ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΩΣ

ΤΜΗΜΑ ΝΑΥΤΙΛΙΑΚΩΝ ΣΠΟΥΔΩΝ

ΠΡΟΓΡΑΜΜΑ ΜΕΤΑΠΤΥΧΙΑΚΩΝ ΣΠΟΥΔΩΝ ΣΤΗ ΝΑΥΤΙΛΙΑ

AN EXPLORATORY RESEARCH OF OIL-SPILLAGES DURING MARINE BUNKERING OPERATIONS

Αντωνιάδου Αγγελική

MN13004

Διπλωματική εργασία

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Ειδίκευσης στη Ναυτιλία

Πειραιάς

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ABSTRACT

Ship bunkering is the process of suppling fuels to ships for their own use and it is a vital marine activity. This study focuses on the methods of bunkering operations, which carries many risks, similar to a number of other shipboard activities. Moreover, this paper analyses the causes of oil spillages during the bunkering operations. Specific guidelines, International standards and Conventions should be applied during all stages of the fuel transfer process in order to be ensured that the operations are executed with safety and diligence. Throughout the bunkering process, human life and the environmental protection are the main priorities. All the bunkering processes are detailed described, from the pre-delivery of the fuel until the completion of the process. The potential threats of oil spill during oil transfer are identified, as well as actual accidental events which have caused oil spills are described in this paper and their root causes are analysed. The catastrophic environmental consequences of the oil spills are described, along with the clean-up methods. In conclusion, the researcher concludes that the human error or omissions are the main causes of oil-spillages and recommends actions to avoid them.

Key Words: Bunkering Operation, Barge, Bunker Oil, Oil spill, SOPEP

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1. INTRODUCTION

Throughout history, maritime activities have contributed in promoting growth and bringing civilization. International shipping transports more than 90% of the global trade (IMO, 2012). Undoubtedly, regional and inter-regional shipping has developed especially in emerging economies rising at an important rate. For instance, previous studies have mentioned that the Latin America and the Caribbean (LAC) region is categorized as one of the fastest growing in terms of container trade (Sanchez and Ulloa, 2007). Thus, shipping is the most efficient and cost-effective method of International transportation for most goods. Interestingly, the global shipping industry generates an annual income of almost 500 Billion Dollars in freight rates. Truly, the intercontinental trade, the import/export of manufactured goods and the bulk cargo of raw would be impossible without shipping. On the other hand, shipping can bring enormous environmental challenges such as solid waste, sewage, pollution from ballast water, noise, as well as oil discharges and air emissions. Fifty-one percent of the oil pollution in the marine environment is caused by ship and the rest forty-nine percent is derived from natural drainage (GESAMP, 2007).

The globalization and the reliance of maritime transport for movements of goods make imperative necessity appropriate prevention measures to be implemented as the possibility of the marine pollution is increased. Marine pollution can be caused by collision, grounding, explosion, fire or release of ship bunkers. Specifically, this paper examines concretely the marine pollution during bunkering operations, while it is a vital process in shipping industry. The aforementioned can be attributed to the bunkers highly cost of purchase, as well as to the enormously emerged cost in case of an oil spillages and the environmental disaster which may cause. According to the World Ocean Review report, about two-thirds of the operating costs of a vessel are related to fuels.

Bunkers refers to the fuel and lube oils, which are stored on a ship and used for machinery operations. Particularly, bunkering is the operation of oil transportation for fuel purposes, which is taking place through a barge, storage tank ashore or truck to another ship. Generally, bunkering is conducted in normal anchor or at berth alongside.

The main types of fuel oil are Marine Gas Oil (MGO), Marine Diesel Oil (MDO), Marine Fuel Oil (MFE), Heavy Fuel Oil (HFO), Liquefied Natural Gas (LNG) and Lube Oil Bunker. The

Heavy Fuel Oil is so named because of its high viscosity. In marine operations, the Heavy Fuel Oil is widely used in combustion equipment, such as main engines, auxiliary engines and boilers. As it is a residual product, its cost is low compering to the other fuels. Approximately, it costs around 30% less than the distillate fuels.

Bunkering of fuel or diesel oil requires highest attention and alertness to prevent any kind of oil spillage or fire accident. When an oil spill occurs at sea, it spreads over the surface of the sea water and has a deadly impact on marine mammals, birds and the environment. Also, the cost to clean up an oil spill is huge and depends on the quantity of oil discharged in the sea. Thus, various expenses should be incurred, such as money paid as penalties, cost of repairs and cleanups. However, the most important consequence is the loss of marine life and the deadly effects on human health which undoubtedly cannot be measured against any amount. For this reason, during the bunkering process all the employees have to adhere to international safety procedures and guidance in order to prevent any kind of accident which has catastrophic consequences.

Petroleum is a complex of thousands of different organic compounds formed from a variety of organic materials which are chemically converted under deferring geological conditions over long period of time. The mobility and the distribution within the environment of the petroleum products, it depends on its solubility. Additionally, the chemical components of oil maybe transformed in water by several processes, including hydrolysis, photolysis, oxidation or biodegradation. It is worth mentioning that the rate and the extent to which oil dissolves in water depends on various reason, such as the water temperature, the degree of the water turbulence and the degree of the oil dispersion in the water. The heavier components of crude oil are almost insoluble in sea water, whereas lighter compounds are slightly soluble, mainly aromatic hydrocarbons, like benzene and toluene. Thus, these lighter compounds are lost very rapidly by evaporation.

Shipping companies pays close attention to the prevention of the marine accidents, as these can affect negatively the financials. Also, these accidents can influence negatively the competitiveness of the shipping company on the long-term, as the company loses its corporate credibility in terms of safety and reputation.

Companies should be committed to all the necessary International and Local Regulations in order to prove that safe working conditions onboard are the main priority. The scope of this study is to identify the causes of oil spillages. This paper is organized as follows: In section 2 the worldwide oil spills trends and causes are presented from International Tanker Owners Pollution Federation (ITOPF). In section 3, the researcher examines the methods of bunkering operations. In section 4 the researcher analyses the importance of high safety standards to be implemented during bunkering operations and the Ship Oil Pollution Emergency Plan is analyzed. In section 5 the International Regulations and Conventions are presented. In section 6, actual oil spills incidents and their causes are analyzed. In section 7 and 8, the implications of oil spills on the environment and the recovery methods are examined respectively. In conclusion, section 9 draws the conclusion remarks of the dissertation research.

2. WORLDWIDE OIL SPILLS TRENDS AND CAUSES

The International Tanker Owners Pollution Federation (ITOPF) maintains a worldwide database of accidental oil spills and categorizes them by size. Specifically, oil spills < 7 tonnes, 7-700 tonnes and >700 tonnes. Interestingly, as it is depicted on the Figure 2.1, the large-sized oil spills have been steadily reduced the last decades.

According to ITOPF, the main causes of oil spills have been grouped into the following categories: collisions, groundings, hull failures, equipment failures, fires and explosions, others and unknown. Specifically, 'others' causes can be the adverse weather conditions or human errors.

The vast majority for oil spills over 700 tonnes, which have been recorder from 1970 to 2017, are attributed to accidental causes, such as collisions, allisions, groundings, hull failures, and not in operational causes, such as loading or bunkering. Interestingly, the pie chart (Figure 2.2) demonstrates that a significant percentage of 32% of large oil spills are occurred due to grounding of the vessel. Additionally, a 29% of large oil spills are occurred due to allision and collision. However, for small and medium sized oil spills, the operations have been grouped into Loading/ Discharging, Bunkering, Other operations (ballasting, de-ballasting, tank cleaning) and unknown operations (Figure 2.3).

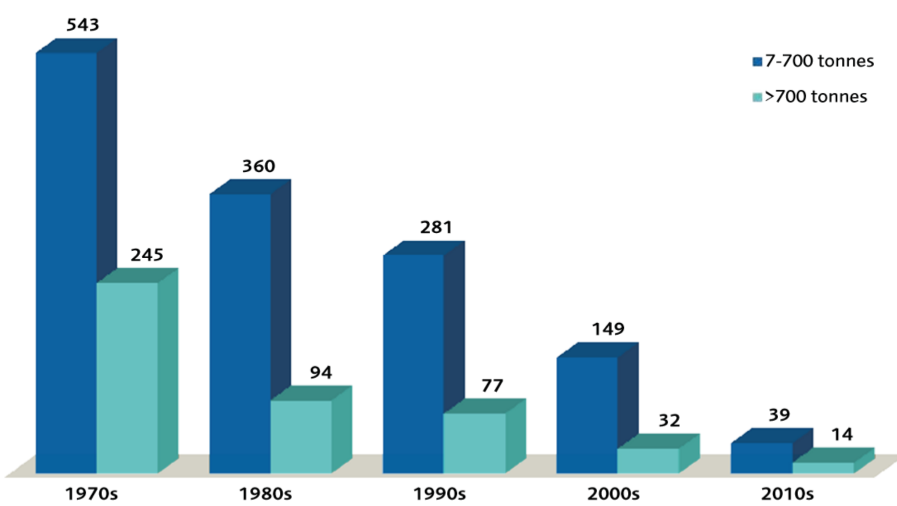


Figure 2.1: Number of medium (7-700 tonnes) and large (>700tonnes) spills per decade from 1970-2017 (Source: ITOPF 2018)

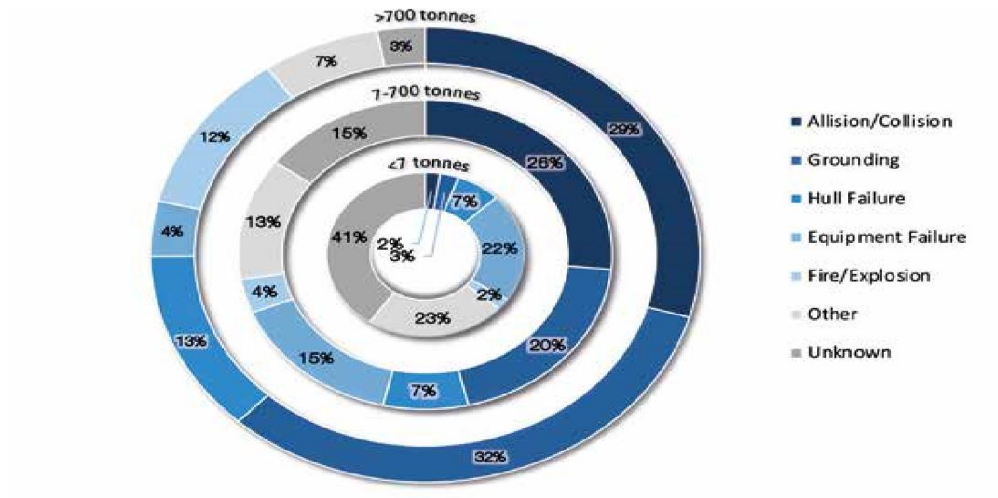


Figure 2.2: Incidence of spills by cause, 1970-2017

(Source: ITOPF 2018)

Specifically, 95% of the reported incidents are medium and small sized spills. It is noticeable that the bunkering acquires the lowest percentage in medium and small spills, 2% and 7% respectively (Figure 2.3). However, 40% and 29% of oil spills are occurred during loading/discharging for spills<7 tonnes and 7-700 tonnes respectively. Specifically, these operations are normally taking place in ports and oil terminals.

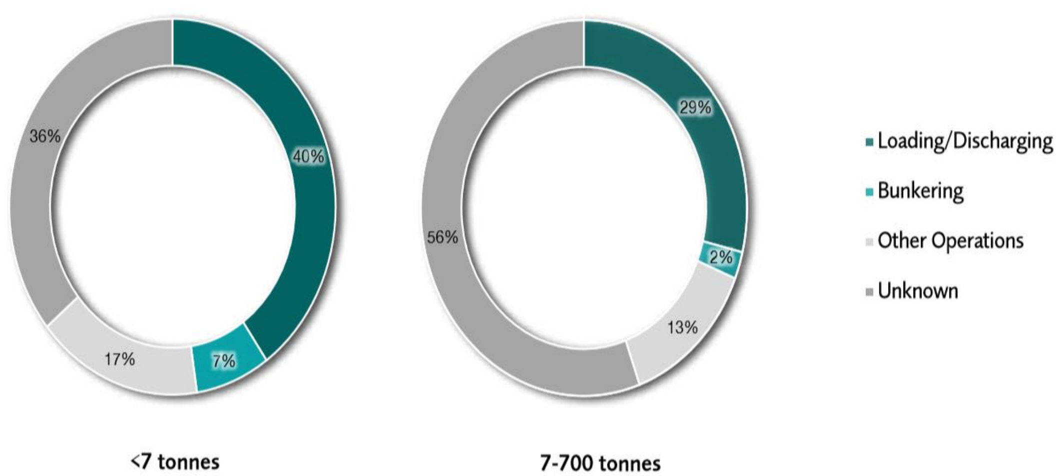


Figure 2.3: Incidence of small (<7 tonnes) and medium (7-700 tonnes) spills by operation, 1970-2017

(Source: ITOPF 2018)

As it is depicted in the bar chart, which analyses the causes of oil spills by operation, the highest percentage of the small oil spillages during bunkering is subjected to the category ‘other’, which as previously mentioned, can be a human error or adverse weather conditions. Also, the equipment failures acquire the second highest percentage.

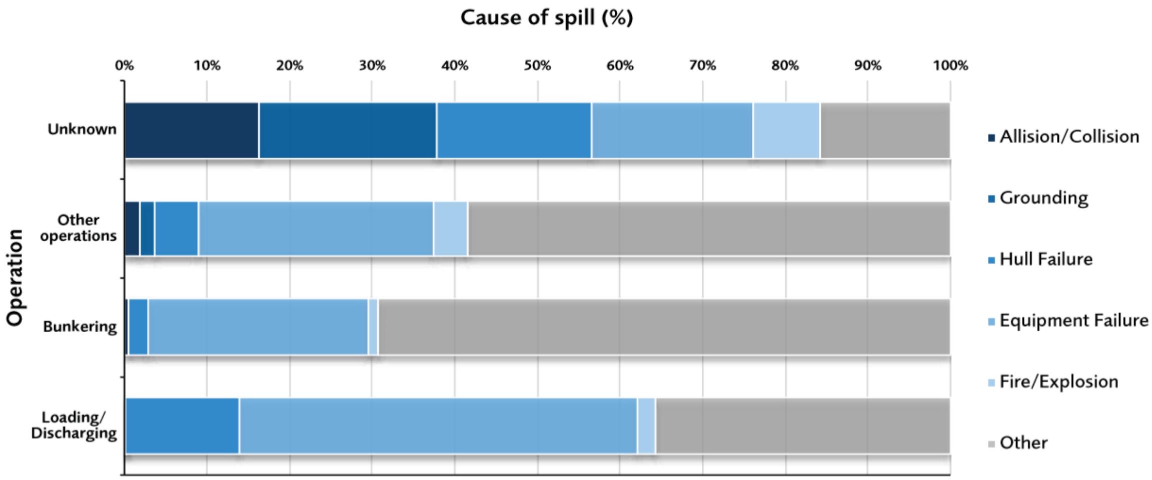


Figure 2.4: Incidence of spills <7 tonnes by operation at time of incident and primary cause of spill 1974-2017 (Source: ITOPF 2018)

3. BUNKERING OPERATIONS AND PROCEDURES

This section describes the procedures which should be followed when handling and delivering fuels by road vehicles, barges and pipelines.

3.1 Bunkering by road vehicle

The delivery of fuels and lubricants to customer's vessels by road vehicle (tankers) is a frequent activity that must be properly managed to avoid road transport accidents, drivers' and customers' crew injuries and to prevent spills during bunkering operations. The road transport is a high-profile operational activity which creates significant risk and requires careful management. Consequently, all road tanker transportations should fully comply with international, country's regulations, laws and European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR).

3.1.1 Management of road transport operations and bunkering procedures

The following procedures shall be applied whenever is contracting and managing operations for the delivery of fuels by road. All contracts for road transport services shall be prepared, tendered, analysed and awarded in accordance with the relevant contract and tender board procedures. All prospective service providers shall be subject to pre-qualification assessments. During operation of the contract, the performance, including QHSSE (Quality, Health, Safety, Security, Environment) of the contractor shall be managed in accordance with standard contractor performance management process which includes:

- Regular performance review meetings with the contractor
- Monitoring of agreed Key Performance Indicators (KPI's)
- QHSSE incident reporting, follow up and review
- Cost and service performance review and management
- Periodic audits of contractor operations in accordance with the international standards and laws

Road transport operations should be executed with accountability and responsibility and should ensure that appropriate subject matter experts are involved in critical steps of the process and particularly during performance reviews and audits.

