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Hanna Askola, VTT Technical Research Centre of Finland Ltd

GUIDEBOOK ON ENVIRONMENTAL, HEALTH AND SAFETY REQUIREMENTS WHEN TRANSPORTING CARBON DIOXIDE BY SHIPS WITHIN FINNISH TERRITORIAL WATERS

ccsp
Carbon Capture and Storage Program

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Report Title: **GUIDEBOOK ON ENVIRONMENTAL, HEALTH AND SAFETY REQUIREMENTS WHEN TRANSPORTING CARBON DIOXIDE BY SHIPS WITHIN FINNISH TERRITORIAL WATERS**

Key words: Carbon dioxide, ship operations, ship transportation, EHS requirements

Abstract

This Guidebook is the Deliverable D130 in the five-year Carbon Capture and Storage Program (CCSP) by Cleen Ltd. The overall long term objective of the program is to develop CCS related technologies and concepts relevant for Finnish conditions enabling piloting and demonstrations, which are a prerequisite for a commercial breakthrough of CCS technologies.

No permanent storage of carbon dioxide (CO_2) is foreseen in Finland. In order to capture large amounts CO_2, safe and efficient transportation to permanent storage is required. Due to the long transport distances and the coastal location of the majority of the emission sources, ship transportation is considered as the most significant option for transferring CO_2 captured in Finland to final storage destinations.

Liquefied gas cargo handling procedures can be complex and the cargo itself is potentially hazardous. Additionally, the marine transport chain of CO_2 would be a complex multi-stakeholder environment including port administration, port operators, product owners, charterers and carriers. The purpose of this report is to present a clear and understandable overview of the current environmental, health and safety (EHS) requirements for handling CO_2 in ship transportation and terminal operations within Finnish territorial waters and ports. The report covers the most relevant legislation and requirements concerning terminal operations and ship transportation.

Shipping of CO_2 is very similar to shipping of liquefied petroleum gases, and the long-standing experience and the existing regulatory framework can be exploited. The International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) under the International Maritime Organization (IMO) rules can be considered to cover the transport of CO_2. All IMO's international codes and regulations are abided worldwide, and they form the spine of various national maritime regulations.

Besides the IMO's regulations, the most relevant Finnish legislation in the topic is considered in this report more carefully. The international regulations and national legislation are continually updated by authorities in order to improve the transport safety and security, as well as to take into account the scientific and technological development.

Disclaimer: The information given in this Guidebook is meant to give a quick overview of the relevant EHS requirements in the international and Finnish legislation. In order to make the text easier to read, some generalisations have been made. In other words, the wording in this document is not exactly following the text in the original international and Finnish versions of the legislation. Some sentences, paragraphs or even acts and decrees, which have been seen as less important in this context, have been left out (e.g. regulations concerning navigation). Therefore, always check not only the original regulations mentioned in this report, but also other acts, decrees and decisions relevant to your work after you have read this Guidebook.

Espoo, February 2015

Guidebook on environmental, health, and safety requirements when transporting carbon dioxide by ships within Finnish territorial waters

Askola H.

11.2.2015

Table of contents

1 INTRODUCTION

This Guidebook is the Deliverable D130 in the five-year Carbon Capture and Storage Program (CCSP) by CLEEN Ltd. CCSP is one example of several platforms created by CLEEN Ltd. The overall long term objective of the program is to develop Carbon Capture and Storage (CCS) related technologies and concepts relevant for Finnish conditions enabling piloting and demonstrations, which are a prerequisite for a commercial breakthrough of CCS technologies.

Environmental, health, safety and sustainability impacts of CCS have to be recognised by operators introducing CCS technologies. Although carbon dioxide (CO_2) is generally not considered to be a hazardous substance, various sections in the Finnish legislation will apply when carbon capture technologies will be introduced at power plants and other industrial establishments in Finland. The current legal environmental, health and safety requirements an operating company must fulfil when introducing various technologies for carbon capture in Finland, are presented in the Deliverable D129.

At the end of the CCS chain CO_2 is to be stored safely for a very long period of time in isolation from the atmosphere. No permanent storage of CO_2 is foreseen in Finland due to the quality of the Finnish ground. In order to capture large amounts CO_2 in Finland, safe and efficient transportation to permanent storage is needed. For an industrial scale application, only pipeline or ship transportation of CO_2 are viable options (Teir et al 2010).

In Finland, transport of liquefied CO_2 in ship tanks may be economically attractive, particularly when CO_2 has to be moved over long distances or overseas (Teir et al 2011). The nearest suitable disposal areas are located in the northern parts of Poland and Germany, in the southern Denmark, and in the southern Baltic Sea area. Due to the long transport distances and the coastal location of the majority of the emission sources, ship transportation is considered as a significant option for transferring CO_2 captured in Finland to final storage destinations. Compared with building of pipelines for transporting CO_2, the infrastructure needed for gas tanker operations requires fewer investments and fewer authorisations. However, pipelines may be preferred for transporting large amounts of CO_2 for distances up to around 1.000 kilometres (IPCC 2005).

Shipping of CO_2 is very similar to shipping of liquefied petroleum gases, enabling the exploitation of the long-standing experience and the existing regulatory framework. The International Gas Carrier regulation (IGC Code) under the International Maritime Organization (IMO) rules is to be modified to include the transport of carbon dioxide. (Energy Institute 2010.)

Cargo handling procedures of liquefied gases can be complex, and the cargo itself is potentially hazardous. For these reasons, personnel operating with gas carriers and within gas terminals require a thorough understanding of terminal operations and cargo properties. To avoid accidents, safe operating procedures need to be followed and clear emergency plans must be prepared. (McGuire et al 2000.) The purpose of this report is to serve as guidance for stakeholders, whenever they are designing, planning or executing CO_2 ship transportation.

2 SCOPE OF THE REPORT

The purpose of this report is to present a clear and understandable overview of the current environmental, health and safety requirements of handling carbon dioxide (CO_2) in ship transportation and terminal operations within Finnish territorial waters and ports. This report covers the most relevant legislation and requirements regarding terminal operations and ship transportation. The Finnish territorial waters are defined in the Act on the Delimitation of the Territorial Waters of Finland (463/1956). The territorial waters in Finland consist of internal and external waters, and the territorial sea reaching to maximum distance of twelve nautical miles from the outer limits of the internal waters. Even though the scope of this report is limited to Finnish territorial waters, international legislation and requirements have to be examined besides the Finnish legislation due to the international CO_2 transportation voyages and the international nature of shipping.

The purpose of the maritime rules and regulations is to ensure the safe transport of dangerous goods, and to reduce damages which could occur in potential accidents. Regulations concerning transporting goods by sea are largely based on international agreements. Safety of Life at Sea (SOLAS) and MARPOL Conventions by International Maritime Organization (IMO) are considered as the most significant international regulations in marine transportation. Some of the most significant national legislation and the European Community law in the topic are considered more carefully in this report, even though the most regulations follow the international maritime regulations' frame and content basically word for word. The international and national legislation and requirements concerning marine transportation chain of CO_2 are viewed in chapter 5.

