WHEN TRUST MATTERS

Methanol as fuel

Practical guideline

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An independent assurance and risk management company

158
years

~12,000
employees

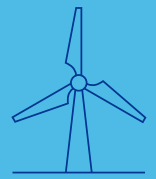
100,000
customers

100+
countries

5% R&D
of annual revenue

Ship and offshore classification and advisory

Energy advisory, certification, verification, inspection and monitoring



Management system certification, supply chain and product assurance

Software, platforms and digital solutions

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The world’s leading ship and offshore classification society

Global reach

Survey stations in 65+ countries and expertise in all ship and offshore segments

20%

market share of the world’s classed ships and mobile offshore units (gross tonnage)

10,563

ships + mobile offshore units in DNV Class
(286,6 mill GT, Feb 2022)

Quality

Among the top-ranking societies in Port State Control performance

DNV dominates the top 10 class society list 6 years in a row: Lloyd's List *Published:* 11/29/2021 *Last updated:* 11/30/2021

One of the most important and widely read maritime newspapers, Lloyd's List has awarded DNV the number 1 position among class societies once again in 2021.

Some important facts about methanol

Physical properties

- Methanol (CH_3OH) is the simplest alcohol with the lowest carbon content and highest hydrogen content of any liquid fuel.
- Methanol is a colourless liquid at ambient temperature and pressure.
- Methanol is a low flashpoint liquid, with a flashpoint of 11ºC
- Methanol has toxic and corrosive properties.

Physical properties compared to oil fuels

METHANOL PROPERTY	VALUE
Energy density (MJ/L)	15.7
Heat of vaporization (kJ/kg)	1098
Autoignition temperature (°C)	450
Liquid density (kg/m3)	798
Adiabatic flame temperature at 1 bar (°C)	1980
Molecular weight (g/mol)	32.04
Melting point (°C)	-97.8
Boiling point at 1 bar (°C)	65
Critical temperature (°C)	239.4
Critical pressure (bar)	80.48
Flammable range in dry air (%)	6 - 36.5
Cetane number	< 5
Octane number	109
Flash point (°C)	12
Heavy Fuel Oil (HFO) equivalent volume	2.54

- **Low volumetric energy density** (15.7 MJ/L versus 36.6)
- **High auto ignition temperature** (450ºC versus 220ºC)
- **Wide flammability range in air** (6-36% versus nil)
- **Low flashpoint** (12ºC versus >60ºC)

What are the safety risks involved?

TOXICITY

FIRE & EXPLOSION

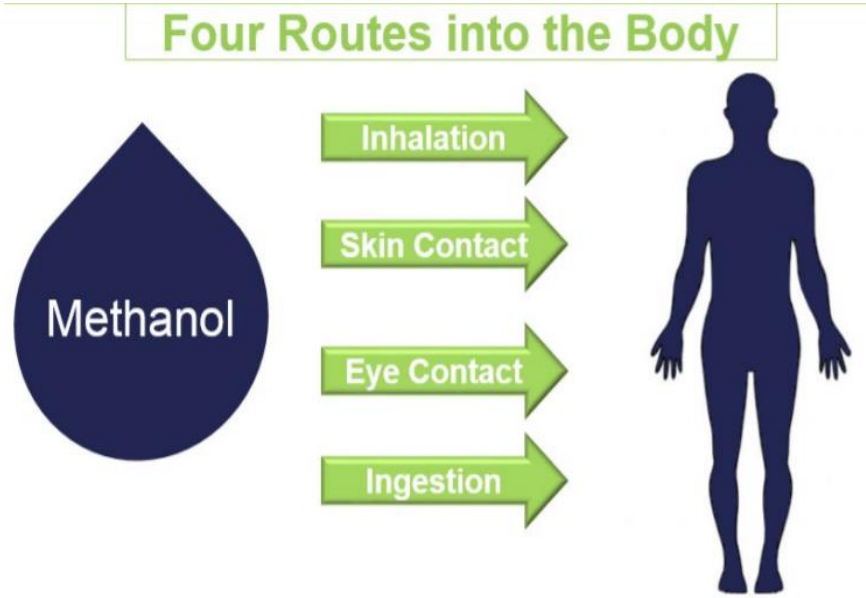
Toxicity to humans

Methanol is toxic and poisonous to the central nervous system

- ✓may cause blindness, coma, and death if ingested
- ✓to be handled carefully if spilled or leaked in confined spaces or on deck

Since its vapor is heavier than air, it increases the risk of inhaling the vapor by the onboard crew.

At high vapor concentrations, methanol **can also cause asphyxiation**.



Permissible Exposure Limit is **200 ppm** time-weighted average (TWA)

(Source: The Occupational Safety and Health Administration (OSHA))

Immediately Dangerous to Life or Health Concentrations (IDLH) value is **6,000 ppm**

(Source: *The United States National Institute for Occupational Safety and Health (NIOSH)*)

Explosion risk

The low flashpoint of methanol implies that it generates an explosive atmosphere in air when the temperature is above 11°C.

