LIQUEFIED GAS HANDLING

By Assistant lecturer: Omer H. Kanam
College of Petroleum and Mining Engineering
Mining Department-III-CLASS
University of Mosul
LEC. NO. 7 & 8

Liquefied Gas Handling

- **What is L.G?**

- **Gas Codes?**
- Gas carriers built after June 1986 (the IGC Code)
- Gas carriers built between 1976 and 1986 (the GC Code)
- Gas carriers built before 1977 (the Existing Ship Code)

Differences

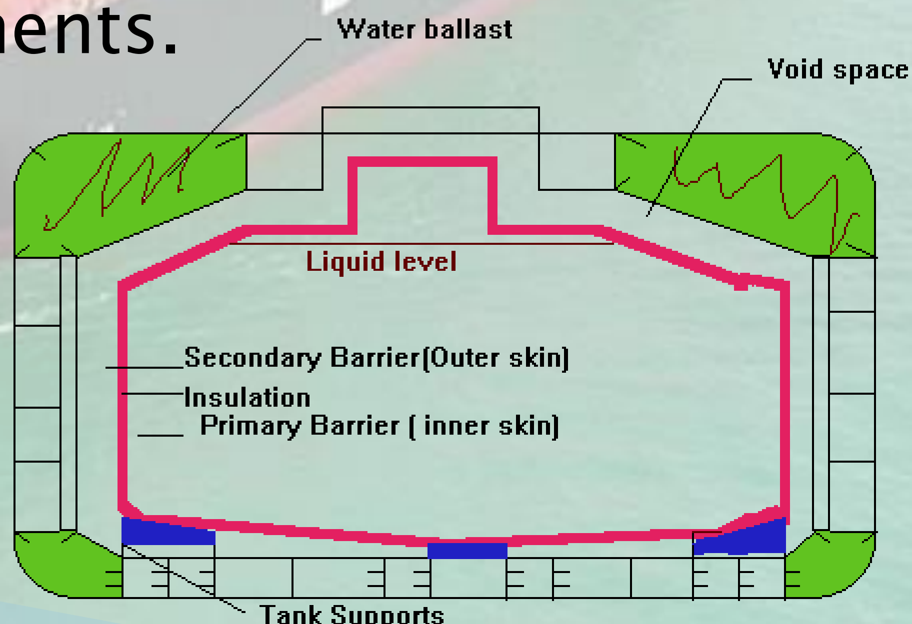
LPG	LNG
Propane, Butane	Methane
C_3H_8	CH_4
Higher Energy Content (93MJ/m^3)	Lower Energy than LPG (38.7MJ/m^3)
Proper combustion Air/Gas=25:1	Air/Gas=10:1
Density = 1.5219 kg/m^3	Density = 0.5537 kg/m^3
Settle	Rises
Compressed into liquid at low pressure	Compressed into liquid at atm. pressure

Design Factors

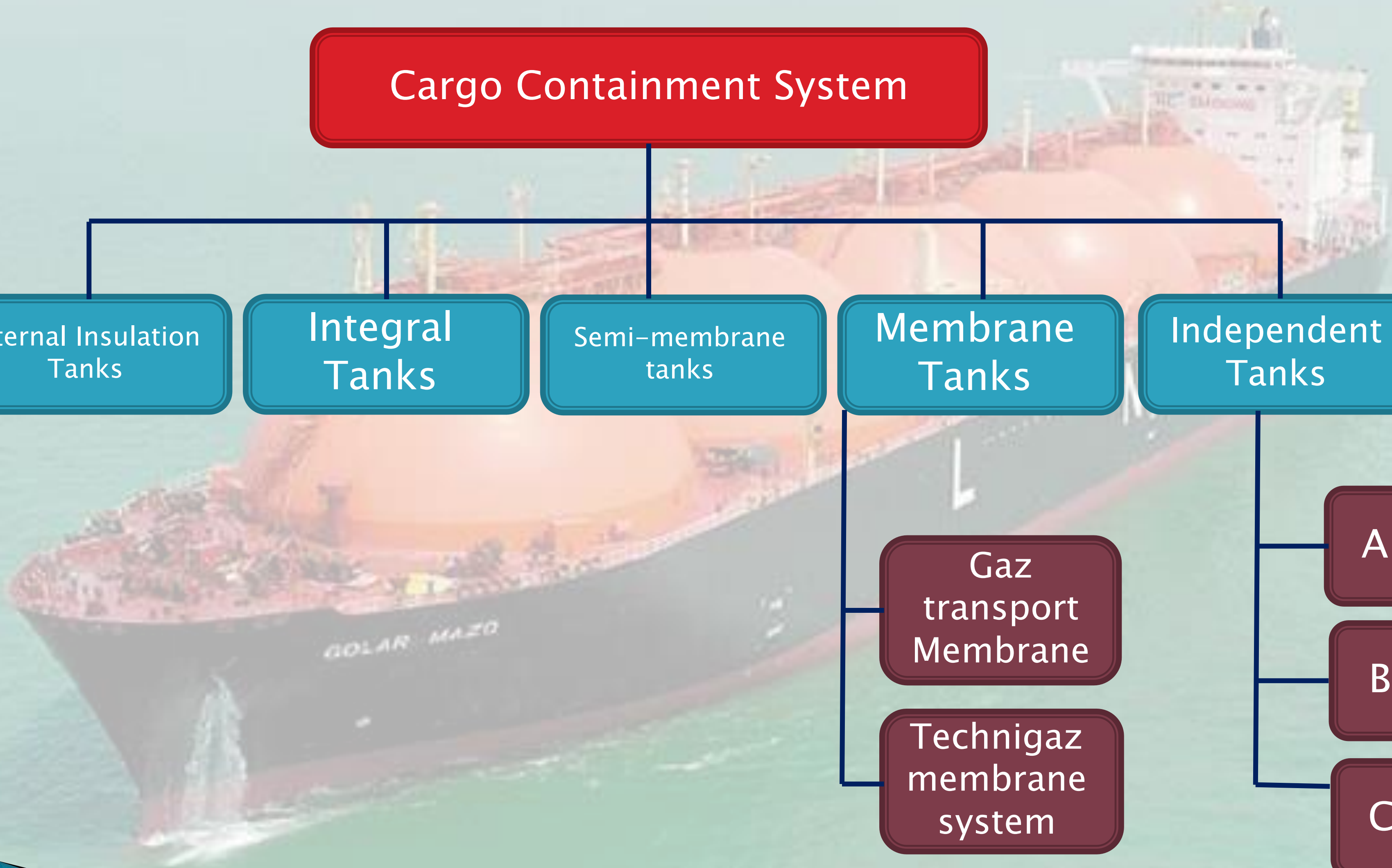
- Types of cargo to be carried
- Condition of carriage (fully pressurised, semi-pressurised, fully refrigerated)
- Type of trade and cargo handling flexibility required by the ship
- Terminal facilities available when loading or discharging the ship