The marine transport chain of CO_2 is a complex multi-stakeholder environment consisting on port administration, port operators, product owners, charterers and ship carriers. Finnish authorities Finnish Transport Safety Agency (Liikenteen turvallisuusvirasto Trafi) and Finnish Transport Agency (Liikennevirasto), supervise safety of transportation and other operations.

According to Railas (2006), besides the laws and regulations due diligence and care shall be observed in the transport of dangerous goods and in other related measures, such as packaging and temporary storage. The type, quantity and transport mode of the goods to be carried have to be taken into account. The parties with an effect on the safety of the transport and temporary storage of dangerous goods, such as the consignor, shipper, loader, carrier, operator and consignee shall for their part ensure the taking of measures necessary to prevent accidents as well as their harmful consequences to people, the environment and property.

For ships' personnel, much of the environmental, health and safety (EHS) information is made available by means of approved courses to obtain dangerous cargo endorsements for sea-going certificates. For terminal personnel, such background may be available at national institutions. (McGuire et al 2000.) In Finland, employers arrange the education and training of their terminal personnel based on the work safety regulations and individual needs.

In this guidebook the CO_2 is considered to be in the liquid state during the temporal storage, loading operations and transporting by ships. According to Aspelund et al (2006), economical large-scale transport of CO_2 by ship could be done in semi-pressurized vessels of around 20 000 m^3 at pressures near triple point (6.5 bar and –52°C) in order to use well established design for commercial construction of LPG carriers and intermediate storage. This condition also gives the highest density in the liquid state, which reduces transport unit costs. Liquefaction of CO_2 is best achieved in an open cycle, as the refrigeration is partly or fully provided by the feed gas itself.

3 OPERATIONS CONSIDERED

The operations of CO_2 transportation chain considered in this Guidebook are

- Temporal storage of CO_2 in terminal area,
- Terminal operations (loading into ships' tanks), and
- Ship transportation.

The possible hazards of CO_2 transportation are explained further in the chapter 4.

3.1 Temporal storage in terminal area

CO_2 transportation in gas tankers requires intermediate storage capacity and loading facilities in one or more harbour terminals in Finland. Terminals are important nodes in the CO_2 transportation chain combining pipeline transportation from emission sources (power plants, industrial establishments) to ship transportation and finally to permanent storage. Transporting the captured CO_2 by pipeline to a Finnish harbour is likely to be continuous and predictable cargo flow, whereas in the ship transportation lot sizes of cargos and loading frequencies may vary due to ship transportation service level and circumstance factors. Therefore intermediate CO_2 buffer storage of up to one-and-a-half times the ship tank capacity will be needed on at least the in loading side (Energy Institute 2010). Intermediate storage of CO_2 is likely to be in semi-refrigerated tanks at about 20 bar (Malmén et al 2012).

Environment, safety and risk aspects

Due to the properties of the liquefied CO_2 gas, temporal storage includes potential dangers to the human beings, assets and environment. One of the most dangerous situations would be a sudden release of the gas from pressure tanks and piping, which would create a risk of intoxication and eventually death of human beings nearby. Risks of the potential hazards can be reduced by maintaining safe storage procedures, controlling access to the terminal storage area, and developing efficient emergency response actions.

3.2 Terminal operations

Terminal operations include planning the CO_2 cargo loading operations from a temporal storage to a gas tanker, loading the cargo according to the agreed loading plan, making cargo and ship stability calculations, and preparing and sending cargo documents for relevant stakeholders. Prerequisite for the succeeded terminal operations is that the terminal and ship operators will get all the information on the amount and any special requirements of the CO_2 cargo well in advance.

To ensure safe terminal operations, a proper understanding of the working practices of both ship and shore personnel are necessary. From an operational viewpoint it should be appreciated that at the ship-to-shore interface two differing working cultures co-exist. (McGuire et al 2000.) The responsibility for safe cargo handling operations is shared between the ship and the terminal and rests jointly with the shipmaster and the responsible terminal representative. The representatives of the terminal company are responsible of the terminal equipment, working orders, technical safety measures, training of the personnel and the up-to-date risk assessments. The representatives of the shipping company (i.e. deck officers) are responsible for the condition and cleanness of the cargo tanks. They supervise

the loading of the CO_2 to the ship according to the loading plan, and maintain the cargo in the planned circumstances. The terminal administration is responsible for the overall safety and security.

Cargo handling procedures

Gas terminal operations can be described advanced due to the good practices in ensuring safety. All loading operations carried out should be under the continuous supervision of experienced ship and shore personnel. These personnel should be familiar with the details, hazards and characteristics of the cargoes being handled and capable of ensuring that such operations can be safely and efficiently completed. If cargo transfer operations need to be stopped, this should be carried out under previously agreed controlled conditions with proper communication. If the situation demands an emergency shut-down, the agreed procedure should be followed, bearing in mind the dangers of excessive surge pressures. (McGuire et al 2000.)

Before commencing operations, maximum cargo transfer rates have to be agreed. This should be done in accordance with vapour return specification, ship or shore re-liquefaction capacity and emergency shut-down requirements. Inevitably, some of these considerations may be based on best practical estimates. Accordingly, during operations, a strict watch should be maintained on flow rates, tank pressures and temperatures. By means of ship/shore communications, adjustments to initial agreements can be made as appropriate. (McGuire et al 2000.)

Good practices in hazardous gas handling operations are considered in detail in *the International Safety Guide for Oil Tankers and Terminals*:

- Before starting to load the cargo or discharge the ballast, the responsible ship's officer and the terminal representative must formally agree that both the ship and the terminal are ready to do so safely.
- A responsible officer must be on duty and sufficient crew on board to deal with the operation and security of the ship throughout loading. A continuous watch of the tank deck must be maintained. A senior terminal representative must be on duty and communications between him and the responsible ship's officer continuously available, and a competent member of the terminal organisation should be on continuous duty in the vicinity of the cargo connections.
- Supervision should be aimed at preventing the development of hazardous situations. In case of such a situation the controlling personnel should have adequate means available to take corrective action. The agreed ship-to-shore communications system must be maintained in good working order.
- At the commencement of loading, and at each change of watch or shift, the responsible ship's officer and the terminal representative must each confirm that the communications system for the control of loading and discharging is understood by them and by other personnel on duty.
- The stand-by requirements for the normal stopping of shore pumps on completion of loading and the emergency stop system for both the ship and terminal must be fully understood by all personnel concerned.

Vapour return facility

It is to be expected that the CO_2 gas vapours generated in the terminal operations need to be collected and re-liquefied for the safety and environmental reasons. Unacceptable gas pressures may develop in the ship's tanks during loading, and those have to lead in a controlled and safe means back to temporal storage facilities.

The vapours generated during loading may be transferred to the shore by a ship's compressor or vapour blower (figure 1). Alternatively, a terminal vapour blower or compressor may be used. In the latter case, loading rates are independent of the ship's vapour return capacity, although they may be limited by the shore re-liquefaction plant capacity. (McGuire et al 2000.)