Accumulation of methanol vapours in confined spaces may lead to explosion if ignited.

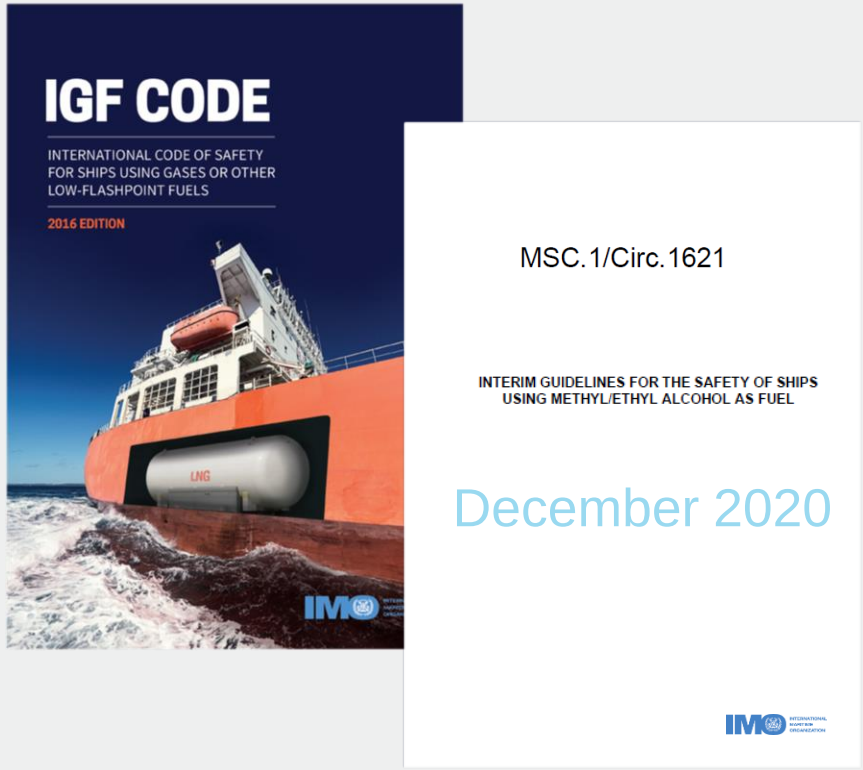
Fire risk

Methanol is highly flammable and constitutes a fire risk in enclosed spaces and on open deck.

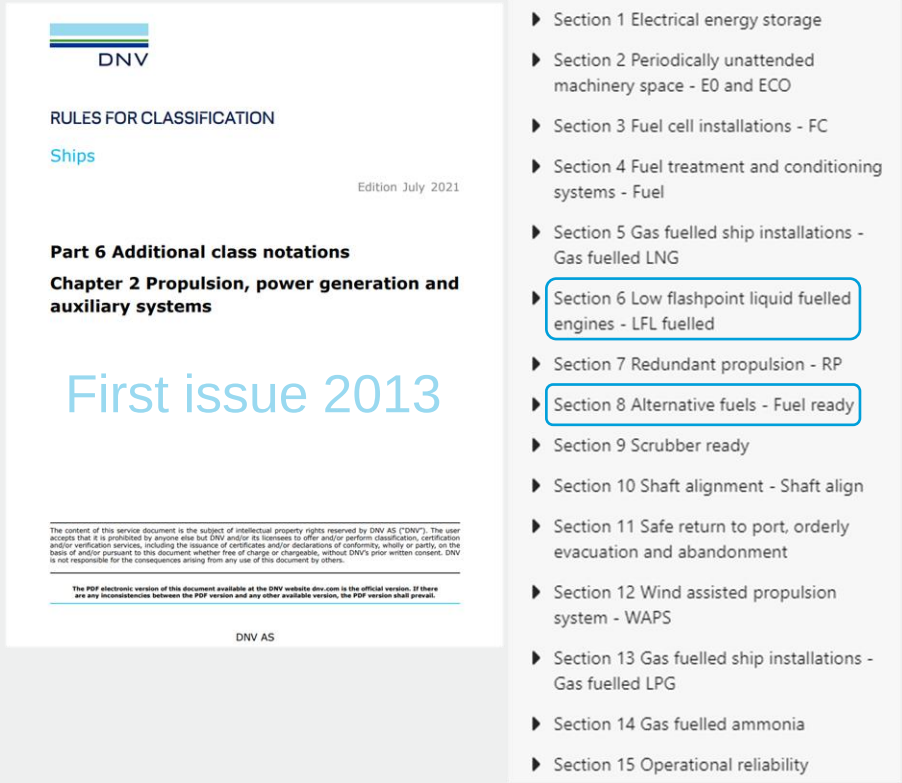
- Methanol flames are particularly hazardous, as they burn at low temperatures with a flame that is nearly invisible in daylight with no smoke.
- A methanol flame often goes undetected until it has spread to adjacent materials that burn in a wider range of light.
- A methanol-water mixture of at least 25% methanol is still capable of burning, so special fire extinguishing practices are to be followed, including the use of alcohol-resistant foams.

