

Mooring in Ship-to-Ship Operations

Martin Kralev

Degree Thesis

Bachelor of Maritime Management

Degree Programme in Maritime Management, Captain

Turku 2022

DEGREE THESIS

Author: Martin Ivanov Kralev

Degree Programme and place of study: Maritime Management, Novia

Specialisation:

Supervisor(s): Peter Björkroth, Ritva Lindell and Tony Karlsson

Title: Ship-to-Ship Operation

Date: 10.2.2022 Number of pages: 30 Appendices: 1

Abstract

The aim was to give guidelines on how to properly moor a ship to another ship at sea. In the thesis was explained the reasons why ship-to-ship operations are needed. In the thesis were included all different stages of the mooring- preparing the ship for STS mooring, different types of mooring lines and fenders, acceptable and not acceptable weather conditions, good areas for ship-to-ship operations, approaching to another vessel and mooring. In the thesis was included many pictures and videos to give the reader practical and visual knowledge. The videos were mounted with voice, one video was mounted with voice and subtitles for a better understanding of the situation. Two videos were mounted with voice. Additionally, the research was conducted by interviews, self-experience, and technical data about the fenders and mooring lines. The interviewed persons were the actual master, chief officer, and navigational officer on the ship.

Language: English

Key Words: Ship transfer, Mooring, Fenders, Mooring lines

OPINNÄYTETYÖ

Tekijä: Martin Ivanov Krlev

Koulutus ja paikkakunta: Maritime Management, Novia

Suuntautumisvaihtoehto:

Ohjaaja(t): Peter Björkroth, Ritva Lindell ja Tony Karlsson

Nimike: Alusten väliset toiminta operaatiot.

Päivämäärä 10.2.2022

Sivumäärä 30

Liitteet 1

Tiivistelmä

Tavoitteena oli antaa ohjeita, kuinka laiva kiinnitetään oikein merellä toiseen alukseen. Opinnäytetyössä selvitettiin syitä, miksi alusten välisiä toiminta operaatioita tarvitaan. Opinnäytetyössä käsiteltiin kaikki kiinnityksen eri vaiheet - laivan valmistelu STS-kiinnitykseen, erityyppiset kiinnitysköydet ja lokasuojat, hyväksyttävät ja ei-hyväksyttävät sääolosuhteet, hyvät alueet alusten välisiä toimintoja varten, lähestyminen toiseen alukseen ja varsinainen kiinnitys. Opinnäytetyö sisälsi paljon kuvia ja videoita antaakseen lukijalle käytännöllistä ja visuaalista tietoa. Kaksi kolmesta videosta oli asennettu vain äänellä ja yksi video oli asennettu äänellä ja tekstityksellä tilanteen ymmärtämiseksi paremmin. Lisäksi tutkimuksessa käytettiin haastatteluja, omakokemuksia ja teknisiä tietoja puskureista ja kiinnitysköysistä. Haastateltavat olivat varsinainen päällikkö, yliperämies ja perämies

Kieli: Englanti

Avainsanat: Väliisen toiminta, Lokasuojat, Kiinnitys, Kiinnitysköysi,

Table of Contents

Abbreviation glossary	1
1 Introduction	2
1.1 Research question and motivation.....	2
1.2 Delimitation.....	3
1.3 M/V Kallio General information and Ship Particulars	3
1.4 Overlook of ship-to-ship operations.....	6
2 Mooring lines and mooring arrangement.....	8
2.1 Mooring lines in general.....	8
2.2 The mooring lines of M/V Kallio.....	9
2.3 Fenders.....	14
3 Preparing the ship for ship-to-ship operation.....	15
4 Weather conditions	16
5 Approaching and mooring.....	18
5.1 Approaching.....	18
5.2 Mooring.....	19
6 Communication with the crew of the mother ship.....	21
7 Conclusion.....	22
References	23
List of figures	25
List of videos.....	26
Interviewees	26
Appendices	27

Abbreviation glossary

STS- Ship-to-ship

M/V- Motor vessel

MARPOL- The International Convention for the Prevention of Pollution from Ships

MEPC- Marine Environment Protection Committee

SSW- Summer Salt Water

CPP- Controllable Pitch Propeller

TCLL- Thousand Cycle Load Limit

PE- Polyethylene

PP- Polypropylene

SMS- Safety Management System

AIS- Automatic identification system

ECDIS- Electronic Chart Display and Information System

HDG- Heading

ROT- Rate of turn

NM- Nautical mile

PPE- Personal protective equipment

VHF- Very High Frequency

1 Introduction

Mooring ship-to-ship is not so-called standard operation for many types of ships. The most often the oil tankers are mooring to another ship, but ship-to-ship operation are done on the bulk carriers too. This thesis will cover especially the mooring of 16690 GT General Cargo M/V Kallio, from preparations to alongside, including types and characteristics of the mooring lines and the fenders. The thesis is limited to type and the size of the vessel with the specific maneuverability, mooring lines, and fenders. The research is conducted in a series of three ship-to-ship operations, interviews, and internet research.

1.1 Research question and motivation

How to do STS mooring operation, properly and safely?

I decided to do this thesis in the summer of 2021 when I was working on M/V Kallio as Watchman Deck. Then we had a series of four ship-to-ship operations, which was something new and interesting for me. Before the first ship-to-ship operation, I started to do my own research, about how is the operation executed and what are the differences between “normal” mooring to the shore. There was quite much information about the ship-to-ship operation of tankers, but very limited about bulkers. This was because only the tankers are required to have a ship-to-ship operational manual.

“Ship to Ship Transfer Operations are described with the standards of MARPOL Annex I, Chapter 8, as amended by Resolution MEPC.186(59): Prevention of Pollution during Transfer of Oil Cargo between Oil Tankers at Sea, Regulations 40, 41, 42.” (IBITCON)

“The regulations apply to oil tankers of 150 gross tonnage and above engaged in the transfer of oil cargo between oil tankers at sea (STS operations) and their STS operations. The regulations shall not apply to bunkering operations.” (IBITCON)

Despite that, there was no obligation for the ship to have a ship-to-ship operational manual, In the Safety Management Manual of the company Ch.13 Operation and

Navigation App. 17 were instructions about the ship-to-ship operation and the procedures. (See appendices)

1.2 Delimitation

This thesis will focus on mooring ship M/V Kallio to another ship for topping operation. The thesis can be used to general knowledge of what is ship-to-ship operation and why is this operation done. But it will be specified on characteristics and mooring equipment on M/V Kallio.

1.3 M/V Kallio General information and Ship Particulars

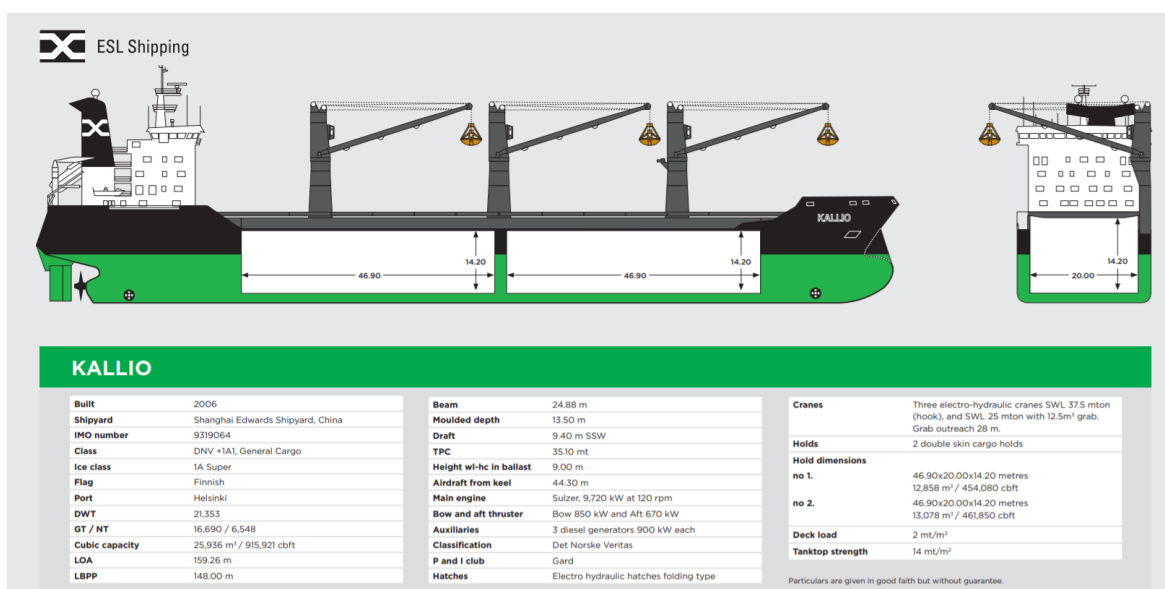


Figure 1: M/V Kallio vessel details picture 1 (ESL Shipping, 2021)

