UK P&I CLUB

Brookes Bell

Risk Focus: Safe Bunker Operations

How to ensure safe bunkering practice to avoid spills

UK P&I CLUB IS MANAGED BY **THOMAS MILLER**

CONTENTS

How to ensure safe bunkering practice to avoid spills

The Club's claim records indicate a recent increase in the number of pollution incidents relating to bunkering operations or internal bunker transfers, and even relatively minor incidents have resulted in very high value claims for the recovery of pollutants, clean-up, restoration operations and third party damages.

Our experience suggests that in only a minority of cases do spills occur due to failure of the hoses or pipelines, which are required to be pressure tested on a periodic basis. Furthermore, the general standard of maintenance of shipboard deck bunker pipeline systems has much improved. The majority of bunker spills occur as a result of a tank overflowing. The oil is discharged from the tank air vent heads and flows into a containment box or "save-all", which then overflows on to the deck. The oil accumulates on the deck and if a sufficient quantity is released, it may then spill over the raised guttering at the deck edge. Oil then flows down the ship's side and onto the water surface, which can then be distributed widely by river or sea currents, going on to oil port structures or other shore features and amenities.

Although the vast majority of bunker transfers are performed without incident, very occasionally, things go wrong. This publication is aimed both at those serving on-board ship and on the bunkering barge.

Introduction

Bunkering operations are routine and yet critical, high risk operations which require to be carefully planned and performed by the crew in accordance with established shipboard procedures. Although the vast majority of bunker transfers are carried out without incident, very occasionally, things can and do go wrong. A loss of containment due to a tank overflow, or leakage from pipeline or transfer hose failure, may result in oil spilling overboard and polluting the marine environment.

UK P&I Club claim records indicate that pollution incidents relating to bunkering operations or internal bunker transfers continue to occur with worrying frequency. Oil spills are bad news on a number of different levels, not least for their potential to inflict serious damage to marine ecosystems and particularly when involving viscous heavy fuel oils. Even relatively minor bunker spills may result in very high value claims for recovery of pollutants, clean up, restoration operations and third-party damages potentially running into seven figure dollar sums. In addition, shipowners and crews may also be exposed to heavy fines and criminal prosecution, with such incidents often being considered as strict liability offences irrespective of how the incident occurred.

The UK Club's recent experience suggests that in only a minority of cases do bunker spills occur due to failure of the hoses or pipelines, whereas the majority of spills tend to be as a result of a tank overflowing. The oil is discharged from the bunker tank air vent head and flows into a containment save-all[1], which then overflows on to the deck and accumulates adjacent to the deck containment guttering at the ship's side. If a sufficient quantity of oil is released (or if insufficient preventative measures are in place) the oil may spill over the guttering at the deck edge, flow down the ship's side and onto the water surface with the potential to be widely distributed by river or sea currents. Apart from the immediate ecological impact to the marine environment, a spill may cause oiling damage to port structures, other vessels, natural shore features, flora, fauna, mariculture and leisure amenities.
In the event of an incident, it is the responsibility of the crew to respond and to alert the relevant authorities to reduce the impact of the spillage on the surrounding environment.

Why do bunker spills occur?

Common causes of bunker spills can be summarised as follows. They should not necessarily be taken in isolation as causation may be due to a combination of factors:

Improper set up of pipeline system valves
Potentially causing either overpressure, or flow of bunkers to an unintended location.

Insufficient monitoring of tank levels during bunkering
All tanks, not only those nominated to receive the fuel.

Excessive transfer rate or pressure
Risk of exceeding the design pressure or capacity of the system; also increases operational stress on the crew.

Air lock
Depending on internal tank structure and the arrangement of ventilation pipework (exacerbated by excessive trim or list), an excessive pumping rate can cause pockets of air to become trapped in the tank. Release of the trapped air can cause a sudden unexpected discharge of mist or oil from the tank ventilator. This can cause a discharge before the tank is perceived to be full, catching operators unawares.

[1] Even on vessels equipped with an overflow loop, the final overflow tank will vent externally to a similar containment arrangement.

Case study – Bunker hose failure

A vessel was bunkering HFO from a shore terminal via a layflat hose. On completion, residual HFO remained in the lines. In order to clear the lines, a compressed air-blow was agreed. The relevant tank valve was confirmed as open in readiness, and the Chief Engineer requested a supply of air at a low pressure.