Rules & Regulations

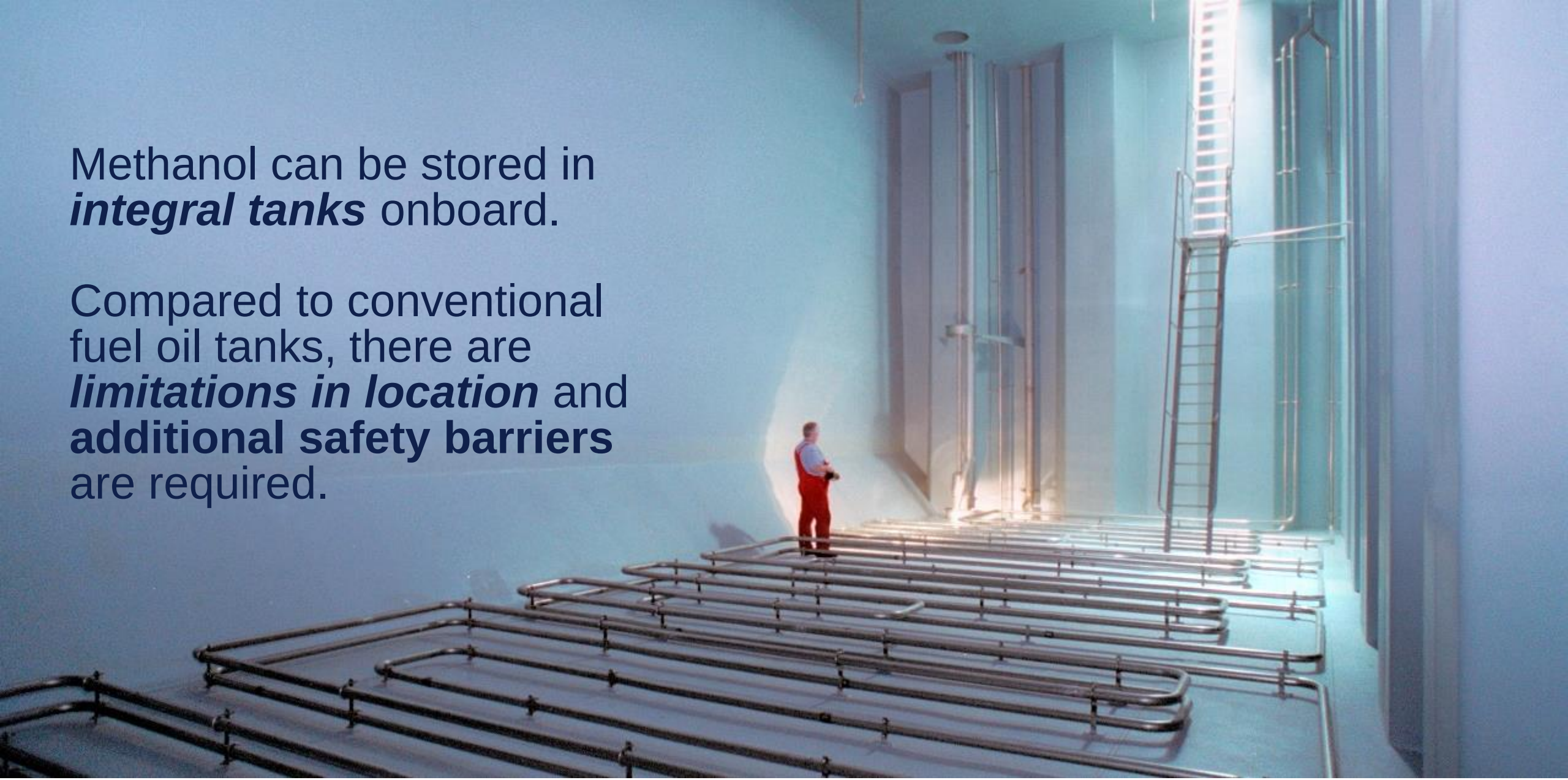
Regulatory status for methanol as fuel



The IMO Interim Guidelines For the Safety of Ships Using Methyl/Ethyl Alcohol as Fuel, supplement to the IGF Code, provides an international standard.



DNV class notations ***LFL fuelled*** and ***Fuel Ready(methanol)*** are available.



Methanol can be stored in ***integral tanks*** onboard.

Compared to conventional fuel oil tanks, there are ***limitations in location*** and **additional safety barriers** are required.

Methanol fuel tanks shall not be located:

- ✓ within machinery spaces of category A
- ✓ accommodation spaces
- ✓ forward of the collision bulkhead and aft of the aftermost bulkhead

Methanol fuel tanks shall be surrounded by protective cofferdams.

Except on those surfaces bound by shell plating below the lowest possible waterline, other fuel tanks containing methanol, or fuel preparation space.

Methanol piping and valves

- ✓ Stainless steel piping is recommended.
- ✓ Stainless steel valves is recommended.
- ✓ Stainless steel material should preferably be 316L.
- ✓ Passivation/pickling and flushing of piping with potable quality freshwater is essential at NB stage.

