Tanker Familiarization

Course material for Aboa Mare

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BACHELOR'S THESIS

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Summary:

The aim with this thesis is to provide Aboa Mare with an updated material to their tanker familiarization course. Furthermore my aim is to provide new future deckhands joining a tanker with essential need to know information that will help them perform their duties on board a tanker. The course material should meet the requirements established by both the STCW and the IMO. The tanker familiarization material is based on STCW, chapter V which states the mandatory minimum requirements for the training and qualification for masters, officers and ratings on oil tankers. Furthermore the IMO has developed a series of model courses for maritime training institutes worldwide which provides the institutes with detailed information such as course timetables, learning objectives, course framework, a course outline, guidance notes for the instructor and a summary of how students should be evaluated. After participating the IMO Model course 1.01, tanker familiarization the candidate should be able to show basic knowledge and understanding in safe cargo operations on board oil tankers, precautions to prevent hazards, apply occupational health and safety precautions and measures, carrying out fire-fighting operations, know how to respond to emergencies and take precautions to prevent pollution of the environment. This thesis is based on a literature research

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Language: English Key words: oil, tanker, safety

EXAMENSARBETE

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Sammanfattning:

Målsättningen med detta examensarbete är att förse Aboa Mare med ett nytt uppdaterat kursmaterial till den grundläggande tankerkursen. Syftet är också att förse framtida lättmatroser med viktig information som skulle kunna hjälpa dem att genomföra sina arbetsuppgifter ombord en tanker. Kursmaterialet skall motsvara de krav som ställs av STCW och IMO. Den grundläggande tank-kursen är baserad på STCW, kapitel V som beskriver de obligatoriska minimumkrav vad som gäller upplärning och kvalifikation av befälhavare, styrmän och manskap ombord en tanker. Dessutom har IMO lanserat ett antal olika modell-kurser åt maritima skolor runtom i världen vars syfte är att förse skolorna med detaljerad information gällande tidtabeller, syfte, kursens uppbyggnad, vägledning för instruktören samt ett sammandrag över hur kandidaten skall bli evaluerad. Efter att ha deltagit i den grundläggande tank-kursen skall kandidaten kunna förevisa kunskap och kännedom i lastning, lossning, förebyggande säkerhetshetsåtgärder ombord en tanker, yrkesrelaterade hälsorisker ombord, brandbekämpning, säkerhetsåtgärder vid kritiska situationer och nödlägen ombord samt kunna vidta säkerhetsåtgärder för att förhindra nedsmutsning av miljön.

Språk: Engelska Nyckelord: olja, tanker, säkerhet

Table of Contents

Abbreviations

Ballast: Seawater taken into a vessel’s tanks in order to get a proper trim.

Crude Oil: A naturally occurring petroleum liquid, consisting principally of different kind of hydrocarbons and containing varying proportions of other substances. Unrefined petroleum.

CCR: Cargo Control Room, the control space on the ship which cargo operations are directed and cargo/ballast valves and pumps are operated from.

Discharging Plan: A plan of the quantities being discharged from the ship, the plan includes maximum rate, starting rate, maximum pressure at manifold, maximum trim and list during discharging, critical stages during discharging etc.

Entry permit: A document issued by a responsible officer allowing entry into a space for a specific time

Enclosed space: A space that has limited openings for entry and exit, unfavourable natural ventilation and is not designed for continuous worker occupancy.

Flashpoint: The lowest temperature at which a liquid gives of sufficient gas to form a flammable gas mixture.

Inert gas: A gas or mixture of gases incapable of supporting combustion of hydrocarbons or otherwise react with the cargo

IMO: International Maritime Organisation

ISGOTT: International Safety Guide for Oil Tankers and Terminals

Loaded passage: The passage from the loading terminal to discharging port

Lower Explosive Limit (LEL): The concentration of a hydrocarbon gas in air, below which there is insufficient hydrocarbon to support and propagate combustion. Sometimes also referred as lower flammable limit.

MARPOL: International convention for the protection of Marine Pollution from Ships

MSDS: Marine Safety Data Sheet, a information sheet for the cargo being loaded/discharged

OCIMF: Oil Companies International Marine Forum

OPA-90: Due to the grounding of Exxon Valdez the United States made it mandatory for all oil tankers calling U.S ports to be equipped with a double-hull.

Oxygen analyser: An instrument for determining the % of oxygen in a sample of the atmosphere drawn from a tank or compartment.

Permit: A document issued by a responsible person which allows work to be performed in a certain space.

Petroleum: Naturally occurring flammable liquid consisting of a complex mixture of hydrocarbons. Petroleum covers both naturally occurring unprocessed crude oils and petroleum products that are made up of refined crude oil.

PPE: Personal protective equipment

Purging: The introduction of inert gas into a tank already in inerted condition

Pumproom: A enclosed space on a tanker which contains cargo pumps, ballast pumps, eductors and stripping pumps

SOLAS: International convention for the Safety of Life at Sea

SOPEP: Shipboard Oil Pollution Emergency Plan

SSSCL: Ship Shore Safety Check List

Spill: Oil getting into the sea

Tanker: A ship designed to carry liquid petroleum cargo in bulk.

Terminal: A facility where tankers are berthed or moored for the purpose of loading or discharging petroleum cargo.

Vetting: The general process of approving a vessel for use by which a company only uses tankers that have been inspected and the risk presented in hiring the tanker is acceptable

1. Introduction

I have been working on tankers since 2002. I started my career on a product tanker owned by Neste Shipping (MT Lunni). I have been working in Neste Shipping on their chemical, product and crude oil tankers as a ordinary seaman, 1st and 2nd officer until the summer of 2012 when I was offered the opportunity to work as a 2nd officer for Knutsen OAS Shipping. Knutsen OAS Shipping is a Norwegian tanker company and their fleet consists of chemical, product, LNG and shuttle tankers. At the moment I am working as a 1st officer on a shuttle tanker, Hanne Knutsen that mostly operates in the North Sea.

The tanker familiarization course outline is based on STCW Convention, Chapter V, Regulation V/1-1 and THE STCW Code, Chapter V, Table A-V/1-1-1. The IMO have implemented these requirements into their model course tanker familiarization 1.01.

This thesis is divided into a theoretical part and 2 Appendices. The theoretical part includes a run-through of the regulations and conventions that set the standards for the tanker familiarization course. Other subjects touched upon are the tanker familiarization course outline the process of writing this thesis.

Appendix I of the thesis is a text extracted from the STCW containing the different requirements that the STCW requires every candidate to demonstrate to get the certification in basic training for oil tankers. Appendix II of the thesis is the actual course material provided to Aboa Mare.

The main focus of the thesis is on basic cargo operations, personal safety, enclosed space entry and pollution prevention onboard a tankers.

1.1 Objective

The objective with the thesis is to provide Aboa Mare with a course material. The material should meet the requirements established by both the STCW and the IMO. The thesis also takes in consideration the needs of the oil tanker industry and what the industry might expect from a deckhand joining a tanker and to provide the student with essential information, which will help him to efficiently perform his duties on board and oil tanker.

The aim is to analyse the current information provided for students prior to joining a tanker vessel, identify important elements that should be incorporated into the teaching framework and to highlight practices and procedures conducted on board a tanker that contributes to the safe and proper operation of the a tanker

1.2 Research question

What should the tanker familiarization course material contain to comply with, and meet the requirements set by both the industry, STCW and IMO?

1.3 Limitations

This thesis is limited to the tanker familiarization course, crude oil tankers and the crude oil industry.

1.4 Method

The thesis is based on a literature research method. The research question was answered through a review of different kind of literature. The literature review is a careful examination of different literature sources, which will point you towards answering the research question. The purpose of the review is to test the research question against what already is known about the subject. The literature reviewed included three books as the primary source of the thesis and internet as secondary. (The review of literature research)

The literature used in this thesis are relevant related to the subject, are of the latest updated editions, written by authors that have knowledge and experience within the subject of this thesis.

1.5 Previous studies

Previous studies within the subject of my thesis have been done. In 2013 Maiju Herrala provided Kymenlaakson Ammattikorkeakoulu, University of applied Sciences with an updated oil tanker safety course. The name of the thesis was " The update of the Oil Tanker Safety Course".

The thesis is comparable since the objective of her thesis was to update the oil tanker safety course so that it would meet the requirements established by the STCW. The aim of the thesis was to serve as a guide for oil tankers, cargo operations on board tankers and regulations concerning these operations.

In essence when comparing the both theses, the previously written material only does not go very in-depth when discussing the information that should be included so that the course material would meet the requirements set by the STCW. As the thesis does not have a theoretical part I was only able to compare the course materials with each other.

2. Theoretical Part

The process of writing this thesis started with breaking up the different parts of the STCW Convention, Chapter V, Regulation V/1-1 and the STCW Code, Chapter V, Table A-V/1-1-1 which states the mandatory minimum requirements regarding the training of officers and ratings on board tankers. The specifications of the minimum standards' of competence that are required of officers and ratings on board tankers is stated in table A-V/1-1-1 of the STCW Code.

When this was done the IMO Model course 1.01 was studied in detail, the different chapters of the model course had to be thoroughly analysed to assure that the course material would comply with both the STCW and the IMO regulations. By doing this students and the teaching staff of Aboa Mare would be provided with a course material that would meet the requirements. The IMO model course is done to comply with the STCW, therefore by following the outline of the model course all aspects of the STCW requirements are covered.

Chapter V, Regulation V/1-1 of the STCW Convention states the mandatory minimum requirements for the training and qualification for masters, officers and ratings on oil tankers. Officers and ratings that are assigned specific duties and responsibilities related to cargo or cargo equipment on oil or chemical tankers shall hold a certificate in basic training for oil and chemical tanker cargo operations. To get this certificate every candidate shall have completed

- at least three months of approved seagoing service on oil tanker and meet the standard of competence specified in section A-V/1-1 paragraph 1 of the STCW code or

- Have an approved basic training for oil and chemical tanker cargo operations and meet the standard of competence specified in section A-V/1-1 paragraph 1 of the STCW Code. Section A-V/1-1

To get the certification in basic training for oil tanker operations every candidate shall be required to demonstrate the competence to undertake different tasks, duties and responsibilities listed in column 1 of table A-V/1-1-1 and provide evidence of having achieved the minimum knowledge, understanding and proficiency listed in column 2 of table A-V/1-1-1 and the required standard of competence in accordance with the methods for demonstrating competence and the criteria for evaluating competence tabulated in columns 3 and 4 of table A-V/1-1-1. (STCW 2011. p 43, 185)

In addition to the basic training for oil tankers, masters, chief engineers, chief mates, engineers and officers and any other person with immediate responsibility for loading, discharging, care in transit, handling of cargo, tank cleaning or other cargo-related operations on oil tankers shall hold a an advanced training certificate for oil tanker cargo operations. (STCW 2011. p 185)

According to the STCW Code, Chapter V, Table A-V/1-1-1 the officer or rating shall be able to contribute to safe cargo operations on board oil tankers, take precautions to prevent hazards, apply occupational health and safety precautions and measures, carry out fire-fighting operations, respond to emergencies, take precautions to prevent pollution of the environment from oil spills and show basic knowledge and understanding in:

- Different types of tankers and the general arrangements and constructions
- Cargo operations
- Properties of oil
- Tanker safety culture and safety management
- Hazards associated with tanker operations
- Hazard control
- Information on the Material Safety Data Sheet
- The use of gas- measuring instruments
- Working practices and procedures related to shipboard safety
- First aid
- Actions in case of fire
- Emergency procedures
- The pollution effects and shipboard pollution

Appendix 1 (STCW 2011. p 186 - 189) include the different requirements set in the STCW Code that are required to be demonstrated by every candidate to get the certification in basic training for oil and chemical tankers.

2.1 STCW

The international convention on standards of training, certification and watch keeping for seafarers, STCW was adopted 7.7.1978 during the international conference on training and certification of seafarers.
The STCW has had two major revisions, one in 1995 and the most recent one, the Manila amendments 2010. Smaller amendments have been adopted into the convention 1991, 1994, 1997, 1998, 2004, 2006.

The convention desires to promote safety of life and property at sea and protect the marine environment by establishing common agreement concerning international standards of training, certification and watch keeping for seafarers. The certification of masters, officers or ratings shall be issued to those candidates who meet the administrations requirements consisting of age, medical fitness, training, qualification and examinations.

One main key that the STCW Convention requires is that all parties has to provide information to allow others to check the validity and authenticity of all seafarers certificates of competency. This is important as unqualified seafarers holding fake certificates of competency are a clear danger to themselves, others on board and the marine environment. The International Convention on Standards of Training, Certification and Watch keeping for Seafarers, as amended, set the standard of competence for seafarers internationally (IMO. International Convention of Standards of Training, Certification and Watch keeping for Seafarers.)

2.2 MARPOL

In 1967 the Torrey Canyon ran aground when she was entering the English Channel and 120.00 tonnes of oil was spilled into the sea. The grounding of the Torrey Canyon was the incident that set in motion events that led to the adoption of MARPOL (International convention for the prevention of pollution from ships) MARPOL 73/78 was adopted by the IMO in 1973 and later also updated in 1978 after several tanker accidents for example the stranding of Argo Merchant 1976, and even though the Argo Merchant was a small tanker it draw huge attention due to the reason that the oil threatened New England resorts and the Georges Bank fishing grounds.

The MARPOL regulations are aimed to prevent and minimise pollution at sea from ships covering both accidental pollution and pollution from routine operations. The MARPOL consist of 6 technical annexes. The MARPOL has contributed significantly when pollution caused by shipping recent years is discussed. (IMO, MARPOL Convention)

2.3 ISGOTT

The main purpose of ISGOTT is to provide recommendations and guidance's on the safe carriage and handling of crude oil and petroleum for tankers and terminals. It does not provide a definitive description of how cargo operations should be conducted on board a tanker.

By combining the content of the Tanker Safety Guide and the International Oil Tanker and Terminal Safety Guide ISGOTT was first published in 1978 and it is recommended that a copy of the guide is kept on board every tanker. The safety, security and the environmental performance on tankers have improved considerably in recent years, these improvements are the result of the good practices adopted by the industry and the dedication to protect the people it employs. The commitment to continuously improve is demonstrated by the tanker industry effort's to keep the International Safety for Oil and Terminals (ISGOTT) updated all the time. The ISGOTT provides the best practices on the oil tankers but also embraces a risk-based view of things by enhancing the risk awareness. They also encourage the seafarers and their employers to identify the risks in everyday operations on board a tanker. Safety is the most important thing in the tanker industry and the ISGOTT has become the standard reference when regarding the safe operation of oil tankers and the terminals.

The guide has to be kept updated so it can reflect on the changes in ship design, operating practices, latest technology and legalizations. ISGOTT is divided into four sections, general information, tanker information, terminal information and the management of the tanker and terminal interface. The authors of ISGOTT still believe that it will provide the best technical guidance on tankers in the future and hopes that operators ensure that the recommendations in the guide are read, fully understood and followed. (ISGOTT. p x, xxi-xxii)

2.4 OCIMF

The OCIMF, Oil Companies International Marine Forum is a voluntary association of oil companies having a interest in the shipment of crude oil and crude oil products. It was formed 04/1970 due to the Torrey Canyon incident in 1967 in response to the growing public concern of marine pollution, particularly pollution caused by oil. In the early 1970's there were a variety of anti pollution initiatives taken both nationally, regionally and internationally but with no cooperation.

Through the OCIMF the oil industry were able to play a stronger and more coordinated role in these initiatives making the industry's expertise available to the government bodies. IMO granted the OCIMF consultative status in 1971 and OCIMF represents the oil industry during IMO meetings. The current OCIMF membership status is 93 companies worldwide. Today the OCIMF provides expertise in safe, environmentally efficient transport and handling of hydrocarbons in ships and terminals. OCIMF have a variety of regulations at the IMO. The aims of these regulations are to improve the safety on board tankers, protect the environment, and improve the awareness of anti-piracy and knowledge within arctic shipping. *(OCIMF, Introduction)*

The purpose of the OCIMF is to:

- Identify safety and environmental issues that oil tankers, terminals, barges and offshore marine operations are facing.
- Development of the international conventions and regulations so that safe construction and operation of oil tankers, barges, offshore support vessels and terminals is achieved.
- To work with the IMO and both regional and national regulatory bodies.
- To promote the implementations and ratifications of international conventions and regulations.
- Encourage enforcement of international conventions and regulations done by Flag states, port states and classification societies.

- Provide charterers and authorities with tanker, barge and offshore vessel data regarding safety and pollution prevention through the SIRE program. *(OCIMF, Objectives)*

2.5 IMO and the IMO model courses

Shipping is perhaps the most international of the world's great industries and at the same time one of the most dangerous of them all. It has been recognized that the best way of improving safety at sea is by developing international regulations that are followed by all shipping nations. IMO was first adopted in 1958 and its first task was to adopt a new version of the International Convention for the Safety of Life at Sea (SOLAS). Although safety always has been IMO's most important responsibility it was not until 1967 when Torrey Canyon ran aground and 120,000 tonnes of oil was spilled when a new huge problem emerged - pollution. During the years after the Torrey Canyon disaster IMO introduced several measures designed to prevent tanker accidents and at the same time minimize the consequences of them. IMO has also developed and adopted several other regulations and conventions such as the international collision regulations, global standards for seafarers, search and rescue codes, the facilitation of international maritime traffic, load lines, carriage of dangerous goods and tonnage measurement. *(IMO. History of IMO)*

The IMO has a series of model courses that are aimed for maritime training institutes worldwide. The IMO model courses is basically a programme with different kind of model training courses developed from a number of suggestions from different IMO member governments, following the STCW 1978. IMO has designed a series of these courses to help implement the STCW and to facilitate access to different kind of knowledge and skills that are demanded by the increasingly sophisticated maritime technology and the shipping industry. These courses provide the institutes with detailed information such as course timetables, learning objectives, course framework, a course outline, guidance notes for the instructor and a summary of how students should be evaluated. They also try to assist instructors to develop training programmes that will meet the STCW Convention standards for seafarers. *(IMO. Model courses)*

The purpose of the IMO model courses is to assist maritime training institutes and the teaching staff in organizing new courses. It is not the intention to present instructors with a teaching package, which they are expected to follow by the book. The tanker familiarization course includes approximately 70 hours of lectures, demonstrations and practical work. *(IMO. Model courses)*

The courses are flexible and may be used by maritime institutes where their teaching staff can use them in organizing and introducing new courses or updating existing training material. The model courses related to the STCW have been revised and updated after the major revision of the Convention in 1995 and the adoption of the Manila Amendments in 2010. *(IMO. Model courses)*

2.6 IMO Model course 1.01 outline

The IMO model courses meet the mandatory minimum requirements stated in the STCW regarding the training of officers and ratings on oil tankers. The IMO model courses 1.01 include the following information.

- The introduction (4h) should include a brief explanation of the course, it's background and purpose. List important stages in the development of oil, chemical and liquefied gas tankers. The introduction should also contain information regarding oil, chemical and liquefied gas cargo and how they are carried and handled. Explain commonly used terms on board tankers and also list the most important international, national and classification society rules and regulations and give a brief introduction about SOLAS, MARPOL, IMO and STCW.
- The characteristics of cargoes (6h) should define, explain and state some simple basic physics terms and meanings such as the basic structure of atoms and molecules and explain and state some simple basic chemistry terms and meanings. This part of the course should also explain and define some simple terms and their practical significance in the tanker trade.
- Toxicity and other hazards (6h) should state and explain the toxicity of cargoes in general. It should briefly explain the basic information regarding fire hazards since all participants should have attended an approved fire-fighting

course. Provide the student with the basic knowledge regarding toxic effects, oxygen deficiency and toxicity of inert gas and how to identify different types of health hazards. Define what pollution means and state what can cause major oil pollution.

- Hazard control (5h) should explain the content of the Material Safety Data Sheet and how it should be understood and read. State the different methods used in controlling the hazards on tankers such as fire, health, environmental, reactive and corrosive hazards.

- Safety equipment and protection of personnel (8h) should cover the use of common instruments for atmosphere evaluation. It should contain information about specialized fire-fighting appliances on board tankers and provide detailed information about breathing apparatus. Provide information and detailed information about PPE and detailed information about resuscitators and how to deal with safety precautions such as tank atmosphere, accommodation and precautions against fire

- Pollution prevention (6h) should explain the most common reasons for pollution by tankers and how to prevent marine pollution by tankers at sea and in port and state the different actions taken in case of an spill on board and how to notify the authorities. Explain the content and importance of SOPEP and the basic fundamentals in the importance between good communication between ship and terminal.

- Emergency operations (5h) covers the aspects of emergency measures taken on board and state the importance on a functional emergency organization on board and how to act when general alarm or fire alarm is given on board. States the importance with muster list and other emergency procedures and instructions given on board. Briefly explain how to act when a typical first-aid situation occurs and how to give the correct treatment on board

- Cargo equipment (18h) should describe the general tank arrangements, piping arrangements, pump types, pump characteristics, draining and stripping systems, measurement of cargo levels and cargo heating on oil tankers.

- Cargo operations (12h). Briefly explain and describe information concerning loading, loaded voyage, discharging, ballast voyage, tank cleaning, COW, use of inert gas etc. on oil tankers. (Marinesoft, Tanker Familiarisation IMO Model 1.01. Courseware specification)

3. The development of the basic tanker course material

The process of developing an course material to Aboa Mare begun by gathering information from relevant and updated literary sources. The main focus when gathering the relevant information was on three publications. By using these publications and following the outline of the IMO model the course material meets the STCW requirements.
The publications used in this thesis were ISGOTT, Crude Oil Tanker Basics and the Manual of Oil Tankers Operations.

As previously stated, ISGOTT is one of the principal industry reference manuals on the safe operation of oil tankers and the terminals and it is also referred to in many IMO regulations and recommendations. The main function of the international associations, which have prepared this publication, is to represent the tanker industry's interests at regulatory bodies such as the IMO and OCIMF. ISGOTT has to be kept updated constantly so it can reflect on the changes in ship design, operating practices, latest technology and legalizations.

The main focus of the Crude Oil Tanker Basics is in basic cargo operations such as venting, purging, understanding the operation of cargo pumps and the fundamentals of inert gas and crude oil washing systems. The time spent exclusively on cargo duties and automated cargo control systems nowadays is of great majority and therefore the basics of operating crude oil tankers is usually forgotten due to increased pressure on the available time for learning the actual basics of crude oil tanker practice. This publication is a good handbook for both officers and ratings on board oil tankers

The 1st Edition Manual of Oil Tankers Operations has been written by senior Nautical Collage lectures that have extensive practical experience in tanker operations as senior officers. The aim of the book is to provide deck cadets and junior deck officers with the essential knowledge to be successful in both academic and practical aspects of their careers. This is an easy-to understand book and the text is adequately supported by line drawings, different photographs, documents and diagrams. This book introduces topics not dealt with in any other teaching publication, and enables ships personnel on board tankers to obtain a firm grasp of a subject, which is constantly developing.

3.1 Appendix II

Appendix II of this thesis contains the information required by the STCW and the material can therefore be used as guideline for the teaching staff at Aboa Mare. The appendix is part of the whole thesis and includes information that will provide both the teaching staff and the student with updated information regarding basic cargo operations, personal safety, enclosed space entry and pollution prevention on board a tanker. Appendix 2 is divided up as follows:

3.1.1 Introduction

The first chapter of the appendix focuses on the different conventions that are of interest when talking about oil tankers and the different operations on board them. The conventions that are discussed in this chapter include the STCW, IMO, OCIMF, MARPOL and SOLAS. Apart from the different conventions the first chapter also contains some essential terminology and definitions that are used on board tankers.

3.1.2 Tankers

This chapter begins with a brief run-through of the tanker history and the construction of oil tankers. Different kind of tankers and the cargoes carried by them are also discussed and tankers that are covered in the chapter are crude oil, chemical, shuttle and LNG tankers with the main focus on oil tankers.