CARGO CONTAINMENT SYSTEMS

- A primary barrier (the cargo tank),
- Secondary barrier (if fitted),
- Associated thermal insulation,
- Any intervening spaces, and
- Adjacent structure, if necessary, for the support of these elements.



CARGO CONTAINMENT TYPES



- Cargo Containment System
  - Internal Insulation Tanks
  - Integral Tanks
  - Semi-membrane tanks
  - Membrane Tanks
    - Gaz transport Membrane
    - Technigaz membrane system
  - Independent Tanks
    - A
    - B
    - C

CARGO TANK TYPES

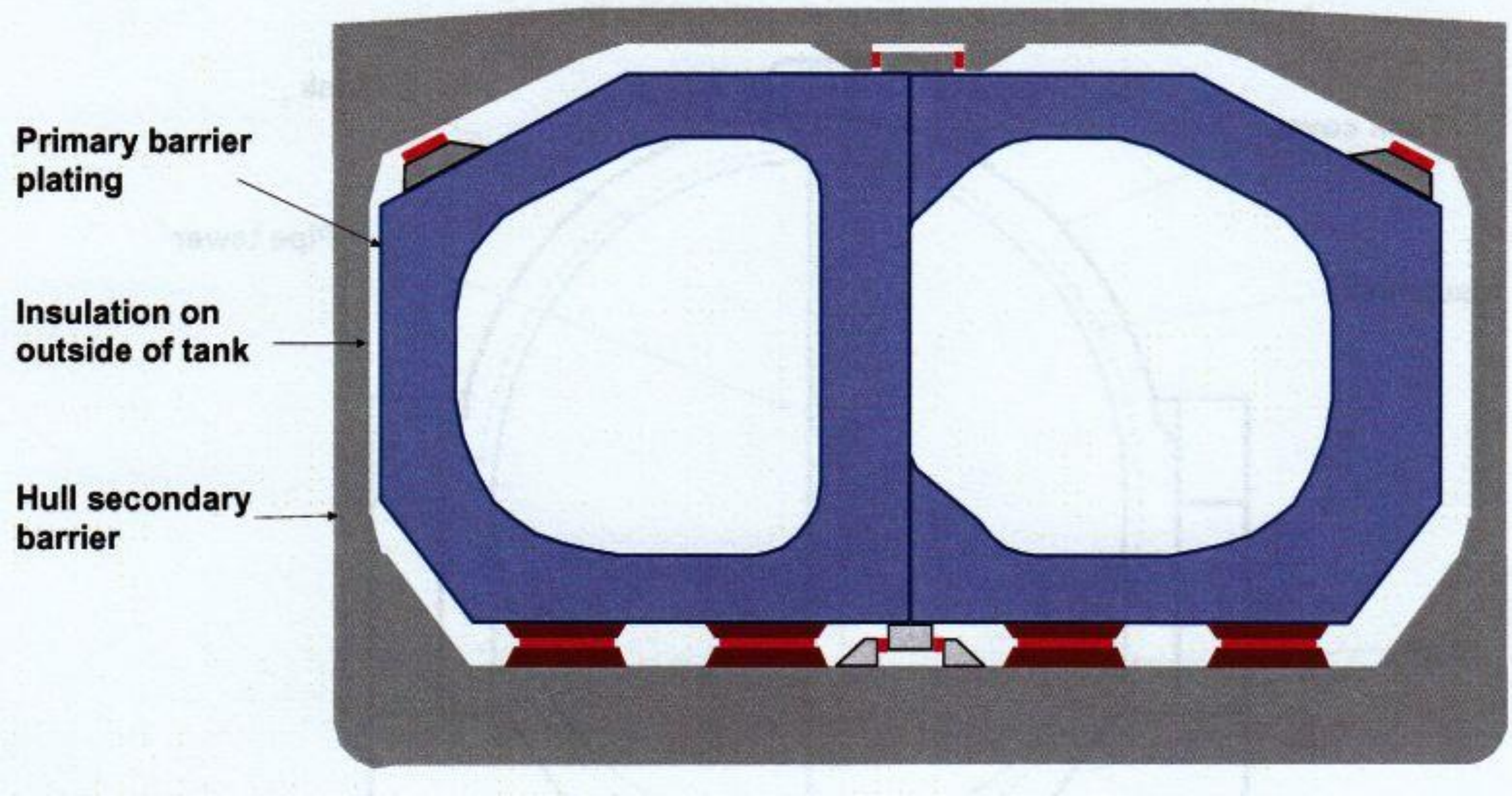
- **Independent tanks (Type A,B, and C)**
- Self Supporting (not a part of ship structure)
- Do not contribute to the hull strength of a ship
- Depends on the design pressure

