

Risk Focus: Methanol Bunkering

A Guide to Safe Methanol Bunkering Practices



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A Guide to Safe Methanol Bunkering Practices

Aligned with the International Maritime Organization (IMO) 2023 Strategy for achieving net-zero greenhouse-gas (GHG) emissions in international shipping by 2050.

The global maritime industry is entering a pivotal phase in its transition toward sustainable, low-emission operations.

As part of this strategy, the IMO has established key indicative checkpoints:

- Reduce total annual GHG emissions by at least 20% by 2030 compared to 2008 levels.
- Reduce total annual GHG emissions by at least 70% by 2040 compared to 2008 levels.
- Promote the uptake of zero and near-zero GHG emission fuels, targeting at least 5% adoption by 2030.

Methanol has emerged as a highly promising marine fuel due to its capacity to virtually eliminate sulphur oxide (SO_x) and particulate matter (PM) emissions, significantly lower nitrogen oxides (NO_x), and deliver meaningful reductions in carbon dioxide (CO₂) emissions, even more so when derived from renewable (bio or e methanol) sources.

Methanol's widespread availability – now supplied in more than 120 ports globally – provides a strong foundation for its scalability as a cleaner alternative to conventional marine fuels, according to reports by Bureau Veritas Marine & Offshore and Ship & Bunker. Unlike traditional fossil-based fuels, methanol can be produced from diverse feedstocks such as biomass, municipal waste, and captured carbon dioxide combined with green hydrogen through Power-to-Methanol (e-methanol) synthesis. This flexibility in production pathways makes methanol a compelling option in the transition toward carbon-neutral shipping. Its liquid state at ambient temperatures further enables straightforward storage, handling, and bunkering with only minor infrastructure adjustments, distinguishing it from cryogenic fuels such as LNG.

The uptake of methanol as a marine fuel is being propelled by both regulatory pressures and market momentum. Major shipowners and operators have begun

investing in methanol-fuelled newbuilds and retrofits, with notable orders from container lines, chemical carriers, and tanker operators. According to data from classification societies and alternative fuel tracking platforms, the number of methanol-capable vessels is steadily increasing, with several hundred vessels expected to be in operation or on order by the end of the decade. This growth reflects a broader industry commitment to meeting emissions targets while maintaining operational flexibility.

To facilitate this shift, marine engine manufacturers such as MAN Energy Solutions and Wärtsilä have developed dual-fuel and methanol-dedicated engines capable of meeting IMO Tier III NO_x regulations and future carbon intensity requirements. These propulsion systems, combined with methanol's clean-burning characteristics, can significantly reduce local and global pollutants, supporting compliance with Emission Control Areas (ECAs) and other environmental standards.

Additionally, methanol's lower flammability compared to LNG and its biodegradability in the event of a spill contribute to a more favourable safety and environmental profile.

As methanol bunkering gains traction in Europe, Asia, and North America, pilot projects and early commercial operations are providing valuable operational data and lessons learned. These initiatives will be critical in building confidence, addressing risk perceptions, and shaping best practices for wider industry adoption. In parallel, policy incentives and regulatory clarity will play a crucial role in supporting investment in methanol production, distribution, and bunkering infrastructure, ultimately enabling methanol to become a mainstream marine fuel in the global decarbonisation effort.

Introduction

Methanol bunkering is an increasingly important operation in the maritime sector as the industry shifts toward low-carbon fuels. The process involves the safe transfer of methanol, typically stored as a liquid at ambient temperature and pressure, from a bunker vessel or shore terminal into a ship's dedicated fuel tanks. Due to methanol's low flash point, toxicity, and corrosive potential, the operation requires meticulous planning, proper material compatibility, and strict adherence to safety protocols. Key considerations include tank preparation, vapour management, leak prevention, and continuous monitoring throughout the transfer. Leading ports like Singapore are actively developing regulatory frameworks, technical standards, and purpose-built infrastructure to support safe and scalable methanol bunkering. As adoption grows, standardized procedures and comprehensive crew training will be essential to ensuring both operational efficiency and environmental protection.

Physical Properties of Methanol

Composition

Methanol (CH_3OH) is composed of carbon, hydrogen, and oxygen. It is a synthetic fuel that can be produced from natural gas, coal, biomass, or CO_2 . It is a single-component liquid fuel.

Boiling Point

Methanol has a boiling point of approximately 64.7°C at atmospheric pressure. It is a liquid at room temperature and pressure, making it easier to store than LNG, which requires cryogenic conditions.

Flash Point

The flash point of methanol is about 11°C , which is low enough for it to be considered easily flammable. It can produce flammable vapours even at room temperature.

Vapour Density

Methanol vapour is heavier than air, with a vapour density of approximately 1.11 (air = 1). This means methanol vapours tend to stay low to the ground, accumulating in enclosed or low-lying areas, increasing the risk of fire or explosion in poorly ventilated spaces.

Colour and Odour

Methanol is a clear, colourless liquid with a slightly sweet odour, though the smell is not strong enough to serve as a reliable warning. It is toxic – even small quantities absorbed through skin, inhaled, or ingested can cause serious health effects, including blindness or death.

Flammability

Methanol is highly flammable, both as a liquid and vapour. It burns with a nearly invisible blue flame, which can be difficult to detect in daylight.

- Flammability range: 6% to 36% by volume in air
- Autoignition temperature: 464°C
- Methanol poses significant fire risk, especially in confined or poorly ventilated spaces.

Moisture Sensitivity and Handling Considerations

Methanol is hygroscopic, meaning it readily absorbs moisture from the surrounding air. This property can lead to water contamination if methanol is not stored properly in sealed containers. The presence of moisture can reduce combustion efficiency, affect ignition characteristics, and potentially lead to corrosion in fuel systems. Therefore, proper storage and handling are essential to maintain methanol's fuel quality and performance.



Risks Involved in Methanol handling

Asphyxiation

As Methanol vapours are heavier than air and can accumulate in confined or poorly ventilated spaces, displacing oxygen and posing a serious asphyxiation hazard. This risk is particularly relevant during leaks or in low-lying areas of bunkering stations and engine rooms.