M/S KALLIO

Details


OWNER	ESL Shipping Ltd.
BUILT	2006 by Shanghai Edwards Shipyard, China
CLASS	Det Norske Veritas +1A1
ICE CLASS	1A Super
CALL SIGN	OJQJ
IMO NO	9319064
PORT OF REGISTRY	Helsinki, Finland
HOLDS	2 HO / 2 HA
GEAR	<ul style="list-style-type: none"> - Three electro-hydraulic cranes SWL 37,5 mton (hook), and 25 mton with 12,5m³ grab - Self-discharge capacity of coal 1 000 mton/hour - Outreach 28 m
MAIN ENGINE	Sulzer, 9 720 kW at 120 rpm
THRUSTERS	One bow thruster (850 kW) and one stern thruster (670 kW)

Dimensions

DWT	21 353 mt
CUBIC CAPACITY	25 936 m ³
TPC	35.10 mt
GT / NT	16 690 / 6 548
LOA / BEAM	159.26 m / 24.88 m
DRAFT	9.40 m SSW

Figure 2: M/V Kallio vessel details picture 2 (ESL Shipping, 2021)

Ship Specific Instruction
1(1)

 **ESL Shipping**

Name of the Ship	Safety manual part. no	Name of the instruction	Department / Distribution to places	Date
Ms Kallio	13.3	Pilot card	Deck/ Bridge	03.07.2014

SHIP'S PARTICULARS

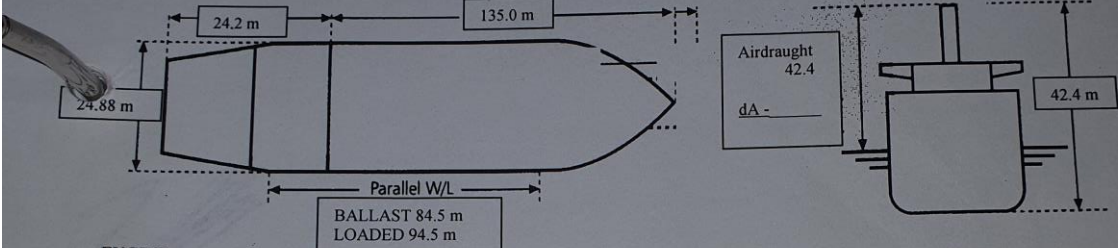
Name MV KALLIO Call Sign OJQJ

Displacement 28740 mt (tonnes) Deadweight 21353 mt (tonnes) Year built 2006

Length OA 159,26 m (m) Breadth 24,88 m (m) Bulbous bow yes

Draught fwd (m) Draught aft (m) Draught amidships (m)

Port anchor 10 (shackles) Stbd anchor 11 (shackles) (1 shackle = 27,4 m/15 fathoms)



ENGINE

Type of engine Wärtsilä 6RT-Flex 50 Maximum power 9720 (kW) 13034 (HP)

	Pitch	loaded speed	ballast speed
Full ahead	<u>95 %</u>	<u>15.5</u> (kts)	<u>16.2</u> (kts)
Half ahead	<u>95 %</u>	<u>12.5</u> (kts)	<u>13.0</u> (kts)
Slow ahead	<u>92 %</u>	<u>8.0</u> (kts)	<u>8.0</u> (kts)
Dead slow ahead	<u>41 %</u>	<u>5.0</u> (kts)	<u>5.0</u> (kts)
Dead slow astern	<u>-48 %</u>		
Slow astern	<u>-98 %</u>		
Half astern	<u>-98 %</u>		
Full astern	<u>-98 %</u>	<u>Emergency astern 75 %</u>	(% of full ahead power)

Engine critical rpm NIL

Crash Stop, loaded condition ~4 min Time limit astern NIL (min)

STEERING

Rudders 1 (number) Becker (type) 70 Degrees (maximum angle)

Time hard-over to hard-over 14 (2 pumps) (sec) Rudder angle for neutral effect 0 DEG

Propellers 1 propeller (number) Direction of turn Left-handed Controllable pitch yes

Bowthruster 850 (kW) Sternthruster 670 (kW)

Figure 3: M/V Kallio Safety manual, Ship particulars (ESL Shipping, 2014)

1.4 Overlook of ship-to-ship operations

There are mainly three reasons for performing ship-to-ship operation- topping, lightering, and salvage operation.

Topping operation is when a ship is loaded while at anchor. This is done because the ship to be topped is too big to enter the harbor at all or she can not take the full cargo capacity because she will get too much draught. In this case, is loaded as much as possible in the harbor and after that is topped at convenient anchorage.

The lightering operation is the opposite process of topping. During lightering operation, a ship is being fully or partly discharged to smaller vessels.

The ship-to-ship salvage operation is performed when a ship is aground. Then the ship is partly or fully unloaded in order to make the ship afloat again.

The first ship-to-ship operation in Finland was done in 1981.



In 1981, Kontula and Alppila (3) performing the first ship-to-ship operations in Finland.

Figure 4: Ship-to-ship operation (ESL Shipping, 2019)

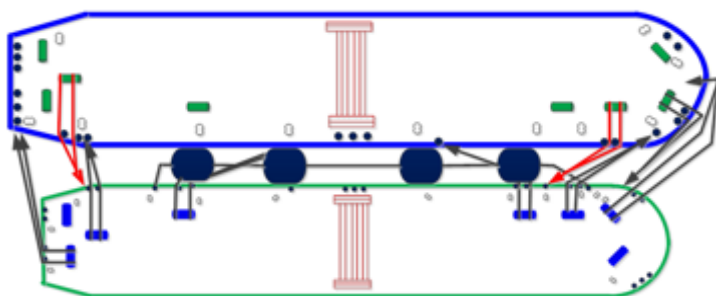


Figure 5: Ship-to-ship mooring from above. (IBITCON)

“A ship-to-ship (STS) transfer operation is the transfer of cargo between seagoing ships positioned alongside each other, either while stationary or underway. Cargoes typically transferred via STS methods include crude oil, liquefied gas (LPG or LNG), bulk cargo, and petroleum products. Most of cargo operations are taking place between a ship and a land-based terminal. Nevertheless it sometime can be useful to transfer cargo from one ship to another in open sea and this is called a ship-to-ship operation. At that moment, one of them will act as the terminal where the other one will moor. The receiving ship is called the mother vessel.” (Mavroudis)

“ The STS transfer operations include:

The conventional or standard lightering process, where the discharging vessel is fully loaded, while the receiving vessel is in ballast condition. (see Figure: Lightering procedure);

The reverse lightering process, sometimes referred to as “topping-off”, where the laden supply tanker discharges to a partially laden receiving tanker. (see Figure: Reverse lightering procedure).” (IBITCON)

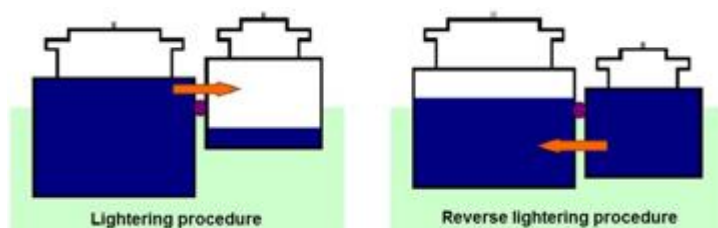


Figure 6: STS transfer operation. (IBITCON)

“In general, the STS transfer operation process can be divided into 5 phases as outlined in the following table:

Phase 1. Pre-Arrival Planning: The Pre-Arrival Planning should be carried out before any STS operations commence. The planning of the STS operation could be performed by the ships operators and managers together.

