



University
of Piraeus

SPOUDAI
Journal of Economics and Business

Σπουδαί

<http://spoudai.unipi.gr>



Ship to Ship (STS) Transfer of Cargo: Latest Developments and Operational Risk Assessment

Nikolaos P. Ventikos^a, Dimitrios I. Stavrou^b

^a*National Technical University of Athens, School of Naval Architecture and Marine Engineering, Laboratory for Maritime Transport, 9 Iroon Polytechniou str. Zografou 157 73, Greece, Email: niven@deslab.ntua.gr*

^b*National Technical University of Athens, School of Naval Architecture and Marine Engineering, Laboratory for Maritime Transport, 9 Iroon Polytechniou str. Zografou 157 73, Greece, Email: dstavrou@mail.ntua.gr*

Abstract

The significant development of Ship to Ship (STS) transfer of cargo operations originates from different operational and trading reasons and factors, all of which however in the context of optimizing the distribution plan between the source and the final consumers (markets). The transferred cargo can be either petroleum products, or liquefied gases (LPG, LNG), or even some dry bulk cargoes. The IMO resolution, MEPC 186(59)/2009, gives to tanker vessels the full operational responsibility of an STS operation of petroleum products. To reduce the possibility of a potential accident with severe effects, risk assessment is necessary for the evaluation of the hazards embedded in the procedures and to prevent the occurrence of mishaps during STS transfers by taking additional control measures. The aim of this paper is to describe the latest developments related to STS transfer cargo procedures and moreover to scrutinize on the implementation of risk assessment in the context of optimizing the procedures. It is intended to determine the factors that can affect the operations; accidents that happened in the past are presented in order to investigate the parameters that should be considered as lessons learned to avoid similar unpleasant situations in future activities related to STS operations.

JEL Classification: R41; P41; Q51.

Keywords: Ship to Ship (STS) transfer; Risk assessment; STS plan; regulations; Transshipment.

1. Introduction

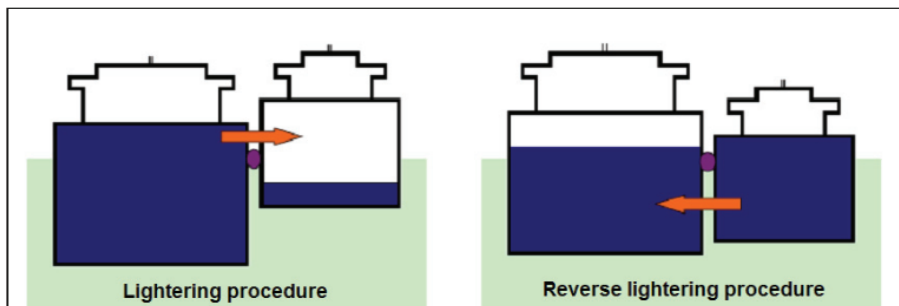
The Ship to Ship transfer (STS) of cargo is a procedure that was initially used on the decade of 1960s due to the increased draft dimension that limited the access of large ships (VLCCs and ULCCs) at specific oil terminals through shallow rivers in the Gulf of Mexico (MAIB, 2010). The STS transfer operation refers to the transfer of cargo between seagoing ships positioned alongside each other. In particular, one ship called “constant heading vessel” moves on a study direction with slow speed, while the other ship called “maneuvering vessel” approach the first ship conducting the “run-in” procedure. The

objective cause for both ships is to come on parallel courses with similar speed and their manifolds in line in order to continue with the transfer procedure. The transfer procedure can be conducted either while stationary or underway (ICS, 2011). The operation is named “Lightering” when the transshipment of the cargo happens from a larger ship to a smaller one or “Reverse Lightering” when the transshipment of the cargo happens vice versa (OCIMF, 2009).

The STS operation comprises five different phases: the Pre-Arrival Planning; the Arrival; the Berthing; the Cargo Transfer, and the Departure. Each phase of the STS operation consists of different procedures to follow and check-lists to complete.

