LNG MANAGEMENT PLAN

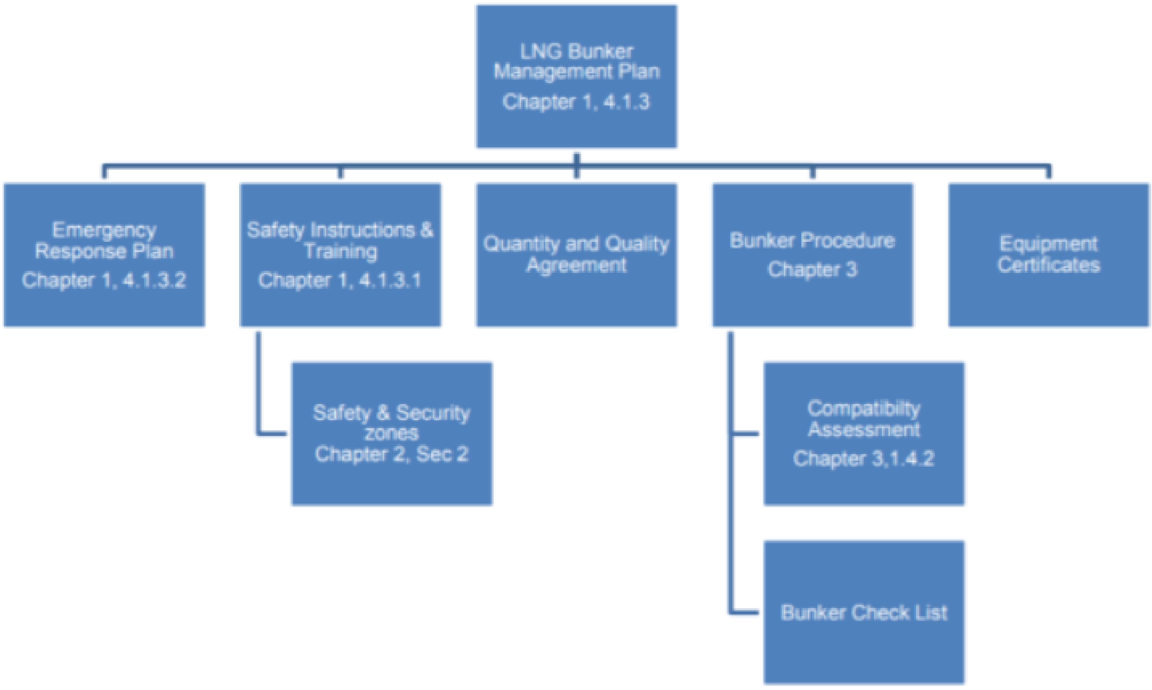
****THIS PROCEDURE IS FOR LNG SHIPS ONLY****

1 Objective

To provide guidance on the safety, technical and compatibility elements between the receiving vessel and the Bunkering Organization for the establishment and maintenance of safe LNG Bunkering operations.

2 Process

This LNG Bunker Management Plan defines all relevant documentation for communication between the receiving vessel and the Bunker Organization.



The LNG Bunker Management Plan is a recommendation of the International Association of Classification Societies (IACS) and the Society for Gas as a Marine Fuel (SGMF) and defines all the documentation required to undertake LNG Bunkering is a safe and controlled manner.

All the requirements of the SGMF Bunkering Guidelines have been taken into account in the development of the GLOBAL HESS procedures and are covered as follows:

IACS Recommendation / SGMF Bunkering Guidelines	**Documentation Reference / GLOBAL HESS Procedure**
Description of LNG, its handling hazards as a liquid or as a gas, including frostbite and asphyxiation, the necessary safety equipment, personal protection equipment (PPE) and description of first aid measures	Liquefied Natural Gas MSDS **OHS-1112** PPE Requirements, MED-17xx LNG emergency
Description of the dangers of asphyxiation from inert gas on the ship	LNG Operations Manual **OHS-1126** Nitrogen System
Bunkering safety instructions and emergency response plan	**TEC-1421** LNG Bunkering Operations **EMR-1006** LNG Emergency procedure, Ship specific ERP, IAPH checklist LNG Operations Manual
Description of the LNG system to include tank measurement and instrumentation system for level, pressure, and temperature control	LNG Operations Manual LNG equipment certificates in the PMS
Definition of the operating envelope for which safe LNG bunkering operations can be undertaken in reference to temperature, pressure, maximum flow, weather and mooring restrictions	**TEC-1421** LNG Bunkering Operation procedure **MAR-1001** Company Navigational and Watchkeeping Orders, Compatibility study
A procedure for the avoidance of stratification and potential rollover	**TEC-1422** LNG Plant Operation
The description of the identified risks and their mitigation measures to comply with during an LNG bunkering operation	LNG Operational Risk Assessment matrix
The description, requirements and monitoring of the hazardous areas and safety zones	**OHS-1209** Working in Gas Hazardous Areas **OHS-1127** Guidance for Gas Hazardous Areas Safety zone assessment for LNG bunkering (provided by LNG supplier)
The description and mitigation of simultaneous operations (SIMOPS) covered by the risk assessment (	LNG Operational Risk Assessment matrix, **OHS-1201** Permit to work **OHS-1407** Risk Assessment
The diagrams of the LNG bunkering system, LNG components and associated systems	LNG Operations Manual LNG Plant P&ID, LNG equipment certificates
Prove that the ship's crew have received proper training for bunkering LNG	**TRG-2701** to **TRG-2708** LNG training requirements
Quantity and Quality agreement	Shell LNG Bunkering Compatibility Record (LBCR) (Provided by Suppliers) IAPH checklist **TEC-1421** LNG Bunkering Operations

Controlled Zones during LNG Bunkering

The IGF Code, ISO Standard 18683 and ISO 20519 and the Society for Gas as a Marine Fuel define a number of control zones which are in place during LNG Bunkering. The following defines how these zones are applied during the LNG Bunkering and how they have been determined:

These zones are:

1. Hazardous Zone
2. Safety Zone
3. Marine Exclusion Zone
4. Monitoring and Security Zone
5. External Zone

Hazardous Zone

Also known as Hazardous Areas and defined as Gas Hazardous Areas in Global HESS. These area areas and spaces where a flammable atmosphere may be present during normal operations and are calculated according to the requirements of an applicable national or international standard. These are determined in accordance with the IGF Code and/ or IEC 60079-10 and are defined in the ship's Hazardous Area plan. This are defined as Zone 0, Zone 1 or Zone 2.

Safety Zones

A zone or zones around the Gas Hazardous Areas where procedures are in place to control access and potential ignition sources. The Safety Zones associated with LNG Bunkering are temporary and are only in place during LNG Bunkering

A safety zone is required to be established around the bunkering station to control ignition sources and to ensure that only essential personnel and activities are allowed in the area that could be exposed to a flammable gas in case of an accidental release of LNG or natural gas during bunkering.

The dimensions of the safety zone are defined in the horizontal and vertical plane considering two possible directions to account for the elevation of the different surfaces over which the cloud can disperse. The horizontal safety zone distances should be measured from the middle of the pontoon, unless stated otherwise. The vertical zone should be seen relative to the elevation of the different dispersion surfaces and extends (for simplicity reasons) over the entire horizontal safety zone distance in the same direction.

No horizontal safety zone over the cruise vessel is defined, because the flammable cloud cannot reach the lower deck. Also, the safety zone does not reach the balconies situated above the recess manifold. The maximum extent of the horizontal safety zone is as follows:

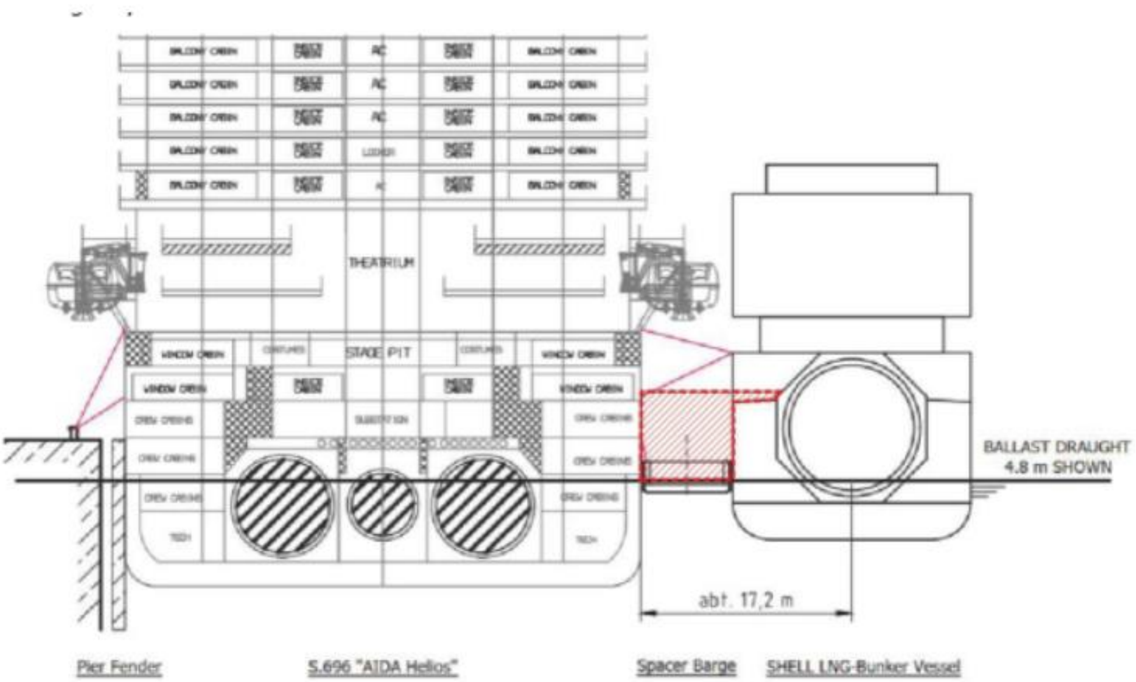
1. over the LNG bunker vessel: 4 meters from the hull to the sloped tank dome and 31 meters extending along the vessel's length in both directions;
2. in the direction parallel to the length of the vessels (above the water and pontoon in between the vessels):
3. in the direction of the cruise vessel: to the hull of the cruise vessel (acting as a barrier).

The extent of the horizontal safety zone is illustrated in the figure below.

The vertical safety zone distances are as follows:

1. above the deck of the pontoon / water in between the two vessels;
2. above the LNG bunker vessel;

The extent of the vertical safety zone is illustrated in the figure below:



The size of the safety zone to be implemented differs slightly in different bunkering locations due to the average expected weather conditions. These safety zones are determined in collaboration with LNG Supplier and agreed with the relevant authorities as followings:

Horizontal Safety Zone			
	Port Specific Requirements		
	Rotterdam	Tenerife	Barcelona
Over the bunker vessel: . from the hull to the sloped tank dome . extending along the vessel's length in both directions;	. 4.0 meters; and . 31 meters	. 4 meters; and . 40 meters	. 4 meters; and . 40 meters
In the direction parallel to the length of the vessels (above the water and pontoon in between the vessels):	43 meters in each direction;	52m in each direction	52m in each direction
In the direction of the cruise vessel:	To the hull of the cruise vessel (acting as a barrier).	To the hull of the cruise vessel (acting as a barrier).	To the hull of the cruise vessel (acting as a barrier)

Vertical Safety Zone			
	Port Specific Requirements		
	Rotterdam	Tenerife	Barcelona
Above the deck of the pontoon / water in between the two vessels	6.1 meters	6.6 meters	6.6 meters
Above the LNG bunker vessel	1.7 meters	1.7m	1.7m

Marine Exclusion Zone
The Marine Exclusion zone is defined by the Port Authority, inside of which no passing traffic is allowed.

This is the distance from the outside of the bunker vessel into the channel and is defined as the following for each port:

Port	Marine Exclusion Distance
Rotterdam	50m
Tenerife	20m
Barcelona	60m*

**For Barcelona the Marine Exclusion zone is driven by the passing ship impacts on the bunkering operation. Port requirement of 30m.

Monitoring and Security Zone
This is the ISPS zone.

External Zone
The external zone is required for land side planning and is not used for normal LNG Bunkering Operations.

3 Records

The LNG Bunker Management Plan must be maintained by the Company for at least five (5) years; however, after three (3) years, this Plan may be stored ashore and maintained by the Company.

4 Additional Responsibilities

4.1 Company

To prepare and maintain a valid LNG Bunker Management Plan.

4.2 Captain

With reference to **HMP-1501 Management Reviews** procedure.

5. References

- SGMG Guideline for LNG bunkering operation
- **EMR-1006 LNG Emergency Response Management**
- **HMP-1501 Management Reviews**
- **MAR-1001 Company Navigational and Watchkeeping Orders**
- **OHS-1112 Personal Protective Equipment Management**
- **OHS-1126 Nitrogen System**
- **OHS-1127 Guidance for Gas Hazardous Areas**
- **OHS-1201 Permit to Work**
- **OHS-1209 Work in Gas Hazardous Areas**
- **OHS-1407 Risk Assessment**
- **TEC-1421 LNG Bunkering Operation**
- **TEC-1422 LNG Plant Operation**
- **TRG-2701 LNG Awareness Training**
- **TRG-2708 CSMART IGF Advanced Management Level 1**

LNG BUNKERING PROCEDURE

THIS PROCEDURE IS FOR LNG SHIPS ONLY

1 Objective

To conduct a safe and efficient LNG bunkering operation while protecting the marine environment.

2 Process

2.1 General Requirements

All Technical Officers engaged in LNG bunkering operations must be thoroughly familiar with the LNG transfer system operations manual, the LNG Bunker Plan (**TEC-1421-F1 LNG Bunkering Plan**), the LNG Bunker Management Plan (**TEC-1423**), and the LNG Plant Operation (**TEC-1422**).

An accurate and up to date line diagram of the vessel's LNG bunkering system must be available at the bunker stations and in the Engine Control Room (ECR).

An up to date copy of this LNG bunker transfer procedure must be available at a place where it can be easily seen and used by the crew engaged in LNG transfer operations.

Any emergency occurring during an LNG bunkering operation must be treated in accordance with the ship's specific Emergency Response Plan, which must include the LNG specific requirements outlined in **EMR-1006 LNG Emergency Response Management**.

Simultaneous operations (SIMOPS) should be risk assessed in advance and reviewed on the day of bunkering with reference to the control measures recommended by the Operational Risk Assessment.

In the event of an LNG spill or significant gas leak:

- The relevant EMR Checklist and Emergency Response Plan must be put into operation. The Person in Charge (PIC) and all involved crew must be familiar with the initial actions from the relevant EMR Checklist and the requirements (see EMR 1006).
- All LNG bunkering operations must be stopped until it is considered safe by the involved crew to resume operation; the involved crew must look to the EMR and Bunker Checklists and consider the following:
  - Whether there are issues that can compromise a safe bunkering; and
  - Whether there is a risk of ignition during a thunderstorm

The Bunkering operation can only be resumed when these issues and/or risks are removed.

In the event of a dispute with regard to the LNG bunkering operation, a quality or quantity Letter of Protest must be issued in accordance with industry guidelines.

2.1.1 Training Requirements

All Technical Officers engaged in LNG bunkering operations must be trained in accordance with TRG 2702 and thoroughly familiar with the ship's LNG fuel system, including its status, the location of safety valves and vent systems and level, temperature and pressure indicators/sensors. Onboard familiarization will be comprised of a dedicated CBT training, handover process per position and PDR assessment based on the assessor/verifier matrix (TRG 2701)

2.2 Pre bunkering preparation

Prior to starting an LNG bunkering operation, the Chief Engineer must:

- Prepare the ship for bunkering of LNG by overseeing the completion of the LNG Bunkering Plan (see **TEC-1421-F1 LNG Bunkering Plan** and **TEC-1421-F5 Example of LNG Bunkering Plan**) and the LNG Pre-Arrival Checklist (see **TEC-1421-F2 LNG Pre-Bunkering Checklist**) at least 24 hours prior to the start of the LNG bunkering operation.
- Verify that the LNG Bunkering Plan is displayed in the ECR.
- Verify the compatibility assessment has been performed, as necessary.
- Verify that all personnel involved in LNG bunkering operations have satisfactorily completed the required training (see TRG 2708– LNG Workplace Familiarization) and are thoroughly familiar with their role in the bunkering operation.

- Place orders for LNG according to the Fuel Management team and provide updates to the Captain regarding the fuel quantities onboard.

- When forecasting required fuel for the intended voyage, the Chief Engineer must consider all contributing factors of fuel consumption (i.e., voyage plan, forecasted weather conditions, ship speed, and current consumption rate) and must verify that sufficient LNG remains on board to keep LNG tanks cold.
- Sufficient LNG heel quantity should be kept on board at all times so that the tank condition is maintained below the bunkering temperature requirements.
    - Review any relevant Permits to Work that are in force, and if necessary, stop any work near the bunker station and/or that may interfere with the bunkering operation.
    - Review the LNG Pre-Arrival Check List and, if satisfied, sign it prior to the start of the operation (use **TEC-1421-F2 LNG Pre-Bunkering Checklist**).

Prior to starting an LNG bunkering operation, the Stability Officer must:

- In consultation with the Chief Engineer and in consideration of the ships trim and stability calculations, review and sign the LNG Bunkering Plan (see **TEC-1421-F1 LNG Bunkering Plan**), at least 24 hours prior to the start of the LNG bunkering operation.

Prior to starting an LNG bunkering operation, the PIC must:

- Complete and sign the LNG Pre-Arrival Checklist (see **TEC-1421-F2 LNG Pre-Bunkering Checklist**). Complete sections 1, 2 and 3 of the LNG Bunkering Checklist (see **TEC-1421-F3 LNG Bunkering Checklist**), sign it and give it to the Chief Engineer to review and sign authorizing that the ship is ready to bunker.
- Designate a suitably trained PIC assistant (see **TRG-2708 CSMART IGF Advanced Management Level 1**).
- Check that simultaneous operations have been risked assessed in advance and reviewed on the day of bunkering with reference to the recommended control measures of the Operational Risk Assessment.
- Hold a pre-bunkering meeting with the Supplier's PIC to coordinate operations. If a face to face pre-bunkering meeting cannot be held with the Supplier's PIC, sufficient bunkering operational information must be exchanged, acknowledged and understood by both parties.
    - Close cooperation and continuous communication must be maintained with Supplier PIC throughout the entire bunkering operation. A means of communication, with back up, must be agreed upon in advance and all signals used must be thoroughly understood by both parties before commencing operations. If for any reason all communications are lost the operation must be stopped immediately.
- Complete Parts B, C and D of the IAPH LNG Bunker Checklist and check that the Supplier PIC has done the same. The mentioned parts of the IAPH LNG Bunker Checklist must be completed prior to bunkering.
- Define and agree on the frequency of rechecks as stated by the IAPH Checklist with the Supplier PIC.
- Check the Custody Transfer Measurements and the certificate of the Custody Transfer Measurement System (CTMS) from the supplier according to the LNG Bunkering Checklist, before and after bunker operations.

- Advise the bunker vessel in advance of undertaking any of the following actions:

    - Any changes to valve line up, LNG tank filling arrangements, etc. which have an impact on the Bunkering Operation
    - The starting/stopping of any agreed SIMOPS that will take place during bunkering
    - Any expected drills on board the Bunker Vessel and Receiving Vessel that might impact the Bunkering Operation
    - Tendering of mooring lines from the Bunker Vessel /Receiving Vessel or to jetty/terminal
- Confirm the quantity and units of LNG with the supplier's representative.
- Request copies of and review the following documentation from the LNG Supplier PIC:
    - Material Safety Data Sheets (MSDS)
    - LNG composition load port data and/or onboard LNG composition
    - Hose pressure test certificate
    - Quick Connect Disconnect Certificate (QCDC)
    - Custody Transfer Measurement System (CTMS) calibration certificate
- Inspect the Supplier's LNG transfer hose QCDC for visible damage as far as practicable before use verify that the hose is of sufficient length to allow for normal movement of the ship and the supplier facility (if applicable), and position them so that it does not bend excessively.
- Issue a Letter of Protest to the supplier if there is doubt as to the condition of the transfer equipment or if a hose certificate is missing
- If available, check that overfilling protection is active.
- Check that all safety precautions have been completed (see MAR-1001 Company Navigational and Watchkeeping orders).
- Check that the safety and security areas are established and clear
- Check that warning signs are displayed

Provide a Notice of Readiness to the Supplier PIC when the ship is deemed ready to perform the LNG bunkering operation in accordance with the Supplier's contractual requirements. The Supplier PIC must acknowledge receipt. Notify the Bridge when the LNG transfer operation is about to commence.

2.3 During Bunkering Operations

During the LNG bunkering operation, the PIC must:

- Be present and control the bunker transfer operation at a control operating station.

- Check that the bunkering sequence is followed as agreed during the pre-bunkering meeting.
- Communicate each bunkering stage to the Bridge and ECR through an agreed method of communication.
- Communicate immediately to the supplier PIC, any emergency or failure of safety equipment on board the ship that may impact LNG bunkering is.
- Verify that the LNG is going to the correct tank(s), there are no leaks, and all the operating parameters are kept within the agreed limits.
- Verify that tank levels, temperature and pressure are monitored at all times during the LNG bunkering operation.
- Verify that the pressure and flow rate in the supply lines and inside the tanks are monitored and recorded so that the maximum working pressure and flow are not exceeded. If the agreed maximum pressure or flow is exceeded, the supplier's representative must be instructed to reduce the pump rate immediately.
- Give the supplier a timely warning to reduce the flow rate or to stop pumping.

- The estimated time of completion (ETC) must be calculated at the beginning of the operation and regularly checked. Any significant change to the ETC must be reported to the barge.

- It is important to respect the maximum designed flow and pressure. When a tank is approaching the calculated loading limit, caution must be exercised to not overfill the tank. The flow rate must be reduced so that the tank filling valve could be closed without getting beyond the maximum permissible bunker line pressure, and with respect to the maximum tank pressure.
- Complete all re-checking actions (Code R) as required by the IAPH LNG Bunkering Checklist.
- During “topping up” of the tanks the PIC must instruct the suppliers to reduce the delivery rate.
- Keep the liquid bunker valves in the valve box open until the supply has been stopped and the hose has been drained/inerted (purged).

- Order the stop of the transfer operation to the LNG Supplier PIC once the agreed volume has been transferred and notify the Bridge and the ECR.
- Complete and sign Sections 4 and 5 of the LNG Bunkering Checklist and give it to the Chief Engineer to sign on completion of liquid transfer (see **TEC-1421-F3 LNG Bunkering Checklist**).

If bunkering has been suspended or discontinued for more than two (2) hours, the PIC must complete the pre-transfer checklist again prior to resuming the bunker transfer.

2.4 Post Bunkering Actions

After the completion of the bunkering operation, the PIC must:

- Complete Sections 6 and 7 of the LNG Bunkering Checklist (use **TEC-1421-F3 LNG Bunkering Checklist**), sign and give it to the Chief Engineer to review and sign to authorize the ship to disconnect.

- Check that the hoses, manifolds, and piping used during the transfer operation are purged so that natural gas levels are below the lower flammability level and are:
  - Properly drained and inerted prior to disconnecting;
  - Free of residual LNG; and
  - Securely blanked.
- Crosscheck the bunkered quantity, including the ship’s consumption during the bunkering and the quantity of vapor returned to the bunkering vessel.
- Ensure safe purging/disconnection of transfer equipment
- Obtain the following documentation from the supplier’s representative (this may be delivered in electronic format):
  - Bunker Delivery Note (BDN) including supporting LNG Composition
  - Supplier CTMS report
  - Supplier Time Log
- Review the LNG Bunkering Checklist and give to the Chief Engineer to review and sign (use **TEC-1421-F3 LNG Bunkering Checklist**)

After the completion of the bunkering operation, the Chief Engineer must:

- Sign the BDN after verifying that it has been completed accurately.
- Issue a Letter of Protest(s), if there were any:
  - Safety-related near misses, interventions of incidents during the operations
  - Issues or discrepancy with the quantity of LNG received
  - Delays to the arrival or mooring of the bunker vessel
  - Delays to the connection or disconnection of the LNG transfer system.
  - Identified issues with the condition of the transfer equipment or if a hose certificate is missing
  - Delays to the unmooring or departure of the bunker vessel

- Review the LNG Bunkering Checklist and, if satisfied, sign Checklist (use **TEC-1421-F3 LNG Bunkering Checklist**)

Once the transfer hose has been drained then the transfer is considered complete. The LNG bunkering operation is deemed to be complete upon the disconnection of the hoses after the agreed quantities of bunker transfer.

3 Record

The following records must be maintained and filed together by the Chief Engineer for at least five (5) years; however, after three (3) years, these records may be stored ashore and maintained by the Company:

- Quantity Claims Log
- Bunker Delivery Note
- Notice of Readiness
- Safety LNG Bunker Checklist (IAPH)
- Copy of Supplier Time Log
- Copy of Supplier CTMS report
- Letter(s) of Protest
- **TEC-1421-F1 LNG Bunkering Plan**
- **TEC-1421-F2 LNG Pre-Bunkering Checklist**
- **TEC-1421-F3 LNG Bunkering Checklist**
- **TEC-1421-F4 LNG Bunkering Time Log**

The above-mentioned records may be maintained electronically.

4 Additional Responsibilities

4.1 Captain

- Carry overall responsibility for the safe LNG bunkering operation.
- Check that environmental conditions (weather, tide, waves, swell) do not compromise a safe bunkering operation.
- Verify that sufficient mooring arrangements are in place
- Monitor traffic density and passing vessels before and during beginning bunkering operations and respond in accordance with the LNG barge to Ship compatibility Plan
- Review the Operational Risk Assessment document prior to and during bunkering.
- That all personnel involved with LNG fuel use, transfer, or emergency response are familiar with the contents of the LNG Fuel Plant Operations Manual (Appendix 1) and meet the basic standard of advance standard of competence as required by STCW.
- Check and update the Emergency Response Plan for LNG bunkering operation.
- Readily provide the LNG Fuel Plant Operations Manual, Emergency Response Plan for LNG Bunkering Operations and LNG Fuel Plant Maintenance Manual for inspections by PSC.

