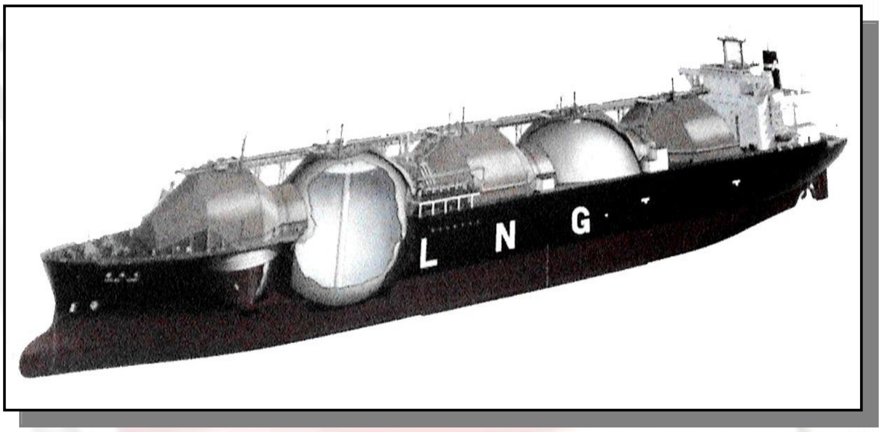


LNG DECK OPERATION (FOR DECK RATINGS)

I. PIPING SYSTEM AND VALVES

I.1 Features of the cargo piping system

a. LNG and LNG vapor are isolated from the atmosphere.
b. Cargo pipe work is installed above deck level.
c. Accommodation of thermal expansion and contraction bellows.
d. Disposal of LNG leakage through pipe flanges (drip trays).
e. Material is stainless steel.

I.2 Main cargo pipelines

I.2.1 Liquid lines

a. Liquid header
b. Liquid branch line
c. Filling line
d. Cargo discharge line
e. Liquid cross over

I.2.2 Vapor lines

a. Vapor header line
b. Vapor branch/suction line
c. Vapor return line
d. Vapor cross over
e. Compressor suction line

I.2.3 Spray lines

a. Spray header line
b. Spray branch line
c. Spray pump discharge line
d. Spray nozzle inlet line
e. Spray return line
f. Spray cross over

I.2.4 Cargo tank vent line

I.2.5 LNG relief line

I.2.6 Inerting/Aerating line

I.2.7 Fuel gas line

I.2.8 Pressure build-up line

I.3 Color System in Piping Arrangements

I.3.1 Color system

a) LNG liquid line	Blue
b) LNG vapour line	Orange
c) Nitrogen line	Light green
d) Inerting/Aerating line	Brown
e) Spray line	Light blue

I.4 Valve Numbering/Coding

I.4.1 First code (equipment code)

a. V (valve)

I.4.2 Second code (system code)

a. L (liquid)
b. G (vapour/gas)
c. S (spray)
d. N (nitrogen)
e. I (inerting/aerating)

I.4.3 Third code (location code)

a. 0 (manifold/cross over)
b. 1 to 4 (tank dome)
c. 7 (flying passage)
d. 8 (compressor top)
e. 9 (in compressor room)

I.4.4 Fourth code (line code)

a. 0 to 4 (liquid line)
b. 5 and 6 (spray line)
c. 7 (vapour line)
d. 8 (nitrogen line)
e. 9 (inerting/aerating line)

I.4.5 Fifth code (serial number)

a. odd numbers (stbd side)
b. even numbers (port side)

I.5 Main cargo valves

I.5.1 Tank dome

a. Branch valve
b. Filling valve
c. Cargo pump discharge valve
d. Cargo pump non-return valve
e. Spray pump discharge valve
f. Spray master valve
g. Spray nozzle inlet valve
h. Spray return valve
i. Vapor connection valve

I.5.2 Manifold, Cross over

a. Liquid manifold ESD valve
b. Liquid manifold Double Shut (Manual) valve
c. Liquid manifold Purge valve
d. Liquid manifold Drain valve
e. Liquid manifold Cooldown valve
f. Liquid crossover Cooldown valve
g. Vapor manifold ESD valve
h. Vapor manifold Bypass valve
i. Vapor manifold Purge valve
j. Vapor crossover Block valve

I.6 Cargo and Relief Valves

I.6.1 Stop Valves

a. Ball Valve
b. Globe Valve
c. Gate Valve (Sluice Valve)
d. Butterfly Valve

I.7 Pressure Surge

Pressure surge can be created when the flow in a liquid line is stopped too quickly. The hazard is greatest when cargo is being transferred over long distances and at high velocity. Pressure surges maybe caused by ESD valves operated. It is important that ESD system is well maintained and properly adjusted.

This can occur when liquid is trapped between valves in a liquid line and becomes warm: In such cases, the valve should be opened very carefully to equalize the pressure slowly. Liquid lines should be drained - after use to prevent this problem.

