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Decision making in case of ships in distress

The under laying criteria for the decision making in case of ships in distress

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1. Abstract

Accidents at sea such as collisions, groundings, fire on board, cargo problem could lead to a ship in distress situation. The possible distress scenario varies per type of ship. Ships in distress could cause extensive damage; economy as well as environmental and human life could be threatened. In order to be optimally prepared it is necessary to work out in advance the different actions that could be taken and the possible consequences of such actions. It is important to consider the potential consequences in the decision making process not only from the point of view of the ship owner, cargo owner or nearest coastal municipality but also from the point of view of the overall consequences for the (marine) environment and the economy (social-economic impact).

Factors which determine the economic and/or environmental damage and which can be influenced by decision making in case of a ship in distress are: (1) Length of coast line affected (persistent floating substances), (2) Area where pollution takes place (economic and environmental sensitivity) (3) Volume and type of product spilled, (4) Response time to combat the spill (drift time towards the coast) and (5) Spreading of the pollutant (sailing with ship in distress), (6) water depth, etc.

The following distress situations have been considered in this report:

1. Ship leaking oil; Leakage or potential leakage of oil from a bunker tank or from a cargo tank of an oil tanker
2. Ship leaking bulk HNS cargo; Leakage or potential leakage of chemical substance(s)
3. Ship adrift due to failure of propulsion and/or steering gear
4. Ship with potential risk of sinking or running aground
5. Ship on fire
6. Ship with explosion danger
7. Ship with cargo problem (shifting cargo; heating reaction, bomb on board fishery vessel or TSHD)

All these situations could result in a ship in distress which requires decision making to reduce and limit the (threat of) damage and prevent further escalation of the situation. The final stage of escalation could be the sinking of the ship or the ship running aground in an unwanted position.

In case of a ship in distress the decision-making often is limited to a few options:

- To bring the ship in a location where she could be brought under control and
- To minimize the damage caused by the distress situation

Response options considered by the crew of the ship itself are;

1. Ship proceeds voyage to planned destination,
2. Ship proceeds to nearest port/harbour,
3. Ship proceeds to a place of refuge
4. Ship will anchor,
5. Ship will continue to drift,
6. Ship will move keeping stern or bow into wind direction,
7. Ship proceeds in direction where assistance is coming from,
8. Ship proceeds towards the nearest coast,
9. Ship proceeds towards open waters,

10. Abandon ship,
11. Evacuate (part of) the crew,

Response options considered in negotiations with the responsible authorities are;

12. Set the ship on fire at sea,
13. Destroy cargo at sea,
14. Ship proceeds towards a location appointed by authorities,
15. Ship will be grounded on purpose,
16. Ship will be subject of a controlled scuttle operation.

Important aspects that need to be considered in the decision making process are:

- A wreck in deeper water normally will be more expensive
- Risk of blocking a harbour entrance may cause enormous financial damage
- Location of pollution; e.g. in sensitive areas could increase the environmental effects
- Distance from the coastline determines, in case of persistent pollutants, the length of coastline that might be polluted
- Distance from the coastline determines the mobilisation time of the response teams
- Fire may increase due to sailing
- Sheltered places could reduce pollution outflow
- Sailing direction could influence the stability of ships in distress the situation
- Compensation for damages influences the willingness of local authorities. In particular if central authorities that normally have to react on a ship in distress situation to save guard national interests.

Finally in case the situation runs out of control and there is serious risk of sinking the options as to ground the vessel, controlled sinking of the vessel or to abandon the ship needs to be considered. In this situation authorities will generally not allow the vessel to come into port due to the risks and a sheltered area is then required.

All these distress situations and response options are worked out in a generic decision tree.

2. Introduction

In case of a ship in distress, the captain of the vessel and the authorities in the coastal state in whose jurisdiction the vessels sails, sometimes run into a conflict of interest. Obviously both understand the urgency in solving the issue and in most incidents bringing the ship into a sheltered area or Place of Refuge is the most viable option. On the other hand the authorities need to take all precautions with regard to protection of their interest e.g. the marine and coastal environment; the population along the coastline and the port infrastructure.

The European Union has, as a result of the mv. 'Prestige' incident, obliged member states to appoint Safe Havens. The mv. 'Prestige' was an oil tanker that was towed away from the coastal waters of Spain into the open ocean, instructed by Spanish authorities, where it sunk in deep waters. This resulted in an enormous environmental disaster polluting more than 200 km of coastline. Also the retrieval of the oil trapped in the tanker was very expensive because of the water depth. If the local authorities had decided that the ship could have come closer to the shore the environmental consequences may have been less and the oil retrieval operation cheaper. This report describes the possible consequences of decision-making in the various situations when a ship is in distress (or in need of assistance as these situation are called today).

In order to be optimally prepared it is necessary to work out in advance the different actions that could be taken and the possible consequences of such actions. It is important to consider the potential consequences in the decision making process, not only from the point of view of the ship owner, cargo owner or nearest coastal state, but also from the point of view of the overall consequences for marine environment and economy. Important in this respect is a balanced weighing of overall risks of the damage that could be caused if the situation should escalate. What are the risks of specific actions in relation to the environment and the economy if a distress situation escalates and the socio-economic impact in the widest sense? The mentioned "overall consequences for marine environment and economy" are also that are to be considered by the coastal state authorities

By sending a tanker to open ocean the damage increases drastically due to the fact that more length of coastline may be polluted than will have if the tanker is brought to a sheltered area. The mv 'Prestige' sank because of the structural damage after she had lost hull plating on the starboard side and ballasting her had compensated the list. An expensive salvage operation was needed to get the remaining oil out of the tanks. Would the mv 'Prestige' have been brought near the coast and sunk there the salvage operation would have cost much less as the water depth makes the salvage operation much easier. For instances: diving operations are much more expensive in deeper waters than in shallower waters and lifting bunker oil out of a tank is much more complex in deeper waters than in shallower water.

What does 'the situation runs out of control' mean? For typical initial ship in distress situations like fire, minor leakage, cargo problem, it means that the fire, leakage and/or cargo problem become worse that may result in more ship damage and finally to a situation the ship will sink or run aground at an unwanted location.

Any crew will try to solve a problem e.g. by extinguishing the fire; control the cargo etc. A crew tries to control a chemical reaction of the cargo. Some reactions can be reduced by cooling the surrounding areas or by releasing pressure in holds. Nevertheless chemical reactions can be very dangerous. If the crew does not manage to control the reaction

assistance from shore is given, the ship could catch fire or even explode with enormous dangers for marine environment and human life as a result. A secondary problem in such cases could be a wreck that hinders the shipping traffic and/or causes a severe pollution problem. With cargo various chemical reaction could take place such as:

- Reaction due to a fire by which toxic vapours could be created.
- Reaction with water (such as calcium carbide that form acetylene with water).
- Reaction with other chemicals on board

Please elaborate on the shifting cargo below deck and unstable deck cargo as well as the bulk cargo topics that may create an unsafe situation of the ship. Then also point at the general responsibilities of the captain and his crew to improve the situation.

International guidelines, such as those agreed by IMO (Assembly resolution No A.949(23)) aim to provide internationally approved checklists both for the authorities requested to designate places of refuge and for the master of a ship in need of such a place because of her specific situation.

Structured information on the incident, on the ship's specifics, on the accompanying safety questions, on the kind of assistance needed, on the insurance coverage and so forth will enable coastal States to identify more easily the risks involved. Decisions on suitable methodology and on how to respond, as well as the identification of suitable places of refuge will be speeded up by such structured information.

3. Problem definition

Accidents at sea will happen despite all preventive measures. Accidents like the 'Erika' and the 'Prestige' get a lot of attention of the public and the press. These accidents have demonstrated that decision making with respect to ships in distress is not well prepared for optimal reduction of the potential damage. But also other incidents such as the Stanislaw Dubois that finally has to bring to sink in the North Sea as the only option left, as there was no harbour that wants to receive here. The Stanislaw Dubois has calcium carbide on board in a hold with water due to an accident. Calcium Carbide will react with water to form the very explosive acetylene.

The 'Prestige' was an oil tanker that broke and sunk off the Spanish coast. The tanker carried 77000 tons heavy oil and was sent to open ocean by responsible authorities, and she sunk in very deep waters. [JH: the fact that the authorities send the ship away, did not cause the sinking] This incident resulted in polluting over 200 kilometers Atlantic coastline. Afterwards the involved governments concluded that by sending the ship to open waters, further off the coast, much more coastline had been polluted than in case the ship had been kept near the coast. The ship also sunk in very deep water that makes the salvage operation more complex and the costs of it much higher. If they had decided to bring the ship closer to the coast the ship had sunk in shallower waters, that would have made it a lot less expensive to salvage the ship and would have diminished the amount of polluted coastline.

In the case of the 'Prestige' high viscous oil was involved, but in case of ships in distress at sea other types of oil or chemicals could be involved as well. The actions that should be taken to reduce environmental and economical damage may depend on various criteria such as: type of cargo, characteristics of the location and temporary circumstances (e.g. weather).

All these aspects should be brought together into one decision tree system and it can't be excluded that options will include not favorable aspects. Communications in those circumstances is essential.

3.1 Aim

The objective of this document is to optimize the decision-making process for responsible authorities in the case of a ship in distress at sea, by developing a framework based on a number of scenarios and the possible actions, including their advantages and disadvantages. This would result in the design of a generic decision making procedure for ships in distress.

3.2 Approach

Ships in distress at sea often cause decision-making problems between ship owner and the authorities in a coastal state. Coastal states and particularly local governments tend to send ships in distress as far away from their coast while the ship owner wants to have his ship as close to the coast as possible, in a sheltered position and preferably in port.

This is not a general approach but in some countries this is still the case. Some recent accident on the North Sea they took the correct solution like the mv. Schieborg or the mv. Sloman Traveller. Both ships struggled with fire in their cargo (containers) and the authorities and ship-owners (P&I club) co-operated intensively to solve the problem. The mv. Schieborg was safely brought into Eemshaven and the mv. Sloman Traveller, after extinguishing the fire was brought into Cuxhaven.

The main point is: bring captain/owners and authorities (port and Coastguard) at the same level of knowledge, including expert advice (salvor and others) and decide for the best option. However bear in mind that basics should be clear to all stakeholders:

- Authorities to protect their interests (properties; inhabitants; infrastructure)
- Captain/owners to safeguard crew and ship and properties of cargo owners
- Both parties to protect the marine environment and undo any damage caused as a result of the incident.