Fire and Explosion Hazard

Methanol is a flammable liquid with a low flash point (approximately 11–12°C) and a wide flammable range in air (6–36% by volume). Even at ambient temperatures, methanol can produce vapours that readily ignite in the presence of an ignition source, leading to flash fires or vapour cloud explosions if uncontrolled.

Corrosive Effects and Material Compatibility

Methanol is chemically aggressive toward certain metals and materials, including aluminium, zinc, and some plastics. Fuel containment systems, piping, gaskets, and seals must therefore be constructed from methanol-compatible materials to prevent leakage, degradation, or structural failure over time.

Overpressure and Vapour Release

In enclosed tanks or transfer lines, methanol vapours can build up pressure when heated or trapped. Without appropriate pressure relief systems, this can lead to sudden releases, jetting, or mechanical failure. Pressure relief valves, venting systems, and temperature control are critical in bunkering infrastructure design.

Sloshing and Tank Dynamics

When stored in partially filled tanks aboard vessels, methanol can slosh during ship motion. This not only introduces dynamic stresses on the tank structure but can also contribute to vapour displacement and potential release. Proper tank design and fill management are essential to reduce these dynamic effects.

Invisible Flame Hazard

Unlike conventional fuels, methanol burns with a pale blue, almost invisible flame in daylight. This presents a unique hazard for onboard firefighting and visual detection. Fire detection systems must include optical or infrared flame detectors capable of identifying methanol fires.

Emergency Shutdown and Control Measures

Emergency shutdown systems (ESDs), pressure relief devices, vapour detection, and remotely operated valves are vital to ensure quick response during a bunkering incident. Regular inspection and testing of these systems ensure operational readiness in emergency situations.



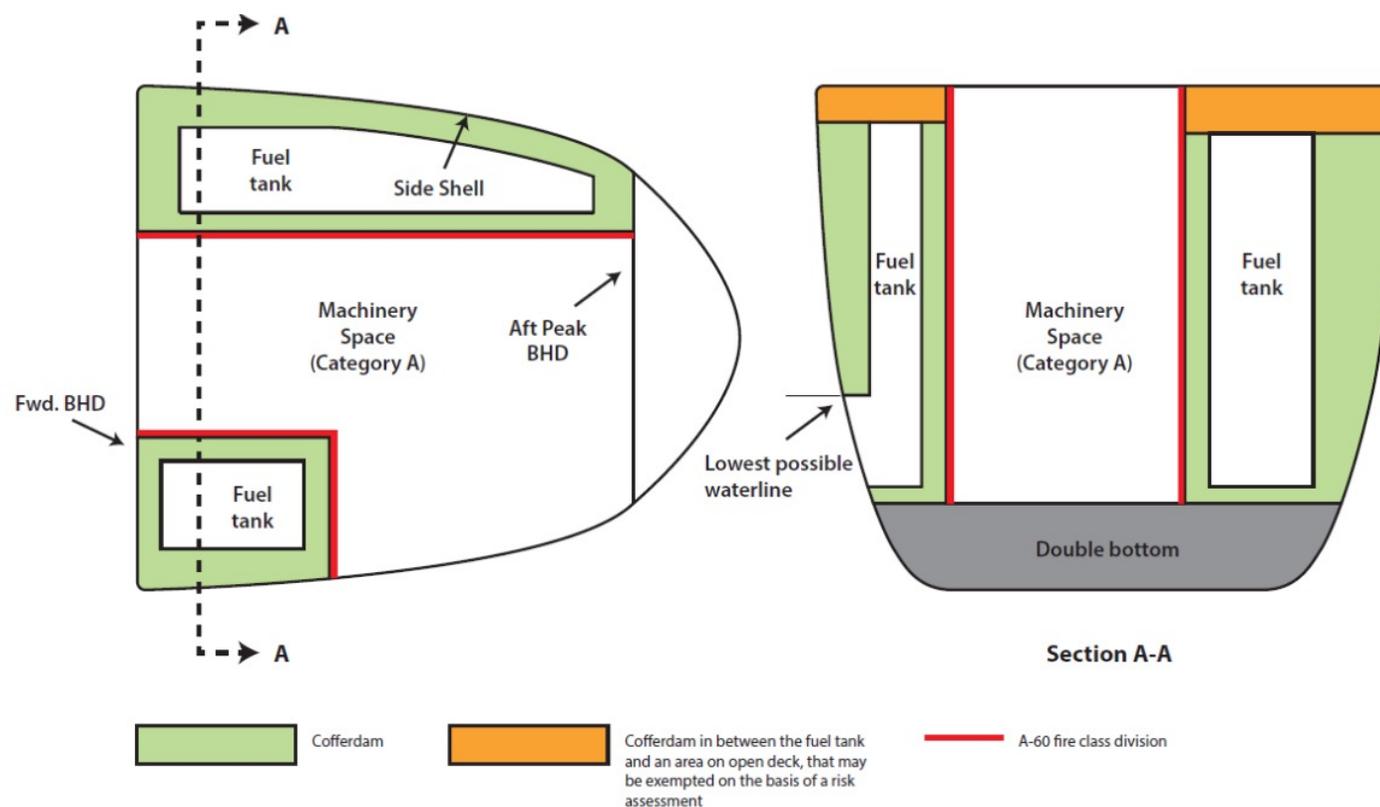
Methanol Bunker Tank Construction

As per Section 5.3 of MSC.1/Circ.1621, fuel tanks containing methanol must not be located within accommodation spaces or machinery spaces of Category A¹¹ due to the fire and toxicity hazards posed by alcohol-based fuels. To further mitigate risks, integral fuel tanks must be surrounded by protective cofferdams, except on surfaces already bounded by the ship's shell plating below the lowest waterline or adjacent to other methanol/ethanol tanks or fuel preparation spaces. The placement of these tanks must also be carefully considered, positioned abaft the collision bulkhead and forward of the aft peak bulkhead to ensure structural integrity and operational safety. Additional safeguards, such as coamings and dedicated spill holding tanks, are required for any fuel tanks installed on open decks, where they are also to be protected against mechanical damage.