II. CARGO MACHINERY and INSTRUMENTATION

II.1 LNG Pumps

a. Each tank is provided with two cargo pumps and one spray pump. The cargo and spray pumps are of electric motor driven centrifugal type. The cargo pumps have single stage while the spray pump has a single stage.

b. As LNG is a non-conductor of electricity, it is used as a cooling medium for the pump motor windings. Electrical components of the pumps may be in contact with LNG without risk. Pump bearings (ball bearing) are lubricated with LNG. Therefore, it is more important that the cargo and spray pumps should not be operated in the dry condition, even momentarily.

c. Pump components are manufactured from stainless steel and aluminum alloys, as these materials are suitable for use under cryogenic temperature. Electric motor junction boxes are designed for easy disconnection during pump exchange operations.

II.2 Cargo Pumps

a. The cargo pumps are located at the bottom of the central pipe tower, one pump each side of the buffer diffuser on the filling line outlet, in each tank.

b. The pump suctions are each located approximately 75 mm from the tank bottom and are protected by fine stainless steel mesh screens.

c. Inducers are fitted to direct the flow of LNG and assist suction at low head pressure.

d. Cargo pump discharge lines rise vertically in the pipe tower to the tank dome. Each tank is bolted directly at each discharge flange to the bottom of its discharge line. Each cargo pump has a capacity of 1,400m^3/hr at 145m head of LNG (Sp. Gr. of 0.5)

II.3 Spray pumps

a. One spray pump is located beside No.1 cargo pump at the bottom of the central pipe tower in each tank.

b. The pump suction, protected by a fine mesh screen, is located 25mm above the tank floor. This allows the pump to strip the tank of liquid prior to warming up operations. Like the cargo pumps, the spray pump is fitted with inducers.

c. The spray pipe discharge line rises vertically through the pipe tower to the tank dome.

d. The bottom 2.7 m section of discharge pipeline is increased in size to 80mm (other pipes are 50mm) and the spray pump discharge flange is bolted directly to lower end of this section.

e. Each spray pump has a capacity of 50m^3/h at 135 head of LNG (Specific Gravity 0.5).

f. During ballast voyages, the spray pumps are used to supply LNG for cargo tank spraying in order to maintain the required cargo tank equatorial temperatures ready for loading. If additional boiler fuel gas is required, the spray pump will be used to supply LNG to the forcing vaporizer.

g. Spray pumps are also used for cool down of cargo piping (on board) and unloading arms (ashore) prior to operation of cargo pumps.

II.4 Inert Gas Generator

Three conditions mentioned under must coexist in order for a fire or an explosion to occur:

- Flammable vapors
- A source of ignition
- The proper amount of oxygen to form a flammable mixture

To eliminate the risk of a fire or an explosion in a cargo tank or hold space of an LNG vessel, the oxygen content in the space is reduced to a point where the atmosphere cannot support combustion. This is done by introducing inert gas into the spaces until the oxygen content is reduced to an acceptable level before LNG vapor is permitted to enter the cargo tank. Inert Gas composition is as follows:

Oxygen	O_2	max. 1.0%
Carbon Dioxide	CO_2	approx. 13.0%
Carbon Monoxide	CO	max. 100 ppm
Sulfur Oxide	SO	max. 10 ppm
Nitrous Oxide	NO	max. 100 ppm
Nitrogen	N2	balance 100 ppm
Soot	0	

II.4.1 Outline of IGG System

Inert gas is produced by light oil combustion. The produced Inert Gas is made of mainly of 85% nitrogen, 15% carbon dioxide and a little oxygen.

This high temperature combustion exhaust gas is first cooled indirectly in the combustor and then directly in the scrubber with sea water. Sulfur in fuel is oxidized in the process of combustion and this sulfur oxide is cleaned and removed simultaneously. Inert gas is cooled at sea water temperature at about +2 deg. Centigrade and is saturated. Moisture is separated from inert gas by upper demister in scrubber tower.

More close dehydration is done by two steps method. Firstly, gas is cooled by the cooler using R22 refrigerant (dew point will be approx. +5 degrees Celcius) and the moisture in the gas is condensed and removed. The remaining moisture is removed by the dryer with an absorbent (alumina). Gas at a dew point of -45 deg. Celsius is supplied to inert gas lines.

Analyzer for oxygen density of inert gas or air, and a dew point analyzer shall be provided with indicator or recorder.

II.4.2 Uses of Inert Gas Generator

IGG is provided for the following purposes:

a. **Cargo Tank inerting by inert gas -** after the tank has been warmed and prior to aerating the cargo tank with a normal air (preparation for tank inspection).

b. **Cargo Tank Gas Freeing by inert gas -** after the tank has been dried by dry air and prior to gassing-up (preparation for loading).

c. **Hold, Space Inerting by inert gas -** to prevent a flammable mixture from forming in the event of leak in the cargo tank wall through a hold is usually being filled up with dry air produced by IGG.

d. **Cargo Tank and hold drying (aerating) by dry air.**

II.5 Cargo Tank/High Pressure Control

Pressure in cargo tanks and holds should be closely monitored, especially during cargo operations and the equipment provided should be used to make necessary adjustments.

Preventing the ingress of air to cargo tank.
Tank pressure is greater than Atmospheric Pressure

Prevention of ingress of air to hold space being filled with dry air.
Hold pressure is greater than atmospheric pressure

Protection of cargo tanks.
Tank pressure is greater than hold pressure

THEREFORE:

Tank Press. > Hold Press > Atmospheric Press.