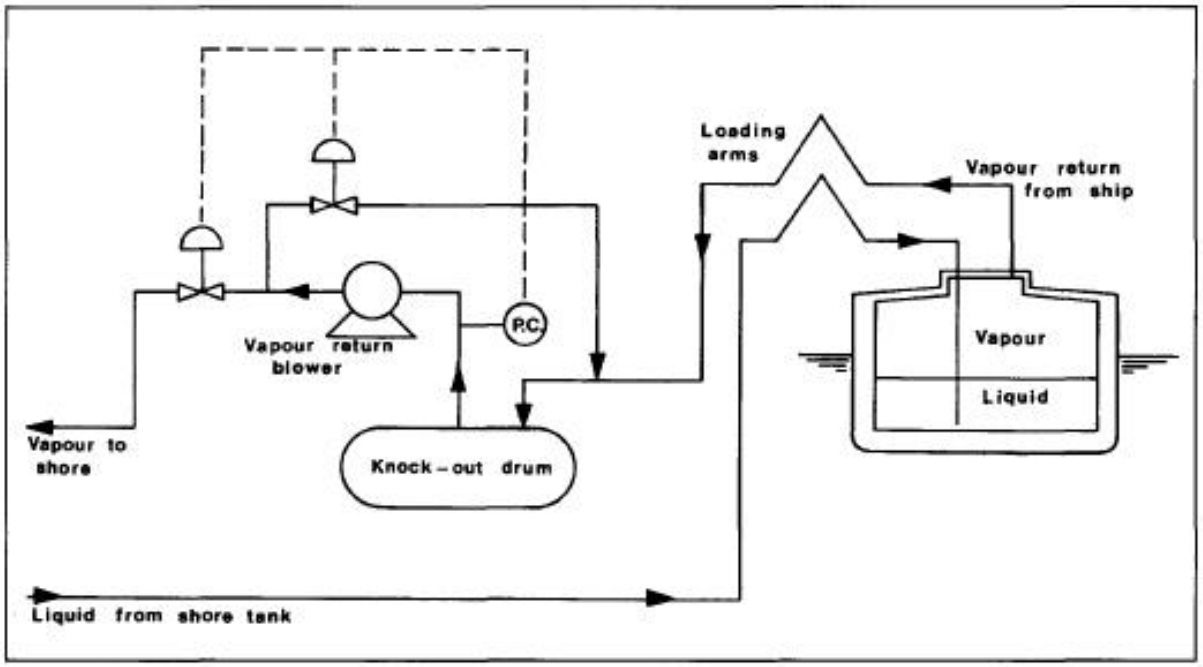

Figure 1. Vapour return using a shore based blower (McGuire et al 2000).

Environment, safety and risk aspects

Liquefied gas cargo handling procedures are quite complex, and therefore seamless co-operation between ship and terminal personnel is required. As it is in the temporal storage of CO_2, also in the terminal operations the most dangerous situation would be a sudden release of the gas from pressure tanks and piping, which would create a risk of intoxication and eventually death of human beings nearby.

3.3 Ship Transportation

Ship transportation of CO_2 includes ship operations at sea. So far the largest carriers for CO_2 shipment are in the range of 10.000 tons per ship and the maximum ship capacity is 20.000 m^3. (Malmén et al 2012). This Guidebook focuses especially in the cargo stabilizing procedures. Further, reporting to the monitoring authorities and stakeholders on a voyage is briefly described. The remaining ship transportation procedures consist of manoeuvring and navigating the ship as a gas tanker.

Gas carriers have many features which are not found on other types of tankers. All gas carriers are designed so that, in normal operation, personnel should never be exposed to the hazards posed by the products being carried. This assumes, of course, that the ship and its equipment are maintained properly and that operating instructions are followed. (McGuire et al. 2000.) The International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC code) defines specific minimum requirements for ship type, tanks, and gauging of CO_2 tankers.

Ship re-liquefaction plant

A CO_2 gas tanker might be fitted with a re-liquefaction plant due to environmental reasons. Usually the plant is located in a compressor house on deck. Adjacent to the compressor house is an electric motor room which contains the machinery for driving the re-liquefaction compressors. The electric motor room and compressor room must be separated by a gastight bulkhead. The IGC Code details the requirements for mechanical ventilation of these rooms. Positive pressure ventilation must be provided for the electric motor room and negative pressure ventilation for the cargo compressor area. (IMO 2000.)

A cascade re-liquefaction cycle is used for fully refrigerated cargoes where a special refrigerant such as refrigerant monochlorodifluoromethane[1] (R22) is used to obtain the lower carriage temperatures. Furthermore in these systems, refrigeration plant capacities are not so affected by sea water temperature changes compared with other re-liquefaction cycles. The cascade system uses a refrigerant such as R22 to condense cargo vapours; a simplified diagram for this system is shown in figure 2. The cargo, in condensing, evaporates the liquid R22 and the R22 vapour is then taken through a conventional R22 closed refrigeration cycle, condensing against sea water — hence the term cascade. (McGuire et al 2000.)

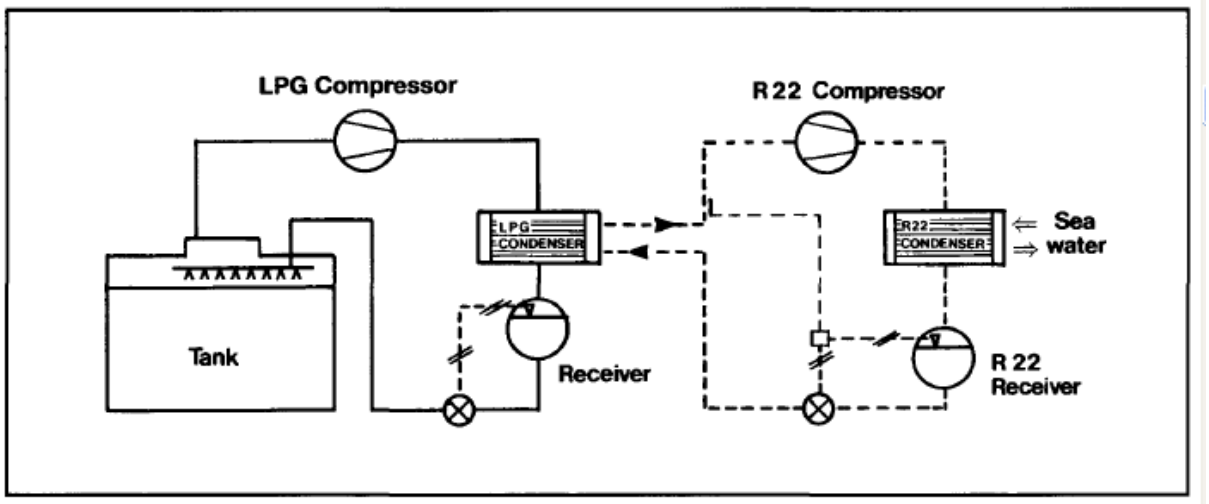

Figure 2. Simplified cascade re-liquefaction cycle (McGuire et al 2000).