One should not be surprised to learn that the owners might decide to abandon the vessel thus leaving further actions to the government. The ample reason is financial consequences. If the owners limit their liability (SDR level) they may conclude that the possible costs involved to bring the vessel into safety are much higher than just leaving the vessel. The question is driven by co-operation between government; owners; insurance and salvor.

This report characterizes the potential damage in case of a ship in distress at sea in chapter 4. Various ship distress situations are discussed in chapter 5. This chapter gives answer to the question what type of ship distress scenarios can be expected for the different ship types. The options to reduce the damage in case of a ship in distress at sea and the decision-making criteria are dealt with in chapter 6. What kind of actions might be taken (by the ship crew) and what are the advantages, disadvantages and limitations for the different actions? Answers to these questions will lead to generic decision making criteria on which a decision-making procedure will be based and described in chapter 7.

Accidents at sea such as collision, groundings, fire on board, cargo problems could lead to a ship in distress situation. The type of distress scenarios could vary by type of ship. For instance for a fishery vessel it is likely to get a bomb in its nets while in the case of an oil tanker, oil spillage is one of the distress scenarios.

Annex 1 gives an overview of the different type of ships used in the transport of cargo or passengers by sea. Ship types considered in this report are: (1) Oil tanker, (2) Chemical tanker, (3) Bulk carrier, (4) Container vessel, (5) LNG tanker, (6) Fishing vessel, (7) Passenger vessel

4. Characterisation of potential damage

The (threat of) damage caused by a ship in distress could be:

1. socio-economic
2. environmental
3. human life

In such cases, a careful assessment of risks related to the identified event and accompanying circumstances must take into account:

- safety of those on board,
- threats to public safety,
- designated environmental areas,
- sensitive habitats and species,
- fisheries,
- economic/industrial facilities,
- amenity resources,
- facilities and manpower available,
- weather, sea and geographical conditions,
- bathymetry,
- tides and seasonal effects.

4.1 Economical damage

Economical damage first of all is the damage to the ship and its cargo and in the second place damage to third parties. Third parties such as shipping, recreation, offshore activities and fishing all could suffer economical damage caused by a ship in distress.

Clean-up costs of the pollution caused by the ship in distress and/or salvage costs in case a ship is grounded or sinks is also considered to be economical damage.

For some types of ship (crude oil tankers) the liability and compensation is well arranged while for other types of ship (chemical tankers, container ships etc.) the liability is not yet arranged for at the same level. The liability conventions are described in 0. In fact who has to compensate for the damage is an important aspect, which should be taken in consideration during decision-making. In particular this is important to third parties, such as municipalities, who may be threatened if the situation escalates. Very often these parties are not completely compensated for the damage caused by the ship in distress. The liability of, amongst others, chemical tankers and container ships is limited while the economical damage could be enormous.

Some types of economical damage are described below.

- Clean-up costs and preventive measures; the cost of the response and other measures taken to prevent or minimise pollution damage.
- Property damage; costs of cleaning, repairing or replacing property that has been damaged or polluted by the ship in distress
- Consequential loss; loss of earnings suffered by the owners of property contaminated by the pollution or damaged by the ship in distress. One example of consequential loss is a fisherman's loss of income as a result of his nets becoming oiled or the area becoming polluted by a chemical, which prevents him from fishing.

- Pure economic loss; For example an owner of a hotel or a restaurant located close to a ship in distress may suffer losses because the number of guests fall during the period of potential danger.
- Costs associated with the capture, cleaning and rehabilitation of wildlife, in particular birds, mammals and reptiles.

Factors that determine the economical damage and that can be influenced by decision-making in case of a ship in distress are:

- Length of coastline polluted (persistent floating substances). In general the longer length of coastline polluted, the higher the cleaning-up costs will be.
- Area where pollution takes place. If pollution takes place in a vulnerable area (fishing grounds, aquaculture area, or tourist area) the financial consequences will be much higher than at open sea.
- Amount spilled. The amount spilled determines the economic consequences in particular the cleaning-up costs and the damage to fisheries, tourist industry, etc.
- Response time to combat the spill (drift time towards the coast). Consequences could be reduced by response. If for instance an oil spill being recovered before it washes ashore will reduce the economic damage.
- Spreading of the pollutant due to continued sailing with ship in distress.

4.2 Environmental damage

Environmental damage is mainly due to a release of a substance into the marine environment. Oil is the most common substance that could be involved in case of a ship in distress. In case of a collision or grounding oil could be released from the cargo of an oil tanker or from the bunker tanks of all types of ship. Also hazardous materials could be released (chemical tankers, container ships) into the marine environment such as cargo from a chemical tanker or bulk carrier or packaged (drums, containers etc.) goods containing hazardous substances. The damage these substances could cause depends on the amount, the type of substance and in particular its toxicity, the behaviour and the sensitivity of the location it gets into the marine environment. With regard to the decision on response measures, it is recommended that authorities of coastal states have a clear picture of the sensitivity in their area of jurisdiction and that response options are balanced against the sensitivity and possible effect of the discharged substance.

Knowledge of behaviour, physical- chemical properties and ecological effects is necessary for the assessment of the hazards associated with spills from a ship in distress. Immediately after release physical behaviour is an important factor to be considered in hazard assessment. The fate of a spill is mainly determined by its physical and chemical properties.

In the initial stage of a spill the partition of the floating, soluble, evaporative and sinking fraction between the water surface, the water column, the air compartment and the sea floor is important. This equilibrium depends primarily on the density, vapour pressure and the solubility of the released substance.

For simplicity reasons and to facilitate decision making in case of a chemical spill, chemical substances have been grouped in behaviour categories and hazard effect categories in order to have a limited number of standard response approaches to chemical spills. The choice of the appropriate approach has been based on (1) short term behaviour of a spill released into the water and (2) the potential hazards of a spill.

With regard to the spill behaviour categorisation, the following categories of chemical substances can be distinguished:

1. Evaporators (gasses and substances that evaporate very fast). In case of such spills, explosion risk and air toxicity are the main hazards that primarily need to be reduced.
2. Floaters (substances that float on the water surface). Like oils there are many other substances that float on the water surface once released onto or into the water. These chemical substances can in general be responded to like oil spills and also behave like oil spills. However any substance should be checked with regard to their behaviour towards equipment used.
3. Dissolvers (substances that dissolve very fast into the water column). These substances need a special approach in case of a calamity. This category of substances is the most harmful for the aquatic ecology. The more toxic a substance in this category the more dangerous it will be.
4. Sinkers (substances that dissolve very slowly and which are heavier than water).

Most chemical substances however are categorised in more than one of these categories.

The potential hazards which oil and chemical substances could cause, when accidentally released into the water are:

- To human being: (1) Explosion hazard; (2) Fire hazard (3) Toxicity in air (inhalation)
- To the aquatic organisms: (4) Bioaccumulation; (5) Persistency; (6) Toxicity in water
- To both human and organisms: (7) Corrosiveness; (8) Radioactivity; (9) Carcinogenic.

Substances with a high boiling point have a low vapour pressure. This means that water-soluble substances with a high boiling point will end up in the water column and substances with a low boiling point will mainly end up into the air.

- Light volatile products will completely evaporate as long as their composition consist of hydrocarbon chain lengths between C1 up to C15 and or substances with a boiling point up to 250 °C
- Light crude oils will evaporate to a higher degree than heavy crude oils (respectively 50% and 5%)
- Heavy products like Bunker C and heavy crude oils will stay in the marine environment as a persistent pollutant and will wash a shore or sink to the sea floor if not recovered before.

Components, which dissolve in water will, under influence of biotic degradation processes and depending on the speed of degradation (biodegradability), stay for a shorter or longer period in the water column. Substances which dissolve in the water column determine the quality of the water. Swimming, fishing could be forbidden if the concentration is too high. Often 1% of the LC₅₀(96) value of the pollutant is used as a threshold to declare the situation safe again.

A floating slick consists of components which are non or very slowly soluble in water and which have high boiling points (the fraction C16 and higher or boiling point >250 °C) Such a floating slick will spread and move on the water surface as a function of the time. Small amounts will still evaporate and depending on the sea state, turbulence and quantity spilled, part of or all the remaining slick will naturally disperse. Floating slicks normally move at the same speed and direction as the current plus an extra 3% of the wind speed in the direction of the wind. Adding these two vectors will result in the actual speed and direction of the slick.

Knowledge of these processes and how they interact is essential for purposes of decision-making. The questions the decision-maker has to answer in this context include the following:

- The drift of the pollutant ?
- What length of coastline might be polluted?
- Volume balance between (1) % evaporated, (2) % dissolved/dispersed and (3) % remaining on the water surface or on the sea floor
- What are the dimensions of the slick on the water surface?
- What are the properties of the remaining slick in case of an oil spill?
- Is response required/possible?
- How much pollutant will wash ashore?

The answers to these questions are time dependent. In fact the fate of a released substance including oil is determined by its spreading, its displacement and its weathering. The most important weathering processes in the short-term are: evaporation and dissolution and in particular for oil spills, natural dispersion (oil-in-water), and emulsification (water-in-oil).

A large number of parameters play a role:

- Physical properties of the pollutant released (density, vapour pressure, solubility, surface tension, viscosity, etc.)
- Chemical properties or, in case of oil, the composition
- Meteorological conditions (wind, sunlight, temperature, etc.);
- Properties of the water (density, current, bacteriological activity, presence of algae, etc.)
- Amount released.

The environmental damage of substances transported by sea is schematically shown in the following figure

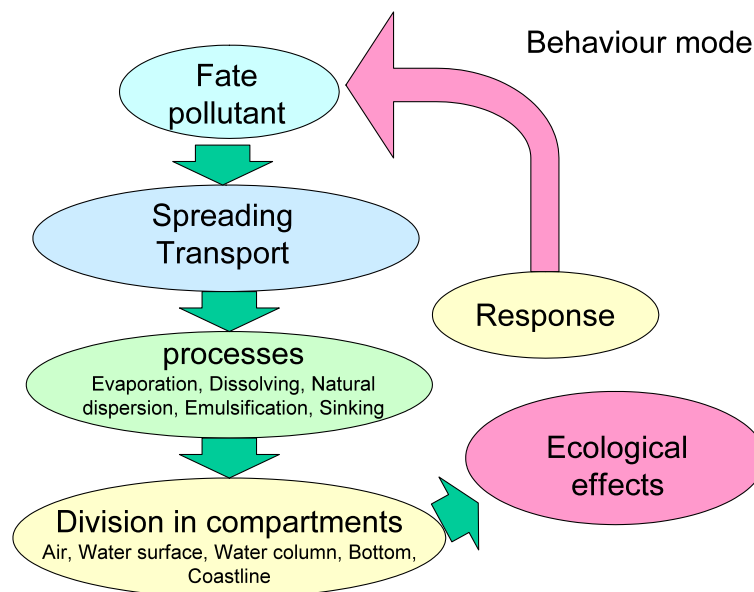


Figure 1 Model to determine the ecological effects

The fate and finally the ecological effects will be influenced by the decisions made in case of a ship in distress. First of all the response can be influenced by allowing the pollution to drift

at sea for a longer period of time and the consequential response action, by bringing the ship further off the coast. This measure means that a floating substance due to wind and current takes more drift time to reach the coastline. More drift time can be used as response time to recover the pollutant. On one hand this is an advantage assuming that the complete spill can be removed before it washes ashore on the other hand in case of a major spill and assuming the spill could not be recovered completely this may result in a longer length of coastline polluted. Experience shows that the length of coastline polluted will be about the basis of a triangle of 30 to 60 degrees seen from the place of the source.