Methanol tank Materials

- ✓ Carbon steel is generally compatible with Methanol.
- ✓ Methanol is however corrosive when water is present.
- ✓ Coating is recommended. Zinc coating is preferable.

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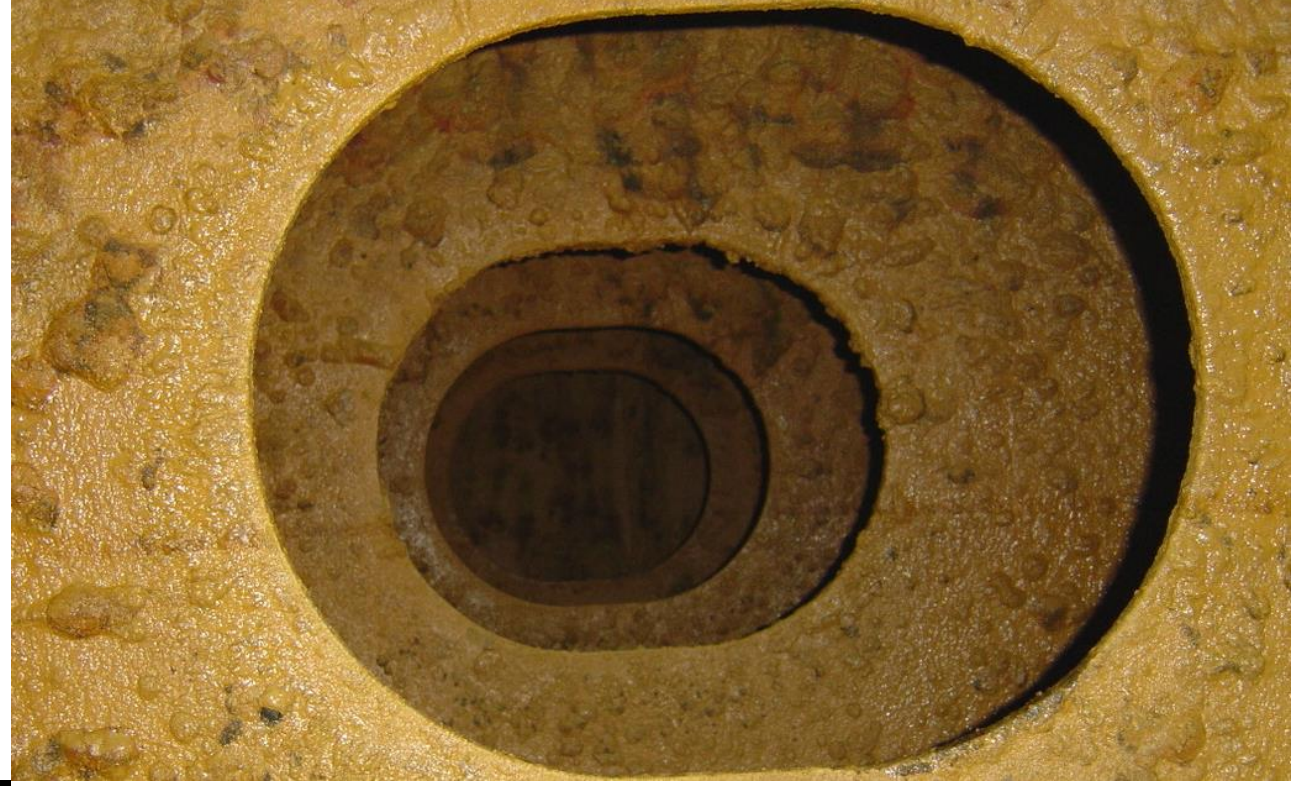
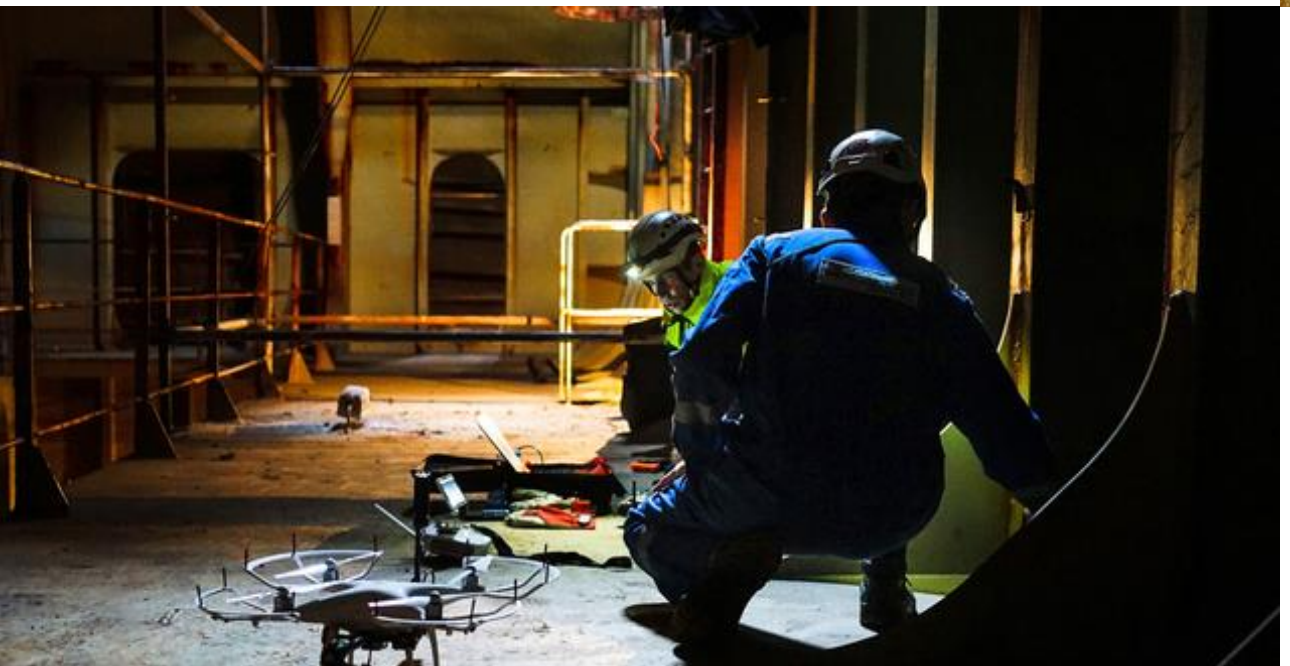
Safe access shall be provided for methanol fuel tanks and cofferdams.