CARGO TANK TYPES

- **Independent tanks (Type A)**
- Constructed of flat surfaces, prismatic tank
- MADP=0.7 bar
- Cargoes carries in a fully refrigerated Condition
- Self Supporting
- Hull space is filling with perlite insulation
- Need secondary barrier because it’s material not crack propagation
- Secondary barrier prevent leakage for 15 days and to carry cargoes below -10
- Hold space must fill with inert gas to prevent flammable

CARGO TANK TYPES

- **Independent tanks (Type A)**

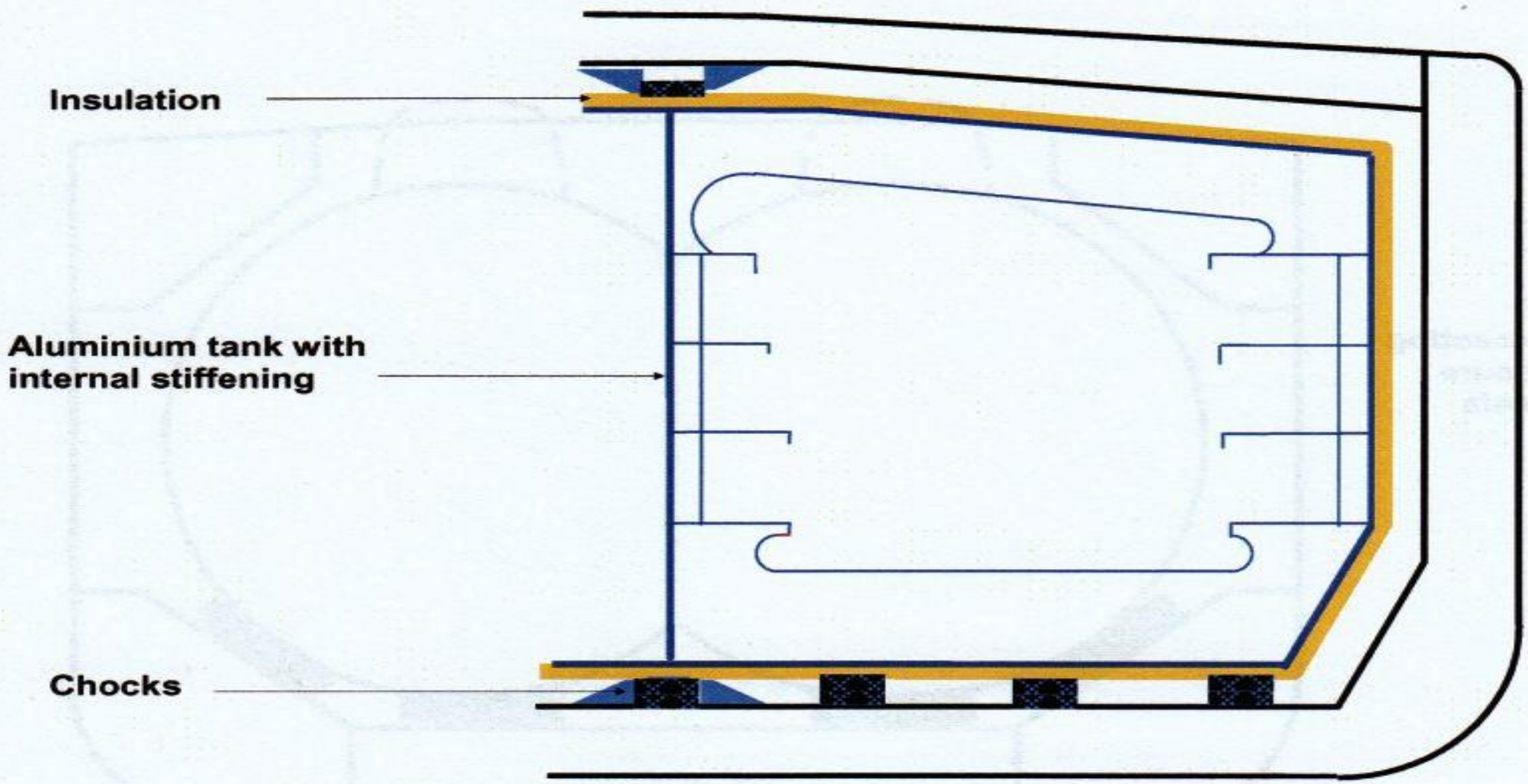


CARGO TANK TYPES

- **Independent tanks (Type B)**
- Flat or Spherical Surfaces
- Depends on detailed stress analysis while designing (fatigue life & crack propagation analysis)
- Spherical tank required partial secondary barrier (drip tray)
- Hold space filled with dry inert gas
- Steel dome covers the primary barrier above deck level
- Insulation on the outside of the tank
- Spherical tank exclusively applied to LNG ships, seldom to LPG trade
- Prismatic shape has benefit of maximising ship hull volumetric efficiency
- MADP=0.7 bar

CARGO TANK TYPES

- **Independent tanks (Type B)**



CARGO TANK TYPES

- **<u>Independent tanks (C)</u>**
- Spherical or Cylindrical
- Design stresses are kept low

1. Used for semi-pressurized, & for fully refrigerated carriage at low temp.

- MADP>2 bar, MWP=5~7 bar
- NO secondary barrier
- Hold space can be filled with inert gas or dry air
- Temp. of carrier Gas (-48C for LPG),& (-104C for ethylene)