3.1.3 Toxicity, Hazard and Hazard Control

The main aspect of the third chapter is toxicity. Subjects discussed are the toxic effects on a human being, descriptions of toxic substances and the importance in the use of personal protective equipment to minimize the possibility for exposure for a toxic substance.
Another subject discussed in this chapter is the main hazard on board a tanker, fire. Furthermore the main sources of ignition are described, what kind of fire fighting equipment's and detectors are available on board a tanker and how to react in case of a fire on board. Volatility, upper flammable and lower explosive limits and the importance of the material safety data sheet are also described.

3.1.4 Emergency, Safety and Protection of Personnel

The importance of safety and protection of personnel is vital on board a tanker and it cannot be highlighted enough. All the essential information regarding personnel protection, enclosed space entry, measuring instruments, alarms and the organizational structure in case of an emergency are covered in chapter four of the course material.
The subject of most importance is the enclosed space entry and the evacuation and rescue from an enclosed space. Essential information concerning enclosed space entry is thoroughly covered. This topic has attracted an increasing amount of attention in recent years, in terms of guidance and regulations and even though new guidance and regulations many seafarers, dock workers and surveyors dies in enclosed spaces every year.

Tankers, like all merchant vessels are subjected to numerous different inspections, the vetting procedure on board tankers are thoroughly covered in the end of chapter four. As a consequence of environmental disasters, different oil companies demand more guarantees from the tankers and they are not willing to risk or find themselves involved in situations that could harm their image and interests in case of an oil spill, emergency or disaster that may harm human beings or the nature.

3.1.5 Pollution

Pollution has always been a significant subject when considering safety concerns. Oil is perhaps the most recognized toxic pollutant. Large tanker accidents such as the Exxon Valdez and the grounding of the Torrey Canyon have become known worldwide. Ships, especially oil tankers pose threats to the marine environment both on inland waterways and on the ocean. There are several different sources that are a threat and they are amongst many other things such as the pollution prevention and actions required in case of an oil sill covered in this chapter.

3.1.6 Cargo equipment on board oil tankers

The different stages within the loading and discharging on board a tanker requires sophisticated equipment and systems are some of the subjects discussed in this chapter. Every stage of the different cargo operations has it's own dedicated and sophisticated system. The cargo pipe-line system, cargo and ballast pumps, tank washing machines, inert gas system, cargo heating systems and P/V valves are just some of the equipment covered. All of the equipment discussed in this chapter is needed on tankers to ensure that the cargo operations are carried out in a safe and smooth manner.

3.1.7 Cargo operations on board oil tankers

When it comes to cargo operations on board oil tankers, utmost care should be taken during loading and discharging. During these operations which may have an extremely hazardous nature, the OOW and the ratings should be focused and know their duties during the different stages of the operation. Loading and discharging are very critical operations, an error may result in an immediate accident or an incident that may compromise the tanker, the environment, the ship crew or the shore personnel. Sometimes even the smallest mistake can take the form of an dangerous situation involving fire, oil spill, and explosions.

In the last chapter of the appendix different stages concerning discharging and loading are covered. Everything from cargo planning to ballasting procedures and the different stages of the loaded and ballast voyage are mentioned.

Operations concerning cargo handling, tank cleaning and pre-wash, ballasting and bunkering require an exchange of information between the ship and terminal. The importance and the content of the ship-shore safety checklist are also discussed.

All cargo operations should be carefully and thoughtfully planned and documented well in advance. The details of the cargo operation plan should be thoroughly discussed with all personnel involved prior to loading or discharging*. (ISGOTT 2006. 159)*

4. Conclusions

The purpose with this thesis was to provide Aboa Mare with an updated basic tanker course material that would comply with the mandatory minimum requirements stated in Chapter V of the STCW. Furthermore my aim was to provide new future deckhands joining a tanker with essential need to know information regarding cargo operations, personal safety, enclosed space entry and pollution prevention on board a tanker that would help them on their way of becoming a deck officer on board a tanker. For these reasons it is evident for me that this is of definite interest for new deckhands and is useful beforehand knowledge for any deckhand working in the oil tanker industry.

4.1 Discussion

As previously mentioned I have been working on various tankers since 2002 and the experience gained during these years as a deckhand, 1st and 2nd Officer has been to a remarkable advantage during this whole writing process. During my years on-board various tankers I have noticed the lack of knowledge and understanding in basic cargo related operations and equipment by new ratings joining. Hence I believe that the course material I provided Aboa Mare with includes the most important and

essential information all new ratings will need to perform his duties on board and also develop to a respected deck-officer on board a tanker.
Both the basic and advanced tanker course have in my opinion too much focus on the crude oil tankers and the crude oil industry and hence the result is that new deckhands joining a product tanker exhibit lack of knowledge even though they have attended the basic tanker course. I attended the basic tanker course with the expectations that I would gain the knowledge needed to perform my duties on board a tanker, at least to some extent. When I then joined a product tanker I was somewhat confused since it was nothing what I had expected, the every day operations were totally different of what I thought it would be after attending the course.

The decision to use three publications to base my thesis on was a result of thorough research on the Internet for literature that would awake interest and would contain relevant information. The thorough search of relevant sources assured that the thesis would contain the most updated information available. New updated literature regarding oil tanker operations and equipment's on board a tanker was not easy to be found but his thesis is written with information from the most latest and updated literature available. In addition of these three publications some sources on the Internet made it possible to begin the process of evaluating the information required to provide Aboa Mare with an up to date material to assist their teaching staff during the basic tanker course. By using these specific publications it was evident that the content of the material would be updated. The material provided to Aboa Mare meet the standards set by the STCW and the publications used are kept updated by the industry, mainly in form of the ISGOTT. The decision to focus on only three literary sources was thoroughly considered as they provided the adequate information for this thesis. The literary sources also provided Aboa Mare with a course material that would be written by using the most updated literature available containing the latest information regarding the tanker industry and the sophisticated equipment on board tankers.

The research question was answered to some extent with minor deviations from the requirements set by the STCW. The properties of oil, basic chemistry, corrosive and reactivity hazards are discussed only vaguely. Ultimately, the most essential purpose was to provide students with a comprehensible material regarding basic cargo operations and equipment on board a tanker.

Writing this thesis has been a challenge, this due to the lack of academic experience, even though the whole process developed me both in an academic aspect and as a deck-officer.

4.3 Future Research

The main focus on future research could be in a thorough analysis of either the chemical and/or the liquefied gas tanker part of the basic tanker course since which also should be include into the course material according to the STCW. The advanced tanker course material could also be analysed and updated on the same basis as this thesis.

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Table A-V/1-1-1

Specification of minimum standard of competence in basic training for oil and chemical tanker cargo operations

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Contribute to the safe cargo operation of oil and chemical tankers	Basic knowledge of tankers: .1 types of oil and chemical tankers .2 general arrangement and construction Basic knowledge of cargo operations: .1 piping systems and valves .2 cargo pumps .3 loading and unloading .4 tank cleaning, purging, gas-freeing and inerting Basic knowledge of the physical properties of oil and chemicals: .1 pressure and temperature, including vapour pressure/temperature relationship .2 types of electrostatic charge generation .3 chemical symbols Knowledge and understanding of tanker safety culture and safety management	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service experience .2 approved training ship experience .3 approved simulator training .4 approved training programme	Communications within the area of responsibility are clear and effective Cargo operations are carried out in accordance with accepted principles and procedures to ensure safety of operations

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Take precautions to prevent hazards	Basic knowledge of the hazards associated with tanker operations, including: .1 health hazards .2 environmental hazards .3 reactivity hazards .4 corrosion hazards .5 explosion and flammability hazards .6 sources of ignition, including electrostatic hazards .7 toxicity hazards .8 vapour leaks and clouds Basic knowledge of hazard controls: .1 inerting, water padding, drying agents and monitoring techniques .2 anti-static measures .3 ventilation .4 segregation .5 cargo inhibition .6 importance of cargo compatibility .7 atmospheric control .8 gas testing Understanding of information on a Material Safety Data Sheet (MSDS)	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service experience .2 approved training ship experience .3 approved simulator training .4 approved training programme	Correctly identifies, on an MSDS, relevant cargo-related hazards to the vessel and to personnel, and takes the appropriate actions in accordance with established procedures Identification and actions on becoming aware of a hazardous situation conform to established procedures in line with best practice

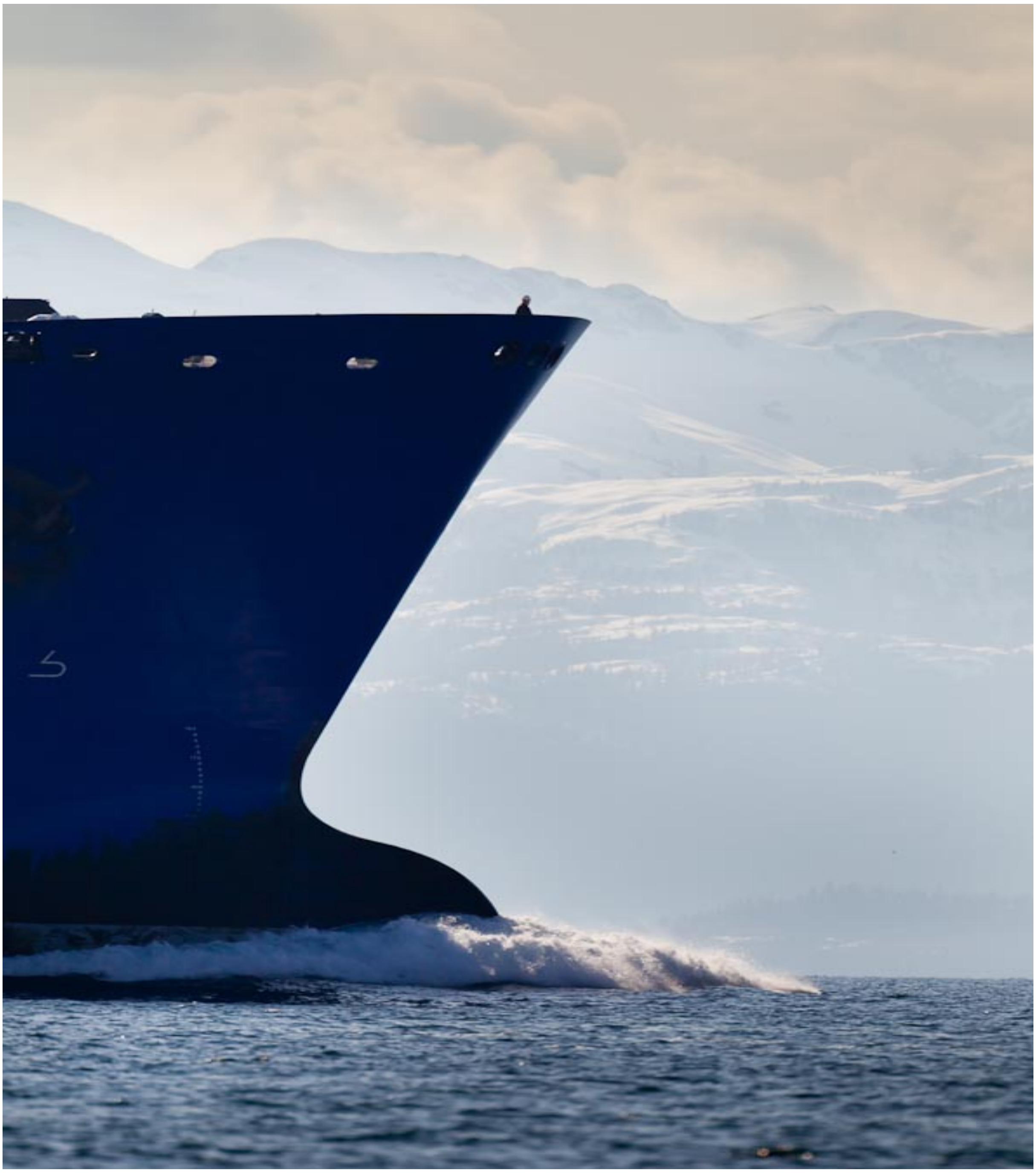
Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Apply occupational health and safety precautions and measures	Function and proper use of gas-measuring instruments and similar equipment Proper use of safety equipment and protective devices, including: .1 breathing apparatus and tank-evacuating equipment .2 protective clothing and equipment .3 resuscitators .4 rescue and escape equipment Basic knowledge of safe working practices and procedures in accordance with legislation and industry guidelines and personal shipboard safety relevant to oil and chemical tankers, including: .1 precautions to be taken when entering enclosed spaces .2 precautions to be taken before and during repair and maintenance work .3 safety measures for hot and cold work .4 electrical safety .5 ship/shore safety checklist Basic knowledge of first aid with reference to a Material Safety Data Sheet (MSDS)	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service experience .2 approved training ship experience .3 approved simulator training .4 approved training programme	Procedures for entry into enclosed spaces are observed. Procedures and safe working practices designed to safeguard personnel and the ship are observed at all times Appropriate safety and protective equipment is correctly used First aid do's and don'ts

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Carry out fire-fighting operations	Tanker fire response organization and action to be taken Fire hazards associated with cargo handling and transportation of hazardous and noxious liquids in bulk Fire-fighting agents used to extinguish oil and chemical fires Fixed fire-fighting foam system operations Portable fire-fighting foam operations Fixed dry chemical system operations Spill containment in relation to fire-fighting operations	Practical exercises and instruction conducted under approved and truly realistic training conditions (e.g., simulated shipboard conditions) and, whenever possible and practicable, in darkness	Initial actions and follow-up actions on becoming aware of fire on board conform with established practices and procedures Action taken on identifying muster signal is appropriate to the indicated emergency and complies with established procedures Clothing and equipment are appropriate to the nature of the fire-fighting operations The timing and sequence of individual actions are appropriate to the prevailing circumstances and conditions Extinguishment of fire is achieved using appropriate procedures, techniques and fire-fighting agents
Respond to emergencies	Basic knowledge of emergency procedures, including emergency shutdown	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service experience .2 approved training ship experience .3 approved simulator training .4 approved training programme	The type and impact of the emergency is promptly identified and the response actions conform to the emergency procedures and contingency plans

Column 1	Column 2	Column 3	Column 4
Competence	**Knowledge, understanding and proficiency**	**Methods for demonstrating competence**	**Criteria for evaluating competence**
Take precautions to prevent pollution of the environment from the release of oil or chemicals	Basic knowledge of the effects of oil and chemical pollution on human and marine life Basic knowledge of shipboard procedures to prevent pollution Basic knowledge of measures to be taken in the event of spillage, including the need to: .1 report relevant information to the responsible persons .2 assist in implementing shipboard spill-containment procedures	Examination and assessment of evidence obtained from one or more of the following: .1 approved in-service experience .2 approved training ship experience .3 approved simulator training .4 approved training programme	Procedures designed to safeguard the environment are observed at all times

Basic Tanker Course

Course material to Aboa Mare



Kim Solax

2014

1. Introduction

The purpose of the IMO model courses is to assist maritime training institutes and their teaching staff in the organization of new courses. It is not the intention to present instructors with a teaching package which they are expected to follow.

1.1 IMO

”Safe, secure and efficient shipping on clean oceans”, is how the IMO defines their objectives. Due to the nature of the shipping industry, it has been identified that, in order to improve the safety of maritime operations it would require a coordinated international organization to effectively carry out the appropriate actions, instead of individual countries acting without cooperating with others. Against this background, a conference held by the UN in 1948 adopted a convention establishing the International Maritime Organization, which at the same time was the first body devoted to maritime matters. IMO has promoted some 50 conventions and more than 1000 codes and recommendations concerning maritime safety and security, prevention of pollution and other related matters. The first convention that the IMO adopted was the International Convention on Safety of Life At Sea (SOLAS). The IMO works through a number of committees each composed of representatives of Member States, the MSC (The Maritime Safety Committee). In May of 2013 IMO had 170 member states. (IMO, Objective)

1.2 SOLAS

The SOLAS was the first convention adopted by the IMO, this was during the first conference held by IMO in 1960. The convention covered measures designed to improve the safety of shipping and came into force in 1965. The convention included information regarding stability, machinery and electrical installations, fire protection, life saving appliances, radiotelephony, safety of navigation and carriage of dangerous goods. The IMO adopted a new version of SOLAS in 1974 and it entered into force in May 1980.

1.3 MARPOL

MARPOL, The International Convention for the Prevention of Pollution from Ships is covering the prevention of pollution caused by ships from operational or accidental causes. This Convention was adopted 02/1973 at IMO and was adopted 1978 in response of tanker accidents 1976-1977. This combined convention entered into force 10/1983. MARPOL has been updated through out the years. The MARPOL

Convention includes regulations aimed to prevent and minimize pollution from ships, both accidental pollution and pollution caused by routine operations. The Convention includes six technical Annexes, the Annexes are as follows:

- Annex I. Regulations for the Prevention of Pollution by Oil. This Annex covers prevention of pollution by oil from operational measures as well as accidental discharges. Annex I made it mandatory for new oil tanker to have double hulls in 1992 and a phase in schedule for the existing tankers to fit double hulls.
- Annex II. Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk. This Annex covers the details concerning discharge criteria and measures for the control of pollution by noxious liquid substances in bulk and includes a list of 250 substances that were evaluated. No discharge of residues that contain noxious substance is permitted within 12Nm of the nearest land.
- Annex III. Prevention of Pollution by Harmful Substances Carried by Sea in Package Form. This Annex of the MARPOL discusses the detailed standards of packing, marking, documentation, labelling, stowage, quantity limitations, exceptions and notifications of harmful substances which are identified as marine pollutants in the IMDG Code (International Maritime Dangerous Goods Code)
- Annex IV. Prevention of Pollution by Sevage from Ships, this Annex discusses the requirements to control pollution of the sea caused by sewage.
- Annex V. Prevention of Pollution by Garbage from Ships. This Annex contains information regarding handling of different kind of garbage and also specifies the distances from land and the manners they may be disposed of. All kind of plastic is prohibited to dispose at sea. The revised Annex wich is to enter in force 01/2013 prohibits the discharge of all garbage into the sea.
- Annex VI. Prevention of Air Pollution from Ships. This Annex sets the limits on sulphur oxide and nitrogen oxide emissions from the ship exhaust and prohibits deliberate emissions of ozone depleting substances. In 2011 IMO adopted ground breaking mandatory technical and operational energy efficient measures which are supposed to reduce the amount of greenhouse gas emissions, these measures are expected to enter in force 01/2013. (IMO. MARPOL convention)

1.4 STCW including the Manila Amendments

The STCW 78 Convention was the first to establish basic requirements on training, certification and watch-keeping for seafarers on a international level. Previously the requirements were established by individual governments and this lead to a wide variation in practices concerning the procedures and standards adopted by each individual country, this proved to be problematic in the shipping industry, the most international of all industries. The STCW Convention prescribes the minimum standard for seafarers relating to training, certification and watch-keeping. The 1995 amendments entered into force on 02/1997 and were divided into the following chapters and regulations:

- Chapter I, General Provisions
- Chapter II, Master and deck department
- Chapter III, Engine department
- Chapter IV, Radio communication
- Chapter V, Special Training requirements for personnel on certain types of ships
- Chapter VI, Emergency, occupational safety, medical care and survival functions
- Chapter VII, Alternative certification
- Chapter VIII, Watch-keeping

Dividing the regulations into different chapters makes it easier for the administrator to make revisions and updates, and there is no need to call a full conference to make changes to the code. The Manila Amendments were adopted 06/2010 marking a major revision of the Convention. These revisions entered in force 01/2012 and there were a lot of important changes made in the revision, including:

- Certifications for AB's
- Requirements regarding modern technology such as ECDIS
- Requirements on hours of work, medical fitness and prevention of drug and alcohol abuse
- Training guidance for DPO's (Dynamic Positioning Operators)
- Training guidance for people operating ships in polar waters
- Competence update for seafarers serving on board all types of tankers, including LNG tankers

- Introduction to web based and distance learning
- Requirements for safety training to ensure that seafarers are properly trained while under pirate attack *(IMO, STCW Convention)*

John Vaid on the website Marine Knowledge sums up the STCW in the following way, Standards of Training, Certification and Watch-keeping Convention refers to a set of regulations or guidelines governing training of seafarers. As we know, the seafaring is one of the oldest professions and the marine profession lacked a uniform set of training standards despite being such a big profession. The lack of any rules or regulations at sea on board ships resulted in malpractices such as lengthy work hours, exploitation of seafarers, conflicting rules and laws in case of an accident. Before the STCW each nation had their own set of rules and this lead to a chaotic situation and made the oceans a dangerous place to work as a seafarer. Proper certification is not the only way to ensure less accidents and a safe working environment at sea, the work hours and other work related issues need to be sorted out and this is taken care of under the STCW. Today almost all seafaring nations are members of the STCW convention and 97% comes under its jurisdiction. *(Vaid, 2012)*

1.5 OCIMF

The OCIMF, Oil Companies International Marine Forum was formed 04/1970. The main reason behind this forum was the Torrey Canyon incident in 1967, this was formed in response to the growing public concern of marine pollution, particular pollution caused by oil. In the early 1970's there were a variety of anti pollution initiatives taken both nationally, regionally and internationally but with no cooperation. Through the OCIMF the oil industry were able to play a stronger and more coordinated role in these initiatives making the industry's expertise available to the government bodies. The IMO granted the OCIMF consultative status in 1971 and OCIMF presents the oil industry during IMO meetings. The current OCIMF membership status is 93 companies worldwide. Today the OCIMF provides expertise in safe, environmentally efficient transport and handling of hydrocarbons in ships and terminals. They are also setting the standards for improvements in this sector. OCIMF have a variety of regulations at the IMO aimed at improving the safety of tankers, protecting the environment, piracy and arctic shipping. In addition to an extensive library, they have a rich portfolio consisting of SIRE (Ship Inspection Report) and TMSA (Tanker Management and Self Assessment) and they continuously develop new tools with OVID (Offshore Vessel Inspection Database), the latest is a new Terminal inspection tool in development. *(OCIMF, Introduction)*

The purpose of the OCIMF is to:

- Identify safety and environmental issues that oil tankers, terminals, barges and offshore marine operations are facing and to develop and to publish the recommended standards that will serve as benchmarks.
- Development of the international conventions and regulations so that safe construction and operation of oil tankers, barges, offshore support vessels and terminals is achieved.
- To work with the IMO and both regional and national regulatory bodies.
- To promote the implementations and ratifications of international conventions and regulations.
- Encourage enforcement of international conventions and regulations done by Flag states, port states and classification societies.
- Provide charterers and authorities with tanker, barge and offshore vessel data regarding safety and pollution prevention through the SIRE programme. *(OCIMF, Objectives)*

1.6 Tanker terminology and definitions

Administration: The government of the state whose flag the ship is entitled to.

Aframax : Average Freight Rate Tanker, this is an tanker samller than 120.000 tonnes and with a breadth of over 32.31m

Arm: An articulated cargo pipe or hose device used to connect the shore piping to the tanker’s manifold flange connection for the transfer of the cargo

API: The American Petroleum Institute founded in 1919 was the first oil trade association to include all branches of the Petroleum Industry.

Approved equipment: Equipment that has been tested and approved by an appropriate authority such as a classification society. The authority have certified the equipment as safe for use in a hazardous atmosphere.

Auto-ignition: When a combustible material ignites without initiation by a spark or flame, when the material has been raised to a temperature where self-combustion occurs.

Ballast: Seawater taken into a vessel’s tanks in order to get a proper trim.

Ballast tanks: Tanks used to carry the ballast water. The tanks can be permanent, dedicated or cargo tanks.