Currently, STS operations play an important role to the transfer of cargo in worldwide scale. The significant development is due to different reasons involving operational and trading factors; the operational factors are related to the optimization of the distribution plan between the source and the final consumers whilst the trading factors are involved with the offshore storage in tankers due to the contango situation, which has arisen during the past few years (Glykas, A., 2011; McClellan, 2011; Open Forum, 2012). The transferred cargo can be either petroleum products such as crude oil, or liquefied gases such as LPG and less often LNG (Waterborne Energy, 2010). The increase of the size of ships involved to STS transfer procedures in combination with the accidents that happened during such operations led to the implementation of international regulations so as to standardize such procedures (Efthimiades, A., 2012). The aim of this paper is to describe the latest developments related to STS transfer cargo procedure (Figure 1). For that purpose the legislative regime of the STS transfer operation is given. Moreover, risk factors involved in the procedure of STS transfer operation are identified and furthermore their role to risk assessment/analysis is determined. The important issue of lessons learnt is highlighted due to the presentation of four different cases that escalated to accidents during STS transfer procedures.

Figure 1. Different case of transshipment between a large and a small ship.



2. Legislative regime for STS operations

The STS transfer operations were initially based on guidelines or recommendations made primarily from the International Chamber of Shipping (ICS), the Oil Companies

International Marine Forum (OCIMF) and the International Maritime Organization (IMO) (IMO, 2007a). Although few accidents or spills directly related to an STS procedure have been recorded, nevertheless public concerns about consequences of oil spills led to the adoption of international regulations concerning the STS transfer procedures. The amendments to the Annex of the Protocol of 1978 related to the International Convention for the Prevention of Pollution from ships, by the addition of Chapter 8 to MARPOL Annex I is the first significant action to establish common rules during STS transfer operations. The IMO resolution MEPC 186(59)/2009 entered into force on April 1st, 2012 and it comprises three regulations; According to Regulation 40, the amendments apply to oil tankers of 150 gross tonnage and above, whereas they shall not apply either to oil transfers associated with offshore platforms or other bunkering operations or STS operations in which warships are involved by any mean. Regulation 41 introduces a Plan relevant to an STS operation which prescribes the individual steps of the STS operation and the associated factors to be considered during each step. It also introduces a superintendent which is a specially qualified person to control the STS operation, not necessarily one of the masters of the ships involved to the STS operation. Finally, it imposes to the masters to keep records onboard from STS transfers that took place over the last three years ready for a potential inspection. Regulation 42 refers to some notifications related to STS transfer operations within territorial waters, or the Exclusive Economic Zone of a Party. In particular, it points out the obligation of the masters to notify the Party 48 hour prior to the STS transfer operation providing specific information related to the scheduled operation (IMO, 2009). The latter is referred to the Article 56 of United Nations Convention on the Law of the Sea (UNCLOS) in which it is determined that the coastal Authorities, have the responsibility for the environmental protection inside Exclusive Economic Zones (EEZ) and consequently they have to monitor and supervise the STS operations inside this area (UNCLOS, 1994).

3. Factors that affect an STS transfer operation

According to IMO resolution MEPC 186(59)/2009, the STS Superintendent must supervise/control the procedure according to the “STS transfer plan”. This is approved by the Administration and it aims at the reduction of the likelihood of a potential accident with human losses and/or environmental consequences. The STS operation plan contains information about each individual phase of an STS transfer operation, description of the mooring and unmooring procedures, cargo and ballast information, duties of the involved personnel, a contingency plan in case of emergency, and other valuable for the operation issues (IMO, 2010).

The development of an STS transfer operation depends on different factors that interact with each other during the operation; hence an STS transfer operation involves in a direct or indirect way the following parties:

- The vessels and their technical specifications (dimensions, compatibility issues, propulsion installations, mooring and anchorage equipment etc.). The compatibility between the involved ships is an important issue along with the usage of the suitable equipment to conduct the transfer (OCIMF/ICS, 2005).