II.6 Emergency Shut Down System (ESDS)

The object of ESDS is to stop the cargo operations or cargo operating equipment for automatic tank protection in case of accidents or emergencies.

Where the gas carriers and terminals are dedicated to each other as most LNG projects, the terminal and ship's ESDS are linked during cargo transfer and safely in combination.

II.6.1 ESDS is activated by:

a. ESDS Loop pressure low
b. Cargo Tank Level, extremely high
c. Manual activation of ESDS switch
d. Electric power failure
e. Cargo Hydraulic Pressure low
f. Control Air pressure low
g. Melting plug
h. ESD signal from shore
i. ESD self diagnosis

II.6.2. Initiation of ESDS causes the ff:

a. ESD valves shut
b. Gas compressors (H/D) and L/D) stop
c. All cargo and spray pumps stop
d. ESD loop and signal is transmitted to shore-terminal equipment trip

Optional: Fuel gas master valve shut
IGG stop

II.6.3 Emergency Shut Down Valves (ESDV)

ESDV is fitted on liquid/vapor manifold and fuel gas line. It is a fail-close type which closes automatically upon low hydraulic pressure.

II.7 Monitoring System

The measuring items of LNG are as follows:

II.7.1 Temperature Measurement

As for LNG carriers which transport LNG at (about -160ºC), the temperature measurement is mainly to measure the temperature of LNG in cargo tank for density correction at the time of CTM and to prevent dangers when detecting the temperature distribution at tank equator ring and hold part for controlling the tank cooldown rate and foreseeing a part of tank leakage etc.

II.7.2 Location of temperature detecting instrument (low temperatures):

There are plenty of temperature measuring points. With regard to areas around the tank, 10 to 50 of temperature sensors shall be fitted. The point included, but not limited to the following, must be measured and monitored:

a. Tank and Hold Part
   Inside tank
   Equator part
   Foundation
   Bulkhead
   Drip pan

b. Pipe Line
   Cross Over
   N2 Crossover
   Liquid Header

c. Compressor
   BOG Suction and Discharge

d. Vaporizer

Discharge gas
Outlet Steam Drain

e. Gas Heater
Discharge Gas
Outlet Steam drain

f. Nitrogen Bleeding Line

The following temperature sensors are fitted at LNG carrier.

a. Thermo bulb
b. Thermo couple
c. Thermistor

II.7.3 Custody Transfer Measurements System (CTMS)

The LNG trading differs from the generality of other liquified gas trading in two respects affecting cargo quantification. LNG is traded within long term projects with dedicated production, transportation and reception. Secondly, cargo boil-off during both loaded and ballast voyages are used as ship's fuel. Commercial cargo quantification is accordingly tailored to the particular project circumstances and contract agreements but is usually on the basis of calorifc value of cargo delivered. Calorific value is derived from a cargo composition and the mass of the liquid transferred with an adjustment made for the calorific content of the volume of the vapor displaced.

The quantification is determined by measuring LNG volume inside the ship's cargo tank. The system for measurement, calculation and output of volume is Custody Transfer Measurement System.

Sampling and Analysis are not carried out on the ship.

II.7.4 Pressure Gauge

Pressures either above or below the design range can damage a system and operating personnel should be fully aware of any pressure limitation for each part of the cargo system; pressures should always be kept between the specified maxima and minima.

II.7.5 Custody Transfer Measurement System (CTMS)

Pressure sensor shall be provided for each cargo tank to measure each cargo tank pressure. The pressure shall be read out directly by the CRT or Printer in cargo control room.

II.7.6 Operation Purpose

Pressure transmitter, differential pressure transmitter and pressure switch shall be provided for cargo tank protection, alarm, monitoring and emergency shut down system.

The pressure sensors are installed in the following parts:

a. Cargo Tank and Hold
b. Inerting / Aerating
c. Cargo Line
d. Nitrogen Line
e. Cargo Handling Machineries

II.7.7 Cargo Tank/ Hold pressure Control

Pressure in cargo tanks and holds should be closely monitored, especially during cargo operations and the equipment provided should be used to make the necessary adjustments.

a. Preventing the ingress of air to cargo tank
   TANK PRES. > ATM PRES.

b. Preventing the ingress of air to hold space being filled with dry air.
   HOLD PRES. > ATM PRES.
c. Protection for cargo tank
   TANK PRES. > HOLD PRES.

   Therefore:

   TANK PRES. > HOLD PRES. > ATM. PRES.