Barrel: A unit of volume used to measure crude oil, equivalent to 159 litres

Bill of Lading: A B/L is the basic document between a shipper and a carrier and a shipper and consignee. It represents the contract of carriage and defines the terms and condition of carriage. It is the final receipt from the carrier for the goods shown on it and for the condition of the goods. It describes the nature, quantity and weight of the cargo being carried

Cargohose: A hose used for transfer of cargo, usually between 6” to 12” in diameter

Cargoplan: A plan giving the quantities and description of the various grades carried in the ships tanks.

Cargopump: A pump used on tankers to discharge the cargo and located either in the bottom of the pump-room or in the bottom of the cargo tank.

Cargotank: A compartment in the cargo area which may be filled with cargo

Cathodic protection: The prevention of corrosion by electrochemical techniques. On tankers usually applied on the hull either external or internal

Clinage: Oil remaining on the walls of a pipe or on the internal surface of tanks after the oil has been removed

Center Tank: A tank located on the tankers centreline

Combustible: Capable of being ignited and of burning

Crude Oil: A naturally occurring petroleum liquid, consisting principally of different kind of hydrocarbons and containing varying proportions of other substances. Unrefined petroleum.

COW: Crude Oil Washing, a method of cleaning the cargo tanks using oil from the tankers cargo

CCR: Cargo Control Room, the control space on the ship which cargo operations are directed and cargo/ballast valves and pumps are operated from.

Discharging Log: An hourly log kept by the OOW including cargo discharged, number of pumps used, manifold pressure, trim, discharging rate, BM, SF, GM etc.

Discharging Plan: A plan of the quantities being discharged from the ship, the plan includes maximum rate, starting rate, maximum pressure at manifold, maximum trim and list during discharging, critical stages during discharging etc.

Discharging Rate: The volumetric measure of liquid discharged from ship to shore within a given period, usually expressed as cubic meters per hour or barrels per hour

Gas Free: A tank or compartment is gas free when fresh air has been introduced into it to lower the level of any flammable, toxic or inert gas for a specific purpose such as hot work, entry or dry dock

Earthing: The electric connection of equipment to the main body of the earth to ensure that it is at earth electrical potential. On board ship, the connection is made to the main metallic structure of the ship, also called "grounding"

Entry permit: A document issued by a responsible officer allowing entry into a space for a specific time

Enclosed space: A space that has limited openings for entry and exit, unfavourable natural ventilation and is not designed for continuous worker occupancy.

ESD: Emergency Shut Down, a system or process by which cargo transfer can be stopped suddenly without hazard or detriment to the vessel or terminal. Usually located at the Manifolds, CCR or at the shore.

Explosive Limits: The limits of the explosive range of hydrocarbon vapour and air mixture. The range between the maximum and minimum concentrations of hydrocarbons vapour in the air which form explosive flammable mixtures. The limits are usually abbreviated LEL for lower limit and UEL for upper limit.

Ex: A hexagon or triangle, represents the European Community symbol for electrical approval. This mark does not mean that the equipment is safe for use in any hazardous atmosphere and therefore it is necessary to check in what kind of atmosphere it is to be used in.

Flashpoint: The lowest temperature at which an oil gives off sufficient vapour to form a mixture which will ignite under standard conditions.

Flow rate: The linear velocity of flow of liquid in a pipeline, usually measured in metres per second.

Flashpoint: The lowest temperature at which a liquid gives of sufficient gas to form a flammable gas mixture.

Hydrocarbon gas: A gas composed entirely of hydrocarbons

ICS: International Chamber of Shipping

Inert condition: A tank is in inerted condition when the oxygen content of the atmosphere throughout the tank does not exceed 8% of the volume

Inert gas: A gas or mixture of gases incapable of supporting combustion of hydrocarbons or otherwise react with the cargo

Innage: The depth of liquid in a tank, may be referred as sounding

Interface detector: An electrical instrument for detecting the boundary between oil and water

IMO: International Maritime Organisation

ISGOTT: International Safety Guide for Oil Tankers and Terminals

ISM: An international standard for the safe management and operation of ships and for pollution prevention. The code requires Safety Management System (SMS) to be established by the company.

Loading Log: A hourly log kept by the OOW including cargo loaded, manifold pressure, trim, loading rate, stress moments etc.

Loading Plan: A plan of the quantities being loaded to the ship, the plan includes maximum loading rate, starting rate, topping of rate, maximum pressure at manifold, maximum trim and list during loading, critical stages during loading etc.

Loading Rate: The volumetric measure of liquid loaded within a given period, usually expressed as cubic meters per hour or barrels per hour

Loaded passage: The passage from the loading terminal to discharging port

Lower Explosive Limit (LEL): The concentration of a hydrocarbon gas in air, below which there is insufficient hydrocarbon to support and propagate combustion. Sometimes also referred as lower flammable limit.

MARPOL: International convention for the protection of Marine Pollution from Ships

Manifold: a set of valves allowing the connection of the tankers cargo lines to the shore lines through hoses or loading arms

MSDS: Marine Safety Data Sheet, a information sheet for the cargo being loaded/discharged

Naked lights: Open flames or fires, lighted cigarettes, cigars, pipes or similar smoking materials, any other unconfined sources of ignition, electrical and other equipment to cause sparking while in use.

Non-Volatile: Flashpoint of 60 degree or above

OCIMF: Oil Companies International Marine Forum

OBO: On board quantity prior to loading. OBO may include any combination of water, oil, load on top, slops and oil/water emulsion

Odour threshold: The lowest concentration of vapour in air which can be detected by smell.

OPA-90: Due to the grounding of Exxon Valdez the United States made it mandatory for all oil tankers calling U.S ports to be equipped with a double-hull.

OPEC: Organisation of the Petroleum Countries, an oil cartel whose mission is to coordinate the policies of the oil-producing countries. The goal is to secure a steady income to the member states and to secure supply of oil to the consumers.

Oxygen analyser: An instrument for determining the % of oxygen in a sample of the atmosphere drawn from a tank or compartment.

Permit: A document issued by a responsible person which allows work to be performed in a certain space.

Petroleum: Naturally occurring flammable liquid consisting of a complex mixture of hydrocarbons. Petroleum covers both naturally occurring unprocessed crude oils and petroleum products that are made up of refined crude oil.

Pour point: The lowest temperature at which a petroleum oil will remain liquid

Pressure surge: A sudden increase of the pressure in a pipeline caused by a sudden change in the flow rate.

PPE: Personal protective equipment

PPM: Parts per million

Purging: The introduction of inert gas into a tank already in inerted condition

Pumproom: A enclosed space on a tanker which contains cargo pumps, ballast pumps, eductors and stripping pumps

Ullage: The vertical distance from the surface of the cargo in a cargo tank to the measurement point for that cargo tank.

ROB: Remaining on board after discharge, excluding vapour. The remaining’s may include any combination of water, oil, oil residue and oil/water emulsion.

Reducer: a short pipe where one end is of a smaller diameter compared to the other. The reducer is connected from a smaller hose or pipe to a pipe of constant diameter

Scupper: A opening through the tankers side, leading water away from deck

Sediment: Solid or semi-solid material which settles out from petroleum and accumulates in the bottoms of the cargo tanks.

Slops: Residual oil which has been transferred to a collecting tank (slop tank) usually mixed with other recovered oils and waters.

SOLAS: International convention for the Safety of Life at Sea

SOPEP: Shipboard Oil Pollution Emergency Plan

SMPEP: Ship born Marine Pollution Emergency Plan

SMS: A system required by the ISM Code which will ensure that all operations and activities on board a ship are carried out in safe manner.

SSSCL: Ship Shore Safety Check List

Stripping: Operation which removes the last cargo from the cargo tank or pipeline, also called draining.

Slops: Oily residues collected on board from previous cargo

Spill: Oil getting into the sea

Tanker: A ship designed to carry liquid petroleum cargo in bulk.

Terminal: A facility where tankers are berthed or moored for the purpose of loading or discharging petroleum cargo.

Topping off rate: The operation of completing the loading of a tank to a desired ullage.

TLV: Threshold Limit Value

Upper Explosion Limit (UEL): The concentration of a hydrocarbon gas in air above which there is insufficient oxygen to support and initiate combustion. Sometimes also referred as upper explosive limit.

Ullage: The distance between the surface of the liquid in a tank and the top of the tank.

Vapour: A gas below its critical temperature.

Vapour lock system: Equipment fitted above the tank on the main deck to enable the measuring and sampling of cargoes without release of vapour pressure

Vapour emission control system (VECS): An arrangement of piping and equipment used to control vapour emissions during cargo operations.

Volatile: Flashpoint below 60 degree

Vetting: The general process of approving a vessel for use by which a company only uses tankers that have been inspected and the risk presented in hiring the tanker is acceptable

Viscosity: The ability of a liquid to resist flow and to develop shear when subjected to a force. It is a measure of how thick the liquid is.

Wing Tanks: Tanks located either port or starboard of the centreline.

2. Tankers

Oil was first discovered in America in 1859 and the European market demands immediately created the big need for transportation of the oil. In the beginning oil was carried in barrels on board cargo ships leading to the adoption of a measurement still being used today (1 barrel = 158,98722 litres). The first bulk oil carrying ships were completely new ideas and essentially experimental until a breakthrough evolved to a new class of ships. (Solly 2011. 1-3)

The problems that were encountered when moving away from barrels to bulk was that oil, during passage, unlike any other liquid cargo transported across the oceans was affected by the differing temperatures around the world resulting in the contraction or expansion of the cargo. This meant that it was never possible to load cargo to maximum capacity, instead the cargo was loaded to 98 % creating a 2 % gap in the tank. The second difficulty was the chemical nature of the cargo. Crude oil emits hydrocarbon gas which is both toxic and flammable and can lead to many accidents such as fire, explosions and sometimes total loss of the tanker. Early tankers developed in the 1880's consisted of a single oil tight longitudinal central bulkhead and joining transverse bulkheads to create separate port and starboard tanks on the ship. One of the greatest contributors to tanker construction was marine architect, Sir Joseph Isherwood. His tanker constructions differed from the standard built vessels to date by improving the length/depth relationship of the tanker hull and basically introducing additional transverse web frames with corner brackets in each tank. This design led to stronger and more stable tanker ships. *(Solly 2011. 1-3)*

The growth of the ocean-going tanker fleet between 1880 to the end of the Second World War was gradual, the average deadweight rose from 1500 tons to about 12000 tons. After the Second World War the average deadweight increased rapidly to about 20000 tons in 1953 and about 30000 tons in 1959. Today there are tankers ranging from 100 000 tons deadweight to 500 000 tons deadweight. The larger vessels are predominantly crude oil carriers and smaller product carriers tend to remain within the smaller deadweight's. Service speeds of oil tankers have shown an increase since the Second World War, going from 12 knots to 17 knots. Both the service speed and the optimum size of the tankers are related to the economical market in the tanker industry. The growth of the tanker fleet increased enormously to meet the rapidly growing demand of oil, up until 1973/ 1974 when the OPEC price increased and slowed the growth, which has led to a decrease of demand in the tanker market.

As a result, it is unlikely that such a significant rise in tanker size and speed will be experienced in the near future. *(Eyres 2001. 21,23)*

In March 1989 the tanker Exxon Valdez, which complied fully with the then current MARPOL requirements, ran aground and discharged 11 million gallons (50 000 000 litres) of crude oil into the highly regarded waters of Prince William Sound in Alaska. The following public outrage led to the United States Congress passing the Oil Pollution Act 1990 (OPA 90) that had an huge impact on the tanker industry. This independent action by the United States Government made it a requirement that existing single hull oil tankers operating in United States waters were given a final date to depart from United States waters, after which all oil tankers operating within the area were to have a double hull. In November 1990 the USA suggested that the MARPOL Convention should be amended to make double hulls compulsory for new tankers. *(Eyres 2001. 23, 25-26)*

Picture 1. Exxon Valdez

A number of other IMO member states suggested that alternative designs offering equivalent protection against accidental oil spills should be accepted. In particular Japan proposed an alternative, the mid-deck tanker. This design has side ballast tanks providing protection against collision but no double bottom. In 1992 IMO adopted amendments to MARPOL which required tankers of 5000 tons deadweight and above contracted for after July 1993, or which commenced construction after January 1994 to be of, double-hulled, mid- deck construction, or other design offering equivalent protection against oil pollution. Studies by the IMO established the effectiveness of the double hull in preventing oil spills caused by grounding and collision, where the inner hull is not breached. The mid-deck tanker had been shown to have a more positive outflow performance in extreme accidents where the inner hull is breached. Whilst MARPOL provides for the acceptance of alternative tanker designs, the United States legislation does not. *(Eyres 2001. 23, 25-26)*

The double-hulled tanker is a type of ship that has two hulls, the outer hull and the inner hull. The double hull is an important requirement on oil tankers. The principle of the double hull is that between the sides and the bottom of the ship there are two layers with empty space between the layers. If one of the layers was to be damaged due to grounding or collision the other layer act as a backup and prevents any spill from the ship or intake of water to the ships tanks. Since there is an empty space between the layers, ballast water is usually stored in these empty spaces. Although the double hull design of the tanker is extremely important and vital in the protection of the ship and her environment, the design would not prevent the ship from minimizing the damage that would be caused if a major incident did occur and the system was breached. Still the double hull provides the best possible safety for a ship involved in the transportation of oil worldwide. A second disadvantage is that it might make the ship unstable due to the two layers of the hull, these will displace the centre of gravity. The maintenance of the double hull is important as the hull is vulnerable to erosion which makes it necessary for the ships personnel to pay extra attention to the condition of the double bottom and to do annual checks of the tanks to make sure no cracks have appeared in the welds between the cargo tanks and the empty layer which is used as ballast water tanks. *(Marine Insight, What are double hulls for ships)*

Present MARPOL requirements state that existing single hull crude oil tankers of 20 000 tons or more deadweight, and existing single hull products carriers of 30 000 tons or more deadweight that if they are equipped with segregated ballast tanks in a protected location on the vessel are able to operate until July 2021. *(Eyres 2001. p 26*)

Picture 2. 3D layout of a double hulled oil tanker.

Sir Joseph Isherwood's design and hull construction lasted until 1993, this is a direct consequence of the aftermath of the Exxon Valdez incident in Alaska 1989, which made it mandatory that all tankers are to be constructed with enhanced protection. The first double hulled tankers Eleo Maersk and Arosa were built 1993, Eleo Maersk in Europe and Arosa in Japan. The design of these ships has a proven value, as new modern tankers are still built with a second bottom and the outside of the tankers is still built around an inner hull. *(Solly 2011. 1-3)*

2.1 Tanker types

Vessels that supply terminals with big quantities of liquefied cargo are called tankers. The cargo transported might be petroleum, kerosene, chemicals, liquefied gas etc. There are different kind of tankers that are used to transport different kinds and amounts of cargo. Tankers are classified by the basis of the cargo which is transported and by the size of the ship. The size of the tanker also determinates in which kind of trade the tanker will operate. Smaller tankers usually perform coastal voyages and the large tankers are used on long haul routes. Currently tanker ships are some of the largest and strongest structures operating in the world Oceans. The construction and technical structuring of tanker ships are implemented by the IMO.

The construction specification of tanker ships are regulated by the IMO through the publication of SOLAS. SOLAS dictates that tanker construction should comply with the regulations set out in the publication, this includes factors such as double bottom hulls. The most common tankers used are Crude oil, Chemical, Product, Gas and Shuttle tankers. Oil tankers, as their name suggests carry oil and by products of oil. The generic terminology oil tanker includes not only crude but also petrol, gasoline and kerosene. Oil tankers are sub divided into crude and product tankers, the crude tankers are used to transport crude oil from the extraction site to the refinery and the product tankers are used to transport petroleum-based chemicals. Based on the dead weight tonnage (DWT) the tanker ships are classified into ULCC (Ultra Large Crude Carrier), VLCC (Very Large Crude Carrier), Suezmax, Panmax, Aframax, Handymax and Capesize. *(Marine Insight, What are Tanker ships)*

2.1.1 Crude Oil Tankers

ULCC's are the biggest oil tankers in operation with deadweight ranging up to a maximum of 550,000 tonnes. The second biggest tankers are the VLCC's with DWT's slightly over 300,000 tonnes. Tankers are also classified on basis of the important international water conduits in which they can gain easy entry, these vessels include the Panmax, Suezmax and Aframax. The Panmax and Suezmax tankers are built to suitably pass through the Panama and Suez Canals, the Panmax tankers having a DWT of 80,000 tonnes and the Suezmax a DWT of 200,000 tonnes. After both canals underwent expansion, higher capacity tankers have been built to pass through them and are known as Post-Panamax and Post-Suezmax. Aframax tankers can gain entry to almost all harbour facilities around the world due to it's DWT of slightly over 100,00 tonnes. *(Marine Insight, Panamax and Aframax tankers, oil tankers with a difference)*

2.1.2 Chemical Tankers

Chemical tankers transport chemicals in various forms and are specially designed for that purpose. Chemical tankers were pioneered in the USA. During the 1920's and 1930's the US chemical industry grew rapidly, especially around the oil and gas fields of Texas and Louisiana. Most of the oil and gas fields in the US were situated near navigable stretches of water, therefore it was natural to start transporting chemicals by sea in purpose built tankers. Presently chemicals are transported by sophisticated tankers which are capable of carrying different kind of chemicals around the world. These chemical tankers are of a slightly different design than other tankers because the products they carry require specialized tanks coated by stainless steel, zinc or epoxy. Chemicals are labelled with different IMO classes and the class states the degree of the product hazard. IMO class I vessels can carry the most hazardous products, IMO class II vessels can carry the second most dangerous products and IMO class III can carry the least hazardous products. It is very difficult to define the limit between a product tanker and a chemical tanker but IMO class I & II vessels are usually referred as chemical tankers (Shipfinance DK. Chemical Tankers)

Chemical tanker operations differ from any other liquid bulk transportation, in that a large number of cargoes of different properties and characteristics and inherent hazards may be carried simultaneously on a single voyage, and the numerous products may be handled at one berth, typically including both discharge and loading as well as tank cleaning. Even less sophisticated chemical tankers are more complex to operate than oil tankers. Transportation of bulk chemicals by sea not only requires specialist ships and equipment, but also specially trained crew, both in theoretical and practical aspects in order to understand the characteristics of the various chemicals and be aware of the potential hazards in cargo handling. A modern chemical tanker is primarily designed to carry some of several hundred hazardous products covered by the IMO Bulk Chemical Code. There are three main types of chemical tanker, these are: the sophisticated parcel chemical tankers, which typically has multiple small cargo tanks, up to 54 with deadweight of 40,000 tonnes. Then there are the normal chemical tankers that carry less difficult chemicals, they are equipped with fewer cargo tanks mostly coated with steel rather than stainless steel and less sophisticated pump and line arrangements. The last type is the specialised chemical tanker which often are dedicated to certain trades and carry a single cargo such as acid, molten sulphur, methanol, palm, wine and fruit juice. *(Chemical tanker guide, Index)*

According to *Shipfinace DK* the total chemical fleet was approximately 2669 vessels with a combined size of 26 million dwt in January of 2012

2.1.3 Shuttle Tankers

Shuttle tankers were first mobilised in the North Sea when the oil exploration started in the area during the 1970's. The immediate success of the shuttle tanker was demonstrated by a steady but undeniable presence and soon grew to become a worldwide feature of modern day shipping. Although the shuttle tankers can be utilised in any other kind of oceanic exploratory conditions they are best suited for areas, which are less accessible through exploratory piping. Shuttle tankers typically deliver oil from a offshore terminal to a refinery. The shuttle tankers are highly manoeuvrable ships that have to handle their cargo without spilling a drop in the offshore conditions. The loading happens from a buoy or a moored storage and production vessel in very marginal conditions with high sea states or strong winds. Increasingly, they are also required to operate in high latitudes where the weather is prone to become even worse with low temperatures and ice also becoming serious operational issues. These shuttle tankers are very sophisticated ships, they operate dynamic positioning systems which enables them to maintain a precise position at a offshore loading installation in deep and exposed waters.*(Bimco, The Super Shuttle)*

Picture 3. The Bow Loading System (BLS) on board a shuttle tanker

The Shuttle tanker may load its cargo through different offshore loading systems such as Floating, Production, Storing and Offshore (FPSO) vessels, Single Point Mooring (SPM), TLS (Tandem Loading System). Where the shuttle tanker is connected to a FPSO, bow to aft STL (Submerged Turrent Loading) or SAL (Single Anchor Loading) systems are used in the most violent and the calmest oceanic areas. Even normal terminal loading may occur from time to time. There are various shipping companies that incorporate shuttle tankers in their fleet. In the near future the usage of shuttle tankers is expected to reach actual extraction of oil in Latin America. The demand for these types of ships seems to be increasing in the coming decades. *(Marine Insight, What are Shuttle Tankers)*

2.1.4 LNG Tankers

The third major source of energy transported by sea is natural gas, the other two are oil and coal. The transportation of natural gas is a rapidly growing shipping activity and the vessels are designed with particular attention to safety and security. *(Shipfinance DK. Liquefied natural gas tankers)*

It is very important that the ships comply with the tough international standards. LNG tankers are high tech ships, using special materials and designs to safely handle the very cold LNG. LNG ships are double-hulled and heavily insulated, with an extensive cargo safety system. LNG ships are equipped with sophisticated leak detection technology, emergency shutdown systems, advanced radar and positioning systems, and numerous other technologies designed to ensure the safe and secure transport of LNG. Before the ship construction will begin, government safety expert's review and maintain a strict oversight on the plans and the building process. The strict oversight has resulted in an outstanding safety record. Over the last 30 years there have been approximately 33,000 LNG voyages done worldwide and not one spill has been reported. *(Global Security, LNG Tanker Safety)*

At minus 161,5 degrees Celsius natural gas liquefies and at this temperature the gas is reduced to 1/630th of its original volume. The natural gas must be cooled down to minus 161,5 degrees Celsius before loaded which means that the refrigerated tanks on the LNG tankers are segregated from the hull with heavy isolation. When the gas is loaded into the tanker it is already cooled down since the vessel do not have any cooling capacity but the tanks are well isolated so that they can keep the correct temperature on the gas to keep it liquefied during the entire voyage. LNG tankers are not vulnerable to explosions because natural gas is not flammable. *(Shipfinance DK. Liqufied natural gas tankers)*

2.2 Different types of cargo

Oil and petroleum are terms that cover many different substances, ranging from crude oils to refined products each of which has a specific area of use and hazard degree. The common feature is that they are hydrocarbons, which means that they consist of a complex mixture of carbon atoms to which hydrogen atoms are attached. Oil can be a very dangerous substance, some of the oils properties makes it very desirable in a controlled environment such as a combustion chamber of a engine. *(Solly 2011. 5)*

2.2.1 Crude oil

There are thousands of different crude oils in existence and each of them have their own unique characteristics. Crude oils vary widely in appearance and viscosity from field to field. The crude oils are usually given a geographical name and an indicator of the hydrocarbon mixture such as Arabian heavy or Iranian light. Crude oil in its natural state does not have any practical uses because it cannot be used in car engines or airplanes. Crude oil is a complex mixture of hydrocarbon compounds and it is formed over millions of years beneath the surface of the earth. Crude oil is extracted by drilling and after that it is pumped to the surface. When crude oil comes out of the well the crude oil still contains water, salts, sediments and dissolved gases which must be separated and stabilised by removing or reducing impurities such as water, hydrocarbon gases and sulphur compounds. These hydrocarbons range from simple highly volatile substances to compounds, which cannot be distilled. Hydrocarbons, natural gases and derivate from crude oil make excellent fuels. The crude oil is highly flammable and can be burned to create energy. Crudes from different sources can be used for different things, some may have more of the valuable lighter hydrocarbons and some may have more of the heavier hydrocarbons. The different compositions of crude oils are measured and published in documents such as MSDS. The refinery uses the information in these documents to decide which crudes it will buy to make the products that its customer needs. *(Solly 2011. 6, 94)*

Each crude oil grade has it’s own characteristics and may be classified as sour, sweet, light, medium, heavy or highly volatile and they range in colour, odour, and in the properties they contain. There is though two crude types that require special considerations when handling them, Paraffinic and Aromatic crudes. There are different kind of properties that need to be considered when handling crude oil. Density, vapour pressure, flash point, pour point, wax content, cloud point, viscosity, basic sediments, sulphur content and benzene content are some of these properties. *(Armitage 2009 p 7-8)*

2.2.2 Chemicals

Chemicals are involved in everything from agriculture to complex manufacturing and are divided into three main groups. Organic chemicals, inorganic chemicals and vegetable oil providing the world with such products as pharmaceuticals, detergents, insecticides and fertizillers, synthetic fibres, rubbers and packing materials.