Mainly persistent substances (boiling point $>250^{\circ}\text{C}$) will wash ashore if not completely recovered at sea. For sinking and fast evaporating substances and dissolving substances this does not play a role. For such substances the toxicity and the sensitivity of the area determines the damage to the environment.

Factors that determine the environmental damage and which can be influenced by decision making in case of a ship in distress are:

- Length of coast line polluted (persistent floating substances)
- Area where pollution takes place (sensitivity)
- Amount spilled (sheltered area)
- Response time to combat the spill (drift time towards the coast)
- Spreading of the pollutant (sailing with ship in distress)

4.3 Human life

Life of crew on board or crew from passing ships or nearby platform(s) and in coastal communities should have the highest priority in decision-making.

Explosion risk and toxic substances in air form the main risk for human beings.

Factors which determine the risk for human life and which can be influenced by decision making in case of a ship in distress are:

- Position of the ship in distress
- Safe haven
- Response time to get assistance
- Distance from municipalities

5. Ship distress scenarios

This chapter describes different distress scenarios involving seagoing vessels. Despite having all kind of navigational aids at our disposal and collision regulations that should prevent collisions from occurring at all, there are still collisions between ships all over the world. Minor and major collisions happen. Minor collisions; resulting in only partial damage of the hull and the cargo tanks remains in tact. As the cargo tanks remain in tact no oil or cargo will be spilled. Due to an added weight from the incoming water in the ship, the minor collision can result in extra shear forces and bending moments and also might result in list. This in combination with bad weather might lead to aggravated situations. The ship might eventually even break up which could result in massive oil spill and a serious endangerment of lives. In the event of a mayor collision with a single hull ship there may be an immediate loss of cargo. In this case there may be also the possibility of a breaking up. The location of the collision will play a vital role. A head on collision will in most cases result in a flooding of the forepeak ballast tank, with no mayor effects. However in the case of a head on collision involving a container ship, some containers could fall over board and the same applies for any deck cargo. Apart from collisions also fire or problems with the cargo itself could lead to a ship in distress.

Distress situations can be split up in a few scenarios such as:

1. Ship leaking oil; Leakage or potential leakage of oil from bunker tank or from cargo tank of an oil tanker
2. Ship leaking chemical bulk cargo; Leakage or potential leakage of chemical substance(s)
3. Ship adrift due to failure of propulsion and/or steering gear
4. Ship with potential risk of sinking or running aground
5. Ship on fire
6. Ship with explosion danger
7. Ship with cargo problem (heating, reaction, bomb on board fishery vessel)
8. Impaired vessel stability

All these situations result in a ship in distress, which requires decision making to reduce and limit the damage, and prevent further escalation of the situation. The final state of escalation could be the ship sinking or running aground at an unwanted position.

5.1 Ship leaking oil

Oil leakage could have two sources:

- Oil from the cargo of an oil tanker and/or
- Oil from bunker tanks of any kind of vessel

Oil tankers

Cargo oil from a tanker could consist of various types of crude oil but also fuel oil. The density of the oil normally determines the weathering such as evaporation and natural dispersion of the oil once released. Light oils will disappear from the water surface by evaporation and natural dispersion and heavy oils will be more persistent and remain floating till they wash ashore somewhere downwind. The movement of slicks is on average 3% of the wind speed and 100 % of the speed of the current.

All ships

A collision with the aft of a ship might break the fuel tanks, or in worst case flood the engine room. In these cases high amounts of heavy fuel oil or diesel oil might be lost. While a collision amidships will only cause damage to the ballast or cargo tanks.

Bunker oil could be diesel oil or various grades of heavy oil such as Bunker C. The density of the oil normally determines the weathering such as evaporation and natural dispersion of the oil once released. Diesel oil will disappear from the water surface by evaporation and natural dispersion and heavy fuel oils will be persistent and remain floating till it washes ashore some where downwind.

Oil spillages will float on the water surface and may pose a hazard to wildlife at sea. The main threat of oil pollution is coastal pollution. Cleaning up the coastline is very expensive and could also lead to loss of income in the tourist sector. Measures should therefore focus on avoiding coastal pollution, in particular in the case of persistent substances such as heavy fuel oils.

5.2 Ship leaking HNS bulk cargo

Leakage or potential leakage of chemical substance(s): Chemical tankers could loose their bulk cargo in case of a collision or grounding. The mv. 'Anna Broere' is a good example of leakage of cargo. After a collision 550 tonnes of Acrylonitril were lost into the sea. The types of cargo a chemical tanker are allowed to transport is described in chapter 17 of the IBC Code. The cargoes that are considered to have severe environmental and safety hazards are to be transported in a type I chemical tanker. This type has more and better safety measures than the type II and III vessel. Most chemical tankers are double hull and therefore have high collision protection.



Photo 6 Ship leaking chemical substance

Chemicals released into the sea from a chemical tanker could be divided into four categories substances e.g.:

- Gasses and Evaporators (substances that evaporate fast and form a gas cloud once released). The hazards of this category could be explosion danger and or toxicity hazard in the air.
- Floaters (substances that stay on the water surface for a certain time very slowly evaporating or dissolving). The hazards of this category are similar to oil spills
- Dissolvers (substances that dissolve quickly and form a cloud in the water column). The hazard of this category is toxicity in water.
- Sinkers (substances that stay on the sea floor for a certain time very slowly dissolving). The hazard of this category is the covering of the seabed.

Chemical spillages will evaporate and/or float and/or dissolve and/or sink and could form a hazard for wildlife at sea, marine organisms and human beings. The main threat of chemical pollution is the safety of human beings and marine life. Response to chemical spills is often not possible once spilled in the marine environment. Measures should therefore focus on avoiding contact with human beings, in particular in case of toxic substances that evaporate. Evaporators and dissolvers will finally dilute till a concentration is reached which is not hazardous anymore. To declare the situation safe again; for gases the MAC value is often used and for dissolvers 1% of the LC50(96) values as threshold level.

5.3 Ship with unstable deck cargo

Cargoes stored on deck could be swept overboard due to bad weather conditions. For example bad stowage or unstable stowage of containers could lead to containers swept overboard.



Photo 7 Unstable deck cargo of chlorine cylinders

Packaged goods that enter into the marine environment could float, submerge or sink to the sea floor. Highly toxic substances normally are transported in heavy duty packages. Such packages will for a certain time stay in the marine environment without releasing their content. The Chlorine cylinders (see 7) are an example of a strong package. These cylinders could stay in the marine environment for more than a year without releasing their content. Floating containers could form a danger to the shipping traffic.

5.4 Ship adrift

Another issue is the ships propulsion and steering gear. If for some reason a so called 'black out' occurs, and the emergency backup system does not kick in, the ship has no propulsion, no steering and is thus adrift. This can cause it to run aground and suffer serious damage. Even if the steering gear is still functioning, but there is no propulsion, a ship depends on the movement of the sea. Failure of the ships propulsion and/or steering gear can be caused by lack of maintenance (human element) or an occasional failure such as a collision.

Collision with a platform or another ship is one of the dangers of a ship adrift by that the distress situation may escalate.

5.5 Ship with potential risk of sinking

The damage due to a collision or grounding can be very different. From a small scratch damage to a heavy damage by that the hull is so badly damaged that the ship makes water. The situation gets even worse if more compartments are breached and a large part of the engine room gets flooded.

Schematically this scenario could be divided in four? stages such as:

- Small hull damage, little or non water intake, ship still floats
- Medium hull damage, severe water intake, ship gets list, temporarily repair required.
- Large hull damage, very severe water intake, ship unstable; salvage assistance required bringing vessel into a port
- Very large hull damage, very severe water intake, ship sinks and consequential wreck removal

Sinking in a shipping lane in front of a harbour is the most severe scenario with such a distress ship.

5.6 Ship on fire

Fire on board ships can be one of the most dangerous situations for its crew, it easily escalates which can lead to fatal consequences.

There are different situations of fire on board a ship:

- Fire in the engine room
- Fire in the cargo
- Fire in the accommodation/superstructure

Engine room fire

Two thirds of the fires onboard a ship will start in the engine room. Every ship has a carbon dioxide installation to beat fires that are situated in the engine room. Once those fires are extinguished the engine room will be out of use for several hours, this because the reintroduction of oxygen could easily reignite the fire. This will result in a situation in which the ship is adrift.

Fire onboard the ship is always one of the most dangerous situations that can occur. Fire in the engine room will most likely be a fire that includes oil. This will cause a very rapid

increase in temperature and can thus spread fast. Because of the amount of fuel and other oils stored in the engine room (or close to it), it is important to respond very fast. One advantage is that there are very good means of extinguishing a fire in the engine room, such as the CO₂ installation.

Cargo fire

The risks of a cargo fire depend mostly on the type of cargo that is on fire. Most chemical tankers have a foam extinguishing system on the upper deck to fight the fire. But environmental risks are very high and depending on the type of cargo this can be dangerous for the health of the crew.

If the fire cannot be extinguished, the decision to abandon ship is often made. It is not unlikely the fire will spread to other cargo. This might lead to raging uncontrollable fires, such fires could damage the ship in such a way that the hull might break up releasing large quantities of oil and/or cargo



Photo 8 **Ship on fire**

5.7 Ship with danger of explosion

Natural gas is a very explosive substance. However in order to make natural gas incinerate, oxygen is needed. In the tanks there is no oxygen and therefore the gas cannot burn while inside the tank. However if gas escapes from the tank, very dangerous situations may occur. The escaping gas will mix with the air outside and form an explosive mixture. If the air mixture contains 5% gas an explosive mixture is created and at that moment all it takes is a spark to set it off. This is called lower explosion limit (LEL). If less gas is present in the air mixture it will not ignite.