3.1.2 Pre-delivery requirements

Before the delivery various checks should be executed in order the safety procedures and operations to be ensured. Thus, the personal protective equipment should be checked and required documentation should be available prior the delivery.

Regarding the Personal Protective Equipment (PPE), drivers and staff involved in delivery operations should use the minimum personal protection equipment and clothing, such as safety helmet and footwear with toe-cap protection, coveralls, high visibility vest, jackets, eye protection, protective gloves for product handing and sampling. Also, whenever there is a risk of falling into water during working in open or unprotected dock sites, lifejackets and high visibility vests should be worn.

Additionally, the vehicles which deliver the fuels should meet all specifications and required equipment according to the International standards.

Specifically, the below equipment should be available:

- A spill-kit suitable to respond to minor spills during marine deliveries, which should contain at least some absorbent pads, mini-booms and absorbent socks
- Sufficient hoses and fittings for the delivery.
- Portable signs are necessary in order to demarcate the area and warn of the fuel delivery operation
- Where vehicles are not fitted with fixed delivery pumps or fixed shore based pumping equipment is not available, arrangements shall be made for the provision of any required supplementary portable equipment and required staff. Ideally, the contractor or service provider shall manage the provision and operation of this equipment. Responsibilities for inspection test and maintenance must be clearly defined.

As it has been already stated, documentation should be prepared and be available for use prior the fuel delivery process, which ensures that the safe transfer of the product can be commenced. Thus, the documentation includes the bunkering pre-delivery safety checklist, material safety data sheet (MSDS) for the bunker transfer and Master's Requisition form. This form should be fully completed by the receiving vessel in order to confirm the product grades, quantities and loading rates. Moreover, local port regulation maybe requires additional documentation.

3.1.3 Vehicle position & boarding of vessels

The selection of the vehicle position is directly correlated with the safety. Thus, the selection of the site should take into account the type of the berth surface, the current use of the berth as well as the presence of any hazard. Also, except from the use of the handbrake, the wheels should be locked in order to prevent any possible movement of the vehicle, which maybe cause a fuel leak. Also, the site should be surrounded with traffic cones in order for potential vehicular accidents to be avoided. Also, the vehicle should be positioned in the most appropriate edge of the dock in order to ensure the efficiently and secure hose connection. Before delivery procedure commences, hose should be checked that have strong connection and endure in case of high tension. Additionally, warming signs should be posted in order to prohibit to step or jump between ship and shore above open water or where a fall from height may result. Prior to the bunkering procedures, portable gangways and mechanical ladders with sanctions and rails on both sides, should be safely placed above any gap that could possibly allow a fall to water.

As soon as, the personnel of road vehicle boarding on the vessel, they should follow all the instruction for safety and security compliance, adhere to all the emergency signs and respect the prohibit entrance to any potential hazardous or machinery space without special permission.

3.1.4 Pre-delivery conference

Effective communication between the road vehicle and the receiver vessel should be established in order to confirm quantities and grades, the delivery plan and conduct the appropriate pre-delivery safety checklists. The road vehicle and the vessel should agree the practical arrangements for taking the required samples.

3.1.5 Delivery

By the time of delivery, the bunkering pre-delivery safety checklists should have been completed as per procedures. Under no circumstances, the delivery should commence in case of inadequate completion of this checklist. Also, the personnel should ensure that the relevant safety signs have been placed in the sensitive area that the bunkering is executed. For instance, signs should be placed in suitable positions so as warm people in the vicinity. Additionally, the hoses and couplings should have been inspected before the inception of the procedure. Thus, it should be ensured that they are free from any leaks. As far as practicable, hose connections above water or unprotected and open grating areas should be avoided. Also, it must be ensured that hoses are not vulnerable to damage by passing vehicles. Hoses should be properly supported, so as no undue strain to be placed on the end connections or joining couplings. Additionally, all connections and joining couplings in hoses should be in good conditions and ensure leak tight connections. Checks should be constantly occurred during the delivery process in order to timely prevent any leakage. As soon as, safe conditions are confirmed, the delivery fuel rate maybe will be increased to the agreed levels. During bunkering procedures, the effectively communication between the road vehicle and the vessel is important as it can prevent any possible accident. This should be continual during the operation and monitor the progress. It is worth pointing out that the emergency stop signals should be tested before the delivery commences. Responsible personnel should be to the pump stop controls throughout the delivery in order to act accordingly in case of emergency. In case of emergency, fire extinguisher shall be readily available in a prominent position. On quick-fit, cam and groove type couplings, particularly where secured to pump outlets, the levers should be secured in position with clips, pins, wire or plastic cable ties to prevent movement and vibration causing them to inadvertently release. Anti-whiplash straps should be securely bounded to the end of the couplings in order to prevent injury from the hose coupling break free. The witnessing of vehicle dips and the breaking of seals by the appointed crewmember should be assisted upon request. However, the customer representatives should not be encouraged to access the top of vehicles. Opening dips should be taken, witnessed and recorded where is appropriate.

3.1.6 Completion and disconnection

On completion of Bunkering, the system and the valves should be shut down and the hoses should be drained in order to eliminate the possibility of oil leakage during disconnection. Also, the hoses should be stowed away. It is critical the vehicle to be displaced from the delivery location in order to allow the area to be inspected to guarantee it is left in a clean condition, free of fuel left overs. The bunkering process will end up with the providing of the appropriate documentation, which confirms the receipt of the delivered quantity. It is vessels' requirement to complete and sign the documentation. Last but not least, all the samples should be hand over for retention and safely stored as per MARPOL ANNEX VI Sample Record Guidelines for three calendar months and should be properly labelled. If there is no complaint for the fuel quality, the samples bottles or cans should be emptied into a designated waste container and not into drainage system. These bottles or cans must not be reused. Particularly, the samples requirements for fuels are the following:

- 3 x min 750ml representative samples for quality assurance
- 1 x min 750ml MARPOL sample for quality assurance (Residual Fuel Oils only)

All the above four sample are drawn by the continuous drip of the fuel from vessel's manifold.

3.2 Barge operations

The delivery of bulk fuels to customer vessels is a frequent activity which must be properly managed and executed in accordance with MARPOL Regulations in order to prevent possible oil spillages.

In general, the bunkering operation procedure can be divided into three important stages:

1. **Preparation:** This stage includes all the necessary actions to be taken in order to ensure the readiness of the bunkering equipment, storage tanks and bunkering safety. At this stage, bunkering safety check list should be completed.
2. **Perform**: The bunkering process has already started as per the pre-decided procedures and the appropriate quantity of bunkers is supplied according to the bunker plan. It is worth mentioning that during the start of the bunkering, the pumping rate is kept low.

These low rates are applied in order to check that the bunkers are coming to the tank to which the valve is opened. In general, it is preferred only one tank to be filled as it is risky to be detected an overflow if the crew gauge more than one tank

3. **Wrap-up:** Wrapping up the bunkering operation with highest safety and ensure that the appropriate quantity of the bunkers has been received onboard. Consequently, the sounding of all the tanks should be executed. After the completion of the bunkering, four samples are taken. One is kept onboard, one for the bunker supplier, one for further analysis and one for the port sate or IMO. The Chief Engineering will sign the Bunker receipt (BDN-Bunker Delivery Receipt or Note), as well as the amount of bunker received. The BDN is a proof of delivery which has to be kept on board for a minimum of 3 years.

It is vital the 'safe berth' of the vessel before the commencement of the bunkering operations. Specifically, the safe fit refers to the draft, length, breath and displacement. The port, terminal and berth information should be fully comprehended before the commencement of bunkering. The loading facility should be assessed according to the Oil International Marine Forum Baseline Criteria Assessment. In particular, barges usually operate within a pre-defined area such as a specific port, harbor or waterway and load regularly at the same facilities where compatibility between shore and vessel has been confirmed.

3.2.1 Barge delivery procedures

Master Responsibility

The master of the ship has the responsibility for all the matters which happens on the ship. Consequently, the master has the responsibility for monitoring and checking the bunker operation, even if it is conducted by Engine Department. Specifically, the master should confirm the safe moor of the ship. The Master should take into consideration the effects of the interaction from passing vessels and fluctuations in water levels, which may occur during the bunkering operations.

Additionally, master should ensure that the Officer in Charge on the Ship attend all the bunkering procedure. Also, he has the duty to confirm that the Officer in Charge establish and maintain effectively communication with the on-duty Deck Officer and Bunker Supervisor.

In coordination with bunker supplier, the handling procedures should be decided. Thus, the quantity, loading and unloading rate should be agreed, capacity and the maximum allowable pressure of the receiving tanks, cargo lines, hoses and shore pipelines, the possible pressure increase due to an emergency shut-down and the estimated time of completion.

The master also has to agree in writing with the Bunker Supplier the action to be taken and the signals to be used in the event of emergency.

To summarize, the barge's Master should ensure that the following actions should be taken:

1. Organize the crew and assure that they use the required protective clothing for their own safety (e.g. life-vests). Ensure that the crew, lists, identity cards area available and all the requested document as per port security requirements,
2. Obtain permissions to go alongside to the customer vessel from the Port Authority. Maybe, port health clearance is required before going alongside
3. Provide customer vessel with all required security information requested as per ISPS code.
4. Display an International Code of Signals “B” flag and/or fixed red light or other signals required by the port.
5. Choose a safe mooring position as far as practical avoiding the flare of bow or stern of the customer's vessel and close to the filling connection
6. Safely maneuvers the barge alongside and securely moor to the receiving vessel. It is particularly important the mooring position to avoid areas where risks from falling objects may arise.

<u>Officer in charge responsibility</u>

The Officer in Charge has to ensure that the correct quantity of Bunkers has been order and agree with the Bunker Supervisor the quantity. Also, the Officer has to specify the tanks to be loaded, decide on the fill level and ensure that there is sufficient capacity in order to receive the requested bunker quantity. It is extremely important, the Officer in Charge to ensure that the tank receiving the bunkers will not surpass the 90% of its normal capacity. At frequent intervals, the agreed back-pressures should be checked, as well as the loading and the uploading rates should not be exceeded. This Officer has the responsibility of taking appropriate preventing measures. Furthermore, the relevant equipment, such as pipelines, loading arms, flexible pipes, should be checked for possible damages during bunkering and possible signs of leakages. If the condition of the equipment is not satisfactory, the chief engineer should be notified. Effective communication with Bunker Supervisor is essential and can prevent undesirable effects. Signs and signals need to be agreed in case of emergency. Last but not least, Officer in Charge should secure that the hoses and pipes have been drained of liquids, the pressure has been revealed and that the vessel’s manifold has been blanked off. Attention to ensure that no ignition sources, like smoking, hot work or naked flames are within the area of Bunkering Operations.

Bunker Supervisor Responsibility

The Bunker Supervisor should ensure that the all the reporting procedures are followed, such as information provided to the Harbor Master prior to the inauguration of the Bunkering Operations (details of the bunker supplier, name of the ship, location of bunkering operations, mode of transfer, estimated quantity of bunkers, proposed estimated time of bunkering and estimated completion time). In conjunction with the Officer in charge should ensure that the bunker barge is securely moored to the ship, sign the bunkering safety check list, establish the safe limits for wind and swell conditions for undertaking bunkering operations.

In general, during the delivery process, it is very important to be ensured that all safety and security precautions are followed. Barge crew should comply with procedures and respect the safety signs of the receiving vessel. The personnel protective equipment should be worn during bunkering operation. The receiving vessel must provide safety access to and from the barge vessel, using a gangway or ladder with stanchions and rails on both sides, with a properly rigged safety net in open areas due to prevent falls in water accidents. Also, all the tanks and valves are inspected in order to confirm that are in the correct order and no leak exist in the hoses and couplings connection. The hoses and couplings should be checked constantly during the delivery process in order to ascertain any possible leakage. The weight of the hose should not put undue pressure on the manifold. As far as, it is practicable, hoses connections over water should be avoided. Thus, the transfer of the fuel can start with a slow rate. It is vital, the pressure gauge and the tank levels to be carefully monitored. In order to avoid any possible leak, low flow rate should implement during changing over tanks. Additionally, from the control room monitor the quantity and the flow rate of the fuel is monitored during the process. Also, these are manually controlled by pressure gauge and flow meter. As soon as, the required amount of oil is being transferred, the hoses connections should be disconnected drained and the manifolds have to be sealed. The two- way communication system should be maintained throughout the delivery process in order the crew to be alert in case of any emergency situation. Reaching at the end of the bunkering process, the transfer rates should be reduced. Additionally, samples must be taken at the start of the bunkering operations. Specifically, four samples are taken in total, one for the receiving vessel, other for the laboratory for analysis and report, one for the barge and the last for compliance with the MARPOL regulations. Moreover, the MARPOL samples are kept at the receiving ship to display the samples upon request. Samples have to be sealed and labelled properly. In any case, the new bunker should not be used until the report is released from the lab.

- 3 x min 750ml representative samples for quality assurance
- 1 x min 750ml MARPOL sample (Residual Fuel Oils only)
- Samples properly labelled, and MARPOL sample identified

All the above four samples Drawn by continuous drip sample from receiving vessel manifold.

At the end, a delivery note is delivered by the supplier and a copy is reserved at the barge and the other is kept to the ship. This note works as a record for the fuel transfer between the two vessels. It is signed by the master of the barge and the chief engineer of the receiving vessel. According to the regulation, copies of the document should be kept by both the barge and the ship for the three next years.

Generally, the bunker delivery note includes the following information:

- Name and IMO number of the receiving ship
- Port

- Date and time of Delivery commencement
- Barge name, address and telephone number of the supplier
- Product name
- Volume in metric tonnes
- Temperature of the product delivery
- Density at 15°C (kg/m3)
- Sulphur content
- Sample seal numbers
- A signed declaration that the fuel oil conforms with MARPOL Annex VI

It is noteworthy to mention that in case that the chief engineer finds out a deficit in bunkers received, which is not agreed by the bunker supplier, he has the right to issue a letter of protest against. Then, the chief engineer will make an entry in the operation in oil record book along with received BDN.

Generally, all barge delivery operations shall comply fully with:

- The relevant requirements of the current edition of the International Safety Guide for Oil Tankers and Terminals (ISGOTT-V)
- All applicable national, regional and local regulations such as the Coast Guard regulations in USA and the European Agreement concerning the International Carriage of Dangerous Goods by inland Waterways
- The Maritime standards and procedures

3.2.2 Completion and Disconnection

On completion of the loading process, the hoses should be carefully drained. The remaining liquid residue can be cleared by blowing ashore with vapor, using the tanker's compressor. Otherwise, the liquid remnants maybe cleared by nitrogen inserted into the loading arm to blow the liquid into the ship's tanks. One the residuals have been cleared, the manifold valves should be closed and the hoses will be carefully disconnected from the manifold flange. Also, final checks have to be executed for the properly competence of the required documentation, accurately complete oil record books, deck and engine record books.

3.3 Pipeline operations and delivery

These procedures cover bunker deliveries that are transported directly from a shore facility/terminal where the receiving customer vessel berths or moors to the facility and delivery is made via hard arms or hoses. All contracts with customer's vessels shall include all requirements for compliance with national regulations and industry standards, including ISGOTT V. It is essential, the shore management facilities to ensure that the procedures are implemented as per agreed national regulations and standards. All shore facilities supplying bunkers to customers shall have detailed operating procedures in order to ensure the safe delivery of fuel. Thus, the facilities should be assessed by a Marine Technical Advisor (MTA) against the relevant aspects of the Oil Companies International Marine Forum (OCIMF) Baseline Criteria for ensuring the highly delivery standards to the customers. Additionally, the vessel which is loading fuel as cargo should be inspected for the Ship Quality Assurance and its vetting requirements.