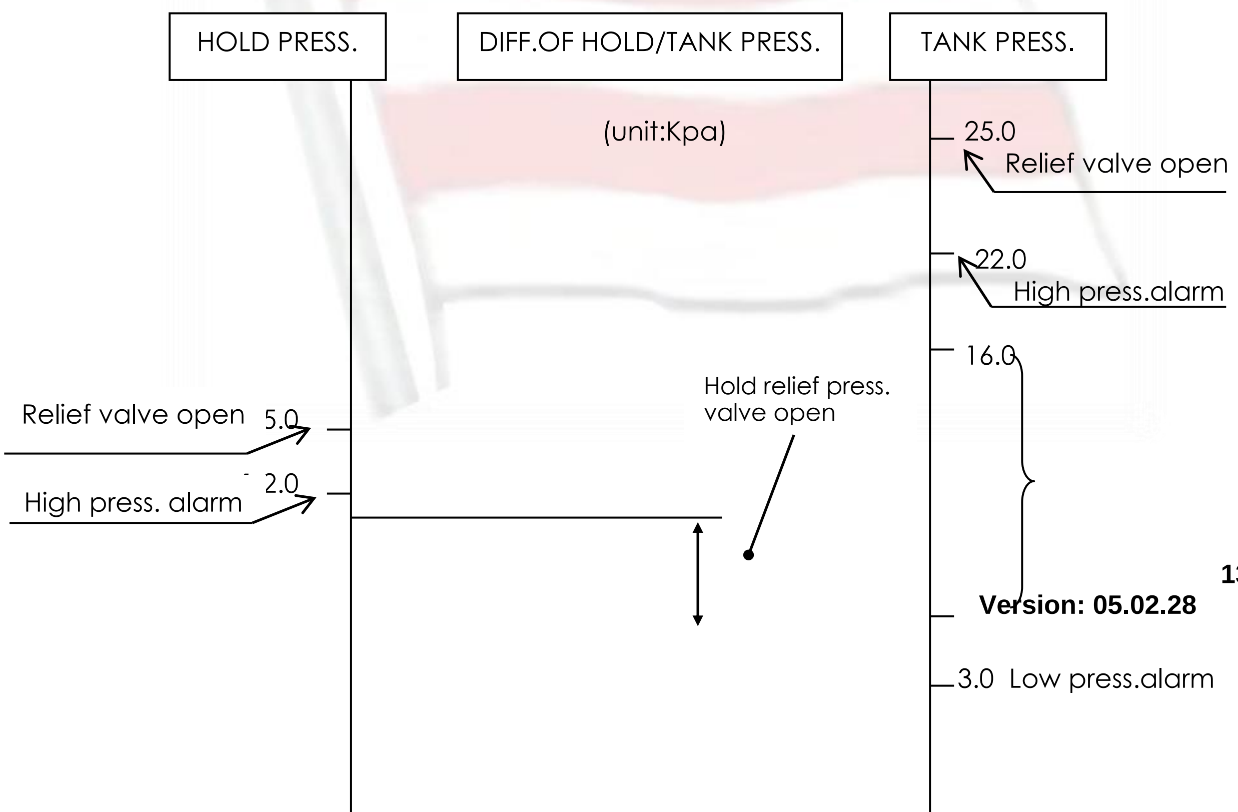
II.7.8 Level measurement

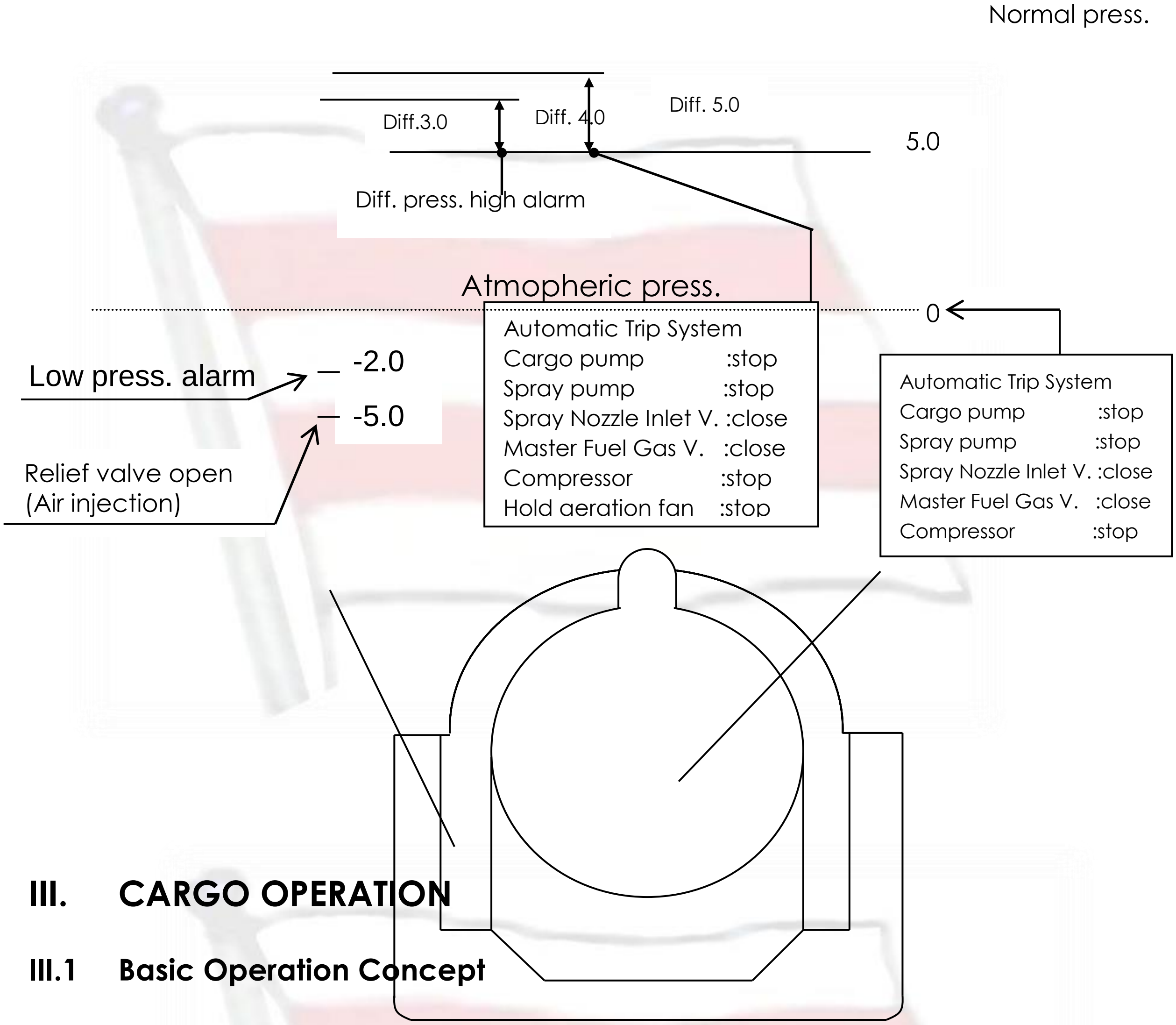
Level gauges are important because LNG Carriers cargo systems are closed and levels cannot be sounded. Level measurement is intended to measure LNG volume in cargo tanks on demand and to display the LNG level for custody transfer purposes. The gauges maybe linked to high level alarms to give warnings of a tank being overfilled, and shut down systems to prevent the cargo over-filling the tank or over-pressuring the tank and causing fracture.