4.2 Chief Engineer

- Oversee the planning and execution of the LNG fueling operations.
- Designate the person in charge (PIC) of the LNG bunker operation at least 48 hours before the bunker operation is planned to commence.
  - The PIC must not hold any IPAM (In Port and Anchoring Manning) duties or be a member of the Engine Ops Team.
  - The PIC must hold a STCW Chapter II or III and meet the IMO requirements of STCW. 7/Circ.23 or Enclosure 3 for advanced training.

- Supervise all technical aspects of the LNG bunkering operations.
- Verify that correct and up-to-date detailed instructions and the LNG Bunker management plan are in use onboard and that the contents of these instructions are known and understood by involved crew.
- Check and update the LNG Fuel Gas Plant Operation and LNG Fuel Gas Plant Maintenance manuals.
- Review any relevant permits to work in force.
- Review and approve the LNG Bunkering Plan prepared by the LNG engineer with the Stability Officer.
- To fulfill MLC rest hour requirements, the Chief Engineer may transfer his/her operational duties to the Staff Chief Engineer.

4.3 Person in Charge (PIC)

- Review the Operational Risk Assessment document prior to and during bunkering.
- Prepare the ship for bunkering including safety tests (using **TEC-1421-F2 LNG Pre-Bunkering Checklist**).
- Sign the relevant Checklists.
- Conduct a job safety review regularly and hold a pre-bunker meeting with the involved crew
- Prepare the LNG Bunkering Plan in consultation with the Stability Officer.
- Manage the bunker process and involved crew.
- Review the bunker documentation from supplier's representative for completeness and make sure all required signatures are received.
- Monitor: tank levels, tank and line temperatures, tank and line pressures.
- Respond in accordance with the Emergency Response Plan.
- Responsible for the overview of the safety of the operations related to the LNG bunkering and shall ensure that all company procedures are applied.
- Only one person can be designated as PIC for an LNG bunker operation, at any given time.

4.4 EOOW (Operator)

- Follow instructions given by the PIC.
- Be informed by the LNG engineer on the status of bunkering operation and keep an overview of the operation at all times.

4.5 Assistant to the PIC

- Communicate with the PIC while monitoring the condition of the manifold, and conduct regular rounds in the bunkering station.
- Help to perform Safety checks according to the Checklist on the LNG systems during the operation as instructed by the LNG Engineer.
- Assist the LNG Engineer as required, and particularly during connection and disconnection sequences.

4.6 Stability Officer

- Provide input on stability requirements to the PIC for preparing the LNG Bunkering Plan (**TEC-1421-F1 LNG Bunkering Plan**) at any given time.
- Consult with the Chief Engineer and the PIC for the trim and stability calculations, if necessary or in case of changes to the LNG Bunkering Plan.

4.7 The Company

- Prepare class or ship specific detailed instructions.
- Provide LNG Fuel Gas Plant Operation and LNG fuel Gas Plant Maintenance Manuals, Emergency Response plan and LNG Bunker Management Plan, and update them as needed. Require and verify that these documents are maintained on board.
- Provide the LNG Bunker Management Plan (**TEC-1423**) for LNG bunkering by providing the ship with the relevant port and supplier contact details and provided pre bunkering conditions.
- Perform a compatibility study with LNG bunker supplier and Port approval.
- Review facility procedures and emergency response for adequacy and compatibility and inform ship accordingly.

- That each responsible person involved in the operation has been duly trained to perform his task according to STCW requirements and the applicable company training procedures; the competency requirements per role are indicated in the dedicated LNG Training matrix.

4.8 Suppliers‘ Representatives

- The supplier will identify the person in charge (PIC) of the operation of the supplier facility (e.g. shore terminal/barge/truck).
- The supplier will also indentify a person who is responsible for the overall management of the bunkering operation referred to as the Person in Overall Advisory Control (POAC).

5 References

- Shell Delivery Procedures Manual
- LNG barge to Ship compatibility Plan
- Operational Risk Assessment Matrix
- LNG Training Matrix
- LNG Assessor/Verifier Matrix (role specific LNG PDR)
- **EMR-1006 LNG Emergency Response Management**
- **TEC-1422 LNG Plant Operation**
- **TEC-1423 LNG Bunker Management Plan**
- **TRG-2708 CSMART IGF Advanced Management Level 1**

TEC-1421-F1 LNG Bunkering Plan
TEC-1421-F2 LNG Pre-Bunkering Checklist
TEC-1421-F3 LNG Bunkering Checklist
TEC-1421-F4 LNG Bunkering Time Log
TEC-1421-F5 Example of LNG Bunkering Plan

LNG PRE BUNKERING CHECKLIST

TEC 1421-F2 LNG PRE BUNKERING Check List

Only required for LNG ships

	LNG receiving ship:		**Notes**
	Date and time:		This check list is a working document completed by the PIC after receiving confirmation from the relevant loctations indicated.
	Port and Berth:		
	LNG bunker vessel / Facility name:		

Check Location

REF	CHECK / ACTION	ECR	Bunker Station	Bridge	Bunker Barge	PIC (X)
1	Ship to Ship Compatibility reviewed and available on board including Vessel Separation Device (VSD) Settings and hose bend radius					☐
2	Person In Charge (PIC) and PIC assistant(s) have been designated?					☐
3	Simultaneous Operations will not interfere with LNG bunkering operation?					☐
4	Work permits/Daily Work plan have been reviewed to ensure no interaction with LNG bunkering operation and within the pre defined Safety zone during the bunkering?					☐
5	Security requirements to be implemented before and during bunkering have been reviewed?					☐
6	Weather forecasts reviewed and allowing operations?					☐
7	Mooring plan prepared and agreed with all involved parties?					☐
8	LNG Bunkering plan (TEC 14xx F1) has been prepared and agreed with all involved parties?					☐
10	Bunkering station piping are inerted with Nitrogen, with normal residual purge press (approx 0.5bar)					☐
11	LNG Bunkering ESD and ESD ship link has been tested and found in good order?					☐
12	Gas detection is working calibrated and tested as planned? (IAPH C38)					☐
13	Bunkering station ventilation is working properly (Full flow)?					☐
14	Fire Fighting equipment is available and found in good order?					☐
15	LNG bunkering room gear are working properly (Handling device/LNG bunkering shell door)?					☐
16	LNG Bunkering Equipment checked and found in good condition according to Explosion Proof equipment applicable standards?					☐
17	Correct LNG bunkering equipment is available (Ropes/Slings/Nitrogen hoses as required for purging)?					☐
18	Bunkering operation area is sufficiently illuminated?					☐
19	LNG Storage Tank sensors have been found working properly (level, pressure sensors, temperature)-Tank overfilling protection are active and not over-ridden ?(IAPH C49/50)					☐
20	All tanks not to be bunkered clearly identified and secured					☐
21	LNG Control valves to be used for the operation have been tested and found in good order? (IAPH C48)					☐
22	LNG BOG System available (at least 1 BOG compressor operational)? (IAPH C47 C52)					☐
23	At least one Duel Fuel Boiler is operational and available during the bunkering?					☐
24	Ensure that the Safety Relief Valves and Thermal Relief Valves have no leak (venting system no residual pressure)?					☐
25	LNG piping sensors are working properly (temperature, pressure)?					☐
26	Confirm internal LNG bunkering pipeline cool down completed (up to the manual liquid bunker valve using cold vapour), check locally if there is any gas leak using a main portable gas detector ? - Note: do not allow vapour to pass the manual liquid bunker valve					☐
27	Confirm LNG storage tanks are cooled down at the required (Compatibility Study) temperature ?					☐
28	Briefing for the LNG bunkering operation between the PIC and the PIC Assistant(s)					☐
29	LNG Bunkering plan (TEC 14xx F1) communicated to ECR and Bridge					☐
30	Confirm all SIMOPS (simultaneous operations) are under control from the ECR and Bridge					☐
31	Inform the bridge that all pre-bunkering checks are complete and request permission from the port authority to undertake the LNG Bunkering operations					☐
32	IAPH Part A completed					☐
33						☐

Comments

Date and Time:	
PIC Name / Rank / Signature	
Chief Eng Signature	

The LNG Pre-Bunkering Checklist must be maintained for a period of at least five years; however after three years it may be stored ashore and be maintained by the Company.
Issued: Oct 2018
Printed copies are uncontrolled documents

LNG BUNKERING CHECKLIST

LNG BUNKERING Checklist - TEC 1421 F3

Only required for LNG ships

LNG receiving ship: _ _ _ _ _ _ _ _ _ ________________________________ Date: ________ Time: ________

Person In Charge (PIC) Name: _ _ _ ________________________________ Rank: ________

Port: _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ ________________________________ Berth: ________

LNG bunker vessel / Facility name: _ ________________________________

Checklist User ID

0.0 CHECKLIST COMPLETION NOTES

	a)	This checklist is divided into 7 key stages of bunkering, with each stage having its own checklist.
	b)	It is to be used in conjuntion with the IAPH checklist. IAPH references are included in the notes column.
	c)	IAPH codes for Agreement, Re-check and Permission are indicated next to each item.
	d)	The activities indicated below each main item (a, b, c…) are reminders of the minimum checks required.
	e)	The MASTER copy of the checklist is completed by the PIC. Other copies are for reference only.

Sec & Ref (IAPH code)	PIC (X)	Note: **Grey box** = N/A; **A** = Agreement; **R** = Re-check; **P** = Permission, **Yellow box** = check those locations; **T** = add the time (corresponds with F4 Bunkering Time Log); **C** = Check Location **Description**	Check Location: Bunker vessel	Check Location: Bunker station	Check Location: ECR	Check Location: Bridge	Time	Notes / Regulatory references / IAPH Ref

1.0 PREPARATION FOR CONNECTION & RE-CHECKS

Sec & Ref	PIC	Description	Bunker vessel	Bunker station	ECR	Bridge	Time	Notes / Regulatory references / IAPH Ref
1.1	☐	**PPE is available and in use for all personnel involved**						C41
	a)	Eye protection		c				
	b)	Personal gas monitor with full battery (tested and calibrated)		c				
	c)	Antistatic coverall (certified)		c				OHS 1112
	d)	Antistatic safety shoes		c				
	e)	Fall arrester		c				
	f)	Lifejacket / buoyancy aids (as required)		c				

Sec & Ref	PIC	Description	Bunker vessel	Bunker station	ECR	Bridge	Time	Notes / Regulatory references / IAPH Ref
1.2	☐	**Internal check of bunker stations completed**					T	
	a)	Confirm internal bunker line cool down completed and valves closed per F2 item 26 pre-check		c				GMACS
	b)	Bunker station valves checked and all in closed position		c				C55 / GMACS
R	c)	All unused connections and valves are closed and secured with caps or fully bolted flanges (Port BS / Stbd BS) (including: Liquid, Vapour, N2 and sample lines, etc.). Confirm that the pressure in the bunker station line manifold is correct.		c				C55
	d)	Confirm that the nitrogen supply pressure in the bunker station is correct		c	c			GMACS
	e)	Confirm bunker hose transfer equipment is in good order		c				C56
	f)	Confirm venting system is prepared for bunkering procedures including: boiler set up for free flow and lines are flushed to boiler with nitrogen		c	c			GMACS
	g)	Release residual manifold pressure to vent line to boiler		c				
A	h)	Open "boiler or vent mast selection valve"			c			Agree with CEO in advance

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			Check Location					
1.3	☐	**Safety systems availability confirmation**					T	C26 C51
	a)	Fixed gas detection system is operational - bunker station detector heads checked		c	c			C38
	b)	Portable gas detectors are calibrated and tested and have fully charged batteries. Visually check when at bunker station.		c	c			
	c)	Fire detection system is operational.-Bunker station detector heads checked		c	c			
	d)	Fixed water mist system is operational. Bunker station nozzles and controls checked.		c				
	e)	Dry powder system is ready for use						LNG Switchboard Room
	f)	Positive nitrogen pressure in all nitrogen protected spaces such as hold spaces, tank connection spaces, valve boxes and cold boxes.			c			GMACS
	g)	Water curtain ready for use		c				C44
A R	h)	Bunker operation sufficiently illuminated		c				C27
R	i)	Tank overfilling protection are active and not overridden			c			C50, GMACS
1.4	☐	**Permission to open LNG bunker station shell door**					T	
	a)	Smoking policy adhered to				c		C40
A	b)	Safety zone secured and related signage is posted advising the passengers				c		C32
	c)	Shell door internally and externally clear to be opened		c		c		
	d)	Red flag hoisted				c		
	f)	Door opening barrier ready		c				
	h)	Shell door systems ready (hydraulics / locks)		c				
	g)	Permission received to open the shell door				c		
1.5	☐	**Shell door opening confirmed**					T	
	a)	Shell door open and secured		c				
	b)	Ventilation exhaust fan is running at maximum flow when door opened		c	c			
	c)	Door opening safety barrier installed		c				
	d)	Appropriate PPE, safety harnesses and fall arrester in use		c				C42
1.6	☐	**Mooring carried out as per mooring plan**					T	
R	a)	Pontoon properly rigged (if required)				c	T	C24
R	b)	Bunker vessel safely moored				c	T	C24
A R	c)	Current weather reviewed against expected weather				c		C23

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1.7	☐	**Pre-bunker meeting with bunker vessel PIC completed**					T	
A R A	a)	Communication agreed (including language) and tested	c	c	c	c		C30
	b)	Emergency signal communication agreed and tested	c	c		c		C31
	c)	UHF radios supplied to bunker vessel (as appropriate)	c			c		
	d)	PIC & bunker watch appointed and procedure agreed		c	c	c		C29 C35 C36
	e)	IAPH Part A Reviewed: Planning checklists reviewed	c					
P	f)	IAPH Part B completed: simultaneous operations (Sim Ops) if applicable reviewed. Competent authorities granted permission for Sim Ops	c			c		B18-21
	g)	Bunker plan ramping up, filling sequence, flowrates, max pressures and ramping down procedures agreed	c	c	c			
A	h)	IAPH Part D completed: Transfer data and Sim Ops agreed: (Pressure & Temp / Operations / Max, Min, etc.)	c			c		
	i)	All documentation received and understood: CTMS calibration certificate, hose certificates, LNG composition, MSDS, Vessel Separation Device (VSD) data. QCDC certificate (if used)	c					C39 C56 Check torque wrench calibration details
	j)	Hose connection type agreed (flange / dry disconnect coupling)	c					C57
	k)	Hose connection sequence agreed	c	c				Liquid Vapour
	m)	Hose connection process and ESD tests agreed	c	c				
	n)	Electrical insulation arrangements confirmed and ICCP condition agreed	c	c				C58
	o)	Notify ships bunkering team of pre bunker meeting outcome. Proceeding to plan or with changes, etc.	c	c	c			
1.8	☐	**Bunkerplan F1 ready to be used**						
	a)	Trends in IAMCS system set up for all 3 tanks			c			
	b)	Bunkerplan F1 initial condition filled in			c			
	c)	Confirm BOG is prepared to be on free flow to boiler and BOG control measures are clearly understood			c			
	d)	CCTV monitoring of bunker process set up			c			
1.9	☐	**Notification all parties stage 1 completed**						

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2.0 LNG BUNKERING CONNECTIONS CHECKLIST

2.1	☐	**Electrical Insulation Confirmed**						C58
	a)	Electrical insulation flange confirmed to be installed on bunker vessel	c	c				
	b)	ICCP system confirmed to be switched off			c			

2.2	☐	**ESD link achieved**					T	
	a)	ESD link in Test / Inhibit position set	c	c				
	b)	Electrical SIGTTO 5 pin or optical connection established		c				
	c)	Correct link selected on ESD panel (Valve cabinet room)		c	c			
	d)	Control of set-up performed and confirmed						

2.3	☐	**LNG Manifold Preparation complete**						
	a)	All bunker station valves confirmed closed		c				
	b)	Pressure in lines at the manifold confirmed zero bar		c				
	c)	Blank flanges removed. LNG system open.		c				
	d)	Guide bolts to be installed		c				
2.4	☐	**Liquid hose connected**					T	C56
	a)	Manifold presentation flange / coupling checked	c	c				
	b)	Filter condition sighted (if possible)		c				
	c)	Confirm no pressure in hose and remove blank		c				
	d)	Hose presentation flange / coupling checked		c				
	e)	Hose condition visually checked for unacceptable damage and deterioration		c				
	f)	New gasket supplied and used for flange connections		c				
	g)	Flanges fully bolted with proper length cryogenic bolts and nuts		c				
	h)	All bolts tightened to correct torque setting		c				Torque:
	i)	Maximum bending radius respected		c				
	j)	Hose bun properly installed with correct hose support		c				

2.5	☐	**Vapour hose connected**					T	
	a)	Manifold presentation flange / coupling checked and damage free		c				Clean, dry undamaged
	b)	Confirm no pressure in hose and remove blank		c				
	c)	Hose presentation flange / Coupling checked		c				
	d)	Hose condition visually checked for unacceptable damage and deterioration		c				
	e)	New gasket supplied / used for flange connections		c				
	f)	Flanges fully bolted with proper length cryogenic bolts and nuts		c				
	g)	All bolts tightened to correct torque setting		c				Torque:
	h)	Maximum bending radius respected		c				
	i)	Hose bun properly installed with correct hose support		c				

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2.6	☐	**Emergency Release System (ERS) active**					T	C43
A	a)	VSD devices connected	c			c		C59
	b)	VSD correctly set on the bunker vessel	c					
	d)	ERC confirmed armed	c					
2.7	☐	**Drip trays and water curtain on standby**						C46
	a)	Drip trays checked and dry		c				C45
	b)	Extendable drip tray rigged		c				C44
	c)	Water pressure at the water supply		c				C44
	d)	Bunker vessel / pontoon water curtain set up	c					
2.8	☐	**Notification all parties stage 2 completed**						

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				Check Location					

3.0 LNG Bunker Connections Tests checklist

3.1		☐	**Hoses and manifold lines are purged**					T	provides protection against singe valve isolation
		a)	Confirm "boiler or vent mast selection valve" open to allow purge to vent mast						GMACS
	A	b)	Nitrogen purging: Liquid line to vent mast. **Vapour line purge process by agreement**	c	c				Agree with CEO in advance
		c)	Tests performed by portable gas detector only		c				
		d)	Purges tested until O2 level is less then 5%	c	c				
3.2		☐	**Pressure test carried out**					T	
		b)	ESD valves closed		c				
		c)	Nitrogen pressure applied by bunker vessel in agreed sequence	c	c	c			Liquid Vapour
		d)	Nitrogen pressure set to minimum 5 bar	c	c	c			
		e)	Pressure to stand for 10 minutes	c	c	c			
3.3		☐	**Hose connection leak test carried out**						
		a)	ESD valves closed	c	c	c			
		b)	Nitrogen pressure minimum 5 bar		c				
		c)	All connections soap tested with good result		c				
3.4		☐	**ESD warm test performed**					T	C54
		a)	ESD panel correctly set		c	c			
		b)	ESD valves opened		c	c			
		c)	ESD activation **by barge** to test the ESD link	c	c	c			
		d)	Ship ESD valve closing time noted		c				Liquid ES Time ________
		e)	ESD is reset at ESD panel and GMACS	c	c	c			Vapour ESD Time ________
		f)	Confirmed ESD valve is opened		c	c			
	A	d)	Release pressure to vent mast. **Vapour line purge process by agreement**						Agree with CEO in advance
	P	e)	Close boiler or vent mast selection valve to prevent risk of gas purge to vent mast	c		c			
3.5		☐	**IAPH Checklist Part B,C,D Declaration**						
		a)	Competent authorities notified, bunker transfer commencing, and have been requested to inform other vessels in the vicinity				c	T	C62
	P	b)	IAPH Part C & Declaration for B,C,D completed:	c					
3.6		☐	AUTHORIZATION: Ship is ready to start LNG bunkering:					T	
	P	a)	PIC Signature ______________________________						
	P	b)	C/E Signature _______________________________						
3.7		☐	**Notification all parties stage 3 completed**						

4.0 Hose and line cooling down and testing

4.1		☐	**LNG system bunker valve line up**					T	
	A	a)	Line up bunker filling valves as per bunkering plan F1 and associated valve identification list/diagram		c	c			
4.2		☐	**Bunker manifold cooled down**					T	
		a)	O2 level is less then 5%		c				
		b)	ESD Liquid valves are opened. Vapour by agreement.	c	c	c			
		c)	Open Manual Liquid bunker valve.		c				
		d)	Cooling of vapour lines by agreement and manual vapour valve remains closed						

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	e)	Bunker vessel is cooling down on a slow rate (<25 m3/hr) by liquid or vapour	c	c	c			
	f)	Hose and manifold is cooled down to < -130 degrees Celsius	c	c	c			
	g)	LNG flow stopped	c	c				
	h)	Bolts and nuts on hose connections torque checked		c				Torque:
4.3	☐	**Cold leak test performed**						
	a)	Hose and manifold is cooled down to <130 degrees Celsius	c	c	c			
	b)	Hose connections, flanges and all other connections have been visually checked		c				
	c)	Hose connections, flanges and all other connections have been tested with portable gas detector for leaks		c				
	d)	Ice prevention / spray guard arrangements in place if necessary		c				
4.4	☐	**ESD cold test performed**					T	
	a)	ESD valve/s opened		c				
	b)	Lines under pressure and below -130 degrees Celsius		c	c			
	c)	ESD activation **by the vessel** to test the closing of the ESD valves		c	c			
	d)	Ship ESD valve closing time noted		c				C54 Ship ESD closing time:
	e)	Bunker Vessel ESD valve closing time noted	c					C54 Barge ESD closing times:
	f)	ESD re-set (ESD panel and GMACS)	c	c	c			
4.5	☐	**Notification all parties stage 4 completed**						

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			Check Location					

5.0 LNG storage tank filling checklist

5.1	☐	**Ramping up according bunkerplan F1 started**						
	a)	Bunker vessel instructed to start on minimum flow	c		c		T	
	b)	Confirm LNG is being directed to the correct tank			c			
	c)	Flow rate requests and changes noted	c		c		T	All changes logged
	d)	10 min (15 mins when possible) notice on any valve adjustment given to bunker vessel	c		c			
	e)	BOG pressure is under control			c			C47
	f)	Vapour return to barge if used (controlled as required - agreed with LNG bunker vessel)	c		c			
5.2	☐	**Bunkerplan F1 records and calculation arrangements**						
	a)	Tank level, pressure, and temperature monitored and recorded	c		c			C50 C52
	b)	Estimated Time of Completion (ETC) regularly checked and communicated			c			
	c)	Trends in IAMCS system monitored for all 3 tanks			c			
5.3	☐	**Safety rounds conducted**						
	a)	Agreed interval for rounds and locations in place			c	c		interval:
R	b)	Records of round made			c			IAPH Records
R	c)	Restricted area free of unauthorized ships/people/ignition sources				c		C33 C40
R	d)	Falling object mitigation measures observed		c		c		C34
R	e)	Accommodation doors, ventilation maintained as required for bunkering			c	c		C37
5.4	☐	**Ramping down according bunker plan F1**						
	a)	Stop LNG bunkering, as per ramp down predefined sequence according to the LNG Bunkering plan (TEC 1421 F1)	c		c			
5.5	☐	**Notification all parties stage 5 completed**						

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6.0 LNG Bunker Disconnection checklist

6.1	☐	**Quantity agreed and confirm loading completed**					T	
A	a)	Agree loading complete and no further pumping of LNG	c		c			

6.2	☐	**Hose & Line Draining and warming completed**					T	
	a)	Bunker Vessel ESD valve closed	c					
	b)	Liquid line drained to tank 2 by gravity			c			
	c)	Liquid line warmed up via water hose from bunker vessel above zero degree and ice is melted		c				Allow adequate time

6.3	☐	**Purging of hose and Lines with Nitrogen completed**					T	E63
A	a)	Liquid and vapour line valves set to suit planned purge process	c	c	c			
A	b)	Nitrogen purging according the pre bunker meeting	c	c	c			
A	c)	Testing CH4 = 0%		c				
A	d)	Ship and Bunker vessel Manual and ESD Liquid & Vapour Bunker valves closed		c	c			
A	e)	Confirm pressure released and remains zero on manifolds after a minimum of 10 minutes wait. If pressure rises take appropriate action (Testing, re-purging, testing)		c	c			

6.4	☐	**Isolation of bunker manifolds**					T	E64
A	a)	Ship and Barge Manual and ESD Liquid & Vapour Bunker valves closed	c	c	c			
	b)	Manual purge and vent lines confirmed closed		c				
	c)	Extendable drip tray and water curtain correctly stowed		c				
	d)	Confirm zero pressure on manifolds		c	c			

6.5	☐	AUTHORIZATION: Ship is ready to disconnect:					T	
P	a)	PIC Signature ______________________________						
P	b)	C/E Signature _______________________________						

6.6	☐	**Notification all parties ship is ready to disconnect**						

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6.7	☐	**Hose Disconection completed**					T	
	a)	Ship to Ship ESD disconnection completed	c	c				Sequence by agreement
	b)	ERC disarmed	c					Sequence by agreement
	c)	VSD disconnected	c	c		c		Sequence by agreement
	d)	Liquid hose disconnected and blank fitted		c				
	e)	Vapour hose disconnected and blank fitted		c				
	f)	Visual inspection of the strainer		c				
	g)	Blank flanges fitted to liquid and vapour manifolds and fully bolted		c				
6.8	☐	**Bunker station returned to normal conditions**					T	
	a)	LNG bunkering station shell door closed and secured		c				
	b)	Bridge informed, shell door closed, and all connections to bunker vessel removed		c				
	c)	Ventilation exhaust fan is running at normal flow when door closed		c	c			
	d)	LNG bunkering manifolds inerted (0.5 bar residual pressure)		c	c			
6.9	☐	**LNG Bunkering System returned to ECR control**					T	
	a)	ECR informed system configuration returned to normal operation						
6.95	☐	**Notification all parties stage 6 completed**						

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7.0 Documentation and notifications

7.1	☐	**Bunker vessel document exchange completed**						
	a)	LNG bunkering documentation received: CTMS report - BDN - Supplier Time Log, Letter of Protests	c		c		T	
	b)	Letters of Protests issued to bunker vessel if required	c		c			
	c)	UHF radios returned to ship (as appropriate)	c			c		
	d)	Competent authorities notified bunker transfer commencing and have been requested to inform other vessels in the vicinity				c	T	E66
	e)	Terminal notified bunker operations completed				c		E67
A	f)	Bunkering safety zone decommissioned and related signage advising the passengers removed				c		E65
	g)	Near misses and incidents have been reported to competent authorities.				c	T	E68
P	h)	IAPH checklist completed (Part E) and exchanged	c		c			

Comments

8.0	☐	Confirmation bunkering process completed					T	
	a)	PIC Signature ________________________________						
	b)	C/E Signature ________________________________						

(STS) SHIP TO SHIP TRANSFER
CODE OF PRACTICE

BAHAMAS PORT AUTHORITY

(BPA)

TABLE OF CONTENTS

RECORD OF CHANGES

Change Number	Revision details / description	Revised Part	Title / Name	Date

FOREWORD

The purpose of this STS Code of Practice is to provide a useful guideline and outline requirements for those involved in such STS operations.
The BPA does not accept any legal obligations or responsibility whatsoever in relation to STS process or in relation to any matters arising from compliance or non-compliance with the STS Code of Practice.
This Code consists of recommendations by the Bahamas Port Authority in the interests of maintaining good operating practice in Bahamas Freeport area.