Facility operating procedures shall specifically ensure that the following requirements which are critical for the safely delivery process to the customer are properly complied with the Internationals standards. Similarly to the previous methods, the pre-delivery bunker safety checklist is required to be completed prior to the delivery process. Critical parameter for the smooth progress of the procedure is that the critical equipment has properly maintained and inspected (jetty structure, fenders, and other fixed equipment). All staff should be received adequate training and use the necessary Personal Protective Equipment (gloves, safety boots, hard hats, safety googles, protective clothing) in order to remain safe in case of any accident. Where there is a danger of falling into water an appropriate life vest is required. Also, the responsible personnel should be fully rested. Lack of sleep can lead to serious mistake which can cause accidents. Additionally, the communication with the Master of the vessel, the Chief Engineer and the designated Responsible Officer should be constantly and they should agree the quantity, the loading rate and the product grades before the start of the delivery procedure.

3.3.1 Pipeline delivery process

As soon as the Pre-delivery requirements have been completed, (ISGOTT V Ship/Shore safety checklist), bunkering operation shall commence. In the begging, the delivery rate should be slow and the pressure should be kept in low levels. In particular, the receiving vessel is responsible to clearly confirm the correct delivery point should be used. The equipment (hoses and couplings) should be in good condition and regular maintenance is required in order to avoid any possibly leakage. Hard arm and hoses operations should be executed in accordance with manufacturer’s instructions. The hoses joining connections over the water or unprotected and open grating areas should be avoided. Also, it should be ensured that any unused connection and flanges are fully secured with fully bolted flanges. Effective communication may prevent any possible accidental oil-spill and help the promptly respond to any emergency/stop signals. At the end of the procedure, it should be taken the opening dip of the delivery tank and ensured that the meter reading is correct. Last but also important, the bunkering samples should be correctly taken and secure handled. Four samples should be retained, as it has already described in the two previous bunkering methods. This procedure maybe helps to reduce or minimize the risk of claims (e.g. machinery breakdown). Precisely, fuel sampling and analysis is essential for the verification of the fuel quality onboard. It is important that the samples taken to be properly labeled. Maybe, it is raised an issue of protest in case that the receiver vessel isn’t invited to witness the sampling. Consequently, one sample should be retained on board the ship, another should be retained by the supplier and the other sample should be used for analysis purposes. The samples should be secure kept for providing it in case of any dispute. As soon as the completion of the bunkering, the samples should be sent to the laboratory for testing as soon as possible. It is recommended, the new fuel not be used as soon as the laboratory result is released and considered as suitable.

3.3.2 Completion and Disconnection

After the completion of the fuel transfer, the procedures which should be followed are the same as the previous bunkering methods and are summarized below:

1. All the system and valves should be shut down

2. The closing dip of the delivery tank or record meter reading should be taken (Ship's Representative to witness)

3. Hose must be carefully drained in order to prevent oil spillages event after disconnection.

4. Hoses should be carefully disconnected and secured with all blanks fitted

5. The documentation confirming receipt of the delivered quantity should be completed and signed by the vessel. All required samples shall be handed over for retention.

4. BUNKERING AND SAFETY

In each port there are international, regional regulations and guidelines which should be applied by all relevant parties during Bunkering operations in order to ensure that the bunkering operations will be executed with safety. In general, bunkering operations should be performed diligently, safely and without justified delay. Bunkering commands cautious planning, co-ordination and co-operation between all parties involved from the point of ordering until the completion of the delivery. It is categorized as a critical operation under the International Safety Management (ISM) code. ISM code requires companies to document and implement clear and detailed procedures and instructions for safety operations. As well as, companies have to adopt safe working practices and to be proactive in order to identify the risks and apply preventing measures.

Otherwise, the non-compliance with recognized procedures in a vessel's Safety Management System during bunkering will result in significant costs, penalties, loss of reliability, damage company's reputation or even criminal charges, where oil spillages occurs. The cost of an oil spill is huge, as there are various expenses such as extraordinary expenses of clean-up works for spilled oil, fines, lawyers, surveyor's fees and compensations to third parties.

Checklists can offer assist to the vessel's and terminal's crew in order to undertake the operations safely, effectively and efficiently. Blind compliance to the checklist maybe has the risk of critical tasks not actually be completed. It is necessary the bunker supplier and receiving vessel to have a pollution emergency plan in case of any malfunction during bunkering operations and all the appropriate spill response equipment should be maintain on board.

Empirical analysis shows that bunker fuel commonly escaped through the air vents of the bunker vessel's tanks. The quantities involved are enough to breach the plugged scuppers, which cause the release of fuel from the confines of the vessel into the marine environment.

However, there are other factors during bunkering operation which can cause bunker spills. For instance, there are cases that the bunker fuel exceeds the tank capacity (overflow), during the filling of the adjacent tank, while the bunker continued to enter mistakenly to the first completed tank. Other cause is the failure to close the adjacent tank. Also, there is a bunker plan where the maximum loading rate is agreed. In the case that the maximum loading rate is overlooked, the air pockets collected in the top frames of the tank. Hence, the fuel is forcefully overflowed. Also, there are other causes, such as the failure to monitor the progression of the loading at sufficient intervals or the failure to adhere to recognised procedures for topping off tanks. For instance, a valve was closed against the flow of one of two receiving tanks. Thus, the overflow is resulted due to the increased pressure to the adjacent receiving tank.

To summarize the reasons of oils spillages during bunkering operations are the below.

- Leaking flanges
- Burst hose
- Leaking valves
- Damaged pipes
- Overflowing tanks/air vents
- Blow out of flange joint
- Incorrect valve opened or closed

Also, the general causes of the overflowing tanks can be the following:

- Failure to appropriately set up the pipeline system valves. The flow of bunkering executed to wrongly direction
- Failure to persistently monitor the tank levels during bunkering. All the tanks should be monitored and not only the selected tanks
- Transferring of bunkering at an excessive rate or pressure. This increases the operational stress on the crew, which maybe lead on to human errors, due to the risk of exceeding the design pressure or capacity
- Air lock. Excessive pumping rate maybe cause the air becomes trapped and cause an unexpected discharge of mist or oil from the tank ventilator
- Malfunction of valve. This maybe is incurred due to the poor valve testing or maintenance

Oil spills are frequently linked to human error. Thus, the responsible personnel for the bunkering maybe follow the operational procedures and checklists but they are not pay the proper attention during the bunkering process due to the complacency of the routine procedures. As it is already mentioned, the communication on board, as well as between vessel and barge is extremely important for the smooth bunkering operation. Thus, when this communication is poor and inefficient, minimize the ability to quickly and effectively respond in the occurrence of an incident or accident. Moreover, poor communication, as well as high work load increases the possibility of accident. Thus, spillages may occur when personnel are distracted by another task, such as cargo operations, inspections and surveys. Additionally, bunkering operations maybe are performed during the night and lasts many hours. For this reason, the bunker team members are essential to fell well-rested, while fatigue maybe contributes to underperformance, slowed reactions, decreased attention, increased mental errors and poor decision making. For this reason, upon request by the state inspector, the crew work and the rest hour's records must be available in order to confirm the compliance.

Moreover, there are incidents that the overflow is caused by faulty bunker system valves or detects in tank level electronic gauging system. For this reason, the appropriate maintenance of the equipment is vital and the verification of the accuracy of electronic system before and during bunkering. Poor design maybe is another cause of the oil spillages such as the inadequate arrangement of tank air vents, which accumulate the gases.

Consequently, the spillages can be avoided with a well –communicated planning and the diligently completion of the check lists. It is vital, the checklist not to be completed 'blindly', but with consistency and responsibility. Also, the pre-work briefing helps the involved engine and deck personnel to understand the plan, their responsibilities and any emergency procedure which should be taken in case of emergency. For this reason, emergency stop signals should be tested in order to be ensured that they have been mutually understood by the ship and the barge/road vehicle or terminal.

Furthermore, the tank levels should be monitored and recorded at all bunkering stages and the loading maximum rate should be checked regularly. Also, it is important the personnel not to be solely rely on the remote gauging system. Last but not least, the personnel should regulate and agree the pumping rate and ensure that the rate is slowed down at critical stages of the bunkering, such as in the commencement of the pumping and before the changeover of the tanks completion.

4.1 Hose and couplings

One of the most importance prevention measures is the rigorous specification controls, detailed inspection, maintenance, testing and use of the hoses and couplings. So, they should be strictly controlled in order to avoid any failure. Specifically, couplings should be joined only with these of the same manufacturers, except from referring in the manufacturer's instructions that they are compatible. Also, couplings made of different materials should not be joined (e.g. bronze to aluminum).

A "whip check" or rope restraint should be connected across the couplings in order to limit the potential movement of the hose in the event of intense pressure which may lead to failures. Always the technical advices from Marine Technical Advisor (MTA) should be strictly followed.

It is important, the couplings to be inspected and rejected if one of the following cases exists:

- There is damage to either of the locking levers
- Any signs of wear on the cams on the female coupling or the groove of the male coupling
- Any other signs of damage to the couplings or seals

4.2 Draining Delivery Hoses and Loading Arms

After completing the delivery operation, the residue contents in the hoses and loading arms should be drained in order to be ensured no occurrence of an oil spill during disconnection. Consequently, blank flanges have to be fitted and fully bolted and loading arms securely stowed. It is common practice for the clearing of lines to be assisted by means of 'stored pressure' when a valve is carefully closed down while a pump is running and then quickly opened to release the pressure. This is acceptable but has to be undertaken in a controlled manner that does not create excessive pressure on the system. For safety reasons, the use of compressed air for clearing lines or arms should be avoided. However, only under exceptional circumstances, compressed air or inert gas has to be used for the clearance of lines or arms of the receiving ships. Thus, the following precautions should be strictly observed. In the reception or delivery tank should be adequate ullage and venting. A competent person must continuously supervise the line clearing operation. Except for the safety, the precise delivery quantity is also extremely important to be given as per order. Thus, where the delivery is metered, the metering unit should be isolated before draining back to the contents of the hoses through the by-pass provided, except from the case that the meter is fitted with a reversing counter. If the meter is not fitted with a reversing counter or it is impossible to drain the hoses into the vessel's tanks, then the hoses should be filled and re-zero the meter counter before commencing delivery. However, if this is not practical, the content of standard lengths of hoses used for deliveries should be calculated and deducted from the quantity registered by the meter, after completing the delivery.

The delivery quantity must to be precisely checked due to the 'mal-practices' during bunkering operations. The most common method is known as 'Cappuccino effect'. Protection and Indemnity Club (P & I) issued various bulletins referring to this practice in order to inform the interested parties and prevent them from falling victim to these ill-practices. This effect is described as the effect which was caused by compressed air blown through the delivery hose. Thus, the aerated bunker creates the impression that the fuel has been delivered as ordered. Indeed, as time has passed, the oil level drops and a short fall is discovered as the entrapped air in suspension settles out of the fuel oil. High consideration should be taken to cappuccino bunker effect as in large bunker deliveries this could have very significant financial implications. Consequently, the engineer should monitor the bunkering process thoroughly as well as the temperature of the receiving bunker in order to detect any sign of pumping air into the bunker.

4.3 Restrictions on bunkering operations

During Bunkering operations, safety is a priority. Safety should be inseparable linked to culture of the company and should be instilled to the personnel. All the pre-defined procedures should be strictly adhered to in order to minimize any possible risk. To ensure that the safe standards of operation are maintained the following restrictions should be taken into account:

- Bunkering operations shall be suspended in case that there are any other vessels maneuvering within the vicinity of the Ship and Bunker Barge in order the safety to be ensured

- In case that the cargo operations are executed simultaneously with bunkering operations the below steps should be followed prior to the commencement of bunkering
    - The cargo terminal has to give the relevant permission
    - The ship's master should carry out an additional risk assessment with the cargo terminal operator (protection of hoses/pipes from damages, ensure that the movement of the ship due to cargo operations will not cause overflows, no risk of ignition)
    - The cargo terminal operator should suspend cargo operations immediately upon request of the Ship's Master or Officer in Charge

4.4 Spill prevention and containment

It is curial, the companies to recognize the importance of the prevention of oil spills and promote high safety standards to their procedures. In this endeavor, the following factors and actions are important:

- Recognize the priority of preventing oil spills and promote high standards among employees and other associates, who handle these products
- The bunkering operations should be always commenced at a low pumping rate and the bunker tanks should be continuously checked in order to ensure that the fuel is receiving into the correct tanks
- Continuously improve their practices in order to minimize the impact of oil spills on the environment, create awareness strategy to the crew and conduct Risk Analysis and Assessments
- Carefully check that the overflow alarms are operated correctly and on-time, so as the engineers and crew act immediately in case of tank overflow
- Develop contingency plans for immediate response and preparedness, which are fully understood by the crew. These plans should provide a framework which detailed describes the steps should be followed in case of emergency
- Tests should be undertaken to the spill response plans at regular intervals

- Adequate training of the personnel and participation in seminars in order to keep them up-to-date with the new regulations and procedures and receive feedback in order to ensure that these are efficient, effective and well-understood. Thus, the management is helped in order to uplift the organized training sessions and seminar, so as to improve the crew skills
- Keep regular and precisely records to monitor the pumping rates and regular check gauges in order to ensure that the lines pressures are not too high

4.5 Ship Oil Pollution Emergency Plan (SOPEP)

As prevention is better than cure, a prevention plan should be carried out on board. As per MARPOL 73/78 requirement under Annex I, all ships with 400GT and above, must carry an oil prevention plan as per the guidelines laid down by the International Maritime Organization under MEPC (Marine Environmental Protection Committee). However, for oil tankers the Gross tonnage reduces to 150 GT as the transfer of oil cargo doubles the risk of oil pollution.

In particular, the ship's Master is the overall in charge of the SOPEP, along with the Chief Officer for implementation of SOPEP on board. SOPEP also includes numerous oils spills scenarios which are possible to occur on a ship.

The SOPEP provide a guide to the Masters and the Officers on board regarding the actions to be taken in case of oil pollution incident or in case that the ship is at risk. All the necessary equipment should be provided in the SOPEP kit, which is kept on board in order to help to the immediate reaction. Thus, in case of pollution, oil absorbent pads, sawdust bags and booms should be available. Need to be mentioned that the SOPEP has approved and no further amendment should be executed without prior approval by the Administration. Amendments only can be executed in the case that there are changes that are non-mandatory. Hence, the owner and the ship manager should add them only in the appendices.

According to SOPEP, authorities should be contacted in order to be informed about the oil spill. These authorities can be the port state control and the oil clean up team. Also, this plan provides guidance for the onboard reporting procedures, as well as for the keeping records of the pollution incident for insurance or compensation purposes. Additionally, SOPEP contains material reference from various organizations, such as guidelines issued by International Chamber of Shipping (ICS), International Association of Independent Tanker Owners (INTERTANKO), Society of International Gas Tanker and Terminals Operators (SIGTTO) and Oil Companies International Marine Forum (OCIMF). Also, SOPEP plan provide procedures for testing various plans and details of when and how the plan has to be reviewed.

It is worth mentioning that SOPEP, not only provides information for preventing and restraint an oil spill, but it can act similar to any regulation of Safety of Life at Sea (SOLAS) as it contains detailed information in the event of collision, grounding, fire etc.

Under the SOPEP, the general duties of ship's crew are described, as follows:

- Master of the ship should inform the authorities about oil spill and keep detailed records. Also, master has to ensure that all crew members are complying with the plan.
- Chief Engineer is in charge of the bunkering operations. Also, in the case of oil spill should instruct the subordinates to prepare SOPEP kit. Additionally, the Chief Engineer should provide Master with updated information in relation to the limitation of the oil leakage.
- Chief Officer is in charge to complete deck operation to prevent any oil spill. In case of an oil spill, Chief Officer has to inform the Master for the situation and take all the necessary actions for oil spillage reduction.
- Deck Duty Officer has to assist the Chief Officer and provide information regarding any potential oil spill incident.
- Duty Engineer assists the Chief Engineer to the mitigation of the oil spillage, using the SOPEP materials.

In general, it is extremely important the familiarization of the crew with the bunkering system and procedures. Adequate safety margins should be kept in order not to be exceeded the maximum loading rate of the tank. As it is already mentioned, it is vital the engine and deck personnel to understand the plan and the emergency procedures in case of accident. Also, the ongoing communication between the barge and the ship is crucial. Double check of the pipeline system valves should be executed. Also, after the completion of the bunkering operations, the hoses must be fully drained before disconnection takes place. Additionally, the vessel filling points should be blanked immediately after the completion of the operation. Crew should not be distracted from their core duties during bunkering operations and if they have a suspicion that something in the bunkering operation does go wrong, is better to suspend the operation and maybe to absorb a small amount of off-hire. Otherwise, if the suspicion is true and something in the bunkering operation is abnormal, this maybe leads to an oil spill with extremely disastrous consequences and huge expenses.