[1] Properties of cooling chemicals are not included in this report. Generally speaking, product details and emergency procedures (proper action as recommended, and text covering first-aid treatment) of each coolant have to be available for each chemical which is transported or used onboard ships. As per the Montreal Protocol, R22 will eventually be phased out in the near future. (McGuire et al 2000.)

Environment, safety and risk aspects

Ship crew needs to perform good operating procedures to avoid cargo hazards. Additionally, specific safety drills should be kept and emergency plans should be available, in case an accident does occur. In some cases the transport of dangerous goods must be reported to authorities, or permission must be applied. (Häkkinen 2009.)

A sudden release of the gas from the ship´s pressure tanks would create a serious risk of intoxication and eventually death of human beings nearby. Precautions like personal breathing equipment and gas measurement devices should be taken also against minor releases. For ships, the total loss of CO_2 gas to the atmosphere would be between 3 and 4 % per 1000 km, counting both boil-off and the exhaust from ship engines. The boil-off could be reduced by capture and liquefaction, and recapture would reduce the loss to 1 to 2 % per 1000 km. (Metz et al 2005.)

Onboard gas tankers, fixed and portable gas measuring instruments are always provided. These instruments are for protecting crew against gases and the dangers they represent as health hazards, especially when entering an enclosed space. Regulations regarding the equipment for the evaluation of tank atmosphere are given in both the Chemical Tankers Codes and the Gas Carriers Codes. (IMO 2000.)

It is always preferable to achieve a gas-free condition in a tank or enclosed space prior to entry of personnel. Where that is not possible, entry into tanks should only be permitted in exceptional circumstances and when there is no practical alternative. In that case, breathing apparatus and protective clothing must be worn. (McGuire et al 2000.)

4 POTENTIAL HAZARDS IN SHIP TRANSPORTATION

4.1 Properties of CO_2

CO_2 gas is non-flammable, colourless and denser than air. It is not toxic, but high concentrations of CO_2 reduce the concentration of oxygen in the air which makes it hazardous to health.

Transportation of CO_2 by ship should be performed in semi-pressurized vessels at pressures near triple point (6.5 bar and –52°C) (Aspelund et al 2006). Besides the non-flammability, the properties of liquefied CO_2 are similar to those of liquefied petroleum gas (LPG) (IMO 2000).

The hazardous nature of the release of CO_2 is enhanced because the gas is colourless, tasteless and is generally considered odourless unless present in high concentrations. When contained under pressure, escape of CO_2 can present serious hazards, for example asphyxiation, noise level (during pressure relief), frostbite, hydrates or ice plugs, and high pressures. The handling and processing of CO_2 must be taken into account during the preparation of a health, safety and environment plan for any facility handling CO_2. (IPCC 2005.)

Suitable control procedures have been developed by industries which use CO_2, for example, minimizing any venting of CO_2 unless this cannot be avoided for safety or other operational reasons. Adequate ventilation must be provided when CO_2 is discharged into the air to ensure rapid dispersion. Due to its high density, released CO_2 will flow to low-levels and collect there, especially under stagnant conditions. High concentrations can persist in open pits, tanks and buildings. For this reason, monitors should be installed in areas where CO_2 might concentrate. Fixed monitors should be supplemented by portable monitors. (IPCC 2005.)

4.2 CO_2 impacts on human health

CO_2 can reduce the concentration of oxygen in the air. Signs of asphyxia will be noted when atmospheric oxygen concentration falls below 16 %. Unconsciousness, leading to death, will occur when the atmospheric oxygen concentration is reduced to 8 % and below. CO_2 intoxication is identified by excluding other causes, as exposure to CO_2 does not produce unique symptoms. (IPCC 2005.)

Longer exposure even to less than one per cent concentration may significantly affect health. Noticeable effects occur above this level, particularly changes in respiration and blood pH level that can lead to increased heart rate, discomfort, nausea and unconsciousness. Other symptoms may be headache, impaired vision and mental confusion.

Protective standards have been developed for workers who may be exposed to CO_2. The occupational standards exist and they provide a measure of the recommended exposure levels for employees. Site-specific risk assessments using these and other health data are necessary to determine potential health risks for the general population or for more sensitive subjects. (IPCC 2005.)

Guidance covering first-aid treatment for accidents involving cargo can be found in the Tanker Safety Guides, and in the Liquefied Gas Handling Principles On Ships And In Terminals (SIGTTO publication). (IMO 2000.)

4.3 Accidental leakages

Accidental leakages of CO_2 can occur due to technical faults of cargo equipment or human errors during operations and transportation. In the event of accidental leakage, emergency inspections or maintenance tasks, personnel may be exposed to liquid or gaseous product. To avoid more victims the rescue personnel has to be equipped with proper breathing apparatus. Previously, many additional and unnecessary deaths have occurred as a result of impulsive and ill-prepared rescue attempts. (McGuire et al. 2000.)

On spillage, liquefied CO_2 is brought immediately into contact with the ground or sea at ambient temperature. The temperature difference between the cold liquid and the material it contacts provides an immediate heat transfer into the liquid, resulting in the rapid release of vapour. (McGuire et al. 2000.)

If CO_2 escapes from a ship tank, the consequent pressure drop can cause a hazardous cold condition with danger of frostbite from contact with cold surfaces, with solid CO_2 (dry ice) or with escaping liquid CO_2. Ship crew should avoid entering a CO_2 vapour cloud not only because of the high concentration of CO_2, but also because of the danger of frostbite. Hydrates or ice plugs can form in the piping of CO_2 facilities and flow lines, especially at pipe bends, depressions and locations downstream of restriction devices. Temperatures do not have to fall below 0°C for hydrates to form; under elevated pressures this can occur up to a temperature of 11°C. (IPCC 2005.)

If the spill forms a pool on the ground or deck, the removal of heat from the ground beneath reduces the temperature difference. Eventually, temperature differences stabilise and the rate of evaporation continues at a lower level. Under these conditions, the liquid will continue to boil until completely evaporated. For spills on the sea, the strong convection currents in the water may maintain the initial temperature difference and evaporation will probably continue at the higher initial rate. In this case, the large quantities of cold vapour produced from the liquid will diffuse into the atmosphere and cause condensation of the water vapour in the air. By this process, a visible white vapour cloud is formed. (McGuire et al 2000.)

Large amounts of CO_2 can also be environmentally hazardous. Experiments have shown that sustained high concentrations of CO_2 would cause mortality of ocean organisms (IPCC 2005). CO_2 effects on marine organisms will have ecosystem consequences. The chronic effects of direct CO_2 injection into the ocean on ecosystems over large ocean areas and long-time scales have not yet been studied.

4.4 Ship and terminal accidents

Ship and terminal accidents of CO_2 may cause sudden and uncontrollable cargo releases. Severe collisions or groundings of gas tankers could lead to cargo tank damage and result in uncontrolled release of the gas. Such release could result in evaporation and dispersion of the CO_2 and, in some cases, could cause brittle fracture of the ship's hull. Compared to the

accidental leakages explained in the previous chapter 4.2, accidents may have far more serious and wider consequences.