Phase 2. Arrival: During the Arrival stage of the operation the two ships conducting the STS operation should establish radio communication, and concur that all operational procedures has been assessed and agreed upon.

Phase 3. Berthing: The Berthing phase of the STS operation consists of the maneuvering and mooring of the two ships. For the maneuvering operation a contingency plan should be in place to deal with any emergency situation.

Phase 4. Cargo Transfer: The Cargo transfer phase should only commence once the two ships are securely moored. The Master should ensure that all the recommended safety procedures in this plan are followed. A contingency plan should be in place to deal with any emergency situations during cargo transfer

Phase 5. Departure: Departure is the last phase of the STS operation.” (IBITCON)

2 Mooring lines and mooring arrangement

2.1 Mooring lines in general

“Lines (or cables) used to secure a ship at a berth. Mooring lines should be arranged as symmetrically as possible about the midship point of the ship.

Breast lines – Mooring lines leading ashore as perpendicular as possible to the ship fore and aft line. Breast lines restrain the ship in one direction (off the berth).

Head lines – Mooring lines leading ashore from the fore end or forecastle of a ship, often at an angle of about 45 degrees to the fore and aft line.

Spring lines – Mooring lines leading in a nearly fore and aft direction, the purpose of which is to prevent longitudinal movement (surge) of the ship while in berth. Spring lines restrain the ship in two directions: headsprings prevent forward motion and backsprings aft motion.

Stern lines – Mooring lines leading ashore from the after end or poop of a ship, often at an angle of about 45 degrees to the fore and aft line.” (Wärtsilä.)

“The main function of mooring lines is to hold a ship fast to her berth against the effects of wind and current or other forces. If the mooring lines are adjusted properly, wind or current loading on the lines is a static load. If you try to use a line to stop a moving ship, that is a dynamic load. The difference between these two types of loads is significant and should be well appreciated by the mariner.” (Brian Boyce, 2007)

“The function of mooring lines is to hold a stopped ship in place. Using mooring lines to bring a moving ship to a stop is inherently unsafe. As you increase the size or speed of the ship, or reduce the stopping distance, you increase the danger. Lines can be effective in removing very small amounts of way, but it is vital that the lines be checked (slipped a little at a time) to increase the stopping distance and slow the rate of deceleration. This is especially important when using low-stretch lines.” (Brian Boyce, 2007)

2.2 The mooring lines of M/V Kallio

When the ship was built on all drums were installed Taizhou hongda 7 strand Nylon Compound mooring lines. The diameter of the line was 50mm and the breaking strength was 567,7 kN. TCLL Value is 52%. The biggest disadvantage of this rope is that it is not floatable.

From 2016 the mooring lines started to be replaced with new ones. At the time when the research is being conducted 8 of 13 mooring lines were replaced.

The new lines were Tipto-winchline 7 strand PP/PE Bi-constituent fiber. The diameter was 50mm with breaking strength 512 kN. There were many advantages of the new lines. They were built from Polyethylene (PE) and Polypropylene (PP) which make the rope floatable. The rope was covered with jacked which increases the crew’s safety by minimizing the risk of snap-back and providing a better grip. Additionally protects the core for a longer service line. The rope is yellow in color with orange yarn, which reduces the chance to stumble on

it. The winches of M/V Kallio were self-tensioning - this line was made especially for self-tensioning winches. Tipto-winchline TCLL value 70.7%.

“Insight into the fatigue performance of ropes may be provided by the Thousand Cycle Load Level (TCLL) value – an accelerated fatigue testing method developed by the Oil Companies International Marine Forum (OCIMF). TCLL expresses the maximum percentage of the nominal breaking strength that a rope can be cycle loaded 1,000 times, tested under strict conditions. Put simply, the TCLL value expresses the rope’s resistance to tension-tension fatigue. The higher the TCLL value, the greater the resistance to high loads or tension-tension fatigue.” (Rope selection, 2021)

The replaced lines are marked with red color on the mooring ropes register below.

1 (2)

ESL Shipping Oy
 Owner : DPA SMS Appendix 33 B 04.07.2019
 17. Inspection and service of the vessel and its equipment

Mooring rope register Ship: Kallio Date updated: 12.2.2021

All mooring ropes on board shall be traceable to the rope certificates. This register is used to keep track of which rope is where. The register and the certificates shall be filed in a mooring rope folder. When ropes are received on board, the location where the rope is used or stored is recorded on this template, together with the certificate number. The certificate is filed in accordance with the ship's filing system. When a rope is moved (for example from store to use) this register is updated. If a rope breaks and part of it is re-used, this register is updated and note made in "Comments" field. When a rope is taken out of service (and disposed of), the rope is removed from the register and its certificate removed from the file. The template shall be updated to reflect the actual arrangements on board. Alternatively, the location of a specific rope can be recorded on the certificate or a page attached to the certificate, in which case the certificates shall be filed in individual pockets in the mooring rope folder.

Amend and add mooring rope locations in accordance with the actual arrangements on board!
St = store, S = starboard, P = Port

#	Location	Rope type / manufacturer	Certificate number	Dates		Comments, maintenance, etc.
				Installed	Turned	
1	Aft port aft drum	Tipto-winchline 7str 50mm	*	07/2016	12.2.2021	*No record of cert. number in proportion to rope. Started to keep this register 07/2019
2	Aft port fwd drum	Tipto-winchline 7str 50mm	*	07/2016	12.2.2021	
3	Aft mid aft drum	Taizhou hongda 7 str 50mm	*	Original	20.12.2020	20.12.2020 New eye splice made
4	Aft mid fwd drum	Taizhou hongda 7 str 50mm	*	Original	20.12.2020	20.12.2020 New eye splice made
5	Aft sb aft drum	Tipto-winchline 7str 50mm	*	07/2016	11.2.2021	11.2.2021 New eye splice made
6	Aft sb fwd drum	Tipto-winchline 7str 50mm	*	07/2016	11.2.2021	11.2.2021 New eye splice made
7	Main deck Hold 2 aft	Taizhou hongda 7 str 50mm	*	Original	20.12.2020	20.12.2020 New eye splice made
8	Bow port / port drum	Tipto-winchline 7str 50mm	*	07/2016		
9	Bow port / sb drum	Tipto-winchline 7str 50mm	*	07/2016		
10	Bow sb / port drum	Tipto-winchline 7str 50mm	*		01/2019	
11	Bow sb / sb drum	Tipto-winchline 7str 50mm	*		01/2019	
12	Bow / fwd port drum	Taizhou hongda 7 str 50mm	*	Original	21.12.2020	21.12.2021 New eye splice made
13	Bow / fwd sb drum	Taizhou hongda 7 str 50mm	*	Original	21.12.2020	21.12.2021 New eye splice made

Figure 7: Mooring ropes register (ESL Shipping, 2021)

H134
1.34.5013
1.34.5013



天达

泰州宏达绳网有限公司
TAIZHOU HONGDA ROPE & NET CO.,LTD
船用产品合格证
CERTIFICATE FOR MARINE PRODUCT