- Organic chemicals contain carbon and are referred as petrochemicals and divided into two main product groups. The first group is the olefins including ethylene, propylene and butadiene and the second consists of aromatic compounds. Organic chemicals are used to produce plastics and artificial fibres.
- Inorganic chemicals do not contain carbon and are a combination of other chemical elements. The most common inorganic chemicals are phosphoric acids and sulphuric acid, which are used in the fertilizer industry whilst caustic soda is used in the aluminium industry. These chemicals are very corrosive to many metals and therefore transported in stainless steel tanks.
- Vegetable oils including animal fats, palm oil and soya bean oil are transported by chemical tankers and are used for edible and industrial purpose *(Shipfinance DK. Types of chemicals)*

The increasing demand for these chemical products throughout the world has led to the development of sophisticated chemical tankers capable of carrying these chemicals worldwide. Chemical tankers primarily transport organic and inorganic chemicals as well as vegetable oils and fats. The total global volume of chemicals is estimated at approximately 60 million tonnes per year, in addition 40-45 million tonnes vegetable oils, alcohols, molasses and lubrication oils. *(Chemical Tanker Guide, Sea Transport)*

2.2.3 Liquefied gas

Natural gas has been used as an energy source since the early 19th century when small amounts were found in Fredonia, New York. The first LNG cargo was shipped in 1959 and forecasters predicted that the LNG trade would reach 100 million tonnes by 1980 but due to the oil crisis it did not happen until year 2000 when it finally reached the 100 million tonnes. By 2010 the number was already 220 million tonnes. The combination of technological advances and enhanced focus on less polluting fuels natural gas is now widely used in many countries around the world. *(Shipfinance DK. Development of LNG tankers)*

Natural gas is extracted through wells and when the natural gas comes directly through the well it consists of several components such as methane, propane, ethane, butane, nitrogen, water and other impurities. After the gas has been extracted it is led to a gas/oil refinery, where all the impurities and some of water is removed. When the majority of water and impurities have been removed the gas is sent to a liquefaction plant, where the remaining water, impurities and carbon dioxide are removed and the gas is cooled to a liquid form and distilled so that the liquid consists exclusively of methane, ethane, propane and small amounts of butane. The gas is now a colourless, odourless and clear liquid. *(Shipfinance DK. Liquefied natural gas)*

The world has enormous quantities of natural gas, but much of it is in areas far from where gas is needed. To move this cleaner burning fuel across oceans, natural gas must be converted into liquefied natural gas (LNG) a process called liquefaction. LNG is natural gas that has been cooled to -162 C, changing it from a gas into a liquid that is 1/1600th of its original volume. This dramatic reduction allows it to be shipped safely and efficiently onboard specially designed LNG vessels. After arriving at its destination, LNG is heated to return it to its gaseous state and delivered to natural gas customers through pipelines. LNG is not new, it has been transported for more than 50 years and has a strong safety record. An LNG spill would not damage the ground or leave any residue as it evaporates. In water LNG is insoluble and would simply evaporate, making water spill clean up unnecessary. LNG is not stored under high pressure and is not explosive. Although a large amount of energy is stored in LNG, it cannot be released rapidly enough into the open environment to cause an over pressure associated with an explosion. LNG vapours mixed with air are not explosive in a unconfined environment. Worldwide there are 91 export terminals designed to receive LNG shipment. *(Chevron, Liquefied Natural Gas. 2012)*

Picture 4. Suezmax Tanker Stena Ast Sunshine

Picture 5. MR Tanker, Stena Conquest

Picture 6. Shuttle Tanker, Bodil Knutsen

Picture 7. VLCC Maran Cygnus and Shuttle Tanker Hanne Knutsen

Picture 8. Chemical Tanker, Widawati

Picture 9. Q-Max LNG Tanker, Mozah

3. Toxicity, Hazards and Hazard Control

A toxic substance is a poisonous substance and may have serious effects on the health on a human being, but there are different degrees of toxicity. Acute toxicity involves effects that are harmful to an organism through a single short term exposure while chronic toxicity is the ability of a substance to cause harmful effects over an longer period of time. A significant amount of one substance may cause no harm, where as a minimum amount of another may be fatal. In any working industry the employer has to provide the employee with a safe working environment, the same goes with the shipping industry where flag states are obligated to provide the same safe environment. Toxic substances may affect humans in four different ways, by being swallowed, through skin contact, through eye contact and through the lungs. The word toxicity is generally used to describe oil cargoes in different forms, ranging from crude oil to refined products. Different cargoes may contain such components that are more toxic than the cargo its self. *(Solly 2011. 11)*

Volatility is used to describe the reactiveness of a substance. There are some substances that are being described as volatile due to the fact that they release proportionally more vapour at a certain temperature compared to other substances at the same temperature. For example, imagine a cup of gasoline and a cup of water in a warm room where the gasoline will evaporate more rapidly and therefore the gasoline is termed a volatile substance. To sustain combustion there has to be sufficient oxygen and sufficient heat energy to ignite the vapour. If vapour, oil and heat are present in the correct proportions all at the same time the hazard of flammability exists. The design of the tankers and the operations onboard a tanker are intended to avoid this hazard by understanding how a flammable atmosphere can be created. Even though all three factors are present, to create a ignition the fuel/air mixture must be in correct proportion with sufficient heat energy. The Lower Flammable Limit is the point of which ignition first occurs, this limit is also known as the Lower Explosive Limit. For most oil cargoes the ignition occurs at about 1 % volume of hydrocarbon gas in air. At approximately 4 % to 5 % the fire will be at its most efficient and at about 10 % to 11 % (petroleum gases) hydrocarbon gas by volume the fire will be extinguished because there will be too much hydrocarbon gas by volume in the air. This point is called the Upper Flammable Limit or Upper Explosive Limit. Different chemicals may have different flammable ranges, methanol for example has a range between 6 % to 36 %. The region between the LFL and UFL is known as the flammable range. In air, the flammable range of most petroleum products carried on oil tankers are between 1 % to 10 % by volume hydrocarbon gas. If the oxygen content is reduced, the flammable range decreases until at about 11 % oxygen by volume there will be in sufficient air to sustain combustion. Any space with less than this oxygen content is described as having an inert atmosphere. *(Solly 2011. 8-9)*

Petroleum has a low oral toxicity compared to other toxic substances, but when it is swallowed it causes discomfort and nausea. When swallowed there is a possibility that petroleum may be drawn into the lungs during vomiting and this can lead to serious consequences. When small quantities of petroleum are inhaled it may cause diminished responsibility and dizziness similar to drunkenness with headache and irritation of the eyes. Inhalation of sufficient quantities can be fatal. The main effect of the gas on personnel is narcosis, exposure of high concentrations for a long time may lead to paralysis, insensibility and death. Many petroleum products cause skin irritation but they are also irritating to the eyes an direct contact with petroleum should be avoided by always wearing appropriate PPE's. Petroleum may contain hydrogen sulphide and benzene, both of which are very toxic. If Petroleum is ignited the gas which is given off by the liquid that burns is a visible flame. Petroleum gases can be ignited and the will burn when mixed with a certain amount of air. If the ratio is too small or too big the mixture cannot burn. The lower and upper flammable limits are limiting proportions expressed as a % by volume of petroleum gas in air. Gas mixtures likely to encounter from petroleum liquids in normal tanker trade range between LFL of 1 % gas by volume in air to a maximum UFL of about 10 % gas volume in air. *(Shipsupplier. Oil tanker hazards of petroleum)*

3.1 General concept and effects of toxicity

To ensure safety on tankers all crewmembers should be familiar with the effects and hazards of toxic substances. The effects of toxic substances vary. Some toxic substances will act immediately depending on the concentration, while others won't have an immediate effect on your health. Health consequences for some substances such as benzene may occur at a later stage as a result of low level exposure for a long period of time. Hydrogen Sulphide, nitrogen, carbon monoxide and carbon dioxide are known as acute poisons and exposure may lead to unconsciousness or death. *(Solly 2011. 12)*

The use of Personal Protective Equipment (PPE) and atmosphere monitoring are vitally important to minimize the possibility of exposure to toxic substances. Threshold Limit Values (TLV's) are exposure guidelines that are based on industrial experience and studies. When talking about safe exposure limits for different toxic substances the Treshold Limit Value (TLV) is the most common. The TLV are guidelines and not strict values of a safe or unsafe atmosphere but they also offer acceptable safe values so the worker exposed for the toxic substance during a working day should not suffer any harm. All of these TLV's are quoted in parts per million (ppm) and the lower the value is the greater the toxicity is. *(Solly 2011. 12)*

3.1.1 Hydrogen Sulphide H2S

Hydrogen sulphide is a by-product of crude oil and is a particularly dangerous, highly toxic, colourless, corrosive and flammable substance. At low levels it has a smell of rotten eggs but when the concentration increases the smell dissipates, this can produce a false sense of security as this leads to personnel thinking that the problem has subsided when in actual fact it is increasing. Crude oils come out the well with very high levels of hydrogen sulphide, but during the stabilisation process the level is reduced before the crude oil is delivered to the tanker. Some crude oils still can contain very high levels of this substance because they are never stabilised. Hydrogen sulphide can also be encountered in other products such as naphtha and bitumens. If the concentration of H2S exceeds 5ppm precautionary measures are advised. When handling cargo containing H2S the atmosphere monitoring equipment and personal gas detectors are invaluable assets. When very high concentrations are likely to be present an Emergency Escape Breathing Device (EEBD) should be made available to the crew members who might be in contact with the substance. In addition to being a health hazard this substance is also considered a public nuisance and the local regulations can ban the release of this substance in the atmosphere. All companies usually have their own additional procedures regarding handling cargoes with high level of hydrogen sulphide.

The physical effects cause to a human body when exposed to H2S, there might though occur national differences in these values.

- 0,1-0,5ppm, you will detect the smell
- 10ppm, may can cause nausea and minimal eye irritation
- 25ppm, strong odour and may cause eye and respiratory irritation

- 50-100ppm, the human sense of smell starts to break down, at 100ppm death may occur after 4-48 hours of exposure
- 150ppm, no sense of smell after 2-5 minutes
- 350ppm, may be fatal after 30 minutes exposure
- 700ppm, immediately fatal *(ISGOTT 2006. 13-17)*

3.1.2 Benzene

Benzene is usually found in large quantities in aromatic hydrocarbons. Benzene primarily presents an inhalation hazard. Exposure to concentrations < 1000ppm can lead to unconsciousness and even death. Benzene can also be absorbed through the skin and is toxic if ingested. *(ISGOTT 2006. 12-13)*

Prior to entering any compartment were the cargo may have contained benzene, checks for benzene vapours should be carried out. Without any appropriate PPE no entry into these compartments should be permitted. Tankers likely to carry cargoes in which benzene may be present should be provided with appropriate detector equipment such as detector tubes. *(Shipsupplier. Tanker hazards of enclosed spaces)*

3.1.3 Carbon monoxide and Carbon dioxide

Carbon monoxide and dioxide are some of the by-products of the combustion when inert gas is produced. Carbon monoxide is a toxic gas that may be present in the cargo tanks following gas freeing, carbon dioxide is not a toxic gas but still can presents a hazard. *(Shipsupplier. Tanker hazards of enclosed spaces)*

3.1.4 Mercaptans

Mercaptans, a colourless gas that has a smell similar to rotting cabbage and may be found in cargo tanks where oil residues are in contact with water. Mercaptans can be detected by smell at small concentrations below 0,5ppm but no health effects are experienced until heavily increased concentrations. The effects of mercaptans on humans are similar to those caused by hydrogen sulphide, some of these can be irritation of the lungs, eyes and throat. The presence of mercaptans can be detected by use of chemical detector tubes. *(ISGOTT 2006. 18)*

3.1.5 Oxygen defiency

Before any entry into any enclosed space the oxygen content in the atmosphere should be tested with an oxygen analyser to check that the air contains 21 % oxygen.

If a compartment has been inerted this is of particular importance. Lack of oxygen should always be suspected when entering an enclosed space, especially if it have contained water, inert gas or been subjected to humid conditions. *(Shipsupplier. Tanker hazards of enclosed spaces)*

3.2 Fire onboard a tanker

The major risk of fire on board any ship lies in the engine room where hot fuel oil runs through different pipes. Tankers are equipped against fire hazards with fixed fire fighting equipment which supply foam or CO^2. The major hazard on a tanker lies in the hydrocarbon gases and precautions are taken to prevent their ignition. It is very important to check the system and test the fire detectors on board the ship. The main types of these detectors are:

- Flame Detectors react to the light produced by the fire and these detectors are preferred since oil fires generally do not produce much smoke.
- Smoke Detectors react to smoke.
- Heat Detectors react to a sudden rise in temperature. The detector does not react to small changes in the temperature *(Solly 2011. 29-47)*

When the three sides of the fire triangle are present (fuel, oxygen and heat) a flame can be maintained the sources of ignition or heat in the fire triangle could be:

- Direct Heat, matches or lighters provide danger and these materials possess sufficient ignition energy to provide the third side of the triangle. Both matches and lighters are controlled by the company safety policy and there are designated smoking areas on board tankers. Hot work is another common form of direct heat, for example welding. The energy required for igniting a flammable mixture of oxygen and acetylene is very small and once it is ignited the flame will ignite any form of flammable material in the vicinity. This is one of the reasons ships suffer more fires during repair and dry dock periods when hot work usually is carried out. Generally these fires are very small and can be extinguished with a portable extinguisher.
- Mechanical Sparking, may be a metal hand tool dropped onto a metal surface. The use of hand tools and power tools for chipping or scraping could also cause a mechanical spark, though their use is not prohibited ISGOTT recommends that such work only would be performed on locations not directly connected to the cargo system. Any work which may result in a spark being

produced should be approached with the possibility that a flammable atmosphere may exist in the vicinity then one side of the fire triangle has to be reduced to a safe level or removed entirely.

- Chemical Energy, smears made by aluminium equipment, such as gangways if scraped on steel surfaces, could cause a spark if struck by a falling object.
- Electrical Equipment, have a large potential of providing a source of ignition. Radar transmitters should be turned off when alongside, radio transmitters and AIS should be set on low power (1W). Essential equipment such as torches should be gas protected. Hand held radios are essential on deck whilst cell-phones and pagers should not be used.
- Static Electricity, one of the most likely sources of ignition and may result from movement of liquid through a pipe or through the turbulence at the start of loading a tank.
- Current Electricity, might occur when a jetty and a tanker are electrically connected through the loading hose or the loading arm. The method of reducing this hazard is to position an insulating flange within the hose or arm thereby blocking the flow of the current. *(Solly 2011. 29-47)*

A crewmember who discovers an fire must immediately raise the alarm indicating the location of the fire and inform the officer on watch. The tankers fire alarm must be operated and given as soon as possible. Crew in the vicinity of the fire should apply if possible the nearest suitable extinguishing attempt to limit the spread of the fire. If the attempt is unsuccessful, it should be aborted by the tankers fire emergency plan. All cargo, ballast and bunker operations should be aborted immediately and all valves closed. Fire control plans must be displayed in visible positions on each deck and the location of all fire-fighting equipment, dampers and controls are shown in detail in the plan. When in port the fire plan should be located near the gangway for the assistance of the fire-fighting personnel based onshore. All fire-fighting equipment should always be ready for use and frequently checked by the officer in charge of them. After an fire or other incident on board where fire-fighting equipment has been used there should be an thorough check of the equipment. Extinguishers should be re-filled, breathing apparatus bottles recharged and foam systems flushed with water*. (Shippsupplier. Tanker shipboard emergency management)*

3.3 Cargo Safety Data Sheet (MSDS)

A tanker has to carry different cargoes such as crude oil, chemicals and gas. All of these cargo types are hazardous for the marine environment as well as for the health of the seafarer. A Material Safety Data Sheet is provided for the different cargoes carried on board to ensure the safety of the seafarers health and the marine environment and to provide useful and accessible information regarding the cargo carried. The MSDS also contains information on the kind of personal protective equipment, appropriate procedures and swift response that are required in case of an emergency. The different cargoes that can be hazardous to the ship and its crew are fuel oil, lube oil, chemicals, LNG, LPG, cargo carried in containers under the IMDG code and different cleaning agents. The MSDS contains some of the following information:

- Identification of the hazards and identification of the mixture or content, especially H2S and Benzene
- Composition of the different ingredients
- Fire fighting, first aid and accidental release measures to be taken
- Handling and storage information
- PPE and exposure control measures
- The chemical and physical properties
- Toxicity information
- Ecological and disposal information
- Transport information *(Marine Insight. MSDS used on ships)*

Fig 1, MSDS of Maersk Dumabrton Crude Oil

4. Emergency, Safety and Protection of Personnel

The ISM Code requires the companies to establish different procedures to identify, describe and respond to shipboard emergency situations. To get the crew onboard to successfully deal with various types of emergency the most important thing is to plan and prepare them. All crewmembers should consider what they should do in case of an emergency. Such as fire, oil spill, collapse of person in tank, ship breaking adrift from jetty or emergency release of the tanker from the berth. The crew will never be ready to foresee what might occur but good planning and training will result in quicker and better decisions and a well-organised reaction to the emergency situation. To make it easier for the crewmembers to act properly during a emergency following information should be readily available:

- Type of cargo and stowage plan
- Any hazardous substances
- Stability information
- Fire fighting plan
- Crew list

The crewmembers should be familiar to different kind of emergencies and practises, training and drills ensures that the crew retain their knowledge of how to act in case of a emergency. *(Shippsupplier. Tanker shipboard emergency management)*

4.1 Procedures and organizational structure in case of an emergency

An emergency organisation should be set up in the event of an emergency and the purpose with the organisation is to raise the alarm, locate and assess the emergency and the dangers associated with the emergency and finally organise the crew and all the necessary equipment. The master and a senior officer on board should be in charge and take control over the emergency situation and other crewmembers assist according to their duties on the muster list and listen to their group leaders. The command centre should have means of internal and external communication and be located on the bridge. An alternate command point should be appointed, usually the cargo control room. The person who first discovers the emergency must inform the officer in charge and rise the alarm and the emergency organisation starts operating according to the muster list. Each crewmember and emergency group should have a designated assembly point, crewmembers that don't have should stand by and act as required. *(Shippsupplier. Tanker shipboard emergency management)*

See Fig 2, Muster list on board Hanne Knutsen

4.2 Protective clothing and equipment

Appropriate protective clothing should be worn by all crewmembers engaged in cargo operations. It is recommended to wear a boiler suit that provides full cover, safety shoes, safety glasses, safety helm and gloves. Safety is the prime priority that is kept in mind by seafarers while on board. These days shipping companies ensure that their crew follow personal safety procedures to achieve utmost safety on board ship the basic step is to make sure that everybody wears their personal protective equipment's made for different types of jobs carried out on ship. The most common PPE's that always are present on board to ensure the safety of the crew are:

- Protective clothing, an overall or boiler suit which protects the seafarer from hazardous substance like oil, water or steam
- The most important part of the human body is the head and it is protected by a helmet. The helmet should be worn with the chin strap to prevent the helmet of falling off.
- The safety shoes ensure that nothing happens to the seafarers feet while working on board
- There are different types of hand gloves which are provided on board ship, some on these are heat resistant gloves to work on hot surface, cotton gloves for normal operation, chemical gloves and gloves for winter condition etc.
- The eyes are the most sensitive part of a seafarer. During cargo operations the chances are very high for having an eye injury. Protective glass or goggles are used for eye protection
- The pump room or the engine room of the ship produces 110-120 dB of sound which is very high for human ears. Even few minutes of exposure can lead to head ache, irritation and sometimes partial or full hearing loss. Ear protection is used on board ship in form of ear muffs or plugs which dampens the noise
- The face mask is the best protection when working with hazardous cargo substances which are harmful for human body if inhaled directly. The face masks are provided to act as shield from the hazardous substances
- The use of chemicals on board ship is very frequent and some chemicals are very dangerous when they come in direct contact with human skin. This suit is worn to avoid such situations. *(Marine Insight. PPE used onboard ships)*

4.3 Respiratory protection

Respiratory protection should always be worn when in contact with cargo, when undertaking open sampling, opening blanks for cargo hose connections, draining lines to open tanks and cleaning up oil spills. Procedures for the use of self-contained breathing apparatures should be provided on board tankers. For a new crewmember it is essential to know how to use respiratory protection. *(Shipsupplier. Oil tanker hazards of petroleum)*

Different types of respiratory protective equipment are made available for use onboard tankers. Some of these are required to be carried on board to meet the fire safety provisions of SOLAS. The ship-owner is responsible for providing equipment needed to safely manage all aspects of on board operational and safety activities. Crew should carry out practical training in the use of respiratory protection on board since it is essential for all the crewmembers to know how to use it. If the user suspects that the equipment may not be operating as it should be he should vacate the space he is in immediately. *(Shipsupplier. Tanker respiratory protective equipment)*

The EEBD, Emergency Escape Breathing Device is an important life saving appliance and is primarily for use in accordance with the SOLAS for escape from machinery or accommodation spaces in the event of a fire. The EEBD's should be provided for use as emergency escape equipment during enclosed space entry. The device contains breathing oxygen for a time period of at least 10 minutes, along with a low pressure audible alarm in form of a whistle sound. Most of the manufacturers provide time duration of 15 minutes to escape out from danger. The EEBD should never be used for life saving purposes or fire-fighting. To comply with the SOLAS requirements, the EEBD should adhere to the FSS Code (Fire System Safety Code), spare parts should be kept on board, be approved by the authority, include a brief instruction for usage and operation and be located in easily visible areas of the engine room and near escape routes with suitable protection and easy accessibility. *(Marine Insight, Understanding emergency escape breathing device EEBD before buying one)*

Picture 10. Dræger EEBD

4.4 Alarms

A fire or a grounding does not come with an alarm but the alarm definitely can help us to tackle the emergency or to avoid it before it occurs. There are different kinds of alarms installed in ships, some in the engine room, some in the accommodation and on the deck. The main reason for these audible or visual alarms are to notify the crew onboard about a dangerous situation that can arise on board. In the international maritime industry it is a normal practice to have different alarm signals for different emergency situations, this enables the seafarer to know and understand the type of emergency that is occurring with regards to the ship he is sailing on. The ships alarm signals are clearly described in the muster list along with the action to be taken when the alarm does occur. Some of the main visual and audible alarms that are installed on ships are:

- The General Alarm on the ship is recognized by 7 short ringing of bell followed by a long ring or 7 short blasts on the ship's horn followed by one long blast. This alarm is used to make the crew on board aware that a emergency has occurred
- The Fire Alarm is sounded as continuous ringing on the ship's electrical bell or continuous sounding of ship's horn.
- The Man Overboard Alarm is used when a man falls overboard, the ship then gives an internal alarm bell sound consisting of 3 long rings and the ship

whistle will blow 3 long blasts to notify the crew on board and the other ships nearby