Despite these strict requirements, certain exemptions and interpretations allow for practical flexibility without compromising safety. For instance, integral methanol tanks may be installed between the boundaries of machinery spaces of Category A if they are separated by a 600 mm wide cofferdam with A60 insulation, which effectively mitigates fire risks and thermal conduction. Likewise,

cofferdams can be omitted between fuel tanks and open deck areas, provided a comprehensive risk assessment has been conducted addressing potential hazards such as fire exposure, chemical toxicity, and operational impact. Chemical tankers utilizing methanol cargo as fuel also benefit from specific considerations; their methanol fuel tanks within the cargo area are exempt

from cofferdam requirements, although compatibility of adjacent cargoes must still be ensured. These provisions reflect a balanced approach to safety and functionality in the design and operation of methanol-fuelled vessels.



¹¹ Category A machinery spaces are shipboard areas containing major propulsion or power-generation equipment – such as main engines, large internal combustion engines (≥ 375 kW), or oil-fired systems – classified as high-risk zones under SOLAS due to fire and explosion hazards.

Venting and Gas Freeing Provisions for Methanol Fuel Tanks

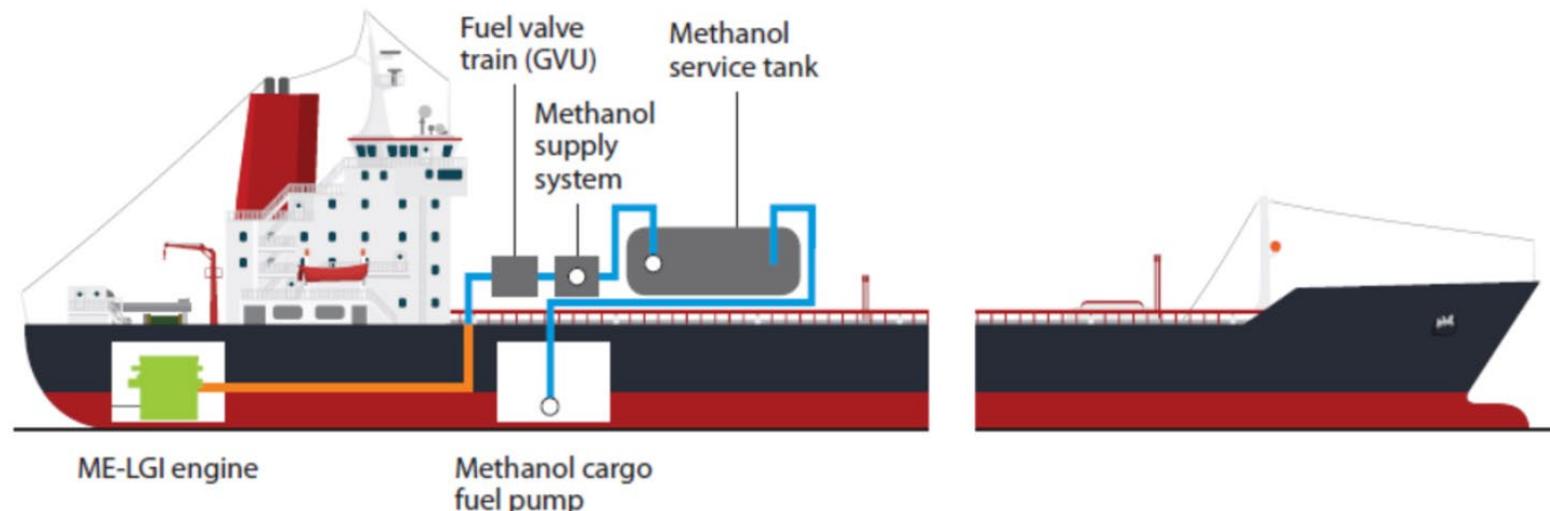
Safe venting and gas freeing systems are critical components of methanol fuel tank design, ensuring that potential leaks or vapour accumulation do not pose risks to personnel, vessel integrity, or the environment. Each fuel tank must be equipped with a controlled

venting system to safely handle pressure changes during bunkering, operation, and maintenance. The venting system should be designed to prevent the spread of flammable vapours to ignition sources, maintain breathable air quality in crew areas, and avoid obstruction of escape routes or lifesaving appliances (LSAs). To ensure this, pressure and vacuum relief valves (PRVs) are required on each tank to maintain internal pressures within safe limits. These valves must vent to a safe location on the open deck and be fitted with flame arrestors or high-velocity vent heads, certified for endurance burning in

accordance with MSC/Circ.677, to prevent flame propagation back into the tank.

In parallel, a fixed gas freeing system must be integrated, enabling safe purging of vapours before tank entry or maintenance operations. The design should prevent the formation of gas pockets by carefully considering the location of inlets, outlets, and internal structures. The vent system should connect to the highest point of each tank, be self-draining under normal conditions, and be adequately sized to accommodate the full design bunkering rate without over-pressurization. Redundancy is

required in pressure relief arrangements; however, pressure sensors with alarm systems may be accepted in lieu of mechanical backup devices in certain cases. Importantly, shut-off valves must not be placed upstream or downstream of PRVs, though bypass valves or shut-offs for temporary isolation may be allowed if alternate overpressure protection is provided. These provisions ensure that methanol fuel systems operate safely and reliably, both under normal conditions and in emergency scenarios, aligning with international safety standards for low-flashpoint fuel operations.