<p>产品名称: 尼龙复合七股绳 Description: 7-strand Nylon Compound Rope</p> <p>规格: $\phi 50\text{mm} \times 220\text{m}$ Dimension: $\phi 50\text{mm} \times 220\text{m}$</p> <p>产品编号: 550645 Serial No.: 550645</p>	<p>工厂认可证号: B JW00320006 Cert. No. of works approval: B JW00320006</p> <p>订货方: / Purchaser: /</p> <p>制造日期: 2005年6月 Date of manufacture: Jun. 2005</p>
--	---

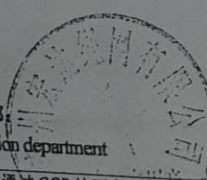
产品明细:
Particulars

<p>材料: 尼龙(复合) Material: Nylon (compound)</p> <p>名义线密度: 1545 Ktex Nominal liner density: 1545 Ktex</p>	<p>结构: 七股 Construction: Seven-Strand</p> <p>额定断裂强力: 500.0 kN Rated breaking strength: 500.0 kN</p>
---	--


试验结果:
Testing Result

<p>线密度: 1553.5 Ktex Linear density: 1553.5 Ktex</p>	<p>断裂强力: 567.3 kN Breaking strength: 567.3 kN</p>
--	--

公司质检部检验结论:
 Inspection results by manufactory:
 经检验符合 Q/321202WHD008-2003 标准要求, 准予出厂。
 Accord with the standard Q/321202WHD008-2003
 Request through examining, permit being Dispatched
 from the factory.

质检部:  日期: 2005.06.20
 Inspection department: Date: Jun. 20.2005

中国船级社检验结论:
 Inspection results by Classification Society:

 兹证明该批产品经中国船级社
 南京分社检验合格

This is to certify that the Products have been
 inspected by Nanjing Branch of the China
 Classification Society with satisfaction.

证书号 Cert. No. 1501701410
 检验师/日期 梁斌 2005-6-21
 Surveyor/Date

绳索上贴有防伪标记
 The rope is stamped with anti-forge mark

本产品与通过 CCS 认可产品的形式一致。
 The type of this product is the same as that has passed the approval by CCS.
 本合格证经中国船级社南京分社盖章、贴防伪标贴、签字确认后, 等同于原船用产品证书。
 This Certificate is with the same power as the original Certificate for Marine Product issued by CCS after stamped strck with anti-
 forge mark & signed by Surveyor to CCS Nanjing Branch.

公司地址: 江苏省泰州市江洲南路 131 号
 ADD: 131, Jiangzhou W.Road, Taizhou, Jiangsu
 电话 (TEL): 0523-6883478 0523-6884055
 传真 (FAX): 0523-6883748

Figure 8: Certificate of mooring rope Taizhou hongda 7 str. 50mm.

Lankhorst Ropes


CERTIFICATE OF ROPES
(Certificate in Acc.to EN 10204 type 3.1)

Rope supplied to: *1/2013*
 ESL SHIPPING OY
 PL 230
 00038 LOGICA
 FINLAND
18/10/13
FWD 33



Certificate number: [Redacted]
 Order number:
 Client number:
 Your reference:

Description: **TIPTO-WINCHLINE 7 STR.W/TIPTO JACKET,50 MM
 TCLL VALUE 70,7%. LENGTH 220 MTR. WITH TWO
 PROTECTED EYES.**

Dimension:	Nominal diameter (mm)	50 MM
	Length (mtr)	1 x 220,00
	Circumference (inch)	6.5
	Mass per unit length (ktx (g/mtr))	1330
Construction:	Number of strands	7 STRANDS LAY W/JACKET
	Composition	OVERBRAIDED
Yarns:	Material	PP/PE BI-CONSTITUENTFIBER
Identification:	Colour of mark-yam	ORANGE
	Product Identification Code (PIC)	39427
Durability	TCLL value	
Strength:	Minimum breaking load (kN)	512 kN.
Date:	Date of test	
Remarks:	Application:	MOORING ROPE
Examination performed by:	LANKHORST ROPES MARCONIWEG 24 3316 AM DORDRECHT NEDERLAND	

Date of delivery 29 Dec 2017	Note of delivery Ropes are produced according to OCIMF guidelines	Stamp third party	Signature of competent person  A. Boon - QHSE Manager
--	---	-------------------	---

The undersigned certifies on behalf of his company that above particulars are correct and that the described wire rope or complete gear are according to the regulations of the EG Machinery Directive 2006/42/CE, appendix II-A. The assembling, examination and test were carried out under his supervision by a competent person, according to the actual code of practise.



 P.O. Box 1039
 3300 BA Dordrecht
 The Netherlands

Marconiweg 24
 3316 AM Dordrecht
 The Netherlands

T: +31 (0) 78 6117 700
 F: +31 (0) 78 6117 750

VAT nr: 0047.56.174.B01
 Chamber of Commerce: 01043170

A Wincor® WorldGroup Brand

www.lankhorstropes.com

Figure 9: Certificate of mooring rope Tipto-winchline 7 str with jacket.

TIPTO®WINCHLINE

A dedicated floating winch line developed especially for self tensioning winches. This load-bearing 7 strand core combines high strength and relatively low elongation. The non-load-bearing braided jacket provides protection of the core for longer service life, and increases crew-safety by minimizing the risk of snap-back. The mooring efficiency of the vessel is enhanced by the ease of handling of the rope due to its low weight and ability to float. TIPTO® WINCHLINE does not lose its strength when wet.













	SPECIFIC GRAVITY 0,93 (floating)		TCLL VALUE 70,7%
	UV-RESISTANCE very good		COLOUR yellow
	ABRASION RESISTANCE very good		MARKER YARN orange
	CHEMICAL RESISTANCE good		WATER ABSORPTION 0%
	MELTING POINT approx. 140°C		ELONGATION 8,5%
	CONSTRUCTION 7 strand + jacket		A3 SPLICE yes

Figure 10: Tipto-winchline 7 str characteristics.



Figure 11: Picture of Tipto-winchline 7 str.

2.3 Fenders

“Floating Pneumatic Rubber Fenders is a fender which is made of synthetic-cord-reinforced rubber sheet with compressed air inside to enable it to float on the water and work as the absorber between ship to ship, ship to berthing structure when they come alongside each other on the water. The design and selection of floating fenders can be confirmed as per the maximum energy absorption of specific conditions.” (Evergreen marine, 2013)

On M/V Kallio there were in use 4 pc. Evergreen Floating Pneumatic Rubber Fenders with diameter 1.5m and length 3m. This type of fenders are also called Yokohama fenders. Before to start approaching the fenders were placed symmetrically on the port side of the ship.



Figure 12: Yokohama fender prepared for lifting. (Martin Kralev, 2021)

On some ships instead of Yokohama fenders, they have big truck tires, but for M/V Kallio the Yokohama fenders were a better choice.

“We have Yokohama fenders, some vessels have big truck tires. I have experience with both, but the Yokohama fenders are more elastic and bigger we have covered bridge wings with windows, so we need to keep bigger distance. If the vessel is rolling and we go too close there is a risk that the wings will hit each other, and the windows will break. At least for this vessel, the Yokohama fenders are better.” (Jansen, 2021)

“The truck tires are not so flexible, and the other thing is if you are close to the other vessel, you do not have much back up for the listing.” (Thomasson, 2021)

3 Preparing the ship for ship-to-ship operation

The first thing is the ship to arrive in the topping area. The topping area is decided by the company. The area should be suitable for STS operation, it should be anchorage with tight gripping seabed because both ships are anchored with only one anchor. One of the best grip is provided by the soft muddy seabed.

“The area is decided by the company. Is it Raahelands roads, Luleå roads, Kotka roads. I can decide inside the area. But in Raahelands we have to stay outside the territorial waters.” (Jansen, 2021)

When the ship is in the topping area she has to be prepared for STS operation. The ship's fenders should be placed and secured on the side of the ship. Usually, it is the port side of the ship because the ship's own cargo cranes are on the port side and the ship is loaded or discharged by her own cranes. The fenders are put on their positions just before the approaching. It can be done at anchor or underway, but it should be in relatively good weather.

