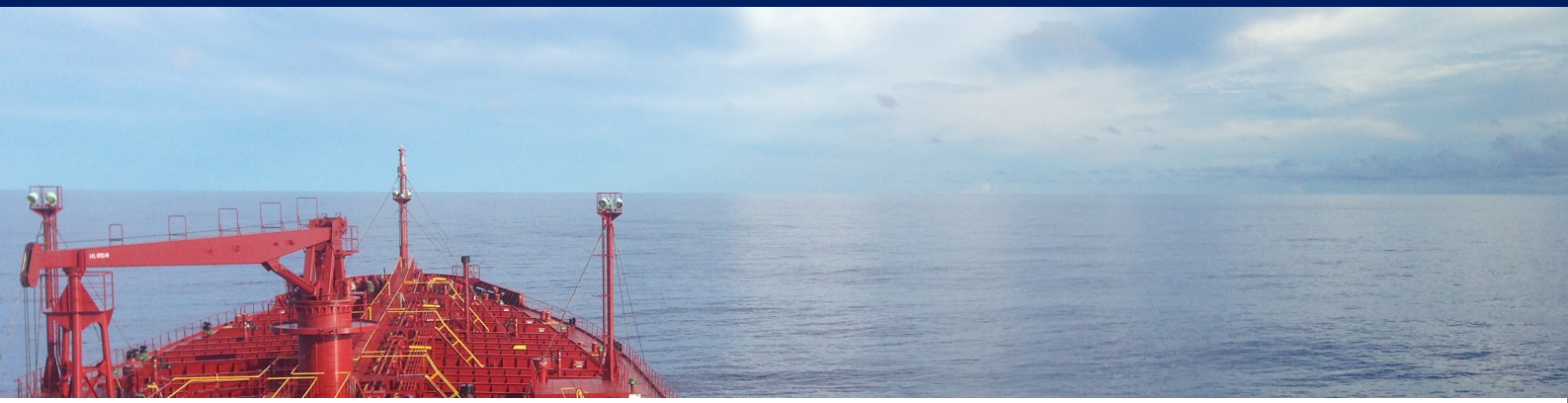




Cargo Tank Cleaning and Preparation Onboard Tankers: Best Practices and Guidelines

Loss Prevention Bulletin

Tank preparation involves tank cleaning often followed by gas freeing and tank entry. This one of the most dangerous and time-consuming operations on a tanker. The task must be carefully assessed for hazards, with all necessary precautions in place to protect vessel and the marine environment.

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Product and chemical tankers carry a variety of commodities, often necessitating frequent tank cleaning to prevent a cross-subsequent off-spec claim. Detailed planning of the tank cleaning is crucial, and the ship's crew must be informed of the schedule. The extent of cleaning required depends on the properties of the previous cargo, the tank coating, the next cargo's preloading specifications and the shipper's requirements.

Why is Tank Cleaning Necessary?

Tank cleaning is essential in the following circumstances:

- Preparing for the next cargo
- Dry dock
- Regulatory Compliance: adhering to MARPOL and other IMO Conventions/Codes
- Preventing build-up of residues e.g. in Residue Oil Tank (ROT) / Slop Tanks
- Facilitating gas freeing for tank inspection / mopping / maintenance / repairs
- Complying with the charter party agreement
- In extreme circumstances to prepare for carrying clean ballast

Industry Standards and Requirements

Procedures and Guides

Several industry organisations, associations, oil and gas majors and independent expert companies provide tank cleaning guides and best practices. These resources come in the form of books, subscription online platforms and apps, free online resources and charterer's instructions.