- The human factor which comprises the masters and the crews involved in the procedure and their individual training/experience with regards to STS transfer operations. The training of the crew involved into STS procedures is critical especially when emergency conditions emerge. It is of high importance to prepare adequately the crew prior to the operation in relation to both emergency transfer procedures and emergency propulsion procedures. The necessary equipment for navigation must be functional and should be checked before the STS operation.
- The special STS equipment that is necessary for the conduction of the operation (fenders, transfer hoses etc.) (National Academy Press, 1998).
- The Person of the Overall Advisory Control (POAC) and his assistants; POAC should have an appropriate management level deck license or a certificate respective international certification standards; The use of a superintendent does not relieve the ship Master of any of his duties, requirements or legal responsibilities; POAC can be either one of the two masters, or a designated superintendent of an STS transfer service company. The objective of POAC is to complete the STS transfer operation safely and in accordance with the regulations set by IMO (OCIMF, 2013).
- Other external factors that interact during the operation such as the selected transfer area (traffic density, geological factors, security threat, underwater pipelines and/or cables, water depth), weather and environmental conditions (sea state, wind, tidal currents, visibility etc.). More specifically, weather conditions are critical during STS operations; it is important to avoid conducting operations in darkness and all limitations should be clearly stated and accepted (OCIMF/ICS, 2005).

4. Risk assessment of an STS transfer operation

A good safety record of STS transfer procedures is the result of the industry practice to control the procedure by the application of best practice guidelines published from organizations such as ICS, OCIMF and IMO. The possibility of the occurrence of an incident that might lead to accident during STS transfer procedures was estimated to provide a minimum level of absolute risk (IMO, 2007b; DNV, 1997; Von Zharen, 1994).

An analysis conducted in 2004 which was based on 1,270 STS transfer operations for a time window of over 10 years indicated that no major pollution incident had occurred; oil leakage was recorded in 7 cases (5.5%) from which only two ended up to the sea. The rate of minor collisions was 11.81 cases per 1000 operations and the related rate of major collisions was 1.57 cases per 1000 operations. During the period of study one fatality and one crew injury occurred. A rate of 3.6 accidents per year was recorded (Marico Marine, 2004). In order to succeed efficient implementation of the guidelines, it is necessary to design a detailed risk assessment of the STS transfer operation, based upon the consideration of the following risk critical factors (OCIMF, 2011; IMO, 2010):

- Correlation between the location of the STS transfer operation and the prevailing weather/environmental conditions;
- Status under which each individual phase of the STS transfer is conducted; at anchor or underway;
- Information of the selected location for the STS transfer operation that might af-

fect the procedure regarding to navigational hazards, traffic density of the area, or its exposure to security threats;

- Determination of the criteria to abort/suspend the operation;
- Elements concerning the possibility of an oil spill, such as a contingency plan and the availability and capability of means for confronting an oil spill;
- Proper level of training skills and qualifications of the personnel involved into an STS transfer procedure for both crewmembers and the team of the STS providing company;
- Proper understanding of the individual phases of STS transfer operations;
- Suitability of the existing STS transfer plans;
- Proper conditions of the STS transfer equipment (e.g. hoses and fenders).

Before the conduction of an STS transfer operation the parties involved should perform a risk assessment to evaluate their safety level and check their abilities and qualifications related to the specific operation. This procedure is known as “Due Diligence” (Glykas, A., 2011) and its basic supporting tool are checklists that should be completed from both sides of the operation. As minimum, risk assessment should address hazard identification associated with the STS transfer operation; the determination of probability and consequences as the selected dimensions of risk; the definition of the proper means to prevent or mitigate consequences; and the emergency procedures for situations in need of adequate contingency and control (OCIMF/ICS, 2005).

The possible scenarios of an accident concerning an STS transfer operation are inductively related to the leakage of oil on deck or at sea; collision between the two ships; fire ignition; human injury or loss; and the responsibility for a window for a piracy attack;

The escalation of an incident to an accident depends on factors that accelerate the procedure and they are usually with respect to human factors, material failure or the combination of these two.