It is obvious that the emergency response planning is essential in order to minimize the catastrophic consequences in case of an accident. Particular, the objective of the emergency response planning is to develop, implement and maintain a management system, through standard plans and procedures. Thus, emergency response planning assists in the timely return to normal and safe operations. Consequently, in case of emergency situation, these plans and procedures will be activated and will minimize the harmful effects on the below:

- Human life and health
- The environment
- Company and/or third-party assets
- Company’s image and reputation

5. INTERNATIONAL REGULATIONS AND CONVENTIONS

In case of a spillage during Bunkering operations, a report has to be prepared immediately regarding the location of the spill, date, time of the incident, details of the vessel, the type and the quantity of the bunker split, and all the actions already taken in order to contain and recover the spill. Major oil spillages have raises International safety issues and have led to the development of major International Conventions and Regulations.

For instance, in 1967 the Torrey Canyon disaster, where 120.000 tons of oil was spilled into the sea, raised serious concerns regarding the mitigation of the tanker accidents and their consequences. Consequently, many international maritime regulations have been introduced in order to prevent tanker accidents and minimize their disastrous effects. Also, regulations have developed regarding the design and the structure of the ships. For instance, the double-skinned hull requirement was adopted after the grounding of tanker 'Exxon Valdez' in 1989, which spilt 10 million gallons of crude oil. Interestingly, published data has shown that these regulations have definitely contributed to the reduction of the marine accidents (Eliopoulu & Mikelis, 2015).

5.1 International Maritime Organization (IMO)

International Maritime Organization is the United Nations specialized agency, which is responsible for the safety, security of the Shipping and is directly concerned with promoting quality in the Shipping industry. Particularly, IMO's target is the prevention of marine accidents and sea pollution (Mitroussi, 2004). Also, its vital role is the protection of the environment and the prevention of the marine and atmospheric pollutions by ships. Its primarily role is to create a regulatory framework for the shipping industry which can be universally adopted and implemented. As shipping is an international industry, the regulations and standards should be adopted on an international basis in order for shipping operates effectively. Thus, IMO provides the regulatory framework in order to be ensured the secure, safe and efficient international shipping. The green and sustainable global maritime transportation is its primary objective.

The recognition of the importance that the marine pollution incident can possible pose a serious threat to the marine environment lead IMO to organize a Conference in July 1989, in Paris, in order to develop further measures to prevent the pollution from the ships. In November 1989, this call was validated by the IMO Assembly and work began on a draft convention. Thus, the aim was to provide a global framework for the international co-operation in order to confront major incidents or threats of marine pollution. IMO put in place an implementation strategy, which is focused primarily on providing tools, such as manuals, training courses and guidelines, to deal with pollution incidents, either nationally or in co-operation with other countries. Particularly, ships are required to carry a shipboard oil pollution emergency plan for responding effectively and timely to oil pollution incidents.

The Convention underlines all the actions to be taken in case of marine pollution incident and the requirement to report the incident to the coastal authorities.

Also, the Convention requires the development of detailed plan for dealing with the pollution incidents, establishment of stock of oil spill combating equipment, as well as oil spills combating exercises.

Additionally, the parties of the Convention are obliged to provide help to any other party in the occurrence of pollution. Also, a provision is made for the reimbursement of any assistance provided.

In conclusion, in 2000, a protocol was adopted relating to the Preparedness, Response and Co-operation to pollution incidences by hazardous and noxious substances (OPRC-HNS Protocol).

The main activities through which IMO's strategy is adopted for the implementation of the OPRC are:

- Oil Pollution, Preparedness, Response and Co-operation (OPRC) Working Group
- IMO Oil Pollution Coordination Centre (OPCC)
- OPRC Information System
- Promoting Research and Development (R&D)
- National Contingency Planning Development Assistance
- Regional/subregional Cooperation mechanisms and IMO's regional strategies
- OPRC Training Strategy

- Participation in International Oil Spill Conferences and Seminars
- Co-operation with industry
- Technical Assistance and Resource Mobilization

OPRC Working Group

IMO's Marine Environmental Protection Committee established the OPRC Working Group in 1991 in order to supervise the implementation of the OPRC Convention, which develops manuals and guidelines in order to assist the countries in the implementation of the Convention. It is composed of experts from governments and intergovernmental organizations, industry organizations and NGO's such as the below:

- Commission of the European Communities
- Helsinki Commission
- International Tanker Owners Pollution and Federation Limited (ITOPF)
- International Petroleum Industry Environmental Conservation Association (IPIECA)
- Oil Companies International Marine Forum (OCIMF)
- International Association of Ports and Harbors (IAPH)
- Oil Industry International Exploration and Production Forum (E & P Forum)
- Greenpeace International

IMO Oil Pollution Co-ordination Centre (OPCC)

This Centre was established within the Marine Environmental Division of IMO in order to carrying out specific actions under the Convention, which have been assigned to IMO, such as education and training, technical assistance, coordination and mobilization of international governments response in case of a major oil spillages upon the request of the country in need.

For instance, this applies in TIER 3 incidents, where major oil-spills need external support except from the local response. Normally, TIER 3 incidents, where large volumes of oil have been spilled into the ocean, governmental, national or international involvements are required. Actually, Oil Pollution Co-ordination Centre tries to gather information in national and regional level in order to uplift the preparedness and response in case of oil spillages.

OPRC Information System

All IMO members requested to provide information for 'OPRC Guide to International Assistance' regarding the competences of Sate's to provide assistance in an oil response incident, regional and industry organizations which can provide technical advice in such an event.

R&D

IMO R&D database includes information regarding the current activity in oil spill technology, research and development. US Coast Guard was originally developed the International Oil Pollution Research and Development Abstract Database (in compliance with the Oil Pollution Act as it is referred in the next section), which request the coordination for a programme of oil pollution research and development (including technological advanced oil pollution practices and equipment).

National Contingency Planning Development Assistance

As the basic obligation of the Convention is the prompt and effective respond to the oil pollution incidence, contingency planning can help to this direction.

Thus, IMO provides technical advice to countries in order to develop national and local contingency plans and ensure that they obtain the appropriate oil spill combating equipment.

Regional/Sub-regional Co-operation Mechanisms and IMO's Regional Strategies

IMO's objective is to reinforce the capability for the national and regional action in order to prevent, control and mitigate the marine pollution. Also, IMO targets to cooperate with other organizations within the United Nations and international, regional and non-governmental organizations in order to support technical co-operation for the achievement of this target.

Training Strategy

The OPRC Convention obliges governments to inaugurate a programme of tests oil pollution responses and training of the relevant personnel through train-the-trainer programmes and manuals.

Participation in International Oil Spills Conferences and Seminars

Definitely, IMO participate and makes a huge contribution to seminars and workshops regarding oil pollution response.

Co-operation with Industry

Indeed, the OPRC Convention is the first convention developed by IMO which clearly recognizes the importance of involving the oil and shipping industry in its implementation. Particularity, the joint IMO/Industry pinpoints the need to effectively co-operate each government and industry for immediate response to any disastrous incident.

Technical Assistance and Response Mobilization

Under the Convention, the governments are obliged to provide support in any case that a country requests technical help in order to respond and mitigate an oil spillage.

5.2 Oil Pollution Act 1990 (OPA 90)

Exxon Valdez tanker accident spill (March 1989) in Prince William Sound, Alaska, which was the 34th in size among worldwide vessel oil spills on record and the most expensive in oil spill history, was the reason for the US Congress to pass the Oil Pollution Act of 1990 (OPA-90).

United States has strict regulations for tankers ships operating in its waters and the responsible polluters may face unlimited liability for the costs to clean-up the polluted area and extremely huge penalties. OPA-90 requires double hulls for tank ships and tank barges travelling in US waters by the year 2015, as the double hulls minimize the damage to a vessel's tanks and thus the amount of the oil spilled is reduced. It is notable that the number of tank ship (barge) oil spills declined to 1375 from 3051 for the 1991-2000 period. In particular, improved standards and detailed contingency planning have contributed to the downward trend in numbers and volumes of spills.

International Maritime Organization (IMO) adopts the double-hull regulation of OPA-90 and ban single-hull tank ships by the year 2015. Also, the transport ministers of European Union (EU) members states agreed to prohibit all the single-hull tank ships by 2010. The root of this decision was the sinking of the single-hull tank ship Prestige, in November of 2002, which was carrying 20.5 million gallons of heavy fuel oil when it broke in half and sank.

It is worth to mention that statistics for the 1970-2000 period on worldwide oil spills by oil-cargo vessels such as tank ships, tank barges and combination oil-cargo/ non-oil-cargo ships, reveal that 53% of the spills are due to oil transfer activities. Surprisingly, only 21 percent of oil spills are due to vessels accidents. These data have been collected by the International Tanker Owners Pollution federation (ITOPF 2002).

5.3 International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)

The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), which adopted by IMO, is the main international Convention, which covers the prevention of pollution of the marine environment by ships from operational or accidental causes. Actually, this Convention is the combination of two treaties, which adopted in 1973 and 1978 and updated by various amendments through the years. Thus, the 1978 protocol entered into force on October 1983. However, some of its requirements were implemented by the shipping operators prior to this date. Specifically, it is obligatory for ships of more than 400 Gross Tons (oil tankers over 150 GT) to carry a Shipboard Oil Pollution Emergency Plan (SOPEP) on board. This plan, transfer information from the owner to the Master on how to react in the case of oil spill. Interestingly, this Convention has been credited by many to be responsible for the reduction in the number of tanker incidents from the ‘70s to ‘80s.

5.4 International Convention on Civil Liability for Bunker Oil Pollution Damage

In 23rd of March 2001, the IMO adopt the International Convention of Civil Liability for Bunker Oil Pollution Damage. This Convention was adopted in order to ensure that the persons, who suffer damage caused by oil spillages, receive suitable, prompt and effective compensation. It is important to mention that the basis of the compensation is to safeguard that claimants are left in the same financial position as they would be in case of not occurrence of the oil spill. Specifically, these oil spillages are caused during the execution of the bunkering operations. Also, it applies to damage caused on the territory, including the territorial area. This Convention came into force in 21st of November 2008. It requires ships over 1.000 gross tonnage to maintain insurance or other financial security, such as a financial institution or guarantee of a bank. Thus, the liability of the register owner for Oil Pollution damage should be covered.

The term 'pollution damage' in the Convention refers not only to the 'physical' damage, caused by the escape and discharge of bunker oil, but it refers to any other type of damage, and in particular the damage which caused to the environment. Specifically, the extent of the compensation is limited to the 'costs of reasonable measures of reinstatement actually undertake or to be undertaken'. Also, it refers to the 'costs of preventive measures and further loss or damage caused by preventive measures'.

5.5 International Oil Pollution Compensation Fund

The International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage is an International marine Treaty, which is administered by the International Maritime Organization. The original Fund Convention, in 1969, was formulated as an improvement to Civil Liability Convention in order to relieve the shipowners due to the unpredictable circumstances. The compensation fund is obliged to pay victims of pollution promptly, when the damages exceed the shipowner's liability, from the unfair liabilities. Over the years, it became clear that the amount of the compensation for the major incidents needed to be increased. Consequently, the scope of the regime has been widened. The IOPC Funds are financed by contributions paid by entities, which receive certain types of oil by sea transport. Thus, this contribution depends on the amount of oil received in the relevant calendar year and cover expected claims and the costs of managing the Funds. This convention came into force on 30 May 2006. Until 2013, the convention had been ratified by 111 states. In particular, this consist of the 91,2% of the gross tonnage of the world's merchant fleet. According to International Oil Pollution Compensation Fund data, it has been involved in 150 incidents of varying size in all over the world.

5.6 International Convention for the Safety of Life at Sea (SOLAS 1974)

IMO introduced the International Convention for the Safety of Life at Sea, in 1974, which was amended to include a chapter 'Management for the safe Operation of Ships' (CHAPTER IX), which aimed to make the ships safer and the seas cleaner. This Chapter requires compliance with the International Safety Management code, which is an International standard for preventing pollution and safer operations. ISM code came into force on July 1998. It was the response of the high profile shipping accidents during the late 80s and early 90s, which was caused by human error. It is estimated that a high percentage of maritime accidents (80%-90%) are attributable to human error. In fact, the ISM code seeks to address the human element of ships operations.

The ISM Code became mandatory for three types of vessels and it is always applied, independently of the date of vessel's construction.

- Passenger ships including passenger high-speed craft on international voyages
- Oil chemical tankers, gas carriers, bulk carriers and cargo high-speed craft of 500 gross tonnage and up on international voyages.
- Other cargo ships and mobile offshore drilling units of 500 gross tonnage and up on international voyages

The ISM code takes a holistic view of a Company and the way that it operates its ships. This gives the flexibility to each company to develop and tailor safety system to its specific operations.

The ISM Code requires owners and operators of ships to implement a Safety Management System (SMS). The aims of the ISM Code are to ensure safety at sea, avoidance of damage to the environment, prevention of human injury and loss of life.

A Safety Management System requires a company to document its management processes and to ensure that the daily tasks and activities are organized and planned in accordance with the legislative and regulations. Also, ISM underlines that the safety and the protection of the environment is integral part of the company policy and culture.

In particular, the company has to define and document all the responsibilities of the personnel who affect safety and pollution prevention. Also, the company has to provide support and all the necessary resources to the personnel in order to carry out their tasks effectively and safely.

5.7 International Ship and Port Facility Security Code (ISPS)

International Ship and Port Facility Security Code is an amendment of the Safety of Sea (SOLAS) Convention (1974/1988) regarding the minimum security arrangements for ships, ports and governments agencies. In particular, ISPS came into force in 2004 regarding the detection of security threats and prevention measures against security incidents which may affect ships and port facilities. ISPS refers to the governments and shipping companies' responsibilities, as well as the duties of the shipboard and port personnel in order to ensure the security.

6. OIL SPILLS INCIDENTS DURING BUNKERING OPERATIONS

Case 1

In 2008, a general cargo vessel, VIRGINIABORG received bunker heavy fuel oil (HFO) and marine gas oil (MGO) from the bunker tanker DANA in the port of Skagen. The bunker plan had been agreed between the two vessels. Also, the pre-delivery checklists have been completed by both vessels. The bunker vessel had an approved contingency plan, which was approved by the Danish Maritime Authority in the context of annual bunker survey. The responsibility of the bunkering was on the chief engineer who was supported by the duty engineer. It is noteworthy that the cargo pumps were controlled from the bridge. Also, the master conducted the bunker operations from the bridge. However, the DANA duty noticed an oil thin layer on the water behind of DANA. Thus, the Master of DANA used the normal stop on the bridge in order to stop directly the pumps. Nevertheless, the oil continued to leak. The result was an estimated total of 400-500 litres were leaked. However, due to the immediate reporting to the Admiral Danish Fleet from tanker DANA, the oil spilled was collected successfully, using a 48 meters oil boom. Interestingly in this case, the cause of the oil spill was not the tank overflow, as it could be reasonable considered. The general cargo vessel VIRGINIABORG had destination the Great Lakes in the U.S. Once, entering the lock in Brunsbuttel with a pilot on board, the vessel hit the wall outside the lock. However, after vessel inspection, the master, pilot and lock personnel agreed that no crack existed. However, they reported only a hollow. Particularly, the no 6 starboard fuel oil tank was hit, which was the tank used during the bunkering procedures. Thus, the oil spillage occasioned by the incomplete and negligent inspection. At the end, the lack of detecting and reporting the crack caused the oil spillage, which was definitely resulted from a human error and lack of communication among the people who inspected the vessel.

Case 2

The tanker ship Dubai Star spilled more than 400 gallons of bunker fuel into San Francisco Bay on October 2009. The vessel was taking oil from the barge south of the Bay Bridge, once oil being dispensed from a tank, onto the deck and dropped into the bay. The cause of the oil spill was the failure to close the valve when one of the fuel tanks reached the maximum capacity. The oil spill was caused due to the failure of one of the crew to notice that the tank level was continuing to increase, as well as, another crew member failed to detect oil which was starting to aggregate on deck. Additionally, the two overflow alarms failed to sound.