2. Fully pressurized gas carriers

- MWP=18 bar
- Poor utilization of hull volume

CARGO TANK TYPES

- **Independent tanks (C)**

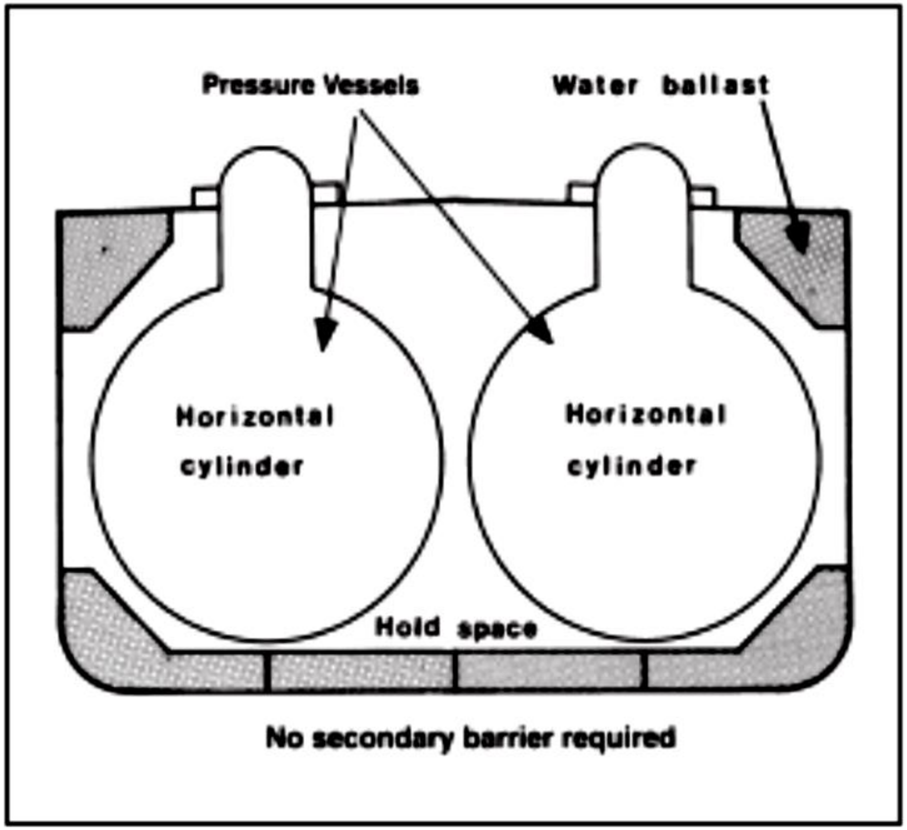


Figure 3.3 Type 'C' tanks — fully pressurised gas carrier

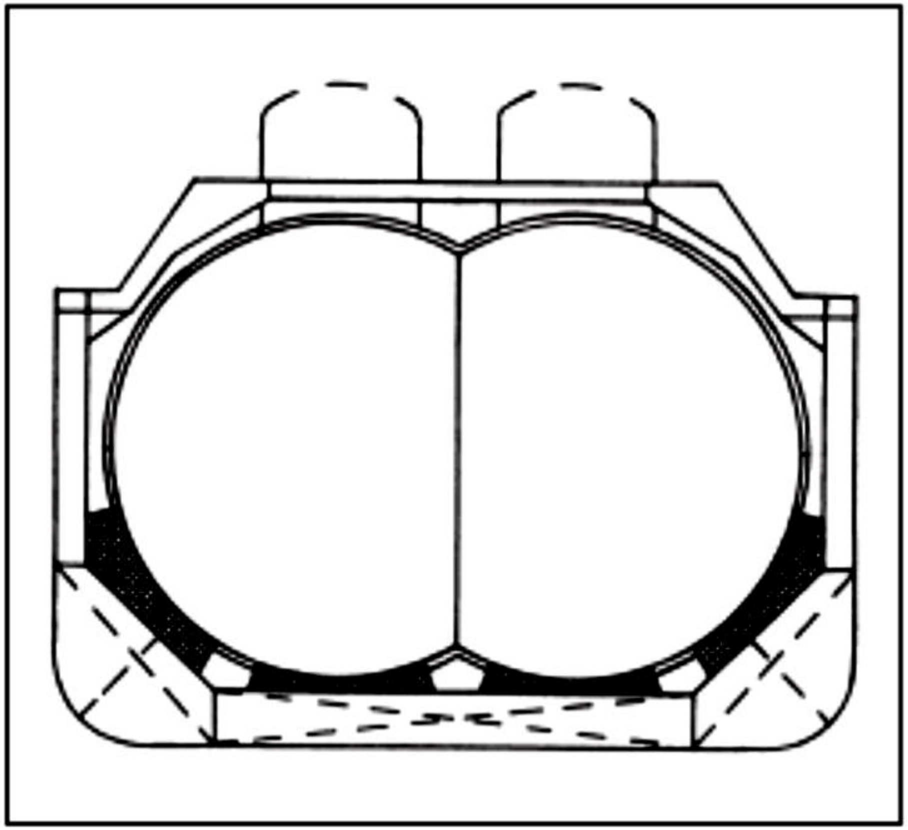


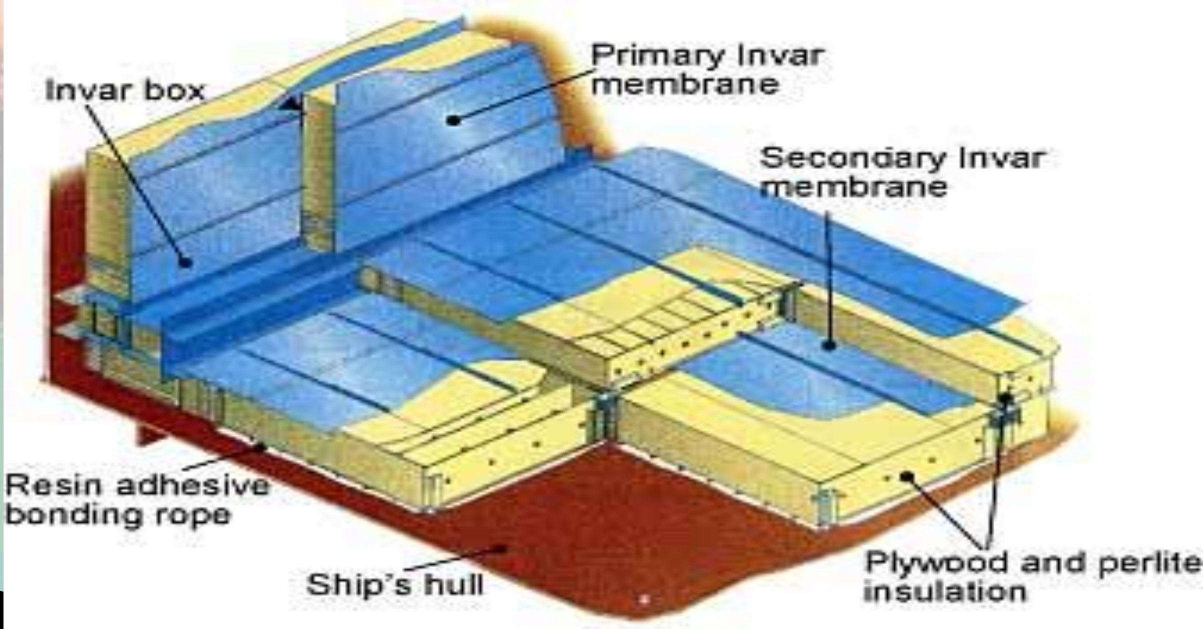
Figure 3.4 Type 'C' tanks — semi-pressurised gas carrier with bi-lobe tanks

CARGO TANK TYPES

- **Membrane Tanks**
- Very thin primary barrier (**0.7 to 1.5 mm thick)**
- Not self supporting
- Supported through insulation inner hull