The grant or renewal of STS licences by the Bahamas Port Authority is conditional on strict compliance with this Code of Practice by an operator wishing to obtain or renew an STS licence. In the event that the Bahamas Port Authority considers that any STS operator is not complying with this Code of Practice, it will suspend or revoke that operator's STS licence immediately for a period to be determined by the Bahamas Port Authority. Should any operator wish to appeal against a decision of the Bahamas Port Authority it should be done in writing to the Authority responsible for the Port.

Conducting STS operations systematically and carefully in accordance with the requirements contained in this Code and International publications/ regulations, namely ISGOTT and the information contained in the CDI / ICS / OCIMF /SIGTTO ''Ship to Ship Transfer Guide" for Petroleum, Chemicals and Liquefied gases' , first edition 2013 , should ensure that such operations are conducted in a safe manner.

STS Operators, Ship's Officers, STS Superintendents, Tug Operators/crews and any other parties that have interest in the STS transfer operation shall not engage in any unethical, fraudulent or other illegal practices. In the event of any inducement to participate in such activities, it should immediately be reported to the Bahamas Port Authority.

STS Operators, Ship's Officers, STS Superintendents, Tug Operators shall comply with all safe working practices and at all times during the STS transfer operation by acting responsibly and professionally. It is important to note that this Code does not alter any obligations of Ship Owners and STS Operators, who must at all times observe all relevant International and other safety standards and applicable laws and regulations.

The standards set out in this Code are subject to periodic review to reflect technological changes, new technical developments and current rules and regulations. Changes to the Code of Practice will be made through the issuance of amendments or revised editions.
Neither the Bahamas Port Authority nor the Government of Bahamas, their officers, servants or agents shall be responsible for any losses which might be caused by or attributable to STS operations. In the event that there is any provision contained within this Code of Practice which any person considers should be varied or not applied in any given situation, written notification should be given to the Bunkering Superintendent as soon as practicable in advance

1. SCOPE

The STS Code of Practice provides guidance on the transfer of liquid bulk cargoes from one ship to another ship (STS) , whilst anchored within Bahamas port limit and other designated areas as these are included in the port lay out and includes documentation, communications, safety and equipment requirements, emergency preparedness and transferred liquid safety criteria.

Bunker , sludge and oily residues Operator in the Port of Bahamas utilizing a Storage Vessel must satisfy the local requirements as these will be included in Appendices section and comply with this Code.

This Code is intended to supplement ISGOTT and the STS Transfer Guide with BPA-specific requirements.

2. DEFINITIONS

For the purpose of this Code, the following definitions shall apply:

BPA	**Bahamas Port Authority-** Plan and procedures for the planned operation
Bunkering Superintendent	Person in charge designated **by BPA**
Bunkering Operations	The supply of fuel oil to a vessel for its own consumption. Normal bunkering operations is/are not considered an STS operation.
Bunker Barge	A bunker barge is usually a small tanker and not a barge as defined here. A licenced bunker barge will deliver marine fuel to ships, usually in port.
Commercial STS Operations	The exchange of cargo between two vessels, excluding Storage vessels anchored within the Bahamas designated anchorage areas and ports limits.
ESD	Emergency shutdown system –ESD systems execute a sequential shutdown of ship pumps and valves in the event of an emergency
JPO	Joint plan of operation-An operation specific plan that includes the operation details
ISGOTT	International Safety Guide for Oil Tankers and Terminals, 5th Edition, 2006, published by the International Chamber of Shipping (ICS) and Oil Companies International Marine Forum (OCIMF).
MARPOL REG	MARPOL residues/wastes is used throughout this document to refer collectively to all waste streams that are generated on board ships during normal operations and during cargo operations and are governed by the MARPOL Convention, including the following: • MARPOL Annex I: oil, oily waste, oily mixtures, oily bilge water, slops, sludge, oily tank washings, oily cargo residues, ballast water containing oily mixtures; . • MARPOL Annex II: tank washings and cargo residues containing noxious liquid substances (NLS) as defined in MARPOL Annex II;
MASTER	The Master of the delivering and receiving vessel.
POAC	Person in overall advisory control: to provide professional advice and guidance to the Master(s) in the coordination and safe completion of the STS transfer operation. It may be one of the Masters or it may be an STS Superintendent. It is not the intention that the POAC in any way relieves the ship's master of any of his duties, requirements or responsibilities
Primary Fenders	Large fenders capable of absorbing the impact energy of berthing enough to prevent contact between the two parties
Secondary Fenders	Fenders used to prevent contact between the two ships, should they rolling or not parallel to each other.
Ship to Ship (STS)	The bulk transfer of cargo from one vessel to another, also known as "Lightering". There is no distinction between "Lightering" and STS operations as far as this Code of Practice is concerned.
Storage Vessel	BPA-licensed Bunker Operator's Storage or "Mother" vessel anchored in the port limits. These vessels receive a bulk liquid transfer, normally sludge and cargo oil residues, from an anchored or inbound vessel during STS operations. Also , the Storage vessel then delivers the receiving liquids to a designated shore facility.

STS Organiser	An STS Organiser is a shore based operator responsible for arranging an STS transfer operation. The Organiser may be an STS Service Provider.
STS Transfer Area	An area within an STS transfer operation customarily takes place .Transfer areas should be selected in safe sea areas as these are designated by the Bahamas Port Authority .
Surveyor	The cargo or bunker surveyor engaged by the ship owner/buyer and/or the cargo or bunker supplier.
Transhipment area	See STS Area

3. DOCUMENTATION

The complete STS documentation shall include the following:

a) STS Notification Form (Appendix B);

b) Completed STS Checklists in accordance with the STS Transfer Guide.

c) Fully prepared cargo loading and discharge plans.

d) Fully prepared Pre-Transfer Safety checklist.

e) STS Superintendent credentials.

f) Risk Assessment.

g) Hose certification - section 18.2 of ISGOTT addresses cargo hoses, with reference to the British Standards BS EN 1765 and BS 1435-2.

h) Fender certification - ISO 17357:2002

4. BAHAMAS PORT AUTHORITY (BPA) STS PROCEDURE

STS Notification requests for operations must be received at least 48 hours prior to the operation to allow sufficient time for the request to be considered and approval to be given or refused.
The Bunkering Superintendent will consider the request using the BPA vetting process that takes the following factors into consideration:

a) Age of the vessel

b) Class

c) Incidents

d) ISM

e) ISPS

f) Past history in Bahamas

g) Mooring Master credentials

h) Liquid amount and type

i) H2S levels, cargo temperature, etc

j) PSC / Vetting history

The Bunkering Superintendent will board the vessel and carry out a physical inspection of vessel and crew before the commencement of cargo operations.

The standards used for this inspection are based upon this Code of Practice and Internationally-recognized standards; ISGOTT and the STS Transfer Guide.

Approved STS Operations - The Bunkering Superintendent will complete the Notification Form and send a copy to the STS Operator and the BPA.

The STS transfer operation will proceed depending on weather conditions and Port operations at the time. Once the STS transfer operation is approved, the Bunkering Superintendent will inspect the vessel(s) and issue an approval note (see Appendix D) to the Operator. The Bunkering Superintendent will be given a 1 hour notice by the service provider, when arrangements on board are 1 hour away from operational readiness.

Unapproved STS Operations – unless all of the requirements set out as above are met, the operation will not be approved

The Bunkering Superintendent will list and track all STS operations on the Status Form. This form will be updated frequently and will include fees for STS operations. Copies of this form and updates are only for internal BPA use.

The STS Form is utilised within the BPA for the verification of STS activities, invoicing and payment

5. STS GUIDELINES AND OPERATIONAL SAFETY

Berthing of vessels intending for STS operations will only be undertaken during daylight hours

All recommendations and guidance outlined in the respective STS Transfer Guide, Petroleum or Liquefied Gas, and ISGOTT should be followed, including, but not limited to the preparation of STS Checklists and Cargo loading/discharge plans in advance of the operation. Compliance with these International standards will be checked during STS vessel inspections.

Bunker barges must depart the Mother Vessel at least one (1) hour before the Delivery Vessel arrives alongside.

Oil containment booms must be placed between the STS vessels, fore and aft, for persistent oil cargoes; e.g. Fuel Oil.

Vessels may utilize a personnel transfer basket but must ensure that the personnel transfer baskets are properly inspected, certified and appropriate for the intended operation.

All Fenders must be maintained in accordance with International Standard (ISO 17357:2002) that specifies the material, performance and dimensions of floating pneumatic fenders which are intended to be used for the berthing and mooring of a ship to another ship or berthing structure. It also specifies the test and inspection procedures for floating pneumatic fenders. It is a requirement that any pneumatic fenders used in STS transfer operation comply with this standard or equivalent.

Tug personnel and Commercial STS operator rigging crews should be trained in basic seamanship skills (certified to STCW 95 standards) and safety to properly and safely rig and unrig fenders and other STS equipment.

The Master of each vessel is to ensure that all crewmembers involved in STS operations are properly trained, prepared for STS operations. They shall have sufficient rest in accordance with STCW-95 standards and are not in any way under the influence of alcohol or any controlled drugs.

To assist in the prevention of fatigue, vessel must have three Deck Officers in addition to the Master of the vessel.

Loading Operations – Tank Capacities

No unauthorised craft should be allowed alongside either vessel during STS operations unless authorised by the vessel. POAC of the operation must be aware of any craft or vessel coming alongside either vessel, of the purpose for being alongside, and must approve this.

Unmanned / Unattended Machinery Spaces (UMS) are not allowed during STS operations.

Any crewmember on board a vessel involved in an STS transfer operation shall be trained and empowered to initiate an emergency shutdown of cargo transfer operations in an emergency or suspicious circumstances.

6. COMMUNICATIONS

A pre-STS checklist and informational package must be sent to the other vessel well in advance of the vessels mooring alongside one another for proper planning and preparation, and copy sent to BPA via e-mail to ……………………

To avoid any misunderstanding, a common language for communication should be established before STS operations begin. This must be stated in the relevant STS or Ship to Shore Checklists

During STS operations essential personnel on the vessels should have a reliable and common means of communication at all times, including a backup system. It is recommended that spare radios and batteries are available on both vessels.

An agreed emergency signal in the form of an air horn and/or hand signals shall be established. In the event of a breakdown in communications, the emergency signal should be sounded and all operations should be suspended immediately. This must be stated in the relevant STS and/or Ship to Shore Checklists

7. WEATHER

In order to ensure safe operations are carried out, the BPA will have a two-phase weather consideration matrix in place.

The weather criteria for berthing and un-berthing of vessels :

- For the Berthing phase will have one set of limitations, whereas the weather criteria for consideration once the vessels are berthed (liquid transfer phase) will have a different set of limitations.

For the berthing and un-berthing phase of operations, weather conditions must not exceed 20 knots of wind and 1 metre of swell height

- For the cargo transfer phase, and in conjunction with the BPA's weather procedures, vessels must report to the VTS and keep VTS fully informed whenever wind gusts reaching 25 knots or higher are encountered, and/or waves of 1.5 meters or higher.

VTS will then take a decision on whether to suspend the operation, cast off the vessels or take any other action, as required.

The Master is responsible for constantly monitoring the mooring situation making sure that the vessel has sufficient lines or wires and proper fendering to avert any damage occurring to the vessel(s).

Wind Speed Indicators must be installed on board all vessels involved in STS operations. A permanent log must be kept of this instrument's readings, especially during manoeuvring operations whilst coming alongside and casting off from another vessel.

All vessels involved in STS operations are to record the weather state (e.g. weather, sea state, wind speed etc) on an hourly basis in the ship's log.

Vessels to suspend cargo operations during the approach of lightning in accordance with recommendations outlined in ISGOTT.

During periods of restricted visibility (less than 100 metres), vessels shall remain in position. No vessels shall move in the bay without the verbal or written authorisation of the Port Authority.

The STS Superintendent should be very familiar with the weather predictions, vessel/crew limitations and BPA/relevant Company weather restrictions.

8. SAFETY DURING OPERATION & FATIGUE PREVENTION

Hydrogen Sulphide (H2S) can present a health hazard in high levels of concentration, particularly with fuel oil cargoes. Further information and safety precautions can be found in ISGOTT, section 2.3.6.

Vessels will not be allowed to enter the port to conduct STS operations unless the H2S level of the bunker, in air, is less than 50 ppm. This requirement does not apply to cargoes which are not intended for the Bahamas bunker market.

Vessels performing STS operations should be aware of the H2S level on board. Precautions should be taken to comply with their Company's Safety Management System (SMS) and ISGOTT (2.3.6) recommendations.

Vessels involved in STS operations shall inform the other vessel immediately if H2S concentration levels exceed 10ppm in the vicinity where personnel are working.

All vessels shall be equipped with at least two (2) of the H2S personal detector units and measuring devices. The detectors must be worn by the vessel personnel during any fuel oil transfer operations.

A Material Safety Data Sheet (MSDS) provides the information necessary for vessel personnel, Surveyors, Emergency Workers and others to decide on the appropriate handling and management of cargoes.

All vessels involved in STS operations shall have the MSDS of the cargo-to-be-transferred on board.

In the planning phase for the STS transfer operation , in cooperation with the Master of nominated vessels, due amount should be taken of the estimated duration and complexity of the operation and an assessment made of any additional workload associated with the activity. The aim should be to ensure that all personnel ,including STS Superintendent , POACs and other involved responsible ,remain fatigue free and that minimum rest periods , as required by applicable legislation , are complied with, particularly when conducting multiple transfers.

Excess noise levels in the vicinity of rest areas can compound fatigue problems. The impact of noise should be monitored and , where necessary , corrective measures taken.

9. CONTINGENCY PLANNING & EMERGENCY PREPAREDNESS / RESPONSE

Despite careful attention to safety procedures, emergencies can occur. Often such events can be contained and their effects minimised by preparing the vessels crew through a system of drills to deal with a variety of emergencies.

Appropriate drills should be held in accordance with the vessels approved contingency plans and such drills, when carried out should be documented.

Oil spill equipment shall be ready for immediate use on board both vessels involved in an STS operation.

A Risk Assessment should be carried out for every designated and individual operation

In the event of any spillage causing or likely to cause pollution, the Master aboard one or both vessels, regardless as to who is the responsible vessel, shall immediately take such actions as are reasonably necessary to effect clean up operations. The actions shall be in accordance with Bahamas laws and regulations.

The BPA shall be notified immediately in the event of any spillage or overflow, even if it is minor and/or contained on deck.

Any contact with another vessel, no matter how slight, must be reported to the BPA immediately.

The Port of Bahamas Oil Spill Contingency Plan has been developed to assist personnel in dealing with an unexpected discharge of oil. Its primary purpose is to set in motion the necessary actions to minimise the discharge and to mitigate its effects.

Effective planning ensures that the necessary actions are taken in a structured, logical and timely manner.

The responsibility of oil spill response in Bahamas falls to the Oil Pollution Action Committee. This committee consists of representatives of the Port Authority , involved parties and the bunkering industry. This plan guides the associated Incident Management Team through the various actions and decisions which will be required in an oil spill response. The tables, figures and checklists within the Plan provide a visible form of information, thus reducing the chance of an oversight or error occurring during the early stages of the incident response.

Training and Exercises in implementation of the Port mitigation procedures must be held at regular intervals. Similarly, exercises in the communications and notification procedure will also be necessary.

The Port of Bahamas Oil Spill Contingency Plan is designed to cover hydrocarbon and tis derivatives. Where a spill is associated with a wider emergency then additional factors involving the safety of personnel will take precedence over the pollution response.

The Port of Bahamas Oil Spill Contingency Plan should be implemented alongside the following plans:

a) Shipboard Oil Pollution Emergency Plan. Regulation 26 of Annex I of MARPOL 73/78 requires that oil tankers of 150 tons gross tonnage or more and all ships of 400 tons gross tonnage or more carry an approved shipboard oil pollution plan (SOPEP) or

b) Shipboard Marine Oil Pollution Emergency Plan. MARPOL Annex II Regulation 17 requires every chemical tanker of 150 GT and above to carry a SMPEP. Scope of this plan is to provide guidance on the actions to be taken if a spill of oil or noxious liquid substance has occurred or is likely to occur.

c) Operating Companies Oil Spill Contingency Plans.

Emergency Action Plans (National Contingency Plan) in use by the Government of Bahamas.

This National Oil Spill Contingency Plan is designed to be implemented when an oil spill incident occurs within the territorial waters of Bahamas.

The Joint plan of operation (JPO) agreed by all involved vessel, should include the contingency plans for operation. The information should include an emergency contact list that should be posted on boar all vessels. Emergency procedures should cover the full scope of the operation and include the following scenarios:

- Vessel collision during mooring /unmooring manoeuvres
- Spillage on deck and overboard
- Toxic or flammable vapour release
- Fire /Explosion
- Multiple mooring line failure
- Emergency unmooring
- Weather deterioration

Consideration should also be given to L

- Procedures for raising the alarm
- Cessation of operations during emergencies
- Notification procedures
- Emergency stations and preparations to initiate emergency procedures
- Deployment of mooring gangs to stations
- Emergency disconnection of cargo transfer equipment
- Preparation of engines for manoeuvring
- Unmooring

An emergency should be indicated immediately by sounding the ship's internal alarm signal and by sounding five or more short blasts on the ship's whistle to warn the other ship.

The emergency signal should be communicated to all personnel on both ships and understanding is confirmed .

It is difficult to anticipate every emergency that could arise. However , some scenarios should be organised and included in the contingency plans.

Examples of potential situations are as follows:

- Emergencies that may arise during manoeuvring
- Emergency form the gas accumulation of deck
- Liquid transfer overflow on deck and overboard
- Mooring lines failure

10. STS SUPERINTENDENTS (POAC)

The role of the STS Superintendent **is not to relieve** the Master(s) of their duties or responsibilities .The STS Superintendent should ensure , through the provision of professional advice and guidance to the Master(s) , the coordination and safe completion of the STS transfer operation .

The STS Superintendent should :

- Review the location-specific risk assessment
- Review the joint plan of operation and associated risk assessment verifies that agreed STS operating procedures are followed and that the operation is conducted in compliance with all applicable regulatory requirements
- Confirms that all required reports are made to the appropriate authority
- Confirms that all relevant checklists are completed
- Review the correct placement of primary and secondary fenders
- Verify readiness of the mooring equipment
- Conducts a pre operation discussion with the responsible persons of involved vessels , including lightering support vessel and tugs as appropriate
- Confirms that personnel involved in each part of the operation are properly briefed and understand their roles and responsibilities
- Discusses currently and forecasted environmental conditions and the need for their continuous monitoring throughout the operation(s)
- Verifies joint agreement of the mooring and unmooring plans
- Reviews and verifies that any site-specific risk mitigations are in place
- Reviews the safe connection of transfer hoses/arms and any other associated emergency release mechanism
- Confirms that transfer rate is being monitored and agreed
- Verifies that the integrity of the mooring arrangement is being continuously monitored
- Ensure the contingency plans are activated in the event of an emergency
- Ensure that transfer lines are properly drained as required
- Confirm the safe disconnection of the hoses/arms
- Supervises the unmooring operation and detachment from another vessel
- Supervises the return of the primary and secondary fenders

All personnel engaged by each company in the operation and support of the STS will be familiar and experienced in their individual roles and able to demonstrate their competence and qualification for the same.

STS Superintendent (POAC) shall attend on both vessels and satisfy himself that there is an adequate exchange of information, including but not limited to the following:

a. Ensuring the Master of the vessel(s) aware of all relevant local regulations

b. Informing the Master of the vessel(s) are aware of weather limitations

c. Ensuring that both vessels have exchanged the relevant information with regards to agreed pumping rates

d. That the POAC will be given a printed copy of the transfer plan from both vessels well in advance of the liquid transfer.

e. That the POAC will highlight any issues he may foresee with the transfer plan.

f. That the POAC will agree and sign that he agrees with the plan

g. That the POAC will not proceed with the STS transfer operation until a printed copy of the plan is available for his records and he fully agrees with the steps therein.

i. That the POAC will be called to any meeting to which there is a change to the agreed plan

j. That all relevant information regarding safety provisions as listed in the various checklists has been divulged to all concerned

k. That manning levels and watch routines are conducive to a safe transfer operation, and comply with relevant provisions in terms of crew work/rest hours

l. That the contingency plans in place on both vessels are compatible between the two vessels, as well as with the BPA's contingency plans

m. That should he disagree with any of the above, he should inform the BPA immediately, and has the authority to stop the operation at any time.

11. RISK ASSESSMENT

A Risk assessment should be undertaken for each proposed STS location and before committing to the STS location. The outcome of the risk assessment should be factored into the development of operational procedures specific to the location ,including implementation of appropriate safeguards to ensure that identified risks are effectively managed.

The Risk assessment should include both physical and operational hazards and be documented and should consider impact and likelihood relating to the identified hazards that apply specifically to the location .It should also include an assessment of residual risks following the application of appropriate safeguards ,controls or mitigation measures.

Factors considered in the risk assessment process should include the following:

- Local legislative requirements
- Whether mooring or unmooring operations are conducted while vessels are alongside or at anchor
- Traffic density
- Availability and capability of support craft at the location
- Exposure of location to security threats
- Operational environmental limits , including abort criteria
- Navigational hazards in the vicinity of the location
- Exposure of location to ,and /or shelter from , prevailing environmental conditions
- Suitability of the location of the particular operation
- Properties of the liquid that will be transferred
- Training , experience and qualifications of personnel
- Adequacy of communications between parties
- Equipment including fenders and transfer hoses
- Emergency planning and procedures

To ensure that the risk assessment remains fir for purpose should be reviewed periodically. When any key condition relating to identified hazards changes, or anew hazards is identified, the risk assessment should be formally revised.

When the generated risk assessment deviate from the assumed or standard condition that has been established or a particular new hazard presented, then review of this risk assessment should be considered to assess and manage the new developed condition on scene.

The risk assessment should identify all potential sources and consequences of risk for the operation and take into account the risk reduction measures already in place , their effectiveness and other factors that could change the probability/frequency of a risk event or its impact

12. SECURITY

The requirements of the International Ship and Port facility (ISPS) Code, together with any local requirements should be adhered to throughout the operation with every vessel to remain responsible for its owns security all the time.

Prior to commencing the STS transfer operation the following security issues should be discussed and associated decisions to be recorded.

- Exchange of sufficient information to determine if a Declaration of Security is required
- Agreement on how, and between whom, communications regarding security are to be made
- Actions to be taken in the event of a breach of security ,such as suspending operations and separating vessel.

Local regulations may impose exclusion zones around the STS transfer operation. Due consideration should be given to establish safe distances that should be maintained from other vessels and actions to be taken of such distances are compromised.

The transfer organisers , when planning the STS transfer operation , should complete a security assessment. If there is any concern that security is not properly addressed at the port, a risk analysis should be undertaken of all aspects of the STS transfer.

