



When Performance Matters

Innovation, Passion & Reliability

Delivering Successful Ship Designs for more than 60 years

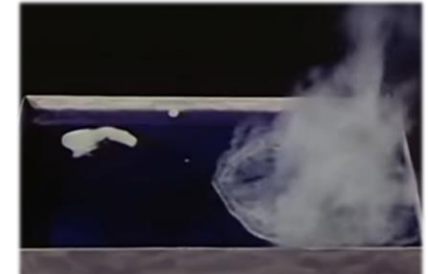
ISO 9001

ISO 14001

LNG

LNG fuel

- What is LNG
 - LNG – Liquified Natural Gas – Methane, propane, butane, nitrogen, CO₂
 - LBG – Liquified Biogas Gas – Methane, CO₂
 - LSNG – Liquified Synthetic Natural Gas – Methane
- Handling and Risk
 - Normal storage temperature at about - 167 C
 - Always evaporated before usage
 - LNG spillage will evaporate
 - Cold NG (Natural gas) will be heavier than air at normal temperatures
 - NG at ambient temperatures are lighter than air
 - Cold LNG can inert an area or compartment from air with risk of suffocation.
 - NG is non toxic, odourless and non visible
 - Can be ignited form 4 to 15% mas composition in air
 - LNG is 600 times more dense than NG
 - Combustion of gas will not be explosive



LNG

LNG Supply system

- Source to ship
 - Production, LNG,LBG,SLNG
 - LNG is primarily transport: ships and pipelines
 - Normally to terminal to terminal and ship to ship.
- Ship to engine
 - Bunkering to LNG tank. NG returned to bunker vessel or the pressure is raised
 - Evaporation at LNG tank supply to engine room at 20-40C
 - External piping is single walled, internal piping dual walled and ventilated or inerted at an over pressure.
 - One Dual walled pipe per consumer with individual one master valve
 - One Gas valve unit (GVU) per consumer (boiler, combustion engine)
 - One boiler running NG is preferred from a safe handling, but it is not required



LNG

LNG Safety concerns

- Cold surfaces
- Fire hazard
- Leakage
- Environmental
- Bunkering

LNG

Cold surfaces

- Normally present in an LNG system
 - Exposed pipes and flanges
 - Generally pipes are insulated or the pipes are shielded such as in the TCS (tank connection space)
 - When working with the cold pipes/hoses safety gear such as adequate clothing and gloves should be used
 - During bunkering
 - Maintenance in TCS
- NG pipes are normally at ambient temperature



LNG

Fire hazard

- Operational deviance
 - Not necessarily a result of failed system
 - Sudden stop of engine – NG filling of exhaust gas system
 - Unintended over pressure in parts of the NG/LNG system
- System failure
 - Pipe leakage
 - In engine room to dual waled pipe vented to dedicated point
 - Outside engine room to atmosphere
 - All likely failures are mitigated and potential lakages are ventilated at safe locations or preferably combusted in the boiler
 - Last resort is to jettison the LNG tank
 - System failure
- External fire
 - Water spray system
 - Controlled burn off of small volumes in un protected pipes



LNG

Leakage

- In engine room
 - Dual walled, ventilated or inerted pipe from Engine room bulkhead to GVU.
 - Dual walled pip from GVU to combustion chamber or ESD shutdown of the room where single walled NG pipes are present.
 - ESD room will require air lock
 - ESD of room where ME is situated will mean shutdown of main engine
 - Dual walled pipe for ME will mean switchover to diesel operation (not loss of propulsion power)
- Outside NG pipes
 - Vent to atmosphere on cargo deck which is a safe area

LNG

Environmental

- Generally positive
 - Less emissions of CO₂, PM, NO_x, SO_x
 - No sticky residuals in case of leakage only gas which cannot be cleaned up
 - Potent GHG of leaked fuel

Bunkering

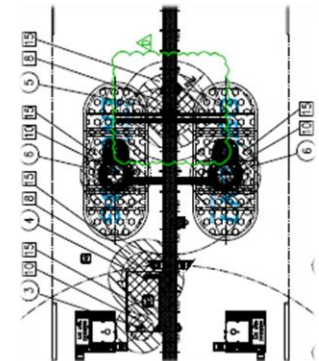
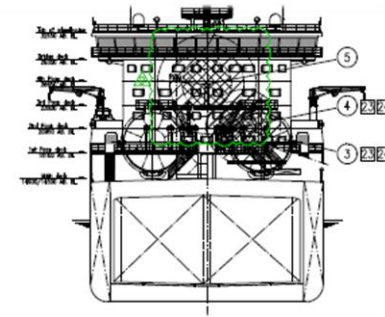
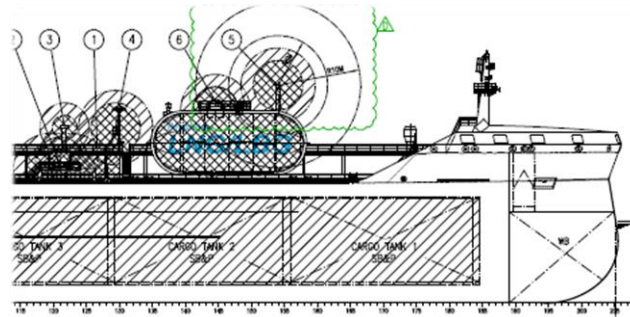
- Outside LNG Bunkering
 - A leakage during bunkering, not likely but with large consequences
 - Ship side cold rupture
 - Ship side rupture due to explosive evaporation of LNG
(instant expansion with a expansion factor of 600 times the volume)
 - SS steel in spill trays
 - Water curtain along ship side
 - Brake away connection
 - ESD connection between ships to shut off pumps and close valves



LNG

LNG Safety mitigation

- HAZID
 - Identify risk
 - Mitigate risk
- Hazardous zone arrangement
 - Related to cargo
 - Related to LNG/NG
 - All equipment in hazardous zones to be EX/ATEX
- Prevention of accumulation
 - Ventilation
 - Explosion relief valves on exhaust gas system
 - Gas detectors in compartments
- Bunkering
 - Breakaway connection
 - Ship to ship communication ESD





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