- Always provided with secondary barrier (to integrate in case of leakage)
- Both Principle types of membrane carry LNG.
- Constructed from invar (36% nickel & 0.2% carbon)
- Perlite filled plywood boxes is a primary insulation (200-300 mm)

CARGO TANK TYPES

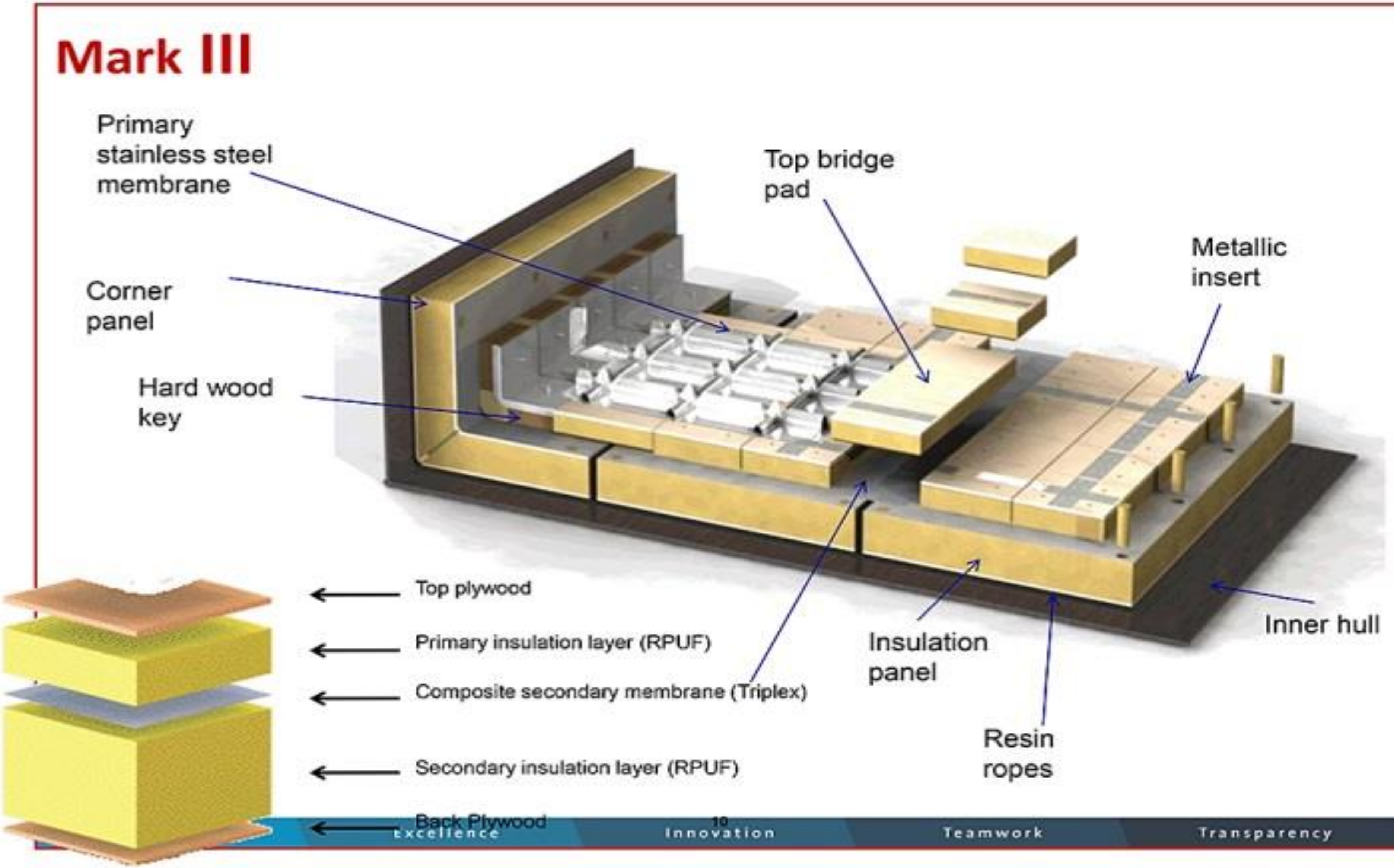
- **Gaz Transport Membrane System**
- Invar (0.7 mm thickness & 0.5 m width)
- Invar is used because it's low thermal coefficient of thermal expansion
- Plywood boxes to hold perlite insulation
- Perlite processed with a silicon to impervious to water or moisture