- Machinery space Alarm in the engine room has various safety devices and alarms fitted for safe operation. The alarm can be seen in the Engine Control Room and the Bridge.
- The machinery space is fitted with CO_2 alarm with a fire extinguishing system. This audible and visual alarm is entirely different from machinery space alarm and other alarms
- The ships cargo spaces are also equipped with cargo space CO_2 alarms.
- Some other alarms can be Abandon Ship Alarm, Ship Security Alarms and different Navigational alarms. (Marine Insight. Different types of alarms used on ships)

4.5 Vetting Procedures

As a consequence of environmental disasters the oil companies demand more guarantees from the tankers and they are not willing to risk or find themselves involved in situations that could harm their image and interests. Tankers, like all merchant vessels are subjected to numerous inspections. Several of the inspections are carried out by flag state inspectors or classification societies. When a ship is heading to a foreign port, the port state authorities have the legal right to inspect foreign flagged ships; these are known as Port State Control (PSC). Since the late 1980’s these inspections have become embedded in the tanker industry. They are commonly known as vetting inspections and are used as a risk management tool by oil, gas and chemical chartering companies such as Repsol, Statoil and Total in order to assess the suitability of a vessel for the carriage of their cargoes. Deck Officers on a tanker will be exposed to frequent vetting inspections. Modern ship vetting has been used since the early 1990’s as a concern over the increased number of shipping incidents in particular tanker casualties and accidents. The vetting of ships was introduced by charterers as a risk management tool to basically determine the standard of the ship and whether it is suitable to carry the charterer’s cargo. Typically ex-tanker senior deck officers are used as inspectors. It was shortly realized that some ships were occasionally meeting oil company X criteri but not company Y criteria. This problem led to a more formal vetting scheme named SIRE and it was introduced by OCIMF. Around the same time a CDI scheme for chemical and gas tankers was introduced. *(Solly 2011. 173,175)*

The inspection process is governed by standard reporting forms and is largely aimed at equipment and the checking of paperwork. As the human element is a very critical factor in maritime incidents the inspector will be looking for a safely operated ship. Each inspector has his own pattern he uses during the inspection but the most common will follow this pattern:

- Introduction and opening meeting
- Checking of ship and crew certification
- Bridge
- Deck
- Outside accommodation, including LSA
- ER
- Internal accommodation
- Closing meeting to provide Master with the findings during the inspection and to give the Master an opportunity to challenge or question the inspector's findings. *(Solly 2011. 176)*

On completing an inspection the inspector hands over a document to the ship, this document contains all the faults and recommendations observed during the inspection. All companies that are members of OCIMF must provide the information resulting from the inspection conducted on the vessel to a common database that contains the information concerning the latest inspection of the ship. This database is called the SIRE. A common question after a vetting is whether the inspection has been passed or failed, but it should be understood that the inspector does not decide that himself. *(Solly 2011. 176)*

His role is only to act as an auditor. It is the charterers of the ship that decide if it will charter the ship after they have the completed the vetting report. *(Solly 2011. 177)*

4.6 Measuring instruments

A portable UTI is a battery powered measuring device that is able to measure ullage, temperature and water/oil interface. The UTI consists of a measuring tape connected to a stainless steel probe which has two sensors, one for detecting the liquid and another one for measuring the temperature. On the main-deck there are special designed vapour locks where the UTI is to be connected to allow measurements made under closed conditions. Through a sounding pipe extending from the tank top to the bottom the cargo content can be measured. One of these vapour locks is the gauging point from which the tank calibration tables are based on. Ullages are measured by lowering out the tape into the tank and when the sensor comes into contact with the liquid a high sound will be emitted. If the UTI is allowed to touch the bottom of the tank it might be damaged so precautions are advised when using this device, before using the UTI make sure that you have the correct information regarding the ullage of the tank when it is empty. If the tanker isn’t equipped with approved temperature sensors the only way of measuring the temperature is by using the UTI. The accuracy of the temperature measured with the UTI should regularly be checked and recorded by comparing the readings with equipment on board that are known to be accurate. If it is not possible to do the calibration on board then it should be done ashore by a competent service company. *(Armitage 2009, 13-16)*

Picture 11. Hermetic UTI

The UTI is used for detecting oil/water interface in cargo tanks. When lowering the probe the frequency of the beeping sound is different when water is detected compared to the sound generated when oil is detected and as a result of the different beeping sounds the interface between oil and water can be determined. When sounding for water the probe must be coated with water paste. Any water found in the cargo tanks is likely an result of suspended water settling during the loaded passage. It is essential to know how to use an UTI when working on board a tanker. *(Armitage 2009, 13-16)*

Portable gas measuring instruments should be made available for tank cleaning, purging, gas freeing and enclosed space entry. The measuring equipment should be able to detect and measure hydrocarbon gas in an inerted environment, combustible gas concentration in air, oxygen concentration, hydrogen sulphide, carbon monoxide and other toxic gases specific to a certain cargo. These instruments are relied on to determine and ensure a safe working environment and maintenance and calibration instructions must be followed and performed by a competent and person on board, usually the Chief Officer*. (Armitage 2009. 118, 120)*

Tankers carry multi-gas detectors which are able to measure a wide range of gases. The multi-gas detector measures accurate oxygen and hydrocarbon gas concentration but when measuring low concentrations of toxic gases caution must be taken if using a multi-gas detector. When measuring low concentrations of toxic gases a gas detection tube should be used. These chemical indicator tubes are the most common form of detecting toxic gas. These sealed glass tubes with a break off tip are filled with chemical crystals which change colour when exposed to a specific toxic gas. A stream of sample atmosphere is allowed to be directed into the glass tubes via a hand pump. When a fixed amount of gas has passed through the tube the concentration of the gas detected shows as a band of discoloured crystals which can be measured against the concentration level marked onto the tube. There are different kind of tubes for different toxic gases and amounts present in the cargo. The amount of gas present is expressed in ppm by volume. The toxic gas detector should only be used to detect toxic gas since it only measure point samples*. (Armitage 2009. 119-120)*

Fixed gas detection systems and portable gas detectors cannot be carried along everywhere while trying to work at the same time. The personal gas detectors are very small, light and easy to use everywhere and fit in your palm. The RIKEN GX2009 is one of the smallest and weighs only 130 grams. These small gas detectors consist of 4 different types of sensors, which simultaneously measures combustibles, oxygen, carbon monoxide and hydrogen sulphide. It is essential to know how these portable measurement instruments work when joining a tanker.

Picture 12. RIKEN personal gas detector

4.7 Enclosed space

The dangers of entering enclosed spaces have always been known within the marine industry, but it still remains a significant risk to seafarers around the world. Many seafarers, dockworkers, surveyors and stevedores have died in enclosed spaces when at sea and there are still dozens of fatalities occurring every year. *(Cousins 2013. 33)*

Enclosed spaces include cargo tanks, double bottoms, fuel tanks, ballast tanks, pump rooms, cofferdams and void spaces but a enclosed spaces are not limited to these. Enclosed spaces usually have unfavourable ventilation, limited entry and exit points and are not worker friendly. *(Shipsupplier. Tanker control of entry enclosed spaces)*

4.7.1 Enclosed space entry

The maritime magazine *Trade Winds* 2nd of May 2008 states, *”More than 1000 deaths are feared to have occurred in ships enclosed spaces over the past 20 years”*

A topic that has attracted an increasing amount of attention in recent years, in terms of guidance and regulations is the dangerous space entry. To ensure the safety of the crew entering an enclosed space a risk assessment should be completed to identify the potential hazards and an appropriate gas test should be conducted. The appropriate atmosphere should contain 21 % oxygen by volume, hydrocarbon vapours of less than 1 % LEL and there should be zero toxic or other contaminants present at the time of entry. The atmospheric hazard areas in a enclosed space are oxygen defiance, flammable vapours and toxic vapours. These conditions can result in fatal consequences. To avoid any potential health dangers precautions should always be taken in advance prior to the entry. All entry operations should be pre-planned before entering. The master and responsible officer will determine if entry into the space may be permitted. The presence of hydrocarbon vapours should always be suspected in enclosed spaces. Other factors that can cause oxygen defiance, flammable or toxic atmospheres should also be considered, these could include factors such as :

- Cargo may have leaked into the space
- Malfunction in cargo pumps
- Cargo residues may remain on the tank surface
- Paint solvent
- Oxygen absorbing cargo or chemicals
- Fractured piping's (Solly 2011.148-155)

The precautions taken before entering an enclosed space are to ensure that the area is as safe as possible for personnel to conduct the work required. The following considerations must be taken into account:

- The space has to be ventilated according to procedures and the atmosphere tested for toxic gases.
- Communication at the entry to the enclosed space is necessary. Radio checks between the person at the entry and the person inside the space should be done throughout the entire operation. Proper function of the radios should be carried out before start of operation. Communication between the watch-keeping officer and the stand-by person at the entrance should also be tested and all relevant information should be given to the officer. Hand-over procedures need close monitoring to ensure that the enclosed space entry operation is mentioned and the status of the operation is passed forward.
- Emergency breathing devices and rescue equipment must be positioned outside the hatch.
- Resuscitation equipment must be outside the entrance to the space.

- The entrance should be monitored at all times by the watchman. He is required to keep a visual lookout and remain in contact with the person inside the space by radio at the agreed intervals. If visual monitoring isn't possible radio contact should be maintained all time.
- The person entering the space should always be wearing relevant personal protective equipment such as personal gas detector, overalls, protective boots, hard hat, safety goggles, escape breathing apparatus, flashlight and a fully charged radio. *(Solly 2011.148-155)*

The entry permit, or other documents should be signed and completed by the responsible person prior to entry. It is the responsibility of the ships owner to establish procedures for safe entry into a enclosed space. The process of the different permits regarding entering an enclosed space should be controlled by the ships SMS. It is the master responsibility to ensure that the procedures for enclosed space entry are being followed and implemented. *(Solly 2011. 148-155)*

Amendments are proposed to SOLAS with the intention to ensure that seafarers are made familiar with the precautions they need to take prior to entering enclosed spaces and what actions to take in case of an accident. This would require crewmembers with enclosed space entry or rescue responsibilities to participate in a drill every two months. The drill would include the inspection and use of PPE's, communication equipment, rescue equipment and other enclosed space associated procedures. Changes to the SOLAS amendments should be a step in the right way and would be addressing the dangers associated with enclosed spaces but their success will rely on the ship owners willingness to tackle this problem. *(Cousins 2013. 33)*

For a new deckhand who is joining a tanker for the first time it is essential to be aware of the basic procedures regarding enclosed space entry and the hazards involved.

4.7.2 Evacuation and rescue from enclosed spaces

If the conditions stated in the entry permit change, or if the conditions in the tank become unsafe the personnel that have entered the space should immediately be ordered out of the space and not permitted to re-enter before the situation has been re-evaluated and the safe conditions restored. When an accident involving personnel in a dangerous space occurs, the first action is like any other emergency, raise the alarm and inform the officer in charge of the operation. Although speed is often most important when human life's are being saved rescue attempts into an enclosed space should not be attempted until necessary assistance and equipment has been mustered. There are many examples of human lives being lost through hasty rescue attempts. A well trained and vigilant safeguard and a pre-trained on board emergency organisation is of great value in a quick and effective response. Lifelines, EEBD's, resuscitation equipment, rescue harness, communication and other rescue equipment should always be ready for use and a well trained emergency team should be available. *(Shipsupplier. Tanker control of entry enclosed space)*

On board the vessel there should be regular drills and exercises concerning rescue from enclosed spaces. Crewmembers with responsibilities concerning safety should be instructed in resuscitation techniques for treatment of persons who have been exposed for toxic substances and vapours or whose breathing has stopped due to drowning. Tankers are provided with special apparatus that are used in resuscitation. It is vital that all crewmembers are fully aware of where they are located and instructions should be provided and clearly displayed. *(Shipsupplier. Tanker control of entry enclosed space)*

5. Pollution Prevention

There is nothing new about the concerns of environmental pollution. The first International pollution prevention legislation was entitled OILPIL and appeared via the 1954 International Maritime Consultative Organisation and it's details were minimal in comparison with todays pollution prevention requirements and it acted more as an international forum for discussion instead of an official set of requirements. It was the Torrey Canyon incident above all others which led the IMO to draw up plans for regulations which resulted in MARPOL 1973. Since MARPOL came into force in 1973 and later revised in 1978 it ensures that shipping remains the least environmentally damaging modes of transport. It clearly highlights the points to ensure that marine environment is preserved by elimination of pollution by all harmful substances which can be discharged from a ship. Whilst MARPOL used OILPOL 1954 as a basis, the new convention extended way beyond the original. There was an original intention for the MARPOL convention to cover areas of pollution, not just oil but also issues of; chemicals, packaged dangerous goods, sewage and garbage. *(Solly 2011.p 133-134)*

Oil is perhaps the most recognized toxic pollutant. Large tanker accidents such as the Exxon Valdez quickly became known worldwide. The grounding of the Exxon Valdez was the most publicized tanker accident but the biggest spill ever recorded happened during the 1991 Persian Gulf War when about 240 million gallons spilled from oil terminal and tankers off the coast of Saudi Arabia. It is not widely known that hundreds of millions of gallons each year end up in our oceans. Large tanker spills account for just over 5% of those hundreds of millions. Crude oil from tanker accidents and offshore drilling is most likely to cause problems that are immediately obvious. Most people have seen images of oil-coated animals and the large oil slicks surrounding the tanker after an accident. *(Jordan 2012)*

5.1 Sources and causes of marine pollution

Ships pose threats to the marine environment both on inland waterways and on the ocean. There are several different sources that are a threat, some of them are:

- Discharge of oily Bilge and ballast water
- Dumping of solid waste into the sea
- Accidental spills of oil, toxic or other fuels in port or underway
- Air emissions from the vessel

- Ecological harm due to introduction of exotic species transported in the vessels ballast water

Ships in general are designed to move safely through the water when they are loaded, when the ship is in ballast condition the vessel fills its ballast tanks with water. During loading operations on tankers the ballast water is discharged at the same time and the water is typically unclean, being contaminated with oil and other wastes. This makes it a source of water pollution. Segregated ballast tanks, which is a requirement on tank vessels reduce or eliminate the oily ballast problem on oil tankers. A similar source of pollution is the discharge of bilge water *(Hecht 1997. p 11)*

Oily spills from vessels are one of the most common sources of water pollution. Cargo spills frequently occur while loading or discharging in a port due to equipment or by human error. These spills are usually relatively small in volume. Much less common but more dangerous are cargo spills which occur when a boat runs aground or breaks in bad weather. These accidents usually occur when ships are approaching, leaving a berth or moving within restricted areas where there are little room to manoeuvring or errors. *(Hecht 1997. p 13)*

The causes and circumstances that cause oil spills can vary and the operation that the vessel was undertaking during the time of the spill usually is the primary cause of the spill and also determinates the size of the spill. According to ITOPF smaller and medium sized oil spills are caused during discharging, loading, ballasting, tank cleaning and when the vessel is underway. The larger spills occur during, discharging, loading, bunkering, at anchor, underway. Primary causes for large oil spills have been designated to collisions, groundings, hull failures, equipment failure fire and explosion. Other causes might be human errors or heavy weather damage. The small and medium oil spills account for 95% of all reported accidents and a large percentage (69%) occurred during cargo operations. The remaining 5% of the oil spills are the large once but the occurrence of these have significantly decreased since 1970 as the figure below shows.

According to ITOPF there where no large oil spills recorded in 2012 even though 7 medium spills were recorded and during the last decades a decrease in large oil spills can be observed, in 1970’s there was a total of 246 oil spills over 700 tones, 1980’s there was 78, 1990’s 93 and between 2000 to 2012 a total of 43 oil spills over 700 tones.

5.2 Prevention of marine pollution

Spillage of oil into the sea must be avoided, for reasons other than the preservation of the environment and safety of the ship. If a spillage occurs from a tanker whilst alongside, considerable repercussions will occur resulting in an extreme outcome. In addition to action from port and coastal authorities the local press are likely to pay a visit with resulting adverse publicity to ship and owners. *(Solly 2011. 186)*

Ship and shore personnel should maintain a close watch for the escape of oil at the beginning of cargo operations. Before commencing cargo operations all deck scuppers must be plugged to prevent oil escaping into the water. During cargo operations rainwater should be drained periodically and scupper plugs replaced immediately after. Oily water should be drained directly into the slop-tanks. During cargo operations a deck-watch should be kept on deck to ensure that oil is not escaping into the sea. The crew should ensure that pipeline valves and drop valves are closed when not in use. A spill-tank should be fitted under the manifolds with suitable means of draining and enough space to retain any leakage from the arm or hose. When topping off cargo or bunker tanks the ullages should be checked from time to time to ensure that overfill of the tanks does not happen as a result of leaking valves, incorrect operations by crew or malfunction in tank radars. If a leakage occurs for any reason from a pipeline, valve, hose or arm the cargo operation should be stopped. When completed with cargo operations the tightness of the blanked manifolds should be checked to avoid any seepage of oil. *(ISGOTT. 349-351)*

See Fig 3, Oil Pollution Prevention Team on board Hanne Knutsen

A more recently prescribed legislative requirement for ships is for them to possess their own Shipboard Oil Pollution Emergency Plan (SOPEP). After considerable training and education, oil spillages still occur every day. This is the reason why authorities impose the requirement for a SOPEP on all vessels over 400GT and on all tankers over 150GT. SOPEP provides a course of action that shipboard personnel should follow in responding to an oil pollution emergency. The steps are designed to assist the crew in actions to stop or minimise the spillage of oil. The SOPEP is divided into two areas, to whom to report the incident and the shipboard actions to be taken during the incident. The master of the ship is in charge of the SOPEP along with the Chief Officer who is in charge of the implementations of the SOPEP on board. *(Solly 2011. 183,186)*

Some of the things that Shuttle Tanker Hanne Knutsen's SOPEP contains:

- The duty of each crewmember in case of a oil spill, including muster station emergency actions to be taken
- General information about the ship and its owner
- The procedures how to discharge oil spill into the sea using SOPEP equipment
- Reporting procedures and requirements in case of an oil spill
- Which authorities to contact in case of oil spill. Port State, oil clean up team etc. are to be notified
- Line drawings of various lines such as fuel and cargo lines and the positioning of vents and trays.
- The ships general arrangements, for example locations of all tanks a the capacity of them.
- Location of the SOPEP locker with a list of the inventory

The Oil Record Book is one of the most important documents on board and it's an innovation from MARPOL 73. The Oil Record Book should contain the information regarding loading, discharging, transferring and cleaning of cargo spaces, discharging of bilge, bunkering operations, internal bilge or sludge transfer etc. *(Solly 2011. 139)*

5.3 Actions required in case of oil spill

Oil spills at sea have become the most dreaded accidents and to prevent these from happening it is always better to take precautionary measures to prevent them from happening again. Even though these precautionary measures are in place oil spills still happen without any warning leaving the crew very little time to respond correctly. The number and nature of emergency scenarios that could develop on a tanker are considerable. The situations where oil spills cause marine pollution are numerous these are often overflow caused by the internal transfer onboard a ship, leaking valves and flanges, fractured pipe's or deck lines. Other contributing factors may be leaking manifolds or hoses during loading and discharging and inadequately fitted scupper plugs, during bunkering or sludge operations. However with proper SOPEP equipment and training, these oil spills can be contained and marine pollution can be avoided. If the oil spill goes overboard, the Master will immediately inform the coastal authority such as the port state control and owner or office management. There are measures to be taken to limit the area affected by the spill. The use of oil booms and other effective SOPEP items are essential to prevent further oil flowing overboard. The use of Oil spill dispersant chemicals can be implemented to contain the spill but with prior permission from port state authorities. Contact with 24 hr Oil Spill Response Organization is to be maintained by the master to aid the further clean up operation by shore team. There are some important steps to take in case of an oil spill, some on them are:

- Immediately close the ship scuppers
- In case of an oil spillage the person detecting the spill should verbally contact the Officer on watch who informs the Master or other Person in Charge
- Stop all cargo operations immediately and locate the effected tank or leak
- Everybody should be alarmed and they should carry out their duties as listed in the muster list for oil spill
- Correct use of the SOPEP equipment's, contain the spill within the ship
- Lower the quantity of spilled tank to a safer level in any other permissible tank.
- The whole scenario should be logged in the log book by either the Master or OOW *(Wankhede. 2010. Marine Insight, Fighting Oil Spill Onboard)*

Oil spills are very dangerous for the marine environment. The ecosystem is detrimentally affected and marine life forms are threatened. Nowadays there are different kind of methods and equipment's that can be adopted and used to clean up oil spills. These are some of the methods used to prevent large oil spills of occurring:

- Oil booms are used to retain the oil spill in a certain area
- Sorbents can be placed on the surface of the spillage affected area, the sorbets suck and absorb the oil from the surface of the water
- Oil can also be burnt on the site where the spillage has occurred though there is a big disadvantage in this because the burning releases exhaust that contain toxic particles that can cause damage to the air and marine environment
- Fertilizers can also be used to disperse the oil spillage in the water and this is a highly recommended method because of the reason that the fertilizers help to hasten the growth of micro-organisms and these help to diffuse the components of the oil spilt in the water

- Skimming means that the oil spillage is removed from the water surface with the help of different tools and equipment's. Only lighter oils can be separated and removed from the water with this method because the density of oil will tend to be lighter than the density of water.
- People onshore and offshore can help to accelerate the oil spill clean-up operation by using simple tools like spades and shovels, removing and isolating the area affected by the oil spillage
- The simplest method of dealing with the oil spill clean-up operation is use the components of nature, sun, wind, weather and the tides. This is also the most cost efficient and slowest method of cleaning up oil spills. *(Marine Insight. Different kind of dispersants used on ships)*

6. Cargo Equipment on board oil tankers

The different stages within the cargo operations on board a tanker require sophisticated equipment and systems. Every stage of the cargo operation has it's own dedicated system. Cargo pumps, tank washing machines, inert gas system, cargo heating systems are just some of the equipment and systems that are needed on tankers to ensure that the cargo operations are carried out in a safe and smooth manner. Oil trade through sea routes has globally increased around the world due to the high demand for oil. The number of tanker ships working at sea has increased too. Safety and efficiency of these oil cargo transports and operations at sea are therefore burning issues. Comprehensive guidelines are provided to ensure that procedures to carry out tanker operations are introduced in form of different kind of check-lists which are easy to understand and use on board tankers. Seafarers are required to follow these checklists before commencing any cargo operations prior to arrival or departure from ports. *(Banawhat (a) 2012. 4-5, 8-9)*

6.1 Cargo and ballast pumps

The most common cargo pump type in use is the centrifugal pump. They are found on large crude tankers as well as small parcel tankers and they are constructed for high bulk pumping rates. The pump works the kinetic energy principle given to the cargo by the centrifugal force exerted, when enough energy is gained the cargo is thrust vertically up the discharge line and along the deck to the manifold and then ashore. The pump consists of an impeller and pump casing. Centrifugal pumps are driven by steam turbines, hydraulic power packs and they can be electric driven. The advantage with this pump is that it can handle large bulk rates, however there are some disadvantages too. Vapour or air bubbles cause cavitation and the centrifugal pump can not strip cargo residues at the end of the discharge and further equipment such as stripping pumps will be necessary to empty the tanker. *(Solly 2011. 83-84)*

6.2 Inert gas system

During the 1950's, 60's and 70's there was a series of explosions on very large tankers caused by cargo vapours that wasn't handled adequately. The explosions occurred during tank cleaning or gas freeing operations. Oil companies carried out large investigations researching causes of the explosions and it was soon realized that in many cases static electricity created a source of ignitions within the flammable atmosphere. It was determined that if the air in a cargo tank could be replaced with an inert gas then no explosions could take place, this because of the airside of the fire triangle has been reduced to a safe level. *(Solly 2011. 49)*

For more economical and safer tanker operations a large supply of inert gas is required due to large tank volumes. The simplest and cheapest way of providing an inert gas is to burn the oil present in the air and use the products of combustion. The SOLAS regulations do not specify the source of the inert gas and it could be generated from a nitrogen generator or a dedicated IG generator from exhaust emissions from boilers which are commonly used on crude oil and product tankers. The emissions from a boiler uptake are known as flue gases and have to be processed before introducing to the cargo tanks. Once processed flue gas is termed inert gas. *(Solly 2011.50-51)*

It is now a requirement under SOLAS (II-2 Reg 4.5.5) that all oil tankers over 20,000 DWT and tankers fitted with COW systems have to be fitted with a inert gas system. The SOLAS definition of an inerted atmosphere is that it contains less than 8% oxygen by volume of the cargo tank. The IG plant must be capable of delivering inert gas to deck with an oxygen content of 5% by volume. A flammable petroleum atmosphere can ignite down to a oxygen content of approximately 11%. The 8% level gives a safety margin *(Solly 2011. 49).*

It is a general principle that ships that are required to be inerted should remain so at all times. The only exceptions are when it is required to gas free the tanks for inspection or repair purpose on the ballast voyage or for dry-docking. The inert gas system is usually used as follows during a normal voyage cycle:

- Primary inerting is used when a ship is coming out of the dry dock and the existing tank atmosphere of 21% oxygen content must be exchanged for an atmosphere containing 8% oxygen or less
- Prior to loading the cargo tanks are inerted and once loading is commenced the inert gas must be vented via the mast riser to prevent overpressure in the tanks. During the loading the inert gas plant is not running.
- Upon loading it may be necessary to top up the inert gas in the tanks for the voyage. Climatic changes and temperature changes will affect tank pressure due to varying cargo levels.
- During discharging the inert gas plant is running all the time. The cargo that is being discharged will be replaced by inert gas and positive tank pressure will be maintained.