To ensure possibility of evacuation of an injured person from the bottom of the tank or cofferdam.





Unless tank access is directly from open deck, a ***tank entry space*** shall be arranged with:

- ✓ mechanical ventilation
- ✓ sufficient open area for efficient evacuation and rescue operations

Entry from accommodation spaces, service spaces, control stations and machinery spaces shall not be arranged

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Methanol tanks require **controlled venting:**

- ✓ Pressure-vacuum (P/V) valves in open air
- ✓ 15 m safety zone
- ✓ Redundancy

An ***arrangement for inert gas purging and gas freeing fuel tanks*** shall be arranged, such as to minimize the hazards due to the dispersal of flammable vapours in the atmosphere and to flammable vapour mixtures in a fuel tank.

Methanol tank monitoring

Pressure sensors

In lieu of duplicating p/v valves, pressure sensors fitted in each fuel tank, and connected to an alarm system, may be accepted.

Closed level gauging

Each fuel tank shall be fitted with at least one closed level gauging device. Unless necessary maintenance can be carried out while the fuel tank is i n service, two devices shall be installed.

(Low pressure sensor)

Low-pressure alarm shall be provided in the nitrogen supply line on the fuel tank side of any double block and bleed valves and pressure reduction units

If pressure/vacuum alarms are fitted in each fuel tank as means to comply with redundant venting requirements, a separate low-pressure alarm is not required.

High Level alarm

High-High Level alarm

Each fuel tank shall be fitted with a visual and audible high-level alarm an additional sensor (high-high level) operating independently of the high liquid level alarm