CARGO TANK TYPES

- **Technigaz Membrane System**
- Primary barrier of S.S. (1.2 mm thickness)
- Having raised corrugations to allow expansion and contraction
- Mark-I type design insulation consists of balsa wood panels held between two plywood layers
- Mark-III type design insulation replaced balsa wood by reinforced cellular foam
- A secondary barrier is a fiberglass aluminum laminate

Technigaz Membrane System

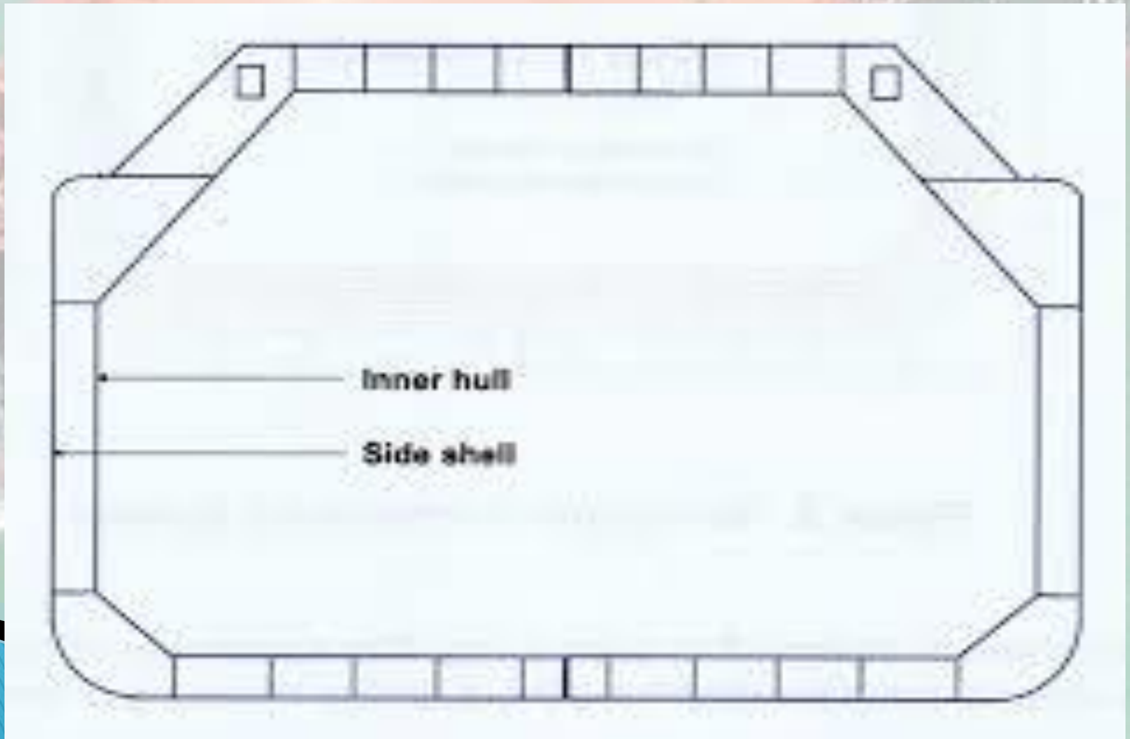


CARGO TANK TYPES

- **Semi-membrane tanks**
- Primary barrier is much thicker
- Flat sides & Larger radiused corners
- Self-supporting when empty but not loaded
- Corners & edges are designed to accommodate expansion & contraction
- Designed to carry LNG and fully refrigerated LPG