5. Lessons learned from STS accidents

To date, STS transfer operations are conducted in a world-wide scale and they have become common practice. The experiences earned from such operations indicate that are safe given that suitable equipment is used by qualified crew/team members under the command of an experienced superintendent and masters, following the procedures recommended on the STS operation plan and the STS operation practice guidance. Although a relatively small number of incidents has occurred and an even smaller number of them escalated to accidents, it is very important to use and build on lessons learned from past accidents so as to minimize the possibility for future accidents. In this context, Table 1 presents relative incidents that escalated to accidents; their investigation provided valuable lessons that can be used as additional guidance to the existing codes and best practices (MAIB, 2011).

In particular the first case (A) lead to the conclusion that one of the upmost important issues during a STS transfer procedure is the matter of communications between individual parties. Proper preparation including pretests to the communication devices in combination with the use of alternative ways of communication in case of emergency can safeguard the procedure from unpleasant situations.

In the second case (B) it is highlighted the need of using personnel with experience and special qualifications in order to accomplish a successful transfer procedure. This can be achieved by choosing carefully the master and the crew and training them with conduction of exercises that simulate STS transfer procedures and emergency case scenarios.

The third case (C) emphasizes to the qualifications of the superintendent. It is of crucial importance that the superintendent has the ability to predict unpleasant situations or prevent the escalation of an incident to an accident. The selection of a high qualified superintendent can help to avoid difficult situations related to the transfer procedure.

The last case (D) highlight two issues with equally importance. The first is the factor of the fatigue of the personnel involved to the transfer, while the second is the related to the conditions (environmental and technical) during the procedure. The control of the fatigue level of the crew can be achieved with rational determination of the watches. The conduction of the procedure during daylight is necessary in order to ensure better control of the different phases of the transshipment and lastly the pretest of the equipment in combination with the repair of the malfunctions can prevent problems during the STS transfer procedure.

6. Conclusions

IMO resolution MEPC 186(59)/2009 gives to tanker vessels the full operational responsibility of an STS transfer operation. In this context, the important issue concerning safety and environmental protection during STS transfer operations is determined and compiled in an “STS operation plan”.

Furthermore, although STS transfer operations were initially limited to oil and oil products, they are currently expanding to gas and chemical products and therefore it is of utmost importance that an amendment of the respective IMO resolution should take place to strengthen the transfer of non-oil cargoes and products.

A smart way to avoid problems during mooring and unmooring procedure is the use of tugs; however if tugs are not available then mooring and unmooring is better to happen underway.

The responsibilities of a superintendent during an STS procedure are multifunctional and demanding. The long-time duration of STS transfer procedures in combination with the consecutive operations that a superintendent might be involved in are factors that may adverse his ability and alertness.

The law allows masters to perform as superintendents but the responsibilities of a master remain even if he/she plays this double role, hence to command the ship and at the same time to coordinate the STS operation. It is advisable to keep the two roles separated and not to cause additional problems with aforementioned combination. Additional to the latter, the use of an assistant of the superintendent onboard the second ship can help towards the prevention of any unpleasant situations.

The factor of human fatigue seems to be determinant in the occurrence and escalation of accidents. The superintendent, the masters and the crews involved into such operations must have adequate rest prior to the initiation of the procedure.

Table 1. Presentation of different cases of incidents during STS transfers operations that led to accidents—Lessons learnt

