity, in order to shorten the cloud and potentially reduce the chance of the cloud reaching an ignition source.

Emergency Response Procedures: A pool fire in this case can occur if a flammable liquid (LNG) spills and forms a pool over a surface AND an ignition source is present. Specifically, if there is a leak and ignition occurs in the area between the tank wall and the secondary containment. The emergency response procedures are the same as for a vapor cloud (Section 4.3.2), as LNG will evaporate from the pool and if the vapor reaches an ignition source, there is potential for a vapor cloud ignition.

4.3.6 Boiling Liquid Expanding Vapor Explosion (BLEVE)

Mitigation Measures: The main goal to eliminate the possibility of a BLEVE:

- Eliminate conditions where a fire could occur in proximity to a storage vessel containing flammable fluids.
- Insulated LNG tanks provide inherent protection from a BLEVE by reducing heat transfer to the vessel contents.
- Install properly sized pressure relief valves (PRVs) in order to release pressure fast enough so that the pressure of the vessel is does not exceed its design pressure. If this is sized appropriately, the liquid inside the tank will boil off slowly, maintaining a constant pressure in the vessel until all the liquid has boiled off. This prevents the rapid phase transition of the liquid to vapor, and prevents the tank from pressurizing above its design limits such that a vapor BLEVE does not occur.
- To provide fire suppression to extinguish a fire if it occurs near a storage container.

Emergency Response Procedures: A BLEVE occurs when a vessel containing flammable liquid is exposed to an external fire, heat is transferred to the vessel contents, and temperature of the contents rises rapidly above its normal boiling point, and relief valves are unable to relieve the vapor pressure with enough capacity such that the vessel fails from high internal vapor pressure in a hot vessel causing a sudden catastrophic failure (rupture). As a result, a rapid, near instantaneous phase transition occurs where there is a massive energy release and a large fireball usually accompanies this if the material is flammable. The emergency response procedures are based on avoidance of conditions that support this from occurring in the first place.

5 – DECOMMISSIONING

Decommissioning of LNG equipment is guided by API standard 376. Disposal of materials generated from the decommissioning of the plant will be detailed in the *Casino Project Reclamation and Closure Plan*, and the *Casino Project Waste Management Plan*. Generally, it is expected that solid waste associated with LNG storage, secondary containment and distribution will be disposed of in conjunction with other material at the mine site.

Certain infrastructure will require specific decommissioning steps. The decommissioning procedures for the LNG facilities and associated infrastructure will be defined during detailed design of the facilities, however, decommissioning of the LNG storage tank is summarized below for example purposes.

5.1 LNG STORAGE TANK

The following steps must be followed to properly decommission the LNG storage tank. Once complete, the tank may be dismantled and is no longer considered contaminated.

1. **Pump-out:** Pump out all recoverable liquid LNG to a storage tank truck. Assisted pump-out may be required is the existing pump capacity is insufficient.
2. **Boil-off:** Once the pump-out is complete, there may be some residual liquid remaining in the tank. Residual liquid can be boiled off by leaking heat into the tank. Assisted boil-off (the addition of hot natural gas) may be used in increase the rate of boil off. The hot gas should be around ambient temperature to prevent temperature profiling within the tank. The boil-off gas can be flared or recovered.
3. **Warm-up:** After the gas has been boiled off, the tank should be warmed up at a maximum rate of 3 °C/hour to avoid thermal stresses. This process can be natural or assisted (via hot gas). The displaced gas from the warm up process would be routed to the flare system. The tank should continue warming at the rate until the temperature reaches -20 °C.
4. **Gas freeing:** Once the warm-up is complete, the gas remaining in the tank from the warm-up process must be removed from the tank via inert gas (nitrogen) introduction. The inert gas is introduced at the bottom of the tank (using the purge line) in order to vent the gas through a pipe on the roof of the tank. The gas can either be sent to the flare system or vented to the atmosphere a safe distance away from the tank roof. Through this process, the inner tank and dome space are gas free.
5. **Inert Gas Freezing:** The inert gas must be displaced by air to allow the space to be breathable. This is accomplished by venting the inert gas to the atmosphere. An oil-free compressor can be used to introduce air into the tank. A double block and bleed isolation is necessary to reduce the potential creation of an internal flammable environment. It is recommended that the tank is physically isolated as well, as this is essential for personnel to enter the tank.
6. **Preparation for Entry:** The tank should be physically isolated from all process and utility systems and air quality confirmed to be safe by oxygen detectors.