It is worth mentioning, that the ship's Master notified the federal and the state authorities minutes later after the incident. Moreover, the Master reported wrongly the emergency of the situation, as he mentioned a 'little bit' amount of oil has been spilled on the deck and that 'nothing is going overboard'.

The oil affects more than 200 acres of beaches, marshland, mudflats as stated by the Department of Fish and Game. Specifically, 113 seabirds died, such as coots, brown pelicans and grebes.

The total amount of the settlement was nearly $2 million. In particular, the amount to pay for damage to natural resources and the cost of response was $1.408 million, as well as $550.000 in penalties.

Case 3

An oil spill was caused by overfilling of a fuel tank, which was reported on September 4 in 2017 on the M/V Vita Horizon, a bulker of 74,483 DWT, flag Malta into the Mississippi river in New Orleans area. It was estimated that an amount of 10-20 barrels of product discharged.

The Plaquemines Parish 911 Center was alerted for emergency help, as well as the fire department and port were notified of the related incident. Also, the responsible parties hired companies in order to start the clean-up operations. Additionally, United States Coast Guard (USCG) inspected the area and issued an information bulletin in order to warm about the traffic near the area for the safety of the clean-up crew.

Case 4

In Brazil, the Cosco's bulk carrier Shao Shan 5, 75.700 DWT cause an oil spill during bunkering operations at Santos Port in Brazil. In particular, the vessel was taking fuel from the terminal, when the hose disconnected. Thus, an unknown quantity of bunker oil spilled on the deck and leaked in the sea. The oil leakage reached Santos Channel. Even if, port and local authorities took immediately actions in order to limit the spill of heavy fuel, the strong winds drifted it down the channel and the oil reached the shore. Consequently, the cleansing was started and floating booms were used to restrict the area of the spill. Also, numerous rescue boats were dispatched to assist the local authorities in the treatment of the environmental pollution. In addition, the fuel was collected by the absorbent pads.

Case 5

In 2012, in the North Mole, Gibraltar, an accident incident was reported, where around three tonnes of fuel had been split while bunkering operation was executed between the refrigerated vessel, Frio Dolphin, and the bunker tanker Vemoil XX. Thus, around three tonnes of oil was spilt into the sea. However, the Gibraltar Port Authority (GPA) and the Department of the Environment respond immediately to the oil spill incident and activate the Gibraltar Government Plan. For the recovery of the oil spill, booms were used in order to protect the harbour and the adjacent marinas, where the oil have been expanded. Also, some dispersants were used for the oil spill mitigation. Indeed, throughout the operation there was a full cooperation between the Gibraltar Port Authority, the Gibraltar Maritime Authority, the Environment Agency and the Gibraltar Tourist Board and manage successfully to control the oil spill.

Case 6

In 2013, the West of England P& I club stated that in the United Arab Emirates port, Saqr port, the number of bunker spills has unusually high number due to the negligence of the involved personnel at the end of the bunkering process. It is noteworthy that the spillages mainly occurred from road tanker hoses were disconnected from the vessels' bunkering manifolds. Consequently, the Port Authority of United Arab Emirates imposes fines of $2.700 or more on both the supplier and receiver.

It is extremely important these cases to be eliminated. Thus, the crew of the vessel has to check that the supply hose is fully drained prior to the disconnection. Consequently, the blind trust to the supplier's assertion that the hose is ready to be disconnected should be stopped in order to minimalize such events.

Case 7

In 2012, a bulk carrier at Jinhae Bay in South Korea started the bunker supply with a bunker hose from the barge which connected to the ship's bunker manifold. In the middle of the bunkering operation, the crew of the ship detected, bunker oils which was spouted out of the air vent. The cause of the accident was that the responsible personnel during the bunkering procedures, open wrongly bunker tank valve. Consequently, the bunker was inserted in a tank, which had not sufficient space and caused the over flow of fuel oil. Thus, the bunkering operations were immediately stopped. The quantity of the fuel which spilled into the sea was about 190 litres. Immediately, Korea Coast Guard, as well as, Korea Marine Environment Cooperation conducted clean-up operations. The clean-up covered an area from the scene of the accident to 6,5 miles.

Case 8

In 2011, general cargo ship received bunkers at the Product Wharf of Gwangyang port. However, bunker C oil spilled to the sea due to the failure of tank changeover on time. It is undoubtedly the lack of communication between the ship and the bunker barge. Directly after the occurrence of oil spillage, the Korean Coast Guard and Marine Pollution Response Corporation proceeded to clean-up operations with oil fences and absorbents.

Case 9

While bunkering operation in Oregon was executed, in the Pacific Northwest, a small quantity of oil was released from the hole, around 5 litres spilled in the sea. This was caused when the engineer in charge of the bunkering operation unscrewed an ullage pipe cover in order to check the quantity in the particular tank. Thus, the fuel spilled due to the air pocket which had been trapped between the beams underneath the tanktop depending on the trim of the vessel. Interestingly, for this small quantity of oil which spilled into the sea, around USD 3,000 was paid by the insurance company.

Case 10

This case refers to quality issue incident and not to an oil-spill event. It is noteworthy to mention that the quality of the fuel oil received has vital importance for the good working condition of the vessel's engines. There are cases which have been detected, where the poor quality of bunker can possibly destroy the vessel's engine. Such is the case of general cargo ship, 4.635 gross tons, which was scheduled to load cargo at Surabaya, in Indonesia. Fuel oil was loaded in No.1 F.O. Tank (93,61 M/T) and in No.2 F.O. tank. Also, the supplier provided the ship only with one bottle of fuel sample. The vessel left the port as soon as the bunkering process was completed.

When, the fuel oil in No.1 F.O. tank was started to be used, the Chief engineer noticed that the turbocharger was surging. Also, it was observed that the temperature of some cylinders was abnormally higher. Additionally, the duty crew noticed that in the drain pipe of fuel oil service tank and settling tank was observed too much sludge and water. The incident reported by the chief engineer to the ship's master and the revolution of the main engine was reduced.

7. THE IMPACT OF OIL SPILL ON THE ENVIRONMENT

Oil spills have disastrous effects on the ecosystem and environment as a whole. Irrespective of the amount of oil spilled, the effects can be devastating. In particular, spillages can have short-term or chronic effects which can last for decades. Thus, chronic effects maybe destroy the ecosystem in it's entirely. The ecosystem is fragile and oil spills can kill organisms, ruin the flora and fauna and have devastating effects on plankton, fish and animals leaving in the seabed. Therefore, the quickest and the more efficient way has to be found in order to clean up the area and the ecosystem to be recovery from the shock as soon as possible.

There are four main ways oil spills effect the environment: physical smothering of organisms, chemical toxicity, ecological changes, and indirect effects.

Specifically, the impact of the oil spills depends on a number of factors, such as:

- The rate of spread of the oil slick
- The oil composition
- The location of the spill
- The time of season of the accident (like bird migrations)
- The chemical properties, toxicity and stability of the petroleum substance
- The species biodiversity at the site of the oil spill
- The number and type of the habitants
- Environmental sensitivity, such as proximity of bird habitant, beaches, rocks and wetlands

One of the most adverse effects of the world's sea and ocean pollution is the mortality of the seabirds (Camphuysen and Heubeck, 2001). In case that birds sense the danger on time, might space and save by relocating. In general, sea birds are very sensitive to the 'surface pollutants'. It is indisputable that the minerals oils pose the highest threat to the seabirds. However, several incidents have confirmed that equal lethal effects have many other substances (Camphuysen and Heubeck, 2001). Consequently, the main cause of the bird's death is the loss of body insulation which is provided by the feathers, as the cold water reaches the skin. Thus, seabirds lead to hypothermia or overheating and death. It is noteworthy that in world's largest oil spillages a huge number of seabirds died. Also, the oil spills can disrupt the migration of the birds. In particular, in Exxon Valdez is estimated that around 250.000 seabirds died (Peterson et al. 2003). Also, more than 4.000 birds died in Prestige oil spill and more than 40.000 contaminated birds were subsequently collected.

Additionally, the marine pollution maybe slows down the rate of the photosynthesis. Thus, the population of many marine pants and sea organisms is reducing. Particularly, the rate of the photosynthesis is declined due to the coverage of a multi millimeter thick slick microlayer in the sea surface. For instance, after the Exxon Valdez spill, the rate of the photosynthesis was dropped sharply, resulting in an extremely reduction of flowering in eelgrass Zostera marina population. Additionally, even several months after the oil spill, the benthic fauna was extremely declined due to the anoxia (Jewett et al. 1999). However, they managed the recovery 2 years after the spill.

Moreover, the marine pollution takes a deadly toll on fish. In particular, the toxic and the volatile components of oil are absorbed by their eggs and juvenile stages. Also, they may consume contaminated food. BP Deepwater Horizon oil spill had deadly effects on shrimp and oyster fisheries. Also, the Exxon Valdez spill destroyed billions of salmon and herring eggs. The direct contact with oil can causes the blockage of the gills. Notably, the exposure of fish in the polluted marine environment can causes various problems, such as respiratory, fin erosion, cellular changes and enlarged livers.

The toxic substances of oil are absorbed by the marine food. Specifically, the toxic substances transferred from phytoplankton to fish, to seal, whales, dolphins and others sea mammals. Thus, oil can block the blowholes of whales and dolphins, making them unable to breathe properly and communicate.

Thus, these catastrophic consequences are transferred to the birds and other predators, which are at the top of the food pyramid from the toxic substances, which absorbed at the lower level of the pyramid. These toxic substances are transferred not only from one species to another, but also from one generation to another.

Remarkably, the accumulation of petroleum hydrocarbons by marine organism depends on the following:

- Degree of bioavailability of hydrocarbons
- The organism capability for metabolic transformations
- The length of exposure

Hydrocarbons and other components of oil are lipophilic and easily assimilated by organism. Thus, mussels have been used as an indicator species in order to detect the presence of petroleum hydrocarbons, due to their strong ability to accumulate petroleum components in their tissues. Their filter-feeding mechanism is very strong.

In some cases, the spilled oil maybe reaches the shore. Consequently, the thick layer of oil maybe covers the rocks, the beaches and the plants in the coastline. Remarkably, the effects of an oil spill on marine and freshwater habitants vary according to the rate of water flow and the characteristics of the specific habitants. For instance, in the cases of marshes and lakes, where the water is standing or is slow-moving, the spilled oil can remain there for long period of time as the oil tends to 'pool'. Consequently, the impact from the spilled oil is more sever that from the flowing water, such as river and streams. Indeed, the flowing river acts as a natural cleaning mechanism.

Additionally, the oil spillages maybe have disaster's impacts on human health. Crude oil consists of thousands of chemical compounds. Some of the light one compound, such as benzene and toluene, are well known as volatile organic compounds, have the attribute to evaporate rapidly after they reach the water surface. Consequently, these chemicals can cause respiratory problems along with temporarily central nervous system troubles. Remarkably, the high human's exposure levels to the volatile organic compounds, maybe link to cancer. Thus, workers who clean up the spills face tremendous health problems with long-term impact, especially if they omit the standards precautions, such as dust and respirator mask.

Another major effect of the oil spill is the negative economic impact. In particular, when crude oil or refined petroleum products are lost, they influence the amount of petroleum and gas which are available for use. Thus, more barrels have to be produced and imported by other countries.

Also, the clean-up activities require a huge cost. The oil spillages may cause serious economic losses for the industries operating in the area, and their business depends on the coastal resources. For instance, tourism and fisheries are two sectors which directly are influenced by the oil spills. Also, other sector and business activities can potentially suffer disruptions and loss of earnings.

Tourism industry is a sector which could not remain uninfluenced by the oil spillages. As the tourists stay away from the polluted areas, the local tourism industry loses earning. For instance, various activities, such as sailing, swimming, boating, rafting cannot be performed. Also, holidaymakers cancel their reservations and hotel and transport companies suffer losses. As soon as the ecosystem balance returns to its initial state, these activities would be expected to recommence. However, in some cases the oil spillages have drawn the global interest; hence, the disruption of the business in the area may long many years due to the negative publicity.

8. RECOVERY OF OIL SPILLS

The respond in an event of an oil spill has to be the top priorities of industry and government. Once an oil spill has been contained, efforts to control and remove the oil from the water should immediately begin. There are several methods to clean up the oil from the shore and restrain it in order not to be expanded. For instance, the washing/ flushing of the shore line, manual and mechanical removal, situ burning and chemicals cleaners. However, the most common methods for recovering oil from the surface and keeping oil from spreading are booms, skimmers and absorbents.

Booms

Boom is a temporary floating barrier which keeps oil from expanding further. Consequently, booms help to concentrate oil in thicker surface layers. This technique helps other collection methods to be used more efficiently. Research has shown that the booms are the most commonly used method globally. The weather conditions affect the efficiency of the boom (wind, wave size). Booms are effective in calm water. However, the boom will fail to stop the oil for speeds over 1 knot because of the drainage. There are four main types of booms: hard boom, sorbent boom, fire boom and towing boom. Hard boom offers the best containment option. Particularly, hard boom creates a skirt under water and it can be used for a long period. On the other hand, if the quantity of oil spilled is small, the sorbent boom can be efficient. Also, for the large spills in a limited area, fire booms are used in order to eliminate the pollutant from the water.

Also, there are the towing booms, where the boom is pulled by towboats in various shapes. Generally, the speed of the towboats is less than 1 knot.

U-booming

In this method, the towboats can tow a boom in a U-shape by carried slowly downstream, holding in a static position or by moving upstream towards the spill source.

V-booming

This technique uses three towboats and a skimmer. In order to maintain the V-shape a good tie-in is required. Particularly, for a wave environment, the V-shaped arrangement should be used in order to block the oil in the controlled area and to keep it out from the wave zone.

J-booming

J-booming method uses two towboats and a skimmer in order to allow simultaneously control and recovery. This method is used mostly along the coast and resulting in a slack boom condition.

Generally, the collected oil could be reprocessed in an oil refinery or in a recycling plant. Various methods of disposal are available including direct disposal to land renovation, road building or other similar activities.

Types of Booms

Fire boom *Hard boom* *Sorbent boom* *Towing boom*

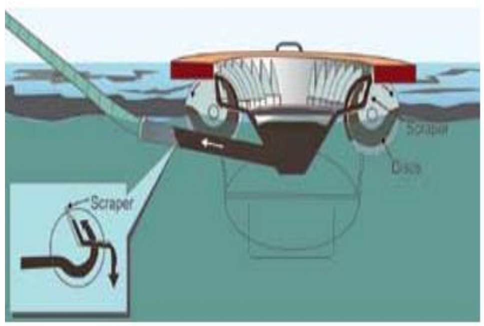
Source: NOAA (National Oceanic and Atmospheric Administration)

Skimmers

A skimmer is a mechanical device for removal and recovery of spilled oil from the water's surface. Skimmers may be self-propelled and may be used from shore or operated from vessels. Oil skimmers are extremely cost effective way for oil removal. Indeed, the efficiency of skimmers depends on weather conditions. In moderately rough or choppy water, skimmers tend to recover more water than oil. For this reason, a variety of skimmer designs have been improved to operate efficiently in different weather conditions, as well as in the Artic Sea, where there is high concentration of ice.

In this section, oil skimmers come in variety of types, such as oleophilic skimmers, weir skimmers and suction (drum) skimmers. Each type offers advantages and drawbacks, depending on the type of oil being cleaned up, the conditions of the sea during cleanup efforts, and the presence of ice or debris in the water.

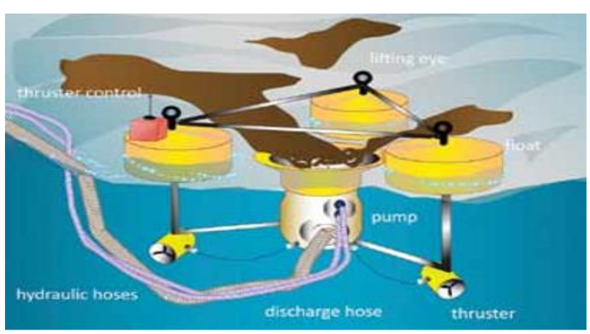
Oleophilic skimmers employ tools that have an affinity for oil in preference to water. Thus, these skimmers use ropes, discs or drums, belts, continuous mop chains of oleophilic materials which as they rotate blot the oil from the water surface. Consequently, the oil is squeezed out or scrapped off the oleophilic skimmer via pumps and drop into a sump for storage. Oleophilic skimmers have been shown that they are the most effective with medium viscosity oils. Indeed, these skimmers have the advantage of the flexibility as they can effective on spills of any thickness.