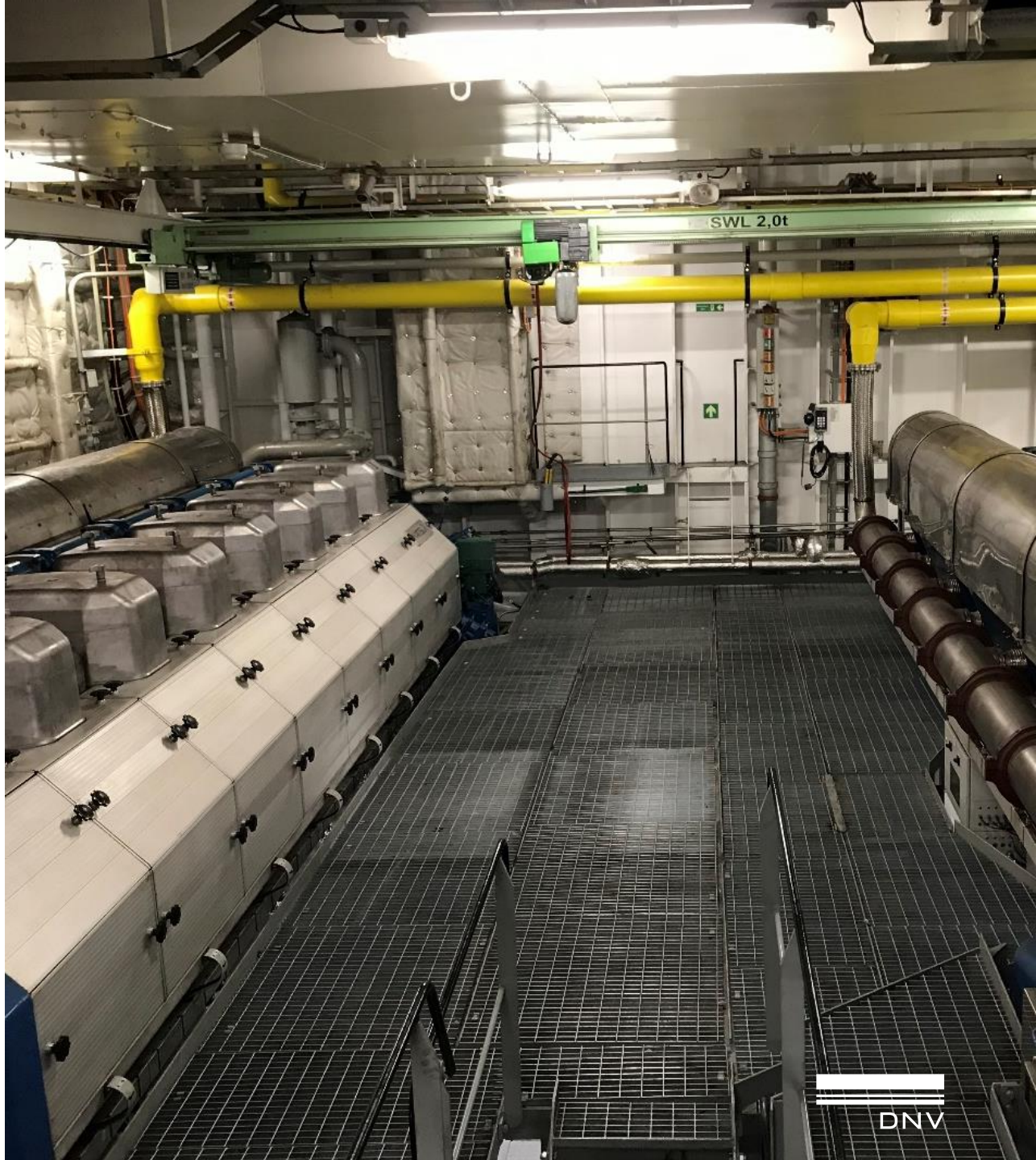
HHL shall automatically actuate a shut-off valve to avoid excessive liquid pressure in the bunkering line and prevent the tank from becoming liquid full

Gas and liquid tight ***double-walled fuel piping systems*** are required in enclosed spaces.

Except in spaces designed for methanol leakages, e.g. fuel preparation rooms.

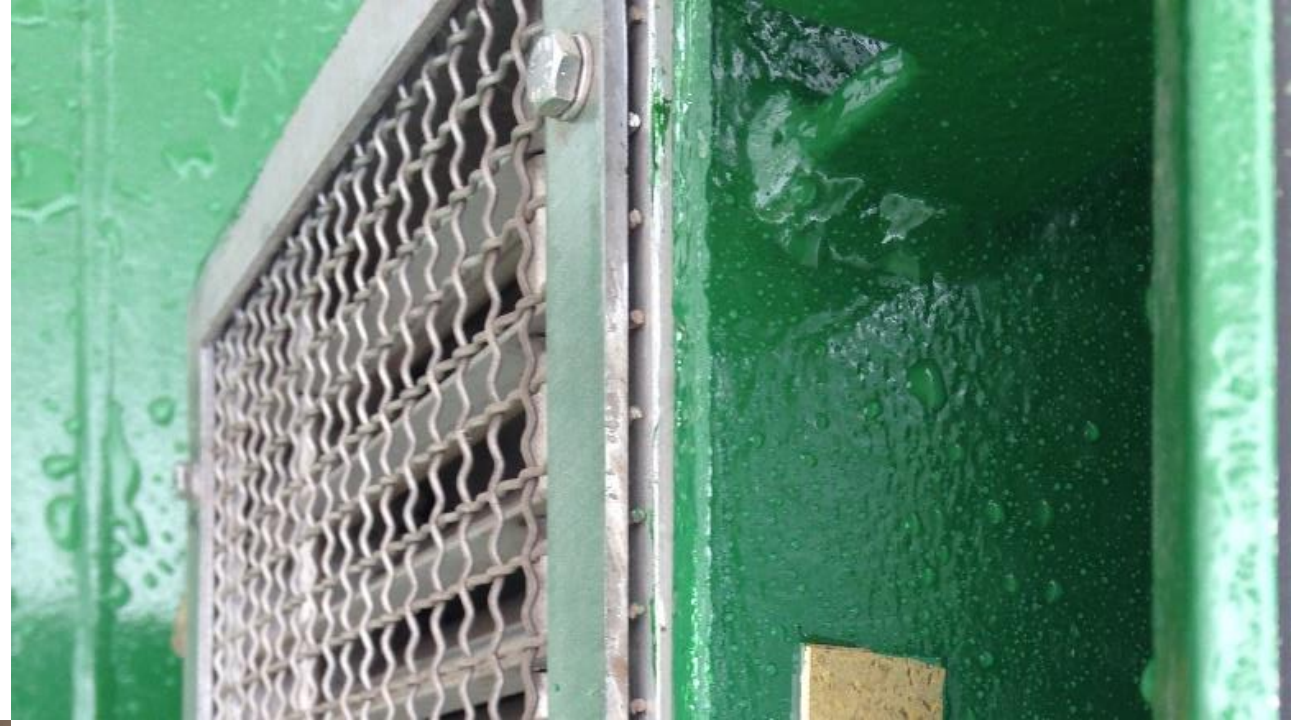
The double walled piping shall be ventilated or inerted (e.g. N_2 pressurized).