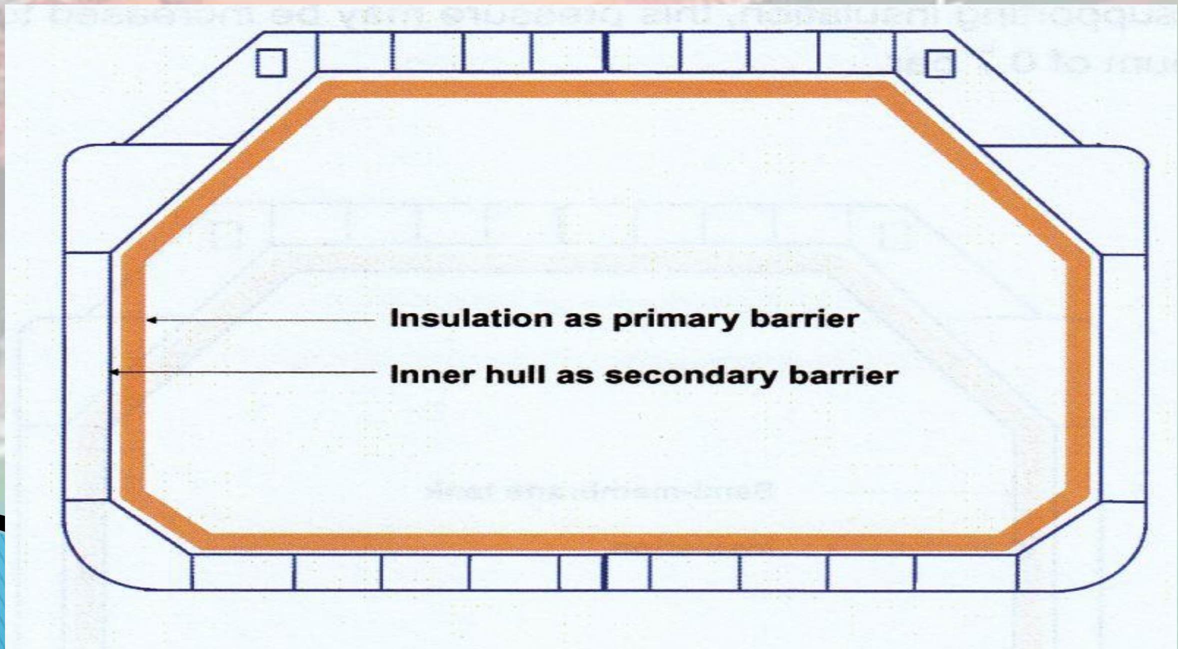
CARGO TANK TYPES

- **Integral Tanks**
- It's part of ship's hull.
- influenced by the load which stress the ship's hull
- Not allowed to carriage of L.G. if cargo temp.<-10



CARGO TANK TYPES

- **Internal insulation tanks**
- Similar to integral tanks in term of internally insulated cargo
- Not self supporting
- Carry L.G which is below -55 C
- Fully refrigerated LPG carrier



END OF PART-I

PART-II

MATERIALS OF CONSTRUCTION

- Minimum Service Temp.
- Low temp.–toughness (this is vital because metals become brittle below a certain temperature).
- Carbon steel, SS, INVAR (% Ni & % Iron), and aluminum is used to achieve low temperature characteristics.
- E.X. Ships carrying fully refrigerated LPG have tanks capable of withstanding temp. down to –55 C.
- Boiling point of liquid at atmospheric pressure.
- Fully refrigerated ethylene (B.P.T=–104C) OR LNG (B.P.T.=–162C)

TANK INSULATION

- **Thermal insulation must be fitted to refrigerated cargo tanks for the following reasons:**
- To minimize heat flow into cargo tanks, thus reducing boil-off.
- To protect the ship structure around the cargo tanks from the effects of low temperature.
- **Characteristics of Insulation Material:**
- Low thermal conductivity
- Ability to bear loads
- Ability to withstand mechanical damage
- Light weight
- Unaffected by cargo liquid or vapour

GAS CARRIER TYPES

- Fully pressurised ships
- Semi-pressurised ships
- Ethylene ships

} smaller size shipment

- Fully refrigerated LPG ships
- LNG ships

} Large size shipment

GAS CARRIER TYPES

- **Fully Pressurised Ships**
- Simplest type
- Fitted with Type C tanks (Design Pr=18 bar)
- No thermal insulation or reliquefaction plant is necessary for these ships and cargo can be discharged using either pumps or compressors
- Heavy because it's design pressure.
- Capacity (4000-6000 m^3)
- Carry LPG & Ammonia
- No secondary barrier required because it's fitted with type C
- Hold Space ventilated with air.
- Discharging by pumps or compressors

GAS CARRIER TYPES

- <u>Semi-pressurised ships</u>
- Fitted with type C tanks (M.W.P=5~7 bar)
- Less weight because of reduction in Design Pr.
- Carry gases such as (LPG, vinyl chloride, propylene, butadiene)
- Capacity (3000-20,000 m^3)
- No secondary barrier required because it's fitted with type C
- Suitable with temp.<-48 C if low temp steels used and -104 C if special alloyed steels or aluminum used
- Discharging/Loading through refrigerated or pressurised facilities

GAS CARRIER TYPES

- **<u>Ethylene ships</u>**
- Built for specific trades but will also operate carrying LPGs or Chemical Gases
- Normally Fitted with type C tanks also A, & B
- Capacities (1000–12000 m^3)
- No secondary barrier is required for type C
- Thermal insulation required
- High-capacity reliquefaction is required
- Double hull is required for cargoes carried <–55

GAS CARRIER TYPES

- **<u>Fully refrigerated ships</u>**
- Carry cargoes at atmospheric pressure
- Carry large quantities of LPG & Ammonia
- Fitted with (Independent, Integral, semi-membrane tanks) (M.W.P=0.7 bar)
- Low temp steel used to permit carriage temp<-48
- Capacity (20,000-100,000 m^3)
- It has 6 cargo Tanks
- Tanks supported on wooden chocks (Allow expansion & contraction & prevent movement of tanks under static & dynamic loads)

GAS CARRIER TYPES

- **<u>Fully refrigerated ships</u>**
- Tanks provided with anti-chocks to avoid lifting in case of ballast tank leakage
- Thermal insulation & reliquefaction is required
- Heaters & booster pumps are provided to allow discharging
- Secondary barrier required when type A used
- Hold space must inerted when carrying flammable cargoes

GAS CARRIER TYPES

- **LNG ships**
- Carry large volume of LNG at B.P.=-162 C
- Capacity (125,000-135,000 m^3)
- Containment systems types are (Gaz Transport membrane, Technigaz membrane, Independent B, Prismatic)
- All LNG ships have double hull through cargo length
- Secondary barrier required
- cargo boil-off is burned as fuel.
- Hold spaces around the cargo tanks are continuously inerted, except spherical type B, it filled with dry air

GAS CARRIER TYPES

- **<u>LNG ships</u>**
- Continuous gas-monitoring of all hold spaces is required.
- Reliquefaction is required
- Most LNG carriers have steam turbine propulsion plants.