Small oleophilic disc skimmer: Requires suitable hoses, pump and hydraulic power supply. Oil adheres to the rotating discs to be scraped off into a sump for pumping to storage.

Source: ITOPF

Weir skimmers use a dam which is attached to the suction hose. They use the gravity in order to select drain oil from the water surface. This type of skimmer is ineffective in steep waves. Some of the weir skimmers have an on-board pump in order to push the recovered oil along the hose rather than be supported to the suction. This is used in order to overcome the friction losses. Generally, these skimmers are prone to become jammed and clogged by floating debris.



A weir skimmer selectively recovers oil via suction hose, by the force of gravity and collects for storage in tanks or drums

Source: ITOPF

A suction skimmer (or drum skimmer) operates like a household vacuum cleaner and are made of polyethylene drums. This type of oil removal ideally suits for oil spillages which have been occurred near the shoreline. Oil is withdrawn through wide floating heads, sticks to the surface of the drum and pushed into storage tanks. Though suction skimmers are generally very effective and remove only 3% of entrained water with the oil, they are vulnerable to becoming clogged by debris. Consequently, in these areas constantly observation is required by the responsible personnel. Suction skimmers are more efficient on smooth water where oil has collected against a barrier. Additionally, the viscosity of the recovered oil for pumping can be improved by the placed of the steam coils to drum skimmers.

Drum Skimmers:
- absorb 3% of water with the oil
- collect 5,000 to 180,000 litres per hour

Drum Skimmers (Source: Spillpro)

Absorbents

Absorbents are materials that absorb oil from contaminated shorelines. Thus, they can be used to recover oil spill through the mechanisms of absorption. Hence, absorbents materials attract the oil to the surface without penetration in the material of the absorbent. This includes the case that the oil is extracted from the sorbent substance for re-use purposes.

On the other hand, sorbents allow oil to penetrate into pore spaces in the material they are made of. Also, they can be divided into three categories: natural organic, natural inorganic and synthetic.

Synthetic materials such as polyethylene and polypropylene usually are more efficient compared to organic and inorganic materials, such as peat moss or vermiculite.

To be useful in combating oil spills, Sorbents need to be both oleophilic (attract oil) and hydrophobic (water-repellant). Although they may be used as the sole cleanup method in small spills, sorbents are most often used to remove final traces of oil and thin layers of oil. Additionally, sorbents maybe are used to sensitive or hard to reach areas, such as turtle egg-laying areas or marshes, as the use of other methods maybe provoke damages in these areas.

In general, sorbents materials have limited use on large spills for the following factors:

- Relative high cost in comparison with skimmers
- Low recovery rates
- Requires intensive labor during the operation
- The generation of large amount of solid waste

Consequently, sorbents maybe not be the suitable response for sensitive or hard to reach areas. Its main objective is to create a physical barrier around the area with the oil spilled or to halt small amounts of free oil.

Once Sorbents have been used to recover oil, they must be removed from the water and properly disposed of on land or cleaned for re-use. Any oil that is removed from sorbent materials must also be properly disposed of or recycled.

Types of Absorbents:

- Boom sorbents are cylindrically-shaped and deployed like a boom

Polypropylene sorbent boom used to collect oil released during flushing operations

Use of Sorbent Materials in oils spill

Source: ITOPF

- Sorbent Pads

Sorbent pads usually use to eliminate secondary contamination.

Use of Sorbent Materials in oils spill

Source: ITOPF

- Pillows are enclosed in a small sack and can be easily handled and placed in confined areas

Recover oil on land using a sorbent pillow

Use of Sorbents for Spill Response

Source: Cedre

- Rolls: continuous sheet of sorbent material

Use of Sorbents for Spill Response
Source: Cedre

- Sweeps are long sheets of sorbent material for the recovery of the final stage of clean-up process

Source: MBT Metblown Technologies

9. CONCLUSIONS

It is undoubtable that clean up method of oil spills is very difficult and maybe takes month and even years to clean up the marine and coastal from the pollution. Also, the unpredictability of the oil spillages enables the clean-up process difficult as there are no baseline data available due to the frequency of its occurrence in the area. Additionally, the restoration of the environment to its original condition maybe takes too long time, after oil spill event, so as the ecosystem to be capable to return in its original functions. At the time of oil spilled into the ocean, with its natural high concentration of polycyclic aromatic hydrocarbons (PAHs), has the tendency to cause long-term residual effects on marine biodiversity. Consequently, the prevention of the oil spills has a vital role as the disastrous consequences may be avoided. However, in case of an oil-spill, the incident should immediately be reported to the proper authorities and to the Protection and Indemnity Club (P&I). The minimum information which should be provided are the name of the tanker, the location of the spill, time, the type of oil, the estimated quantity and the preventive measures which put in place in order to mitigate the oil-spill. As it has been described to this study, mostly the oil-spills have been caused due to the negligence of the responsible personnel and the lack of communication. Thus, the effective communication between the barge and the vessel, during all phases of the bunkering operation, has strategic importance in order to quickly respond in case of emergency. Unfortunately, human error or omission is the main cause of oi-spills. For instance, a possibly omission from the crew maybe are the below:

- Failure to agree a secure loading rate with the bunker barge or shore loading facility
- Failure to stick to the agreed loading rate during the bunkering process
- Failure on the part of the vessel's crew to check that the bunkers are being loaded at the agreed rate and failure to request the loading barge to slow down
- Failure to precisely monitor the tanks
- Failure to respond an emergency alarm, which indicates that the tank is nearly full

Consequently, the adequate training of the personnel is extremely important in order to be avoided such catastrophic events. It has vital importance, the selection of the appropriate personnel for the bunkering operation, who has understood the bunkering plan in order to avoid errors and omissions which may cause disastrous effects. Additionally, the Senior Engineers should be very careful to the planning of the bunkering and all the duties of the personnel involved in a bunkering operation should be clearly defined. It is important to consider that the fatigue of the crew maybe lead to omissions, as it impairs all mental functions, including perception. Thus, crew fatigue maybe decreases their attention and reactions in case of emergency, increase mental errors and decrease performance consistency. Consequently, work hour limitations should be established. Also, the regular inspections and the appropriate maintenance of the vessels and the pipelines are extremely important. Thus, the inappropriate and damaged equipment should be delisted and disposed. All the needed equipment for the oil prevention should be ensured that is kept on-board such as absorbents pads, absorbents, booms, absorbents pillows, skimmers, as well as all the Personal Protective Equipment (PPE's) for the crew. Awareness programmes, such as regular seminars and workshops regarding the importance of adhere to and follow strictly the International Conventions should be organised regularly in order to understand the recent Conventions, their amendments and the relevant legislations. Also, crew has to receive regular training from accredited organisations in order to be familiar with the equipment and the procedures, as well as in order to increase the readiness of the seafarers to respond in the case of emergency. Also, the Emergency Response Plans should be renewed, re-evaluated periodically and strictly followed by the personnel. These plans should clearly describe the actions, roles and specify the responsibilities. It is suggested, the Emergency Response Plans to be supported by a detailed mapping of the environmental sensitivity of the areas, which have been affected by the oil-spill. This analysis maybe helps the effectiveness of the response plan in order to select the appropriate methods for each particular environment. In relation to the Emergency Response plans, all the involved personnel should be participated in anti-pollution exercises regarding TIER-1 (oil spills with limited impact to the marine environment, which require only crew members response) and TIER-2 (Spills beyond immediate TIER-1 capability that have a more serious impact and which may require some degree of external support including possibly local authorities, industry mutual aid arrangements). Additionally, it is recommended the performance of the crew members to be evaluated annually and these records to be kept and communicated to the employees in order to improve their performance. Thus, the management should reward all levels of personnel, who identify practices and procedures which reduce risks, as this management approach consist a motivation for all employees.

Undoubtedly, oil is a key strategic importance commodity worldwide and its flow is determined by the global supply and demand. In 2017, the oil which was transferred via waterways was approximately two billion metric tonnes. Thus, considering the major quantity of the global demand of oil, as well as the majority of goods which are carried by sea, there is a significant potential exposure to oil pollution incidents affecting the marine environment. Consequently, the contemporary shipping industry is considered as a high-risk business. Arguably the oil spills have huge environmental, socio-economically and health effects. Therefore, it is logical that the Coastal States, which are involved in the import and export of oil or their location is among the strategic maritime routes, are possibly most exposed to the dangers of oil pollution. Empirical study has shown that the large oil spills tend to happen around oil ports and common oil transportation routes. Therefore, extremely importance has to be given to the better protection of the world's marine ecosystem through the implementation of improved and new prevention techniques and emergency response systems (Garnacho et al., 2010). Specifically, forecasting, risk and management strategies and restoration projects should be developed. Research and Developments (R&D) projects have been significantly progressed the last years (Shi, 2012). For instance, Satellite Remote Sensing, the Automatic Identification System (AIS), the Beidou Navigation Satellite have been used for oil spill identifying and monitoring. Most of the R&D projects are focused on effective spill prevention and response. However, the oil spill mitigation and prevention cannot solely rely on the significant progress on preparedness and response in the contingency planning, but also to the human factor. It is a fact that, the main causes of marine accidents are crew errors or omissions.

Consequently, trying to solve only technical problems onboard will cover only a small percentage of the general issue. Thus, in shipping industry higher attention should be given to human factor. Safety culture is imperative and should be further developed and consist an integral part of seafarers' behavior and culture. Continuing training of the seafarers is an issue that urgently needs attention. Thus, there is an urgent necessity for further training and guidance to the seafarers on bunkering operations in order to focus on the vital importance of diligently execute these operations, so as the oil spills and other incidents (fire, loss of human life) due to human error to be eliminated. Also, crew qualifications and seminars have to be regularly organised in order to increase the sense of the safe navigations and sensitivity of marine environment protection. In fact, oil pollution from ships is well regulated with a vigorous international regulatory framework to deal with liability and compensation in case of oil-spillages. However, as it is described to this paper, thought the strictly regulations environment, oil-spills still occurs due to human errors. Consequently, companies have to focus to their people and ensure that the oil transfer procedures are effectively implemented with vigilance in accordance with the vessel's Management System in order to reduce or eliminate the risk of harm to the environment. Companies have to make the crew member to feel integral part of the company and always adopt health and safety company's standards, procedures and policies.

In conclusion, it should be noted that the oils spills are not only derived from the vessels and they can be caused by the extraction and exploration of crude oil (offshore platforms, drilling wells). Moreover, the marine ecosystem can be affected from the land-based activities and industries, such as the industrial discharges and emissions, municipal wastewater discharge and agricultural and forestry run-off and emissions. For instance, the land-based activities can affect the marine environment through the discharges into the sea or can indirectly affect the marine ecosystem with the release of carbon dioxide emissions and other greenhouse gases.

As the marine environment is vital resource for the life on Earth, we should protect this precious asset, which has a great contribution to the quality of our life and global economic prosperity.

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GLOSSARY

- **ADR**: ADR is formally the European Agreement concerning the International Carriage of Dangerous Goods by Road. It was adopted in 1957 under the auspices of the United Nations Economic Commission for Europe (UNECE) and governs the transnational transport of hazardous materials. "ADR" is derived from the French name of the treaty, ‘Accord européen relatif au transport international des marchandises Dangereuses par Route’.
- **BALLAST TANK:** A ballast tank is a compartment within a boat, ship or other floating structure that holds water, which is used as ballast in order to provide stability for a vessel.
- **BALLAST WATER:** Ballast water is carried in ships’ ballast tanks in order to improve stability, balance and trim. Ballast water discharges by ships can have a negative impact on the marine environment. The discharge of ballast water and sediments by ships is governed globally under the Ballast Water Management Convention, which was entered into force in September 2017. Ballast water discharge typically contains a variety of biological materials, including plants, animals, viruses, and bacteria. These materials often include non-native, nuisance, exotic species that can cause extensive ecological and economic damage to aquatic ecosystems, along with serious human health issues including death.
- **BDN:** Bunker Delivery Note is the standard document required by MARPOL Annex VI which contains information regarding the delivery of fuel oil: name of receiving vessel, port, date, quantity and characteristics of fuel oil. The note has to be retained on the vessel, for inspection purposes, for a three-year period after the fuel has been delivered.
- **BIODEGRADATION:** Biodegradation is the breakdown of organic matter by microorganisms, such as bacteria, fungi.
- **BUNKER BARGE/TANKER:** The vessel (sea going or not) provided by the Bunker Supplier in order to supply Bunkers or receiving Bunkers from ships.

- **BUNKER SUPERVISOR:** The appropriate qualified person assigned by the Bunker Supplier to supervise the Bunker Operations on behalf of the Bunker Supplier.
- **BUNKERING OPERATIONS:** the transfer of Bunkers between vessels, road tankers or shore facilities.
- **BUNKERS**: petroleum in any form, including crude oil, fuel oi, refined products and any noxious liquid substance.
- **COUPLING:** Coupling is a device which connects parts of machinery.
- **CRUDE OIL:** Grude Oil Petroleum is a naturally occurring, yellow-to-black liquid found in geological formations beneath the Earth's surface. It is commonly refined into various types of fuels.
- **GESAMP:** The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) is an advisory body, established in 1969, that advises the United Nations (UN) system on the scientific aspects of marine environmental protection. GESAMP functions are to conduct and support marine environmental assessments, to undertake in-depth studies, analyses, and reviews of specific topics, and to identify emerging issues regarding the state of the marine environment.
- **HOSE:** Hose is a flexible tube designed to carry fluids from one location to another. Hoses are also sometimes called pipes or more generally tubing.
- **ICS:** International Chamber of Shipping is the principal international trade association for merchant shipowners and operators, representing all sectors and trades and over 80% of the world merchant fleet.
- **INTERTANKO:** International Association of Independent Tanker Owners is the association of the independent tanker owners and operators of oil, chemical and gas tankers.

- **IPECA**: International Petroleum Industry Environmental Conservation Association develops shares and promotes good practice and knowledge to help the industry and improve its environmental and social performance.
- **KPI:** Key Performance Indicators is a measurable value that demonstrates how effectively a company is achieving key business objectives.
- **LOADING ARMS:** Loading arms are used to loading and unloading liquids into Vessels, storage tanks, trucks, railcars.

APPENDICES

BUNKERING PLAN AND SAFETY CHECK-LIST

Bunkering Plan and Safety Check-List

Port/Terminal/Area (position):		Date:
Receiving Vessel:	PIC:	Master:
Delivering Facility/Barge:	PIC/Master:	

Duties

Person Monitoring Tank Levels:	
Point of Transfer / Bunker Station Watch*:	
Deck Rover**:	

** Point of transfer is the point of connection hoses between supplier and vessel (usually manifolds)*

***The main duty of the deck-rover is to watch for oil spills on deck and over the side during bunkering. The deck- rover may perform other duties not in conflict with his or her primary duty. The deck-rover must: (i) Visually inspect the deck and water near or opposite all bunker tanks and each tank's sounding tube and vent, if accessible; and (ii) Remain in a position during changing over of tanks or topping-off to view any spills on deck or in the water.*

1. Quantities to be Loaded and Transfer Rates

Grade	Volume at Load Temp	Loading Temp	API or Density	Tonnes	Transfer Rate	Maximum Tr. Rate	Topping Off Rate
Fuel Oil:							
Gas Oil/Diesel:							
LubOil in Bulk:							

2. Bunker Tanks to be Loaded

Fill Sequence	Tank No.	Tank Capacity @ 100%	Grade	Volume of Oil in Tank on Starting			Volume to be Loaded	Planned Final		
				☐ Sound. ☐ Ullage	Volume	% Full		☐ Sound. ☐ Ullage	Volume	% Full

3. Checks by Barge Prior to Berthing

Bunkering	Ship	Barge	Code	Remarks
1. The barge has obtained the necessary permissions to go alongside receiving ship.				
2. The fenders have been checked, are in good order and there is no possibility of metal to metal contact.			R	
3. Adequate electrical insulating means are in place in the barge-to-ship connection.				
4. All bunker hoses are in good condition and are appropriate for the service intended.				