Case	Narrative	Investigation analysis	Lessons learnt
<p>A. Collision between two Aframax oil tankers at the end of the STS procedure</p>	<p>After STS operation completed the ships started procedure so to separate. While moving with 2.5 knots, the last lines slipped, causing movement of the stern of one vessel close towards the other. To correct movement superintendent used propulsion and steering orders. However, the engine did not start. Efforts of the superintendent to avoid collision between the ships using consecutive steering orders were ineffectual; the ships collided suffering minor damages.</p>	<ul style="list-style-type: none"> Main cause of the collision was the engines failure. The personnel of the engine room were not aware of the emergency procedures when the engine fails to start. Internal poor communications led to the delay of the relay of the engines problem from the officer on bridge to the superintendent; Superintendent had conducted 8 consecutive STS operations. Fatigue may have affected him adversely. 	<ul style="list-style-type: none"> Unmooring procedure has many navigational hazards that must be very carefully examined. <ul style="list-style-type: none"> Communication between MCR- Bridge, and Bridge-superintendent is vital to avoid difficult situations. Training of crew for emergency procedures is very important. Exercises should be conducted prior STS. The fatigue of the superintendent must be under consideration.
<p>B. Collision between two Aframax oil tankers at the beginning of STS procedure</p>	<p>During the second attempt (unsuccessful first attempt) the helmsman of the ship experienced the same difficulty (like first time) to maintain steady course; the superintendent did not realize it. After the maneuvering vessel slipped towards the constant heading vessel the superintendent tried to avoid collision with consecutive steering orders. The two ships collided. Heading vessel suffered from serious damages on three starboard ballast tanks.</p>	<ul style="list-style-type: none"> Inexperience of the master of the maneuvering vessel contributed to the evolution of the incident to accident. Poor communications between the two ships worsen conditions during the approach of the maneuvering ship. Lack of risk assessment and poor line of sight between the bridge wing gyro repeater and the bridge master indicator of the maneuvering ship. Inability to secure a fwd secondary fender at deck level. 	<ul style="list-style-type: none"> The experience and qualifications of involved masters and superintendent as well as the ability of crew are decisive factors for the success of the STS operation. Good internal and external communications are vital during an STS transfer operation. Both sides should implement a thorough STS transfer plan including accurate check of lists and detailed risk assessment so to prevent accidents.
<p>C. Collision between VLCC and Aframax tanker at the beginning of STS procedure</p>	<p>Two ships were in the stage of moving with parallel courses 10m abeam of each other with similar speed. The superintendent ordered to stop the engine and next he ordered “dead slow ahead”. The officer relay by mistake “dead slow astern” and that was the movement executed. The astern movement resulted an inability to steer and the two ships collided. The hull of the two ships suffered medium structural damages.</p>	<ul style="list-style-type: none"> The superintendent had a recommendation for refreshing his training but no one followed it up and check his ongoing record. The poor communication between the superintendent and the officer and the helmsman on the bridge. The crew was unable to secure the secondary aft fender at a position that could protect the vessel in case of collision. 	<ul style="list-style-type: none"> Ensure the accuracy of communications between the superintendent, or the master usually positioned at the bridge wing, and the officer and the helmsman on the bridge. The qualifications of the superintendent are of crucial importance to conduct a successful STS operation. The training of crew is of utmost importance so as to limit the consequences in case of an accident.
<p>D. Collision between a VLCC and an Aframax tanker at the beginning of STS procedure</p>	<p>Two tankers conducted “run-in” procedure for STS operation; helmsman was on the wheel for one and a half hours trying to execute course orders. A problem led the operation to be executed during the night. Poor exterior helm repeater illumination. When the manifolds came in line the superintendent used steering orders to do final approach. The maneuvering ship start swing towards to the constant heading ship. The superintendent tried to correct the movement. He then noticed that the indicator of the helm was on the opposite direction to the one he ordered. The two ships collided and suffered structural damages.</p>	<ul style="list-style-type: none"> Delay of the initiation led STS to be conducted in darkness. That had adverse affection on the procedure. Poor visibility of the helm indicator in the wing bridge caused lack of control at the executed orders. <ul style="list-style-type: none"> Superintendent was not checking if his orders were executed correctly. Helmsman was executing orders to keep courses for an hour and a half and during final approach he had to adjust to a different situation in which he had to execute specific helms angle. This led to a lapse of concentration. 	<ul style="list-style-type: none"> It is of utmost importance to use persons with special qualifications when difficult operations are conducted including “run-in” or mooring procedures. The fatigue of the personnel must be taken under serious consideration. It is preferred that STS transfer operations are conducted with day light. Finally, Bridge instrumentation including helms indicators on the bridge wing must be inspected and remedy measures must be taken in order to ensure that they operate normally under any circumstances

The success of an STS transfer operation is based on the experience of the superintendent and the masters as well as on the good training of the personnel involved. However, for these parts to collaborate in harmony and with the necessary accuracy it is of utmost importance to follow the “STS transfer plan”; this plan provides guidance to avoid mistakes and prevent actions that might lead to unfortunate circumstances.