An accident to a liquid CO_2 tanker might release liquefied gas onto the surface of the sea. CO_2 releases are anticipated not to have the long-term environmental impacts of crude oil spills. CO_2 would behave differently from LNG, because liquid CO_2 in a tank is not as cold as LNG but much denser. Its interactions with the sea would be complex. Hydrates and ice might form, and temperature differences would induce strong currents. Some of the gas would dissolve in the sea, but some would be released to the atmosphere. If there were little wind and a temperature inversion, clouds of CO_2 gas might lead to asphyxiation and might even stop the ship's engines. (Metz et al 2005.)

If collision should rupture a tank of CO_2, a sudden and large release of CO_2 would pose immediate danger to human life and to surroundings. The risk of tank rupture can be minimized by making certain that the high standards of construction and operation currently applied to LPG are also applied to CO_2. (Metz et al 2005.)

Ship transportation of CO_2 through populated areas requires attention to route selection, over-pressure protection, leak detection and other design factors. (IPCC 2005.) The risk of ship accident can be minimized by careful planning of routes, and by high standards of training and management.

5 CODES, LEGISLATION AND REGULATIONS

Codes, legislation and regulations on carrying goods by sea are largely based on international agreements and the European Community law. That will also apply on the transportation of CO_2 from Finland to permanent storage locations. The purpose of the requirements is to ensure the safe transport of goods and to reduce damages which would occur in potential accidents.

International Maritime Organization (IMO) is the United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships (IMO 2013). The International Convention for the Safety of Life at Sea (SOLAS) and the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) by IMO are considered the most significant international regulations in marine transportation regarding safety and environmental issues.

IMO's international codes and regulations are abided worldwide, and they form the spine of various national maritime regulations. The international and national maritime regulations are continually updated to improve the transport security as well as to take into account the scientific and technological development (Häkkinen 2009).

In this chapter, the most important EHS requirements in the international regulations and Finnish legislation concerning CO_2 transportation by ships are overviewed. Several laws, decrees and regulations define safety of gas and liquid terminals. The most relevant laws concern occupational safety, fire and rescue operations, dangerous goods, environmental issues, ship safety, traffic safety and crime prevention.

The international regulations apply to technical and operational safety of ships, terminals and infrastructure, and to environmental protection. The following Finnish legislation focuses on terminal and ship operation, and it includes for example Act on the Technical Safety and Safe Operation of Ships (1686/2009) and Act on Environmental Protection in Maritime Transport (1672/2009). Some legislation, such as Occupational safety and health act (738/2002) and Rescue act (379/2011), are already covered in the CCSP report D129 and therefore they are not further explained in this chapter.

There are two appendices in this report. The appendix A summaries all the international regulations which have been examined in this study, whereas in the appendix B the Finnish legislation examined is summarized. The tables in the both appendices are structured to include points of transport, responsibility and participants, and supporting regulations. As one can notice, there are many Finnish maritime regulations which do not apply for transportation of CO_2 due to its form of liquefied bulk, or its type of cargo considered as waste.

5.1 International Regulations

IMO has developed important provisions relating to maritime safety and environmental issues. Of these, the International Convention for the Safety of Life at Sea (SOLAS) and the International Convention for the Prevention of Pollution from Ships (MARPOL 73/78) are the most significant related to ship transportation and terminal operations both nationally and internationally.

The SOLAS Convention is the designation of the international maritime transport related safety rules and regulations. The Convention is an international treaty that specifies the construction, equipment and minimum requirements for the operation of vessels. The SOLAS chapter VII is focusing on the Carriage of Dangerous Goods and it sets a frame for example the IGC Code for ships carrying liquefied gas in bulk.

The MARPOL 73/78 Convention is an international convention for the prevention or to limit pollution of the marine and other environmental pollution. Annex II contains the regulations on pollution prevention of the marine environment by noxious liquefied substances carried as bulk.

Besides the SOLAS and MARPOL Conventions, there are several other international Conventions and regulations which support safe and environment-friendly ship transportation. Various IMO conventions demand individual flag state administrations to survey gas terminals and tankers and the related infrastructure and terminals.

5.1.1 International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk

Regulation: International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC code).

Key requirements: The purpose of the IGC Code is to provide an international standard for the marine transportation of liquefied gases in bulk and certain other substances, by describing the design and construction standards of ships involved in gas carriage. The equipment a gas tanker should carry so as to minimize the risk to the ship, to its crew and to the environment, having regard to the nature of the products involved, are defined in the IGC Code. Each of the products defined in the IGC Code may have one or more hazard properties, which include flammability, toxicity, corrosivity and reactivity. Further possible hazards may arise due to the products being transported under cryogenic or pressure conditions.

The requirements in the IGC Code are intended to minimize risk of severe collisions and groundings of gas tankers as far as it is practicable, based upon present knowledge and technology. The code primarily deals with ship design and equipment. In order to ensure the safe transport of the products the total system must, however, be appraised. Other important facets of the safe transport of the products, such as training, operation, traffic control and handling in port, are being or will be examined further by the IMO.

The IGC Code applies to ships regardless of their size engaged in carriage of liquefied gases. The structure, equipment, fittings, arrangements and material (other than items in respect of which a Cargo Ship Safety Construction Certificate, Cargo Ship Safety Equipment Certificate and Cargo Ship Safety Radio Certificate or Cargo Ship Safety Certificate are issued) of a gas carrier should be subjected to several scheduled and additional surveys. The condition of the ship and its equipment should be maintained to conform with the provisions of the Code to ensure that the ship will remain fit to proceed to sea without danger to the ship or persons on board or without presenting unreasonable threat of harm to the marine environment.

Specific requirements concerning CO_2 transportation: Terminal personnel and ship crew should be made aware of the hazards associated with the cargo being handled and should be instructed to act with care and use the appropriate protective equipment during cargo handling.

Cargo information should be on board and available to all concerned, giving the necessary data for the safe carriage of cargo. Such information should include:

- a full description of the physical and chemical properties necessary for the safe containment of the cargo;
- action to be taken in the event of spills or leaks;
- counter-measures against accidental personal contact;
- fire-fighting procedures and fire-fighting media;
- procedures for cargo transfer, gas-freeing, ballasting, tank cleaning and changing cargoes;
- special equipment needed for the safe handling of the particular cargo;
- minimum allowable inner hull steel temperatures; and
- emergency procedures.

The captain of the gas tanker should ascertain that the quantity and characteristics the product to be loaded are within the limits indicated in the International Certificate of Fitness for the Carriage of Liquefied Gases in Bulk and in the Loading and Stability Information booklet.

Terminal personnel and ship crew involved in cargo operations should be adequately trained in handling procedures. Additionally, all crew should be adequately trained in the use of protective equipment provided on board and have basic training in the procedures, appropriate to their duties, necessary under emergency conditions. Ship officers should be trained in emergency procedures to deal with conditions of leakage, spillage or fire involving the cargo, based on the guidelines developed by IMO, and a sufficient number of them should be instructed and trained in essential first aid for cargoes carried.