Hazardous Area Zones Classification (Zones 0, 1, and 2)

– See Figure 1 and 2

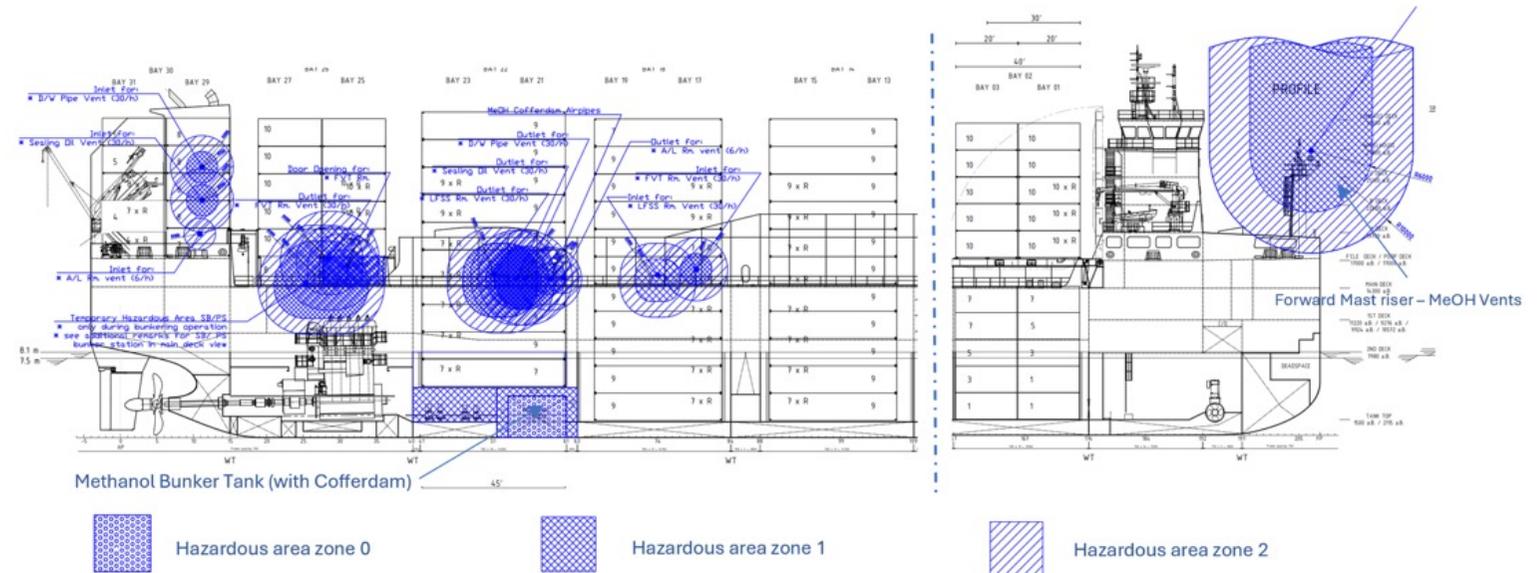


Figure 1 – Typical Hazardous Zone Locations on a Methanol-Powered Container Ship

In the context of gas and low-flashpoint fuel handling, such as methanol, hazardous areas are classified to indicate the likelihood of the presence of flammable vapours or gases. This classification guides the design and installation of electrical and mechanical equipment to prevent ignition in these environments. As per SIGTTO and aligned with IEC standards, hazardous areas are categorized into Zones 0, 1, and 2:

- **Zone 0:** An area where a flammable gas-air mixture is continuously present or present for long periods during normal operation. For example, the interior of methanol fuel tanks or piping systems that are normally filled with fuel vapour fall under this category.
- **Zone 1:** An area where a flammable atmosphere is likely to occur in normal operation. This includes locations immediately surrounding vent outlets, bunkering connections, or where leaks are expected during regular operations.
- **Zone 2:** An area where a flammable atmosphere is not likely to occur in normal operation, and if it does, will only persist for a short time. This typically includes areas adjacent to Zone 1, such as the outer limits of fuel handling areas or enclosed spaces near equipment that could release vapours under abnormal conditions.