- ISGOTT - International Safety Guide for Oil Tankers and Terminals (ICS, OCIMF, IAPH)
- CTSG - Tanker Safety Guide - Chemicals (ICS)
- GTSG - Tanker Safety Guide - Liquefied Gas (ICS)
- IGC Code - International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IMO)
- Cargo Tank Cleanliness Standards for Chemical Tankers (INTERTANKO)
- HM 50 - Hydrocarbon Management 50: Guidelines for the cleaning of tanks and lines for marine tank vessels carrying petroleum and refined products (Energy Institute)
- HM 40 - Guidelines for the crude oil washing of ships' tanks and the heating of crude oil being

Industry Requirements / Vetting

In addition to regulatory requirements, tankers must often undergo industry vetting. The SIRE programme, managed by OCIMF, covers all tanker types. Additionally, the CDI conducts inspections on chemical tankers.

Documentation

Prior to, during, and after tank cleaning, certain documentation is required. When a cargo is nominated, it needs to be checked against the manufacturer's tank coating resistance list, which should be kept on board.

Tank cleaning instructions are typically issued by the charterer. The officer responsible for cargo, usually the Chief Officer, will then prepare a tank cleaning plan outlining the various stages and timings for the tank cleaning operations. All tank cleaning operations must be recorded in the vessel's Cargo Record Book or Oil Record Book Part II, as required.

Upon completion of tank cleaning the vessel will prepare a certificate, such as a Tank Cleanliness Certificate, a Dry Tank Certificate, Tank Inspection Report, or Certificate of Tank Fitness for gas tankers. A Tank Cleanliness

transported by sea (Energy Institute)

- Ship Pre-Cargo Matrix White Oil Petroleum Products & Components (Shell)
- Shell Chemicals - Cargo Handling Sheets (Shell)
- MIRACLE - Tank Cleaning Guide and Cargo Database (ChemServe GmbH)
- Dr. Verwey's Tank Cleaning Guidebook & App (ChemServe GmbH)
- Milbros (Venson Nautical)

Given the vast amount of chemicals and products available for transport, it is unlikely that a ship's crew will be familiar with all cargoes. Therefore, we recommend that owners consult a tank cleaning specialist company when necessary to ensure proper tank cleaning on their vessels.

Regulations

Tank cleaning is a highly regulated area within shipping. The principal regulation is MARPOL. Additional regulations can be found in SOLAS, the IBC Code, the IMDG Code, MLC, ISM Code, Flag State regulations, PSC inspections including USCG. National regulations concerning the previous cargo, particularly food products, include FOSFA, NIOP, EU, CIQ, CODEX and Kosher considerations.

Certificate is for chemical tankers cleaned to a specific tank cleanliness standard. It should include cargo tanks, tank volumes, coating type, previous and next cargoes, required tank cleanliness standard, tank test methods, and results. Dry Tank Certificates and Tank Inspection Reports are less detailed and generally state the specific tanks and their fitness for the nominated cargo. This certificate is to be presented to the charterer's representative surveyor for signature, indicating acceptance of the tanks' fitness for loading.

The Safety Data Sheet (SDS) should be supplied to the vessel as soon as possible to allow necessary preparations, but no later than before the cargo is loaded on board.

Tank Preparation



Tank preparation encompasses various stages, with tank cleaning being the most common.

The preparation steps vary depending on the type of vessel and cargoes. These steps include:

- Planning
- Bottom Flush
- Tank Cleaning
- Verifying Results
- Pre-wash after discharge
- Decanting & discharging ashore

Planning Stage

Effective planning is crucial for successful tank cleaning. When planning, consider the previous and next cargoes, such as water miscibility and viscosity as well as the product characteristics like polymerisation, reaction with water and odour. Additionally, take into account the surrounding conditions such as atmospheric temperature, seawater temperature and adjacent cargo temperatures along with hardware availability.

The tank cleaning plan must encompass the entire cargo system including tanks, pumps, pipelines, and valves (including manifolds). Typically, the plan includes categories such as cargo information, cleaning method, temperature, cleaning medium, fuel oil consumed, sequencing and time for cleaning, changing the atmosphere and verification.

During the planning stage, identify potential hazards of tank cleaning, assess risk, and implement proper preventative measures to reduce the risk to as low as reasonably practicable. A fixed risk assessment can be used if the vessel frequently carries the same cargoes, provided it is reviewed regularly and referred to prior to tank cleaning. For new or infrequently carried cargoes, a new risk assessment should be conducted.