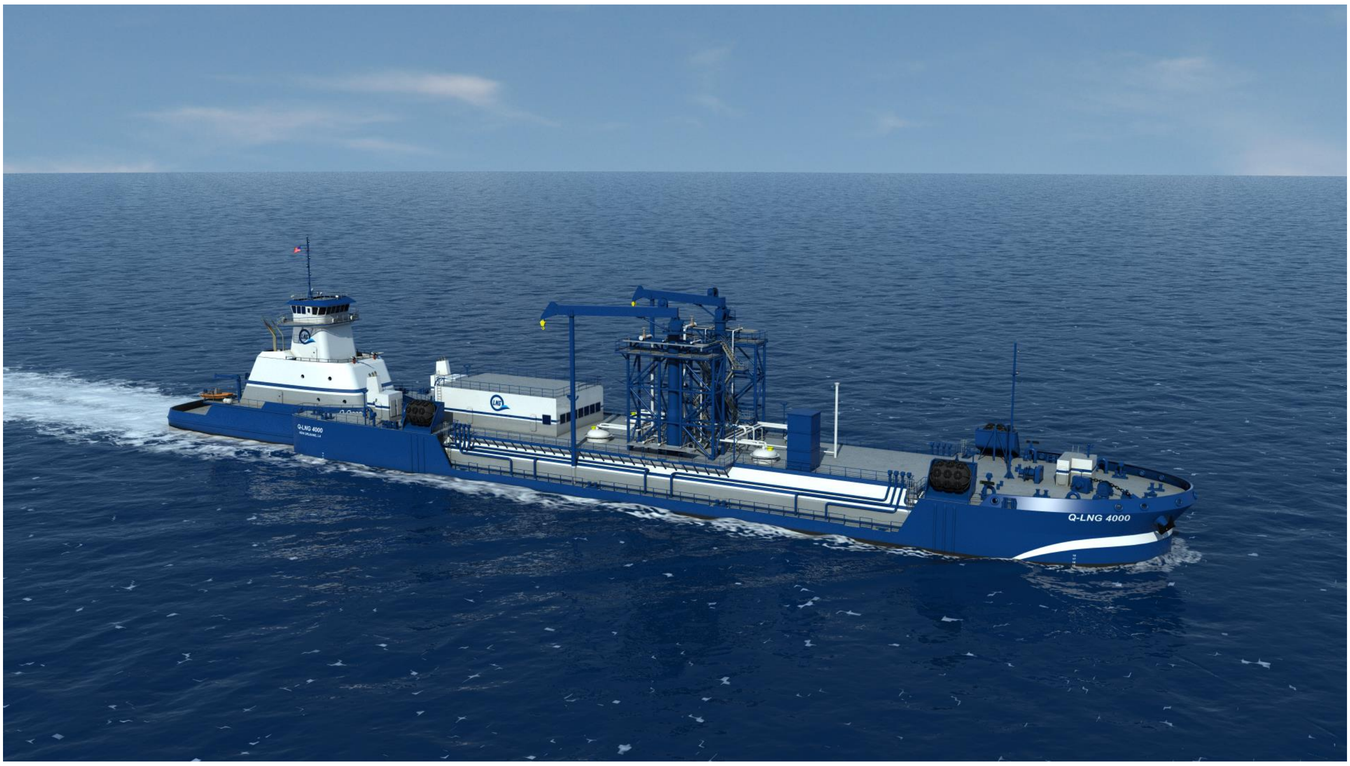
This assessment should :

- Identify the security measures and procedures in place
- Evaluate the assets and infrastructure to protect
- Identify any threat to the port, the terminal ,the delivering vessel and the vessel alongside
- Identify areas of operation vulnerable to security threats
- Consider weaknesses in infrastructure ,security polices and procedures

13. REFERENCE PUBLICATIONS / STANDARDS

1. International Maritime Organization (IMO) "Manual on Oil Pollution, Section 1Prevention
2. Ship to Ship Transfer Guides (Petroleum-Liquified-), Latest edition
3. ISO 17357:2002 High pressure floating pneumatic rubber fenders.
4. British Cargo Hose Standards BS EN1765 and BS1435-2
5. MARPOL Annex VI 73/78 Regulations For The Prevention Of Air Pollution From Ships
6. International Safety Guide for Oil Tankers and Terminals (ISGOTT)(ICS,OCIMF,IAPH)
7. International Safety Guide for Inland Navigation Tank barges and terminals(ISGNITT , CCNR ,OCIMF)
8. BAHAMAS Merchant shipping act (Chapter 268) Ship and Port Facility (Security) Regulations 2016

SHELL LNG BUNKERING SYNOPSIS



Shell response to information from Carnival Cruise Lines in connection with the Environmental Impact Assessment related to the planned activity at Grand Port, Grand Bahamas

Shell
LNG

This Document and any information contained in it is confidential and delivered for informational purposes only and upon the express understanding that it will be used only for the purposes set forth above.

Contents

SHELL'S OVERVIEW AND CAPABILITIES

Company background

Shell is a global group of energy and petrochemical companies with around 92,000 employees in more than 80 countries and territories. Using advanced technologies, we take an innovative approach to help build a sustainable energy future. We are publicly listed with revenue of 305 bln USD in 2017. Additional financial data can be found here: http://www.shell.com/investors.html.

The Shell Group (Royal Dutch Shell) operates various business lines globally across the upstream and downstream sectors of the oil, gas and renewable energy businesses. We supply advanced transport, heating and industrial fuels to corporate and distributing companies in many industries worldwide including transport, mining, manufacturing, power generation and home energy. Further details on out businesses can be found here: http://www.shell.com/business-customers.html.

The role of natural gas in meeting energy demand

Energy is vital to our daily lives. We need it to produce food, fuel transport and to generate electricity. Global energy demand could double in the first half of the 21st century. To meet the world's growing energy demand, all forms of energy will be needed, including developing more natural gas reserves.

At Shell we believe natural gas, the cleanest-burning fossil fuel, will play an increasingly important role in the global energy mix. The world has about 230 years' supply of gas at today's rate of consumption, according to the International Energy Agency (IEA).

Many of the world's cities and industries that need natural gas as an energy source are located far from the gas fields. Transporting gas by pipeline can be costly and impractical. Converting natural gas to liquefied natural gas (LNG) by cooling it to around –160 °C makes it easier to store the gas and transport it around the world. LNG is a clear, colourless liquid that takes up 600 times less space than gas in its gaseous state. The abundance of gas along with a global market for liquefied natural gas (LNG) help increase security of supply.

Shell in Numbers (2018)

92,000
Average number of people we employed

$21 billion
Cash flow from operating activities

30 million customers
Served every day through 43,000 Shell-branded retail stations

30.9 million tonnes per annum
LNG liquefaction volumes

2%
Our share of the world's oil production

70+
Number of countries in which we operated

50%
Share of our production that was natural gas

1%
Our share of global supply of energy

3.7 million
Our production of crude oil and natural gas, in barrels of oil equivalent a day

57.1 million
Tonnes of LNG we sold

$1.0 billion
spent on R&D

$102 million
Spent on voluntary social investment worldwide

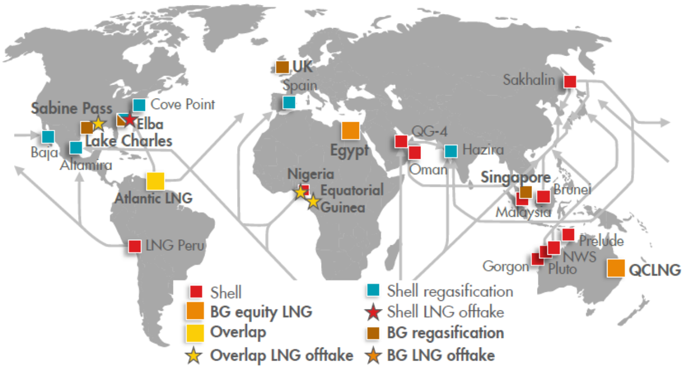
1 million tonnes
Amount of CO_2 captured by Quest CCS facility in 2016

Shell LNG Capabilities

With more than 50 years of experience in Liquefied Natural Gas (LNG), Shell has helped shape the industry since its inception, and is today the world leader in LNG production, marketing and trading, shipping, storage and regasification.

Since 15th February 2016, BG Group is part of Royal Dutch Shell. This combination brings together two world-class portfolios creating a more competitive company and stronger global LNG supplier. We have acquired productive oil and gas projects across countries including Brazil and Australia and have been able to shape a simpler, leaner company. Together we will focus on our core expertise in deep water and LNG.

Shell Integrated Gas Assets



Shell, together with its joint venture partners, holds 52% of the global LNG liquefaction capacity through assets in Australia, Brunei, Malaysia, Nigeria, Oman, Qatar, Russia, Trinidad & Tobago and Peru. This spread of potential supply locations around the world combined with Shell's presence in LNG trading and operations means that Shell's LNG customers enjoy LNG supply that is among the most reliable in the world. Together with our JV partners we are linked to around one third of the world's LNG carrier operations. In 2016 Shell LNG sales volumes reached 57.1 mtpa, about 22% of the global LNG trade. Among international oil companies, Shell has by far the largest LNG production capacity.

Shell is also the world's largest LNG shipper, with its first LNG cargo shipment in 1964 on the route from Algeria to UK. We own and lease 50 of the world's LNG carriers, approximately 12% of the global LNG fleet. We are linked to around one third of the world's LNG carrier operations. Shell has also been the trusted technical operator for national LNG shipping companies of Malaysia, Brunei, Nigeria and Qatar.

LNG as a Marine Fuel

Recognising the potential for LNG as a transportation fuel, Shell has been working since 2011 on establishing an LNG infrastructure, for both road and marine applications, and has established itself as the LNG market leader. In the marine market, Shell's aspiration is to develop a network of LNG bunker locations covering the majority of the world's marine traffic by 2025. Tapping into the company's strong market knowledge and long partnerships with marine customers through Shell's existing marine fuels and lubricants businesses, Shell is confident of achieving the company's ambition to be the global market leader also in LNG bunkering. Below map highlights our LNG bunker network ambitions including existing and future potential supply points.

LNG Bunkering Network

Specific experience in LNG as Marine Fuel

GASNOR

In 2012, Shell acquired Gasnor – the Norwegian small scale LNG market leader. Annually, Gasnor distributes over 140,000 tons of LNG to Norway and the rest of Scandinavia. The company operates 3 LNG production plants in Norway and has over 10 years of operational experience serving marine and industrial customers by road and ship.

The high LNG safety standards of Shell together with the hands-on experience of Gasnor have brought tremendous collective value and contributed significantly to the development of operating standards in locations beyond Norway. Similarly, the high LNG safety standards of Shell have helped to further improve operations in Norway.

As of today, Gasnor has performed more than 70,000 LNG transfers via currently 22 road tankers and 2 distribution vessels, showcasing a strong safety track record. In the marine customer segment, Gasnor currently delivers LNG to approximately 30 ships, among which the Fjord 1.

FJORD 1: POWERING THE LNG HIGHWAY

"Fjord 1 is the largest ferry company in Norway and operates car/passenger ferries and express boats along the coastline of Norway. The company is concerned about the environmental Impact of its operations and started up Ferries operating on LNG in 2000. Fjord 1 now has 12 ferries operating on LNG – And the latest one "MF Boknafjord" is also the world's largest of its kind."

"We have compared traditional diesel fuelled ferries with LNG fuelled ferries, and have experienced a significant reduction of local emissions and virtually zero particulate matter. We have also experienced that the noise level on board these ships is significantly lower than on a traditional ferry. Fjord 1 has a broad background experience with ships operating on LNG.

Introducing LNG as fuel is a pilot project and some adjustments have been made, but the overall operational experiences have been positive. The supply of LNG has not caused disturbance to our operations, the bunkering operations have been efficient and we have a good feeling of security for the procedures."

Oscar Bergheim
Head of Production Fjord 1

NORTHWEST EUROPE

Shell has acquired capacity rights in the Gas Access to Europe (GATE) terminal in the Port of Rotterdam, ensuring we can import and store our own LNG cargoes. In addition, Shell was the launching customer of the break bulk jetty where bunker vessels can load LNG for distribution in and around Rotterdam. This jetty has been in operation since 2016. A purpose-built Shell bunker vessel (*Cardissa*) is currently in operation, while an additional bunker barge will be built – both to be based at the port of Rotterdam. Contracted customers for these vessels are Containerships, Sovcomflot and Carnival.

We currently also load LNG in dedicated trucks for supply to several different marine customers, such as Chemgas, Sabic and Aida. We have successfully performed truck to ship bunkering operations across Western Europe. Shell has recently signed a time-charter agreement with Plouvier Transport for 15 new inland dual-fuel barges, which will predominantly run on Liquefied Natural Gas (LNG).

SINGAPORE

Shell is leading the LNG bunkering developments in Singapore. Shell was awarded the LNG bunkering licence by the Maritime and Port Authority of Singapore (MPA) in January 2016. In June 2017, Shell's LNG bunker vessel, *Cardissa*, loaded at the Singapore LNG terminal performing the first ever LNG bunkering in the country. From 2018 onwards, Shell is supplying LNG to two LNG fuelled tugs that will operate in the port.

GULF OF MEXICO

Shell marked the delivery of the LNG-powered Offshore Supply Vessel (Harvey Energy) in March 2015, for its deep-water operations in the Gulf of Mexico. The vessel, chartered from specialist company Harvey Gulf International Marine, is the first of its kind in the region to run on both Liquefied Natural Gas (LNG) and diesel. She has surpassed all operational expectations as the OSV of choice for time sensitive trips while running on 99% LNG fuel and operating for around seven days before refuelling. A second LNG-fuelled vessel (Harvey Liberty) was delivered to Shell in October 2015 and a third (Harvey Power) in March 2016.

3rd Party Collaboration

Shell firmly believes in collaboration with reputable and leading industry experts. Whilst we have a broad base of in-house expertise, we recognize there is significant value in seeking out mutually beneficial relationships with key LNG marine experts, who provide unique skills.

VESSEL OPERATORS

While Shell decided to own and operate the *Cardissa* in North West Europe to gain first-hand operational and technological experience, our strategic objective has always been to cooperate with reputable barge operators with LNG knowledge and a proven track record of safe operations. We believe this is the most practical and cost-effective approach for widespread LNG bunkering deployment. We are working closely with a number of potential barge owner/operators, including Jones Act operators. Shell has established good working relationships with Antony Veder (owner of Coral Methane vessel) and others prospective bunker vessel owners like Exmar, BW and Bernard Schulte. In the US, we are working closely with QLNG, Moran and other credible operators.

OEMs

Shell is closely collaborating with several of the main engine and equipment manufacturers (MAK, MAN, Wartsila) to progress the development of LNG as a marine fuel. Key areas of co-development include research on engine efficiency across a range of methane numbers, technology to reduce methane slip, and R&D efforts to reduce LNG equipment costs. Shell is also collaborating on the development of key bunkering technologies, such as the LNG transfer arm (FMC), efficiency with gas fuel systems and onboard sub-cooler technology (Air Liquide).

INFRASTRUCTURE PROVIDERS

Shell has come to acknowledge that we are typically more efficient in developing small-scale LNG liquefaction and infrastructure solutions together with partners. We are working closely with industry experts in this domain. While we do not envision a need for shore-based infrastructure for supplying Carnival Cruise Line, these relationships are well established and readily accessible.

INDUSTRY COLLABORATION

LNG market development is challenged by various factors that can only be mitigated through collective industry efforts.
Shell has experienced the benefits of collaborating successfully with port authorities, governments, barge operators, and customers. Through associations like SEA/LNG, Shell aims to accelerate momentum for Marine LNG through collaborative actions. Shell is an original member of SIGTTO (Society of Gas Tanker and Terminal Operators) in the conventional LNG business and a founding member of SGMF (Society of Gas as a Marine Fuel). These organizations, like OCIMF (Oil Companies International Marine Forum) provide global platforms to promote safety and industry best practices. Shell is a committed and active member of the relevant societies and has provided support and personnel both at the working and leadership levels.

SOCIETY OF GAS AS A MARINE FUEL
Shell is a founding member of SGMF and currently holds the Chair of the SGMF Technical Committee. In addition, Shell Subject Matter Experts (SMEs) have actively contributed to the development of the following guidance issues to date: ▪ *SGMF Safety Bunkering Guidelines* ▪ *Quality and Quantity Guidance* ▪ *Manifold Arrangements For Gas Fuelled Vessels* ▪ *Training and Competency Standard Matrix*

FIT FOR PURPOSE SUPPLY NETWORK

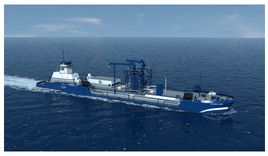
Shell's ambition is to create a strong global LNG bunker network that can offer reliable supply of LNG bunkers around the world. The section below describes our proposed supply chain to answer your needs in US South East (Florida) and provides an indication for other geographic areas potentially of interest for the future.

LNG Bunkering Supply in US South East (Florida)

Through our global LNG supply portfolio, Shell is able to leverage our advantaged supply points in order to serve CCL in the most safe, reliable and competitive manner. Given the proximity to the requested delivery points (Port Canaveral and Miami), we plan to supply the three CCL vessels from Shell's LNG capacity position at Elba Island LNG Terminal in Savannah. The location has two jetties to prevent loading congestion and ensure reliability.

The Elba Island LNG Terminal is a Kinder Morgan facility operated as Southern LNG (SLNG), with a total of 2.5 mtpa of LNG production capacity and 11.5 bcf (325,640,000 m^3) storage capacity under full development. In 2012, the project received authorization from the Department of Energy to export to Free Trade Agreement (FTA) countries and in 2016 to non-FTA countries as well. The liquefaction trains are currently well under construction, with first two out of the total 10 expected to be in operation by 2019. Shell is the 100% capacity holder for all liquefaction volumes and the sole import capacity holder.

Shell's proposed supply chain for CCL may include Shell loading the LNG from the Elba Island LNG Terminal and delivering by bunker barge/vessel to the requested delivery ports. Consequently, we would be relying on our shipping assets portfolio to ensure safe and reliable supply of LNG to your cruise ships.



To be able to service vessels along the southern US East Coast and support growing cruise line demand for LNG marine fuel, Shell has signed in 2017 a long-term charter agreement with Q-LNG Transport, LLC. for a 4000 m^3 articulated tug barge. Q-LNG will build the LNG bunker barge (LBB) and assume the owner-operator role. With its pioneering design and delivery capabilities, the LBB will be highly efficient and manoeuvrable and feature an innovative transfer system enabling it to load LNG from conventional or small terminals and bunker a variety of customers.

In addition to the 4000 m^3 LBB, Shell is actively engaging the market to get the best advantaged, fit for purpose bunker vessel(s).

With regards to the regulatory side of LNG bunkering, Shell has established strong working relations with the relevant stakeholders. Shell has actively engaged and collaborated with port authorities, US Coast Guard (UCG) and local stakeholders to conduct HAZIDs for Port Canaveral, Port of Miami and Jacksonville, as well as other ports within the Gulf Coast. Given Shell's LNG technical and safety expertise, we have been invited to participate in various LNG working groups, such as MERPAC and CEPAC as well as to collaborate closely with USCG as an industry participant on the USCG relevant policy letters. Leveraging our acquired experience, Shell will work with CCL to ensure all relevant risks are identified and mitigated to meet all industry standards and regulators' requirements.

SHELL MARINE LNG VALUE PROPOSITION

In this changing global shipping environment, Shell LNG strives to offer a compelling value proposition. Shell LNG is a cost competitive compliant fuel that can help CCL achieve your sustainability goals. Leveraging Shell's highest safety standards, leadership and experience in LNG shipping, we are confident we can bring a value enhancing marine bunker solution to CCL newbuild cruise ships.

Highest Safety Standards

SAFETY

Shell holds itself to the highest standards within quality, safety and the environment and operates under the principle of "GOAL ZERO. NO HARM. NO LEAKS." Safety is a deeply held value and Goal Zero is our vision for causing 'no harm and no leaks'. To prevent process safety incidents, we need to keep our products "in the pipe." Leaks also harm the environment, and as a good neighbour we cannot let this happen.

Our customers also have high demands and expectations for safety and security of supply. Shell has established an extensive system of quality and environmental control and procedures that will help us avoid accidents and incidents that have undesirable consequences on health, safety and the environment. We secure and maintain high standards of safety in accordance with the generally accepted standards prevailing in the LNG industry, including ISO/TS 18683 and ISO 20519.

To achieve Goal Zero we need to build a strong culture where everyone is motivated to relentlessly pursue no harm to people and protect the environment through a number of HSSE programs:

- Behavioural HSSE
- Operational Safety
- Incident Investigation and Learning From Incidents (LFI)
- Process Safety
- Contractor HSSE Management

It is through experience and application of these HSSE programs that Shell partners in the following areas:

- HSSE in shipyards associated with hydrocarbon vessels including:
  - Safety toolboxes
  - Permit to work processes
  - Managing and working with hydrocarbons and cryogenic liquids
  - Managing asphyxiation risks
  - PPE and Personnel safety
- Commissioning of Gas Fuelled Ships
  - Initial loading of fuel tank
  - Nitrogen cool down and gassing up
- Initial bunkering
  - Preparation testing including essential safety systems such as ESD and gas detection
- Gas Trials
  - Propulsion train testing
  - Verification of BOG rate
  - Tank and fuel safety systems

PARTNERS IN SAFETY

Through collaboration and engagement, our Partners in Maritime Safety program aims to share best practice material in order to achieve a step-change in our safety performance and get to a zero incident industry. The program focus includes leadership visits, reflective learning, learning engagement tools and a resilience program. The program has been in effect for the past 6 years and we have seen the number of serious actual and potential incident frequency reduce from 1 in 7 to 1 in every 25 days, this includes global data, all incident types and all vessels on Shell Business. Additional information on the program and how DCL can actively participate in the partnership can be found in the below link.

Maritime partners in safety | HSSE materials for contractors

SHELL REQUIREMENTS FOR QUALITY ASSURANCE FOR MARITIME VESSELS

All vessels must be positively vetted, i.e. there must be positive information that the vessel is suitable for the intended use. Compliance with the TM-MS is carried out on each occasion a vessel is proposed for Shell use. A wide spectrum of data is considered in assessing the suitability of a vessel. Vessel inspection reports are one of the key components in the overall vetting assessment. A final decision is made regarding the suitability of the vessel based on all the information available at the time of the assessment. The entire process of vetting of vessels and barges is based on the level of risk for the Royal

Dutch Shell Group of Companies4. Application of these requirements extends beyond consideration of strict legal liability.

SHELL MARINE LNG DELIVERY PROCEDURE MANUAL

The Shell Marine LNG Delivery Procedures Manual (DPM, Appendix D) is Shell's reference document for the operational aspects of all Marine LNG Bunker Delivery activities, where Shell has an involvement in any given capacity. Shell's involvement of the bunkering operations could be as:

- i.) The Owner/Seller of the LNG Bunkers, and/or
- ii.) The Owner, Operator or Charterer of the LNG Bunker Vessel, or
- iii.) The contractor of a 3rd party vessel engaged in the delivery of Shell or 3rd Party LNG Bunkers to a Shell Customer on Shell's behalf.

The requirements and procedures described in the document are the minimum applicable to Shell's business activities and will support the site-specific operations manual. The DPM is still in early years of practice in the LNG bunker trade and through the cycle of continuous improvement capturing learnings and customer feedback they will evolve to incorporate all new best practices as they develop.

The DPM does not replace the operator's vessel and location specific bunker procedures, as required by the USCG or other regulatory bodies.

In addition to the actual transfer operation, the bunkering procedure focuses on key areas to ensure a safe operation without leaks or venting. These include:

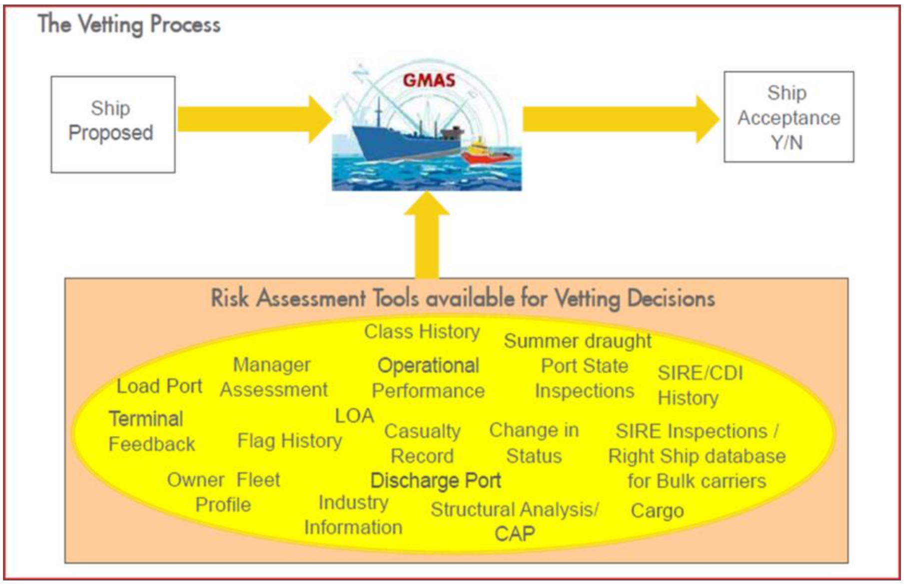
1. Safe connection of the transfer system
2. Purging and inerting without methane to atmosphere
3. Pre-transfer testing in both cold and warm conditions
4. Transfer including ramping up and down to ensure integrity of system
5. Normal disconnection of the transfer system
6. Emergency shutdown (ESD) and disconnection, and the recovery of the transfer system (ESD2)
7. Organizational Plans

BUNKERING OPERATIONS & SAFETY

To prevent process safety incidents, we need to keep our products "in the pipe." Leaks harm the environment, and as a good neighbour we cannot let this happen. The DPM (Appendix D) includes Shell's Golden Rules that apply to all staff and contractors;

- Comply with the law, standards and procedures.
- Intervene in unsafe or non-compliant situations.
- Respect our neighbours.

Our customers have high demands and expectations towards our security of supply. Shell has established an extensive system of quality and environmental control and procedures that will help us avoid accidents and incidents that have undesirable consequences on health, safety and the environment. Shell-owned bunker vessels and Shell-operated bunker vessels operate under Shell's Integrated Management System (IMS) which incorporates ISO 14001, ISO 9001, and the ISM Code. Shell contracted parties which are the owners, charterers or operators of bunker vessels shall have a Safety Management System which satisfies the ISM Code. All Shell-owned, Shell-operated or Shell chartered bunker vessels shall implement and comply with these policies meeting the Golden Rules. Sections 2.1-2.4 of the DPM (Appendix C) discuss Shell's HSSE system, policy and commitment, and per Section 7.8 of the DPM (Appendix C) the following documents will be shared: Shell's "Commitment and Policy on Health, Security, Safety, the Environment and Social Performance", Shell MSDS information, and Shell Life Saving Rules.



It is important to highlight the Shell Shipping Quality and Assurance (SSQA) Process, an extensive vetting process that Shell requires for all the vessels on Shell Chartered business. Each vessel is required to complete the process in the left diagram as part of acceptance to operate on Shell business. Our vetting process drives our operators to Top Quartile performance through proactive incident management, safety culture, SIRE/CDI Inspection Performance, consistent and proactive management.

Shell has a long history of industry engagements to establish LNG safety best practice and is willing to share background associated with work developed to date. Shell is proactively engaged in the development, maintenance and application of national, regional and international standard development as well as industry best practice through NGOs.

Highlights include:

- European Sustainable Shipping Forum (ESSF) – Member
- ISO 18683 "Guidelines for systems and installations for supply of LNG as fuel to ships" – Working Group Member
- ISO DIS 20519 "Ships and marine technology – Specification for bunkering of gas fuelled ships" – Working Group Member
- PGS 33 "Delivery Installations of liquefied natural gas (LNG) vessels" (Dutch) – Working Group Member

RISK MANAGEMENT

It is critical to ensure that all credible hazards are identified and associated risks eliminated or mitigated to ensure the risk of LNG bunkering is As Low As Reasonably Practicable (ALARP). Typical Risk Management activities include the following and will be applied for the bunkering operation and location:

1. Hazard Identification Studies (HazID)
2. Hazard Operability Studies (HazOP)
3. Failure Mode and Effect Analysis (FMEA)
4. Qualitative Risk Assessment (QRA) for the quantification and establishment of Safety distances, if applicable

The risk assessment process will identify critical hazards resulting from both design and operational practices and identify appropriate mitigations. To ensure safe bunkering operations at the relevant location and demonstrate that to the appropriate and relevant authorities it is proposed that a joint HAZID at those locations is carried out. Additionally ensuring, if applicable, that the risk associated with simultaneous operations (SIMOPS) are captured and identified during the risk management process, as detailed in the DPM.