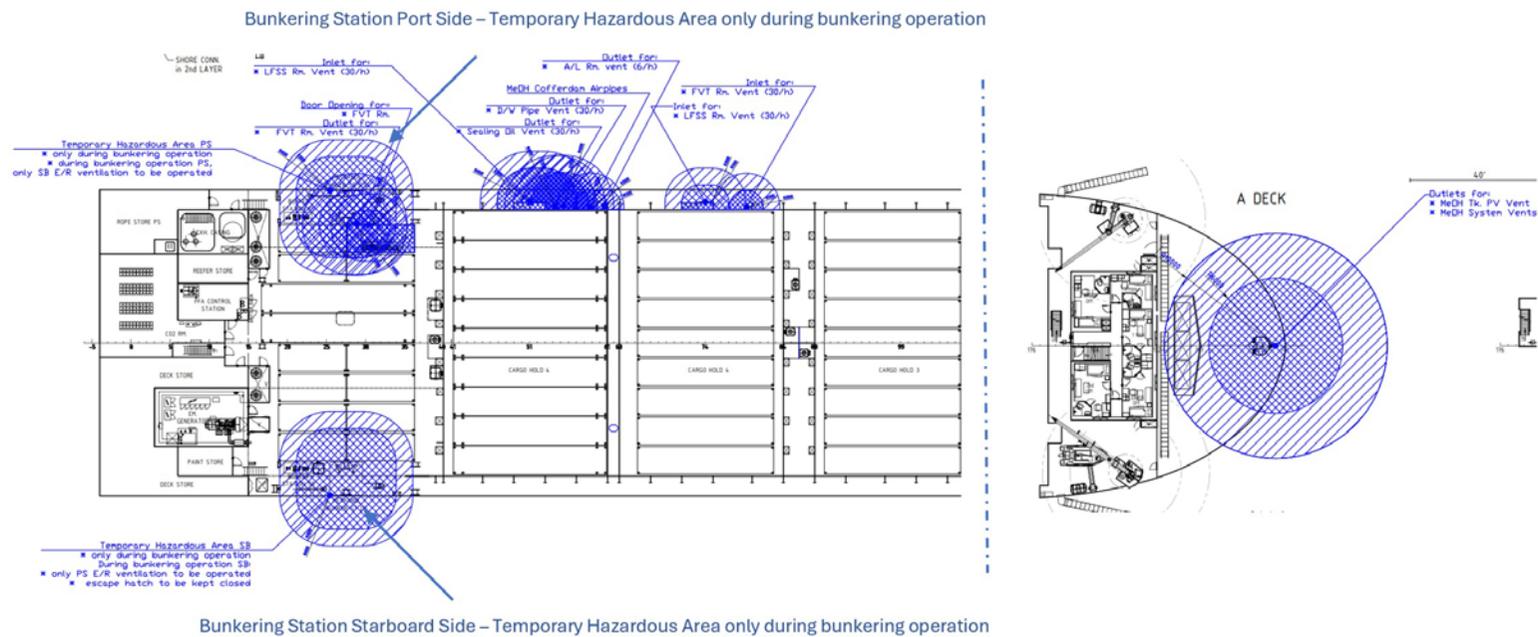


Figure 2 - Typical Bunker Station Locations on a Methanol-Powered Container Ship

Inerting and Tank Atmosphere Control in Methanol Fuel Storage Systems

Methanol fuel tanks must remain inerted at all times during normal operation to prevent the formation of flammable atmospheres. Inerting and gas freeing operations must be carefully controlled to ensure no part of the process introduces a flammable mixture, with the use of a reliable inerting medium. Cofferdams around tanks should allow purging

or water filling via non-permanent connections and be drained using a separate system, such as a bilge ejector.

To avoid backflow of vapours into the inert gas system, the supply line must include a double block and bleed valve arrangement and a closable non-return valve, all located within hazardous spaces. Where non-permanent connections are used, two non-return valves may be substituted. Each tank must also have a clearly marked blanking arrangement, typically a removable spool piece.

Venting systems must direct vapours upward through outlets at least 3 m above deck and 10 m from accommodation intakes or ignition sources, see Figure 1. Vent pipes should be fitted with approved flame arrestors and designed to prevent freezing or blockage. The vent system must be independent of the fuel preparation space ventilation and capable of handling the full bunkering flow rate without over-pressurization.

Gas freeing should discharge vapours safely, either via high-velocity jets (≥ 30 m/s), flame-protected outlets (≥ 20 m/s), or underwater outlets. System design must consider materials, fan performance, pressure losses, driving medium pressure, and vapour density to ensure efficient and safe gas freeing operations.

Inert Gas Availability on Board

Inert gas is required to be permanently available on board in order to achieve at least one voyage from port to port, taking into consideration the maximum fuel consumption expected and the maximum voyage duration. The system should also be capable of maintaining the tanks in an inerted condition for a period of two weeks in harbour with minimum consumption during port stay.

Where inert gas is also stored for fire-fighting purposes, it must be carried in separate containers and must not be used for fuel gas services. A production plant and/or adequate storage capacity may be used to achieve the availability target.

The inert gas used must not modify the characteristics of the fuel. If a production plant is fitted, it should be capable of producing inert gas with an oxygen content not exceeding 5% by volume at any time. A continuous-reading oxygen content meter should be installed in the inert gas supply line from the production equipment, and it should include an alarm set to activate at a maximum of 5% oxygen content by volume. The system design must ensure that if the oxygen concentration exceeds 5% by volume, the inert gas is automatically vented to the atmosphere.

The system should be able to maintain an atmosphere with an oxygen content not exceeding 8% by volume in any part of any fuel tank. In addition, the inert gas system must include pressure control and monitoring arrangements suitable for the specific fuel containment system.

Where a nitrogen generator or nitrogen storage facilities are installed in a separate compartment outside the engine room, the compartment should be equipped with an independent mechanical extraction ventilation system capable of providing a minimum of six air changes per hour. If the oxygen content within this compartment falls below 19%, an alarm should be activated. A minimum of two oxygen sensors must be installed in each such space, and both visual and audible alarms should be located at each entrance to the inert gas room.

Nitrogen pipes should only be routed through well-ventilated spaces. When nitrogen piping passes through enclosed spaces, it should have only the minimum number of flange connections necessary for fitting valves, be fully welded, and be kept as short as possible. Inert gas piping must not pass through accommodation spaces, service spaces, or control stations.

Methanol Bunker Hoses

Bunker hoses carried on board are to be suitable for methyl or ethyl alcohol service. Each type of bunker hose, complete with its end fittings, should undergo a prototype test at normal ambient temperature consisting of 200 pressure cycles from zero to at least twice the specified maximum working pressure. After completing the pressure cycle test, the prototype should demonstrate a bursting pressure of not less than five times its specified maximum working pressure at both the upper and lower extreme service temperatures. Hoses used for prototype testing are not to be used for bunkering service.



Figure 3 – Methanol and Vapour Return Hoses

Before being placed in service, each new length of bunker hose produced should be hydrostatically tested at ambient temperature to a pressure not less than 1.5 times its specified maximum working pressure but not exceeding two-fifths of its bursting pressure. The hose should be stencilled or otherwise clearly marked with the date of testing, its specified maximum working pressure, and, where applicable, its maximum and minimum service temperatures for non-ambient applications. The specified maximum working pressure should not be less than 1 MPa gauge. Arrangements should be provided for draining any remaining fuel from the bunkering hoses upon completion of operations.

Where fuel hoses are carried on board, provisions should be made for their safe storage. Hoses should be stored either on the open deck or within a dedicated storage room fitted with an independent mechanical extraction ventilation system capable of providing a minimum of six air changes per hour.

Joint plan of Operation (JPO)

All STS transfer operations for tanker vessels required a Joint Plan of Operation (JPO), the purpose of this is to outline procedures, risk assessments, responsibilities, procedures, and safety measures required to carry out a safe and efficient methanol bunkering operation between a receiving vessel (RV) and a bunker vessel (BV). This document outlines the agreed-upon operational steps, communication protocols, emergency procedures, and equipment requirements that must be followed throughout the entire transfer process.

The JPO serves as a shared reference for all involved parties, including the receiving vessel, the bunker vessel operator, fuel supplier, terminal personnel, and relevant port authorities. It ensures that all activities are conducted in compliance with applicable international regulations, local port requirements, industry standards, and the Safety Management Systems (SMS) of the involved vessels and organizations.

This plan remains valid regardless of the exact date of operation, which may be subject to change. Any operational changes or exceptions must be reviewed and agreed upon during the pre-transfer safety meeting. Activities not explicitly addressed in this JPO are considered prohibited unless formally approved. Such prohibited activities may include, but are not limited to: personnel transfer during operation, active use of cathodic protection systems (other than passive systems), or unrelated maintenance work in the bunkering zone.