The primary risk during tank cleaning operations is fire or explosion. Washing tanks in an inert atmospheric state provides the lowest risk of occurrence. If the vessel lacks a supply of inert gas, strict procedures must be followed to ensure equipment integrity.

Bottom Flush

A line and bottom flush is the first cleaning step required for all non-inert tanks as per ISGOTT.

Tank Cleaning

Tank washing mediums include cold seawater wash, hot seawater wash, freshwater wash, freshwater rinse, deionised wash/rinse, treated water wash/rinse (e.g., reduce hardness), and chemical or detergent wash.

Tank washing methods include butterworth, injecting, re-circulating, rinsing, steaming, purging, inerting, gas freeing, local cleaning, stripping and mopping and drying.



Verifying results

Verification of the tanks' level of cleanliness is more often required before the charterer's permission to load the next cargo. This can be done through enclosed space entry for a visual inspection and coating assessment, which may include wall wash testing, or by wash water analysis, eliminating the need for enclosed space entry.

Prewash

Prewash must be carried out for chemical tankers as per MARPOL Annex II.

Decanting & discharging ashore

Slop tanks must be decanted as per the relevant MARPOL Annex. The ROT must be discharged ashore in a timely manner.



Hardware and Equipment

Tank cleaning hardware must be maintained, kept clean and certificated where required. Equipment that may be used includes tank cleaning machines (both fixed and portable), pumps, pipes, valves (including manifolds), hoses, samplers, Ullage Temperature Interface (UTI) tape, tank heating coils and any equipment used locally in the tank by crew such as lances.

Compatibility

Cargo compatibility involves multiple components, including the vessel's tank coatings, adjacent cargoes, tank cleaning agents, water, the USCG Compatibility Chart and oxygen

One of the key issues we encounter is the nominated cargo not being compatible with the vessel's last three cargoes, as well as the liquid or vapour element of other cargo onboard.

Coating

In addition to ensuring cargo compatibility with the tank coating, the tank coating itself has specific criteria that must be adhered to for maintaining its condition.

The tank coating needs to be compatible with the tank cleaning agent. The Manufacturer's Cargo Resistance Guide must be kept on board and referred to during the planning stage. For aviation fuel, oil majors often have coating compatibility lists due to the high sensitivity of the cargo.

Temperature is a crucial factor to consider during washing. Excessive use of tank hot water can lead to the degeneration of the tank coating.

A visual condition assessment of the coating is necessary if a tank inspection is conducted post-cleaning. Damaged, flaking or blistering paint can lead to increased retention of residues from previous cargoes. Tanks with damaged coatings should be avoided for certain critical cargoes.

The three main types of cargo tank coatings we encounter are zinc, epoxy and stainless steel. Rubber is another tank coating found on some chemical tankers. Zinc and epoxy tank coatings are known to have issues dependant on the cargo carried.

Due to epoxy's organic nature, it can absorb or adsorb cargo residues and then desorb them back into subsequent cargoes, even the second or third ones. Some cargoes are more prone to absorb into certain tank coatings than others.

Often, compatibility checks are performed for the next cargo against the last cargo but checks against the second last and third last cargoes are sometimes overlooked. Lengthy voyages along with elevated temperatures increase absorption rates, raising the risk of residues desorbing into succeeding cargoes. It is critical to check the last three cargoes to prevent this kind of contamination. For more details, refer to our *LP Bulletin on Cargo Tank Coatings*.

Safety Concerns

Entry into Enclosed Space

Safety regulations and procedures relating to enclosed space entry must be strictly followed to safeguard the

Cargo SDS

The Safety Data Sheets (SDS) for cargoes, (previously Material Safety Data Sheet, MSDS), required by MARPOL

crew, vessel, marine and atmospheric environments, and other property involved with commercial operations. For more information, please see our bulletin on Enclosed Space Entry ([link](#)) and the IMO Resolution A.1050 (27) Revised Recommendations for Entering Enclosed Spaces Aboard Ships ([link](#)).