- Purging is carried out to remove all the hydrocarbons present inside a cargo tank for eliminating the risk of fire, this method is also used to remove any flammable mixture formed inside the cargo tank. The procedure for purging is that inert gas is purged into cargo tank, the object is to reduce the oxygen content to under 8% and the hydrocarbon concentration to under 2% which is below the level where any combustion can be supported if air is subsequently introduced to the tank
- Gas freeing is required for tank entry purpose, all hydrocarbons has to be purged below 2% by volume with inert gas and then ventilated to 21% oxygen and less than 1% of the LFL. *(Solly 2011. 59-60)*

6.3 Tank cleaning

Tank cleaning is time and labour intensive work. Tank cleaning is a necessary part of tanker life and although guidance is available nothing is better than deck-officers with personal experience of tank cleaning on board. Tank cleaning is carried out to monitor quality control for carriage of the next cargo, to put clean ballast in cargo tanks, tank inspection, maintenance, residue control and for dry docking. The degree of tank cleaning varies naturally, ranging from very little if the same grade of cargo is being carried the next voyage to highly intensive for particularly sensitive cargo to load. Tank cleaning is one of the most hazardous operations carried out on a vessel during a voyage. ISGOTT has recognized this and give advice on safety precautions to be taken during tank cleaning. In the 1950's tanks were washed by hand hoses and each company and even each master had their own tank washing procedures. An increase in ship size and tank size meant that hand washing was no longer an option so portable tank cleaning machines were used and the cleaning procedures reconsidered. Steam and water washing were favoured and nowadays there are three types of water wash:

- Cold water wash will be necessary for the majority of cargoes. This is done with sea water which is drawn directly from the sea and pumped through the tank cleaning line ant to the machines.
- Hot water wash with hot water of at least 60$°C$ might be required for some cargoes due to their high pour point which is the temperature at which a liquid will not flow. The water used for hot water wash is heated through a tank cleaning heater. Coated tanks may have recommended maximum water temperature for washing, typically 75$°C$.

- Chemical wash is used in extreme cases. Chemical tankers use this method due to the high standard of cleanliness required. The decision to use chemicals should not be taken lightly as problems may occur in disposing of the wash residues because reception facilities ashore will not generally accept them because the oil cannot be recovered and processed readily and the reception firm has the problem of disposal *(Solly 2011. 123-124).*

The majority of tank cleaning is carried out with portable or fixed tank cleaning machines. Due to a reduction in manning on merchant vessels and the use of inert gas, most of the modern tankers use the fixed tank cleaning machines. The machines are powered by the washing medium and comprise a single or multiple nozzles that rotates 360° and about its own axis, this ensures maximum coverage of the cargo tank surface. The water pressure used during tank washing is usually between 8-10 bars. The amount of machines depends on the size of the cargo tank and its structure. MARPOL dictates a maximum amount of shadow sectors allowed in each cargo tank, these are usually stated in terms of percentage of the horizontal and vertical surface area. Portable machines have the advantage that they can be spotted at any height within the tank. They are lowered into the tank through access holes located on the deck with a flexible hose that is connected to the washing main on deck. The success of the tank cleaning is linked to the ability to keep the tank drained due to the build up of oil/water in the bottom of the tank. Stripping pumps or eductors are used for draining purpose. *(Solly 2011. 126-128)*

6.4 Crude Oil Washing

Crude oil washing is carried out to ensure that the sludge and clingage are at a minimum to ensure a maximum outturn of cargo. Generally a good trim of up to 5m must be maintained during COW. The COW system uses the same equipment as water washing. These are fixed machines with a pumping system for the delivery and stripping the tanks. The number of tanks to be crude oil washed is laid down in MARPOL Annex I. Approximately 25% of the tanks shall be washed on a rotational basis for residue control purpose. Tanks do not need to be washed more than once every four months. Due to the commercial benefits in crude oil washing it is common for all tanks to be bottom washed towards the end of the discharge in order to maximize the cargo outturn. It is necessary to pressure test the COW line before arrival at the discharging port and this is done by running up a cargo pump at slow speed and taking suction from a cargo tank and pressuring the line to its working pressure. The line should then be inspected for leaks and the line test recorded in the Log Book. The vessels COW manual will give detailed guidance on operational procedures. *(Solly 2011. 128-129)*

Below the advantages of crude oil washing are stated:

- Reduced operational sea pollution
- Improved cargo outturn
- Reduced tank corrosion
- More cargo able to be carried due to less residues
- Less de-sludging time for dry-docking preparation
- Less salt water discharged to refineries

The disadvantages of crude oil washing:

- Higher workload during discharge operation
- Discharge time extended with 6-12 hours
- Higher risk of pollution in port

The COW precautions:

- There must be a port specific plan
- COW line must be pressure tested before use
- Communication must be tested
- A responsible person must check for leaks before and during COW
- The vessel must be inerted and oxygen content less than 8%
- The washing machines must be operating correctly and make sure that washing program has been set if used.
- Stern trim has to be maintained during COW to aid draining
- Conditions under which COW should be suspended understood *(Solly 2011. 130)*

6.5 Various tank arrangements and cargo pipeline systems

An oil tanker is divided into a number of tanks usually divided in wing tanks (port/ starboard) and then the centre tank. A more common arrangement is to have two rows of tanks separated by a single centre bulkhead. The number of tanks is determined by the size of the ship and the trading pattern. Larger tankers often have a smaller number of tanks, between 8-16 since they load or discharge one grade of oil and are not in need of any segregation. Smaller tankers may have between 20-40 cargo tanks each one capable of carrying a separate cargo. Most product tankers will handle 5 or 6 grades at on time. Some product and chemical tankers have a separate cargo pump in each tank to increase the segregation options. *(Solly 2011. 73)*

On board a tanker there are a number of different pipe-line systems, both placed on the main deck and below. The main lines are the bottom lines, deck lines and pump room lines. The bottom lines are positioned on the tank bottom and the most common bottom line systems is the direct line system and the single or double ring main system. The direct line system, also known as the closed loop system is mostly found on crude oil tankers as these can carry single grade or two grades of cargo. In the direct line pipe-system the cargo lines for loading lead straight from the manifold to the tanks and all tanks are connected by bottom crossover valves to two or three lines designated for loading. When loading the cargo it is loaded directly into the tanks without any additional bends or crossovers. The ring main system or the independent line system is a much more flexible system. This system is mainly used on product tankers for the reason that these tankers carry up to 5 to 6 grades at the same time. The system provides possibilities to carry different grades of cargo, load or discharge them simultaneously. Each manifold leads the cargo from the deck directly to the tank. Each tank is fitted with an individual pump. This system includes more bends and valves and is more vulnerable to leaks compared to the direct line system. *(Solly 2011. 74)*

One end of the cargo pipe-line system starts and ends in the cargo tanks, for loading and discharging, the other end is at the cargo manifolds. The manifold provide the flanges at which the shore cargo hoses and arms are connected. The arrangement of the deck pipe-lines depends on the number of cargo pumps and manifolds on board the tanker. It is common to have the same amount of cargo manifolds as cargo pumps both on the port and starboard side of the deck. This usually numbers between two, three or four manifolds depending on the arrangement. On the deck of a tanker, there are many additional lines that exist other than those required for cargo operations. These are service pipes for bunker fuel, main fire line, inert gas line, steam lines and electrical cable piping. *(Solly 2011. 78,80)*

The pump room might in some cases be a very complex network of lines. The pump room is generally located aft off the cargo area. The pump room is built with the dexterity to load the cargo through the same set of lines, which are used for the purpose of discharging the cargo, there is though, a by-pass so that the loaded cargo doesn't have to be routed through the cargo pumps which are located in the pump room. *(Solly 2011. 78,80)*

6.6 High level and overfill alarms

These alarms will prevent the possibility of overfilling a cargo tank. The high level alarm will indicate when the tank is 95% full of its capacity, the overfill alarm indicates a level of 98%. These alarms are a requirement as per MARPOL and are of great importance on board tankers and they should be tested before entering port. The alarm panels are located either in the CCR or at the bridge where it is possible to acknowledge the alarms. By using a main switch located in the CCR, the operator decides where the main control is located. During cargo operations its usually in the CCR and when navigating it is on the bridge. *(Bhanawat (a) 2012. 76-79)*

6.7 Fixed gas detection system

Present day tankers are equipped with fixed gas detection systems to determine whether any flammable toxic vapours are present in the air. The main principle of gas measuring equipment used on tankers is to draw a sample of the air, which is examined and compared with a standard, pre-determined and calibrated value. The fixed gas detection system mainly consists of a sampling point, analysing unit, sample driving pump, sensors, flow switches and display console. Gas measuring equipment is mostly fitted in enclosed spaces such as ballast tanks, cofferdams, forepeaks, void spaces and pump-rooms. The gas detection system should always be kept running. *(Bhanawat (a) 2012. 55-56)*

6.8 Tank radar gauging system

Tank gauging systems measure the tank ullage locally and the readings are displayed in the CCR. These measurements are used to control the cargo level and quantity. Different kinds of computer-based loading programs also use the measurements to calculate draught, trim and hull stresses. Cargo quantities are difficult to manage closely without gauging facilities. Accurate cargo quantities are of the upmost importance when monitoring tank levels during cargo transfer to ensure that planned cargo quantities are attained, without over filling the tanks. The final ullage gauging device will also make it possible to calculate the loading or discharging rates and this will enable the deck department to estimate the cargo completion time and pilot ordering times. The most common gauging systems is the radar gauge system which bounces a pulse of radar energy off the cargo surface back to a reflector. The time taken for the pulse to be received is related to the ullages and therefore the cargo quantities can be calculated. These radar gauges operate with high accuracy. *(Solly 2011. 71-72)*

6.9 Cargo heating systems

The cargo is heated with heating coils within the cargo tank, steam is supplied to all these coils through inlets, return lines and valves. The heating coils are most often made of stainless steel. All these lines circulate the steam into the cargo tanks and the cargo is heated. There is a main steam line, which branches out into individual lines providing heating for various tanks on board the tanker. Alternatively heat exchangers mounted onto the deck can be used. This system is very efficient but cannot be used whilst discharging a tank as the cargo is re-circulated through the heater and back into the tank to achieve heat. Therefore, during discharging re-circulation cannot take place and the cargo is subsequently cooled throughout the discharge operation. When crewmembers are operating the heating lines special care should be taken when and if steam valves have to be opened to avoid severe burns. PPE’s should always been worn when in contact with heated pipelines or stem. *(Solly 2011. 108)*

6.10 Mast Riser

Mast risers are fitted on board tankers to allow for large volumes of vapours to escape during loading, discharging and ballasting. To relieve excess pressure built during loading operations the mast riser valve can be opened manually to release gases into the atmosphere. *(Bhanawat (a) 2012. 23)*

6.11 P/V Valves

According to SOLAS Chapter II-2 paragraph 59, tankers must be fitted with a different kind of venting arrangement. One of them is the pressure vacuum valve, which has to be fitted on every cargo tank. The valve must be able to open and close in response to pressure changes in the cargo tank due to temperature variations. The working principle of this valve is that it consists of a measured weight that moves due to the pressure changes in the tank. As the pressure in the tank increases the weight is lifted up and relieves the excess pressure to protect the tank structure. If there is vacuum in the tank the suction on the vacuum side moves the weight down and allows air to enter the tank. A second method of venting must be fitted that will permit full release of the vapour during loading or discharging if the primary method fails to do it. *(Armitage 2009. 27-28)*

A pressure vacuum breaker can be incorporated into the IG system. This is a system protection device against over and under pressure but it doesn't protect individual tanks. The PV-breaker is connected to the main IG-line. The breaker is filled with a mixture of water and glycol. At normal pressure the liquid level stays the same the level of the liquid will rise and fall according to the pressure exerted, if the upper pressure limit is exceeded the level will drop and release the excess pressure to the atmosphere. In case of vacuum is created the liquid level will rise and air will be drawn in from the atmosphere relieving the vacuum in the system. *(Solly 2011. 57, 58)*

Other methods that can be used are pressure sensors that are fitted on each tank and connected to a monitoring alarm system, which gives off audible and visual alarms in case of overpressure or under pressure. During loading tank pressure should be extremely closely monitored. There is a direct relationship between the loading rate and the pressure in the tank. The higher the loading rate is, the higher the pressure in the tank will become. *(Armitage 2009. 27-28)*

6.12 Stripping pumps and eductors

The last process of removing the remaining cargo from the tanks is called stripping. This is usually done by either stripping pumps or eductors. The final stripping may be a very time consuming part of the discharge and the stripping operation must be very carefully planned to save as much time as possible. To save time modern tankers are equipped with stripping lines which make it possible to continue discharging whilst performing internal stripping between cargo tanks. Fluid driven eductors are usually used and they are located in the lower levels of the pump-room since they need suction to function and assist the stripping of the cargo or ballast from lines, pumps and tanks. Development of suction in a large pipeline can be time consuming when involving a stripping pump, for that reason tankers are equipped with eductors. The eductor hasn't any moving parts and it simply establishes a venture effect by its design and through the flow of liquid. The eductor employs the venture effect by having cargo pumped through the main direction of the flow. *(Solly 2011. 85)*

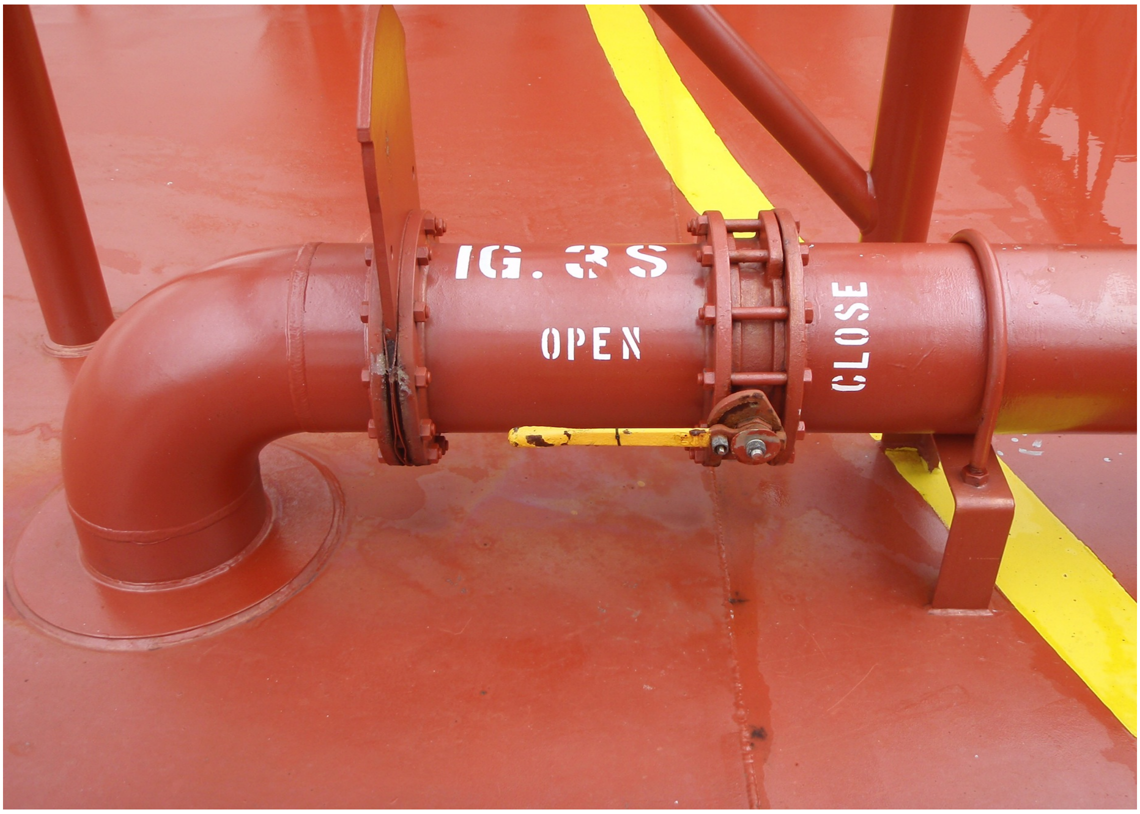
6.13 Emergency stops

Emergency stops are major safety features on board tankers in case of an emergency such as oil spill, leakage or in case of any emergency from the shore side. These remote switches are placed at various locations, usually at the manifolds, in the pump room and in the Cargo Control Room. The emergency stops should always be tested before entering a port. When the emergency stop is pushed during operations it will stop all the cargo pumps and close the manifold. *(Bhanawat (a) 2012. 58-59)*

6.14 Oil Discharge Monitoring and Control System (ODME)

OILPOL Regulations of 1954 required that no oil or oily mixtures that had a oil content above 1/100ppm was to be discharged into the water within fifty miles of land. The use of the system in both machinery spaces and cargo discharges is mandatory as per MARPOL. MARPOL requires ODME to be fitted on all tankers of 150 GT and above. This system is provided onbord to control overboard discharge by ensuring the amount of oil outflow is within the limits. Nowadays testing of the ODME must be properly recorded onboard the vessel. MARPOL requires that the system shall be fitted with a recording device to provide a continuous record of the discharge in litres per nautical mile and total quantity discharged, or the oil content and rate of discharge. *(Solly 2011. 141)*

Picture 13. The maindeck of MT Tempera



Picture 14. IG-line on board MT Tempera

Picture 15. Cargo Control Room (CCR) on board Bodil Knutsen

Picture 16. Manifolds of MT Tempera

Picture 17. Mast Riser onboard Hanne Knutsen

7. Cargo Operations on board oil tankers

When it comes to cargo operations on board oil tankers, utmost care should be taken during loading and discharging. During these operations which have an extremely hazardous nature the OOW and the deck-watch should be focused and know what they are supposed to do during the different stages of the operation. Loading and discharging are very critical operations, an error may result in an immediate accident or an incident that may compromise the tanker, the environment, the ship crew or the shore personnel. Sometimes even the smallest mistake can take the form of an ugly situation involving fire, oil spill, and explosions.

All cargo operations should be carefully and thoughtfully planned and documented well in advance. The details of the cargo operation plan should be thoroughly discussed with all personnel involved prior to loading or discharging*. (ISGOTT 2006. 159)*

7.1 Precautions whilst a Tanker is at a Petroleum Berth.

When a tanker is alongside a petroleum berth the ship must comply with the terminals safety regulations as well as the ship's regulations and procedures. There must be sufficient officers and crew on board at all times to deal with cargo operations and possible emergency situations. As a rule of thumb, no more than 50% of any department should be ashore at the same time and at least one of either Captain or Chief Officer should be on board during port operations. Fire-fighting equipment should be available for instant use and be placed at the correct locations on the deck. It is also very essential that the main engine and auxiliary engines required to manoeuvre the ship are ready for immediate use. Repairs and other work that may immobilize the vessel shouldn't be carried out at berth without Port Authority permission. The ship's crew are responsible for frequent checks according to SSSCL and the ship's own procedures. Good mooring practice should be kept at all times. It is especially important that spring lines are kept tight at all times when loading arms are connected because of the limited fore and aft operating range of the arms. The current oil industry advice is that the use of emergency towing wires is not recommended. Research has shown that far more injuries to the personnel have occurred in rigging them than can be justified by their perceived benefit. In fact the industry research could not identify a single incident of the wires being used for their intended purpose. However, terminal regulations may still require them to being rigged. If they are to be used then the emergency towing off wires should be rigged forward and aft on the offshore side from the berth in order that tugs can attach themselves to a tanker in event of an emergency. *(Solly 2011. p 97)*

Picture 18. Oil Tanker during mooring

7.2 Cargo Planning

The Chief Officer is directly responsible for all the cargo related operations on board and delegates tasks to other officers and the rest of the crew. An important part of successful operations is the planning of loading/discharging. For a plan to be as effective as possible it should contain sufficient information to cover all aspects and avoid misunderstandings among the officers and the crew on board. The Chief Officer must consider all the information that his subordinates are likely to need in order to carry out the operations successfully and without any incidents. The cargo plan should include information about the cargo operations and give very clear and precise instructions to officers and crew involved (Solly 2011.p 87). Before commencing any loading or discharging operations the ship's cargo pipelines and all relevant valves should be set as the cargo plan states. The officer in charge should always double-check the valves before commencing. *(ISGOTT 2006.p 159)*

An effective cargo plan should at least contain the following information:

- Grades to be loaded/discharged
- Sequence of loading/discharge
- Quantities
- Expected density/loading temperature
- Tanks/lines or pumps that will be used
- Status of critical valves in pipeline system
- Ballasting/de-ballasting sequence
- Inert Gas requirements
- COW and stripping instructions
- Starting rate, Maximum rate and topping off rate.
- Maximum manifold/cargo-line pressure
- Mooring management
- Watch-keeping arrangements
- Port specific detail such as tidal streams, water depth at berth, crane operations and communications. *(Solly 2011 p 87-88)*

See Fig 4, Loading Plan on board Shuttle tanker Hanne Knutsen

See Fig 5, Discharging plan on Shuttle tanker Hanne Knutsen

7.3 Prior, during and after Loading

Prior to the arrival at the loading terminal the tanker has to ensure readiness in the following aspects. Ensure that IGS, COW, cargo pumps, valves and the IG recorder are fully operational. Check that all portable gas meters are fully operational and in working condition. Ensure that deck area and pump room is clear of oily substances and the oil spill equipment are ready for use. The high level 95% and overfill 98% alarms should be tested. *(Banawhat (b) 2012. 8 - 9)*

The responsibility for safe cargo handling operations is shared between the vessel and the terminal. The manner in which the responsibility is shared should therefore be shared between both of the parties. *(ISGOTT 2006. 160)*

Loading of the cargo can be carried out in different ways, by gravity, by pumps or through ship to ship. Before starting the loading the Chief Officer and the terminal representative should agree that both the tanker and terminal are ready to commence loading safely. An emergency shutdown procedure should be agreed before commencing loading and also be recorded. This procedure should state the circumstances in which loading must be stopped immediately. A deck officer should be on watch in the CCR while loading and a continuous watch on deck should be carried out. The agreed ship to shore communication system should be agreed and constant radio checks should also be carried out. Prior to commencing loading the inert gas plant should be closed and the inert gas pressure in the tanks reduced unless both loading and discharging is taking place at the same time. *(ISGOTT 2006. 160-161)*

When all the necessary terminal and tanker valves are open and the vessel is ready the loading can commence at a slow rate, usually an initial rate of 500m3/h is agreed on. When it's possible the loading should start by gravity to a single tank. Usually a first foot is loaded at first, this stage involves loading up to a foot or more in one tank or in all tanks. Samples are then taken for analysis to find out if tanks are free of residues from the previous cargo and this will also allow the terminal to make a quality check ensuring that the correct grade is being loaded. If the samples are ok the vessel can continue the loading. When the vessel receives cargo and there are no signs of leaks the terminal can start to increase the loading rate. The vessel opens the cargo tanks as stated in the loading plan. When the terminal starts the pumps the vessel manifold should be checked for leaks by the deck-watch until full loading rate is reached. Throughout loading the vessel should monitor all tanks to confirm that cargo is entering the correct tanks and there is no cargo escaping into pump-rooms, cofferdam or the sea. The vessel should hourly check and monitor tank ullages and double-check with UTI if necessary. Vessel should also hourly check and record share forces, bending moments, draught, trim and GM. The deck-watch should carry out frequent inspections on the cargo deck, pump-room, moorings, gangway and over-side areas. Cargo figures should then be compared with the terminal figures. Checks according to the SSSCL item ”R” should be carried out as agreed with terminal. When topping off cargo tanks the vessel should test the ship-shore communication and inform the terminal in adequate time to reduce the loading rate to topping off rate that has been agreed upon loading. The ullages from topped off tanks should time to time be checked by UTI to ensure that no overflows occur due to leaking valves. After topping off and the loading has been completed all individual, segregation and manifold valves should be closed. The vessel should never load a tank to more than 98% volume as the remaining 2% volume has to accommodate the expansion of the cargo due to variation in the temperature during the loaded voyage. The vessel should never close all its valves against flow of cargo. Shore valves should be closed before vessel's valves. *(ISGOTT 2006.162-165)*

See Fig 6, Instructions for the deck-watch during terminal loading.