Flow through the pipeline was heard and the Chief Engineer requested an increase in the air pressure. During this increase, the hose failed at the connection to the vessel, spraying oil onto the surrounding deck area and into the sea.

Scupper plugs were in-place, but there were no suitable containment measures fitted at the freeing ports, allowing contamination of the surrounding waters.

Investigation findings

- The receiving vessel systems were found clear and in order, but there was some scope for HFO to remain in the lines.
- As the air pressure was increased, it is believed that the clamp connection in way of the layflat hose/flange was placed under fluctuating pressure loads, causing it to repeatedly flex and subsequently fail.
- Similar hoses found at the terminal were found to have some minor creases in way of the clamp connection. Storage of the layflat hoses was found to be such that it was possible to cause kinking of the hose at the clamped connections.

Failure of the supplying hose does happen, whether as a result of poor maintenance or excessive pressure for operational reasons. There are a variety of hose types in use, such as the collapsible layflat used in this case, or reinforced spiral bound.

Fuel transfer hoses should be resistant to abrasion and weathering. Where vulnerable, they should be suitably protected from impact damage. New hoses are pressure-tested and certified, then should be re-tested to 1.5 x nominal pressure every 12 months and visually checked before every operation.

Storage should not overstress the material. Limits are placed on the maximum bending radius, and some storage situations can exceed this limit, particularly at the connection. This also applies to layflat hoses where permanent kinking should be avoided.

Receiving vessels should check the condition of delivery hoses themselves and, if in doubt, request the original test certificate and records of the last pressure test.

Vessel freeing ports should be identified and confirmed as having adequate sealing arrangements, which should be fitted for the entire operation.

Malfunction of valves
Potentially related to lack of valve testing or maintenance.

Loss of containment from transfer pipelines and hoses
This may be due to poor maintenance/insufficient pressure-testing, over-pressurisation, or failure to properly close/blank off unused manifold connections.

The human element

In spite of fully functioning ship's systems/equipment and provision of adequate procedures documented in the Safety Management System, bunker spills can still occur. These can often be attributed to human error, likely a failure to properly follow the documented procedures. The reasons for this are varied, but a number of recurring factors are evident:

Complacency
Bunkering operations are routine and ordinarily performed without incident. This can engender over-familiarity leading to a lack of attention to detail.

High work-load and simultaneous shipboard operations
Bunkering often takes place concurrently with cargo operations, storing, maintenance, inspections, audits and surveys; imposing high (and often conflicting) demands on the crew.

Fatigue: Not unrelated to the above – bunkering operations may be performed over extended periods at unsociable hours – but there may be additional contributing factors.

Unfamiliarity
Involvement of inexperienced or unfamiliar personnel.

Poor communication on-board and between ship and barge
A common feature of bunker spills, where no effective means of communication is established either internally on-board or with the barge, compromising the ability to respond quickly and efficiently to an incident.

It is therefore of the utmost importance that bunkering operations are carefully planned throughout and that the necessary risk control measures are in place to prevent an incident and enable effective response.

Bunkering fundamentals

A number of systems and procedures should be in-place at all times. These include:

- An annual pressure test of all bunker lines – details of the date and test pressure to be stencilled on the manifold.
- All valves, flanges and fittings (pressure gauges, sampling equipment, thermometers and any remote indication devices) to be maintained in good order.

- All manifolds, valves, pipelines and tank vents should also be conspicuously labelled and colour coded as appropriate for ease of identification.

- Where remote tank level gauges are fitted, calibration certification should be valid and current.

- Safety Management System (SMS) procedures should include:
  - Suitable instructions for stemming of bunkers, including advice on maximum capacities of tanks (normally restricted to safe margins of 85% or 90% of each tank volume).
  - Provision and maintenance of a Shipboard Oil Pollution Emergency Plan (SOPEP) detailing systems and procedures as well as emergency contact details for the vessel, the management company (DPA) and relevant port and terminal authorities.
  - Provision of an oil-spill locker, easily accessible yet secured against routine use of the contents. The contents should be the subject of regular inventories to ensure adequate supply and condition of equipment and chemicals.
  - Regular oil-spill drills to encourage on-board familiarisation with systems and procedures. During these drills, it should be made clear that all personnel, whether on or off-duty, and whether or not involved in the bunkering operation, are obliged to intervene (by stopping the bunkering operation) if they notice or have any suspicion of a spill.
  - Provision of clear, simple, emergency contingency plans for reference as required in the event of an incident.
  - Provision of a bunker checklist providing guidance for the complete operation, including preparation.
  - Provision of a 'bunker board' to be displayed at the vessel's manifold during bunkering. Containing pertinent information such as:
    - System diagrams.
    - Checklists: current and completed.
    - A Bunker Plan (in tabulated form), outlining responsible personnel, vessel details, fuel grade details, acceptable delivery rates, receiving tank designations, capacities, fill order and expected percentage of fill on completion.