Exposure Limits

Exposure to toxic gases presents a significant risk to crew. Exposure limits to toxic substances have been developed to protect personnel against harmful vapours in a working environment. These have been developed for most known substances.

These limits are established by international organisations, national administrations, and local regulatory standards. Compliance with exposure limit regulations set by the jurisdiction of operation is essential. However, the American Conference of Government Industrial Hygienists (ACGIH) is the standard body referred to.

Each substance measures its threshold limit value (TLV) in parts per million (ppm). TLV-TWA (time-weighted average) refers to a concentration averaging over a specified time, traditionally an 8-hour workday or a 40-hour workweek. TLV- STEL (short-term exposure limit) is a 15-minute time weighted average exposure which should not be exceeded at any time during the workday. TLV-C (ceiling) is the concentration that should not be exceeded at any instance during working exposure time. Nevertheless, the best practice is to maintain concentrations of all atmospheric containments as low as reasonably practicable (ALARP). Information for each substance carried onboard can be found on the cargo's Safety Data Sheet (SDS).

Tank atmosphere is measured by fixed and portable instruments relaying concentrations of hydrocarbon gas and oxygen. Chemical indicator tubes are used for measuring low concentrations of toxic gases. Multi-gas detectors are also available which can be used for pre-entry checks but are commonly used a personal gas detector as part of a crew's personal protective equipment (PPE) when entering an enclosed space.

provide essential safety information about the cargo.

During tank cleaning cargo residues present hazards after the bulk of the cargo has been discharged. Risks to the crew's personal wellbeing are covered under the sections of health effects and first aid measures which includes the PPE required. The SDS lists hazardous or toxic components, particularly the H2S and benzene information.

Total loss is the largest risk to vessels during tank cleaning. This could result from explosion, fire, or sinking due to hull breach from explosion. The SDS outlines actions following a fire onboard or accidental release of cargo liquid or vapour. The hazards from accidental release of cargo include human health risks, fire or explosion risks or pollution risks to the atmosphere or water. The emergency response protocols are in the MFAG section of the IMDG Code.

ERI Cards offer additional guidance for accidental chemical release, available from the European Chemical Industry Council's website (<https://www.ericards.net>).

Static Accumulation

As previously mentioned, the primary way to reduce the risk of fire or explosion during tank cleaning is to keep the cargo tank atmosphere inert.

Non-inert trading tankers face a higher risk of static discharge or explosion during tank cleaning operations than an inerted vessel. ISGOTT outlines the essential procedures to follow.

Handling static accumulator oils adds another risk for these vessels. As per ISGOTT, oils with an electric conductivity less than 50 picosiemens/metre (pS/m) are considered static accumulators. Examples include xylene, ULSD and commercial jet fuel. ISGOTT details how to prevent electrostatic generation through measures such as bonding, initial slow loading of cargo and spread loading over multiple tanks.

Minimising excess water from entering the cargo tank is paramount, as oil and water mixture form a potential source of static electricity.

Reactivity

Cargo reactivity is an essential consideration during tank cleaning. Cargo may react with substances independently i.e. a cargo reacting with one other substance such as water, air or another cargo, or may react concurrently i.e.



reacting to multiple different substances at a time such as different cargoes, or cargo residues found in a slop tank or ROT. The reaction can be a produce flammable, toxic or corrosive gases or aerosols, generate heat, or form peroxides that may cause explosive reactions.

Planning for tank cleaning operations must account for cargo reactivity to prevent unwanted outcomes. Safety is the primary concern when it comes to cargo reactivity, followed by contamination risks if cargo contacts unwanted substance, such as water, air, or another cargo. Which can result in a hefty off-spec claim.

Dealing with the reactivity of one cargo during tank cleaning is reasonably straightforward, however this becomes more complex when dealing with multiple cargoes as their residues may react with one another. When tank cleaning from two cargoes that may react with one another, the risk of reactivity occurring must be lowered.