The types of level gauge commonly used of LNG carriers are as follows:

a) Float Gauges
b) Capacitance Gauges
c) Radar type Gauges

TANK PROTECTION SYSTEM (MHI LNGC)





III. CARGO OPERATION

III.1 Basic Operation Concept

Operation scheme of LNG carriers

(a) Drying After Drydock
(b) Inerting after refit
(c) Gassing up
(d) Initial cooldown
(e) Loading
(f) Laden voyage
(g) Discharging
(h) Ballast voyage
(i) Warming up
(j) Inerting before refit
(k) Aeration
(l) Dry-dock

III.1.1 Inerting after refit

- Before introducing vapor or liquid into the cargo system, it is essential that all air is purged from the system to prevent formation of flammable mixtures. In this operation, the object is to replace all air inside the cargo tanks and pipe work with inert gas.

- Inert gas from the ship's inert gas generator is connected to the LNG liquid header and led to the bottom of each cargo tank. The displaced air escapes to the atmosphere via the LNG vapor header and vent riser. Oxygen measurement is carried out using a portable analyzer on samples drawn from each of the sampling points in each cargo tank. Venting continues until the oxygen concentration at all points is consistently less than 1% and the dew point is less than –40°C.

- Inerting of LNG liquid and spray lines, including manifold crossovers, vaporizers and relief valve lines are carried out concurrent with tank inerting.

- This operation would be carried out before the vessel's arrival at the loading port. Other operations, which will be carried out in preparation for the first loading, will be, purging/ filling insulation (annular) spaces with nitrogen, and purging/filling hold spaces with dry air.

III.1.2 Gassing up

- If the cargo system contains inert gas, it is essential that prior to cooldown and loading, the inert gas is displaced by warm LNG vapor. This is necessary to remove any condensable gases (particularly carbon dioxide or traces of water vapor) that are present in the inert gas. Any moisture and carbon dioxide will freeze during cooldown.

- This operation takes place at the loading terminal immediately prior to cooldown and loading. LNG is supplied via the liquid manifold line to the LNG vaporizer supply line. After vaporization, the LNG vapor is delivered to the Vapor header line and then to the top of each cargo tank. The displaced inert gas is drawn from the bottom of the tanks through the filling lines, liquid header line to the shore flare stack or vent mast.

III.1.3 Initial cooldown

- The cargo tanks will be under an inert gas atmosphere on arrival. Prior to the first loading, and after gassing up with LNG vapor, spraying LNG received from the loading terminal through the spray nozzles gradually cools down the cargo tanks. This operation, which produces cold vapor, is to be returned to shore.

III.1.4 Loading

- LNG is introduced to the cargo tanks through the filling line, while vapor is returned to shore using the HD compressors.

III.1.5 Laden voyage

- In normal operation, the boil-off gas from the tanks is compressed using the LD compressor and used as fuel for the main boilers.

- Two methods are available to control the vapor pressure in the cargo tank:

1) Disposal of excessive vapor by means of the Boil-Off gas system.

2) Venting of excessive vapor through the vent mast, and steam dump system (if necessary).

- Good voyage planning allows available natural boil-off to be converted to useful work. Venting and steam dumping are waste of energy.

- It is possible to vaporize LNG to provide fuel, by operating the forcing vaporizer.