The above points should form part of the vessel's normal operating procedures. Even so, in order to plan and complete safe bunkering, additional measures are required for each bunkering operation. These can be divided into four stages of key decisions and checks:

1. Pre-arrival
2. Prior to bunkering
3. During bunkering
4. On Completion

Case study – The human element

Following extensive engine maintenance, relief of the Chief (C/E) and Second Engineers (2/E) and a shift to anchorage, a 40,000dwt bulk carrier proceeded to connect and take bunkers overnight. The plan called for filling of 8 bunker tanks. The filling sequence was verbally requested by the Chief Officer, but due to time constraints, no formal sequence was recorded on the bunker plan.

The bunker valve control station showed conflicting information in that the layout of the system mimic panel differed slightly to that of the tank layout/level gauge schematic.

After four hours of bunkering, at midnight, four tanks remained to be filled, and the C/E was monitoring filling of two of those tanks. He was relieved by the 2/E (who had been involved in the earlier maintenance operations). The C/E had conflicting duties in preparation for departure. He informed the 2/E of the tank filling sequence, and said he would return as soon as he could.

Shortly after, when the filling tanks approached 90% full, the 2/E opened the valves to the two remaining empty tanks and closed the now full tanks.

Soon after, a high-level alarm sounded on one of the now filling tanks. Confused, the 2/E closed the valve to the tank in alarm (leaving one tank filling). The C/E was called to investigate, and he found that the Second Engineer had mistakenly opened the wrong filling valves – supplying two tanks which had already been filled to 90%. At that time, the motorman reported fuel on deck outside and the operation was stopped by informing the barge.

Investigation findings

- A Bunker Plan and a pre-bunker meeting were documented on the bunker board; however, they were generic and not in accordance with the company SMS. No filling sequence was stated on the Bunker Plan.

- The 2/E was unfamiliar with the layout of the systems, and was not aware of the discrepancy in the posted diagrams. As no tank filling order was available, he assumed the tanks were being filled aft to forward, and opened the wrong valves in spite of the C/E's verbal instructions.

- The high-level alarm for the tank which overflowed (the one remaining tank being filled) was defective. This had not been tested prior to bunkering, contrary to pre-bunkering procedures.

- A flow reduction was not requested prior to shutting in tank valves.

- Engine room staff, including the C/E and 2/E, had worked a long day on maintenance. No consideration was made for rest periods prior to the bunker operation.

The Engineers' workload appears to have adversely affected preparation for the bunker operation. Fatigue and tight time constraints prevented full checking and familiarisation.

1. Pre-arrival planning

Mindful of potentially conflicting vessel operations, it is essential that crew designated to perform bunkering duties are not distracted from their task. Key members of staff should be appraised of their forthcoming duties in good time and should be properly rested and rotated as required for the duration of the operation.

The Bunker Plan[2] should be completed, confirming the capacity of the vessel's tanks allows adequate free volume.

A visual check of pipelines, including any internal or external overflow arrangements should be carried out. Overflow containment should be empty. The layout and operation of valve controls and gauges should be verified.

High-level and overflow alarms should be tested by physical activation if possible.

Readings of remote level gauges should be verified by manual ullages or soundings.

The SOPEP locker contents should be complete and readily available. The appropriate oil spill response contact details should be available.

The bunker checklist (covering requirements for preparation, operation and completion of bunkering) must be diligently completed at appropriate times by the persons assigned to perform the various tasks. This should never be pre-completed as a 'tick-box' exercise to satisfy ISM requirements.

Prior to arrival at the bunker port, an oil-spill drill should be carried out with all crew. The Bunker Plan should be discussed, and the location of all relevant vents and potentially vulnerable points should be highlighted. All crew should be shown how to stop the operation (which may be simply to shout "STOP" at the barge personnel), if necessary.

2. Prior to bunkering

The vessel's fuel oil transfer pump should be isolated and unused bunker manifolds should be verified as securely blanked off. The system valves should be aligned to supply the desired tanks from the operational manifold. Correct alignment (and remote indication, if appropriate) of system valves should be checked and double checked.