INCIDENT REPORTING, INVESTIGATION & EMERGENCY RESPONSE

It is expected that Shell, Shell Contracted Parties and CCL shall maintain an incident reporting system. Shell maintains such incident reporting system in line with Shell's Fleet Management Practices, which can be made available upon request.

Emergency preparedness and response plans will be developed in accordance with ISO 18683 in addition to all marine regulatory requirements and industry guidance and communicated to authorities and third parties accordingly. The plans shall be developed with an emphasis on rescuing casualties, safeguarding and evacuating others, minimizing damage to property and the environment, preventing escalation, and bringing the incident under control. Shell, Shell Contracted Parties and CCL shall also ensure that their emergency response capabilities are practiced and tested at regular intervals as "table top" and practical exercises to ensure emergency response training is maintained.

CREW TRAINING SUPPORT

Training of crew and operators of LNG Fuelled vessels and those who will be involved in LNG Bunkering activities is an area with large uncertainty especially where an operating company has no hydrocarbon vessels within their fleet. Shell is able to assist customers in working towards the current STCW.7/Circ.23 "Interim Guidance on Training for Seafarers On Ships Using Gases Or Other Low-Flashpoint Fuels" via the following opportunities:

1. Training by means of witnessing live LNG cargo operations at an import/export terminal (at the convenience of CCL) including:
    a. Pre-transfer operations including connection, purging and testing
    b. Transfer operations
    c. Post-transfer activities and disconnection
2. Combination of hands-on and classroom training to customers for familiarisation with the LNG transfer system that will be utilised:
    a. Basics of LNG characteristics and HSSE of LNG operations
    b. Hose transfer systems topics include:
        - Flange preparation
        - Connection and tensioning
        - Leak testing
        - Monitoring during transfer and leaks
        - Disconnecting

3. Sailing time on an operational LNG carrier within the Shell operated LNG Fleet

Fundamentals to Safe LNG Bunkering

General Information on LNG

Natural gas is one of the cleanest burning fuels available today with negligible sulphur or ash content. When burned in an engine or boiler, it can produce low levels of NOx (depending on engine type) and less CO2 than petroleum-based fuels. Worldwide reserves of natural gas are thought to be significantly higher than for petroleum and the International Energy Agency estimates there is enough supply for 250 years of consumption.

Natural gas is a colourless mixture of several gases, but is principally composed of methane (CH_4) with a typical concentration of 70 to 99 percent by mass, depending on the origin of the gas. Other constituents commonly found in natural gas are ethane (C_2H_6), propane (C_3H_8), and butane (C_4H_{10}). Small amounts of other gases, such as nitrogen (N_2), may be present. When lowered to a temperature of about -162°C at atmospheric pressure, methane vapor becomes a liquid (LNG). At -162°C, the volume is reduced to about 1/600th of the volume needed for methane vapor. As a result, methane is typically transported as a cryogenic liquid. The density of LNG is less than half of water, which means LNG will float. Further, the methane vapor from LNG will at first be heavier than air. As such, a vapor release from an LNG tank will hover close to the water surface, ground or deck. When the vapor warms to above about -100°C, it will be lighter than air and begin to further dissipate.

LNG has roughly half of the density of traditional heavy fuel oil, but its calorific value is roughly 20 percent higher. Considering both its lower density and higher heating value, on a volumetric basis (m^3) roughly 1.8 times more LNG needs to be bunkered to achieve the same range compared to bunkering heavy fuel oil.

Due to heat leakage through the insulation of the fuel tanks, LNG in storage will be evaporating and giving off natural gas constantly. If the boil-off gas is consumed in the engines or boilers of the ship, the temperature and pressure of the LNG in the fuel tanks will be maintained. If the boiloff gas is not consumed, the pressure and temperature in the fuel tanks will rise.

Natural gas, like other combustible liquids, is not flammable in the liquid phase and cannot ignite. However, in the vapor phase it is highly flammable and will readily burn when there is a 5 to 15 percent by volume mixture with air. Although methane is colourless, cold methane vapours cause the moisture in air to condense resulting in what appears to be a white cloud. A general guide is that within the visible cloud, the methane concentration is still within the flammable range. Therefore, it is critical that equipment and procedures are in place to prevent a flammable mixture from occurring, and that sources of ignition are non-existent in and around areas where a flammable mixture is likely to occur.

Hazard Identification (HAZID)

The principal objectives of the HAZID should identify:

- Hazards and how they can be realised (i.e., the accident scenarios)
- The consequences that may result
- Existing measures/safeguards that minimise leaks, ignition and potential consequences, and maximise spill containment
- Recommendations to eliminate or minimise risks

The HAZID process should be carried out in accordance with a recognised process using appropriately experienced subject matter experts. It is recommended that professional guidance is sought to ensure that the process is carried out to an adequate and appropriate level of detail. An independent chair is very helpful.

The outcomes of the HAZID may include hazard rankings and should include recommendations for additional safeguards and analysis; this may include actions requiring more detailed analysis or studies to establish that the measure in place meet the acceptance criteria agreed by the Administration.

HAZID Technique

The HAZID technique is a brainstorming activity to consider hazards of a system, to be prompted by guidewords to assist hazard recognition. The basic HAZID Study approach involves:

- The assembly of an appropriate team of experienced personnel, including representatives of all disciplines involved in the area being reviewed and (as needed) interfaces with adjacent systems.
- Short presentations detailing the scope of the study.
- Application of the relevant guidewords to identify hazards and other HSE concerns.
- After identification of the hazards, each hazard was risk ranked using the risk matrix
- Only the consequences related to safety, environmental, asset, and reputation were risk ranked using the risk matrix. Operation issues were not risk ranked during the HAZID.
- Scenarios were risk ranked based on the applicable consequences only. For example, if a scenario consequence is related to only asset damage or safety impact and it does not result in any environmental consequence then that scenario was not risk ranked for the environmental category.
- Consequence category was ranked without considering the safeguards and likelihood was ranked by considering all the existing safeguards in place.
- Details of the generic safeguards that are referred in the HAZID worksheet.
- Recordings of the discussions were entered onto worksheets summarizing the nature of the hazard, its consequences, threats, safeguards in place, risk ranking, and recommendations for any actions required.

To facilitate the HAZID process, the bunkering process may be divided into smaller steps, each of which are then addressed systematically. It is recommended that the following list is used to structure the HAZID exercise for LNG bunkering:

- Preparation (compatibility, testing, mooring)
- Connection
- Inerting of relevant pipe sections
- Cooling down
- Transfer start
- Transfer at nominal flow
- Transfer stop including topping-up
- Draining and purging
- Inerting
- Disconnection
- Commissioning
- Security
- Local, (weather etc), generic and port specific issues also need to be addressed

PHAST Modelling

PHAST (Physical Hazards Analysis Software Tool) can be used to model consequences from release events. PHAST is an industry accepted third party consequence modelling package. PHAST modelling will be used to determine:

- Discharge rates from inventories with respect to time
- Flammable gas dispersion of un-ignited gas (dense gas from cryogenic spills and momentum jets from high pressure gas inventories)

Bunkering Process

Operational Readiness During Bunkering Process

Communications and Monitoring

Communications between the receiving ship and bunker supplier is critical for carrying out the bunkering operation safely. Communications should be established before the bunker hoses are connected and can end after the hoses are disconnected. It is important for the supplier and receiver to both speak a common language and fully understand each other.

Although currently there are no established standards, compatibility of all communication links between the receiving ship and bunker supplier must be confirmed and tested.

Radio and communication equipment for involved persons should include the following considerations:

- Radio equipment to be used in the safety zone during the operation should be designed for use in hazardous areas and should be intrinsically safe.
- Any radio equipment, cell phones, or portable electronic equipment in the safety zone that are not intrinsically safe should be removed from the area.

In addition to the communication system, a monitoring system with data link may be provided. The monitoring system allows both parties to monitor their own systems as well as critical aspects of the other's system. This data link may be an integral part of the emergency shutdown system or independent. Integrated systems allow for automatic shutdown of the bunkering operation upon receiving an alarm, such as from the gas, fire, or smoke detection systems, or from manual activation. The typical technologies used for data and communication links in the LNG industry include electrical and fiberoptic cables, radio frequency and pneumatics. All of the listed technologies, except pneumatics, have the capacity to transfer additional information, such as communications or monitoring of other important, but non-LNG related systems. Pneumatic systems are simple and dependable, but generally only capable of sending one signal. They are typically used as the emergency shutdown.

Emergency Shutdown (ESD)

Having a means to quickly and safely shut down the bunkering operation by closing the manifold valves, stopping pumps, and closing tank filling valves is essential to ensure safety. The ESD should be capable of activation from both the bunker receiving ship and the bunker supplier, and the signal should simultaneously activate the ESD on both sides of the transfer operation. No release of gas or liquid shall take place as a result of ESD activation. Typical reasons for activation of the ESD include the following:

- Gas detection
- Fire detection
- Manual activation from either the supplier or receiver
- Excessive ship movement
- Power failure
- High level in receiving tank
- Abnormal pressure in transfer system
- High tank pressure

- Other causes as determined by system designers and regulatory organizations

Special Precautions for LNG

The issues associated with cryogenic substances like LNG are extremely important to understand and respect. LNG cannot simply be handled as 'cold diesel'. It is in fact extremely cold and can cause serious burns to human flesh. Even uninsulated LNG pipes and equipment can become cold enough to cause serious injury to personnel. In addition, the cryogenic temperatures are cold enough to cause steel to become brittle and crack. Because of these issues, the piping system, material requirements, and safety issues are much different than for an oil fuel system. The hull or deck structures in areas where LNG spills, leaks or drips may occur must be either suitable for the cold temperatures or protected from the cold temperatures.

Drip trays are commonly used to contain LNG leakage and prevent damage to the ship's structure. This includes the location below any flanged connection, which are typically fitted with spray shields, in the LNG piping system or where leakage may occur. Drip trays should be sized to contain the maximum amount of leakage expected and made from suitable material, such as stainless steel. Cryogenic pipes and equipment are typically thermally insulated from the ship's structure to prevent the extreme cold from being transferred via conduction. These requirements are especially important at the bunker station because this is where LNG leaks or spills are most likely to occur.

Inerting and Purging

Before bunkering, it is necessary to inert and purge the bunker hoses and other warm bunker lines. In order to prevent a flammable gas mixture, the inerting process includes displacing air from the bunker lines with inert gas, typically nitrogen, to ensure the oxygen content is less than or equal to 1 percent. Purging, also known as gassing up and gas filling, is the process of displacing the inert gas with warm natural gas. Purging can either be done with vapor purge lines, which force vapor from the tank through the bunker lines; or by slowly pumping small volumes of LNG through the bunker lines, which will quickly vaporize and purges the lines. After the bunker lines have been inerted and purged, the lines are slowly cooled to the temperature of LNG with the use of cold LNG vapor and/or LNG. This process prevents the risk of cold shock and damage that would occur if LNG was allowed to flow through the warm hoses and pipes at the normal flow rate. Once the bunker lines have been cooled, the transfer of LNG can begin.

After bunkering, it is very important to drain the bunker lines so that LNG does not remain trapped in pipes or hoses. If LNG remains trapped in a sealed section of a pipe or hose, it will warm, vaporize and pressurize the pipe and may cause the pipe or hose to burst. One way to drain the bunker line is to allow the LNG to vaporize in the pipes while the valves leading to the ship's fuel tank are left open. This allows the LNG and natural gas vapor to flow to the tank. Purge connections also can be used after bunkering to force the remaining LNG into the ship's fuel tanks.

When bunkering is complete, and the lines have been drained of LNG, it is necessary to inert the LNG bunker lines to prevent a flammable gas mixture from accumulating in the pipes or hose. Inerting is to be completed prior to disconnecting the bunker lines. Typically, nitrogen is used to displace the warm natural gas from the bunker lines. The bunker facility and receiving ship should agree on the means to properly manage and dispose of the remaining natural gas and nitrogen so that the natural gas is not released into the atmosphere. This may be accomplished by pushing the natural gas and nitrogen mixture back into the bunkering facility tanks or by using gas combustion units or boilers. Furthermore, it should be confirmed with all agencies having jurisdiction over the bunkering operation that the proposed procedure is acceptable.

Safety and Firefighting

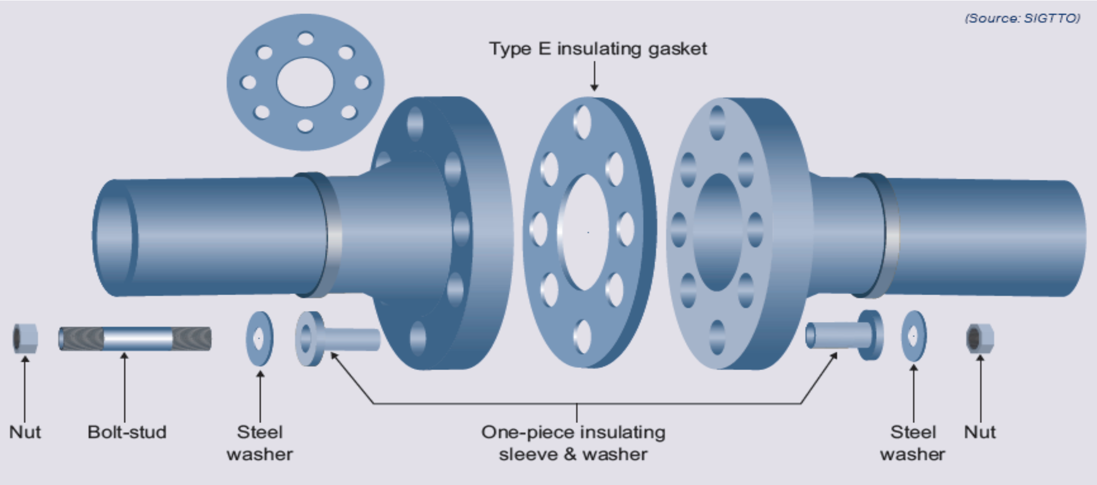
A permanently installed fire extinguishing system is fitted at the bunker station and drip trays. Manual release of the system should be easily possible from outside, but near, the bunker station. In addition, portable dry chemical fire extinguishers are typically located near the bunker station and in nearby areas with easy access by the crew. For enclosed or semi-enclosed bunker stations, a fixed fire and gas detecting system should be fitted.

A water curtain is frequently fitted wherever large quantities of cold LNG can leak and damage critical structural components, such as the ship's side shell directly below the LNG bunker station and bunker hoses and above the waterline.

Electrical Isolation

Vessels transferring or receiving low flashpoint flammable liquids, such as LNG, need to take additional precautions against ignition resulting from electrical arcing. Two causes of arcing are static electricity buildup in the LNG bunker hose and differences in potential between the ship and bunker supplier's facility, including the quay or pier, trucks, bunker vessels, etc. It used to be common practice to connect a bonding cable between a ship carrying low flashpoint flammable liquids and the loading or offloading facility to physically ground the two objects together to equalize the difference in potential. However, it was noted that the bonding cable was not fully effective at equalizing the potential. Furthermore, if the cable accidentally broke or became detached, the chances of arcing would be greatly increased.

An effective way of preventing arcing is to isolate the ship and the bunker supplier using an isolating (insulating) flange fitted at one end of the bunker hose only, in addition to an electrically continuous bunker hose. The isolating flange prevents arcs from passing between the ship and facility even if there is a difference in potential. Furthermore, because the hose is electrically continuous, and one end is grounded to either the ship or the bunker supplier, static electricity will effectively be dissipated. An alternative method is to use one short section of insulating hose without any isolating flanges, but with the rest of the bunker hose string electrically continuous. To ensure that the ship is completely isolated from the supplier, it may be necessary to isolate mooring lines, gangways, cranes, and any other physical connections. This is typically done by using rope tails on mooring lines, insulating rubber feet on the end of gangways, and prohibiting the use of certain equipment that would otherwise pose an unacceptable risk of arcing.



Initial Gassing Up

Before the initial filling of an LNG fuel tank or after it has been completely emptied and gas-freed, it will be full of air. Before LNG can be introduced to the tank, the air needs to be removed by inerting the tank (typically with nitrogen) to ensure an explosive mixture of gas and air is never present in the tank. Some ships might not be fitted with a nitrogen generator or nitrogen storage tank with sufficient capacity to inert the entire fuel tank or tanks. This task might be accomplished by the LNG bunker supplier or another source, such as a nitrogen tank truck or a fixed tank onshore. Even if the ship has a large enough nitrogen capacity, it should have proper connections to accept an outside source of nitrogen in case of system failure or emergencies.

LNG bunkering can begin only after the LNG fuel tank has been properly inerted, purged and cooled down. The tank is inerted with nitrogen gas. After inerting the tank, the inert gas is typically displaced with warm natural gas. Displacing the inert gas with warm natural gas is known as purging, gassing up or gas filling. The inert gas is either returned to the shore facility or vented. Venting of the inert gas is stopped when the natural gas vapors are detected. It should be confirmed with all agencies having jurisdiction over the bunkering operation whether the inert gas can be released into the atmosphere; some agencies may require that the inert gas be captured and stored or processed since it could contain natural gas. The tank is then gradually cooled in stages to the temperature of the incoming LNG. The cooldown process can be accomplished using cold natural gas and/or LNG.

This initial cooldown is typically done by spraying LNG into the fuel tank to slowly cool the piping, the tank and the gas in the tank. This is a slow process that uses a much lower flow rate than normal bunkering to ensure uniform cooling and minimize induced thermal stresses in the tank. The cooldown process may take several hours, typically 12 to 18 hours, depending on the size of the tank. The cooldown procedure is typically developed by the tank's manufacturer and includes directions for the use of the tanks spray nozzles and bottom filling. Once the tank is cooled to the specified temperature, continuous filling of the tank can continue to the desired level. Although the procedures and sequence of events will differ, the use of cold nitrogen gas and/or liquid nitrogen also is common for the cooldown process.

Draining and Stripping

The requirement to strip the LNG fuel tank prior to entry into a shipyard may vary worldwide depending on shipyard or port authority policies. Tank stripping can be accomplished by building up the tank pressure to force the LNG out of the ship's tank to another tank, or by using stripping pumps. Any liquid left in the tank after stripping can be removed by circulating warm methane vapor from the ship's vaporizer. After stripping, the tank will need to be inerted with nitrogen. If human entry and inspection is required, the tank has to be purged with fresh air to gas-free.

As specified in the ABS Gas Fueled Ships Guide, all LNG fueled ships also should have some means of emptying the fuel tanks without relying on the ship's own gas machinery system. This capability would allow another vessel or shoreside facility to empty and strip the LNG fuel tank for scheduled events or in case of an emergency where the tank could release gas.

Simultaneous Operations

Industry best practice expects SIMOPs during LNG bunkering to be the norm, as is the case for oil bunkering. SIMOPs will need to be reviewed to identify potential interactions and determine if any measures need to be implemented before the activity can proceed. In certain circumstances it may not be possible for a SIMOP to take place at the same time as bunkering.

SIMOPs can take place anywhere around the bunkering location, including on the receiving ship, on the bunker vessel, on the quayside, or in surrounding waters.

A leading industry body SGMF (Society of Gas as a Marine Fuel) defines SIMOPs as:

LNG bunkering plus one, or more, other activity and/or operation conducted at the same time where their interaction may adversely impact safety, ship integrity and/or the environment

LNG bunkering plus one, or more, other activities and/or operations where their interaction may adversely impact safety, ship integrity and/or the environment

For this guidance, "LNG bunkering" as an operation includes: lifting and placing of the bunker hoses using a mechanical handling device; connecting and leak testing; transferring LNG and managing vapour return; monitoring LNG tank pressures and temperatures; and purging and disconnection.

Cargo handling (even if it is LNG on an LNG carrier), bunkering of other fuels, loading of stores, passenger movements, maintenance and testing are all operations independent of LNG bunkering.

Planned SIMOPs (Regular & Non-standard):

- people/passenger/crew movements
- passenger/vehicle embarking/disembarking near LNG bunkering
- vehicle movements delivering passengers/crew/visitors
- cargo loading/unloading
- lifting of cargo from/to dockside to/from ship
- loading/unloading of heat generating or other hazardous cargoes operation of hatch covers
- loading/unloading of pumped cargoes and solid cargoes using conveyor belts that may create static electricity
- loading/unloading of cargoes that create noise and airborne dust
- loading supplies and removing waste
- service vessels/deliveries (for example, stores, port officials, oil bunkers, lube oils, crew change, laundry and garbage collection) port/ terminal activities
- construction and maintenance activities
- operation of local generators (sparking engines)
- hot work, welding, grinding or paint removal (using a blow torch)
- disposal of waste and rubbish by burning

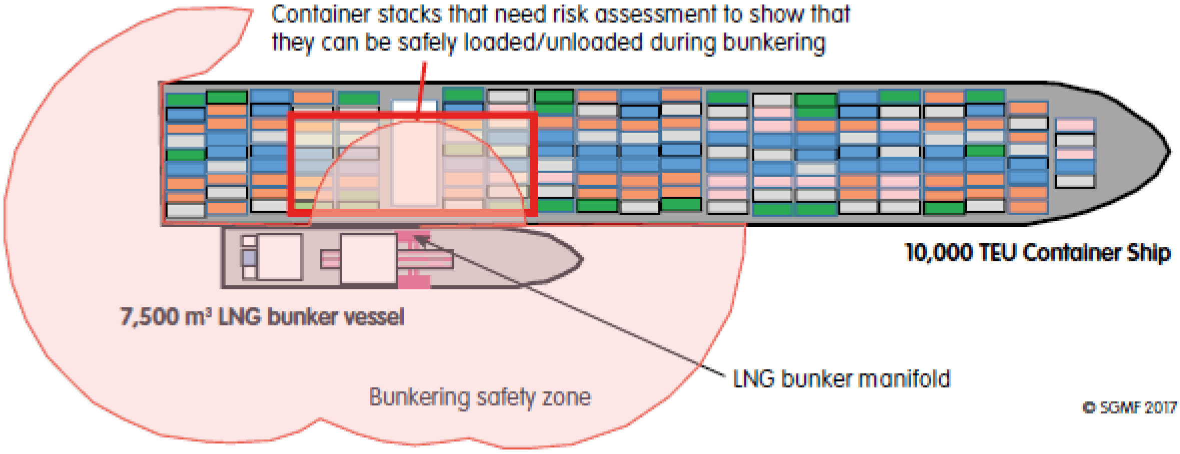
- vehicle movements
- monitoring of mooring lines, particularly between bunker vessels and gas-fueled ships
- maintenance, inspection and cleaning of vessel areas and equipment
- use of non-intrinsically safe electric or sparking machinery or tools
- testing of stabilization systems
- testing of high-power radio and radar systems
- testing of ballast water systems
- maintenance and testing of power generation systems (black-out concerns)
- maintenance and testing of control systems (full functionality not available/spurious alarms distract)
- testing of cargo equipment (cranes, conveyors, pumps, and so on)
- control system software upgrades (local or centralized systems)
- hold cleaning
- inspection of hull using divers
- maintenance and testing of non-intrinsically safe electrical equipment
- hot work, welding, grinding or paint removal (using blow torch), use of sparking tools
- cabin/common area cleaning
- life boat drills
- ballasting operations
- simultaneous bunkering with other fuels
- Dynamic Positioning (DP) system operation and/or testing
- helicopter operations

Safety Zones

SGMF defines the safety zone as:

The three-dimensional envelope of distances inside which the majority of leak events occur and where in exceptional circumstances there is a recognised potential to harm life or damage equipment/infrastructure as the result of a leak of gas/LNG.

The zone is temporary in nature, only being present during LNG bunkering. It may extend beyond the gas-fuelled ship/LNG road tanker/bunker vessel, interconnecting pipework, ISO containers, and so on. The bunkering safety zone is shown diagrammatically below.



The purpose of the safety zone is to minimise the risk of harm to people, impact on the environment and damage to equipment. This is achieved by controlling all activities that take place within the zone and observing and assessing the risks of activities within the monitoring and security area which, if left to continue without management, could subsequently impact the safety zone.

Typical control measures in the bunkering safety zone should include:

- excluding non-essential people and vehicle movements
- protecting staff through use of appropriate PPE
- avoiding (or controlling) ignition sources
- effective communication between the POAC/PIC(s) and all involved
- a method for quickly and effectively shutting down operations should an unplanned event occur

SIMOPs must not compromise these basic requirements for the safety zone. If additional personnel or activities are required, they must observe these control measures.