7.4 Ship Shore Safety Check List

Operations concerning cargo handling, tank cleaning and pre-wash, ballasting and bunkering require an exchange of information between the ship and terminal. Before commencing loading the ship's Chief Officer and a terminal representative should meet up for a ”safety” meeting and the Ship/Shore Checklist (SSSCL) will be completed. ISGOTT has a pro-forma checklist, which is commonly used. This checklist contains a number of questions, which must be answered by both the ship and the terminal. Some questions are marked as:

- A, any procedures & agreements should be in writing in the remarks column and must be signed by both parties
- P, in case of a negative answer, the operation should not be carried out without permission of the port authority
- R, items are to be re-checked at mutually agreed intervals *(Solly 2011. 93,94)*

Some of the following things are discussed during the Ship/Shore safety meeting before the cargo operation can start:

- Means of safe access to be provided between ship and shore either by ship or shore gangway
- The ship has to be securely moored to ensure it does not move during the loading/discharging
- The means of communication, normal means of communication are UHF or VHF radios
- Local safety and pollution regulations
- The vessel's fire fighting equipment had to be ready for use and fire hoses must be rigged at all times
- Action to be taken in the event of spills or leaks
- Depending on the terminal fire wires might be a requirement. The wire is rigged on the opposite side to which is alongside. These wires are used in case of emergency so that the vessel can be towed out of port limits
- All scuppers should be plugged to prevent oil getting spilled overboard. Temporarily opened scupper plugs should be monitored continuously during heavy rain etc.

- Maximum pumping rates and maximum pressure available at the ship/shore cargo connection, and any other restrictions
- Cargo hoses and loading arms to be in good condition and properly rigged
- Number and sizes of hoses or arms to be used, manifold connections required for each cargo to be handled and any limitations on the movement of hoses or arms
- All tanker and bunker hatches to be closed
- Copy of ship's fire plan, IMO crew list and stowage plan should be kept near the gangway to assist the shore fire fighting team in case of a fire.
- The tanker should move under it's own power at all times while alongside
- Smoking permitted only in designated smoking areas
- The SSSCL should be rechecked usually with a frequency of 4 hours
- The emergency escape route from the ship should be agreed. Usually the ship gangway opposite the side which is alongside is used for this.
- The emergency shutdown procedure and signal should be understood by all involved in the cargo operation.
- The hazards and toxicity of the cargo should be identified and understood
- All external doors should be locked in case of leakage of cargo vapours and due to ISPS regulations. *(Banawhat 2012 (b). 11 - 22)*

7.6 The Loaded Passage

Monitoring and taking care of the cargo is very important during the loaded voyage. This involves following heating instructions, maintaining watertight integrity of cargo tank spaces and vapour release control. The vapour release control is increasingly being considered due to cargo loss. It has been estimated that 1.6 to 4 million tons of cargo is lost due to VOC emissions yearly. MARPOL Annex I addresses air pollution and will reduce the quantity emitted during loading due to use of vapour return lines. For voyage emissions there are no current restrictions when at deep sea. If the pressure builds up then either the ship venting arrangements will release the pressure or then it can be released manually through the mast riser. Any release of hydrocarbon vapour has a polluting consequence. If these can be retained onboard they are still a part of the cargo when reaching the terminal and will be available to the refinery. *(Solly 2011. p 104)*

7.7 Prior, during and after Discharging

The cargo discharge is the time where some things could possibly go wrong. The discharge operation is directly under the control of the vessel's officers and crew and it will be evident if there are deficiencies in the discharging equipment or in the operational practice. There are important factors that impact on the vessel's performance and they need to be considered in the planning stage of the discharge such as the size and length of shorelines, the elevation of storage tanks, the use of booster pumps and the properties of the cargo that is carried. *(Solly 2011. 104).*

Before commencing discharging the Chief Officer and the terminal representative must agree that both the tanker and the terminal are ready to safely commence discharging. This agreement usually involves the SSSCL. During discharging no abrupt changes in flow-rate should be made and the vessel should follow the maximum manifold pressure and discharging rates given by the terminal at the preloading meeting. *(ISGOTT 2006. 179)*

Discharging can be carried out by using the cargo pumps located either in the pump room or on deck. When the tanker is ready to start the discharge it will contact the terminal and inform them about their readiness to commence. When the terminal informs their readiness to receive cargo the manifold can be opened, pumps can be started and when the cargo is passing the manifold the deck-watch will confirm this to the CCR, the OOW then informs the terminal that cargo is passing. As the cargo is passing the deck-watch should check the manifold area and the pump room for any signs of leaks and keep an eye on the manifold pressure. If the cargo tanks are loaded to full capacity, 95% or even 98% they should always be de-bottomed one by one to approx. 90% before starting bulk discharge to avoid cargo overflowing on deck if trim or list exceeds maximum values. When all cargo tanks are at 90% the discharging rate can slowly be increased up to full pressure or full discharging rate according to the discharging plan. The ullages should be frequently monitored during the discharging to ensure that cargo is getting discharged from the correct tanks and not transformed into other tanks. *(Banawhat 2012. 36 - 39)*

See Fig 7, Instructions for the deck-watch during discharging.

7.8 De-ballasting, ballasting and the Ballast Voyage

Before starting de-ballasting the water-surface of the ballast tanks should be inspected, once they are checked and found to be free from oil de-ballasting can be commenced by gravity at first and with ballast pumps when needed. The rate of de-ballasting depends on the loading rate, the loading plan contains detailed information about the different de-ballasting sequences. During loading de-ballasting can be used to keep the vessel upright and the final stages of de-ballasting includes stripping of the ballast tanks. When ballasting basically same things happen but in different order, start ballasting by gravity and change to ballast pumps when needed. *(Banawhat (b) 2012. 53 - 54)*

On a double-hulled crude oil tanker the ballast voyage will involve a quick water wash of any cargo tank that is to be gas-freed and inspected. The heavy weather ballast tank may also be washed *(Solly 2011. 49).*

It is very important that Masters and Officers are aware that partially loading a cargo tank with heavy water ballast may present a large problem due to ”sloshing”. The combination of free surface and the flat tank bottom can result in heavy rolling and damage internal structure and pipelines *(ISGOTT 2006. 187).*

On a product tanker the ballast voyage is a busy period where the cargo tanks are prepared for the next cargo. The degree on tank cleaning required will depend on the cargo to be loaded, previous cargoes, tank coating condition and weather conditions. Irrespective of any charterer’s advice it is the vessel’s responsibility to arrive at the loading terminal with the nominated cargo *(Solly 2011. 49)*

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Picture 2. Double Hulled oil tanker

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Picture 3. BLS onboard Shuttle Tanker

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Picture 4. Stena Ast Sunshine

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Picture 5. Stena Conquest

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Picture 6. Bodil Knutsen. Own archive

Picture 7. Hanne Knutsen. Ola Ivar Rød. Captain Hanne Knutsen

Picture 8. Widawati

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Picture 9. Mozah

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Picture 10. Dräger EEBD

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Picture 11. Hermetic UTI

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Picture 12. Multigas detector

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Picture 13. MT Tempera. Own archive

Picture 14. MT Tempera. Own archive

Picture 15. Bodil Knutsen. Own archive

Picture 16. MT Tempera. Own archive

Picture 17. Hanne Knutsen. Own archive

Picture 18. Oil Tanker mooring

http://upload.wikimedia.org/wikipedia/commons/9/93/Mooring_an_oil_tanker_in_Saint-Nazaire.jpg

MAERSK

Dumbarton Crude Oil
Material Safety Data Sheet

1. Identification of Substance/Preparation and Company Information

Product Name: Dumbarton Crude Oil

Supplier: Maersk Oil North Sea UK Limited
Crawpeel Road
Altens Industrial Estate
Aberdeen
AB12 3LG

Telephone No: 01224 216600

2. Composition/Information on Ingredients

Chemical Names and Synonyms: Dumbarton Crude Oil

Globally Reportable MSDS Ingredients:

Substance Name	Approx.
Whole Crude Density @15°C	0.8310 g/ml
C5+ Density @15°C	0.8581 g/ml
Sulphur Content	0.28 % Wt
Mercaptan Sulphur	<1 ppm
Hydrogen Sulphide	<1 ppm
Total Nitrogen	0.0603 % Wt
Basic Nitrogen Content	0.0211 %Wt
Conradson Carbon Residue	1.42 %Wt
Nickel (Ni)	0.8 mg/kg
Sodium (Na)	15.3 mg/kg
Vanadium (V)	2.6 mg/kg
Salt content	60 mg/l
Methane	<0.01 %Wt
Ethane	0.01 %Wt
Propane	0.25 %Wt
Isobutane	0.25 %Wt
n-Butane	1.07 %Wt
Isopentane	0.97 %Wt
n-Pentane	1.44 %Wt
Hexanes C6+	98.74 %Wt

Note: Crude oils may contain varying concentrations of hydrogen sulfide depending on gas stripping operations. Crude oils may also contain varying concentrations of benzene, cumene, cyclohexane, ethylbenzene, naphthalene, toluene, and xylene. See Section 8 for exposure limits (if applicable).

Figure 1

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Dumbarton Crude Oil
Material Safety Data Sheet

3. Hazard Identification

This product is considered hazardous according to regulatory guidelines (See Section 15).

Emergency Overview: Brown-black Liquid. Extremely flammable. Vapour accumulation could flash and/or explode if in contact with open flame. Exposure to fire can generate highly toxic fumes.

Hydrogen sulphide, an extremely flammable, very toxic gas, is expected to be present.

Potential Health Effects: Inhalation of H2S may be fatal.

Overexposure to H2S or vapours/aerols/liquids may cause respiratory irritation, dizziness, nausea, loss of consciousness, central nervous system effects and in cases of extreme exposure, possibly death.

Overexposure to benzene may result in cancer, blood disorders and damage to the bone marrow. Low viscosity material-if swallowed may enter the lungs and cause lung damage.

Exposure to normal hexane may result in nerve damage.

Potential Environmental Effects: Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment.

For further health effects/toxicological data, see Section 11.

4. First Aid Measures

Eye Contact: Flush thoroughly with water. If irritation occurs, call a physician.

Skin Contact: Dry-wipe the skin. Cleanse the area with waterless hand cleaner, and follow by washing thoroughly with soap and water. Remove contaminated clothing. Launder clothing before reuse. Discard shoes if material has penetrated to inside surface. In case of contact with hot product, flush skin with cold water to dissipate heat. Get medical advice immediately. (See Section 16 - Injection Injury Warning)

Inhalation: Immediately remove from further exposure. Get immediate medical assistance. For those providing assistance, avoid exposure to yourself and others. Use adequate respiratory protection. Give supplemental oxygen, if available. If breathing has stopped, assist ventilation with a mechanical device.

Ingestion: Seek immediate medical attention. Do not induce vomiting.

Note to Physicians: Material if aspirated into the lungs may cause chemical pneumonitis. PRE-EXISTING MEDICAL CONDITIONS WHICH MAY BE AGGRAVATED BY EXPOSURE: Benzene-Individuals with liver disease may be more susceptible to toxic effects. Hexane-Individuals with neurological disease should avoid exposure.

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Dumbarton Crude Oil
Material Safety Data Sheet

5. Fire Fighting Measures

Extinguishing Media: Carbon dioxide, foam, dry chemical and water fog.

Special Fire Fighting Procedures: Use water to keep fire exposed containers cool. If a leak or spill has not ignited, use water spray to disperse the vapours and to protect personnel attempting to stop leak. Water spray may be used to flush spills away from exposures. Prevent runoff from fire control or dilution from entering streams, sewers, or drinking water supply.

Special Protective Equipment: For fires in enclosed areas, fire fighters must use self-contained breathing apparatus.

Unusual Fire and Explosion Hazards: Extremely flammable. Vapour accumulation could flash and/or explode if in contact with open flame. Exposure to fire can generate highly toxic fumes.

6. Accidental Release Measures

Notification Procedures: Report spills/releases as required to appropriate authorities.

Procedures if material is released or spilled:

Land Spill: Shut off source taking normal safety precautions. Take measures to minimize the effects on ground water. Recover by pumping using explosion-proof equipment or contain spilled liquid with sand or other suitable absorbent and remove mechanically into containers. If necessary, dispose of adsorbed residues as directed in line Section 13.

Water Spill: Confine the spill immediately with booms. Warn other ships in the vicinity. Notify port and other relevant authorities. Remove from the surface by skimming or with suitable absorbents. If permitted by regulatory authorities the use of suitable dispersants should be considered where recommended in local oil spill procedures.

Environmental Precautions: Prevent material from entering sewers, water sources or low lying areas; advise the relevant authorities if it has, or if it contaminates soil/vegetation.

Personal Precautions: See Section 8

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Dumbarton Crude Oil
Material Safety Data Sheet

7. Handling and Storage

Handling: Avoid contact with skin. Avoid inhalation of vapours or mists. Use in well ventilated area away from all ignition sources. Trace amounts of H2S may be present. Keep face clear of tank and/or tank car openings. Avoid all personal contact and breathing gas. Avoid sparking conditions. Ground and bond all transfer equipment. See Section 8 for additional personal protection advice when handling this product.

Storage: Inhalation hazard: Contains trace amounts of H2S. Environment should be tested for contaminant before entering area. Drums must be grounded and bonded and equipped with self-closing valves, pressure vacuum bungs and flame arresters. Store away from all ignition sources in a cool area equipped with an automatic sprinkling system. Outside or detached storage preferred. Storage containers should be grounded and bonded.

Empty Container Warning: Empty containers retain residue (liquid and/or vapour) and can be dangerous. DO NOT PRESSURISE, CUT, WELD, BRAZE, SOLDER, DRILL, GRIND OR EXPOSE SUCH CONTAINERS TO HEAT, FLAME, SPARKS, STATIC ELECTRICITY, OR OTHER SOURCES OF IGNITION; THEY MAY EXPLODE AND CAUSE INJURY OR DEATH. Do not attempt to refill or clean container since residue is difficult to remove. Empty drums should be completely drained, properly bunged and promptly returned to a drum reconditioner. All containers should be disposed of in an environmentally safe manner and in accordance with governmental regulations.

8. Exposure Controls and Personal Protection

Engineering Controls: If current ventilation practices are not adequate to maintain airborne concentrations below the established exposure limits (see section 2), additional ventilation or exhaust systems may be required. Where explosive mixtures may be present, electrical systems safe for such locations must be used.

Personal Protective Equipment (PPE): Wear positive pressure air supplied respirator in situations where there may be potential for airborne exposure to H2S above limits (see section 2) . H2S has poor warning properties, and appropriate air purifying cartridges are not commercially available. A certified air purifying respirator with an organic vapour cartridge may be used under conditions where H2S is not detected, and airborne concentrations of hydrocarbons are expected to exceed exposure limits. Protection provided by air purifying respirators is limited (see manufacturer's respirator selection guide). Use a positive pressure air supplied respirator if there is a potential for an uncontrolled release, exposure levels are not known, or any other circumstances where air purifying respirators may not provide adequate protection.

Skin: The use of gloves impermeable to the specific material handled is advised to prevent skin contact and possible irritation (see glove manufacturer literature for information on permeability).

Eye/Face: Approved eye protection to safeguard against potential eye contact, irritation or injury is recommended. Depending on conditions of use, a face shield may be necessary.

Other Protective Equipment: A source of clean water should be made available in the work area for flushing eyes and skin. Impervious clothing should be worn as needed.

Dumbarton Crude Oil
Material Safety Data Sheet

9. Physical and Chemical Properties

Appearance:	Liquid
Colour:	Brown-black
Odour:	Hydrocarbon Rotten egg
Boiling Point:	140°C
Melting Point:	No Data Available
Flash Point:	< 16 °C
Solubility in Water:	Negligible
Explosive Properties:	N/A
Oxidising Properties:	N/A
Vapour Density (air=1):	0.21
Relative Density (15 °C):	0.8310
Pour Point	9 °C
Wax content	4.3 %Wt
Total Acid Number	0.1 mgKOH/g
Reid Vapour Pressure	3.7 psi
Water Content	0.045 %Wt
Volume of Water and Sediment	0.05 %Vol
Kinematic Viscosity @ 20°C	12.75 cSt
Kinematic Viscosity @ 40°C	6.286 cSt

10. Stability and Reactivity

Stability (thermal, light, etc.): Stable.

Conditions to Avoid: Heat, sparks, flame and build up of static electricity.

Incompatibility (Materials To Avoid): Strong oxidizers.

Hazardous Decomposition Products: Product does not decompose at ambient temperatures.

Hazardous Polymerization: Will not occur.

11. Toxicological Information

Toxicity following a single exposure (oral, dermally or by inhalation) to high levels of residual fuel oils is normally of a low order. Under certain conditions small quantities of Hydrogen Sulphide, a toxic gas, may be liberated into the vapour phase. Residual fuel oils may contain polycyclic aromatic hydrocarbons and have been classified as category 2 carcinogens.
Dusts generated during the removal of combustion deposits will be harmful if inhaled.
Repeated contact may reslt in serious irreversible disorders.

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Dumbarton Crude Oil
Material Safety Data Sheet

12. Ecological Information

Environmental Fate and Effects: In the absence of specific environmental data for this crude oil product, this assessment is based on information developed with various other crude oils. Overall, crude oil will float on the water surface if released in an aquatic environment; if released on land, crude will absorb to sediment and soil. Generally, crude oil is harmful to aquatic organisms. Indirect toxicity to aquatic wildlife may result from physical fouling, and shoreline habitats can be significantly impacted by crude oil. Because of the range of components which comprise crude oil, individual hydrocarbon components will begin to partition to specific environmental media (air, water, soil, and sediment) immediately following a release. Volatile components will be degraded in the atmosphere via hydroxyl oxidation. Overall, crude oil is inherently biodegradable in aquatic and terrestrial environments, since most fractions of crude oil are known to degrade at moderate to rapid rates, while some of the heaviest components are expected to persist.

13. Disposal Considerations

Waste Disposal: Product is suitable for burning in an enclosed, controlled burner for fuel value. Such burning may be limited pursuant to the Resource Conservation and Recovery Act. In addition, the product is suitable for processing by an approved recycling facility or can be disposed of at an appropriate government waste disposal facility. Use of these methods is subject to user compliance with applicable laws and regulations and consideration of product characteristics at time of disposal. RCRA INFORMATION: Disposal of unused product may be subject to RCRA regulations (40 CFR 261). Disposal of the used product may also be regulated due to ignitability, corrosivity, reactivity, or toxicity as determined by suitable local area legislation.

14. Transport Information

ADR/RID:	Petroleum Grade Oil, Flammable Liquid, Class 3, Item 31c. Hazard Identification No. 30.
UN:	Petroleum Grade Oil, Flammable Liquid, Class 3, Un Number 1267.
IATA/ICAO:	Petroleum Grade Oil, Flammable Liquid, Class 3, Packing Code, Class 3
IMO:	Petroleum Grade Oil, Flammable Liquid, Class 3,
EMERGENCY ACTION:	Flammable Liquid, Class 3W

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Dumbarton Crude Oil
Material Safety Data Sheet

15. Regulatory Information

Labelling

Flammable (F+)
Carcinogenic Category 2
Symbol: Black Skull & Cross Bones
Classification: Toxic. Dangerous for the environment
R45 - May cause cancer.
R52/53 - Harmful to aquatic organisms, may cause long-term adverse effects in the aquatic environment
R66 - Repeated exposure may cause skin dryness or cracking
S53 - Avoid exposure - obtain special instructions before use.
S45 - In case of accident, or if feeling unwell, seek medical advice immediately - show the label where possible.
S61 - Avoid release to environment. Refer to special instructions/safety data sheet

16. Other Information

Further information can be found in various publications, a list of which may be obtained from the Health and Safety Executive.

17. Documentary Information

Issue date: 01/04/08
Previous Issue Date: 10/05/07
Original Issued Date: 10/05/07

18. Disclaimer

The information in this Data Sheet applies only to the products designated herein and produced or supplied by Maersk Oil North Sea UK Limited or its subsidiary companies. It is based on our experience and on the data available to us at the time of its issue and is accurate to the best of our knowledge. The customer is strongly advised to observe and ensure that its employees and customers observe all directions contained herein. However, no warranty is made or implied that the information is accurate or complete and no liability will be accepted whatsoever - (other than liability in respect of the matters referred to in Section 2 Unfair Contract Terms Act 1977) arising out of the use of the information or the products designated herein. Where third party products are used in conjunction with or instead of products produced or supplied by Maersk Oil North Sea UK Limited or its subsidiary companies, the customers should himself obtain all necessary technical, health and safety information about such products from the third party.