An ***arrangement for inert gas purging and gas freeing*** of fuel bunkering-, supply-, return- and vent lines with nitrogen shall be provided.



Separate mechanical ventilation of exhaust type is required in hazardous spaces:

- ✓ Fuel preparation room
- ✓ Double walled fuel piping (inerting is an acceptable alternative)



Enclosed bunkering stations is subject to special consideration with respect to provisions for mechanical ventilation to ensure that any vapour being released during bunkering is removed outside.

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Passive fire protection (A-60) required for:

- ✓ Bunkering station
- ✓ Fuel tank boundaries
- ✓ Fuel preparation spaces

Depending on fire category of adjacent spaces.

Fixed fire-extinguishing required for:

- ✓ Bunkering station
- ✓ Fuel preparation room
- ✓ Machinery space of category A

Fire detection and fire alarm required for:

- ✓ All compartments containing methanol fuel systems

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Nitrogen is needed for

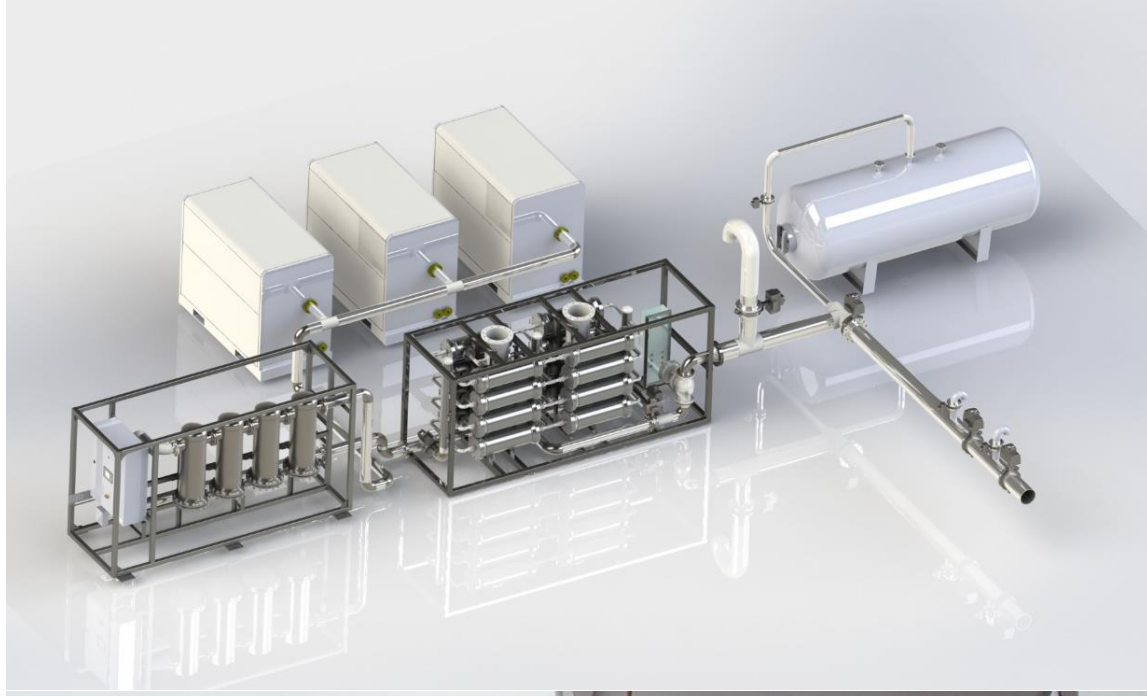
- ✓ Keeping an inert atmosphere in fuel tanks at all times
- ✓ Filling cofferdams after a tank leakage (or fill with water)
- ✓ Purging bunkering lines after refuelling
- ✓ Purging fuel lines after ESD
- ✓ Purging tank vapours in fuel tanks before gas freeing with air

Nitrogen shall be available permanently on board:

- ✓for at least one trip (max fuel consumption and length of trip) and;
- ✓to keep tanks inerted during 2 weeks in harbour (min port consumption)

A production plant and/or adequate storage capacities might be used to achieve the availability target.

NB! The above does not account for nitrogen required to gas-free tanks.



Fuel preparation room

Fuel preparation rooms shall not be located in engine rooms, be gas tight and watertight to surrounding enclosed spaces and vented to open air.

Fuel preparation rooms shall have separate mechanical extraction ventilation with capacity of minimum 30 (45 for class) air changes per hour.