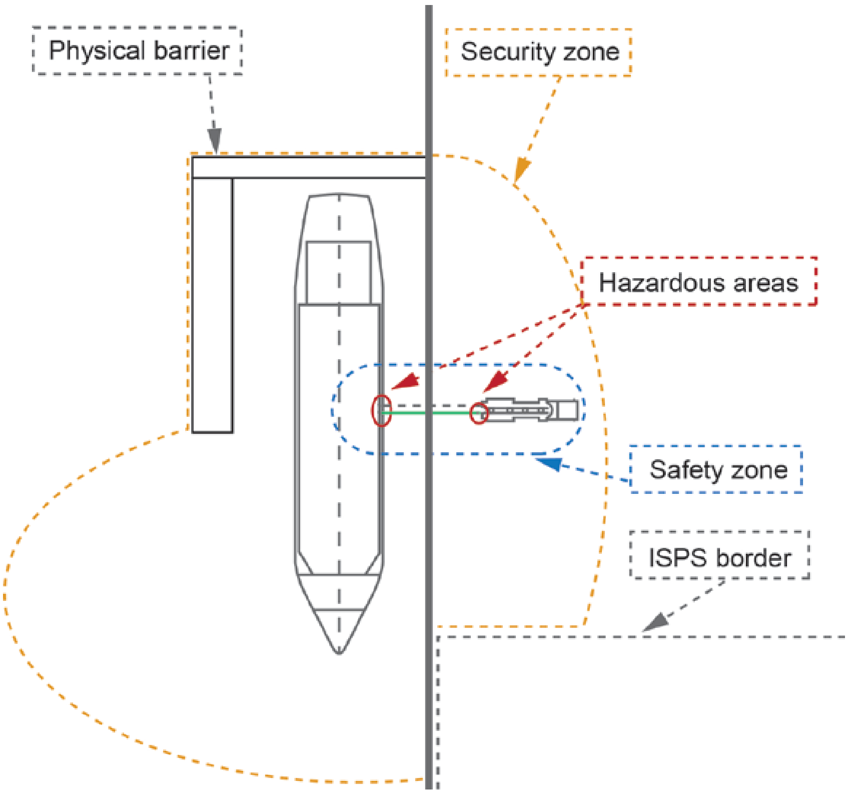
- areas of the deck where cargo will be loaded and where any cargo may be dropped
- hazardous zones around any non-intrinsically safe electrical equipment which may escalate another hazard
- the hazardous nature of some cargo's areas where untrained people and vehicles congregate

Security Zones

The purpose of the security zone is to create an area of sufficient size that keeps other vessels, vehicles, equipment, and cargo operations far enough away so that they pose little risk of damaging or interfering with the LNG bunkering system and equipment. This zone is intended to keep nonessential personnel far enough away so that injury by any hazardous incident during the bunkering operation is unlikely, and to make it difficult for a person to intentionally damage or interfere with the bunkering system and equipment.

The requirements regarding how to mark off the zones, what signs are needed, how to enforce the zones, which personnel can enter the zones, and what safety equipment and PPE are needed are to be specified in the operating manuals prepared for the bunkering operation.

Distances: The size of the zones depend on an assessment of the hazards and how they are affected by distance from the bunkering operation or other potential sources of gas release. Hazard levels decline as the distance from the source is increased and the distance at which the hazard probability is considered low enough to be accepted without special measures or precautions in effect can be determined by several means. The hazard identification and risk assessment processes are normally where the distances will initially be set, as they should fully explore the hazards to be encountered.



Bunker Stations

Much like oil fueled ships, LNG fueled ships will have bunker stations allowing the ship to refuel through hoses from either a shoreside facility, truck or a small LNG bunker vessel or barge. The bunker station provides connections to the ship's fuel gas system and fuel tanks to allow loading of LNG fuel and, in some cases, return of displaced vapor from the fuel tanks. Due to the additional hazards present with LNG, the requirements and capabilities of bunker stations on LNG fueled ships are more complex than for oil fueled ships. The following describes the primary considerations for LNG bunker stations.

Location: Bunker stations present risks for allowing LNG and vapor to escape into the atmosphere, potentially creating a flammable mixture with air. The location of the bunker station is a critical factor for determining the level of risk associated with the ship's bunkering operation and arrangement. The location will be considered a hazardous area.

Outfitting: Depending on the location of bunker stations, certain additional outfitting requirements may exist. For example, on certain types of ships bunker stations are located below the weather deck. These normally require a suitable watertight door in the side shell, which prevents waves and weather from entering the space, but can be opened to allow the ends of the bunker hoses to enter the bunker station. Furthermore, an air lock may be required to separate the bunker station from adjacent non-hazardous areas.

Ventilation: Proper ventilation of bunker stations is necessary to remove any vapors released during bunkering operations. For bunker stations located within the ship's hull or elsewhere that is not an open deck, a forced ventilation system may be required.

Gas Detection: Permanently installed gas detectors are provided for enclosed or semi-enclosed bunker stations in order to detect the release of methane vapors.

Controls: The controls for bunkering operations may be remotely located from the manifold area.

Bunker Piping Systems

The bunker piping system consists of LNG transfer pipes and, in some cases, vapor return pipes between the bunker station and the fuel tank. The following describes the main considerations for LNG bunker piping.

Flow Rates: Bunker pipes are sized according to the design flow rates through the system. The design flow rate is based on the LNG fuel tank capacity, pressure, temperature and other factors, such as vapor return capability, flow velocity limits and bunkering time window. The flow rate is also dependent on the achievable bunkering rate from the bunker vessel or shore facility.

Some vessels may require a shorter bunker time than others depending on their operating profile. Depending on the size of the fuel tanks and frequency of bunkering, owners may wish to maximize the bunker rate. A vapor return from the receiving tank back to the supplier's tank may help achieve a higher flow rate. Pre-cooling the LNG fuel tank before bunkering and other methods discussed in detail later in this Advisory can help to achieve the highest flow rate possible.

Pipe Materials, Fitting Joints, Deck and Bulkhead Penetrations: All LNG system pipe components that could come in contact with LNG must be suitable for cryogenic temperatures. This includes all pipes, valves, fittings, penetrations, etc. It is important to minimize the number of pipe joints in order to minimize the potential for leaks. This is achieved by using welded connections wherever possible. For all joints located in areas where leaking LNG can cause damage to the ship's structure, drip trays and spray protection should be provided with suitable containment capacity and constructed of a material that is suitable for LNG, typically stainless steel.

Pipes, valves, and other fittings used for handling LNG should have a minimum design temperature of -165°C (-265°F). Typically, these pipes are stainless steel and have to pass an impact test at a colder temperature than the design temperature.

To protect the crew from exposure to extreme cold, and to minimize heat influx and subsequent warming of the LNG leading to potential boil-off while bunkering, the bunker lines are typically insulated. Rigid foam or other types of insulating materials may be used, or the pipes can be vacuum insulated.

Bunker Hose Fittings: Presentation flanges at the bunker manifold are not yet standardized for gas fueled ships, but LNG connections are expected to be significantly different than those for other service, such as potable water, diesel fuel oil, oily waste, etc., so that it is impossible to connect hose fittings for other services to the LNG and vapor connections. ISO/TS 18683:2015 indicates bunkering systems are to be designed to connect to a standard ANSI flange and also provides informative annexes on the presentation flange and dry-disconnect coupling geometry. Furthermore, ISO has reported to the International Maritime Organization (IMO) that it will develop a standard for ship LNG connectors to be published in time for entry into force of the IGF Code.

Pipe Routing: According to classification and regulatory requirements, LNG and vapor piping may not pass through accommodation spaces, service spaces, or control stations, but they can pass through certain enclosed spaces, such as machinery spaces, if the pipes are either double walled or installed in a ventilated pipe or duct.

In the case of double-walled piping, the arrangements consist of two concentric pipes with the inner pipe used for LNG or vapor transfer. The space between the concentric pipes is pressurized with inert gas at a higher pressure than the maximum pressure in the inner pipe. A monitoring system with alarms is fitted to detect a loss of inert gas pressure, thus indicating a leak in either of the concentric pipes.

The typical ventilated pipe or duct method consists of the LNG or vapor pipe(s) located inside of a larger pipe or duct. The air space between this outer pipe or duct and the LNG/vapor pipe(s) is provided with mechanical exhaust ventilation with a capacity of at least 30 air changes per hour. The volume of one air change is equivalent to the total volume of the air space for the full length of the pipe or duct. The ventilation system maintains the air space pressure below atmospheric pressure so that a leak in the inner pipe, outer pipe or duct, or both will not allow natural gas to enter the non-hazardous space. A monitoring system with alarms is fitted to detect natural gas in the air space between the inner and outer pipes, thus indicating a leak.

Emergency Shutdown System (ESD):

The ESD system is critical to the safety of the vessel and is typically a hardwired system. The ESD system is to be fitted to stop bunker flow in the event of an emergency. Generally, the ESD system is activated by manual and automatic inputs. The ESD system is to be tested prior to each bunker operation.

The bunkering facility and receiving ship should be fitted with an ESD system so that any activation of the ESD systems would be implemented simultaneously on both the bunkering facility and receiving ship. Any pumps and vapour return compressors should be designed to take into consideration the surge pressure in the event of ESD activation. A physical ESD link should connect the two parties.

The bunkering line should be designed and arranged to withstand the surge pressure that may result from the activation of the ERS and quick-closing of the ESD valves.

On ESD activation, manifold valves on the receiving ship and bunkering facility and any pump or compressor associated with the bunkering operation are to be shut.

An ESD activation should not lead to LNG being trapped in a pipe between closed valves. An automatic pressure relief system is to be provided that is designed to release the natural gas to a safe location without release to the environment.

If it is not demonstrated to be required at a higher value due to pressure surge considerations, a suitable closing time of up to 5 seconds should be selected, depending on the pipe size and bunkering rate from the trigger of the alarm to full closure of the ESD valves, in accordance with the IGF Code.

The manual activation position for the ESD system should be outside the bunker station and should have a clear view of the manifold area (the 'clear view' may be provided via CCTV). There should also be a manual activation at the bridge/control station.

LNG bunker transfer should not be resumed until the transfer system and associated safety systems (fire detection, etc.) are returned to their normal operating condition.

Emergency Release System

The transfer system should be capable of being disconnected rapidly using an emergency release system (ERS), the ERS includes the necessary valves that will close automatically upon activation to minimise the release of LNG natural gas and to minimise damage to the system due to ships drifting or vehicle movement. The ERS may be one of two types, active or passive.

Active systems utilize an Emergency Release Coupling (ERC) and activation of the release is coordinated with the ESD. The ERC may be triggered either by use of an emergency operation button or automatically in the event of an ESD2 protocol being reached.

The means of remotely operating the ERC should be positioned in a suitability protected area allowing visual monitoring of the bunkering system operation.

Passive systems consist of a dry breakaway coupling that releases when the forces applied to the coupling exceed a threshold value. Where this type of ERS arrangement is fitted an ESD link may be used so that the ESD is triggered before the forces applied to the dry breakaway coupling reach the level where the coupling disconnects.

The dry breakaway coupling used in the transfer system needs to be suitably certified for the range of loads likely to be exerted on it during the bunkering operation.

The dry breakaway coupling should be configured within the transfer system so that, in the worst allowable conditions for current, waves and wind, it will not be subjected to excessive axial and shear forces likely to result in the loss of tightness or opening of the coupling. When the safe working envelope of the transfer system is exceeded, the dry breakaway coupling should operate.

Care should be taken that, in the event of an ERS disconnection, the backlashing hoses do not harm people or equipment at the manifolds. During the bunker transfer operation personnel should not be in the vicinity of the ERS in case of sudden activation.

Full operating instructions, testing and inspection schedules, necessary records and any limitations of the ERS should be detailed in the ship's operating manuals.

Operational Equipment

Fendering, Vessel Separation and Cryogenic Spill Protection: Where required, a fender system should be provided to maintain separation and prevent damage to the receiving ship or the supplier's facility. Bunker vessel's mooring lines and fenders should be insulated such that an arc cannot pass between the two vessels. If an arc is allowed to occur, it could ignite any LNG vapor that escaped or was vented while bunkering. The supplier should be equipped with drip trays and water curtains as necessary to prevent damage occurring from cryogenic liquid spills. The supplier's facility also should be designed such that leaks, or spills will not be directed onto the receiving ship's structure.

Bunker Hose and Fittings: Typically, the bunker hose is expected to be provided by the supplier. It should be suitably long and flexible, such that the hose can remain connected to both the supplier's manifold and the receiving ship's manifold during normal relative movements expected from wind, waves, draft changes, current, and surges from passing vessels. Typically, bunker hoses are constructed of composite materials and are flexible to allow for relative movements. The supplier should provide a bunker connection at the hose end that will match the receiving ship's connection. Although industry standardization has not yet been implemented, ISO/TS 18683:2015 references relevant standards.

Additionally, the hose should be capable of releasing without damage or significant spills if the relative position or movement of the receiving ship exceeds the limits. LNG bunker hoses are typically fitted with connections that are of the quick connect type and remain sealed until the connection (drip-free type) is made. The receiver's end of the hose also will usually be fitted with an emergency release system (ERS), such as a drip-free, breakaway coupling that gives way before excessive pull causes the hose to break or other damage to occur. This type of coupling uses spring loaded shutoff valves to seal the break and stop any LNG or vapor release. Quick connect and break-away couplings are readily available in the market and minimize the possibility of LNG leakage and gas escape.

Hose Handling: The LNG and vapor hoses are typically supplied and handled by the bunker vessel or shoreside bunkering facility with the assistance of the receiving ship's crew. The bunker vessel or facility may have a hose handling crane or boom which can lift the end of the hoses to the receiving ship's bunker station. For ships with bunker stations located unusually high above the waterline, it may be necessary for the ship to be fitted with a davit or crane which can be used to raise the end of the bunker hoses to the bunker station.

Bunker Loading Arms: Instead of bunker hoses, loading arms may be used for transferring LNG to the receiving ship. Loading arms generally consist of a rigid structure with swivel joints to allow for articulation of the LNG connection and relative movements between the receiving ship and the supplier and may include a powered emergency release system. LNG fluid can pass through either a flexible hose supported within the arm or solid pipes with swivel joints. Loading arms will typically be more mechanically automated and eliminate some of the handling issues that are present with hoses but loading arms can induce higher reaction forces on the bunker manifold that need to be considered in the design of the bunker station.

Monitoring and Control: Typically, both the supplier and the receiving ship will have an emergency shutdown system. A complete emergency shutdown should be possible to initiate from either the receiving ship or the supplier. The supplier's and receiver's tanks will both have separate monitoring systems, but constant communication via radio or other methods should be available at all times.

Fire Protection: The bunker supplier should have an appropriate firefighting system or equipment as required by governing regulations. Typical systems included portable and fixed dry chemical systems and/or fixed water spray systems. Different regulations for these systems will apply depending on if the supplier is a manned vessel, unmanned barge, tank truck, fixed installation onshore, etc., and may be dependent on the bunkering arrangement.

Inerting and Purging Requirements for Hoses and Pipes: Before bunkering begins, the hoses and associated pipe should be inerted with nitrogen gas and then purged with LNG vapor. After each bunkering, the hoses and associated pipes should be purged with LNG vapor and then inerted with nitrogen. Depending on the arrangement and capabilities of the receiving ship and the supplier, this can be done separately or while the bunker hose is connected to both manifolds. The requirements for inerting and purging should be determined before the bunker hoses are connected.

Ignition Sources, Safety Zones and Vent Mast Locations: All sources of ignition in the vicinity of the bunkering operation need to be eliminated before bunkering. To ensure this, a safety zone is established around the bunkering operation. Access near the bunker station and other high risk areas should be blocked to all passengers and non-essential crew before, during, and after bunkering, as necessary. Cargo operations should be suspended until bunkering is completed unless permitted by the SIMOPS arrangements. During bunkering, the bunker vessel should be positioned such that its vent mast is not near any openings on the receiving ship, or if mobile tanks are used they should be positioned such that any leaks will vent away from critical locations or openings on the receiving ship. If this is unavoidable due to the arrangements of the receiving ship, then these openings should be secured while the bunker vessel is alongside the receiving ship.

Lighting, Platforms and Other Outfit: The supplier should arrange adequate lighting to create a safe working environment. If adequate lighting cannot be provided at night or during inclement weather, bunkering should be postponed until suitable daylight exists. On bunker vessels, platforms and ladders should be placed to allow easy access to all required bunker connections, valves, and controls. Both the supplier and the receiving ship should have all necessary safety equipment and other gear available and ready for use before beginning the bunkering procedure.

Personal Protective Equipment: All personnel involved directly with LNG handling operations should wear personal protective equipment (PPE) including gloves, face protection and other suitable clothing to protect against LNG drips, spray, spills, and leaks. PPE is also required to protect against skin damage caused by contact with the cold pipes, hoses, or equipment. Although no standard exists for required PPE during bunkering procedures, guidance is provided by SIGTTO and others. Material Safety Data Sheets (MSDS) identify LNG health hazards and provide guidance for PPE, LNG handling, first aid, firefighting measures and firefighting equipment.

Mooring

It is the responsibility of the Master(s) to ensure that the vessel(s) is/are securely moored in accordance with greed/approved mooring plans. The following should be taken into account:

- Wind
- Current/tides
- Waves/swell
- Surges from passing ships
- Ice and changes in draught, trim or list

Lines, fenders, winches and other mooring equipment should be visually checked for wear or damage.

The receiving ship should be securely moored to the bunker supplier to prevent excessive relative movement during the bunkering operation.

For ship-to-ship bunkering the bunker ship should be securely moored according to the result of the compatibility check, so that excessive movements and overstressing of the bunkering connections is not possible.

For the mooring of the bunker ship the limiting conditions should be considered such as weather, tide, strong wind, waves and current.

Bunker Operations

It is important to note that LNG bunker procedures may vary greatly between projects, ships, and bunker facilities. The use of standardized procedures and checklists from existing projects may be helpful as guidance. However, vessel-specific procedures for the bunkering operation should be developed to include any characteristics or features that are unique to the particular bunkering facility and receiving vessel or location.

Before Transfer:

The following requirements should be considered during the pre-bunkering phase:

- The risk assessment has been conducted and the findings have been implemented
- An LNG Bunker Management Plan has been established and is applicable to the ship, the LNGBMP is to include:
    - Compatibility assessment
    - Emergency response plan
    - Safety instructions and training

Note: A compatibility assessment demonstrates that the safety and bunkering systems of the bunkering facility and the ship to be bunkered match, the LNGBMP is normally completed at the planning stage long before initiation of any particular bunkering operation, elements of the LNGBMP should be updated if the bunkering operation differs from the one that was originally planned. For example: change in equipment, method, facility arrangements or process.

- The necessary authorities have been informed regarding the LNG bunkering operation
- The permission for the transfer operation is available from the relevant authority
- SIMOPS information including the requirement that risk mitigation is exchanged
- The boundary conditions such as transfer rate, boil-off handling and loading limit have been agreed between the supplier and the ship to be bunkered
- Initial checks of the bunkering and safety system are conducted

The following should be agreed before commencing the bunker transfer:

- Transfer time, temperature and pressure of the delivered LNG, pressure inside the receiving ship's tank, delivery line measurement, vapour return line measurement (if any) should be agreed and checked prior to engaging in any LNG bunkering operation

- The maximum LNG temperature that the receiving ship can handle should be stated by the receiving ship in order to avoid excessive boil-off generation

- Liquid levels, temperature and pressure for the LNG bunker tanks of the receiving ship should be checked and noted on the bunkering checklist

- The maximum loading level and transfer rate, including cool down and topping up should be agreed upon, including the pressure capacity of pumps and relieving devices in the connected transfer system. The filling limit of the receiving tank depends on MARVS (as per IGC/IGF codes) and accounts for the possible expansion of cold LNG

- The agreed transfer conditions should be included in the LNG bunker management plan.

Compatibility Assessment

A compatibility assessment of the bunkering facility and receiving ship should be undertaken prior to confirming the bunkering operation in order to identify any aspects that require particular management. The compatibility assessment should be undertaken with the assistance of an appropriate checklist to be completed and agreed by Master(s) and PIC prior to engaging in the bunkering operation.

The compatibility assessment will usually be separated into items that need confirmation only once for each bunkering scenario that need to be confirmed well in advance of the bunkering operation and those that need to be confirmed for each bunkering operation.

As a minimum, the following should be checked prior to engaging further in any LNG bunkering operation:

- Have the regulating authority, bunkering facility/Bunker Organisation and receiving vessel agreed and harmonised their safety and emergency response plans?

- Are written operational procedures available for all parties?

- Have the actions from the risk assessment been handled and closed out?

- Can the operation be carried out without a release of gas to atmosphere?

- Compatibility of the communication system (hardware, software if any, signals and language) between the PIC, ship's crew and Bunker Organisation personnel

- ESD system: the compatibility of different types and makers of equipment, the possibility of testing prior to engaging in the bunkering operation, the handling of potential trapped volume of LNG/gas after an ESD agreement

- Will it remain so for the duration of the bunkering operation? (This should allow for consideration of concurrent cargo/ballasting operations and the potential change in draught when the fuel is bunkered.)

- Bunker envelope:

    - Checking that the hazardous areas between the receiving vessel and the bunkering facility's mutual footprint. It might be necessary to impose additional restrictions during bunkering to take into account a potential release of gas through vent masts in emergency situations

    - Checking that the hazardous, safety and security zones lie within those approved and enforced by local/national regulators

- Bunker connection: ensure the connection compatibility of different types and makers of equipment, ensuring that the whole transfer chain meets relevant ISO standards, including electrical isolation and anti-static principles

- Emergency release system (ERS): ensure that the procedure is mutually agreed, that systems are in place and connected
- Vapour return line when appropriate: have vapour management procedures been agreed to avoid any release to the atmosphere?
- Nitrogen lines availability and connection
- Mooring equipment and mooring configuration: are mooring arrangements acceptable, according to the mooring plan?
- Bunker station location
- Transfer system sizing and loading on the manifold: is the height difference between the manifold of the receiving vessel and the bunker supplier within the operational range of the bunker hose/loading arm arrangement?
- Location of ERS
- Closure speed of valves
- Must the transfer system be leak-tested before transfer begins?
- Are there physical safeguards in place to prevent inadvertent connection of liquid to vapour or vapour to liquid lines?
- Is there an agreement to conduct simultaneous operations (SIMOPS)?
- HAZOP results as applicable: in particular SIMOPS, uncontrolled sources of ignition and possible dropped objects
- Have the LNG transfer profile (ratio/time) and vapour management schedules been agreed?
- Are the receiving tank volume and temperature prior to bunkering within acceptable limits?
- Are properties of the LNG to be supplied acceptable (temperature, pressure)
- Have tidal motions and change in freeboard during the planned bunker operation been observed?
- Have acceptable weather limits — such as wave length, wave height, current, tide, wind speed and weather forecast (lightning and so on) — been determined?
- Are there any conflicting operations in port or at anchorage, according to port authorities and the Vessel Traffic Service (VTS)?
- Are cryogenic protections systems — such as water curtains and insulated hose saddles — compatible?
- Have the safety and emergency protocols been agreed (safety and security zones)?

Communications

A communication system with back-up should be provided between the bunkering facility and the receiving ship. Agreed working channels for communication should be tested before the transfer operation begins.

There should be at least two reliable and independent means of communication available at all times during bunkering operations. No transfer operations are to begin until effective communication has been confirmed by all the parties involved.

If communications fail, all bunkering operations should be suspended immediately and not resumed until communication has been reestablished. Communication failure is defined as any situation resulting in fewer than two functioning means of communication.

The electrical components of the communication system located in hazardous and safety zones should be type approved according to IEC60079.

The language to be used during the bunkering process should be agreed between all parties before operations begin.

Equipment for non-verbal communication should be robust and reliable. The signs and symbols to be used should be agreed by all parties before bunkering begins.

During transfer:

The bunkering phase begins after the physical connection between the bunkering facility and the receiving ship's bunker station has been safely completed and with the opening of the LNG transfer valve from the bunker ship, the truck tanker or the onshore bunkering facility.

It continues with the cooling down of the transfer line followed by the LNG bunker transfer and ends at the end of the topping up phase and the closure of the LNG valve from the bunkering facility.

- Monitor tank levels.
- Monitor tank pressures and temperatures.
- Monitor pump transfer rates.
- Adjust pump flow rates as necessary.
- Adjust top spray and bottom fill rates as necessary to control tank pressure.
- Adjust mooring lines and bunker hoses and arms as necessary.
- Monitor that the integrity of security and safety zones is maintained. Monitor that weather and sea conditions remain within limits.

After transfer:

The post bunkering phase begins once the bunker transfer (final topping up phase) has been completed and the bunkering facility LNG delivery valve has been closed. It ends once the receiving ship and bunkering facility have safely separated and all required documentation has been completed.

- LNG transfer stops.
- LNG in lines is allowed to vaporize and displace the remaining liquid back to the tanks.
- Supplier and receiver inert all bunker lines and bunker hoses utilized during the bunker operations.
- Supplier's bunker hoses, communications, monitoring, ESD and electrical isolation or bonding connections are disconnected from the receiving ship's manifold.
- Receiving ship unmoors from the quay or pier, or bunker vessel unmoors from the receiving ship and notifies port authority

Appendix B details an example of a bunker transfer manual from an LNG Bunker vessel currently in service.

Emergency Procedures

Emergency response planning and preparedness are critical to protect personnel, the environment, the public and assets during an incident. In addition to the typically required emergency response plans aboard the ship, specific plans relevant to an emergency involving the LNG system and bunkering operations also should be developed and implemented.

Emergency procedures can be classed as 'higher level' and 'lower level'. Higher level procedures are intended to provide general instruction to all relevant personnel, while lower level procedures are more specific to certain incidents, areas aboard the vessel, or equipment. The emergency procedures are intended to provide guidance and direction on how to carry out an organized and effective response to an incident, which may include LNG spill and/or gas release, fire or other hazardous situation. Some possible incidents that directly affect bunkering are loss of power by the supplier or receiver, non-LNG related fire near the bunkering, unexpected breakaway of one of the vessels, etc. Emergency procedures also should exist for other external incidents not directly related to the bunkering, such as a fire or gas release on a quay, pier or bunker vessel. Other emergency procedures should handle incidents relating to injury sustained by personnel involved in bunkering, such as frostbite induced by contact with extremely cold LNG or equipment.

It is important that personnel from both the supplier and the receiving ship are familiar with and trained in the emergency procedures and have access to them at all times. The training, drills, and exercises should ensure that all involved personnel understand the procedures, their role and responsibilities, and the use of the emergency response equipment available at the supplier and aboard the receiving ship.

The emergency procedures can be updated to reflect lessons learned from previous incidents or exercises or to reflect any modifications made by the supplier or receiving ship. SIGTTO and other agencies have developed numerous publications specifically related to the hazards of LNG which can be referenced when developing emergency response procedures.

Appendix C details an example of a bunker vessel's emergency response plan.

Crew Training & Certification

Proper crew training is essential to promote safe LNG bunkering practices. Those involved with bunkering should receive comprehensive, formal training, including emergency response training to deal with conditions of leakage, spillage, or fire and first aid training specific to LNG. The courses will generally cover basic training for all ship's crew and more advanced training for the ship's crew responsible for handling LNG and operations associated with LNG. Crew training courses for LNG handling typically could take three to five days. The courses should cover LNG fundamentals, hazards, safety, fire prevention and firefighting and person-in-charge responsibilities and procedures.