MUSTERLIST

M/T HANNE KNUTSEN

FIRE ALARM	LIFEBOAT ALARM
SIGNAL: INTERRUPTED RINGING WITH THE ALARM BELLS	SIGNAL: UNINTERRUPTED RINGING OR; SEVEN SHORT AND ONE LONG RINGING WITH THE ALARM BELLS

ANY ALARM SHALL BE FOLLOWED BY AN ANNOUNCEMENT IN THE SHIPS PA SYSTEM (SPEAKER)

FOLLOWING AN ALARM ALL PERSONNEL ONBOARD SHALL MUSTER AT THEIR STATION ACCORDINGLY

LIFEBOAT - ALLOCATION AND DUTIES
ALL CREW AND PERSONNEL MUSTER AT LIFEBOAT RAMP

2ND OFFICER	BOAT LEADER - RELEASES LIFEBOAT
CHIEF OFFICER	SUPERVISING ALL PREPARATIONS
CHIEF OFFICER JR	SUPERVISE / ASSIST
3RD OFFICER	ASSIST BOAT LEADER / PREPARE RADIO EQUIPMENT
CHIEF ENGINEER	OPERATING SPRINKLER AND AIR BOTTLES
2ND ENGINEER	ASSIST WITH ENGINE
3RD ENGINEER	ASSIST WITH SAFETY BELT
ELECTRICIAN	RELEASE ELECTRICAL CABLE
BOSUN	REMOVING LASHING
FITTER	REMOVE CHAIN AT THE POOPDECK
CHIEF STEWARD	BRING BLANKETS, FOOD AND WATER
MESSMAN	BRING BLANKETS, FOOD AND WATER
BOY	BRING BLANKETS, FOOD AND WATER

ALL OTHER CREW AND PERSONNEL: AS PER ORDER

LIFEBOAT WILL BE RELEASED AFTER CAPTAINS ORDER ONLY

FIRE / MAN OVER BOARD / HELICOPTER OPERATIONS

CHIEF OFFICER IN CHARGE OF FIRE FIGHTING ON DECK AND ACCOMMODATION
CHIEF ENGINEER IN CHARGE OF FIRE FIGHTING IN ENGINE ROOM
3RD OFFICER IN CHARGE OF RADIO COMUNICATION DURING DISTRESS
SMOKE DIVERS TO BE FULLY DRESSED IN FIREMAN'S OUTFIT AND BREATHING APPARATUS.
TEAM LEADERS TO SUPERVISE AND ASSIST SMOKE DIVERS & RELAY COMMUNICATION BETWEEN SMOKE DIVERS, BRIDGE & FIRE LEADER.
IF A PERSON IS MISSING, THE PERSON NEXT IN LINE TAKES OVER HIS DUTIES.

BRIDGE		CREW.NO
MASTER	Henning Rogstad	612
C/O JUNIOR	Carl Fredrik Larsson	614
3RD OFFICER	Henrik Allan Nielsen	613
DECK CADET	Loid John M. Millamina	425
DECK CADET	Jonathan McCreadie	511
DECK CADET	Heine Bjørgen	513

DUTIES	ENGINE ROOM		CREW.NO
AS SITUATION	2ND ENGINEER		510
REQUIRES	MTM	Mark B. Guardaya	417

DUTIES	BACK-UP SQUAD	CREW.NO
PROVIDE BACK-UP AND ASSISTANCE AS REQUIRED		

DUTIES	SQUAD 1		CREW.NO
TEAM LEADER	2ND OFFICER		622
SMOKE DIVER	BOSUN	Alan Arcamo	420
SMOKE DIVER	A/B	Eduardo Presinede	414
ASSIST	A/B	Robert P. Manalo	415
ASSIST	O/S	Kevin Jay L. Casano	413

DUTIES	SQUAD 2		CREW.NO
TEAM LEADER	3RD ENGINEER		522
SMOKE DIVER	MTM	Allan B. Benavidez	418
SMOKE DIVER	MTM	Elmer C. Mendoza	419
ASSIST	A/B	John Kevin D. Del Ric	416
ASSIST			

DUTIES	TECHNICAL SQUAD		CREW.NO
CLOSE FIRE FLAPS AND ASSIST AS PER ORDER	ELECTRICIAN		621
	FITTER	Conrado A. Comision	422

HELICOPTER OPERATION			CREW.NO
HLO	TBC		
FIRE FIGHTER	BOSUN	Alan Arcamo	420
FIRE FIGHTER	AB	Eduardo Presinede	414

DUTIES	MEDICAL SQUAD		CREW.NO
PROVIDE FIRST AID AND MEDICAL CARE AS REQUIRED	CHIEF STEWARD		516
	MSM	Phillip Joy T. Celocia	411
	BOY	Edward Louie Pesimo	512

MOB-TEAM			CREW.NO
COXSWAIN	CHIEF OFFICER		514
CREW	AB	Robert P. Manalo	415
CREW	MTM	Mark B. Guardaya	417

DUTIES	FIRE LEADER		CREW.NO
IN CHARGE OF FIRE-FIGHTING RESPONSE	DECK	CHIEF OFFICER	514
	ENGINE	CHIEF ENGINEER	610

PREPARING MOB			CREW.NO
PAINTER	AB	Eduardo G. Presined	414
COVER + LASHING	AB	John Kevin D. Del Ric	416
LOWERING	BOSUN	Alan Arcamo	420

SQUAD 1 MEETS IN FIRESTATION NO.1 (STARBOARD)
SQUAD 2 MEETS IN FIRESTATION NO.2 (FOAM STATION)
TECHNICAL SQUAD AND MEDICAL SQUAD OUTSIDE FIRESTATION NO. 1

PASSENGERS, SERVICE / EXTRA AND OTHER PERSONNEL:

- MUSTER AT BRIDGE WHEN THE FIRE ALARM IS SOUNDED

- MUSTER AT LIFEBOAT RAMP WHEN THE LIFEBOAT ALARM IS SOUNDED

Figure 2

..

Instructions: General alarm

Master	In charge of the emergency operation onboard. Report the incident according to procedures. Remains owners representative until relieved by an appointed qualified individual.
Off duty Officer	Assist the Master. Transmit and receive reports as requested by Master. Keep log of all events and the overall progress.
Chief Officer	In charge of deck operation. Informs and keeps the Master updated regarding the situation and the results from actions taken to limit outflow.
Chief Engineer	In charge of bunker operation. Organise onboard clean-up equipment. Start fire/foam pump as required.
Duty Engineer	Prepare for fire fighting. Assist Chief Engineer. Ensure sufficient air pressure to deck.
Deck duty Officer	**Tank overfill (Loading):** Open up to empty or slack tank. Alert and inform Chief Officer regarding the situation. Mobilise off duty crew as necessary. **Discharging – Crude oil washing:** If un-controllable leakage from manifold, hoses or cow line: Stop cargo pumps by using the emergency stop. Close all manifold valves. Alert and inform Chief Officer. If leakage is from the flange, cargo line or other small leakages:. Alert and inform Chief Officer and bosun and reduce pumping speed.
Duty Deckhand	Mobilise deckhands, keep the oil from escaping overboard. Mobilise fire fighting squad, if needed. Assist Chief Officer as needed.
Off-duty Personnel	If oil leakage is detected alert immediately by all possible means. Inform Officer on duty immediately. Open valves from air driven portable pump(s) to slop tank(s) or an available empty tank and start pump(s). Position sorbent material (booms) to prevent oil from reaching the railing. Commence clean-up by using the onboard spill clean-up equipment. Assist according to instructions and as needed.

To meet at designated musterstation.

Figure 3

Terminal Loading Plan

Port	Hound Point		**Terminal**	
Voyage No.	392/13		**Date**	29.03.2013
Cargo	Forties Crude Oil		**Prospect**	675 000 bbls
Density @15°C	0.8230 (approx)		**Load temp.**	20,0 °C
Dep. Draught (SW)	Fwd: 13,00 mtrs	Mid: 13,00 mtrs		Aft: 13,00 mtrs

- VOM 02-30, Ship/Shore Safety – ISGOTT Checklist
- VOM 02-40 p. 1, Crude Oil Tankers – Cargo Operations Terminal Checklist
- VOM 02-40 p. 2, Crude Oil Tankers – Cargo Operations Terminal Checklist

Lining up for Loading:

Check that all manual cargo system valves on deck are closed. Check that spill trays are completely drained and that valves are closed. Check that all manifolds are blinded and that all bolts are in place. Connect hoses to cargo manifolds 2-3, 16" on starboard side. Line up from the tank and up to the manifold and then open up the correct manifold valves.

- Deck cross over valves: VB117, VB118, VB119, VB120, VB121, VB122 – **open**
- Tank line up: Drop lines VB070, VB071, **CT 3 P/S** tank valves – **open**
- Manifold valves – **open**

Loading procedure:

When ready for loading; open up **CT 3 P/S** and commence loading at a slow rate. Open up vapour return line. Check both manifolds and all lines on deck for leakages. When everything is checked and found ok; open up the rest of the tanks, slowly increase the loading rate up to maximum and load in all tanks according to the pre-planned conditions. Operate with great caution the valves in the main cargo flow.

- Drop lines: VB066, VB067, VB068, VB069 – **open**
- Tank valves: **CT 1, 2, 4, 5, 6, SLOP P/S – open**
- Bottom cross over valves VB056, VB057, VB058, VB059, VB185 (to slop)
- Ship stop
- Shore stop

Topping up procedures:

Call Chief Officer in good time before topping up commences. Adjust the tanks so that not all tanks are finished at the same time. Reduce the loading rate in due time before final topping up, giving the terminal time to reduce their pumps in a safe manner.

Anticipated loading rates:

Rate at commence of loading: *2000 m^3/h for 10 min.*
Max rate during loading: *11800 m^3/h.*
Topping off rate: *2000 m^3/h*
Agreed loading rates are subject to changes if more time is needed for de-ballasting, topping of tanks, etc. A request for change of loading rates must be directed to the feeders control room.

Trim/ list:

List will be adjusted by **CT 4 P/S** and trim with **CT 1/6 P/S.** Maximum trim during loading operation: 3.5m. 30 cm trim on departure.

De-ballasting:

Check the water surface of **WBT 1-6 P/S** visually for any irregularities. Commence de-ballasting by gravity according to the pre-planned conditions when the vessel has loaded for approx 30 min), then start both ballast pumps and continue the de-ballasting. Follow strictly the pre-planned conditions during the entire loading.

Sequence Plan for Cargo:

HRS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
CT 1P/S																								
CT 2 P/S																								
CT 3 P/S																								
CT 4 P/S																								
CT 5 P/S																								
CT 6 P/S																								
SLOP P/S																								

Officer's duties:

Chief Officer is in charge of the loading operation and will be available at all times. Officer on watch is responsible for filling in all required checklists and logs, and to load and de-ballast according to pre-planned conditions. Officer on Watch shall also:

- Ensure that duties according to the ship security level in force are carried out as described in the Ship Security Plan.
- Frequently monitor the shear forces and bending moments.
- Frequently monitor the inert pressure of all cargo tanks.
- Frequently monitor the backpressure.
- Instruct the deck watches to stop draining rainwater overboard if oil film appears on the sea surface.
- The ballast pumps temperatures to be checked on regular basis throughout the pumping of ballast. Casings, High: 50°C, High High: 70°C. Bearings, High: 70°C, High High: 90°C
- If considered necessary, call for time-out*.

- Sealing fluid is filled on the ballast pumps.
- Forward thrusters gravity tanks handles are switched over to loaded position when forward draught exceeds 11.0 m.
- The cooling & seal water valves for the ballast vacuum pump are opened before the pump is used.
- Ballast vacuum pump are switched to manual mode and stopped when the loading is completed.
- Check lists completed after loading

Watchmen duties:

There will be a minimum of two watchmen on duty at all times. One watchman will always be stationed at the manifold area, while the other watchman is walking around checking for leakages from the cargo system, checking mooring lines etc. The pumproom must be checked every hour during the whole loading. The watchmen must also check the sea surface frequently for any irregularities.. Duties as required by the Ship Security Plan, e.g. controlling and logging embarking persons and their effects, to be carried out as well. If more crew is needed in order to manage all duties, OOW must be advised immediately so that more crew can be sent on deck. If in doubt or if irregularities are observed, the Officer on Watch must be informed immediately. If considered necessary, call for time-out.

Time-out during cargo operations:

If an abnormal alarm sounds, or the remote monitoring and control system fails, the cargo operation shall immediately be stopped. The Officer on Watch shall notify his superior and establish procedures for local control and monitoring, e.g. manual soundings. Sufficient deck hands shall be available and the operation shall not start again until a sufficient level of safety has been re-established. Always available: **C/O & Bosun**

<table>
<tr><th colspan="2">CCR</th><th colspan="2">Deck</th></tr>
<tr><td rowspan="2">0000-0400 / 1200-1600</td><td rowspan="2">2/O Ellegård</td><td rowspan="3">0000-0600 / 1200-1800</td><td rowspan="3">AB Del Rosario / OS Baino / DCT Trotter</td></tr>
<tr></tr>
<tr><td rowspan="2">0400-0800 / 1600-2000</td><td rowspan="2">C/O Jr. Nilsen</td></tr>
<tr><td rowspan="3">0600-1200 / 1800-2400</td><td rowspan="3">AB Buena / OS Presinede / DCT Dumaloan</td></tr>
<tr><td rowspan="2">0800-1200 / 2000-2400</td><td rowspan="2">3/O Solax</td></tr>
<tr></tr>
</table>

See enclosed loading sequence plan and pre-planned conditions.
If any problem or if any doubt – call Chief Officer immediately!!

Figure 4

Discharge Plan

<table>
<tr><td>Port</td><td colspan="2">Brunsbüttel</td><td>Terminal</td><td colspan="2">Elbeharbour</td></tr>
<tr><td>Voyage No.</td><td colspan="2">392/13</td><td>Date</td><td colspan="2">03.04.2013</td></tr>
<tr><td>Cargo</td><td colspan="2">Forties Blend Crude Oil</td><td>Prospect</td><td colspan="2">676 000 bbls</td></tr>
<tr><td>Density @15°C</td><td colspan="2">0.8376</td><td>Load temp.</td><td colspan="2">30 °C</td></tr>
<tr><td>Dep. Draught (SW)</td><td>Fwd: 7 mtrs</td><td colspan="2">Mid: 8 mtrs</td><td colspan="2">Aft: 9 mtrs</td></tr>
</table>

- VOM 02-30, Ship/Shore Safety – ISGOTT Checklist
- *VOM 02-38 # 1-6*, Crude Oil Washing – Pre-Arrival
- VOM 02-40 p. 1, Crude Oil Tankers – Cargo Operations Terminal Checklist
- VOM 02-40 p. 2, Crude Oil Tankers – Cargo Operations Terminal Checklist

Lining up for Discharging:

Check that all manual cargo system valves on deck are closed. Check that spill trays are completely drained and that valves are closed. Check that all manifolds are blinded and that all bolts are in place. Connect hoses to cargo manifolds 2-3, 16” on port side. Line up from the tank and up to the manifold and then open up the correct manifold valves.

- Deck cross over valves : 117, 118, 119, 120, 121, 122 – **open**
- Bottom line valves: 183, 184, 185 – **open**
- **Bottom crossover lines 56, 57, 58, 59 – open**
- Cargo pumps suction valves: 63, 64, 65 – **open**
- Pump room discharge valves: 73, 74, 75, 76, 78, 80 – **open**
- **CT 4 P/S** tank valves – **open**
- Manifold valves – **open**
- Fill sealing liquid in the cargo and ballast pumps.

Discharging procedure:

When ready, start discharging from CT 4 P/S with COP #3. Check both manifolds and all lines on deck for leakages. When everything is checked and found ok and you have confirmed that the terminal is receiving cargo and is ready for a higher rate; open up the rest of the tanks, start up the other pumps and slowly increase the loading rate up to maximum.

Empty the tanks in the following sequence: 1&4 P/S (COW) → 3&6 P/S → 2&5P/S

- Split the lines and use COP # 3 on CT 1&4 P/S and COP #2 on CT 2,3,5,&6 P/S.
- COW CT 1&4 P/S at the same time with supply from slop P/S.
- Meanwhile we run cargo ashore from CT 2 & 5 P/S with COP #2
- When COW are completed, eject CT 1&4 P/S with COW pump with supply from slop tanks..
- When CT 1&4 P/S are empty. Stop COW pump and start COP#1 for stripping 3 &6 P/S.
- When 3 &6 P/S are empty, eject them with supply from CT 2 & 5 P/S and COP#2.
- Simultaneously open the cross over valve and discharge from CT 2 & 5 P/S with COP#3.
- Strip CT 2 & 5 P/S with COP #3 before we finally eject them with COW pump from slops.
- Empty slop tanks with COP#1 and COW pump.
- Discharge all tanks according to the pre-planned conditions.
- Drain down all lines with stripping pump trough stripping line.

Crude Oil Washing:

We will wash following tanks in the following sequence: **CT 1 + 4 P/S**. Call Chief Officer 1 hour before commence of COW, which will start when there is about 300 m^3 cargo in the tanks. Make sure that there is enough difference between the tank pairs so that we have at least 1.5 m of cargo in the next tank pair to be washed. Wash **CT 1+4 P/S** with **COW pump** with supply from bottom line.

- Ensure that all machines are set to bottom wash.
- Measure the tank atmospheres (O_2 content must be less than 8%)
- *VOM 02-38 #7-12, Crude Oil Washing – Before Crude Oil Washing*
- *VOM 02-38 #13-19, Crude Oil Washing – During Crude Oil Washing*
- *VOM 02-38 #20-24, Crude Oil Washing – After Crude Oil Washing*

Stripping:

Strip the tanks carefully as they are getting empty. Use the ejector to take out the last drops from the tanks; then drain all cargo lines with the ejector before pumping ashore the slops.

Trim/ list:

Adjusted list by **WBT 3 P/S**. Maximum trim during the operation: 6 meters.

Sequence plan for discharging:

HRS	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
CT 1P/S																				cow				
CT 2 P/S																								
CT 3 P/S																								
CT 4 P/S																				cow				
CT 5 P/S																								
CT 6 P/S																								
SLOP P/S																								

Ballasting:

Commence ballasting by gravity according to the pre-planned conditions when the vessel has discharged for approx 1 hour, then start both ballast pumps and continue the ballasting.

Sequence plan for Ballasting

WBT 1 P/S																									
WBT 2 P/S																									
WBT 3 P/S																									
WBT 4 P/S																									
WBT 5 P/S																									
WBT 6 P/S																									

Officer's duties:

Chief Officer is in charge of the discharging operation and will be available at all times. Officer on watch is responsible for filling in all required checklists and logs, and to discharge and ballast according to pre-planned conditions. Officer on Watch shall also:

- ✓ Ensure that duties according to the ship security level in force are carried out as described in the Ship Security Plan.
- ✓ Frequently monitor the shear forces and bending moments.
- ✓ Frequently monitor the inert pressure of all cargo tanks.
- ✓ Frequently monitor the backpressure.
- ✓ Instruct the deck watches to stop draining rainwater overboard if oil film appears on the sea surface.

- ✓ The ballast pumps temperatures to be checked on regular basis throughout the pumping of ballast. Casings, High: 50°C, High High: 70°C. Bearings, High: 70°C, High High: 90°C
- ✓ If considered necessary, call for time-out*.

- Sealing fluid is filled on the ballast pumps.
- Forward thrusters gravity tanks handles are switched over to loaded position when forward draught exceeds 11.0 m.
- The cooling & seal water valves for the ballast vacuum pump are opened before the pump is used.
- Ballast vacuum pump are switched to manual mode and stopped when the loading is completed.
- Check lists completed after loadin

Watchmen duties:

There will be a minimum of two watchmen on duty at all times. One watchman will always be stationed at the manifold area, while the other watchman is walking around checking for leakages from the cargo system, checking mooring lines etc. The pumproom must be checked every hour during the whole loading. The watchmen must also check the sea surface frequently for any irregularities.. Duties as required by the Ship Security Plan, e.g. controlling and logging embarking persons and their effects, to be carried out as well. If more crew is needed in order to manage all duties, OOW must be advised immediately so that more crew can be sent on deck. If in doubt or if irregularities are observed, the Officer on Watch must be informed immediately. If considered necessary, call for time-out.

Time-out during cargo operations

If an abnormal alarm sounds, or the remote monitoring and control system fails, the cargo operation shall immediately be stopped. The Officer on Watch shall notify his superior and establish procedures for local control and monitoring, e.g. manual soundings. Sufficient deck hands shall be available and the operation shall not start again until a sufficient level of safety has been re-established. Always available: **C/O & Bosun**

CCR		Deck	
0000-0400 / 1200-1600	**2/O** Ellegård	0000-0600 / 1200-1800	**AB** Del Rosario / **OS** Baino / **DCT** Trotter
0400-0800 / 1600-2000	**C/O Jr.** Nilsen		
0800-1200 / 2000-2400	**3/O** Solax	0600-1200 / 1800-2400	**AB** Buena / **OS** Presinede / **DCT** Dumaloan

See enclosed loading sequence plan and pre-planned conditions.
If any problem or if any doubt – call Chief Officer immediately!!

Figure 5

Instruction for watchmen on duty during loading at terminal.

- Check that all valves to sandpiper pump, gas raiser and manifold drains are closed prior arrival loading terminal.
- Confirm with CCR weather Riser or vapour return line to be used during loading. If riser are to be used make sure it is open and sandpiper pump running during loading.
- Start the deck trunk fans in high speed in good time before operation, and make sure the fans is running during the operation.
- Make sure that the following are in order; all scupper plugs fitted, rain water is drained prior to arrival, but make sure that no oily film enter the sea surface.
- Make sure that all manifolds not in use are blanked off with all bolts fitted.
- The vessel is to be earthed to the jetty before connecting of the loading arms.
- The Fire fighting equipments are to be rigged and prepared for use. Fire hoses are to be rigged, both fore and aft of the manifold.
- The oil pollution equipment must be ready for immediate use.
- One watchman to be stand-by at the manifold at all times.
- Enter the deck trunk minimum every hour and check for leaks etc. Follow the procedure for “entering deck trunk”. Report any abnormalities to CCR.
- Check the fire wire in both ends frequently, adjust if necessary.
- Check/adjust the mooring lines/wires regularly, this is of extreme importance.
- Check also the sea surface around the vessel frequently, report to CCR if anything abnormal is observed.
- Make sure that all doors to the accommodation, stores etc. are closed during the operation.
- If the vessel’s gangway is being used, make sure that the safety net is properly rigged.
- Make sure that the departure board are placed with correct departure time.
- All visitors names to be entered into the visitors log.
- The watchmen to hoist/lower flags switch on/off deck lights.
- Always give feed back to CCR when involved in ballast handling regarding sounding, valve closing/opening etc.
- Always give feed back to CCR when involved in cargo handling as sounding, valve closing/opening etc.
- Do not hesitate to call the CCR if /when any doubts.
- Do not hesitate to press the Terminal Emergency stop button, normally located by the shore gangway or immediately call the CCR.

Figure 6

Instruction for watchmen on duty during discharging terminal.

- Check that all valves to sandpiper pump, gas raiser and manifold drains are closed prior arrival discharging terminal.
- Start the deck trunk fans in good time before entering.
- Make sure that the following are in order; all scupper plugs fitted, rain water is drained prior to arrival, but make sure that no oily film enter the sea surface.
- Make sure that all manifolds not in use are blanked off with **all** bolts fitted.
- The vessel is to be earthed to the jetty before connecting of the discharge arms.
- The Fire fighting equipments are to be rigged and prepared for use. Fire hoses are to be rigged, both fore and aft of the manifold.
- The oil pollution equipment must be ready for immediate use.
- Sandpiper pumps to be ready for immediate use in case of oil spill.
- One watchman to be stand-by at the manifold at all times.
- Enter the deck trunk minimum every hour and check for leaks etc. Follow the procedure for “entering deck trunk”. Report any abnormalities to CCR.
- Check the fire wire in both ends frequently, adjust if necessary.
- Check/adjust the mooring lines/wires regularly, this is of extreme importance.
- Check also the sea surface around the vessel frequently, report to CCR if anything abnormal is observed.
- Make sure that all doors to the accommodation, stores etc. are closed during the operation.
- If the vessel’s gangway is being used, make sure that the safety net is properly rigged.
- Make sure that the departure board are placed with correct departure time.
- All visitors names to be entered into the visitor’s log.
- The watchmen to hoist/lower flags switch on/off deck lights.
- Always give feed back to CCR when involved in ballast handling regarding sounding, valve closing/opening etc.
- Always give feed back to CCR when involved in cargo handling as sounding, dipping, crude oil washing, valve closing/opening etc.
- Do not hesitate to call the CCR if /when any doubts.
- Do not hesitate to press the Emergency stop button.

Figure 7