Transfer operations including emergency procedures should be discussed between ship personnel and the persons responsible at the shore facility prior to commencement and communications maintained throughout the transfer operations.

Cargo emergency shutdown and alarm systems involved in cargo transfer should be tested and checked before cargo handling operations begin. Essential cargo handling controls should also be tested and checked prior to transfer operations.

Personnel should not enter CO_2 cargo tanks, hold spaces, void spaces, cargo handling spaces, or other enclosed spaces where gas may accumulate, unless:

- the gas content of the atmosphere in such space is determined by means of fixed or portable equipment to ensure oxygen sufficiency and the absence of toxic atmosphere; or
- personnel wear breathing apparatus and other necessary protective equipment and the entire operation is under the close supervision of a responsible officer.

When carrying CO_2 cargoes at low temperatures:

- if provided, the heating arrangements associated with cargo containment systems should be operated in such a manner as to ensure that the temperature does not fall below that for which the material of the hull structure is designed;
- loading should be carried out in such a manner as to ensure that unsatisfactory temperature gradients do not occur in any cargo tank, piping, or other ancillary equipment; and
- when cooling down tanks from temperatures at or near ambient, the cool-down procedure laid down for that particular tank, piping and ancillary equipment should be followed closely.

Reflections to the Finnish Legislation: Act on the Technical Safety and Safe Operation of Ships (1686/2009); Act on Ships' Crews and the Safety Management of Ships (95/2013).

5.1.2 International Convention for the Prevention of Pollution from Ships

Regulation: International Convention for the Prevention of Pollution from Ships (MARPOL 73/78), (MARPOL Consolidated Edition 2011/2012).

Key requirements: Marpol 73/78 is an international convention for the prevention or to limit pollution of the marine and other environmental pollution. The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78 Convention) is concerned with preserving the marine environment through the prevention of pollution by oil and other harmful substances and the minimization of accidental discharge of such substances. Its technical content is laid out in six Annexes, the first five of which were in the 1973 Convention, as modified by the 1978 Protocol, and cover pollution of the sea by oil, by noxious liquid substances in bulk, by harmful substances in packaged form, by sewage from ships and by garbage from ships. Annex VI was adopted by the 1997 Protocol and covers air pollution from ships.

MARPOL Annex II defines regulations for the control of pollution by noxious liquid substances in bulk. It's applicable for all ships certified to carry noxious liquid substances in bulk, and therefore it is suitable for CO_2 transportation by sea as well.

The discharge requirements of the Annex shall not apply to the discharge into the sea of Noxious Liquid Substances or mixtures containing such substances when such a discharge:

- is necessary for the purpose of securing the safety of a ship or saving life at sea; or
- results from damage to a ship or its equipment:
- provided that all reasonable precautions have been taken after the occurrence of the damage or discovery of the discharge for the purpose of preventing or minimizing the discharge; and
- except if the owner or the master acted either with intent to cause damage, or recklessly and with knowledge that damage would probably result; or
- is approved by the Administration, when being used for the purpose of combating specific pollution incidents in order to minimize the damage from pollution. Any such discharge shall be subject to the approval of any Government in whose jurisdiction it is contemplated the discharge will occur.

Specific requirements concerning CO_2 transportation: According to the Annex II the gas tanker must meet all following conditions:

- hold a Certificate of Fitness in accordance with the appropriate Gas Carrier Code for ships certified to carry liquefied gases in bulk;
- hold an International Pollution Prevention Certificate for the Carriage of Noxious Liquid Substances in Bulk, in which it is certified that the gas tanker may carry only those Noxious Liquid Substances identified and listed in the appropriate Gas Carrier Code;
- be provided with segregated ballast arrangements;
- be provided with sufficient pumping and piping arrangements,
- be provided with a manual, approved by the Administration, ensuring that no operational mixing of cargo residues and water will occur and that no cargo residues will remain in the tank after applying the ventilation procedures prescribed in the manual.

Every ship of 150 gross tonnage and above certified to carry Noxious Liquid Substances in bulk shall carry on board a shipboard marine pollution emergency plan for Noxious Liquid Substances approved by the Administration. The plan shall consist at least of:

- the procedure to be followed by the master or other persons having charge of the ship to report a Noxious Liquid Substances pollution incident;
- the list of authorities or persons to be contacted in the event of a Noxious Liquid Substances pollution incident;
- a detailed description of the action to be taken immediately by persons on board to reduce or control the discharge of Noxious Liquid Substances following the incident; and
- the procedures and point of contact on the ship for co-ordinating shipboard action with national and local authorities in combating the pollution.

Reflections to the Finnish Legislation: Act on the Technical Safety and Safe Operation of Ships (1686/2009); Act on Environmental Protection in Maritime Transport (1672/2009).

5.2 Finnish Legislation

Besides the international regulations and agreements, national legislation and regulations apply to loading and transportation of CO_2 in Finnish territorial waters and harbours. The most relevant laws concern occupational safety, fire and rescue operations, dangerous goods, environmental issues, ship safety, traffic safety and crime prevention.

In the following sub-chapters the Finnish legislation concerning transportation chain of CO_2 is examined in three chain phases. These phases include temporal storage in port area, terminal operations (ship loading) and ship operations (marine transportation). Finally, environmental legislation concerning marine transportation is discussed. The Finnish legislation presented in this report provides an overall view of the ship operations, and doesn't necessarily cover all issues related to the transportation of CO_2 by ship.

5.2.1 Temporal storage in port area

The legal requirements concerning EHS-issues of terminal storage in Finland are introduced in CCSP research report D129 “Data package about environmental, health and safety requirements related to the capture, transfer and intermediate storage of carbon dioxide in Finland”. According to that report the essential EHS-requirements of temporary storage of chemicals in ports are included in following acts and decrees:

- Occupational safety and health act 738/2002, Government decree on the safe use and inspection of work equipment 403/2008
- Act on safe handling of chemicals and explosives 390/2005, Government decree on the supervision of handling and storage of dangerous chemicals 855/2012, Government decree on the safety requirements of handling and storage of dangerous chemicals 856/2012
- Environmental protection act 86/2000
- Pressure equipment act 869/1999, Decision by the Ministry of Trade and Industry on pressure equipment 938/1999, Decision by the Ministry of Trade and Industry on the safety of pressure equipment 953/1999
- Rescue act 379/2011, Government decree on rescue services 407/2011.

This legislation covers the temporal storage of CO_2 in port areas. Because the information of requirements is described in detail in report D129, all of it is not repeated here.

5.2.2 Terminal Operations (loading CO_2 from shore to ship)

Legislation: Act on the Technical Safety and Safe Operation of Ships (1686/2009); and Government Decree on the Occupational Safety in Loading and Unloading of Ships (633/2004).

Purpose: The purpose of these regulations is to ensure safe loading operations between shore and ship by paying attention to technical and management issues.