Also if a tank is leaking, air can enter into the tank that also might lead to an explosive mixture. This is probably the most dangerous situation imaginable because there is an explosive mixture trapped inside the ship. Should the mixture explode the other tanks will most definitely be ripped open as well, so even more gas can escape, form an ignitable mixture and catch fire or explode. The magnitude of such a disaster is hard to predict because luckily this has never happened with a LNG tanker. Not only LNG could form an explosive

mixture in air there are also various bulk chemicals with a low flash point that can form explosive mixtures in air.

Another phenomenon is the flameless explosion that occurs when the LNG warms up quickly when it contacts water. The liquefied gas has a temperature of -162°C when the double hull is ripped open and the LNG comes into contact with water the liquefied gas warms up very quickly. When the LNG warms up it rapidly evaporates and expands its volume in a split second with 600 times. This explosion generates no heat but it produces huge stress on the walls of the tank and the ship's structure. For this type of explosion no ignition is needed. After a flameless explosion the danger of an explosion with fire still exists because the fuel for such an explosion has not been used yet. This phenomenon is called 'rapid phase transition'.

Gas cloud

In the event that gas expands but does not ignite, an enormous gas cloud can come into existence. In a worst case scenario the cloud contains 600 times the liquid volume of gas of natural gas. This gas cloud can be of great danger to human life because of the simple fact that humans breathe oxygen and not natural gas. Tests have been performed with gas clouds. In these tests gas was spilled on purpose over open sea. After releasing the gas the Lower Explosion Limit (5% gas) was measured. The danger area is defined as the area where a minimum of half the LEL is measured (2.5%). The cloud in which these amounts of gas are present is a visible vapour like cloud. In experiments where 20 m^3 of gas was released over 10 minutes the LEL within the cloud had a length between 110 and 150m. In experiments with 40 m^3 releases over the same period of time the LEL within the cloud could reach a length of 400m. Releases of amounts up to 200 m^3 have also been tested with a resulting visible cloud of 400 up to 2000m long. Larger amounts of gas spilled means bigger clouds, e.g. if 25000 m^3 gas should be spilled the expected cloud length is 6000 m.

The main concern is that if a leakage of gas should take place in port the gas cloud can drift into populated areas. The cloud can suffocate people in this area and of course also in the port area. In a worst case scenario the cloud will reach a populated area and ignite in this area due to the time the gas has had to mix with the air. A huge fireball will be the result.

5.8 Ship with cargo problems

Hazards associated with the shipment of bulk cargoes can be considered as belonging to the following categories:

- Structural damage due to improper distribution of the cargo
- Loss or reduction of stability
- Cargoes liquefying
- Chemical reactions

Structural damage due to improper distribution of the cargo: If the cargo is not properly distributed throughout the ship the structure can be overstressed and the ship has no adequate standard of stability. Bulk cargo is very often high-density cargo, so particular attention has to be paid to the distribution of weights so as to avoid excessive stresses. A general cargo ship is normally constructed to carry cargoes of about 1.39 to 1.67 cubic meters per ton while bulk carriers often carry cargoes with a stowage factor of about 0.56 cubic meters per ton or lower..

Loss or reduction of stability during a voyage, that usually results from: a shift of cargo in heavy weather due to the cargo having inadequately been trimmed and secured or improperly distributed. When a shift of cargo occurs, depending on the amount of cargo shifting and the angle of repose of the cargo, weight shifts over to one side. This can cause the ship to list, that, in turn, causes more cargo to shift. This kind of chain reaction can capsize a bulker very quickly. Especially with grain cargoes cargo shifting poses a great danger, since grain settles during a voyage and creates extra space between the top of the cargo and the top of the hold. The cargo is then free to move from one side to the other as the ship rolls.

When loss or reduction of stability occurs, the ship can list, capsize and even sink. If the cargo causes the loss or reduction, the risk that the ship capsizes and sinks is very high, due to the fact that the cargo might keep shifting and worsen the stability. If flooding occurs the risk is also very high, due to the intact stability of the ship. If a cargo hold floods, a huge free surface moment is created and loss of stability is very likely. If a smaller compartment of the ship floods, the risk is, of course, smaller.

The crew can try to regain (full) stability by using ballast water or even the cargo. If the crew manages to regain stability by losing/taking in ballast water or shifting/jettisoning the cargo the problem is solved and the risks for the ship and the environment are eliminated.

Cargoes liquefying under the stimulus of vibration and motion of a ship underway and then sliding or flowing to one side of the cargo hold. Some particular bulk cargoes, such as finely divided coal, tend to liquefy when absorption of ambient moisture occurs. The liquefied cargo at the bottom of the hold shifts easily and can produce a free surface effect. The free surface effect reduces the stability and might even cause capsizing. This free surface effect is eliminated in case of a completely empty or completely full cargo hold.

Chemical reactions e.g. emission of toxic or flammable gases, spontaneous combustion or severe corrosive effects: Bulk carriers often carry bulk cargoes that can present a hazard during transport because of their chemical nature. Some of these materials are classified as dangerous goods in the International Maritime Dangerous Goods Code; others are materials that can cause hazards particularly when transported in bulk.

Dangerous atmosphere in holds on board (chemical reactions of the cargo). A dangerous atmosphere can be, for example, an explosive atmosphere, as well as a toxic atmosphere. If this atmosphere escapes from the hold, the crew can be in danger, as well as the ship itself and the surroundings of the ship. The crew has to take measures to reduce the risks as much as possible, but sometimes they simply can not. The risk for the ship in case of an explosive atmosphere is large; imagine what would happen if one of a bulk carrier's holds would explode. The ship would be torn apart, causing it to sink. An explosion would kill everybody in the area, so it would at least endanger everybody onboard. If some compartment onboard would explode, the chance of losing oil is huge. Even if the ship would not be torn apart after a smaller explosion, the risk of losing oil would still be large.

If a toxic atmosphere arises, the risk for the ship is lower than with an explosive atmosphere, but still considerable. The crew cannot enter the hold without protective clothing and breathing apparatus.

5.9 Running aground

When a ship runs aground the double bottom may be ripped open. If this happens there are several possibilities of what may happen with the substance inside the tank. If the tank is

empty or filled with ballast water the only thing that will happen is the tank filling with seawater that results in a change of stability of the ship. The ship could suffer some list. This should not be a problem since the ship will probably still have enough stability left because of the low location of the leak.

The tank that is damaged can also contain bunker oil. This is a much more serious problem as oil starts leaking into the sea.

6. Options, risks and criteria

In the former chapter the distress situation are described. In this chapter the response options will be dealt with. In case of a ship in distress the decision-making often is limited to a few options to bring the ship in such a position that on one hand “bringing under optimal control could take place” and on the other hand the damage caused by the distress situation will be minimized.

The following 16 response options will be considered

1. Ship proceeds voyage to planned destination,
2. Ship proceeds to nearest port/harbour,
3. Ship proceeds to safe haven/places of refuge,
4. Anchor the vessel,
5. Let the ship drift by current and wind,
6. Keep stern or bow of ship in wind direction,
7. Ship proceeds in direction assistance will come from,
8. Ship proceeds towards the nearest coast,
9. Ship proceeds towards given location,
10. Ship proceed towards open waters,
11. Ground the vessel,
12. Lightening or discharging the cargo at sea,
13. Destroy cargo at sea,
14. Evacuate part of the crew,
15. Abandon ship,
16. Controlled sinking of the vessel..

Under international law, a coastal State may require the ship’s master (or the company owning or managing the ship) to take appropriate action within a prescribed time limit with a view to halting a threat of danger. In cases of failure or urgency, the coastal State can exercise its authority by taking response action appropriate to the threat. It is therefore important that coastal States establish procedures to address these issues, even if no established damage and/or pollution has occurred, preferably through a maritime assistance service.

For each decision, maritime authorities and, where necessary, port authorities should make an objective analysis of the advantages and disadvantages of the options mentioned above for a ship in need of assistance:

An assessment should analyse the following points:

- The seaworthiness of the ship concerned (buoyancy, stability, availability of means of propulsion and power generation, docking ability etc.);

- The nature and condition of cargo, stores, bunkers, in particular hazardous goods;
- The distance and estimated transit time to a sheltered area /or place of refuge;
- Whether the master is still on board;
- The number of other crew and/or salvors and other persons on board,
- An assessment of human factors, including fatigue;
- The legal authority of the country concerned to require action of the ship in distress;
- Whether and how the ship concerned is insured: if the ship is insured, the identity of the insurer, and the limits of liability available;
- Whether there is agreement by the master of the ship and the company owning or managing the ship to the proposals of the coastal State/salvor to proceed, or to be brought, to certain place;
- The provisions of the financial security required;
- Any commercial salvage contracts already concluded by the master of the ship or the company owning or managing the ship;
- Information on the intention of the master and/or salvor;
- The designation of a representative of the company owning or managing the ship in the coastal State concerned;
- Any measures already taken.

In the following Table 1 the relevant response options are given for the various distress situations.

Ship distress scenarios →	leaking oil	leaking chemicals	unstable deck cargo	adrift	sinking	on fire	cargo problem	danger of explosion	running aground
Possible actions ↓									
1 proceed voyage to planned destination,									
2 entering the nearest port ,			X				x		
3 entering safe haven	x	x	X			x	x	x	
4 anchor the vessel,	x	x	X	x	x	x	x	x	x
5 Let drift by current and wind	x	x		x	x				
6 Keep bow in wind direction		x	X	x		x	x	x	
7 Keep stern in wind direction		x		x		x	x	x	
8 proceed into direction assistance will come from	x	x	X		x	x	x	x	
9 proceed towards the nearest coast,	x	x	X		x	x		x	
10 proceed towards given location	x	x	X		x	x	x	x	
11 proceed towards open waters,	x	x			x	x	x	x	
12 ground the vessel					x		x		x
13 Lightening or Discharging at sea	x	x	X				x		x

14	destroy cargo at sea		x				x	x	x	x
15	evacuate the crew					x			x	x
16	abandon the ship,				x	x	x	x	x	x
17	controlled sinking to the sea floor					x				x

Table 1 Relevant response options for the various distress situations

Ad 1 Ship proceeds voyage to planned destination

Ship proceeding toward planned destination is only allowed if the ship is completely under control e.g. no fire, no leakage and no cargo problem anymore. Some times permission will be given if it can be expected that the situation will be under control in short notice. Besides the authorities responsible at sea (Coast Guard) the authorities of the harbour of destination should be involved in the decision making process.