1. Checks Prior to Transfer

Bunkering	Ship	Barge	Code	Remarks
5. The barge is securely moored.			R	
6. There is a safe means of access between the ship and barge.			R	
7. Effective communications have been established between Persons in Charge (Responsible Officers).			A R	(VHF/UHF Ch ....). Primary System: Backup System: Emergency Stop Signal:
8. There is an effective watch on board the barge and on the ship receiving bunkers.				
9. Fire hoses and fire-fighting equipment on board the barge and ship are ready for immediate use.				
10. All scuppers are effectively plugged. Temporarily removed scupper plugs will be monitored at all times. Drip trays are in position on decks around connections and bunker tank vents.			R	
11. Initial line-up has been checked and unused bunker connections are blanked and fully bolted.				
12. The transfer hose is properly rigged and fully bolted and secured to manifolds on ship and barge.				

13. Overboard valves connected to the cargo system, engine room bilges and bunker lines are closed and sealed.				
14. All cargo and bunker tank hatch lids are closed.				
15. Bunker tank contents will be monitored at regular intervals.			A R	at intervals not exceeding …………minutes
16. High level and overfill alarms are in good condition and their alarm settings properly adjusted.				
17. There is a supply of oil spill clean-up material readily available for immediate use.				
18. The main radio transmitter aerials are earthed and radars are switched off.				
19. Fixed VHF/UHF transceivers and AIS equipment are on the correct power mode or switched off.				
20. Smoking rooms have been identified and smoking restrictions are being observed.			A R	Nominated Smoking Rooms Tanker: Barge:
21. Naked light regulations are being Observed.			R	
22. All external doors and ports in the accommodation are closed.			R	
23. Material Safety Data Sheets (MSDS) for the bunker transfer have been exchanged where requested.			R	
24. The hazards associated with toxic substances in the bunkers being handled have been identified and understood.			R	H_2S Content…………………………… Benzene Content………………………

DECLARATION

We have checked jointly where appropriate, the items of the Check-List in accordance with the instructions and have satisfied ourselves that the entries we have made are correct to the best of our knowledge. We have also made arrangements to carry out repetitive checks as necessary and agreed that those items coded '**R**' in the Check-List should be re-checked at intervals not exceeding _______hours.

If, to our knowledge, the status of any item changes, we will immediately inform the other party.

1. For Ship	2. For Barge
3. Name	4. Name
5. Rank	6. Rank
7. Signature	8. Signature
9. Date	10. Date
11. Time	12. Time

13. **Record of repetitive checks:**

14. Date:	15.	16.	17.
18. Time:	19.	20.	21.
22. Initials for Ship:	23.	24.	25.
26. Initials for Barge:	27.	28.	29.

FUEL OIL MANAGEMENT PLAN

Vessel: ______________ **Voy. No:** ______________ **Date:** ______________

Operation arranged through:

Terminal pipeline: * ________ **Barge alongside: *** ________ **Barge at anchor: *** ________

Road tanker (truck): * ________ **STS offshore underway: *** ________ **STS Static: *** ________

** Tick as appropriate. Where Road Tanker bunkering is required, company's employees to be informed.*

Port/Terminal or Barge or STS vessel NAME/Position: ______________

Receiving vessel PIC / Rank:	
Delivery Facility PIC:	
Communication details:	

Quantities to be Received and Maximum accepted Transfer Rates

Tanks to be loaded	Capacity @ 100%	Tank filling limit (%)	Qty in the tank (MT)*	Qty to load (MT)	After load Qty (MT)	Filling (%)	Initial Rate (m3/h)	Max Rate (m3/h)	Topping-Off Rate (m3/h)	Max Line Pressure (kg/c2)
Fuel Oil										
Gasoil / Diesel										
LubOil in Bulk										

** If commingling expecetd, inform company's employees Operations department immediately*

Bunkering sequences and Line-up

If multiple grades will be received, state the rotation:	
Line-up * :	

** State the lines to be used and the associated tanks and valves to be open and closed for each grade.*

Duties

Person(s)/rank Monitoring Tank Levels:	
Point of Transfer / Bunker Station Watch *:	
Deck Rover **:	

* *Point of transfer is the point of connection hoses between supplier and vessel (usually manifolds).*

** *The main duty of the deck-rover is to watch for oil spills on deck and over the side during bunkering. The deck- rover may perform other duties not in conflict with his or her primary duty. The deck-rover must: (i) Visually inspect the deck and water near or opposite all bunker tanks and each tank's sounding tube and vent, if accessible; and (ii) Remain in a position during changing over of tanks or topping-off to view any spills on deck or in the water.*

Voyage/Bunkering orders special instructions*

** State briefly any special requirement provided by the Voyage / Bunkering instructions. Pay attention to the Charterers/Owners instructions regarding the approved bunker barges or vessels for the operation, the sampling and the Safety precautions.*

Emergency notification *(As per SOPEP or VRP)*

Emergency Telephone Number:	
Emergency E-mail address:	

Information*

** State any Emergency requirement provided by the Voyage / Bunkering instructions and the parties to be called, along with contacts.*

All sections of the Form FOMP-02, must be signed as read and understood by the involved personnel:

Prepared By (Name/Rank/Signature): ______________

Person In Charge: ______________ *Name/Rank* *Signature:* ______________

Person monitoring tank level: ______________ *Name/Rank* *Signature:* ______________

Deck Rover: ______________ *Name/Rank* *Signature:* ______________

Approved by the Chief Engineer: ______________

Bunkering Conference - Pre-Arrival Checklist	
Twelve (12) to twenty four (24) hours prior to arrival a pre-arrival conference should take place that must be participated by the Chief Engineer, 2nd Enginner, Chief Officer and Duty persons. Results of the conference to be reviewed by Master. The progress of vessel's preparation for the bunkering should be checked against the items included in this Plan and any other port specific item. Pending items, if any, during the conference should be followed up by the PIC and properly recorded. The date/time that the conference took place should be recorded in the respective cells of this Form. The pages P-1 and P-2 of this Plan should be sent to company's operations department at least 12 hours prior bunkering. Bunkering Plan should be available to the responsible officers and Dury persons in ECR and CCR until completion of the operation. Upon bunkering operation/plan completed, the Chief Engineer to file the plan as per company's Filing System. Full set of Bunkering Plan along with the documents requested by FOMP-04, par.3.7 should be sent to company's Operations department.	
Pre-Arrival Conference meeting	
Are all personnel aware of the intention to bunker and of the emergency response procedures?	
Are appropriate PPE available to be used and all involved aware off?	
Is the Bunkering Plan Discussed with all involved and contents understood and agreed? *(Chief Officer must be presented and his review and co-operation is needed).*	
Establish and check the common communication link between bunkering station, duty officer and engine room, using intrinsically safe radios	
Is the Library's Risk Assessment (code R5.1) carried out and hazards and Risk Controls in place discussed with all personnel involved? *(Where revision needed in accordance to your operation demand, this should be properly addressed and forwarded to the company for final review).*	
Are duty persons familiar with sampling procedures and performing?	
Are all unused manifold valves and blank off manifold connections with all securing bolts, properly tightened, with a gasket in place.	
Are the required reducers for this operation available and ready for use?	
Deck scuppers and air driven anti-polution pump ready for use.	
Ensure that the vessel's bunkering tanks portable gauging equipment and fixed gauging systme is in good order	
Check all bunker tank air pipes are open and unblocked	
Reconfirm space remaining in all bunker tanks to be filled	
Are all bunker tank manhole covers and tank lids closed and secured?	
Check all bunker tank high level alarms are functioning	
Is the designated overflow tank properly prepared?	
Are all SOPEP equipment (sawdust, sand, absorbent pads, empty drums, squeegees, brushes etc.) in key locations ready for use?	
Are the no smoking / no naked flame warning notices ready to be posted?	
Are fire fighting appliances ready for use?	
Are all flag or light signals required by local regulations ready to be displayed?	
When bunkering from a barge ensure that all needed information about fendering are available to you and sufficient for the safe operation.	
Is the lighting for the safe means of access between the vessels in good order?	
Check the weight of the hose does not exceed the SWL of vessel's lifting gear	
Check hose is of such a length that there is sufficient play to allow for movement, and that it is adequately supported	
Ensure that Material Safety Data Sheets have been provided for each grade of fuel being stemmed	
Are all personnel aware of the H2S safety precautions as described in the SOM-04, SOM-15 and in the FOMP-03?	
Are Chief Engineer's Standing Orders issued and fully understood by all personnel involved? *(refer to FOMP-03, par. 1.3)*	

Person In Charge: ____________________ *Signature:* ____________________
Name/Rank

Person monitoring tank level: ____________________ *Signature:* ____________________
Name/Rank

Deck Rover: ____________________ *Signature:* ____________________
Name/Rank

Approved by the Chief Engineer: ____________________

Fuel Oil Management Plan (FOMP)

Line-up (actual records)	
Bunker Segregation Valves between Grades always closed (Confirm that measures to prevent unintended opening are in place). Enter name/rank/signature of the person who checked.	
Line-up and valve setting for the bunker operation is rechecked and verified by the PIC before operation starts (Time rechecked and PIC name to be recorded in the next column)	

Hoses Connection - disconnection
- A bolt should be fitted in every hole, and tightened correctly and evenly. Nuts and bolts should be of the correct size and material, and damaged bolts should not be used. Improvised arrangements using G-cramps or similar devices must not be allowed for flange connections. Care should be taken to protect manifolds from mechanical damage.
- During connection, and when connected, flexible hoses should be suspended by suitable equipment to ensure that they are not subjected to excessive bending or liable to be crushed between the ship and the jetty/barge.
- Reducers and spool pieces should be made of suitable material compatible with the cargo, and comply with relevant industry standards.
- When long reducers or spool pieces are used the resulting length must be properly supported to avoid exerting excessive cantilever force.
- If leakage develops from a bunker pipeline, valve, hose or metal arm, all operations through that connection should be stopped and the situation treated as an emergency until the cause has been identified and the defect remedied.

Pre-Bunker transfer Checks	
Bunkering Safety Check-List has been filled, discussed, signed and all personnel involved are fully familiar with the contents.	
Provide means of draining off any accumulations of water on deck	
Empty out and plug save-alls for manifolds and bunker tank vents	
Reconfirm space remaining in all bunker tanks to be filled	
Ensure all sounding pipe caps are tight, except when sounding tank	
When bunkering from a barge ensure there is sufficient fendering between vessels so there is no metal to metal contact. Ensure that the barge is securely moored alongside.	
Check the weight of the hose does not exceed the SWL of vessel's lifting gear	
Check hose is of such a length that there is sufficient play to allow for movement, and that it is adequately supported	
Inspect hose and couplings for damage.	
Place drip trays under hose couplings and flanges	
Check that delivery note quantities and bunker specifications are correct	
Ensure that Safety precautions contents of the Material Safety Data Sheet is fully intendified and followed	
Discuss bunkering plan with supplier	
Agree with supplier the quantity of oil to be pumped aboard	
Agree unit of measurement (metric tons, cubic metres, barrels etc.)	
Discuss vessel's emergency response procedures with supplier	
Discuss supplier's own emergency response procedures	
Check the established communication link between vessel and supplier	
Agree signaling system with supplier - Commence Pumping	

Chief Engineer: ____________________

Vessel:		**Voyage Nr.:**		**Date:**	
Port/Terminal or Barge or STS vessel NAME/Position:					

Bunker Survey (before bunkering)

Tank	Capacity @ 100%	Grade - % sulphur	Ullage (M)	Volume (m3)	Density	Temp (C or F)	Table used	VCF	Quantity (MT)	Tank filling (%)
Total Quantities of each Grade:	**Grade:**					**Total Quantity:**				MT
	Grade:					**Total Quantity:**				MT
	Grade:					**Total Quantity:**				MT
					Trim:		**m**			

Bunker Survey (after bunkering)

Tank	Capacity @ 100%	Grade - % sulphur	Ullage (M)	Volume (m3)	Density	Temp (C or F)	Table used	VCF	Quantity (MT)	Tank filling (%)
Total Quantities of each Grade:	**Grade:**					**Total Quantity:**				MT
	Grade:					**Total Quantity:**				MT
	Grade:					**Total Quantity:**				MT
					Trim:		**m**			

Bunkers Received - Vessel's Clculation	**Grade:**		**Qty:**	MT	**Bunkers Delivered - Facility Clculation**	**Grade:**		**Qty:**		MT
	Grade:		**Qty:**	MT		**Grade:**		**Qty:**		MT
	Grade:		**Qty:**	MT		**Grade:**		**Qty:**		MT

Remarks

Delivery Facility:		**Surveyor:**		**Chief Engineer:**	

Vessel:		**Voyage Nr.:**		**Date:**	

Port/Terminal or Barge or STS vessel Name/Position:	

STANDARD INSTRUCTIONS

The bunkering operation must be carried out in compliance with the procedures being set out in the Fuel Oil Management Plan (FOMP) - Part A.

Samples handling *(Refer to FOMP-05 - Bunkers Sampling and FOMP-05A - Bunkers Sampling Guidance Checklists)*

1. Use the "Form FOMP-04 – Request to Witness Sampling" and invite barge Master or Terminal representative to witness the sampling and sign the form. If he does not attend, issue a LOP.

2. Take representative samples for each grade of fuel oil using a continuous drip sampler at our vessel's inlet bunker manifolds and split the sampling in 5 parts, of minimum 400ml each and distribute as follow:

- **a.** One part will be submitted for analysis. Please liaise closely with the Surveyor to take this sample to the LAB for analysis. If not Surveyor is appointed then proceed as follow:
  - Hand the sample to your local agents, requesting them to send it by DHL to the LAB for analysis, by utilizing the
  - Ensure that LAB is notified of the sample by emailing the completed Sample Collection Form to
  - The LAB address is as follow:
- **b.** The second part will be offered to the fuel supplier.
- **c.** The third part will be offered to the fuel supplier as the MARPOL sample.
- **d.** The fourth part will be retained on board.
- **e.** The fifth part will be retained on board as the MARPOL sample.

3. Make sure that only one sample will be forwarded to LAB for analysis. Either by the surveyor or by the Agents as per par.2.a. above.

4. Make sure that for all bunkering in Russian Black Sea ports, the sample for analysis will be forwarded from Konstantinoupolis only and not from the Russian Black Sea port, or the surveyors or through the agents.

5. If the supplier provides to you its own samples then follow the guidance provided in FOMP-05, paragraph 1.5.

Quantity Discrepancies *(when to call your operator)*

- ALERT your Operator and the Time Charterer (if applicable) and DO NOT SIGN the BDN whenever:
  - **a.*** *(For bunkering of MORE than 1000 mt)* - the quantity received on board is less by more than 10mt of the total quantity that the barge or terminal supplier insists that was delivered, or
  - **b.*** *(For bunkering of LESS than 1000 mt)* - the quantity received on board is less by more than 5mt of the total quantity that the barge or terminal supplier insists that was delivered.

* *Check bunkering orders if requests stricter discrepancies and follow accordingly.*

Letters of Protest (LOP)

- In addition to the FOMP requirements, Masters should make a protest whenever the quantity of bunkers delivered is LESS than that stated on the bunker receipt. The correct procedure for lodging the complaint is as follows:
  1. The supplier`s delivery receipt MUST be marked "SIGNED UNDER PROTEST. SHIPS FIGURE XXXX MT".
  2. A letter of protest must be completed and a copy attached to the delivery receipt.
  3. The supplier should countersign both the delivery receipt and the LOP, otherwise an additional LOP for "refuse to sign" to be issued.
  4. A copy of the LOP and the delivery receipt, both signed by the suppliers representative, should be retained on board

Note: *When bunkering is arranged by Charterers, make sure that requirements of FOMP-04, par.3.2 are strictly followed.*

Make the required records in the FOMP-01: Marine Fuel Sulphur Record Book.

Documents to be forward to Company operations Dept.

1. Pror bunkering

- **a.** Page A-P1 & A-P2 of this plan, at least 12 hours before operation.

2. After Bunkering

- **a.** Full set of this plan.
- **b.** Barge's tank surveys/Ullage reports
- **c.** Copy of BDN. (Same to be uploaded in the ULTIMA upon bunkering completed).
- **d.** Distribution list of samples.
- **f.** Letters of Protest (LOPs), Quality certificate and barge's pumping rate (where applicable).
- **g.** Bunker supplier and Bunker Surveyor evaluation forms (Forms FOMP-05 & 06).