III.1.6 Unloading

- Normally, as the two cargo pumps in each tank pump out the cargo (liquid), cargo vapor is returned from the shore via vapor line and pressure is monitored to ensure that the pressure in the cargo tank remain within acceptable range.

- In the event of the shore terminal being unable to return vapor, make up vapor must be generated by feeding LNG to the LNG vaporizer on board.

- A certain amount of cargo will be left in all tanks (heel) for cooling down, with an extra reserve for fuel during ballast voyage.

III.1.7 Ballast voyage

- During the ballast voyage, the cargo tanks are spray cooled utilizing the spray pumps and extra cargo left on board for this purpose. This ensures reduced boil-off and avoids the need for long cooldown period during the next loading, as well as providing fuel for the boilers.

III.1.8 Warming up

- Maximum cargo will be discharged from all tanks in order to reduce the time necessary to vaporize the remaining liquid.

- The ship will return to sea and the tanks will be circulated with warm LNG vapor supplied (through the loading lines) by the HD compressor, via the gas heaters, at a maximum outlet temperature of 80 C.

- The remaining LNG will be vaporized and excess vapor generated will be vented via the vapor line and vent mast.

- Insulation and hold space pressures must be carefully monitored, as pressure will increase due to warming up.

III.1.9 Inerting before refit

- Before introducing air into the cargo system, it is essential that all hydrocarbons are purged from the system to prevent formation of flammable mixtures. This operation, the objective of which is to replace all the methane gas in the cargo tanks and cargo pipe work by inert gas, is carried out as an intermediate step between Warm-up and Aeration.

- The procedure is essentially the same as for Inerting After Refit, but with the following difference: completion of each step in purging has the object of achieving a hydrocarbon concentration of 1% volume or less.

III.1.10 Aeration

- Aeration is carried out immediately after Inerting Before Refit. The objective is to replace all inert gas in the cargo tanks and cargo pipe work with air. Again the procedure is essentially the same as for Inerting After refit, but with the following differences:

1) Completion of each step in aeration has the object of achieving an oxygen content of 20% or more. At the same time, the carbon dioxide content should be less than 0.5% and carbon monoxide content should not exceed 50 parts per million (ppm). Taking regular samples and measuring oxygen content will monitor aerating progress. Only after the oxygen content is confirmed at 20% or more at all sampling points should carbon dioxide and carbon monoxide content measurements are made. The portable gas analyzer is provided with carbon dioxide and carbon monoxide detector tubes of various ranges.

2) In preparation, almost all checks will have already been covered by those made in preparation for Inerting After Refit. In addition, the nitrogen bleed to the insulation spaces should be shut off and the Nitrogen Gas Generator shut down. It should be verified that the Inert Gas Generator has been changed to "Air Production" mode and that the unit has settled down and is producing good quality dry air before changing delivery back to the cargo system.

III.2 Cargo Operation and Safety Concept

a. The ship must never start cargo pumps until asked to do so by the Terminal Control Room.

b. Under normal operational conditions, valves in use should be fully open. However, loading valves are partially closed when topping-off, and pump discharge valves are controlled within the permissible range to prevent overload or cavitations. Cavitation is indicated by fluctuations in pump current and discharging pressure. The vapor line valves at the tank domes are locked open under normal circumstances.

c. The blank flanges fitted to the manifold must be kept in place at all times except when connecting to load or unload.

d. Special care must be taken to avoid LNG leaks, as the temperature of liquid can cause fracture on the steel deck. Expansion bellows and welded joints should be inspected regularly where possible. Manifold flange joints are to be checked under nitrogen pressure with a soap solution prior to loading or unloading.

e. Cargo and spray pumps that have been disconnected or exchanged during refit periods, should be tested at initial cooldown (when LNG inside the cargo tank is at a suitable depth) to ensure correct operation and rotation. Starters and motor insulation should be checked during each loaded voyage.

f. Taking great care during refit and maintenance operations eliminates the presence of water or other contaminants in the cargo system. Inerting and purging procedures are to be strictly followed. Cargo manifold strainers are fitted at the Loading and Unloading ports to prevent the possibility of contamination.

III.3 Loading Concept

Cargo loading can be carried out using vapor line (vapor header) and liquid line (liquid header). Where vapor is carried out with shore vapor return facilities, liquid is taken on board through the liquid header and directed to the cargo tanks. Vapor generated is returned ashore via the vapor return connection using the cargo compressor in order to control the tank pressure. This is the reason why operation is done on a closed cycle.

III.3.1 Operation planning

a. Comply with the "Cargo Operation Manual."
b. Decision of topping-off liquid level in accordance with loading/filling restrictions.
c. Total cargo volume on loaded departure.

III.3.2 Preparation

a. Before berthing:

- Tank equator temperature.
- Warming up of HD compressor(Old vessel)
- Fire-fighting gears, gas detectors. Drip trays, manifold water curtain, etc.,

b. After berthing:
- Liquid line temperature.
- Mooring tension.

III.3.3 Operations after berthing

a. Rigging gangway and start manifold water curtain.
b. Connect hull-bonding cable.
c. Connect pneumatic hose and optical cable
d. Connect communication cable.
e. Carryout ship/shore joint check.
f. Pre-loading meeting with terminal staff.