During subsequent tank cleaning operations, the compatibility of new cargo residues transferred to the ROT must be considered in relation to existing residues to prevent reactions. Time between ROT discharges ashore needs consideration as accumulated residues increasing reactivity risk. Furthermore, prolonged accumulation makes residue removal difficult from the tank surfaces. We have seen cases of residue reactions causing pinholes in tank bulkhead and contaminating cargo in adjacent slop tanks.

Common tank cleaning problems



The most common issues we encounter with tank cleaning are failed inspections and cargo contamination due to inadequate tank cleaning, often influenced by tank coatings. When tanks are considered not clean enough by charterers, further cleaning is costly and time-consuming affair.

Below are key questions to ask in such cases:

- Were the Charterer's tank cleaning instructions followed effectively?
- Was a third-party tank cleaning expert consulted, such as Milbros or MIRACLE?
- Did the Chief Officer and crew have sufficient experience with these cargoes?
- Did the vessel fail a Wall Wash Test (WWT) or was Wash Water Analysis (WWA) used for verification?
- Was the previous cargo compatible with the tank coating?
- Have previous cargo residues been absorbed into an epoxy coating?

Ensure officers and crew have sufficient experience to carry out tank cleaning, typically facilitated by the SIRE Tanker Crew Matrix.

If the charterer's tank cleaning instructions were not followed effectively and the tanks are considered not clean enough, follow additional charterer's instructions and consult the latest tank cleaning recommendations from expert companies.

Failure in a WWT, does not always indicate inadequate tank cleaning for a vessel to load the next nominated cargo once dilution factors are considered. As this is known to be a subjective test, vessel's owners can request a repeat test from another surveyor and retain samples for secondary analysis.

WWA can eliminate the need to gas-freeing and tank entry for WWT. This method has been shown to be more effective than WWTs for verification and tank cleaning. Please see out *LP Bulletin on Cargo Tank Cleaning Verification Methods*.

Incompatible cargoes with tank coatings, such as a high FFA content edible oil with zinc, are hard to clean and will more often require further cleaning.

Aggressive cargoes carried in epoxy-coated tanks will leave cargo residues within the tank coating. Cleaning will not help desorb the residues, periodic ventilation at an elevated temperature is needed. Please see out *LP Bulletin on Cargo Tank Coatings* for more information.

In summary, if a vessel fails a tank inspection and the charterer requests additional cleaning, P&I should be contacted to clarify further details before commencing extra cleaning. If the tanks do require further cleaning and the cleaning instructions have been followed accurately, third party expert guidance should be sought. In cases where the tanks were not cleaned sufficiently and a cargo contamination claim arises, P&I should be contacted and an investigation conducted. Findings from the investigation should be shared across the company's fleet to raise awareness and reduce the risk of reoccurrence.

Other tank cleaning problems

A common issue with tank cleaning problem is the presence of residues remaining on tank surfaces after cleaning. Expected residues include white residues, IG residues, iron oxide residues, hydrocarbons, and odours. Additional cleaning is required to remove these residues, a tank cleaning specialist such as Milbros or MIRACLE should be contacted to determine the next steps.

As previously mentioned, we have encountered cases where the cargo residues left in the ROT have reacted, causing pinholes in the cargo tank bulkhead and contamination the cargo in the adjacent slop tanks.

While all documentation is importance, the Tank Cleanliness Certificate, Dry Tank Certificate, or Tank Inspection Report often present issues. These certificates are sometimes unavailable when requested or contain incomplete information. Additionally, stipulations written by the surveyor are common which then invalidates the certificate.

IG Problems

On ships fitted with an inert gas generator (IGG), poor maintenance, especially the scrubber unit, can lead to cargo contamination by water, soot, SO₂ and SO₃. We have encountered several claims relating to this issue and strongly recommend keeping the IGG's planned maintenance up-to-date and ensuring sufficient spares are onboard.

Members requiring further guidance should contact the Loss Prevention department.