“If there is too much swell it is dangerous to lift the fenders. It is really important for the crane driver to drive carefully, if they swing too quickly the fender can move “like hell”. “ (Thomasson, 2021)

In the video, you can see how the fenders are installed by the crew.

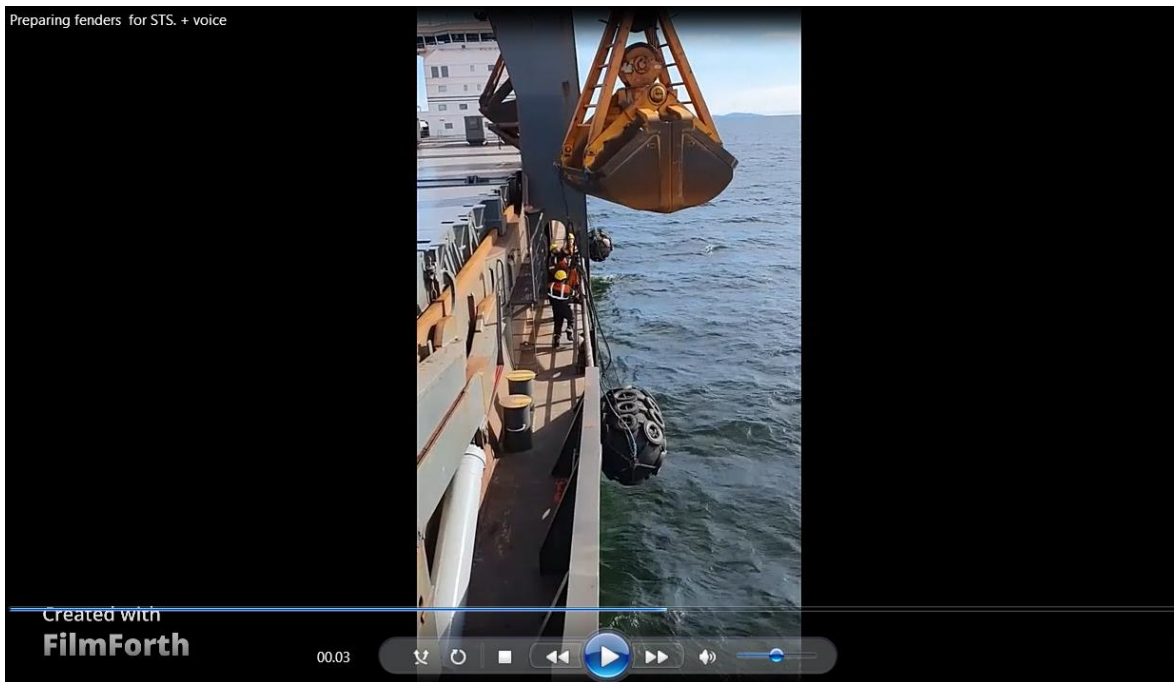


Figure 13: Screenshot of the video *Preparing fenders for STS*. (Martin Kralev, 2022)

Video 1: <https://www.youtube.com/watch?v=1495xni457k>

Link to video 1. *Preparing fenders for STS*. (Martin Kralev, 2021)

During lifting the fenders everyone should be with PPE. It is very important for everyone involved to recognize dangerous and safe areas.

4 Weather conditions

The state of the weather has a crucial impact on the whole operation. During all stages – preparing, approaching, mooring, cargo transfer, and the cast-off, the weather should be within acceptable limits. It is very hard to deal with the weather because on one side it is always safer to wait for better weather, but you can not wait forever. If you start the approaching and it is canceled at some stage then you have more problems to deal with.

“We have to monitor the weather forecast. We can compare between the official paid service from the finish meteorological institute forecast and the Windy for example. But what you see from the window is the real case. My thumb rule is wind 12m/s and 1m wave, that is the limit when we are approaching. When we are alongside it can be a little more. One meter already starts bumping in and out, then you have a risk that the lines will break. You have to be very careful and keep an eye on the lines all the time. And monitor the

weather forecast on the internet, it is quite good nowadays. But it is better to go one hour later than earlier because you have to wake up the crew and then if you are not able to go alongside you have to go out and then you have to think about the rest hours of the crew. So, it is better to go alongside a little bit later than too early.” (Jansen, 2021)

When the ships are moored together the weather should be monitored very closely. If the waves become too big the ships can start bumping each other and the mooring lines can break. The other tricky moment is when is the right time for cast-off?

“The right time to cast- off is of course before the lines are broken. But if there is a little cargo in the hold and there is a risk for the lines you can try to manage to stay alongside because if you cast- off it may happen to wait for one day for the next possible spot to go alongside. But if it is in the middle of the operation, it is better to cast-off earlier than late. If needed you can take more lines from the other vessel, but you have to do it on time because if it starts to move too much is too late. When the waves are going in between, the vessels start to go out and in and it is very hard, even if you have all lines they will break.” (Jansen, 2021)

“If the weather is on the limit we can cast-off or we can take extra lines from the other vessel and hope for the best, but it is risky.” (Thomasson, 2021)

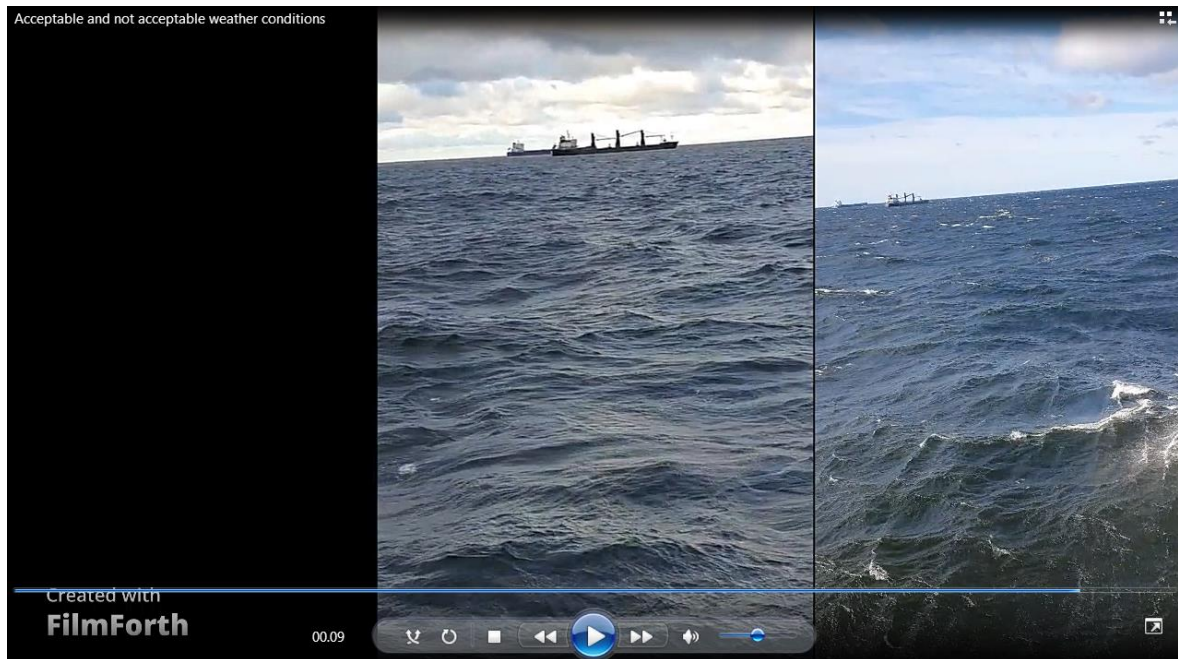


Figure 14: Screenshot of the video *Acceptable and not acceptable weather conditions for STS*. (Martin Kralev, 2022)

Video 2: <https://www.youtube.com/watch?v=Zc4E0dQSdBk>

Link to video 2. *Acceptable and not acceptable weather conditions for STS*. (Martin Kralev, 2021)

One way of separating the not acceptable waves from the acceptable waves is the crest of the wave. If the crest of the wave becomes white the waves can be counted as not acceptable.