Checklists

Part of the LNG bunker operation includes the completion of checklists before and after bunkering by the persons-in-charge. The checklists serve to ensure that all requirements for bunkering have been completed in the correct order. Checklists should be specifically developed for each receiving vessel in accordance with the regulations and circumstances applicable to that vessel and the expected type of bunker supply and bunker location. The following lists items that are typically included in LNG bunker operation checklists. It is for illustration purposes and for actual bunkering a more detailed list may be required. ISO/TS 18683:2015 has some detailed checklists for reference in its appendices.

Before Bunkering:

1. Verify all required notifications were issued and permissions received from port authorities.

2. Confirm that the bunker operation security and safety areas have been established and only required personnel are present within their boundaries. Confirm all required separation distances to at risk locations are in place.

3. Confirm that all accessible portions of the bunker piping system and equipment to be used have been inspected and worn or inoperable parts replaced.

4. Review and agree with the supplier's person-in-charge as to:

    a. The sequence of transfer operations

    b. The transfer rate and transfer quantity, plus which tanks are to be filled

    c. Compatibility of the hazardous zones between the supplier and receiver

    d. The duties, location and watches of each person assigned for transfer operations

    e. Methods of inerting and purging bunker lines and handling of any nitrogen used in the inerting process

    f. Method of handling vapor in the receiving tanks

    g. Emergency procedures

    h. Pressure, temperature, and volume of supplier's tanks and confirmation they are safe for transfer to the receiving ship's tanks

5. Confirm that the transfer connections (hose or arm) can allow the ship to move to the limits of its moorings without placing strain on the manifolds.

6. Confirm proper fit up of bunkering connection.

7. Confirm that all vessels are properly moored and that adequate measures are in place to account for changes in tides, winds, and currents, and for any surges.

8. Confirm that weather and wind are within allowed criteria and that the forecast over the bunker time period confirms they will remain so.

9. Confirm proper lighting of the bunkering operation, including all bunker lines, is in place to allow visual checks.

10. Confirm that all ignition sources in the bunker operations areas and any other hazardous areas (e.g., around tank vents) have been eliminated.

11. Confirm all openings to non-safe interior spaces are closed.

12. Confirm that drip trays and water curtains are in place and operable.

13. Confirm all required personnel are in place according to the LNG fuel transfer system operations manual. All personnel are wearing any required PPE.

14. Confirm language fluency.

15. Confirm firefighting equipment is ready for use.

16. Confirm electrical isolation or bonding is in place.

17. Confirm the following systems have been tested and operate properly in accordance with the operating procedures:

    a. Sensing and alarm systems

    b. Emergency shutdown (ESD) system

    c. Communication systems

18. Confirm the receiving vessel bridge has been informed that the bunkering operation is about to commence.

During Operations:

1. Continuous communication is possible with the supplier's person-in-charge.

2. Inspect all accessible portions of the bunker piping system and equipment for leaks, defects and other issues at regular intervals.

3. Monitor that level and pressure gauges in the receiving tanks continue to function and that levels and pressures remain within allowed values.

4. Monitor that the integrity of the safety and security zones is maintained.

5. Ensure bunkering is stopped and hoses properly disconnected upon notification or detection of electrical storms, high winds, or other contingencies identified in the emergency manual.

After Bunkering:

1. Confirm tank levels are within the allowable loading limit and the custody transfer is agreed.

2. Confirm bunker hoses, manifold, and piping are properly drained and free of residual LNG.

3. Confirm bunker hose is properly inerted prior to disconnecting.

4. Confirm all communications, monitoring, ESD, electrical isolation or bonding connections are safely disconnected and secured.

5. Confirm bunker manifold connections are securely blanked.

6. Confirm port authority has been notified of bunkering completion.

Ships Safety Management System

All vessels which operate for Shell must have a Safety Management System which addresses the following areas:

- Safety and environmental protection policy
- Company responsibilities and authority
- Designated person(s)
- Master's responsibility and authority
- Resources and personnel
- Development of plans for shipboard operations (includes Risk Assessments)
- Emergency preparedness
- Reports and analysis of non-conformities, accidents and hazardous occurrences
- Maintenance of the ship and equipment
- Documentation
- Company verification, review and evaluation

Regulatory Framework

Bunkering with LNG is a new process that presents a number of unique risks and hazards not seen with oil fuel bunkering. For that reason, most regulatory organizations having jurisdiction over vessel design, operation, and bunkering are focusing their attention on it. Many new regulations and requirements are being developed and implemented, so keeping abreast of the regulatory framework is important to anyone involved with LNG bunkering.

The primary organizations that will be involved with reviewing LNG bunkering system designs and arrangements, as well as possibly the fueling procedures, are as follows.

Classification Societies

Classification societies, such as ABS, DNV or LR, will have a major role in reviewing the design and construction of LNG bunkering systems on board gas fueled vessels (receiving ships) and any LNG bunker vessels. Besides reviewing the design and surveying construction according to its own Rules and standards, class societies may be the reviewing organization for compliance with national and international regulations on behalf of the flag Administration and some port States.

ABS have prepared classification requirements for vessels that will adopt LNG as fuel. ABS developed a report, Bunkering of Liquefied Natural Gas-fueled Marine Vessels in North America, that can be used as a reference for understanding the regulatory framework. The detailed report provides an overview of LNG supply in North America and the regulations and requirements that apply to bunkering operations in both the United States and Canada.

Flag Administrations

Flag Administrations, such as the USCG, the UK Maritime and Coastguard Agency (UK MCA), and other national maritime agencies, have primary responsibility for enforcing international and national regulations related to the bunkering systems, processes, and procedures. International regulations are primarily those issued by IMO. National regulations apply to vessels registered in that country. Most of the nations where LNG fueled vessels will be actively operating have developed or are in the process of developing national regulations. National regulations can be more restrictive than class Rules or international regulations. Some flag Administrations may delegate all or part of their review and approval process to classification societies, while others will carry out the review and approvals themselves.

Port States

Port States are actively involved in the LNG bunkering process because they are the locations where the actual bunkering process will take place and, thus, any of the risks to life, environment, and property will be borne in their waters. The port State will have primary jurisdiction over any land-based facilities that may be part of the LNG bunkering process. Port State regulations will likely cover more parts of the bunkering process than either class Rules or flag Administration regulations. For example, port States could include requirements on the actual bunker procedure, locations where bunkering is permitted, restrictions on bunkering times and weather conditions, simultaneous cargo operations, bunkering supply facility, training, required documentation, acceptability of risk assessments, permits, etc. Since port States (and local jurisdictions within the port State, such as port authorities, harbor masters, and local and regional governments) can have a broad authority over the bunkering process it is important to determine early on which ones will be involved, particularly at the local or port level.

Required Approvals

Classification societies, flag Administrations and port States will likely each require review and approval of some aspects of the receiving gas fueled vessel and/or the bunker supplier. The flag Administration and port States are also likely to require the review and approval of the LNG bunkering procedures. The approval process has the potential to be far more extensive than for oil fuel bunkering because of the additional complexity and hazards encountered with LNG. In order to reduce the risks for major design changes and delays, it is critical that the approval process be initiated early on in the development of a project involving an LNG fueled vessel or an LNG bunkering supply facility or vessel. Design details and operating procedures may be specific to a variety of different bunkering scenarios, bunkering vessel types and bunkering locations, so the preparations for the approval process may need to be quite comprehensive. Detailed consultation and collaboration with the classification society and the regulatory organizations are recommended. All parties involved in the project development should be prepared to submit detailed designs, reports, analyses and procedures to the multiple reviewing organizations.

International Maritime Organization (IMO)

The IMO has the primary responsibility for the development of requirements for ships involved in international voyages. There are specific references that apply to LNG fueled vessels in the two primary IMO regulations applicable to vessels – SOLAS and MARPOL. But the primary regulations addressing vessels that have LNG on board are found in the IMO Codes and Guidelines identified as follows.

IGC Code: The International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) is the primary code for LNG carriers. The IGC Code is applicable to any internationally trading bunker supply vessel to which SOLAS is applicable or when required to be applied by class, national or port regulations. It is not applicable to vessels that carry LNG as engine fuel only. However, it provides criteria for LNG carriers using LNG cargo boil-off as fuel and has been used as guidance in the development of rules and regulations intended to be applied to LNG fueled vessels. The IGC Code has been in effect for many years and reflects the knowledge gained from years of safe and reliable LNG transport across the oceans.

MSC.285(86): In June 2009, IMO issued resolution MSC.285(86) as an interim measure to provide guidance for the first LNG fueled vessels. The resolution is voluntary and may or may not be utilized by flag States. Pending the adoption of the IGF Code, it is the pertinent IMO guidance. It contains criteria on the design, construction, arrangement, safety, and operation of LNG fueled vessels for use by flag Administrations. There are no specific requirements for the LNG bunkering operation, but the hardware and systems used for bunkering are covered.

IGF Code: The International Code of Safety for Ships using Gas or Other Low Flashpoint Fuels (IGF Code) is currently being developed by IMO. The IGF Code will replace the current IMO guidance document (MSC.285(86)).

ISO 28460:2010 Petroleum and natural gas industries — Installation and equipment for liquefied natural gas — Ship-to-shore interface and port operations.

OCIMF Effective Mooring 3rd Ed. ISBN 13: 978-1-905331-65-9

ISM (International Safety management) Code: means the International Management Code for the Safe Operation of Ships and for Pollution Prevention adopted by the Organization by resolution A.741(18). This is a mandatory safety standard which shall be implemented for all vessels greater than 500 gross tons.

ISO/TS 18683:2015: An ISO technical specification titled Guidelines for Systems and Installations for Supply of LNG as Fuel to Ships was released in January 2015. It describes the properties of LNG, the safety hazards, the risk assessment process, and the functional requirements for LNG bunkering systems. While ISO/TS 18683:2015 is not specifically a standard or regulation, it is expected to be cited in many national and local regulations. Under direction from IMO, ISO has indicated that a standard for LNG bunkering connectors will be developed for publication at the same time the IGF

Code enters into force.

United States: In the USA, the USCG is the lead agency with oversight over LNG fueled vessels and LNG bunkering. It has issued several documents pertinent to bunkering:

1. Policy Letter CG-521 01-12: Equivalency Determination – Design Criteria for Natural Gas Systems. This document supplements the recommendations contained in the IMO resolution MSC.285(86) with USCG interpretations and supplementary requirements. It is applicable to US flag LNG fueled vessels and is relevant to LNG bunkering by covering the bunkering equipment and systems on the receiving vessel.

2. Policy Letter CG-OES 01-15: Guidelines for Liquefied Natural Gas Transfer Operations and Training of Personnel on Vessels using Natural Gas as Fuel. This policy letter provides USCG guidelines for LNG transfer operations and training of personnel working on US and foreign flagged vessels. It includes guidance on the required manuals, equipment and systems, as well as crew responsibilities and training.

3. Policy Letter CG-OES 02-15: Guidance Related to Vessels and Waterfront Facilities Conducting Liquefied Natural Gas (LNG) Marine Fuel Transfer (Bunkering) Operations. This policy letter focuses on the safety aspects of the LNG transfer (bunkering) operation and provides safety and security recommendations for the supplier. It covers transfer operations that are from vessel to vessel, from mobile tank to vessel, and from waterfront facility to vessel that occur in the USA.

These policy documents serve as guidance for USCG Headquarters and Sector reviews of proposed gas-fueled vessels, bunkering facilities and bunkering operations until the final regulations are developed and approved.

Europe: The use of LNG as vessel fuel in non-LNG carriers was developed first in Europe, particularly in Norway. Regulations and requirements for LNG bunkering in the early projects in Norway were developed on a case by case basis. Reference was made to the guidelines and standards for LNG cargo transfer and to risk assessments for the planned bunkering operation.

Currently, in some places in Northern Europe LNG bunkering is a daily occurrence, including bunkering taking place with simultaneous cargo and passenger operations, and in these instances an appropriate safety and regulatory framework was developed for that particular port, but it is well recognized in the European Union (EU) and countries outside the EU, such as Norway, that a more comprehensive regulatory framework is needed.

In anticipation of the growing use of LNG as a fuel in Europe, the European Maritime Safety Agency (EMSA), national governments, port authorities and regional planning groups have carried out studies on what regulations and standards are currently applicable to LNG fuel use and bunkering and what gaps exist that should be filled by new regulations and standards. One key study issued in 2012 was a final report based on an EMSA commissioned study on standards and rules for bunkering gas-fueled ships. It provides a comprehensive overview and gap analysis of the regulatory framework for LNG bunkering in Europe. Table 1 below from the EMSA study is a summary of the different approaches being taken to the regulation of LNG bunkering in the primary LNG bunkering nations.

APPENDICES

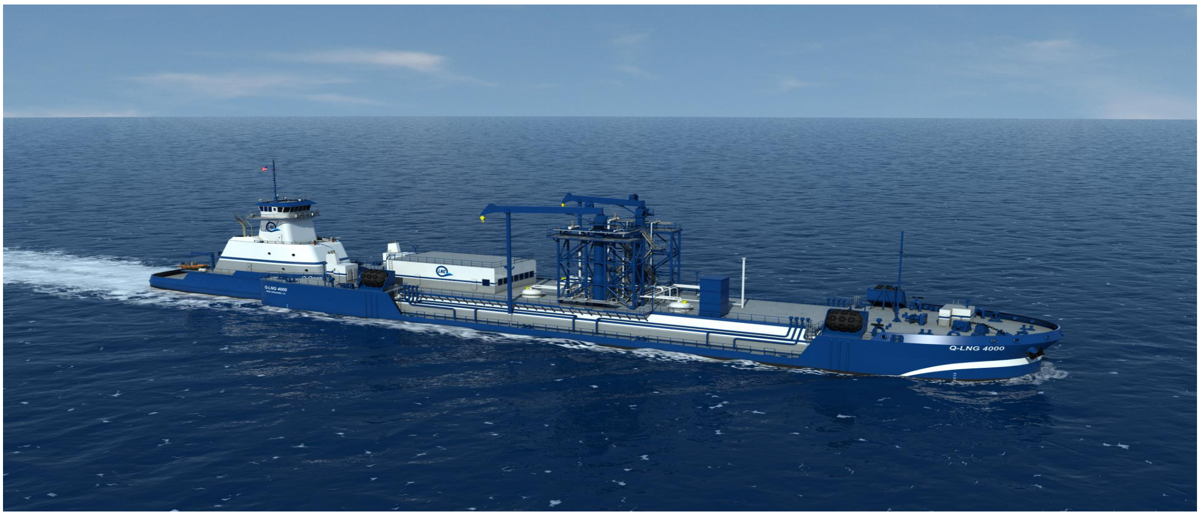
Appendix A – Shell LNG Bunker Portfolio
Appendix B – Bunker vessel transfer manual
Appendix C – Bunker vessel emergency response plan
Appendix D – Shell Marine LNG Delivery Procedure Manual
Appendix E – Shell Requirements for Quality Assurance of Maritime Vessels

APPENDIX A - Shell LNG Bunker Portfolio

USA - 4,000 m3 LNG Bunker Barge 2020 (Under construction)

Main Characteristics:

LOA	125.7 m
LWL	121.3 m
Draft	3.7 m (barge) 5.5 m (tug)
Depth	9.9 m (barge) 6.4 m (tug)
Beam	19.5 m
Service Speed	10 kts
Propulsion	Twin Azipods
Bow thruster	900 kw
Tanks	4 Type C
Gross volume, each	999 m^3
Max PRV setting	4 Bar (g)
Handling	Turbo-Brayton Subcooling
Lower Manifold reach	2 m above waterline
Upper Manifold reach	24 m above waterline
Liquid hose diameter	6 "
Transfer rate	600 m^3/hour
Supply Point	Elba Island Terminal Savannah, Georgia



Shell will supply LNG to marine customers in the South-East US from Shell's LNG capacity position at Elba Island in Savannah, a Kinder Morgan facility operated as Southern LNG (SLNG), with a throughput of 2.5 Mtpa of LNG production. Shell is the 100% capacity holder for all liquefaction volumes and the sole import capacity holder. SLNG received FERC approval for export and is currently constructing the facility, expected to be ready for export in 2019.

Shell has signed a long-term charter agreement with Q-LNG Transport, LLC. for a 4,000 m3 articulated tug barge (see photo above), for delivery in 2020. Q-LNG will build, own, and operate the LNG Bunker Barge (LNG), which is intended to be used to supply LNG to vessels along the southern US East Coast. Additionally, Shell is currently reviewing additional delivery options using larger LNG vessels in the region.

Europe: Cardissa Bunker Vessel

CARDISSA MAIN PARTICULARS

Length overall	119.9 meters		
Breadth	19.4 meters (MLD)		
Design Draft	5.8 meters		
LNG total Capacity	6500 cubic meters		
LNG Bunkering Arm		**Hose Transfer System**	
Minimum from Waterline	8 meters	Hoses Available	2 x 6” 18m
Maximum from Waterline	19 meters	QCDC to ISO 21593	2 x 6”
Liquid flange size	8 inches (ANSI150)	Liquid manifold flange size	Upper: 16” & Lower: 10”
Vapour flange size	6 inches	Vapour manifold flange size	Upper: 16” & Lower: 8” (reducers available)

BOIL OFF GAS MANAGEMENT

Ship owners/operators choosing LNG as their marine fuel are adopting different types of containment systems, which will require the bunker vessel to be able to deliver LNG to pressurized as well as atmospheric tanks. A novel technology of Boil Off Gas (BOG) management is included in the design of the Cardissa. The system uses a method of sub-cooling the LNG within the cargo tank, ensuring that the LNG is kept and supplied at the lowest possible cryogenic temperatures.

LNG TRANSFER SYSTEM

Together with many key partners, Shell has developed an LNG transfer system based on a loading arm. The FMC developed LNG bunker arm will limit personnel exposure during bunkering operations and provide controlled emergency shut down and disconnect features. Another benefit is the quick connection and disconnection, leading to a reduced duration of the bunker operation. Additionally, Cardissa has a hose-based transfer system with the flexibility to use at either Cardissa’s upper or lower manifolds. The hose transfer system has an integrated ERS for manual or automatic ESD2 with a controlled hose release mechanism.

DUAL FUEL ENGINES

Cardissa is designed to be clean burning and help driving down the GHG emissions, and is thus fitted with dual fuel engines, which are capable of burning LNG and MGO. Dual fuel engines were specified for the Cardissa since they provide a further level of safety and redundancy with the ability to switch to 100% MGO fuel in the event that LNG was not available.

HIGHLY EFFICIENT AND HIGHLY MANOEUVRABLE

Cardissa is capable of undertaking number of STS operations safely in the port area yet also has an efficient hull form for transit to various locations within Europe. She will operate safely in a congested port area and still provide effective full seagoing capability although she does not have DP2. To achieve her high manoeuvrability capabilities, Cardissa has a sophisticated hull form, diesel electric propulsion with twin screws, high lift flap rudders and a bow thruster. She can also operate without tug assistance while safely managing LNG bunkering operations.

Europe: Coral Methane Bunker Vessel

LNG BUNKER BARGE MAIN PARTICULARS

Length Overall	117.8 m
Breadth	18.6 m
Draught	6.3 m (for LNG)
Cargo Tanks	C-Type; 2 x 3750 m3 (total gross 7,500 m3)
Pumping Capacity	750 m3/hr
Cargo Transfer System	Kongsberg/Emerson
BOG Managmeent	ALAT subcooler
LNG Transfer	6" hose transfer system

Coral Methane is owned and operated by Anthony Veder

MEETING DEMAND & EXPANDING THE FLEET

Following consultation from customers, coupled with developing key hubs, Shell expanded its bunkering fleet into suitable vessels of opportunity. The Coral Methane provided an excellent opportunity to grow Shell's bunker vessel portfolio using a proven vessel design built to international standards. Modification were made to provide added capability for LNG bunkering including the installation of a hose transfer system, ALAT subcooler and upgraded cargo management system.

LNG TRANSFER SYSTEM

The Coral Methane has a 6" Hose Transfer System (HTS) provided by KLAW for use at its lower manifold and the system meets Shell requirements for bunkering, including:

- SIL2 as per IEC 61508 rated ERS
- 6" hoses (15m) for liquid and vapour lines
- Vessel Separation Detection (VSD) system
- SIGTTO 5-pin electric (Trellborg) and pneumatic ESD link

Europe: LNG London Bunker Barge Design Features – 2019

LNG BUNKER BARGE MAIN PARTICULARS

Length Overall	110 m
Breadth	15 m
Draught	3.1 m
Deadweight	1340 MT
Cargo Tanks	C-Type vacuum insulated 4 x 750 m3 (total gross 3,000 m3)
Pumping Capacity	660 m3/hr
Cargo Transfer System	Kongsberg/Emerson
BOG Managmeent	3 x StirLNG subcooler engines
LNG Transfer	6" Kanon bunker boom 6" mid-ships manifold hose transfer system

LNG London is owned by LNG Shipping (a joint venture between Victrol and CFT) and managed by Victrol.

BOIL OFF GAS MANAGEMENT

LNG London will use the StirLNG engine technology to assist in managing BOG onboard. The system uses a method of sub-cooling the LNG, ensuring that the LNG is kept at the same loaded temperature and able to deliver at that same temperature to the customer.

LNG TRANSFER SYSTEM

The primary LNG transfer system is an LNG bunker boom supplied by Kanon who has extensive experience in developing conventional bunkering technology solutions. The boom includes vacuum insulated hard piping with a hose based connection for bunkering. As an alternative, LNG London has a hose based transfer system to ensure continued supply if the bunker boom is unavailable or unsuitable for whatever reason.

Singapore: LNG Bunker Barge – 2020 (under construction)

MAIN CHARACTERISTICS

Length Overall	119.5 m
Breadth	19.5 m
Draught	5.8m
Cargo Tanks	C-Type; 2 x 3750 m3 (total gross 7500 m3)
Pumping Capacity	1000 m3/hr
Cargo Transfer System	Kongsberg/Emerson
BOG Managmeent	Fuel gas or gas combustion unit
LNG Transfer	8" bunker boom (6" vapour) 8" hose transfer system (6" vapour)

APPENDIX B – Bunker vessel, LNG transfer manual

Attachment

APPENDIX C – Bunker vessel, emergency response plan

Attachment

APPENDIX D – Shell Marine LNG Delivery Procedure Manual

(attached)

The safe, secure and efficient delivery of Marine LNG is critical to the sustainability of using LNG as a marine fuel. This Shell Marine LNG DPM sets out operational rules, methods and procedures applicable to a Marine LNG Bunkering Operation in which Shell is involved as: (i) the owner and/or Seller of the Marine LNG; (ii) the Owner, Operator or Charterer of the Bunker Vessel; or (iii) where Marine LNG is delivered by a third party's Bunker Vessel contracted by Shell to deliver either Shell-owned or third party-owned Marine LNG to a customer on Shell's behalf.

This DPM was written and reviewed by a multi-disciplined LNG Marine Fuels working group within Shell, and in consultation with selected LNG Marine Fuel customers and Port Authorities. It is based on best industry practices, but at a time when the bunkering of Marine LNG is in its infancy. The expectation, therefore, is that this document will be reviewed on a regular basis and amended to accommodate

- Any developments of applicable standards
- Learnings from actual Bunkering Operations.
- Fundamental changes in Receiving Vessels LNG systems for example change from IMO Type C LNG tanks to Atmospheric LNG tanks.

This DPM is written as a generic document and largely based on International standards and industry best practice. However, it is recognised that Bunkering Operations will also take place in areas governed by Local Regulations where some of the International standards referenced may not apply. In such cases the applicable local regulations and standards shall be complied with, along with the other requirements of this DPM.

The Seller, the Buyer and Shell Contracted Parties shall comply with their respective obligations set out in this DPM, and these obligations should be written into their operating procedures. Where requirements set out in this DPM are assigned to the Seller, and Shell Contracted Parties these are applicable to the Bunker Vessel. Where requirements set out in this DPM are assigned to the Buyer, these are applicable to the Receiving Vessel. Where requirements set out in this DPM are assigned to the Seller, Shell Contracted Parties and the Buyer, then these are applicable to both the Bunker Vessel and the Receiving Vessel. In case of a conflict between this DPM, the Commercial Terms and Shell Marine GTCs, the following order of hierarchy shall apply: (1) Commercial Terms (as most prevailing); (2) Shell Marine GTCs; (3) this DPM.

The Seller, the Buyer and Shell Contracted Parties shall also comply with operational requirements contained in the applicable Local and/or Port Authority Regulations (which shall prevail over relevant operational provisions of this DPM), and the industry.

The rules, methods and procedures detailed in this DPM shall be complied with by the Masters and personnel of the Bunker Vessel(s) and Receiving Vessel(s). The Master(s) of the Receiving Vessel(s) and of the Bunker Vessel(s), respectively, shall be responsible for the safe conduct of operations during the Bunkering Operation in accordance with this DPM and other applicable rules and regulations.