Ad 2. Ship proceeds to nearest port/harbour

Ship proceeding toward nearest port/harbour is only allowed if the ship is completely under control e.g. no fire, no leakage and no cargo problem anymore. Some times permission will be given if it can be expected that the situation will be under control in short notice or that the situation only can be get under control within the harbour. Besides the authorities responsible at sea (Coast Guard) the harbour authorities of the nearest port/harbour should be involved in the decision making process. On shore there are likely more adequate means of solving any problem. The great advantage of going to the nearest port is that it will be easier to get help. There should be no risks for the port or shipping, this has to be considered together with the possible effects on the environment.

Ad 3. Ship proceeds to safe haven

A safe haven is a specially prepared place where a ship could go to even if there are still some problems on board. The intention of such a safe haven is that it may be easier to get the distress situation under control than in case the ship stays at sea. Decision-making should be done in co-operation with the authorities of the safe haven and the sea authorities. They have to inspect the ship and decide on the stability of the ship and the risk they are taking. On shore there are likely more adequate means of solving any problems. Contingency planning for an area suitable for a place of refuge/safe haven should include:

- roles and responsibilities of authorities and the responders in charge,
- response equipment needs and availability,
- response techniques required and permitted,
- international, regional or bilateral co-operation,
- existing logistics for emergency response, such as lightening, towage, stowage, salvage and storage,
- customs and financial implications to be considered in response operations; - the vulnerability of the area concerned.
-

The Contracting Parties noted that the designation and use of places of refuge could encounter local opposition and involve political decisions. Therefore, granting access to a

place of refuge could involve a political decision. Such a decision can only be taken on a case-by-case basis, with due consideration given to the balance between:

- the advantages for the affected ship and for the environment resulting from bringing the ship into a place of refuge; and
- the risk to the environment resulting from that ship being near the coast.

It should be made clear to the authorities and the public involved that a well-defined place of refuge can limit the extent of coastline threatened by the scale of dangers arising from the casualty.

The analysis should include a comparison between the risks involved if the ship remains at sea and the risks that it would pose to the place of refuge / sheltered area and its environment. Such a comparison should cover the following points:

- the safeguarding of human life at sea;
- the safety of persons at the place of refuge and in its industrial and urban surroundings (risk of fire or explosion, toxic risk, etc.);
- the risk of pollution;
- if the place of refuge is a port, the risk of disruption to the port's operation (channels, docksequipment, other installations);

Ad 4. Anchor the vessel (remain position)

In almost all distress situations anchoring the vessel should be considered. In case of a ship adrift this will be the primarily option to get the situation under control until the emergency tugboat arrives.

In case of a leaking ship and to keep the outflow concentrated, the sensitivity of the area for pollution will be an important criterion. Also the water depth needs to be considered. The anchoring of the ship in distress should not disturb shipping traffic.

Ad 5. Let the ship drift by current and wind

Let the ship drift by current and wind could have an advantage for leaking ships, as the pollution will stay around the ship. In particular at low wind speeds the pollution will be concentrated around the ship and less area will be polluted. In case of a ship adrift this option has to be weighted against anchoring the ship. This also depends on the time an emergency-towing vessel will be available on the distress position.

Ad 6. Keep stern or bow of ship into wind direction

Keep stern or bow of ship in wind is an option when toxic gas is involved or fire on board. In case of a fire it is to prevent that the fire reaches the cargo or the accommodation. In case of a gas clouds it is to prevent contact with the crew in the accommodation or wheelhouse.

If a ship is on fire at sea the fire fighting procedures should be followed. The captain should immediately put the ship's bow or stern toward the wind. Bow or stern depends on the place of the fire on board and the location of the accommodation. This can be done by propulsion and/or by anchoring. This move must keep the hot fumes away from the cargo or the toxic cloud away from the crew.

Ad 7 Ship proceeds into the direction assistance will come from

The ship could proceed into the direction assistance will come from, in order to speed up the sailing time for the assistance (fire fighter team, emergency tug boat, salvage team). These teams have means to get the situation under control more easily. The ship in distress could already sail in the direction from which the assistance will come from to

accelerate the help. In case of leakage this option is not ideal, as the polluted area will increase by sailing.

Ad 8 Ship proceeds towards the nearest coast

It is known from accidents in the past that the closer pollution takes place near the coast (coast in the down wind direction) the less length of coastline will be polluted. In particular heavy persistent oils tend to pollute the shoreline. The cleaning up costs and financial damage of such pollution will increase with the length of coastline polluted. Also the fact that nearer the coast the water depth will decrease could play a role, as salvage of a sunken vessel will be less expensive and easier in case it is expected that a distress situation could run out of control.

Ad 9. Ship proceeds towards a dedicated location

Dedicated locations could be chosen on the basis of sensitivity for pollution. Another reason could be a sheltered place for wind and current in order to get control over the situation more easily. This option depends on the availability of such places and the permission procedures. In case of a release of a toxic gas cloud it is important to know where the gas cloud will reach the coast. Moving the distress ship to a more favourable place where the gas cloud down wind does not pass a populated area can chance this.

Ad 10. Ship proceed towards open waters

This option is contrary to option 8. In particular dangerous situations for the public could be avoided to proceed towards open water. Toxic gas clouds could travel over large distances and the further away from the coast the less dangerous the toxic cloud will be, as diluting will reduce the concentration of the toxicity of the gas cloud.

In case of non-persistent pollution (volatile chemicals light crude oil etc.) the contribution of the reduction of the volume through natural processes as evaporation and natural dispersion get larger before the pollutant reaches the coast. This also gives more response time before the pollutant reaches the coast.

For persistent pollutants this option is very risky in particular when the response at sea fails. If the situation runs out of control the ship may sink in deeper waters, which makes wreck removal a lot more expensive; if oil is spilled, a larger stretch of coastline will be polluted, the ship is still in distress and the crew is still in danger.

Sailing to open sea does not solve any problem itself. But it can reduce the consequences when the situation runs out of control.

Ad 11. Ground the vessel

In case of cargo problems and or the risk of sinking this option could be chosen as it prevents the ship from going completely under water. As long as the ship stays above the water it is possible to get control over the situation and prevent spillage of the bunker and/or cargo. Also a salvage operation may be less costly.

Grounding can be done near the coast, at sea on a bank, at high tide, at low tide, on a sand bank, etc. Watertight compartments and water tight doors need to be closed before grounding.

Ad 12. Lightening or discharging at sea

Lightening at sea, if possible, could stabilize the leakage. Also cargo could be pumped to other tanks of the ship itself. The intention is to stop the leakage. It could even be considered to deliberately discharge a part of the cargo in order to save the ship and the remaining cargo.

Ad 13. Destroy cargo at sea

Sometimes the situation is so dangerous that the only option left is to destroy the cargo at sea. In particular cargo problems such as over heating, reactions, polymerisation could easily run out of control. Destroying the cargo or putting the cargo overboard is the only option left.

Mines on board a fishing vessel are for that reason thrown overboard.

Ad 14. Evacuate part of the crew

In case of a very dangerous situation that could not be brought under control e.g. explosion danger, fire, reaction in cargo etc., it is recommended to keep a minimum number of the crew on board.

Ad 15. Abandon the ship,

The next stage of option 15 “evacuate part of the crew” is to abandon the ship in case the situation gets worse and there is life-threatening danger for all of the crew.

If a fire could not be kept under control and there is no possibility left for the crew and emergency services to get the fire under control the crew should abandon the ship. Also in case of chemicals this option sometimes is the only way left.

Ad 16. Controlled sinking to the sea floor

The next stage of option 14 “destroy cargo” is to let the ship sink. The option is the last option to be considered but if the situation on board cannot be stabilized and no harbour is willing to receive the ship because the risks are too high than there is no other option left than let the ship sink. This option has been used in the case of a polymerization of styrene and in case of a reaction of calcium carbide with water. Controlled sinking of a ship in distress means that, if possible, the non-dangerous cargo/substances are removed first before the ship sinks. In particular bunker oil needs to be removed.

7. Generic decision making approach

The decision making in case of ships in distress focuses on prevention in order that the initial damage is kept to a minimum and that further damage is kept under control. The decision making in case of a ship in distress has to focus on the response to the distress situation in such a way that in the end the total damage is kept to a minimum.

A certain measure could increase the damage for one party but decrease it for another party. As an example: Going to shore of a municipality will increase the risk for that particular municipality but can decrease the risk for other municipalities in a more sensitive area.

Environmental damage, economical damage and safety of life could all play a role and have to be weighed against each other.

The first step in case of a ship in distress is to retrieve all possible information from the crew on the exact situation, the cargo of the ship and sea conditions. It is the responsibility of the crew and owners to get the situation under control as quickly as possible with the assistance of e.g. a salvor. Under control means: that the ship can continue its voyage toward its original destination without meeting problems to enter that port. Any actions that can enhance this situation need to be considered.

Coastal state authorities will assess the situation and identify the possible affect to the marine environment and socio-economic consequences, including the (dis)advantages of the option to bring the vessel into a port.

The crew itself will in the first place do extinguishing a fire. If they do not succeed, fire-fighting assistance from shore is required. Proceeding towards the location the tug with fire fighting equipment comes from can enhance the mobilisation time of the fire fighting team. Sailing on the other hand can increase the fire.

The possibility that the situation becomes worse and could run out of control always should be kept in mind. Clearly identify the consequences in case the ship becomes unstable and may sink and what could be the secondary damage caused by the ship in distress be if the situation runs out of control.

The following steps normally will be taken:

- Get the initial problem under control by own means (ship's crew extinguishes fire, stop leakage, stabilize deck cargo, etc.)
- Get additional assistance from shore to get the problem under control (emergency tugboat, fire fighting team, salvage team, spill response team etc.)
- Bring the ship in such a position that above actions could take place in an optimal way

The decision-making is on one hand focussed on "how to get the distress situation under control" and on the other hand on "saving the ship and crew". The ship owner's first priority is the crew, the ship and its cargo to be safe. Therefore the captain wants to have his ship safe and preferably in port as soon as possible.

As the situation could run completely out of hand (ship sinking or run aground on an unwanted location) the decision makers on shore as well as the captain always should have in mind what the consequences will be in that case. In other words will an action to get the situation under control not include a big risk if the situation gets out of control? As an example: proceeding towards a harbour to get the situation under control versus the risk that the ship can sink in the shipping lane in front of the harbour.