5 Approaching and mooring

5.1 Approaching

The approaching is the most challenging part of the STS operations because if it is not executed properly the vessels can collide with each other.

First of all the approaching should begin with the proper angle of approach.

“If the vessel is already waiting, they are facing the wind because here in Kotka roads is not much current. Then is easy to approach, the vessel will be steady, and you just go alongside slowly from aft. But in the areas where is a strong current the vessel will have heading to

the current and the wind is from the side then you need to check how much is the wind, so you do not go too fast and collide with the other vessel. If you are waiting for the other vessel to drop the anchor you have to wait more, it takes time to become stable. If you go too early, it may happen that she is still veering and searching for her position. If she is coming too fast you have to go away, then you do one round and approach again when she is more stable. That has happened sometimes.” (Jansen, 2021)

5.2 Mooring

When the ship is at a good distance is time to pass the spring lines and the position of the vessel to be checked. Passing the spring lines and connecting them to the bollards is a very difficult and dangerous operation too.

“Mooring to a vessel is harder, because the other vessel is at anchor, and she is moving when you go alongside. There are fenders on our side, the line that we send can be caught up by the fender, you need to check this time by time. Because the captain is maneuvering at the same time you need to make sure that the line will not go to the propeller. You have to slack only when it is needed. It is different on the pier, there when the captain is approaching it is in only one direction, after that you can give the ropes. But in ship-to-ship he might approach, then he might go astern there can be plenty of maneuvers just to go alongside.” (Gaitan, 2021)

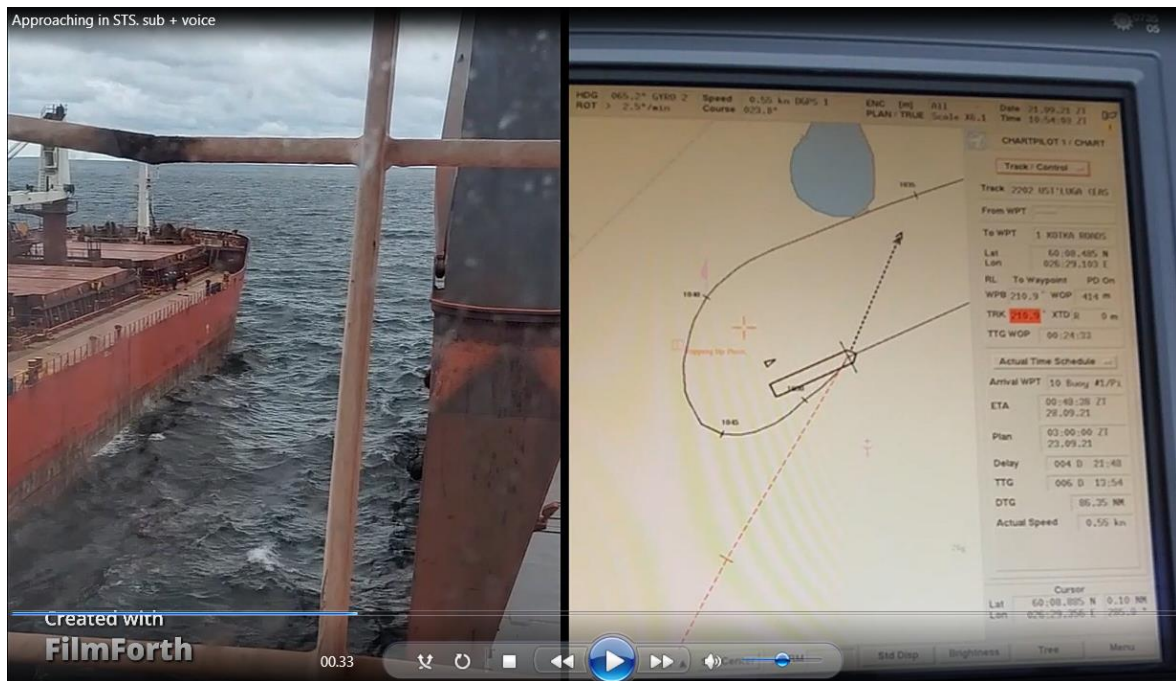


Figure 15: Screenshot of the video Approaching in STS. (Martin Krlev, 2022)

Video 3: https://www.youtube.com/watch?v=jkP_GJAeDB0

Link to video 3. *Approaching in STS*. (Martin Krlev, 2021)

In the video is shown how the approaching and mooring with the spring lines are practically done. The purpose of the approaching is for the ships to get close enough, but not to collide. On the left side is the view from the bridge on the right side is the screen of the ECDIS. The brand of the ECDIS is SAM Electronics. On the ECDIS is visible the own ship and the vector of the own ship. The direction of the vector shows the direction of movement of the ship and the length shows the speed of the ship. On the top left side of the screen, you can see the ship's HDG, ROT, Speed, and course. On the bottom left side is the range. At the beginning of the video, it is 0.5NM. The small triangle on the left side of the ship is the AIS target of the mother ship. The bridge of the ship is the referent point of the AIS target. In this case, it is in the aft part. The actual size of the mother ship is bigger than our ship.

When our ship arrived in the topping area the mother ship was waiting at anchor. In advance, the mother ship was advised to drop her port anchor because we will moor to her starboard side. Unfortunately, the weather was not acceptable for mooring and cargo

operation, so we dropped our ship's anchor and waited for acceptable weather conditions. Then the weather was within the limits we prepared our ship with the fenders on the port side and sailed toward the mother ship. We came from the opposite direction, passed behind her stern, and started to approach with a small angle. To match the desired angle of approach the master used the CPP ahead and rudder to port or starboard. In the beginning, the speed of our ship is 1.3 kn while getting closer the speed is gradually reduced. When the ship is in the right position the forward movement of the ship is stopped with CPP astern and bow and aft thrusters are used to make the ship to move to port. Because the bow thruster is more powerful than the aft thruster, rudder to starboard and CPP ahead can be used to make the stern move faster to port. At the end of the maneuver, the ships are alongside with fasten spring lines. One forward spring line and two aft spring lines are used. The aft spring lines are two because they are used to keep the ship in position.

“On our vessel, the mooring arrangement is one plus four forward and two plus four aft. We have two spring lines on the aft because when another vessel is at anchor the wind is coming from forward to aft. So, the aft springs are taking the most of the tension.” (Thomasson, 2021)

6 Communication with the crew of the mother ship

Communication with the crew of the mother ship is of extreme importance. Bad communication and miss understanding can cause major damage to the ships, the environment, and even the crew.

“Sometimes we have problems with the communication. We send the company safety information beforehand. There are all procedures how we do and there we put our VHF communication channels. Many times, we send the information via the agent but I do not know if they really give it, many times they do not give the email address to us, so I have to rely on. Many times, there are Indian or Chinese their English is very bad, so it is just to try to communicate and get the cargo plan and try to agree on how it's done. But many times, is very good communication, no problems, we can agree on everything, and the process is smooth. This also speeds up the operation.” (Jensen, 2021)

“It is quite difficult to communicate especially when the crew of the other vessel is with bad English. Sometimes we try to communicate by signals. Also, the captain on the bridge can communicate with the officer on their bridge. Then he will pass the message down to the mooring station. But if the other crew speak good English, it is not so difficult for us.” (Gaitan, 2021)

7 Conclusion

In the thesis was shown practically how the STS mooring operation is executed. The maneuvering of the ship by the master on the bridge and the commands to the officers on the mooring stations. Additionally in the research was included technical data about the mooring lines, fenders, and self-tensioning winches. The research can be used for general knowledge about STS operations on all General Cargo vessels. But maneuvering, mooring arrangements, and bridge equipment are specified for M/V Kallio.