Shell LNG Bunkering
DPM V 1.0.pdf

APPENDIX E – Shell Requirements for Quality Assurance for Maritime Vessels

Attached

Requirements for
Quality Assurance o

LNG SAFETY DATA SHEET

Safety Data Sheet

Material Name: **Natural Gas, Refrigerated Liquid ((Cryogenic Liquid) with High Methane Content)**

Location: **United States**

Section 1 – Product and Company Identification

GHS Product Identifier	Natural Gas, Refrigerated Liquid (Cryogenic Liquid)
Chemical Name	Natural Gas, Refrigerated Liquid
Other Names	Liquefied Natural Gas, LNG, Liquid Methane, Marsh gas, Methyl hydride, Fire damp, UN1971, UN1972, R50, Biogas
Product Use	Industrial engine fueling, heat homes, generate electricity, supply other industrial processes, illuminated/cooking gas.
Synonyms	Liquefied Natural Gas, LNG
Manufacturer Info	Eagle LNG 16236 Normandy Blvd Jacksonville, FL 32234
Supplier Info	Eagle LNG 20445 State Highway 249 Suite 250 Houston, TX 77070
24-Hr Phone	Eagle LNG 1-800-633-8253 CANUTEC 1-613-996-6666

Section 2 – Hazards Identification

GHS Classification	H220 – Flammable Gases - Category 1 H280 – Compressed Gas - May Explode if Heated H281 – Gases Under Pressure - Refrigerated Liquefied Gas H361 – Suspected of Damaging Fertility or the Unborn Child - Category 2 H373 – May Cause Damage to Organs H380 – Simple Asphyxiant
Hazard Pictograms	

Signal Word	Danger
Hazard Statements	H220 – Extremely flammable gas. H280 – Contains gas under pressure; may explode if heated. H361 – May damage the unborn child (inhalation). H373 – May cause damage to organs (central nervous system) through prolonged or repeated exposure. H380 – May displace oxygen and cause rapid suffocation. H401 – Toxic to aquatic life.
Precautionary Statements	P201 – Obtain special instructions before use. P202 – Do not handle until all safety precautions have been read and understood. P210 – Keep away from heat, sparks, open flames, hot surfaces. – No smoking. P260 – Do not breathe vapors/gas. P273 – Avoid release to the environment. P280 – Wear gloves, protective clothing, eye protection, face protection. P308+P313 – if exposed or concerned: Get medical advice/attention. P314 – Get medical advice and attention if you feel unwell. P377 – Leaking gas fire: Do not extinguish, unless leak can be stopped safely. P381 – Eliminate all ignition sources if safe to do so. P405 – Store locked up. P410+P403 – Protect from sunlight. Store in a well-ventilated place. P501 – Dispose of contents/container according to local, regional, national, and international regulations.
Other Hazards not Contributing to the Classification	Odorless, colorless liquid. This product is NOT odorized. Asphyxiant in high concentrations. Contact with liquid may cause cold burns/frostbite.

Section 3 – Composition / Information on Ingredients

Substance/Mixture Substance
Chemical Name Methane
Other Names Liquid natural gas, Liquid methane, Marsh gas, Methyl hydride, Fire damp, UN1971, UN1972, R50, Biogas
Formula CH_4

Chemical Name	CAS#	Concentrations
Methane	74-82-8	>90%
Ethane	74-84-0	<4%
Propane+	74-98-6	<2%
Hexane+	110-54-3	<0.05% (500 ppm)
Oxygen	7782-44-7	<20ppm
Nitrogen	7727-37-9	<4%
Carbon dioxide	124-38-9	<50 ppm
Water	7732-18-5	<0.5ppm

Section 4 – First Aid Measures

Necessary First Aid Measures:

General Remove the victim from the source of contamination. Medical attention should be prompt in all cases of over-exposure to Natural Gas. Rescue personnel should be equipped with Self-Contained Breathing Apparatus. Also note that there is no specific antidote and treatment of over-exposure should be directed at the control of symptoms and the clinical condition. Take a copy of the label and SDS to physician or other health professional with victim(s).

Eyes Remove victim from the source of contamination. Never introduce oil or ointment into the eyes without medical advice. Irrigate exposed eyes with copious amounts of room temperature water for at least 15 minutes. If the victim cannot tolerate light, protect eyes with dark glasses. The use of bandages is not recommended for keeping the eyelids closed as exerting pressure on the eyelid may cause further damage. If irritation, pain, swelling, or other symptoms persist, the patient should be seen by a health care physician.

Skin	Clothing frozen to the skin should be thawed prior to removal. Remove contaminated clothing and flush affected area with lukewarm water. DO NOT USE HOT WATER. Keep victim warm and quiet. A physician should see the patient promptly if frostbite has occurred.
Ingestion	A physician should see the patient promptly if frostbite has occurred.
Inhalation	RESCUE PERSONNEL SHOULD BE EQUIPPED WITH SELF-CONTAINED BREATHING APPARATUS. Quick removal from the contaminated area is most important. Conscious persons should be assisted to an uncontaminated area and inhale fresh air. Unconscious persons should be moved to an uncontaminated area, given assisted resuscitation and supplemental oxygen. PROMPT MEDICAL ATTENTION IS MANDATORY IN ALL CASES OF OVEREXPOSURE TO NATURAL GAS. Further treatment should be symptomatic and supportive.

Important Symptoms/Effects (Acute and Delayed):

Acute

Eyes	Extremely cold material. Liquid can cause burns similar to frostbite.
Skin	Extremely cold material. Dermal contact with rapidly evaporating liquid could result in freezing of the tissues or frostbite.
Frostbite	Try to warm up the frozen tissues and seek medical attention.
Ingestion	Ingestion of liquid can cause burns similar to frostbite.
Inhalation	No known significant effects or critical hazards.

Over-exposure Signs/Symptoms

Eyes	Adverse symptoms may include the following: frostbite, decreased night vision, tunnel vision, dizziness.
Skin	Adverse symptoms may include the following: frostbite.
Ingestion	Adverse symptoms may include the following: frostbite, nausea, vomiting, gastrointestinal hemorrhage.

Inhalation	Adverse symptoms may include the following: hyperventilation, cyanosis, bronchoconstriction, respiratory depression, pulmonary edema, lung congestion.

Indication of Immediate Medical Attention and Special Treatment:

Notes to Physician	In case of inhalation of decomposition products in a fire, symptoms may be delayed. The exposed person may need to be kept under medical surveillance for 48 hours.
Specific Treatments	No specific treatment.

Section 5 – Fire Fighting Measures

Extinguishing Media	Water, foam, carbon dioxide, dry chemical. Use water (as fog) in flooding quantities. Dry chemical is preferred as firefighting agent. If safe to do so, allow flame to burn out. If flames are accidentally extinguished, explosive re-ignition may occur. Use extinguishing media appropriate for surrounding fire.
Unsuitable Extinguishing Media	None.
Specific Hazards From Chemical	Contains gas under pressure. Contains refrigerated liquid. In a fire or if heated, a pressure increase will occur and the container may burst or explode.
Hazardous Thermal Decomposition	None.
Special Protective Actions for Fire-Fighters	If tank, rail car or tank truck is involved in a fire, **ISOLATE** for 1600 meters (1 mile) in all directions established under ERG 115. If fire becomes uncontrollable or container is exposed to direct flame, consider **EVACUATION** of 530 meters (1/3 mile) in all directions established under ERG 115. The flammable mixture of gas and air may extend far beyond the distances that are regarded as adequate for normal safety purposes, with the result that the flammable mixture may become ignited by a household fire or automobile engine well outside the specified danger zone. Vapor may thus be

set alight over a very large area and flame propagation through the mixture may reach explosive violence.

Special Protective Equipment for Fire-Fighters	Self-contained breathing apparatus with a full face-piece operated in pressure-demand or other positive pressure mode, full bunker gear, and other proper protective equipment. Approach area from up-wind. Do not extinguish fire unless flow can be stopped. Cool all affected containers with flooding quantities of water to prevent impingement and potential BLEVE of the container. Apply water from as far a distance as possible. Under prolonged exposure to fire or intense heat, the containers may rupture violently and rocket. Flashback along vapor trail may occur. Due to the high heat radiation from a natural gas fire, it is important to ensure other combustibles in the vicinity do not catch fire. Avoid application of water to pooled product as water may create rapid phase transition of the material, creating small concussion-like explosions and increase the vaporization rate which may migrate downwind faster than expected.

Section 6 – Accidental Release Measures

Precautions, Protective Equipment, and Emergency Procedures

Non-emergency Personnel	No action shall be taken involving any personal risk or without suitable training. Evacuate surrounding areas for at least 100 m (330 ft). Keep unnecessary and unprotected personnel from entering. Do not touch or walk through spilled material. Avoid breathing gas. Provide adequate ventilation. Wear appropriate respirator when ventilation is inadequate. Put on appropriate personal protective equipment.
Emergency Responders	Use appropriate protective clothing and wear a Self-Contained Breathing Apparatus when entering the area. Eliminate all ignition sources. Shut off the flow of product if safe to do so. Clear the affected area and allow the liquid to evaporate and gas to dissipate. Test for sufficient oxygen and ensure oxygen level is at least 19.5% prior to re-entry.

Environmental Precautions	Ensure emergency procedures to deal with accidental releases are in place to avoid contamination of the environment. Avoid dispersal of spilled material and runoff and contact with soil, waterways, drains and sewers. Inform the relevant authorities if the product has caused environmental pollution (sewers, waterways, soil or air).

Materials and Methods for Containment and Clean-up

Small Spill	Immediately contact emergency personnel. Stop leak if without risk.
Large Spill	Consider initial downwind evacuation for at least 800 meters (1/2 mile) in all directions. Note: see Section 1 for emergency contact information and Section 13 for waste disposal.

Section 7 – Handling and Storage

Safe Handling

Protective Measures	Put on appropriate personal protective equipment (see Section 8). Contains gas under pressure. Contains refrigerated liquid. Do not get in eyes or on skin or clothing. Avoid breathing vapor. Empty containers retain product residue and can be hazardous. Do not puncture or incinerate container. Use equipment rated for cylinder pressure. Close valve after each use and when empty. Use a suitable hand truck for cylinder movement. Never allow any unprotected part of the body to touch uninsulated pipes or vessels that contain cryogenic liquids. Prevent entrapment of liquid in closed systems or piping without pressure relief devices. Some materials may become brittle at low temperatures and will easily fracture.
General Occupational Hygiene	Eating, drinking and smoking should be prohibited in areas where this material is handled, stored and processed. Workers should wash hands and face before eating, drinking and smoking. Remove contaminated clothing and protective equipment before entering eating areas. See also Section 8 for additional information on hygiene measures.

Storage Conditions

Conditions for Safe Storage (plus incompatibilities)	Proper grounding procedures to avoid static electricity should be followed. Store and use with adequate ventilation and isolate from oxidizing agents. Outside or detached storage is preferred only if

adequately protected from the weather and direct sunlight. Avoid high temperatures. Storage areas should be located at a safe distance from occupied premises and neighboring dwellings. Protect against physical damage. Prohibit open flame, and inspect for leakage. Containers are equipped with a safety relief valve.

Section 8 – Exposure Controls / Personal Protection

Occupational Exposure Limits

Chemical Name	Advisory Agency	Exposure Limits
METHANE	USA ACGIH ACGIH TWA (ppm)	Formerly 1000 ppm Based on Aliphatic hydrocarbon gases, Alkanes [C1-C4] ; Refer to Appendix F : Minimal Oxygen Content of the 2014 TLV Book
	USA ACGIH Remark (ACGIH)	Simple Asphyxiant; Explosive
ETHANE	**Alberta** OEL TWA (ppm)	1000 ppm
	British Columbia OEL TWA (ppm)	1000 ppm
	Northwest Territories OEL STEL (ppm)	1250 ppm
	Northwest Territories OEL TWA (ppm)	1000 ppm
	Saskatchewan OEL STEL (ppm)	1250 ppm
	Saskatchewan OEL TWA (ppm)	1000 ppm
PROPANE	**USA OSHA** OSHA PEL (TWA) (mg/m³)	1800 mg/m³
	USA OSHA OSHA PEL (TWA) (ppm)	1000 ppm
	USA NIOSH NIOSH REL (TWA) (mg/m³)	1800 mg/m³
	USA NIOSH NIOSH REL (TWA) (ppm)	1000 ppm
	USA IDLH US IDLH (ppm)	2100 ppm (10% LEL)
	Alberta OEL TWA (ppm)	1000 ppm
	British Columbia OEL TWA (ppm)	1000 ppm
	Northwest Territories OEL TWA (ppm)	1000 ppm
	Québec VEMP (mg/m³)	1800 mg/m³
	Québec VEMP (ppm)	1000 ppm
	Saskatchewan OEL STEL (ppm)	1250 ppm
	Saskatchewan OEL TWA (ppm)	1000 ppm
HEXANE	**USA ACGIH** ACGIH TWA (ppm)	50 ppm
	USA ACGIH ACGIH chemical category	Skin - potential significant contribution to overall exposure by the cutaneous route
	USA ACGIH Biological Exposure Indices (BEI)	0.4 mg/l (Medium: urine - Time: end of shift at end of workweek - Parameter: 2,5-Hexanedione without hydrolysis)
	USA OSHA OSHA PEL (TWA) (mg/m³)	1800 mg/m³
	USA OSHA OSHA PEL (TWA) (ppm)	500 ppm
	USA NIOSH NIOSH REL (TWA) (mg/m³)	180 mg/m³
	USA NIOSH NIOSH REL (TWA) (ppm)	50 ppm
	USA IDLH US IDLH (ppm)	1100 ppm (10% LEL)
	Alberta OEL TWA (mg/m³)	176 mg/m³
	Alberta OEL TWA (ppm)	50 ppm
	British Columbia OEL TWA (ppm)	20 ppm
	Manitoba OEL TWA (ppm)	50 ppm
	New Brunswick OEL TWA (mg/m³)	176 mg/m³

	New Brunswick OEL TWA (ppm)	50 ppm
	Newfoundland & Labrador OEL TWA (ppm)	50 ppm
	Nova Scotia OEL TWA (ppm)	50 ppm
	Nunavut OEL STEL (mg/m³)	440 mg/m³
	Nunavut OEL STEL (ppm)	125 ppm
	Nunavut OEL TWA (mg/m³)	352 mg/m³
	Nunavut OEL TWA (ppm)	100 ppm
	Northwest Territories OEL STEL (ppm)	62.5 ppm
	Northwest Territories OEL TWA (ppm)	50 ppm
	Ontario OEL TWA (ppm)	50 ppm
	Prince Edward Island OEL TWA (ppm)	50 ppm
	Québec VEMP (mg/m³)	176 mg/m³
	Québec VEMP (ppm)	50 ppm
	Saskatchewan OEL STEL (ppm)	62.5 ppm
	Saskatchewan OEL TWA (ppm)	50 ppm
	Yukon OEL STEL (mg/m³)	450 mg/m³
	Yukon OEL STEL (ppm)	125 ppm
	Yukon OEL TWA (mg/m³)	360 mg/m³
	Yukon OEL TWA (ppm)	100 ppm
NITROGEN	USA ACGIH Remark (ACGIH)	Simple asphyxiant
CARBON DIOXIDE	USA ACGIH TWA (mg/m³)	9000 mg/m³
	USA ACGIH TWA (ppm)	5000 ppm
	USA ACGIH STEL (mg/m³)	54000 mg/m³
	USA ACGIH STEL (ppm)	30000 ppm
	USA ACGIH Remark (ACGIH)	Asphyxia
	USA OSHA PEL (TWA) (mg/m³)	9000 mg/m³
	USA OSHA PEL (TWA) (ppm)	5000 ppm

Engineering Controls

Explosion proof ventilation systems may be acceptable if it can maintain an adequate supply of air to maintain LEL levels. Grounding and bonding of equipment is required during the transfer of product to eliminate potential of static discharge. Oxygen detectors.

Environmental Exposure Controls

Emissions from ventilation or work process equipment should be checked to ensure they comply with the requirements of environmental protection legislation. In some cases, fume scrubbers, filters or engineering modifications to the process equipment will be necessary to reduce emissions to acceptable levels.

Protection Measures

Hygiene	Wash hands, forearms and face thoroughly after handling chemical products, before eating, smoking and using the lavatory and at the end of the working period. Appropriate techniques should be used to remove potentially contaminated clothing. Wash contaminated clothing before reusing. Ensure that eyewash stations and safety showers are close to the workstation location.
Eye/Face Protection	The following protection is required: safety glasses or splash googles and full face shields.
Respiratory Protection	Use a properly fitted, air supplied respirators where local or general exhaust ventilation is inadequate. OSHA approved supplied air/self-contained air respirators must be used in confined spaces, oxygen deficient atmospheres, and rescue situations.

Skin Protection

Hand Protection	Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times. Insulated gloves suitable for low temperatures are to be worn.
Body Protection	Use fire/flame resistant/retardant clothing while handling material, and in accordance with the hazards of the task and site.
Other	Safety footwear is to be used in accordance with the hazards of the task and site.

Section 9 – Physical & Chemical Properties

Physical State	Liquid / vapor
Color	Colorless
Molecular Weight	16.04 g/mol
Molecular Formula	CH_4
Boiling/Condensation Point	-160 °C (-256 °F)
Melting/Freezing Point	-183 °C (-297 °F)
Odor	Odorless.
pH	Not applicable.
Flash Point	-187 °C (-306 °F)
Evaporation Rate	Not applicable.

Lower Explosive (Flammable Limits)	5% by volume.
Upper Explosive (Flammable Limits)	15% by volume.
Vapor Pressure	4.66 x 10^5 mm Hg @ 77°F (25°C)
Specific Volume (ft^3/lb)	13.8889
Specific Gravity/Density	808.5 kg/m^3
Gas Density (lb/ft^3)	0.072
Relative Density	0.55 (0.55-0.64)
Solubilities	0.60 ml in 1 g ethyl alcohol @ 20°C; soluble in benzene, methanol, toluene; slightly soluble in acetone; 0.91 ml in 1 g ether @ 20°C; in water 22 mg/liter @ 25°C.
Partition Coefficient: n-Octanol/Water	Not applicable.
Auto-Ignition Temperature	537 °C (999 °F)
Decomposition	When ignited in the presence of oxygen, will burn to produce carbon monoxide, carbon dioxide.
Viscosity	34.8 uP @ -181.6°C; 76.0 uP @ -78.5°C; 102.6 uP @ 0°C; 108.7 uP @ 20°C; 133.1 uP @ 100°C; 160.5 uP @ 200.5°C; 181.3 uP @ 284°C; 202.6 uP @ 380°C; 226.4 uP @ 499°C
Explosion Sensitivity to Mechanical Impact	Not sensitive.
Explosion Sensitivity to Static Discharge	Static discharge may cause methane vapor / gas to ignite explosively.

Section 10 – Chemical Stability & Reactivity Information

Reactivity	Sensitive to static discharge.
Chemical Stability	The product is stable.
Hazardous Reactions	Under normal conditions of storage and use, hazardous reactions will not occur.
Conditions to Avoid	Avoid heat, open flames, sparks, and flammable atmospheres.
Incompatible Materials	Strong oxidizing agents.

Hazardous Decomposition Products	Under normal conditions of storage and use, hazardous decomposition products should not be produced.
Hazardous Polymerization	Under normal conditions of storage and use, hazardous polymerization will not occur.

Section 11 – Toxicological Information

Toxicological Effects

Acute Toxicity	Not available.
Irritation/Corrosion	Not available.
Sensitization	Not available.
Mutagenicity	Not available.
Carcinogenicity	Not available.
Reproductive Toxicity	May damage the unborn child.
Teratogenicity	Not available.
Specific Target Organ Toxicity (Single Exposure)	Not available.
Specific Target Organ Toxicity (Repeated Exposure)	Not available.
Aspiration Hazard	Not available.
Information on Likely Routes of Exposure	Not available.

Potential Acute Health Effects

Eye Contact	Extremely cold material. Liquid can cause burns similar to frostbite.
Inhalation	Vapors may cause dizziness or asphyxiation without warning.
Skin Contact	Extremely cold material. Dermal contact with rapidly evaporating liquid could result in freezing of the tissues or frostbite.
Ingestion	Ingestion of liquid can cause burns similar to frostbite.

Symptoms Related to Physical, Chemical, and Toxicological Characteristics

Eye Contact	Adverse symptoms may include the following: frostbite.
Inhalation	Vapors may cause dizziness or asphyxiation without warning.
Skin Contact	Adverse symptoms may include the following: frostbite.
Ingestion	Adverse symptoms may include the following: frostbite.

Delayed and Immediate Effects/Chronic Effects from Short and Long-term Exposure

Short-term Immediate Effects	Not available.
Short-term Delayed Effects	Not available.
Long-term Immediate Effects	Not available.
Long-term Delayed Effects	Not available.
Potential Chronic Health Effects	Not available.

General	No known significant effects or critical hazards.
Carcinogenicity	No known significant effects or critical hazards.
Mutagenicity	No known significant effects or critical hazards.

Teratogenicity	No known significant effects or critical hazards.
Developmental Effects	No known significant effects or critical hazards.
Fertility Effects	No known significant effects or critical hazards.

Numerical Measures of Toxicity

Acute Toxicity Estimates	Not available.

Section 12 – Ecological Information

Toxicity	Not available.
Persistence and Degradability	Biodegradation may occur in soil and water. Volatilization is expected to exist entirely in the vapor phase in ambient air.
Mobility in Soil	If released to soil, ethane is expected to have very high mobility based upon an estimated K_{OC} of 37.
Other Adverse Effects	Can cause frost damage to vegetation.

Chemical Name	$LogP_{OW}$	BCF	Potential
LIQUEFIED NATURAL GAS	-	Not established	-
ETHANE	<= 2.3	-	-
CARBON DIOXIDE	0.83	None.	-
NITROGEN	0.67	-	Low

Section 13 – Disposal Considerations

Disposal Methods	The generation of waste should be avoided or minimized wherever possible. Disposal of this product, solutions and any by-products should at all times comply with the requirements of environmental protection and waste disposal legislation and any regional local authority requirements. Dispose of surplus and non-recyclable products via a licensed waste disposal contractor. Waste should not be disposed of untreated to the sewer unless fully compliant with the requirements of all authorities with jurisdiction. Waste packaging should be recycled. Incineration or landfill should only be considered when recycling is not feasible. This material and its container must be disposed of in a safe way. Empty containers or liners may retain some product residues. Do not puncture or incinerate container.

Section 14 – Transportation Information

	DOT	TDG	Mexico	IMDG	IATA
UN Number	UN1972	UN1972	UN1972	UN1972	UN1972
UN Proper Shipping Name	NATURAL GAS, REFRIGERATED LIQUID (CRYOGENIC LIQUID, WITH HIGH METHANE CONTENT)	NATURAL GAS, REFRIGERATED LIQUID (CRYOGENIC LIQUID, WITH HIGH METHANE CONTENT)	NATURAL GAS, REFRIGERATED LIQUID (CRYOGENIC LIQUID, WITH HIGH METHANE CONTENT)	NATURAL GAS, REFRIGERATED LIQUID (CRYOGENIC LIQUID, WITH HIGH METHANE CONTENT)	NATURAL GAS, REFRIGERATED LIQUID (CRYOGENIC LIQUID, WITH HIGH METHANE CONTENT)
Transport Hazard Class(es)	2.1 	2.1 	2.1 	2.1 	2.1 
Packing Group	---	---	---	---	---
Environment	No.	No.	No.	No.	No.
Additional Information	ERG (2012) NUMBER: 115	ERG (2012) NUMBER: 115	---	---	---

Special Precautions

Transport within user's premises: always transport in closed containers that are upright and secure. Ensure that persons transporting the product know what to do in the event of an accident or spillage.

Transport in Bulk According to Annex II of MARPOL 73/78 and the IBC Code

E – the material may be stowed "on deck" or "under deck" on a cargo vessel and on a passenger vessel carrying a number of passengers limited to not more than the larger of 25 passengers, or one passenger per each 3m of overall vessel length, but is prohibited from carriage on passenger vessels in which the limiting number of passengers is exceeded. 40 – Stow "clear of living quarters"

Passenger aircraft / rail: Forbidden.

Section 15 – Regulatory Information

United States - State Regulations

Connecticut	Hazardous Air Pollutants - HLVs (30 min)
	Hazardous Air Pollutants - HLVs (8 hr)
Delaware	Accidental Release Prevention Regulations - Sufficient Quantities
	Accidental Release Prevention Regulations - Threshold Quantities
	Pollutant Discharge Requirements - Reportable Quantities
	Volatile Organic Compounds Exempt from Requirements
Maine	Air Pollutants - Greenhouse Gases (GHG)
Massachusetts	Oil & Hazardous Material List - Groundwater Reportable Concentration - Reporting Category 1
	Oil & Hazardous Material List - Reportable Quantity
	Oil & Hazardous Material List - Soil Reportable Concentration - Reporting Category 1
	Oil & Hazardous Material List - Soil Reportable Concentration - Reporting Category 2
	Right To Know List
	Volatile Organic Compounds Exempt From Requirements
Minnesota	Hazardous Substance List
New Jersey	Right to Know Hazardous Substance List
	Discharge Prevention - List of Hazardous Substances
	Environmental Hazardous Substances List
	Excluded Volatile Organic Compounds
	Special Health Hazards Substances List
	TCPA - Extraordinarily Hazardous Substances (EHS)
New York	Reporting of Releases Part 597 - List of Hazardous Substances
Ohio	Accidental Release Prevention - Threshold Quantities
Oregon	Permissible Exposure Limits – TWAs
Pennsylvania	RTK (Right to Know) List
Texas	Effects Screening Levels - Long Term
	Effects Screening Levels - Short Term
Washington	Permissible Exposure Limits - Simple Asphyxiants

Canada

WHMIS	Class A: Compressed gas.
	Class B: Flammable/Combustible Material
	Division 2.1 – Flammable Gas
Domestic Substances List	Listed.

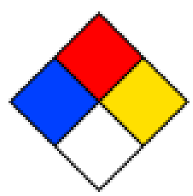
CEPA Toxic substances	Not listed.
Canadian ARET	Not listed.
Canadian NPRI	Not listed.
Alberta Designated Substances	Not listed.
Ontario Designated Substances	Not listed.
Quebec Designated Substances	Not listed.

Section 16 – Other Information

Emergency Response Guide (ERG) Number	115 (UN 1972)

NFPA

Health Hazard	3 - Short exposure could cause serious temporary or residual injury even though prompt medical attention was given.
Fire Hazard	4 - Rapidly or completely vaporize at atmospheric pressure and normal ambient temperature, or which are readily dispersed in air and which will burn readily.
Reactivity	0 - Normally stable, even under fire exposure conditions, and are not reactive with water.
Specific Hazard	SA - This denotes gases which are simple asphyxiants.



HMIS Rating

Health	3 - Serious Hazard
Flammability	4 - Severe Hazard
Physical	3 - Serious Hazard

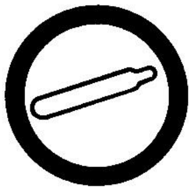
Safety Data Sheet

Material Name: **Natural Gas, Refrigerated Liquid ((Cryogenic Liquid) with High Methane Content)**

Location: **United States**

Canada WHMIS

Classification	A – Compressed gas B – Flammable/Combustible Material
Class	2 – Flammable Gases
Division	2.1 – Flammable Gas



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Date of Issue:	March 19, 2018

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