For the compensation of the damage it is important to know which compensation regime is applicable to the incident and what financial implications are compensated to what extent. If a harbour authority or municipality has to take a certain risk would they be compensated in case the situation runs out of control? For instance if a tanker proceeds toward the coast to get into sheltered waters in order to get the situation easier under control means a risk for that particular coastal area in case the situation runs out of control. If such a coastal municipality will not be fully compensated for the financial damage they are not likely to agree with the ship proceeding towards their coastline. In case of danger for human life the situation is even clearer.

[JH: it is not an easy decision and certainly not taken by the ship crew or the owners. This decision is the responsibility of the authorities and the authority in charge will bear the consequences, even take into account the existing compensation levels.

Fout! Verwijzingsbron niet gevonden. shows a decision making tree in case of distress situation at sea. Distress situations are; a fire on board, an oil leakage or chemical leakage, problem with the cargo, explosion danger, etc. As long as it is likely the situation could be kept under control the ship could proceed towards its final destination. If it is expected that, after the crew solves the initial problem, the ship urgently needs to be repaired the ship could proceed to the nearest harbour. In case assistance from shore is expected, the ship could sail towards the direction from which the additional assistance is to be expected. This will not necessarily be the nearest harbour. However, taking into consideration the actual situation on board it may also be a valid option that the ship stays at the position in order to avoid further listing or a further increase of stress situation.

If the crew does not successfully get the situation under control, the next step will be to ask for additional assistance from shore. Depending on the distress situation assistance will be required. For instance:

- An emergency towing vessel (ship adrift),
- Fire fighting team (fire on board, explosion danger, cargo problem),
- Spill response team (oil or chemical leakage) or salvage team (construction problem, cargo problem).

In this stage, in which the situation with the help of these team(s) is likely to be controlled in short notice the ship can proceed towards its final destination or proceed toward the nearest harbour.

The next stage will be a situation in which the distress situation may not be controlled in short notice, or if more assistance is required, or if the distress situation becomes more serious. In this stage response options that will accelerate solving the problem and which could minimize the damage in case the distress situation will last longer or escalates need to be considered. In this stage the decision maker should also have in mind that the situation could become worse e.g. major pollution, uncontrolled ship a drift, increasing fire resulting in damage to the ship, etc.

In this stage the following aspects need to be taken in consideration:

- A wreck removal operation in deeper water normally will be more expensive
- Risk of blocking a harbour entrance could cause enormous financial damage
- Location of pollution; e.g. a sensitivity areas could increase the environmental effects
- Distance from shore determines, in case of persistent pollutants, the length of coastline polluted

- Distance from the shore determines the sailing time of the assistance teams from shore (mobilisation time)
- Fire may increase due to sailing speed
- Sheltered places could reduce the pollution outflow
- Sailing direction could influence the stability of the situation
- Compensation of damages influences the willingness of local authorities to cooperate [JH: there is no evidence for this speculation]

Finally in case the situation runs out of control and there is serious risk of sinking the options to ground the vessel, controlled sinking of the vessel, abandon the ship need to be considered. In this stage normally there is no harbour willing to receive the vessel and a safe haven or sheltered area are not available.

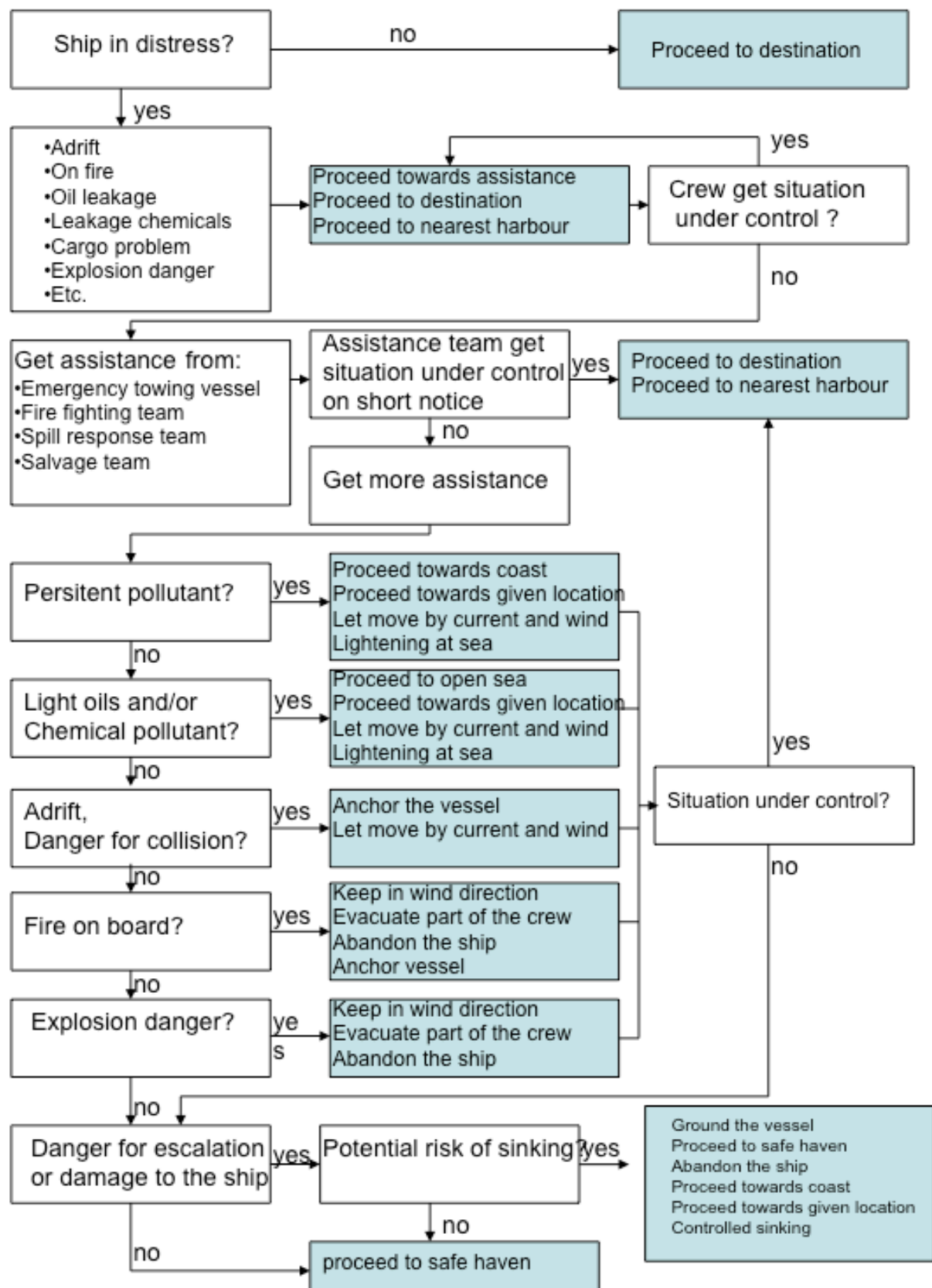


Figure 2 Decision-making tree in case of a ship in distress

8. Conclusions and recommendations

There is no general rule to take decisions in case of a ship in distress, weather circumstances, type of ship, season, availability of safe haven, compensation, all play a role.

Some statements however can be made about the decision-making.

- Any ship in a distress situation should be brought under control as soon as possible primarily by the crew itself and secondarily by external assistance from shore.
- If the distress situation is under control or almost under control the ship should precede towards a port as soon as possible and have necessary repair works carried out.
- As long as the situation is not under control one should focus on measures that do not increase the seriousness of the situation (fire, cargo problem, leakage, etc.) or take measures that minimize the impact. Sensitive areas should be avoided in case of (potential) pollution. Near coast should be avoided in case of toxic or explosive gas releases in case of fire or cargo problems.
- The stability of a ship/deck cargo could be influenced on the sailing, wind and current directions. Sailing could increase fire; deck cargo could get unstable in transversely waves.
- A distress situation that runs out of control could finally result in a major pollution and even in a sunken ship.
- The deeper the water the ship sinks in the more complex and expensive a salvage operation will be. Therefore it should always be tried to get a ship with potential risk of sinking into shallow waters. But first of all: it should never sink.
- In case of release of heavy oil and other persistent substances, the length of coastline polluted is determined by the distance from the coast downwind the pollutant's position. It therefore should always be tried to have such releases as close to the coast as possible. As the tidal current normally is more or less perpendicular to the coastline this will not have any influence on this
- In case of release of light oils and volatile and/or soluble substances the pollution damage normally will be less if the release takes place further away from the coastline, out at sea to a place with low sensitivity.
- Maybe it is safe to leave the vessel where it sank, under conditions that is and you need to identify those conditions).

9. Liability Conventions

The compensation regime for crude oil tankers was originally established in 1978 and is now based on two Conventions:

- The 1992 International Convention on Civil Liability for Oil Pollution Damage (1992 Civil Liability Convention) and
- The 1992 International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage (1992 Fund Convention). A Protocol to the 1992 Fund Convention was adopted in 20, which established a Supplementary Fund (Supplementary Fund Protocol).

The 1992 Civil Liability Convention

Under the 1992 Civil Liability Convention, claims for compensation for oil pollution damage caused by persistent oil may be made against the registered owner of the ship from which the oil that caused the damage originated (or his insurer). However, the shipowner can normally limit his financial liability to an amount determined by the size (tonnage) of the particular ship involved. The shipowner is obliged to maintain insurance to cover his liability under the Convention, although this obligation does not apply to ships carrying less than 2 000 tonnes of oil as cargo.

The shipowner is liable to pay compensation for pollution damage caused by the escape or discharge of persistent oil from his ship even if the pollution was not due to any fault on his part. The shipowner is exempt from this liability only in very special circumstances.

The 1992 Fund Convention

The 1992 Fund was established in 1996 under the 1992 Fund Convention and is financed by companies and other entities in Member States that receive certain types of oil carried by sea. The Fund is an intergovernmental organisation set up and governed by States.

The 1992 Fund is governed by two bodies: the Assembly and the Executive Committee. The Assembly is composed of representatives of the governments of all Member States. The Executive Committee, composed of 15 Member States, is a subsidiary body elected by the Assembly. The main function of this Committee is to approve claims. However, the Executive Committee normally gives the Fund's Director very extensive authority to approve and pay claims.

Under the 1992 Fund Convention additional compensation is made available by the 1992 Fund when claimants do not obtain full compensation under the 1992 Civil Liability Convention. This can happen in the following cases:

- The damage exceeds the limit of the ship owner's liability under the 1992 Civil Liability Convention.
- The ship-owner is not liable under the 1992 Civil Liability Convention because the damage was caused either by a grave natural disaster, or wholly caused intentionally by a third party, or wholly caused as a result of the negligence of public authorities in maintaining lights or other navigational aids.
- The ship-owner is financially incapable of meeting his obligations under the 1992 Civil Liability Convention in full, and the insurance is insufficient to pay valid compensation claims.