The research found that the mooring set of M/V Kallio- self tensioning winches, 8 pc floatable mooring lines Tipto-winchline with jacket, and 4 pc Yokohama fenders, improve the safety and significantly increase the success ability of the operation.

Additionally, the safety on the mooring stations and reducing the chance a mooring line to be caught by the propeller or bow and aft thrusters can be achieved by replacing the 4 original Taizhou hongda mooring lines with floatable Tipto-winchline with jacket.

References

Mavroudis, Global transport & logistics. Ship to Ship Operations. Retrieved January 18, 2022 from <https://www.mavroudis.com.cy/services/ship-to-ship-operations/>

IBITCON. Solutions for shipping. Ship to ship transfer operation plan. Retrieved January 18 2022 from <http://en.ibicon.ru/plan-obespecheniya-transportnoy-bezopasnosti-potb>

ESL Shipping. (2021). M/V Kallio vessel details picture 1. Retrieved January 20, 2022 from https://www.eslshipping.com/hubfs/Documents/Vessel%20details_Kallio.pdf?hsCtaTracking=559a5437-d073-48e5-8017-15b285ad0145%7C77752d36-30b9-428d-ae9d-9ae59838cb4e

ESL Shipping. (2021). M/V Kallio vessel details picture 2. Retrieved January 20, 2022 from <https://www.eslshipping.com/fleet/ships/m-s-kallio>

ESL Shipping. (2014). M/V Kallio Safety manual, Ship particulars. Retrieved September 2021.

ESL Shipping. (2019). Ship to ship operation. Retrieved January 20, 2022 from <https://www.eslshipping.com/en/news/esl-shipping-celebrates-70-years-in-business>

Wärtsilä. Mooring lines. Retrieved January 21, 2022 from <https://www.wartsila.com/encyclopedia/term/mooring-lines>

Brian Boyce. (2007). Using mooring lines to slow a vessel poses serious risks. Retrieved January 17, 2022 from <https://professionalmariner.com/using-mooring-lines-to-slow-a-vessel-poses-serious-risks/>

Rope selection. (2021). Rope Selection, Procurement and Usage. Retrieve January 18, 2022 from file:///C:/Users/marti/Downloads/Rope_Selection_FINAL_05-28-21_wUGd2EF.pdf

Tipto-winchline 7 str characteristics. Lankhorst ropes. Retrieved January 22, 2022 from <https://www.lankhorstropes.com/synthetic-fibre-ropes/tipto-winchline>

Picture of Tipto-winchline 7 str. Retrieved January 22, 2022 from

<https://www.yumpu.com/en/document/read/9343473/the-master-of-innovation-in-ropes-lankhorst-ropes>

Evergreen marine. (2013). Retrieved February 3, 2022 from
<http://www.evergreenmaritime.com/technology-and-service/marine-fenders-design/floating-pneumatic-rubber-fenders/>

List of figures

Figure 1: M/V Kallio vessel details picture 1 (ESL Shipping, 2021)

Figure 2: M/V Kallio vessel details picture 2 (ESL Shipping, 2021)

Figure 3: M/V Kallio Safety manual, Ship particulars (ESL Shipping, 2014)

Figure 4: Ship-to-ship operation (ESL Shipping, 2019)

Figure 5: Ship-to-ship mooring from above. (IBITCON)

Figure 6: STS transfer operation. (IBITCON)

Figure 7: Mooring ropes register (ESL Shipping, 2021)

Figure 8: Certificate of mooring rope Taizhou hongda 7 str. 50mm. (Taizhou hongda rope & net CO., LTD, 2005).

Figure 9: Certificate of mooring rope Tipto-winchline 7 str with jacket. (2017)

Figure 10: Tipto-winchline 7 str characteristics. Lankhorst ropes (2017).

Figure 11: Picture of Tipto-winchline 7 str. The master of innovation in ropes- Lankhorst Ropes p.R-3.

Figure 12: Yokohama fender prepared for lifting. (Martin Kralev, 2021)

Figure 13: Screenshot of the video Preparing fenders for STS. (Martin Kralev, 2022)

Figure 14: Screenshot of the video Acceptable and not acceptable weather conditions for STS. (Martin Kralev, 2022)

Figure 15: Screenshot of the video Approaching in STS. (Martin Kralev, 2022)

List of videos

1. <https://www.youtube.com/watch?v=1495xni457k>

Link to video 1. Preparing fenders for STS. (Martin Kralev, 2021)

2. <https://www.youtube.com/watch?v=Zc4E0dQSdBk>

Link to video 2. Acceptable and not acceptable weather conditions for STS. (Martin Kralev, 2021)

3. https://www.youtube.com/watch?v=jkP_GJAeDB0

Link to video 3. Approaching in STS. (Martin Kralev, 2021)

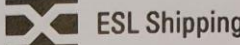

Interviewees

Master M/V Kallio Erik Jansen.

Chief Officer M/V Kallio Johnny Thomasson.

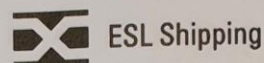
Navigational Officer M/V Kallio Christopher Gaitan.

Appendices

<p>SAFETY INFORMATION FOR LIGHTERING OPERATIONS</p>					
	1/4				
<p>For the Master of the vessel to be lightered.</p> <p>This information sheet is compiled in order to ensure smooth and safe lightering operation. It contains the most relevant aspects to be considered. These guidelines will not issue any liabilities towards any of the parties but should be used as best practices, developed based on significant experience.</p>					
<p>Operating vessel: _____</p> <p>E-mail: _____</p> <p>Phone: _____</p> <p>Master: _____</p> <p>Ch.Off.: _____</p> <p>Date commencing operation: _____</p>	<p>Vessel to be lightered: _____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>_____</p> <p>Operation location: _____</p>				
<p>General:</p> <p>These instructions are normally applied. However, the operating vessel may give other or further instructions if required because of weather conditions, cargo type, equipment restrictions, etc.</p>					
<p>Communication: _____ VHF channel used: <input type="checkbox"/></p> <p>Language to be used is English. Keep radio watch during the whole operation on given radio channels and make sure all crew understands the importance of following both information and orders from the operating ship. Good communication is key for a successful STS operation.</p>					
<p>Lightering planning (to be provided well in advance):</p> <p>To minimize risk, the lightering should be made with a minimum of shifting, preferably none per lightering sequence (for example forward hold during first sequence and aft holds during second sequence). Discharging from holds more than 60m apart at the same time is not possible. A lightering plan proposal is attached; please return without or with amendments. Please do not hesitate to ask for advice!</p>					
<p>Anchoring:</p> <p>Use your port-side anchor. Our vessel will be moored to your starboard side.</p>					
<p>Mooring:</p> <p>Our vessel has its own fenders.</p> <p>When we are approaching:</p> <ul style="list-style-type: none"> - Make sure that all floodlights, light buoys, railings etc. reaching over the gunwale and bridge wing on your starboard side are turned inside or removed before mooring starts and keep them so during the whole operation. If possible, remove also all loose railings, equipment etc. standing over the top limit on starboard side of the hatch covers or around the hold openings inside the crane's working range. 					
<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 30%;">Safety Management Manual</td> <td style="width: 30%;">Ch. 13 Operation and navigation App. 17A</td> <td style="width: 20%;">Owner : DPA</td> <td style="width: 20%;">Version: 21.07.2021</td> </tr> </table>		Safety Management Manual	Ch. 13 Operation and navigation App. 17A	Owner : DPA	Version: 21.07.2021
Safety Management Manual	Ch. 13 Operation and navigation App. 17A	Owner : DPA	Version: 21.07.2021		
<p>ESL Shipping Ltd ESL Shipping; Ship To Ship (STS) </p>					

Safety information for lightering operations page 1. (ESL Shipping, 2021)

SAFETY INFORMATION FOR LIGHTERING OPERATIONS



2/4

- We will give you a notice of mooring time as well in advance as possible.
- Please wake up your mooring crew (same crew as when arriving to harbor).
- Prepare your heaving lines, both ends, roughly close to your spring line chock.
- Forward springs will be given first and placed on bollard on deck. Our mooring crew will give further instructions after evaluation of the availability of your bollards etc.
- Aft spring comes later (when we are alongside) on the same bollard, if there are no other suitable bollards. Mooring will start with 3+1 in both ends with our lines.
- Prepare one of your mooring lines to both ends. Lines from your vessel may be needed depending on your vessel's bollard positions and weather conditions. You will be advised if your lines are needed when we are in position.