Key requirements: The Act (1686/2009) lays down provisions on the technical safety, load line, survey, tonnage measurement and safe operation of ships. The Act applies to Finnish vessels in and outside Finnish waters and to foreign vessels in Finnish waters as provided below.

A vessel used for navigation shall be such in design, construction, equipment and loading, or in such ballast and fitted with such necessary equipment, and also such in all other respects, that life, property and the environment may be considered to be safeguarded, having regard both to the nature of the fairways and the service on which the ship is engaged.

Authorities ensure the Technical Safety and Safe Operation of Ships by arranging inspections. The purpose of the survey of a ship is to ensure that the ship’s structure, machinery and equipment comply with the provisions concerning the safety of ships. The survey also ensures that the ship complies with the provisions on the prevention of pollution from ships.

According to Act, a ship shall be loaded in such a manner that it has adequate stability and loading capability and that its structures are not subjected to undue strain. Upon the loading

of a ship, full regard shall be had of the suitability of the ship for the intended carriage and the characteristics of the cargo to be carried. All necessary precautions shall be taken against hazards to human life and health, the ship and its cargo, and the safety of the environment.

The Government Degree (633/2004) applies to the loading and unloading of ships as well as to handling of goods and any other port work immediately incidental thereto. The port holder is responsible for the general planning and arrangements of occupational safety as well as the general safety and health of the working conditions and work environment in the port. To reconcile the activities of employers and self-employed persons and to ensure the safety and health of those working in the port, the port holder must determine and assess the safety of the port area. In the determination and assessment, the hazards that other port work causes to loading and unloading and the arrangements relating to the storage of dangerous goods must be taken into account.

According to the Act (1686/2009), the port holder must draw up port safety instructions that include a description of the common principles of occupational safety and a description of traffic arrangements in the port area as well as codes of conduct in emergency and dangerous situations. If a major accident risk exists in relation to the port operations, the instructions must include directions for the prevention of the risk and for the codes of conduct in the event of an accident. The functionality of the safety instructions must be checked by practical training, if necessary. In the determination and assessment of hazards and risks at work, special attention must be paid to the movement, access routes, lone working and dangerous goods.

The employer responsible for loading or unloading, together with the ship's master, must ensure that each work phase can be carried out safely and that communication between the involved parties functions sufficiently well. Especially, it must be ensured that procedures in the event of interruptions and emergencies are safe and that changes in the work phases can immediately be reported to the ship's master. Where necessary, the key phases and procedures are written into a checklist that both parties confirm with their signatures.

Other work that causes loud noise, dust, fumes or other corresponding harm must not be carried out when loading or unloading work is under way. In cargo-handling premises and other work premises, there must be sufficient and adequate ventilation to remove substances that are dangerous or harmful to health and to ensure that breathing air includes a sufficient amount of oxygen. If there is a reason to suspect that work premises do not contain enough oxygen for breathing or that there are explosive vapours, gases or a risk of toxication in the premises, the space must not be entered without appropriate personal protective equipment until it has been proved safe.

When handling and storing dangerous goods, special care and caution must be observed. Before an employee handles dangerous goods or works in premises where dangerous goods are or have been stored, the employee must be informed about the risk factors and protective procedures relating to the handling. The instructions given in the markings on the dangerous goods must be taken into account when handling them. Handling of dangerous goods is prohibited unless they have been packed and marked appropriately. Dangerous goods must be stored in appropriate premises or in areas specifically reserved for them.

When dangerous goods are temporarily stored in the port area, provisions concerning their transportation must be taken into account.

5.2.3 Transportation in Finnish Territorial Waters

Legislation: Act on Ships' Crews and the Safety Management of Ships (95/2013); Vessel Traffic Service Act (623/2005); and Pilotage Act (940/2003).

Purpose: The purpose of these regulations is to ensure safe voyage in Finnish territorial waters by ensuring the competence of Finnish crews, monitoring marine traffic, and providing navigating assistance.

Key requirements: The Act on Ships' Crews and the Safety Management of Ships (95/2013) lays down provisions on the manning of ships, the certification of seafarers and watchkeeping. All ships shall be manned in such a manner that the ships, crew, passengers, cargo, other property or the environment are not needlessly put at risk. The ship's complement and the competence of the crew shall be such as to enable the proper performance of all watchkeeping, safety- and security-related duties and duties related to marine pollution prevention. Seafarers must have the required qualifications set out in the Act and the provisions issued under it. Certificates of competency or certificates of proficiency are issued to persons who have demonstrated competence. In addition to the training required for the capacity held onboard, seafarers may be required to participate to special training in accordance with the characteristics of the ship on which they serve and the duties they have been assigned for.

The objectives of the Act (623/2005) are to increase the safety and efficiency of vessel traffic and to prevent damage caused to the environment by vessel traffic. The Act applies to a vessel traffic service operated in Finland's territorial waters, and to temporary management of vessel traffic in special circumstances. The Act also lays down provisions on the supervision of traffic within VTS-area related traffic separation schemes of the VTS authority outside Finland's territorial waters and traffic covered by ship reporting systems. Notwithstanding what is provided in the Act on the operation of a vessel traffic service, monitoring and management of vessel traffic may also be carried out by the port and harbour authorities.

The VTS authority must notify the relevant maritime, SAR, environmental, territorial surveillance, police or Customs authorities and port or harbour operators of any relevant matters observed by it or reported to it and relating to the safety, SAR, environmental protection, territorial surveillance or Customs inspection of a specific vessel or the people on board. The VTS authority shall communicate relevant information on a vessel considered to endanger the safety of shipping or pose a threat to maritime safety, life or the environment to the relevant VTS authorities of European Union Member States located along the planned route of the vessel.

The master of a vessel must notify the VTS authority of the following events taking place in the VTS area or its vicinity:

- any incidents or accidents affecting the vessel's safety, such as collisions,
- grounding, damage, malfunction or engine failure, leakage or cargo shifting and
- any hull or structural defects;

- any incidents or accidents endangering the safety of navigation, such as any
- malfunction potentially affecting the manoeuvrability or seaworthiness of the vessel and any defects affecting the vessel's propulsion machinery, steering gear, electrical power generation installations or navigation instruments or communication equipment;
- any circumstances that may cause pollution of the waters or the coast, such as discharge of pollutants into water or risk of such discharges; and
- any pollutant spills and containers or packages drifting on the sea.

The purpose of the Pilotage Act (940/2003) is to enhance the safety of vessel traffic and prevent environmental damage generated by vessel traffic. Vessels shall use a pilot in the public fairways located in Finnish waters and the part of the Saimaa Canal leased by Finland, and which have been defined as compulsory pilotage areas, if pilotage is required by the hazardous or harmful nature of the cargo or by the size of the vessel.