The 1992 Fund does not pay compensation if:

- the pollution damage resulted from an act of war, hostilities, civil war or insurrection, or was caused by a spill from a warship (in which case the ship owner is also not liable under the 1992 Civil Liability Convention), or
- the claimant cannot prove that the damage resulted from an incident involving one or more ships as defined in the Conventions (that is, a laden, or, under certain circumstances, unladen sea-going vessel or seaborne craft constructed or adapted to carry oil in bulk as cargo).

The Supplementary Fund Protocol

The 2003 Protocol to the 1992 Fund Convention established a Supplementary Fund to provide additional compensation for pollution damage in those States that are Members of the Supplementary Fund. The criteria under which compensation claims qualify for compensation from the Supplementary Fund are identical to those of the 1992 Fund. The 1992 Fund's claims settlement policy set out in this Manual therefore applies also to compensation payments by the Supplementary Fund.

JH: pay attention to HNS protocol; to Bunker Convention and International Wreck Convention. You may check the ITOPF web site or IMO to be up-to-date.

10. Annex 1: Ship's types

10.1 Oil tanker

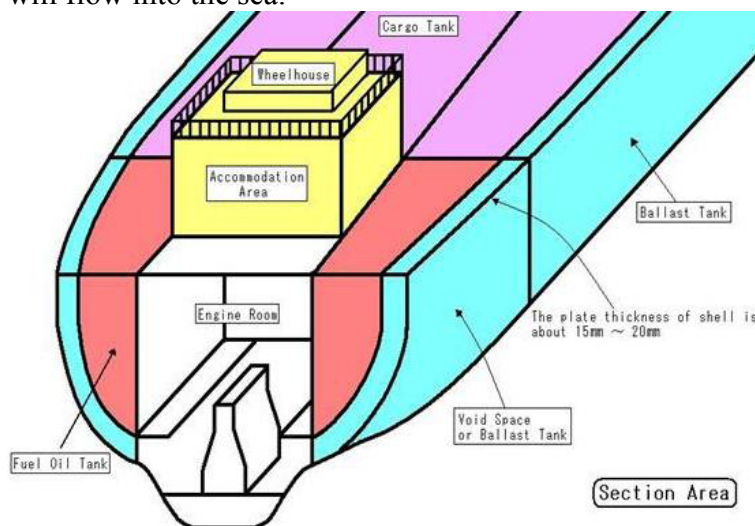
A crude oil tanker is designed to carry large amounts of non-refined oil in bulk around the world. Sizes can be up to 550.000 GT. There are various sizes of oil tankers, such as:

- 10,000–24,999 DWT: General Purpose tanker
- 25,000–44,999 DWT: Medium Range tanker
- 45,000–79,999 DWT: Large Range 1 (LR1)
- 80,000–159,999 DWT: Large Range 2 (LR2)
- 160,000–319,999 DWT: Very Large Crude Carrier (VLCC)
- 320,000–549,999 DWT: Ultra Large Crude Carrier (ULCC)

The hull design is an important component of the structure of an oil tanker. Nowadays there are three types of hulls in existence; the single hull tanker and the double hull tanker and a hybrid of both.

Before 1993 almost all tankers were single hull tankers. This means there is only one layer of steel between the cargo and the seawater. In an event of a crack in the hull, the oil can leak out easily. These tankers may have a protective ballast tank in front of the ballast tank, on places where they are most likely to be damaged in case of a collision.

The double hull construction became mandatory for tankers with a dwt. of 5000 tons or more built after 1993. This means that after 2015 no single hull tankers will be in service anymore, this date is set to 2010 if the tanker wants to carry heavy graded oils. A ballast tank usually separates the double hull with a space of approximately 2-3 meters. This means in the case of minor grounding or minor collision, it is not likely oil will be spilled. However if the list of the most severe tanker incidents is considered then the double-hull construction would not have made a difference. If tankers are stuck on pinnacles that penetrate the tanks, the contents will flow into the sea.



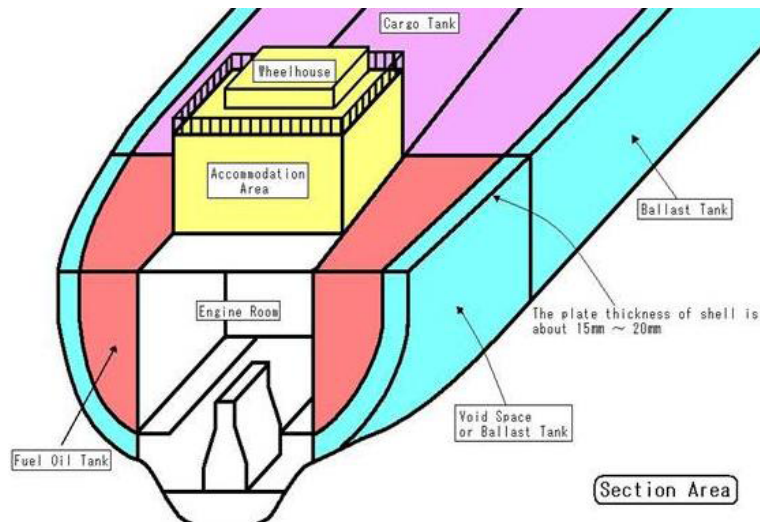


Figure 3 Overview tanks of a crude oil tanker

The inert gas plant.

To protect the oil tanker from explosions, an inert gas plant is installed. The crude oil itself is very difficult to ignite. The vapours evaporating from the oil are explosive. To prevent an explosion from occurring, the oxygen level is kept low by the inert gas plant, this system lays a protective carbon dioxide layer on top of the crude oil.

The Fuel tanks:

Just as any other ship, a crude oil tanker needs fuel. Most of the tankers use slow running two-stroke engines that can cope with very heavy fuels. These fuels are located in purpose made bunker tanks situated in wing tanks near the engine room. These wing tanks are protected from outside forces by void spaces or ballast tanks.

The Cargo tanks:

Each oil tanker is divided into several cargo tanks. Each tank is restricted to a maximum size; the size of each cargo tank is related to the size of the tanker. This way, in the case of a crack, the oil tanker will not spill all of its cargo at one time. As a positive side effect the separated cargo tanks give extra strength to the vessel's hull. The cargo of oil tankers could be crude oil or oil products such as fuel oils.

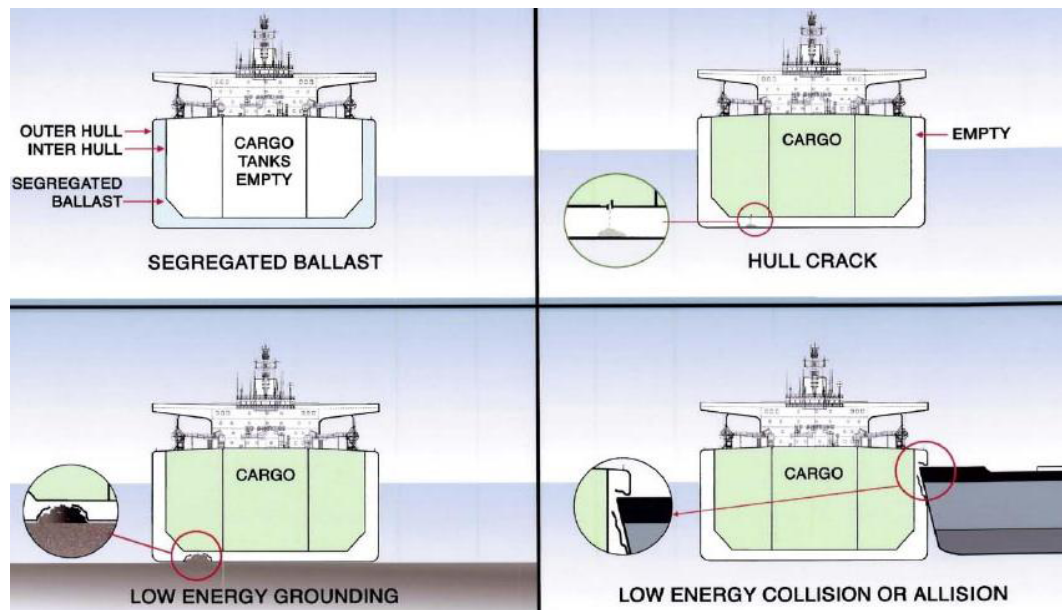


Figure 4 Distress situations

10.2 Chemical tanker

A chemical tanker carries different types of liquid chemicals in bulk. The chemicals are transported under atmospheric pressure and at low temperatures (max 80°C). The size of these ships can vary between rather small ones (5,000 DWT or less) to bigger ones (over 40,000 DWT). This is considerably smaller than an average crude oil or product tanker. That is because of the usually smaller amounts of chemical cargo and the sometimes much smaller ports where the ship loads or unloads.

The tanks often have heating, the reasons for this are; either the cargo requires it (to keep the cargo in the right conditions) or the viscosity will increase when it cools down making pumping operation very difficult if not impossible. For safety reasons all chemical tankers must be equipped with a so-called 'double hull'. This means that outside the normal tank shell is another hull (usually the extra space is used for ballast water when necessary). This makes the chance of leakage after a collision or grounding much smaller.