Fuel preparation rooms shall be provided with leakage detection, both for vapours and liquids.

Fuel preparation rooms shall be provided with a dedicated bilge system, operable from outside the space.

Bunkering station

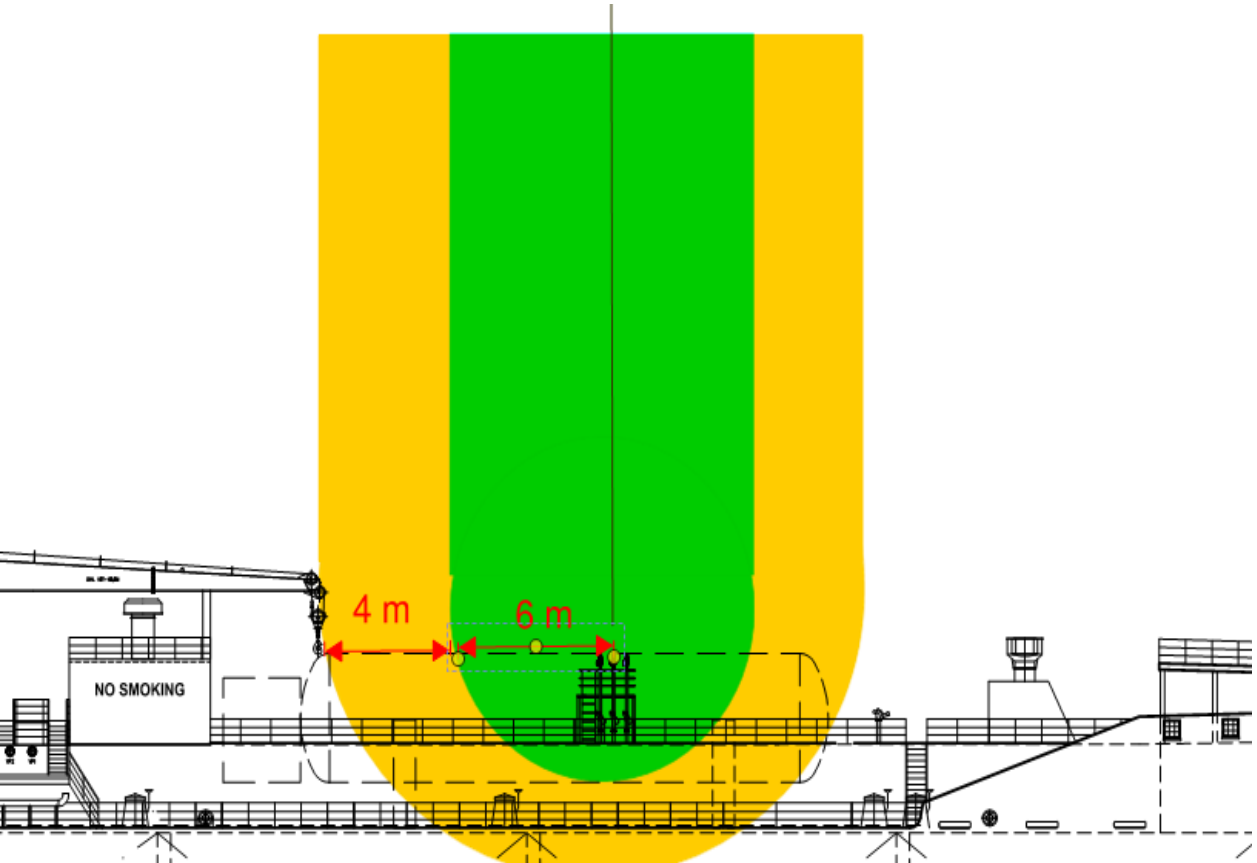
The bunkering station shall be separated from other areas of the ship by gas tight bulkheads.

Air lock access from non-hazardous space.

Control of the bunkering shall be possible from a safe location in regard to bunkering operations.

Hazardous areas requiring certified safe electrical equipment ***in enclosed spaces:***

- ✓ Methanol fuel tanks and piping systems
- ✓ Double walled piping systems
- ✓ Cofferdams
- ✓ Fuel preparation rooms



Hazardous areas requiring certified safe electrical equipment ***on open deck:***

- ✓ Fuel tank P/V vent outlets
- ✓ Fuel preparation room ventilation inlet and outlet
- ✓ Double walled piping ventilation inlet an outlet
- ✓ Fuel piping valves and flanges
- ✓ Bunkering stations

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Summary

- In a well-to-wake perspective, using methanol as fuel can increase CO2 emissions or reduce them by up to 90% depending on the production method. Tank-to-wake reduction is 8-9%.
- Methanol provides approximately half the energy per volume compared to oil
- Methanol is toxic to humans, is more flammable than oil, and constitutes an explosion risk in enclosed spaces.
- The IMO Interim Guideline for methyl/ethyl alcohols as fuel provides a design standard for ships and its use must be agreed with the Flag Administration in each case.
- The physical properties of methanol dictates the need for additional safety barriers affecting the ship design.

Thank you!

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