III.3.4 Arm Connection

a. Vapour arm to be connected first.
b. Liquid manifold flange blanks removed and manifold strainers fitted.
c. Arm connection.
d. Pressure test (leak check) with nitrogen gas from shore using soap suds.
e. Purging with nitrogen gas from shore until oxygen is less than 1%.

III.3.5 Initial CTM

a. Stop boil-off gas burning and close Fuel gas valve.
b. Carryout CTM.

III.3.6 ESDS trip test before arm cooldown (warm condition)

a. Initiate ESD signal from ship and shore.

III.3.7 Start transfer of BOG to shore

a. Fully open ship's vapor ESD valve and transfer to shore BOG via HD compressor.

III.3.8 Arm cooldown/ Liquid line cooldown

a. Line-up for arm cooldown.
b. Open liquid manifold manual valves, and other necessary valves.
c. Confirm opening of all liquid branch valves and filling valves at end tanks.
d. Open liquid ESD valves.
e. Carry-out arm cooldown for about 90 minutes.
f. LNG flow is to be controlled from shore.
g. Carry out ship's liquid line cooldown after finished arm cooldown during liquid line cooldown,LNG flow is to be requested by shipside.
h. Filling valve open ratio should be adjusted for even cooling.

III.3.9 ESDS test after cooldown (cold condition)

III.3.10 Start loading

a. After completion of line-up for loading, request shore to start loading.
b. Initiate starting of HD compressor.
c. Some BOG will be sent to ship's boiler as fuel by HD compressor and excess BOG returned to shore.
d. While loading, check manifold pressure, flow sound, tank pressure, loading rate, trim, list, ship movement.
e. Deballasting must be started after settling of loading.

III.3.11Completion of loading

a. Give 1-hour notice and 30, 15 and 10 minutes before slow down of rate.
b. Stop LD compressor and dual burning.
c. Towards the end of the operation request shore to reduce loading rate to achieve topping-off accurately.
d. Carry out closing of filling valve.
e. Complete the loading of each tank.
f. Stop HD compressor.

g. Request shore to stop last loading pump when 10-15 cm from final topping level.
h. The last tank-filling valve must remain open for prevent blocking.
i. Close liquid manifold double shut valves.

III.3.12 Liquid drainage/vapour purging

a. All LNG remaining in the loading arm and manifold connection is to be drained to the cargo tanks through the spray line, assisted by nitrogen pressure from shore.
b. On completion of liquid drainage, close liquid manifold ESD valves.
c. Carry out nitrogen purging of liquid manifold connections until hydrocarbon content is less than 1% at purge valves.
d. Disconnect liquid arm.

III.3.13 Final CTM

- After confirmation of drainage in loading arms, shut vapour manifold ESDV carry-out final custody transfer gauging.

III.3.14 Arm disconnection

a. After final CTM, start vapour arm purge and disconnection.
b. When vapour arm is disconnected, arm disconnection stage is complete.

III.3.15 Restart gas burning and hold meeting.

III.4 Discharging Concept

Cargo unloading can be carried out using a vapour header and a liquid header, same as in loading operation. The use of the ship's submerged cargo pumps is employed. In order to control tank pressure, LNG in cargo tanks can be sent to shore storage tanks, and BOG from shore side with return gas blower to ship's tanks.

III.4.1 Operation planning

a. Compliance with "Cargo Operation Manual."
b. Decision of cargo pumps stop level in accordance with heel quantity.

III.4.2 Line Cooldown

a. Liquid line cooldown is carried out using one spray pump to pump LNG from cargo tank through the spray header to the liquid manifold pipe work.
b. Vapor displaced from the crossover pipe work passes through the liquid header and the spray by-pass and return valves or passes through the liquid header and filling valves to cargo tank.

III.4.3 Preparation

a. Before berthing:
- Liquid line temperature.
- Mega test of cargo and spray pump motor.
- Fire fighting gear, gas detector, drip trays, etc.

b. After berthing:
- Sufficient power available.
- Mooring tension.
- Cargo hydro pump running.

III.4.4 Operations after berthing

a. Rigging gangway and start water curtain.
b. Connect hull bonding.
c. Connect pneumatic hose and / or optical cable.
d. Connect communications cable and test.
e. Carry out joint ship/shore check.

III.4.5 Arm connection

a. Vapor arm to be connected first.
b. Liquid manifold flange blanks removed and manifold strainers fitted.
c. After arms have been connected.
d. Pressure test (leak check) with nitrogen gas from shore using soap suds.
e. Purging with nitrogen from shore until oxygen content is less than 1%.

III.4.6 Initial CTM

a. Stop gas burning and close Fuel gas master valve.
b. Carry out CTM.

III.4.7 Before arm cooldown ESDS trip test (when warm)

a. Initiate ESD signal from ship and/or shore.

III.4.8 Start transfer of BOG to shore

a. Fully open ship's vapour ESD valve and transfer BOG to shore via vapour crossover block valve.
b. Ship's tank pressure is controlled by opening ratio of vapour crossover block valve..