Shifting:

Shifting a vessel alongside another vessel is always a safety hazard. During shifting operation keep your mooring crew available on deck. An advance notice will be given by our crew.

Lightering operation:

- At some point during the operation, one or several excavators may be lifted into your holds to shift the cargo in a favorable position and assist the cranes.
- Vessel should be hold up in upright position throughout the whole operation. Heavy list (over 0,5 degrees) causes risk of bilges, bridge wings, etc. hitting each other.
- Keep in mind that a (heavy) port list may develop, especially in the end of the operation, as our cranes cannot reach all the way to the port side of cargo holds.
- Remember that you are responsible for your own trim and stability calculations and monitoring during the operation.
- If crane drivers need to be notified, please contact operating ship on given radio channel. OOW and all cranes are equipped with radios. The view from the crane is very limited so for your crew's safety never walk or work under the grabs working range or stand on hatch covers without noticing our ship and crane driver with radio. Use Hi-Vis clothing!
- Arrange for as good as possible lighting of the holds and the deck area.
- **Ensure that the ladders to the holds are kept clean and in good shape (primary route for the excavator drivers) – important safety matter!**
- Assist our crew and excavator drivers when transferring from ship to ship. The most safe method of transfer is to be agreed on a case by case basis. The provision crane may be used, if provided with a basket certified for transfer of people. Pilot ladders and equivalent may be used - fall prevention arrangements shall be in place.
- Cargo hatches to be kept open or partly open all the time to ensure that dangerous fumes are ventilated away and that visibility is maintained (avoiding warm cargo to create steam), unless advised otherwise in cold weather.

18

19

20

21

22

23

24

25

26

27

28

29

30

Safety Management Manual	Ch. 13 Operation and navigation App. 17A	Owner : DPA	Version: 21.07.2021
--------------------------	---	----------------	------------------------

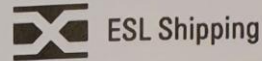
ESL Shipping Ltd

ESL Shipping: Ship To Ship (STS)

The ASPO Company

Safety information for lightering operations page 2. (ESL Shipping, 2021)

SAFETY INFORMATION FOR LIGHTERING OPERATIONS



3/4

- Ensure you have crew stand-by in case quick unmooring is needed (because of weather change or equivalent).
- Maximum waterline – hatch coaming distance to be confirmed with operating vessel master (normally to be kept below ~13 m).

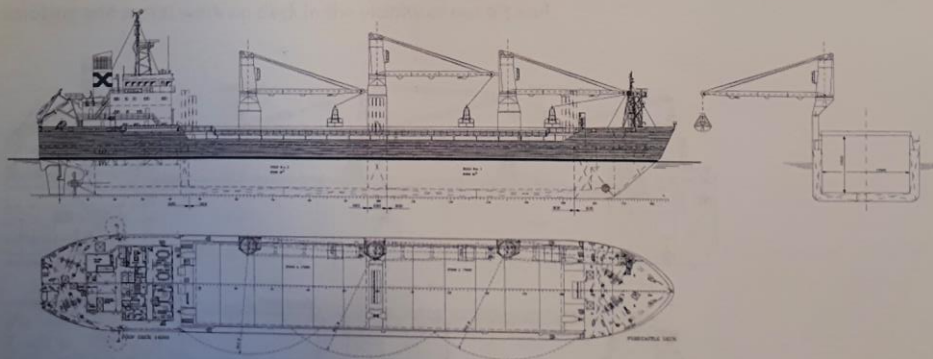
As your seamen colleagues we are very convinced that all parties are well motivated and aim at completing the operation in a safe and timely manner. However, if any question rise or in any doubt of these guidelines or in relevant matter, don't hesitate to contact our experienced crew. Together we will solve any potential problems.

On Behalf of Operating Vessel: _____
Master

Operating vessel details below:

13 000 DWT:

Name: **Tali or Pasila**
 LOA: 137 m
 Distance cargo hold 1, fwd, to cargo hold 3 aft: 83 m
 Crane's working range (ship's side / diameter): 22 / 26 m



Safety Management Manual ESL Shipping Ltd	Ch. 13 Operation and navigation App. 17A	Owner : DPA	Version: 21.07.2021
--	---	----------------	------------------------

ESL Shipping; Ship To Ship (STS)

The ASPO Company

- 18
- 19
- 20
- 21
- 22
- 23
- 24
- 25
- 26
- 27
- 28
- 29
- 30
- 31

Safety information for lightering operations page 3. (ESL Shipping, 2021)

ESL Shipping

SAFETY INFORMATION FOR LIGHTERING OPERATIONS 4/4

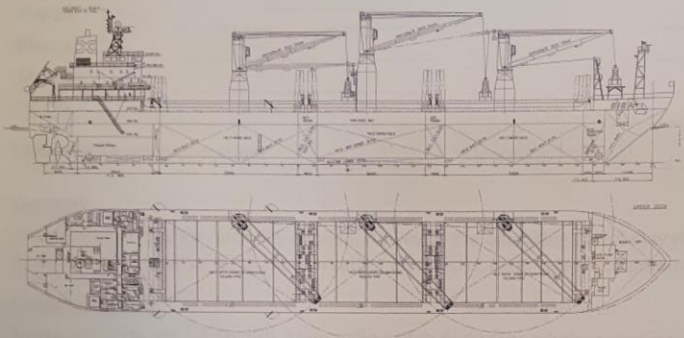
20 000 DWT:

Name: **Alppila, Eira or Kallio**

LOA: 156 - 160 m

Distance cargo hold 1, fwd, to cargo hold 3 aft: 100 m

Crane's working range (ship's side / diameter): 23 / 26 m



25 000 DWT:

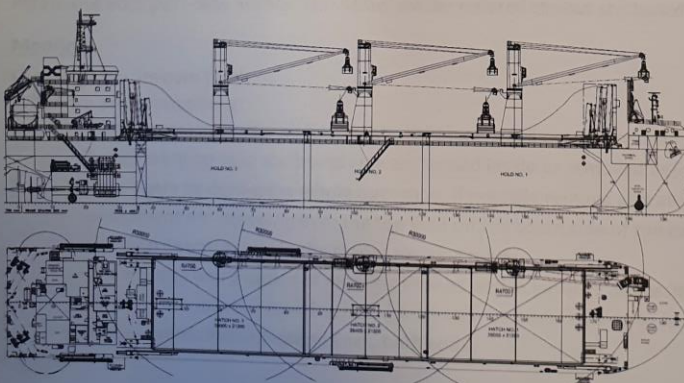
Name: **Haaga or Viikki**

LOA: 160 m

Distance cargo hold 1, fwd, to cargo hold 3 aft: 104 m

Crane's working range (ship's side / diameter): 30 m

Mv Haaga and Mv Viikki are LNG powered vessels, with a gas container on aft deck. Avoid naked light, smoking and metal work on deck in the vicinity of our aft end.



Safety Management Manual	Ch. 13 Operation and navigation App. 17A	Owner : DPA	Version: 21.07.2021
--------------------------	---	----------------	------------------------

ESL Shipping Ltd ESL Shipping: Ship To Ship (STS) The ASPO Company

18

19

20

21

22

23

24

25

26

27

28

29

30

31

Safety information for lightering operations page 4. (ESL Shipping, 2021)