The operation involves the ship-to-ship transfer of bio-methanol fuel from a bunker vessel to a receiving vessel, at a designated terminal jetty equipped to handle methanol. The receiving vessel's methanol tanks will be inerted with nitrogen gas prior to bunkering to reduce flammability and oxygen levels in accordance with safety protocols and classification society requirements.

Both vessels will use certified equipment specifically designed and approved for methanol service. This includes methanol-compatible hoses, gaskets, vapour return lines, quick connect/disconnect couplings (QCDC), and appropriate flanges. All transfer connections will be leak-tested before fuel transfer begins. An insulation flange will be installed to mitigate electrostatic discharge risks.

The bunker vessel will approach the receiving vessel at a controlled speed, using appropriately sized fenders to ensure safe mooring and transfer conditions. Mooring arrangements will follow a pre-approved configuration based on a completed mooring analysis. Mooring lines will include both synthetic and steel-reinforced types, with synthetic covers to reduce sparking risk.

The operation will typically include:

- Mooring and gangway setup
- Pre-transfer safety meeting and checklist completion
- Connection and leak testing of transfer equipment
- Methanol fuel transfer and sampling
- Line draining, purging, and disconnection
- Unmooring and post-operation close-out

Emergency shut-down (ESD) systems and gas detection equipment to be tested and verified before the operation begins. In case of an emergency, both vessels will follow their approved response plans in accordance with ISM Code procedures and notify relevant authorities immediately.

Environmental operating limits for wind, swell, and current will be monitored continuously, and operations will be suspended if conditions exceed agreed thresholds. A post-operation debrief will be scheduled to review the bunkering process, share lessons learned, and document opportunities for improvement.

Commercial – Quality and Quantity Agreement

In 2025, BIMCO introduced a dedicated Methanol Annex to its Bunker Terms, recognising the increasing adoption of methanol as an alternative marine fuel and the need to address its unique operational and safety characteristics. This development reflects the industry's broader decarbonisation efforts and the growing number of methanol-fuelled vessels entering service. The Methanol Fuel Quality Clause, derived from this annex, outlines the minimum quality and handling requirements for methanol used as fuel under time charter parties.

According to this clause, charterers are required to supply methanol fuel that:

- is free of foreign matter, including particulate contamination and free water,
- complies with an agreed fuel specification, generally aligned with the latest technical standards recognised by the industry,
- meets a minimum methanol purity threshold (e.g. $\geq 99.85\%$ by mass),
- limits the maximum content of known impurities such as oxygenates, aldehydes, halides, sulphur and nitrogen compounds, heavy metals, and residual water,
- includes a minimum lower heating value (LHV) suitable for engine performance,
- ensures chemical compatibility with the vessel's engine and fuel system components, and
- is accompanied by appropriate documentation, including laboratory test results and conformity certificates.

Additionally, charterers must provide the owners with a copy of the Bunker Delivery Note (BDN), containing detailed information on fuel composition, quantity, delivery conditions, and origin. The BDN must be supported by a fuel quality certificate from a recognised testing facility. All bunkering operations involving methanol must follow strict safety protocols, including closed or remote sounding procedures, as outlined in the Methanol Annex and the International Code of Safety for Ships using Gases or other Low-flashpoint Fuels (IGF Code).

Failure to comply with the agreed specifications renders the charterers liable for any loss or damage suffered by the owners or the vessel, including damage to the fuel system, off-hire periods, and third-party claims. A compatibility assessment between the methanol fuel and the receiving vessel's equipment is also required before the first supply, typically conducted by the supplier in consultation with the ship operator. This ensures safe handling and performance consistency throughout the charter period.

Custody Transfer System

Custody transfer equipment is typically installed on the methanol supply vessel to accurately measure both the quantity and energy content of methanol delivered during bunkering. As methanol is traded based on its energy or mass, precise determination of transferred volume, density, and temperature is essential. Mass-based measurement is generally preferred, as it provides greater accuracy than volume-based methods, which require temperature corrections. The supply vessel is often equipped with advanced metering systems such as Coriolis mass flow meters or positive displacement meters, supported by temperature and pressure sensors for real-time monitoring. Proper calibration and verification ensure traceability and compliance with custody transfer standards.