Risk assessment is the paramount tool for the parties involved to an STS transfer operation so as to identify the hazards associated to the STS transfer procedure and determine the proper way to confront any adversity that might occur.

Finally, it is important for the efficiency of any transfer that guides and practices are to be revised and amended taking into account the lessons learned from the recorded accidents, providing a thorough risk assessment that will ensure the success of STS transfer operations.

References

- DNV, 1997. Risk Assessment of Ship-to-Ship Transfer. Report for Marine Safety Agency. DNV Project C7912. November 1997.
- Efthimiades, A., 2012. Ship to ship Cargo Transfer Operations (STS), Service Our Ships (SOS), February 2012.
- Glykas, A. and Perissakis, S., 2011. A Risk Assessment Methodology as a tool for screening of Ship to Ship (STS) Transfer Operation. European Conference on Shipping Intermodalism & Ports, ECONSHIP 2011.
- Oil Companies International Marine Forum (OCIMF), 2013. Ship to Ship transfer guide for petroleum, chemicals and liquefied gases, First Edition, Scotland. UK.
- International Maritime Organization (IMO) Sub-Committee on Bulk Liquids and Gases, 2007b. Amendments to Marpol Annex I for the prevention of Marine Pollution during Oil Transfer Operations between Ships at Sea. Comments on the report of the corresponding group.
- International Maritime Organization (IMO), 2007a. Amendments to Marpol Annex I for the Prevention of Marine Pollution During Oil Transfer Operations between ships at sea, Comments on the report of the correspondence group.
- International Maritime Organization (IMO), MEPC, 2010. Manual on Oil Pollution, Section I, Prevention of pollution, IMO Publication.
- International Maritime Organization (IMO), MEPC, 186(59), 2009. Amendments to the annex of the protocol of 1978 relating to the international convention for the prevention of pollution from ships 1973.
- Iranian Classification Society (ICS), 2011. Ship to Ship Transfer operation.
- Marico Marine, 2004. Falmouth Harbour Commissioners. Ship-to-Ship oil transfer Preliminary Risk Assessment.
- Marine Accident Investigation Branch (MAIB), 2010. Report on the investigation of the collision between MT Saetta and MT Conger on completion of a ship to ship transfer 9.5 miles south east of Southwold. UK.
- Marine Accident Investigation Branch (MAIB), 2011. Safety Digest, Lessons from Marine Accident Report 1/2011.
- McClellan, T., 2011. Oil Spike Eases Big Contango [Online], Available at: http://www.mccoscillator.com/learning_center/weekly_chart/oil_spike_eases_big_contango/
- National Academy Press, 1998. Oil Spill Risks from Tank Vessel Lightering. Washington. D.C.
- Iranian Classification Society, (2011), Ship to Ship Transfer operation.

- Oil Companies International Marine Forum OCIMF/ICS, 2005. Ship to Ship transfer guide, petroleum, 4th edition, Witheby's Publications. 32-36 Aylesbury Street. London EC1R0ET. UK.
- Oil Companies International Marine Forum (OCIMF), 2009. Ship to Ship Transfers-Considerations Applicable to Reverse Lightering Operations.
- Oil Companies International Marine Forum (OCIMF), 2011. Ship to Ship Service Provider Management, First Edition-2011, Scotland, UK.
- Open Forum, 2012. IMO rules push Ship-to-Ship transfers back into the limelight [Online]. Available at: <http://pdfsb.com/>
- United Nations, 1994. United Nations Convention on the Law of the Sea (UNCLOS).
- Von Zharen, W.M., 1994. USCG study: Risk Evaluation of Ship-to-Ship Oil Transfer. Marine and Environmental Management Research, Inc.
- Waterborne Energy, 2010. LNG industry now OK with ship-to-ship transfer [Online] Available at :<http://blog.chron.com/newswatchenergy/2010/02/lng-industry-now-ok-with-ship-to-ship-transfer/>