The master is responsible for the navigation of the vessel also when he is following the pilot's navigating instructions. The master is obliged to provide the pilot with all the information that is of significance for the pilotage. The pilot is responsible for the pilotage operation. The pilot shall present the master of the piloted vessel with a passage plan based on up-to-date charts and any other information and instruction necessary for the safe passage of the vessel, and the pilot shall supervise any measures related to the steering and handling of the vessel that are of significance for the safety of vessel traffic and environmental protection. The pilot is obliged to report to the Vessel Traffic Service any observations of significance for the safety of navigation, for protection of people, property and the environment, and for maritime and customs surveillance. The pilot shall also report any damage caused to or by the vessel and, upon request, provide the authorities with further information thereon.

5.2.4 Environmental issues

Legislation: Act on Environmental Protection in Maritime Transport (1672/2009).

Purpose: The purpose is to prevent environmental pollution resulting from the normal operation of ships, by prohibiting discharges and emissions of noxious substances into water and air, or by setting limits on discharges and emissions into water and air. Furthermore, the purpose is to organise the reception of waste in ports resulting from the normal operation of ships.

Key requirements: The Act (1672/2009) shall apply to ships sailing in Finnish waters or within Finland's exclusive economic zone. Exceptions to the application of this Act concerning inland waters and domestic voyages are set out below. The Act shall also apply to Finnish ships when sailing outside Finnish waters or outside Finland's exclusive economic zone.

According to the Act *noxious substance* means oil, noxious liquid substances, sewage, and garbage. If a noxious substance has been mixed into a non-noxious substance, the mixture of such substances shall also be considered a noxious substance. It is prohibited to discharge noxious substances and air pollutants into water or air, as provided in, or by virtue

of, this Act or as provided in European Community legal instruments. If noxious substances falling under different discharge provisions are mixed with each other, the most stringent discharge provisions shall apply.

The master of a tanker or his representative shall keep a cargo record book concerning cargo operations and damage incurred in the context of unloading, as set out in Annex II to the MARPOL 73/78 Convention. Additionally, on board Finnish ships and foreign ships of 400 gross tonnage and above engaged in international voyages calling at a Finnish port a garbage record book shall be kept as well.

It is prohibited to emit air pollutants from ships in Finnish waters or in Finland's exclusive economic zone, as well as from Finnish ships outside Finnish waters or Finland's exclusive economic zone, as set out in Annex VI to the MARPOL 73/78 Convention, in the Helsinki Convention, or in other international commitments binding on Finland, or in European Community legal instruments. The prohibitions against and restrictions on emissions laid down in this chapter shall not apply to:

- emissions necessary for the purpose of securing the safety of the ship or saving life at sea;
- emissions resulting from damage to the ship or its equipment, provided that all reasonable precautions have been taken after the occurrence of the damage for the purpose of preventing or minimising the emissions, and provided that neither the owner nor the master acted either with intent to cause damage, or recklessly and with knowledge that damage would probably result.

In order to control air pollution, ships of 400 gross tonnage and above engaged in international voyages must have an international air pollution prevention certificate (*IAPP Certificate*) to prove that they comply with the provisions of Annex VI to the MARPOL 73/78 Convention.

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APPENDIX A: Summary on the most relevant international regulations

Procedure	Responsibility and participants	"Supporting" Regulations
Terminal Storage	*Charterer*	Seveso II (96/82/EC)[2]
Terminal Operations	*Terminal operator*	
Ship Operations: liquefied carbon dioxide	*Terminal operator; Shipping company*	IGC Code, International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk; Noxious liquid substances: SMPEP (marine pollution emergency plan)
Ship Operations: Chemicals	*Terminal operator; Shipping company*	MARPOL 73/78 Convention (International Convention for the Prevention of Pollution from Ships 1973, as modified by the Protocol of 1978); MARPOL 2011/2012 (Annex II) Control of pollution by noxious liquid substances; IBC Code (liquid bulk chemicals) (or BHC Code); Noxious liquid substances: SMPEP (marine pollution emergency plan)
Transportation in Finnish Territorial Waters: reporting	*Shipping Company; Authorities*	Directive 2002/59/EC
Garbage handling / dumping	*Shipping Company; Authorities*	London Convention (1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and other Matter, 1972 (as amended in 2006)); Regulation on shipments of waste (2006/1013/EC); 'Helsinki Convention' the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (SopS 2/2000), as amended

[2] Doesn't consider CO_2 as a hazardous substance

APPENDIX B: Summary on the most relevant Finnish legislation

Procedure	Responsibility and participants	"Supporting" Regulations
Operations in general	*All*	Rescue Act (379/2011); Occupational Safety and Health Act (738/2002); Decree on the Protection of Marine Environment (76/2010)
Terminal Storage	Terminal operator, Charterer, "cargo owner"	Decree on the Transport and Temporary Storage of Dangerous Goods in a Port Area (251/2005);[3] Rescue Act (379/2011)
Terminal Operations	Terminal operator, Charterer, "cargo owner"	Act on the Technical Safety and Safe Operation of Ships (1686/2009); Government Decree on the Occupational Safety in Loading and Unloading of Ships (633/2004); The Finnish Act on Transport of Dangerous Goods (719/1994); [4] Finnish Maritime Code (674/1994); Act on the Prevention of Pollution from Ships (300/1979)
Ship Operations: liquefied carbon dioxide	*Terminal operator; Shipping company,* Charterer, "cargo owner"	Chemicals Act (744/1989);[5] Finnish Maritime Code (674/1994); Act on the Prevention of Pollution from Ships (300/1979); Decree on the chemical and gas tankers (244/1982)[6] Act of protection of the marine environment (1145/1994), Annexes II and III; Decree on the industrial handling and storage of hazardous chemicals (59/1999);[7] Act on the Technical Safety and Safe Operation of Ships 1686/2009; Act on Ships' Crews and the Safety Management of Ships (95/2013)
Ship Operations: chemicals	*Terminal operator; Shipping company,* Charterer, "cargo owner"	Chemicals Act (744/1989); Act of Safe Handling of Chemicals and Explosives (390/2005); Act of Environmental Impact Assessment Procedure (468/1994); Decree on the chemical and gas tankers (244/1982);[8]
Transportation in Finnish Territorial Waters	*Shipping Company,* Charterer, "cargo owner" *Authorities*	Finnish Maritime Code (674/1994); Pilotage Act (940/2003); Vessel Traffic Service Act (623/2005)
Transportation in Finnish Territorial Waters: reporting	*Shipping Company;* Charterer, "cargo owner" *Authorities*	Decree on the reporting obligations regarding sea transportation of hazardous and environmental pollutant substances (1303/2011)[9]
Garbage handling /dumping	*Shipping Company;* Charterer, "cargo owner", *Authorities (Finnish Transport Safety Agency)*	Act of protection of the marine environment (1145/1994); Act on Environmental Protection in Maritime Transport (1672/2009); Degree on the Protection of marine environment (76/2010); Number 495 Government decision on the part of the national waste plan concerning transfrontier waste movements

[3] Doesn't apply to gas tankers
[4] Doesn't apply to gas tankers
[5] The Chemical Act does not classify CO_2 as a dangerous substance
[6] Abated 732/2012
[7] Abated 855/2012
[8] Abated 732/2012
[9] Doesn't apply to gas tankers