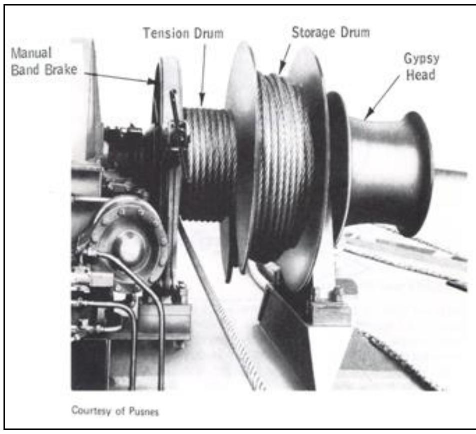
Safety check list during Bunkering Operations

Safe access between the Ship-Shore or Barge or Truck

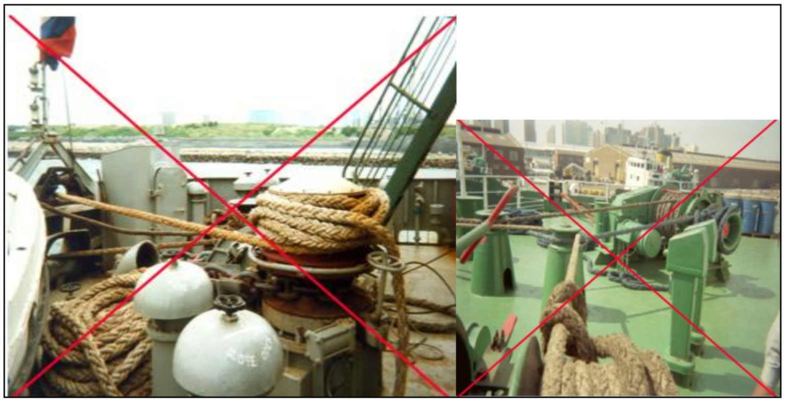



Safe access is provided with the accommodation ladder.

The Ship is securely moored



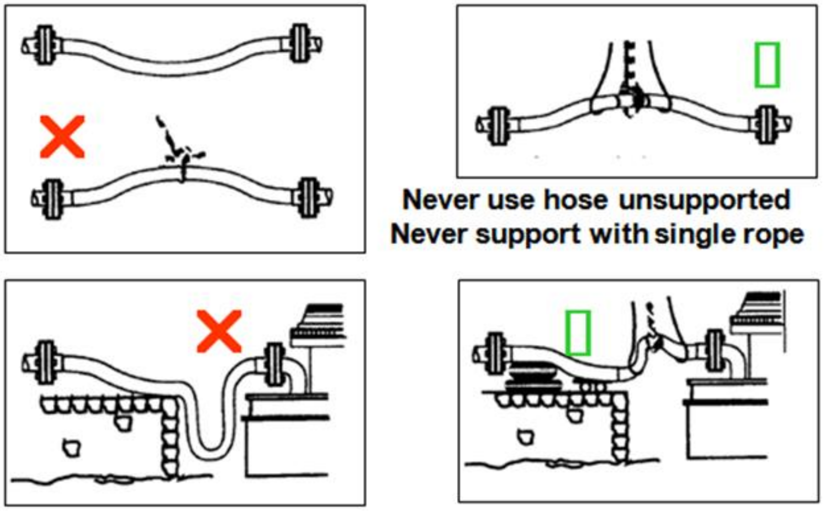
Ships should remain adequately secured in their moorings. Attention should be given to the movement of the ship caused by wind, currents, tides or passing ships and the operation in progress.



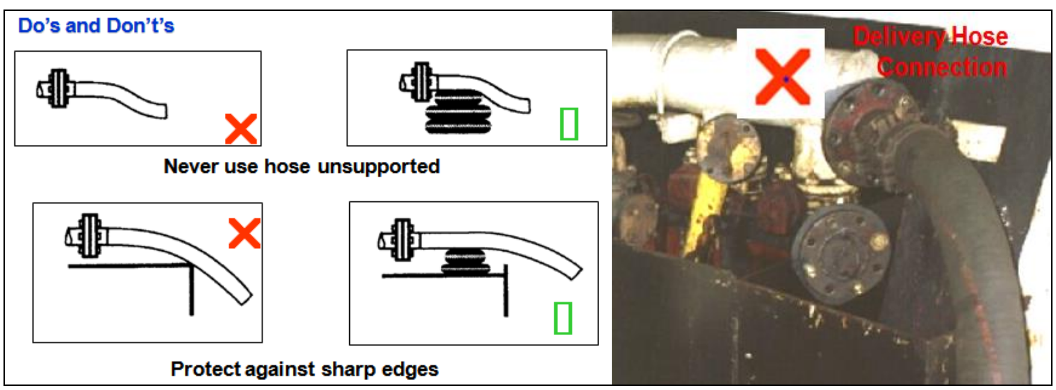
The agreed Ship-Shore / Barge or Truck communication system is operative (via portable VHF system or by Hands & or by Voice)

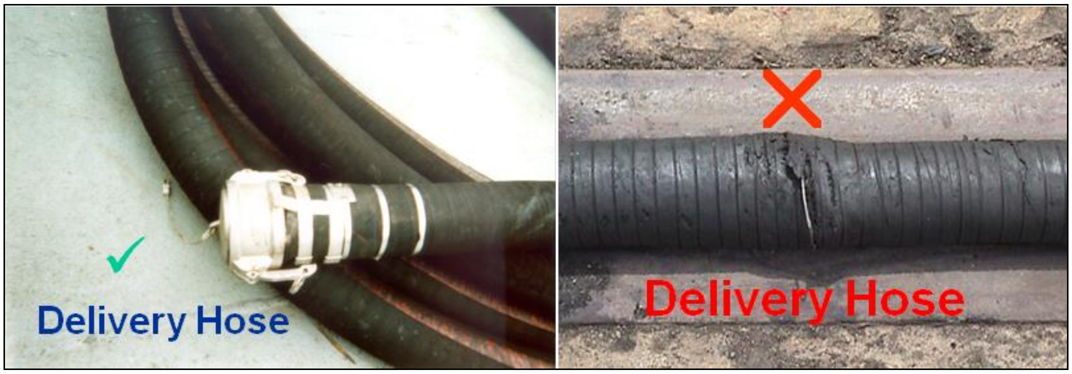
- The Ship's fire hoses and fire-fighting equipment is positioned and ready for immediate use
- The Terminal's / Barge or Truck, fire-fighting equipment is positioned and ready for immediate use

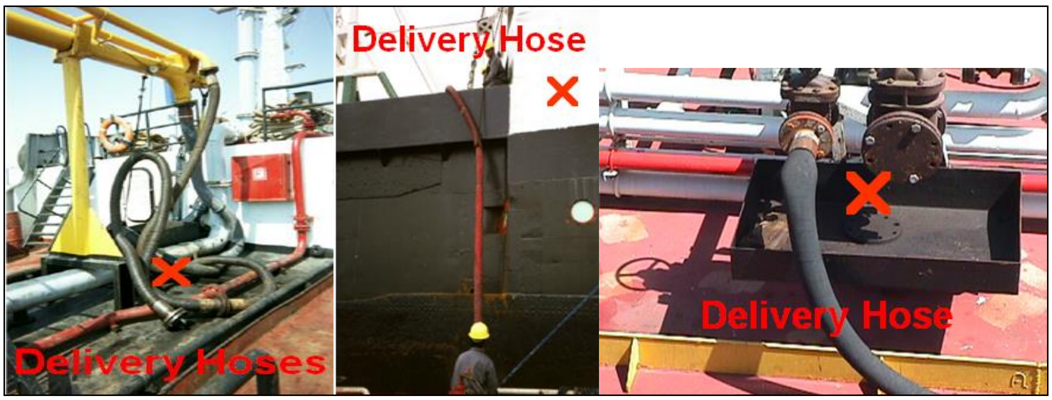
The Ship's / Terminal's / Truck, cargo and bunker hoses/arms, lines and manifolds are in good condition, properly rigged and appropriate for the service intended.



Never overbend hose or allow hose to hang between jetty & ship.







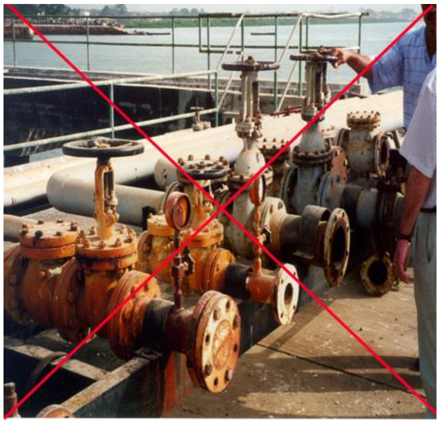
Fuel oil lines and Hoses marked with pressure test and date.

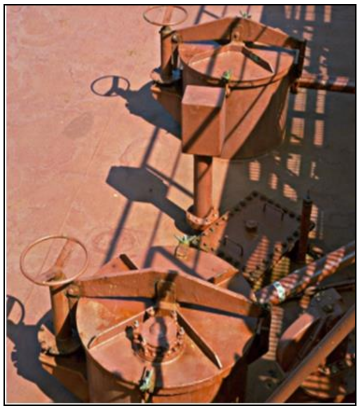
Ensure that Ship oil pollution emergency plan (SOPEP) is available.

SOPEP on the locker room

SOPEP on the deck.

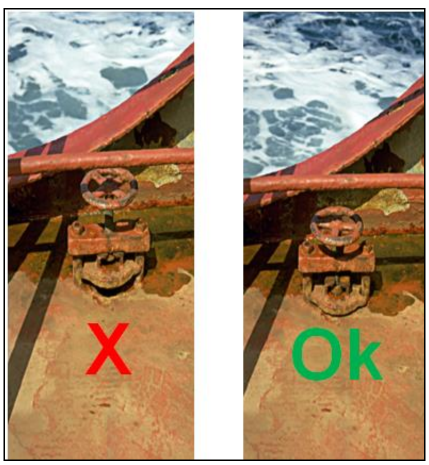
The cargo and bunker hoses/lines /arms should be in good condition, properly rigged and appropriate for the service intended. The cargo transfer system is sufficiently isolated and drained to allow removal of blank flanges prior to connection. Unused cargo and bunker line connections should be closed and blanked. Blank flanges should be fully bolted.

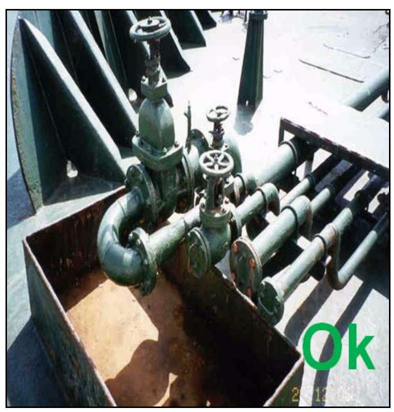




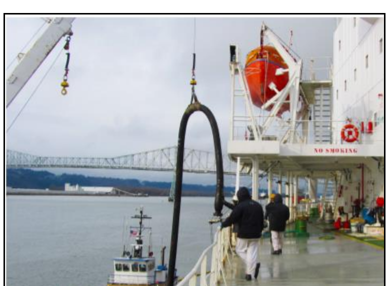
All cargo, ballast and bunker tank lids are closed.

Sea and overboard discharge valves, not in use, are closed and visibly secured.





Scuppers and 'save-alls' are effectively plugged and drip trays are in position and empty



Crew preparing to bunker

Check all scupper plugs to avoid accidental spills

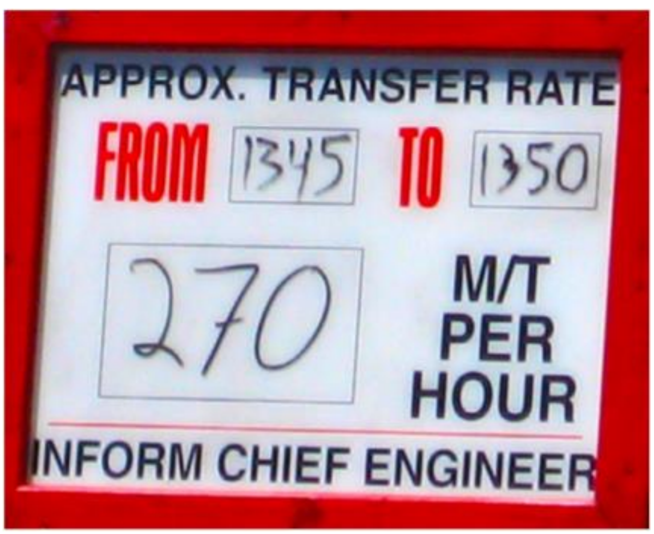
All External doors, windows in the accommodation should be closed during cargo / bunkering operations. These doors should be clearly marked as being required to be closed during such operations.

There is adequate supervision and an effective deck watch in attendance on the Ship / in Terminal and in Truck, at all times for the operations and emergencies. All personnel connected with the operations should be familiar with the dangers of the substances handled.

A point-of-transfer watch must remain at the point of connection with the delivering vessel during bunkering.

The operation of the P/V valves and/or high velocity vents should be checked using the testing facility provided by the manufacturer.

Sounding tape near the fuel tank sounding location.



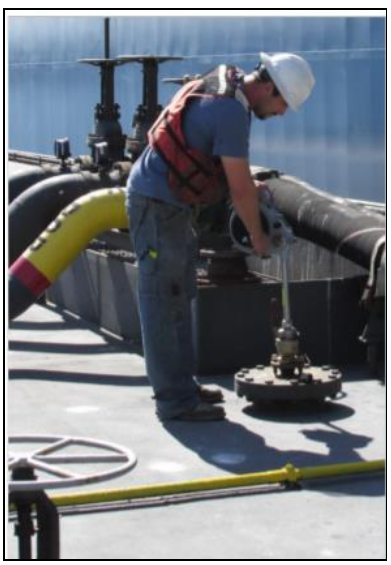
Planned transfer rate.

The receiving vessel's, should prepare a preloading plan for bunkering that includes a planned transfer rate. The planned rate should meet company standards, be at or below the maximum rate allowable for the tanks to be filled, and consider the time it takes for ship's crew to detect and correct any problems.

The receiving vessel's should compare the calculated transfer rate to the planned rate. If the transfer rate is higher than planned, the receiving vessel should contact the delivering vessel or facility immediately to reduce it. The receiving vessel's must frequently calculate and record the rate of transfer based on the soundings. Record transfer rates in the bunkering file.

Crew tending tanks during oil transfer.

- ✓ All fuel system valves, manifolds, and piping should be marked clearly with their use and the tanks they serve.
- ✓ Maintain easy-to-read fuel system markings.
- ✓ Vessel fuel oil valves and manifolds should be well-lit so the crew can see what they are for and if they are open or closed.



Crew sounding tanks during oil transfer.

Fatigue plays a major role in oil spills during bunkering
A number of fatigue-related effects have been identified:

- Lapses in judgment or failures to respond.
- Inappropriate responses.
- Decreased performance consistency.
- Slowed reactions.
- Increased mental errors.
- Decreased memory and recall.
- Decreased attention.
- Increased risk-taking behavior.

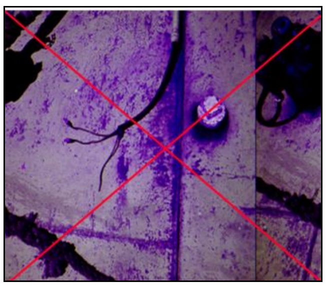
Never hesitate to stop bunkering to avoid a spill.

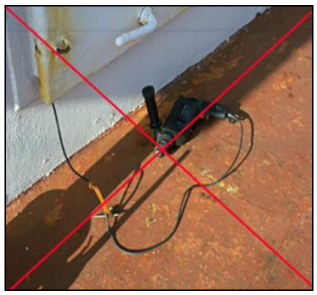
Smoking rooms have been identified and smoking requirements are being observed. Buildings, places and rooms designated as areas where smoking is permitted should be clearly marked as such.

Hand torches (flashlights) are of an approved type.

Portable VHF/UHF transceivers are of an approved type.

Damaged units, even though they may be capable of operation, should not be used.





Electric cables to portable electrical equipment within the hazardous area are disconnected from power. The use of portable electrical equipment on wandering leads should be prohibited in hazardous zones during cargo Bunkering operations and the equipment preferably removed from the hazardous zone.