III.4.9 Arm cooldown

a. Open necessary liquid manifold cooldown valves, spray crossover and spray header valves.
b. Open liquid manifold ESD valve
c. Carry out cooldown for about 90 minutes.
d. Start spray pump and terminal staff will request to adjust liquid manifold cooldown valves to maintain appropriate line pressure.

III.4.10 After arm cooldown ESDS trip test (when cold)

III.4.11 Start unloading

a. After completion of line-up for unloading, start cargo pumps in turn.
b. As the vapor pressure falls, request start of shore return gas blower.
c. While unloading check manifold pressure, flow sounds at manifold, tank pressure, liquid level, unloading rate, trim, list, and ship movement.
d. Adjust pump discharge valves to obtain required discharging rate.
e. Ballasting must be started after settling of unloading.

III.4.12 Completion of unloading

a. Give 1 hr., 30 minutes notice to shore before reducing rate.

b. On each tank, stop the non-strip pump (1st pump) at the level about 50 cm. before its finishing level and stop the 2nd pump at finishing level.
c. Request shore to stop RGB.
d. Complete the unloading of each cargo tank in turns.
e. Close liquid manifold double shot valves.

III.4.13 Liquid drainage/vapor purging

a. All LNG remaining in the loading arm and manifold connection is to be drained in the cargo tanks through the spray line, assisted by nitrogen pressure from shore.
b. On completion of liquid drainage, close liquid and vapor manifold ESD valves.
c. Carry out vapor purging of liquid and vapor manifold connections until hydrocarbon content is less than 1% at the purge valves.
d. Start liquid arm disconnection.

III.4.14 Carry out final CTM

III.4.15 Arm disconnection

a. After final CTM, start vapor arm disconnection.
b. When vapor arm is disconnected. Arm disconnection stage is complete.

III.4.16 Restart gas burning and hold meeting.

III.5 Precautions and Reports During Cargo Watch

III.5.1 General Precaution

- At least one person should keep watch near the manifold and turn over his watch on site.
- When turning over your watch, hand over events during your watch, i.e., the present state and schedule in detail.
- If you are not sure or in doubt, check with the officer of the watch.

III.5.2 Duties of deck watchkeeper

The deck watch should report following items to the cargo control room at regular intervals:

- Pipeline check for any LNG or oil leakage.
- Manifold pressure and loading arm condition.
- Mooring condition.
- Gangway condition.
- Emergency towing wires
- Oil spill on sea surface around vessel area.
- Weather and sea condition.
- Unauthorized crafts within vicinity.
- Arrangement of fire-fighting equipment.
- Unauthorized persons on ship.
- Unauthorized photography.
- Loading and unloading of stores.
- Open flames in non-designated areas.
- Confirm all openings to accommodation are closed.
- Other events relevant to present operation and personnel/ship/terminal safety.

IV. EMERGENCY OPERATION

IV.1 DISCHARGING CARGO LEAKAGE FROM HOLD DRIP PAN

In the unlikely event of leakage from a cargo tank, leaking LNG will be directed through the tank insulation to a drain pipe, through a rupture disc and into the hold drip pan of that tank.

Provision is made for leaked cargo to be educted from the hold drip pan and return to the cargo tank. However it is envisioned that under most conditions the liquid would evaporate from the drip pan without the need to use an eductor.

The hold drip pan is the secondary barrier; its purpose is to prevent LNG from coming into contact with the ship's structure. The drip pan which is manufactured from aluminum is designed to contain any leakage of LNG for a period of 15 days when used in conjunction with eductor system.

A small LNG eductor is provided in each hold space. The driving fluid is LNG supplied by the spray pump in the cargo tank. Eductor drive and discharge connections are permanently piped to isolating valves and blank flange connections located near the spray by pass line at each tank dome.

The principal particulars of the hold drip pan, LNG eductor and spray pump are as follows:

Drip Pan	-	Evaporating Capacity:	100 liters/hr
LNG Eductor	-	Drive Capacity:	10 m3/hr
		Drive Pressure:	500 kpa
		Suction Capacity:	1m^3/hr
		Suction Head:	Om LNG
Spray Pump	-	Capacity:	40m3/hr x 135 Total Hd.

Cryogenic flexible hoses are used to connect the eductor connection to the spray system. The discharge of the eductor is returned to the cargo tank filling line.

IV.2 Emergency Discharge by Tank over Pressure

In the unlikely event of the failure of two cargo pumps in any one cargo tank, the remaining cargo can be transferred to any cargo tank by pressurization of the affected tank. The rate of transfer is controlled by the tank pressure.

The transfer operation will normally take place at sea on completion of the unloading and gauging of the tank. The ship will then return to complete the unloading prior to inerting, aerating and replacement of the defective cargo pump.

As an emergency operation, control will be by remote manual control from the IAS or CCR, with personnel available on deck for local monitoring and operation of hand operated valves.

The full safety precautions are to be implemented as for normal cargo transfer operations, including:

- Pressurize fire hoses available

- Dry Powder system available
- Safety Personnel patrolling the cargo areas during the full operation of purging, cooldown and pressurized transfer of LNG.