Crew Training for IGF Code Compliant Vessels

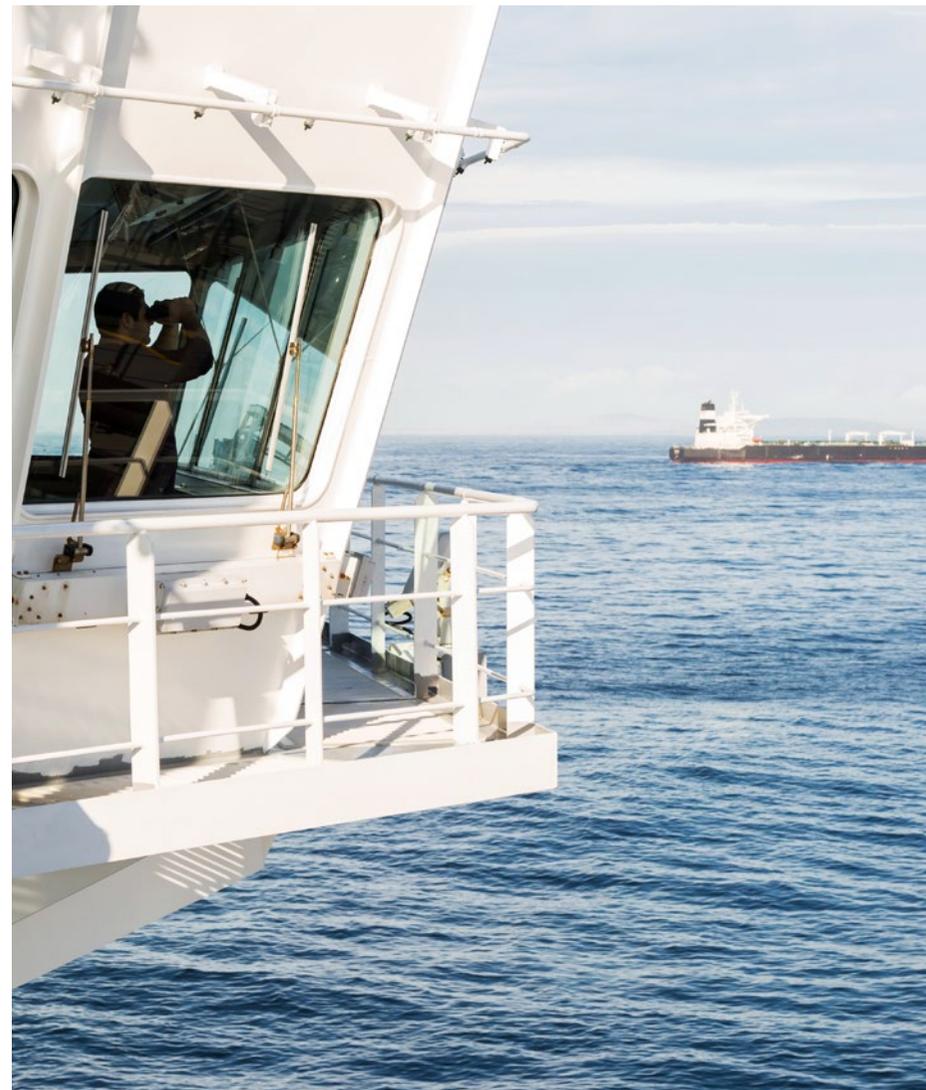
The International Convention on Standards of Training, Certification, and Watchkeeping for Seafarers (STCW) sets forth essential training and certification requirements for personnel working on ships governed by the IGF Code. Section A-V/3 of the STCW Code specifically outlines the mandatory minimum standards of competence for both basic and advanced training to ensure safe handling, operation, and emergency response related to low-flashpoint fuels such as Methanol.

Basic Training Requirements

All seafarers assigned to designated safety duties related to the use, care, or emergency handling of fuels on IGF Code-compliant ships must hold a Certificate of Proficiency (COP) in Basic Training. This certification aligns with the competencies specified in Table A-V/3-1, which focus on fuel properties, hazard recognition, safety procedures, and emergency protocols. Alternatively, personnel already holding a valid COP for liquefied gas tanker cargo operations under Regulation V/1-2 may be considered to meet the basic training criteria for IGF Code vessels.

Advanced Training Requirements

Masters, engineers, and any personnel with direct responsibility for fuel systems must obtain a COP in Advanced Training per Table A-V/3-2. To qualify, candidates must complete approved advanced training and accrue at least one month of relevant seagoing service, including participation in three Methanol bunkering operations, two of which may be substituted with simulator-based training.



Bunkering Procedures

Preparation of Methanol Fuel Tanks

The preparation of methanol fuel tanks prior to initial loading or after maintenance is a critical multi-stage process that ensures operational safety, structural integrity, and fuel purity. These operations, drying, inerting, and leak testing, require careful execution, as methanol is toxic, flammable, and hygroscopic (absorbs moisture).

External support may be required to provide nitrogen or inert gas for tank preparation, as most vessels do not have the capacity to perform full inerting independently. Maintaining a stable and monitored inert gas (IG) pressure inside the tanks is essential throughout the bunkering process to prevent oxygen ingress and maintain a non-flammable atmosphere. The IG pressure must be continuously monitored and adjusted, with excess gas returned to the supply vessel through the vapour return line.

Pre-Bunker Transfer Checklist

A pre-transfer checklist must be jointly completed by both the methanol supplier and the receiving vessel. Once signed, it serves as formal authorization to commence bunkering. Operations must be paused or suspended if any conditions change significantly during the transfer.

- **Weather Conditions**

Forecasted and observed weather conditions must be within the operational limits of the mooring and transfer systems. Adverse conditions such as high wind speed, poor visibility, heavy seas, or electrical storms may restrict or delay bunkering.

- **Communications**

A reliable and tested communication system must be established before starting operations. All personnel involved must have a clear understanding of communication signals. Standard visual or sound signals must be agreed upon to overcome any language barriers.

- **Lighting**

Adequate lighting is required in all operational areas. In case of lighting failure or poor visibility, bunkering must be suspended until sufficient lighting is restored. Emergency lighting is to be used only for safely halting operations.

- **Authorisations and Notifications**

All necessary permits and notifications required by port or flag authorities must be obtained prior to commencement. Regulatory documentation should be readily available onboard for inspection.

- **Mooring**

The bunker vessel and receiving ship must be securely moored as per the agreed mooring plan. The impact of environmental factors such as wind, current, and passing traffic must be considered. All mooring lines, fenders, and winches must be inspected for integrity and readiness.

- **Safe Access**

A secure and safe means of access must be maintained between vessels throughout the operation.

- **Preparations and Inspections**

Before connection, all methanol transfer systems – including hoses, couplings, and manifold valves – must be inspected and pressure-tested. The transfer system should be inerted and verified to be free from air and moisture.

All inspections and safety checks must be recorded in the pre-bunker checklist. Preparations include:

- Establishing exclusion and safety zones
- Isolating non-EX-rated electrical equipment in hazardous areas
- Setting communication equipment to low-power mode
- Confirming compliance with personnel work/rest hours
- Verifying PPE readiness (including chemical-resistant gloves, goggles, and antistatic clothing)
- Testing Emergency Shutdown (ESD) and Emergency Release (ERS) systems
- Inspecting hoses, gaskets, and couplings for damage or contamination

- Checking tank levels, IG pressure, and temperature
- Confirming tanks are oxygen-free ($O_2 < 8\%$ by volume)
- Verifying vapour return line readiness
- Agreeing on transfer rates, pressure limits, and emergency stop criteria
- Ensuring fire and gas detection systems are active
- Securing doors, vents, and non-essential openings in the safety zone
- Confirming spill response equipment availability
- Earthing both vessels and transfer systems
- Reviewing weather forecast and tidal conditions
- Verifying compatibility and interlock of systems between both vessels
- Conducting leak and pressure tests before initiating flow

During Bunkering Supervision

The entire operation must be supervised by qualified personnel from both the bunker supplier and receiving vessel. All simultaneous operations must be approved by the Master of each vessel.