Ensure that hydraulic pressure, as well as any backup hand operated equipment, is available for hydraulic operated valves. The bunker board, as previously described, should be prominently displayed.

Consideration should be made for the effect of trim changes on bunkering operations, including the containment capacity of any areas with save-alls/freeing ports.

SOPEP equipment should be deployed before starting operations:

- First response equipment should be available adjacent to the manifold. This should include a suitable portable pump and emergency containment (e.g. empty 200 l drums).
- Check save-alls around the bunker manifolds and fuel oil tank vents are empty and are fitted with drain plugs.
- Check there are no non-bunkering related leaks which could fill shared containment arrangements.
- Deck scuppers and freeing ports should be plugged with suitable dedicated devices. Consideration should be made for controlled drainage in the event of rainfall.

[2] Mindful of cargo and stability issues as well as operational preferences, the Master/Chief Officer and the Chief Engineer should jointly agree on the sequence of filling of the bunker tanks.

A responsible engineer should, with the supplier's representative, jointly inspect the supplying barge's gauges and tank measurements and confirm the quantities and grades to be transferred. If in doubt as to the condition of the supplier's connections or hoses, it is reasonable to request review of the supplier's pressure test certificates.

The supplier is responsible for his barge or facility and the supply hose to the ship's manifold; the supplier's representative is entitled to also check the manifold connection on the receiving ship before beginning[3].

The maximum pumping rate should be agreed, along with the maximum pressure at the receiving manifold, procedures/rates for commencing of transfer and for topping off and also, if required, the maximum air pressure for the final blow-through.

Communications systems between the vessel's crew and with the supplier should be agreed and tested. This should include signals for stopping the transfer in an emergency, and transfer should not start until communications are checked and verified.

3. During bunkering

On commencement, the manifold pressure should be kept to a minimum until it is clear that the intended tanks are filling, and there is no delivery to unintended tanks, overflow or leakage. When satisfied, the pumping rate should be increased until the agreed pressure/flow rate is reached; this may not necessarily be the maximum.

Close monitoring of tank filling rates is required – but readings of any remote level gauges should be periodically verified during the bunkering operation by manual ullages or soundings.

Regular communication checks with the supplier should be maintained, along with a continual manifold watch throughout the bunkering operation.

During rainfall, excess water should be manually drained from the deck and from save-alls as necessary, in order to maintain maximum containment capacity.

When topping-off tank levels or reducing capacity by closing full tanks off, the supplier should be warned, and an appropriate reduction in flow rate considered.

On completion, and assuming delivery quantities are not in dispute, the supplier may blow through the connection to the vessel with compressed air. It is important that a maximum air pressure is agreed, and that the system is suitably aligned for this operation. No valves may be closed and no disconnection is made until completion of the blow-through is confirmed by the supplier.

4. On completion

The manifold valve should be closed. Following disconnection, the hose blank and the bunker manifold blank should be securely fitted without delay. The hose should not be lifted away from the manifold save-all until this has been done. The vessel's fuel system valves should be re-aligned for normal operation. Consideration should be made to leave scupper plugs in place until departure from the port, but all SOPEP equipment should otherwise be secured and re-stowed appropriately.

The Master should confirm to the agent that bunkering operations are completed without incident.

Case study – Human factors

A vessel was stemmed to receive 250 MT of IFO 380 from a barge whilst alongside. The bunkers were to be received in a pair of empty top side tanks, each with a full capacity of 200 cubic metres. As per company management procedures, bunker tanks were not to be filled in excess of 85% capacity, which in this case corresponded to a minimum ullage of 55 cm. The Third Engineer (3/E) was placed in sole charge of performing the bunkering operation, which was commenced into the starboard side tank only at 15:20 hours. At 16:30, the 3/E recorded the ullage of the tank as being 51 cm and yet bunkering operations continued. At 16:35, he saw that the ullage had reduced to 35 cm and rushed to the engine room to divert the bunkers into the port side tank. However, by the time he reached the valve station, the starboard side tank was already overflowing on deck, with oil being spilt overboard.

This was a very poorly planned bunkering operation from the outset with an almost complete neglect of the company SMS procedures. The bunkering checklist was ticked off but not in fact implemented. The 3/E should have been supported by another member of the engine room staff during the operation and in ready communication with the bunker barge. Consideration should also have been given to filling both port and starboard tanks at the same time.