GAS CARRIER LAYOUT

- Pump room & pipelines should not be placed below the upper deck therefore, submersible pumps used for cargo discharge
- Pipelines to cargo tanks must be taken through a cargo tank dome which penetrates the deck
- Where ships are fitted with a reliquefaction plant, this is located in a compressor house on deck.
- Adjacent to the compressor house is an electric motor room which contains the machinery for driving the reliquefaction compressors.
- Electric motor and compressor rooms separated by a gas tight bulkhead

GAS CARRIER LAYOUT

- Pr+ ventilation for the electric motor room & Pr– ventilation for the cargo compressor area.
- Airlock entrance provided to motor room with two gastight doors (1.5m apart)
- Doors should be self closing to ensure they are not open & alarms must provided
- A cofferdam required between cargo area & engine room & fuel tanks
- Fire protection system fitted on Gas tankers (water spray)

GAS CARRIER LAYOUT

- Cargo tank=evaporators
- Cargo=Refrigerant
- Seawater=coolant of the condenser
- The reliquefaction is boil off vapour to sufficient pressure to be liquefied against normally seawater
- The vapours created due to the ambient heat input (while maintaining constant pressure in the storage vessel) are called “boil-off”.

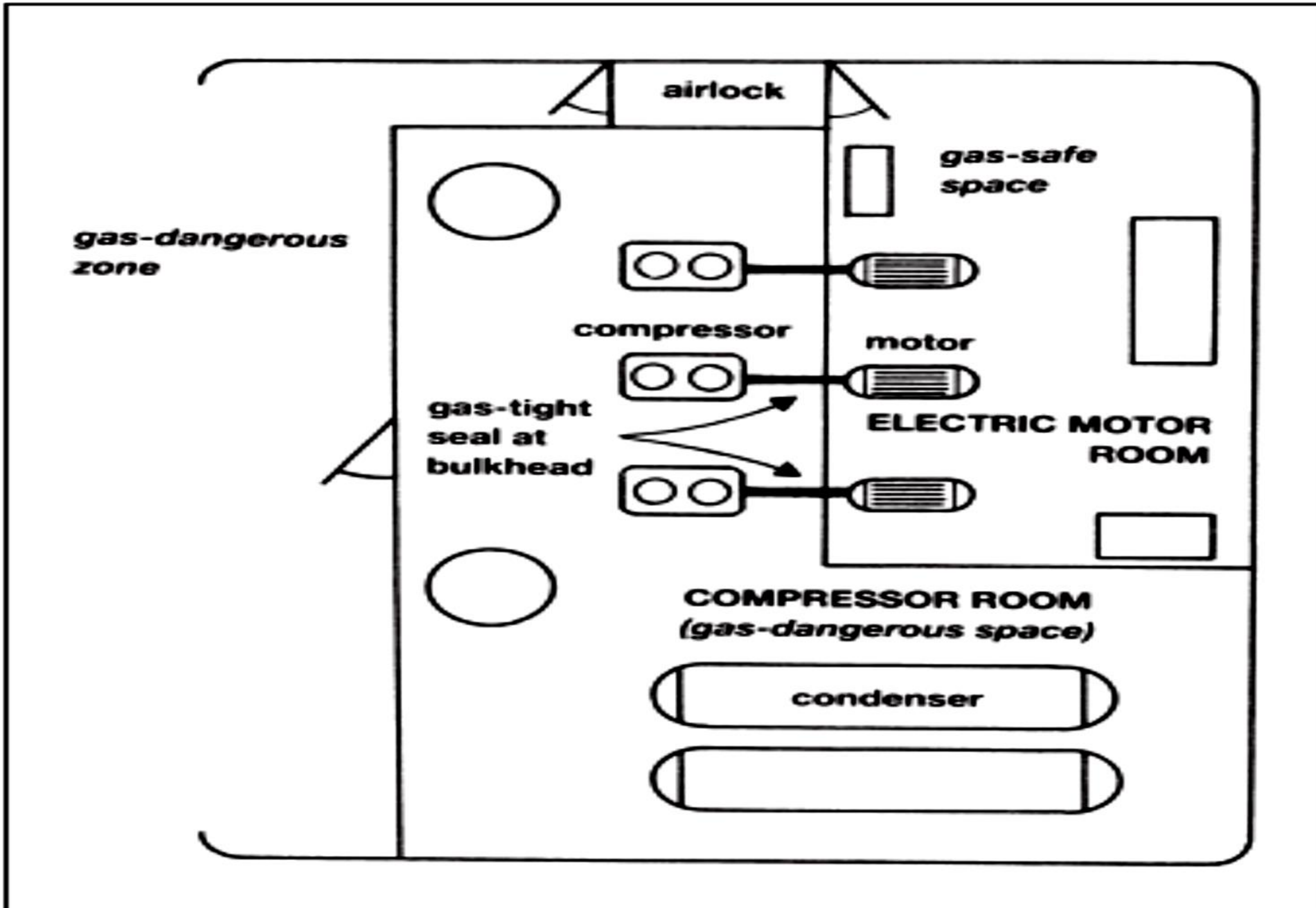


Figure 3.7 Compressor room/electric motor room on a gas carrier

Fire Protection System

- A water spray fitted on the following area:

1. Cargo tank domes
2. Cargo tank areas above deck
3. Cargo manifold areas
4. The front of the accommodation including lifeboat boarding areas
5. Control room bulkheads facing the cargo-deck

- Dry powder must fitted on Gas tankers too
- Dry powder installation is activated by nitrogen pressure which is stored in cylinders adjacent to the powder containers.

Questions?

Thank you