Continuous monitoring of the following parameters is essential:

- Tank levels and temperatures
- Inert gas pressure (IG pressure) – must remain within defined safe limits
- Transfer rates and manifold pressures
- Vapour return line pressure and flow
- Mooring line tensions and environmental conditions

If any irregularity is observed (pressure surge, leak, abnormal temperature rise), the transfer must be stopped immediately using the ESD system.

Access to safety zones must be restricted to essential personnel only.

Bunker Transfer Process

Once hoses are connected and leak-tested, methanol transfer may begin at a slow, controlled rate. The rate should be gradually increased to the agreed steady-state transfer rate, ensuring pressure balance between supply and receiving tanks is maintained.

Vapour return management is critical: methanol vapours and inert gas must flow back to the bunker vessel through the return line to maintain tank pressure equilibrium and prevent overpressure on the receiving vessel.

Topping-Off

As the tank approaches full capacity about 80% or earlier, the transfer rate must be reduced to a controlled topping-up speed. This phase requires heightened attention to prevent overfilling or excess pressure buildup.

The ESD system must not be used as a routine means to stop transfer at high level limits. Instead, the supplier and receiver must coordinate manual flow reduction and termination.

After Bunkering Post-Transfer Checklist

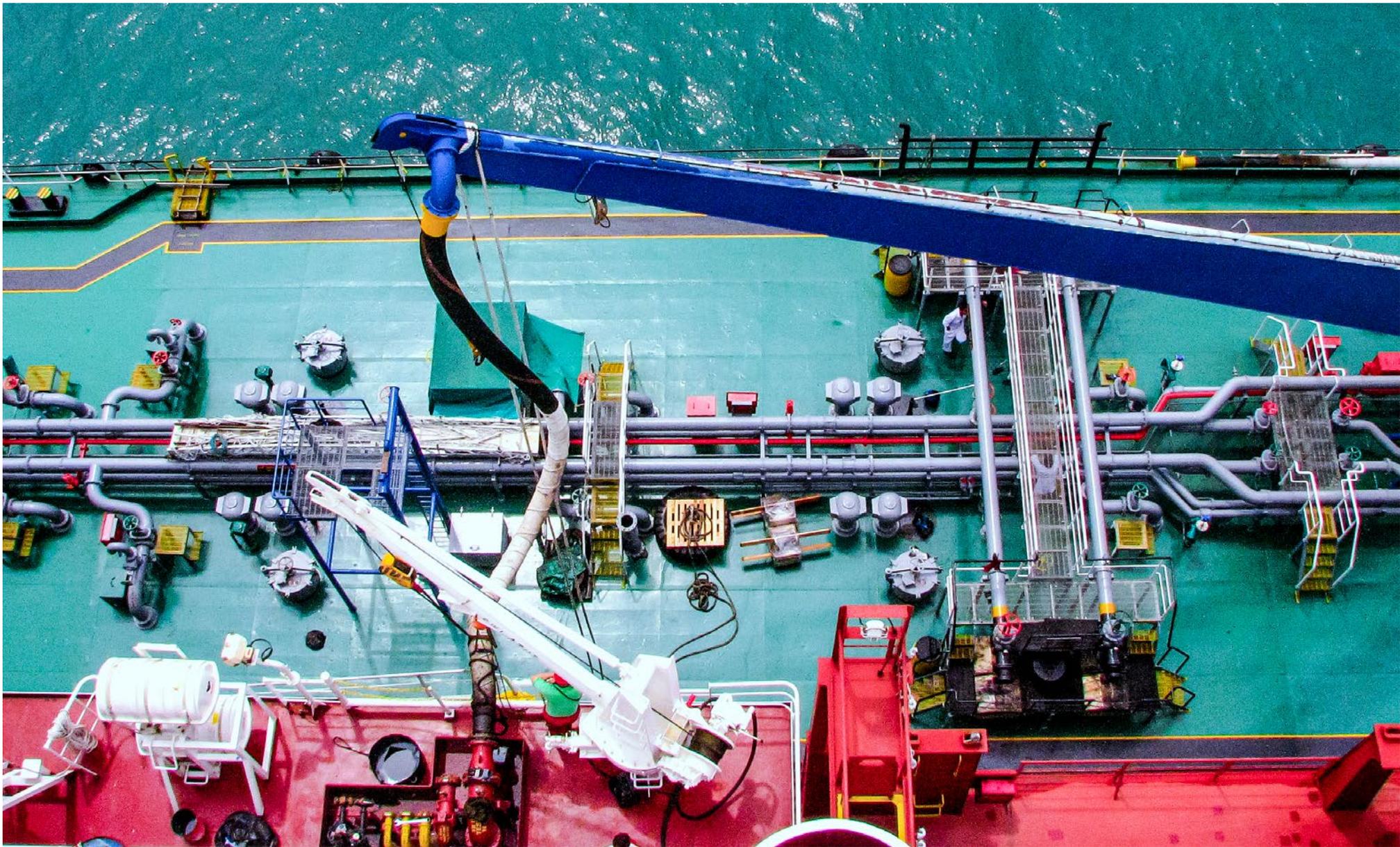
A post-transfer checklist must be jointly completed, covering all shutdown, disconnection, and reporting procedures. Any incidents, alarms, or deviations during the operation must be logged and reported to the responsible authorities.

Draining and Purging

All hoses and transfer lines must be drained and purged with nitrogen to remove residual methanol. Purging prevents the formation of flammable mixtures and helps maintain the inert condition of the system. Methanol residues must not be released into the environment.

Disconnection of Hoses

Before disconnection, the system must be verified as methanol-free, and vapour concentration should be below the lower flammable limit (LFL). Transfer lines should then be blanked or sealed to prevent ingress of air or moisture.



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- ISO 20519:2017 (Specification for Bunkering of Methanol and Other Low Flash Point Fuels)



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