The tank overflowed from both the forward and aft air vents. At the aft vent, the oil was not contained within the save-all as the vent head was located immediately adjacent to the side plate, allowing oil to land directly on deck. At the forward vent, oil was able to escape because the save-all drain plug was not fitted. Although the main deck scuppers were plugged, oil was still able to flow over the deck containment and into the dock.

Investigative findings

- Bunkering operations should be performed in strict compliance with SMS procedures.
- Bunkering plans are to be carefully considered by the Chief Engineer and checklists diligently completed at the site of the task, not just a "tick box exercise".
- Bunkering is not a one man job. It requires teamwork and communications with ship and barge personnel.
- The pollution may have been avoided with better design of the tank vent and save-all arrangements.
- It's not a save-all if the drain plugs are not fitted or missing!

[3] Indeed, they should be invited to do so for verification of sampling procedures.

Summary – Key points

- In spite of provision of suitable procedures, bunker spills still occur with worrying frequency.

- Common causes include setup or monitoring failures, excessive transfer rates or equipment malfunction (valve or hose failure).

- Human error is also common, caused or exacerbated by complacency, high work load and fatigue, unfamiliarity, or poor communication.

- Procedures in place should include:
  - Allow adequate safety margins when stemming bunkers – stem only to 85% or 90% capacity, as dictated by the vessel's SMS procedures.
  - Appropriate maintenance and testing of systems and pipelines, including calibration of remote tank gauges.
  - Provision of suitable instructions for operation and for emergency response, including bunker check lists and a bunker plan.
  - Regular bunker/oil spill drills to encourage familiarisation with bunker systems and procedures.

- Pre-arrival preparations should include:
  - Planning for key personnel availability, including suitable rest periods.
  - Plan for tank capacities and filling sequence.
  - Ensure pipelines are in good order, and empty overflow containment (including save-alls). Test high level and overflow alarms.
  - Ensure SOPEP locker contents are readily available.
  - Diligent completion of the bunker check list at appropriate times – not in advance.
  - Carry out a final oil spill drill and appraise all crew of the impending operation and of their expected duties.

- At the bunker port – prior to start:
  - Verify correct alignment of the system valves and isolation/blanking of unused components. Check and double-check this point – assume nothing.
  - Prominently display the bunker board with fully completed documentation.
  - Deploy SOPEP equipment, including fitting plugs to save-all drains as well as to scuppers and freeing ports. Control drainage in the event of rainfall.
  - Check the supplying facilities tank measurements, confirm quantities and grades to be transferred, and in which order, and check the condition of the supplier's hose and manifold.
  - Establish communication, especially emergency signals, and agree pumping rates for the various stages of the operation.

- During bunkering:
  - Start slowly, and build up to full flow rates once appropriate distribution of the fuel (checking none is being delivered where it is not wanted) is established. Confirm pumping rates are at or below the maximum specified.
  - Closely monitor tank filling rates and confirm by soundings as appropriate. Do not place over-reliance on remote gauges.
  - Maintain regular communication with the supplier.
  - Avoid distractions.
  - If in doubt, suspend the operation. It's better to have a delay than a spill.
  - Slow down the flow rate for topping off tanks.

- On completion:
  - Allow the supplier to blow-through the lines with compressed air.
  - Close the manifold valve. Disconnect and install all relevant blank flanges before removing the bunker hose from the vicinity of the manifold.
  - Realign the fuel system for normal operation.
  - Inform the agent that bunkering has been completed, hopefully without incident.

About us

UK P&I Club

UK P&I Club is a leading provider of P&I insurance and other services to the international shipping community. Established in 1865, the UK P&I Club insures over 240 million tonnes of owned and chartered shipping through its international offices and claims network. 'A (Stable)' rated by Standard & Poor's with free reserves and hybrid capital of $597m, the UK P&I Club is renowned for its specialist skills and expertise that ensure 'best in class' underwriting, claims handling and loss prevention services.

ukpandi.com

Brookes Bell

Serving the Marine and Energy Industry since 1903, Brookes Bell operate from Liverpool, London, Glasgow, Shanghai, Hong Kong and Singapore. Brookes Bell lead the market in professional expertise and experience across the major maritime and scientific disciplines. All our full-time personnel work exclusively for us and enable us to provide specialist advice on a wide range of inter-disciplinary areas. Brookes Bell are an ISO 9001 quality approved company with solid and time-tested processes ensuring smooth and reliable completion of all work for our clients.

brookesbell.com

ukpandi.com brookesbell.com