The structural arrangement of a type 1 chemical tanker is made to the highest precautions possible. This type of tanker is allowed to transport cargo's that are considered to have severe environmental and safety hazards. A type 1 chemical tanker is only allowed to be transported in the shaded space in the figure below. The by IMO set minimal measurements outside of the type 1 chemicals tank are given in the figure below. The maximum tank capacity is limited by the hazard of the cargo. The maximum tank capacity for a type 1 tanker is: 1250 m³

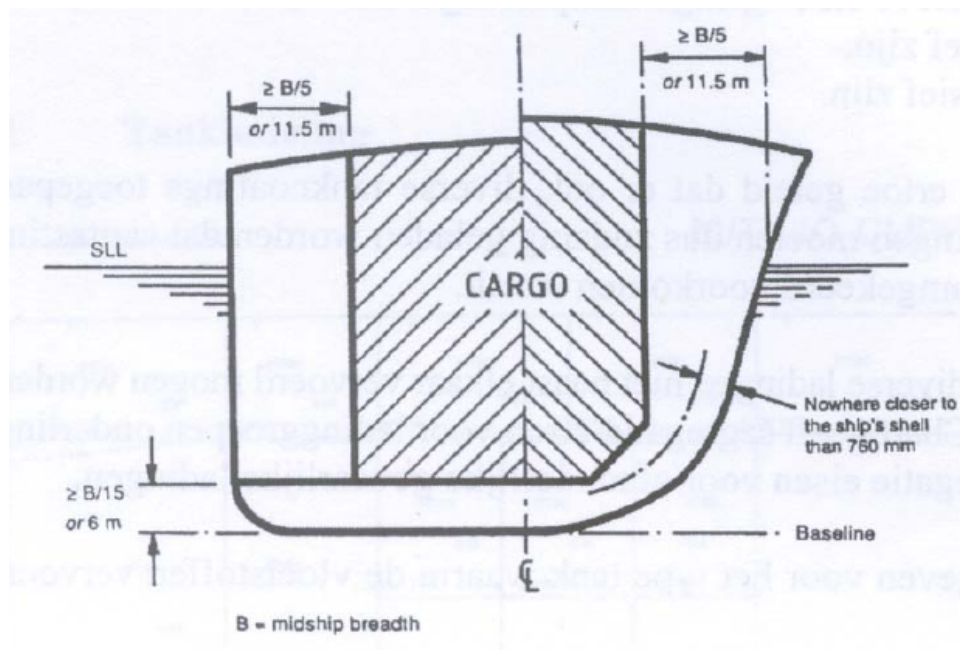


Figure 5 a typical chemical tanker type I

The image above shows the requirements for the double hull that IMO has set for the type I chemical tankers. The distance in between the cargo tank shell and the outer hull is for this type the biggest. The size of the tanks is also restricted; a cargo tank may not be larger than 1250 m³. A cargo tank must also be separated from fresh water tanks, the accommodation, other cargo (depending on the kind of chemicals) and the engine room.

A chemical tanker also has relatively more tanks than an oil tanker; this is to accommodate several different kinds of cargo at the same time. The tanks have an epoxy coating or are made from stainless steel. The type of tank is important, because some types of cargo can only be put into a stainless steel tank, while others require a certain type of epoxy coating. A stainless steel tank is for example very well suited for transporting different types of acids (sulphuric acids, phosphoric etc.). Tanks with an epoxy coating on the other hand can transport vegetable oils.

Because of the variety in cargoes (with different demands in safety measures), there are three different types of chemical tankers. These are type I (for the most dangerous chemicals), type II (for less dangerous chemicals) and type III (for relative safe chemicals).

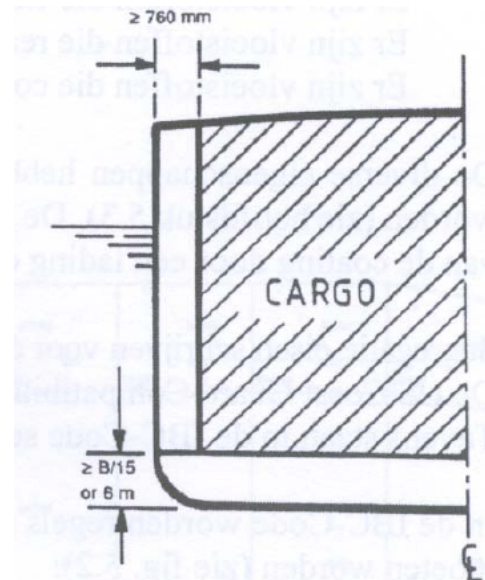


Tank of a chemical tanker (photo 1) each tank is fitted with a submersible pump (photo 2)

A tanker of type 1 is allowed to transport all possible cargos. In practice the space in the ship that isn't allowed to carry chemicals of type 1 is filled up with tanks that are allowed to carry chemicals of type 2 or 3. In practice there are only tankers of type 2 which have cargo tanks that are allowed to carry cargos of a tanker type 1. This is because the offer of type 1 cargos is too small to make a type 1 tanker profitable. In that type of ship there are transported type 1 chemicals in the center tanks and type 2 chemicals in the wing tanks.

Chemical tanker type 2

The structural arrangement of type 2 tankers is made to an important level of precaution. This type of tanker is allowed to transport cargo's that are considered to have high environmental and safety hazards. A type 2 chemical is only allowed to be transported in the shaded space in the figure below. The by IMO set minimal measurements outside of the type 2 chemicals tank are given in the figure below. The maximum tank capacity for a type 1 tanker is: 3000 m^3



Chemical tanker type 3

The structural arrangement of a type 3 tanker is made to a limited level of precaution. This type of tanker is allowed to transport cargo's which are considered to have possible environmental and safety hazards. A type 3 chemical is only allowed to be transported in the shaded space in the figure below. The by IMO set minimal measurements outside of the type 3 chemicals tank are given in the figure below. The maximum tank capacity for an type 1 tanker is: unlimited.



10.3 Bulk carrier

A bulk carrier is a type of ship which purpose it is to carry cargo in loose/unpacked condition and of a homogeneous nature. Cargoes like; grains, coal, ore, and cement. Bulk carriers can be roughly divided into three categories:

- **Handy size bulk carriers:** approximately 30.000 tons deadweight, often with own cargo gear. Cargo: precious ore, sand, scrap, (china) clay, grain and forest products. This category bulk carrier represents 71% of all bulk carriers and also has had the

highest rate of growth in the last few years. This is partly due to new regulations that put constraints on the construction of larger vessels. Handy size ships are typically 150-200 m in length, with about five cargo holds and about four canes.

- **Panamax bulk carriers:** approximately 80.000 tons deadweight, they seldom have cargo gear. Cargo: grain and ore. The ships have the following dimensions: a beam of 32.31m, a length of 294.13m and a draft of 12.04m.
- **Cape size bulk carriers:** approximately 160.000 tons deadweight and over, no cargo gear. Cargo: coal and ore.

Ship's structure

A general arrangement of a typical bulk carrier shows a clear deck with hatches and the superstructure and machinery at the aft. Large hatches with steel covers are designed for quick loading and discharge of the cargo. Since the bulk carrier makes many voyages in ballast a large ballast capacity is provided to give adequate immersion of the propeller. The typical bulk carrier shape however has experienced a relatively high casualty rate during the late 1980s and early 1990s, giving rise to concern as to their design and construction. Throughout the 1990s bulk carrier safety has been worked on extensively by the IMO and others and is ongoing. Based on experience with accidents it was concluded that the accidents occurred due to structural failure, leading to loss of watertight integrity of the side shell followed by progressive flooding through damaged bulkheads. The flooding resulted either in excessive hull bending stresses or excessive trim, and loss of the vessel. Much of the work has concentrated on the hull structure, stresses experienced, protective coatings arising from discharging cargoes, poor maintenance and inadequate inspection of the ship structure.

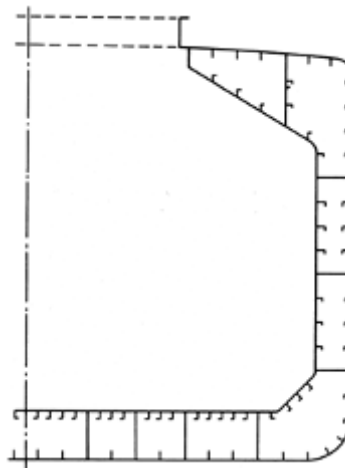


Figure 6 Traditional bulk carrier amidships section

The sequence of loading and discharging the cargo is particularly important. It is relatively easy to cause structural damage by large shear forces between full and empty tanks as well as unacceptable hull bending. Many bulk carriers lead particularly demanding working lives. Cargo grabs, bulldozers and hydraulic hammers may cause physical damage to plating, frames and brackets, and if not investigated promptly and repaired where necessary, the overall structure may be weakened. Also the fact that, in loading ports where the cargo delivery rate is high, the inability to pump out ballast water quickly enough may occasionally result in the hull being over-stressed. Even more the cargo itself gives little or no internal

support to the insides of the holds.

All these possible damages are worsened when the vessel sails in heavy weather; the stresses then experienced will be at their greatest. After all these facts, we can conclude that a bulk carrier may relatively easily suffer structural damage, which can even lead to sinking.

10.4 Container vessel

Container ships are cargo ships that carry their entire load in truck-size intermodal containers, in a technique called containerization. Capacity is measured in Twenty-foot Equivalent Unit (TEU), the number of standard 20-foot containers measuring $20 \times 8.0 \times 8.5$ feet ($6.1 \times 2.4 \times 2.6$ metres) a vessel can carry. This notwithstanding, most containers used today measure 40 feet (12 metres) in length. Above a certain size, container ships do not carry their own loading gear, so loading and unloading can only be done at ports with the necessary cranes. However, smaller ships with capacities up to 2,900 TEU are often equipped with their own cranes.



photo 1: container vessel

Informally known as "box boats," they carry the majority of the world's dry cargo, meaning manufactured goods. Cargoes like metal ores or coal or wheat are carried in bulk carriers. There are large main line vessels that ply the deep-sea routes, then many small "feeder" ships supplying the large ships at centralized hub ports. Most container ships are propelled by diesel engines, and have crews of between 20 and 40 people. They generally have a large accommodation block at the stern, near the engine room. Container ships now carry up to 15,000 TEU on a voyage. In 2008, the M/V Emma Mærsk was the world's largest container ship and had a capacity of 15,200 containers, based on 20 feet containers.

Risks

The ceaseless transit of these containers (at any given time, between 5 million and 6 million units) entails a great deal of risk. About 3% to 5% of all containers transported by sea contain hazardous chemicals.

Some of the risks are linked to the loading and unloading of containers. The risks involved in these operations affect both the cargo being moved onto or off the ship, as well as the ship itself. Containers, due to their fairly nondescript nature and the sheer number handled in major ports, require complex organization to ensure they are not lost, stolen or misrouted. In addition, as the containers and the cargo they contain make up the vast majority of the total

weight of a cargo ship, the loading and unloading is a delicate balancing act, as it directly affects the centre of mass for the whole ship. In March 2007, a London based container ship capsized in Antwerp, Belgium while loading.

It has been estimated that container ships loose over 10,000 containers at sea each year. Most go overboard on the open sea during storms but there are some examples of whole ships being lost with their cargo. When containers are dropped, they immediately become an environmental threat or a threat for shipping.

Cargo too large to carry in containers can be handled using flat racks, open top containers and platforms. There are also container ships called roll-on/roll-off (RORO), which utilize shore-based ramp systems for loading and unloading. RORO's are usually associated with shorter trade routes, as they are unable to carry the volume of crane-based container vessels.

However, due to their flexibility and high speed, RORO's are frequently used in today's container markets.

10.5 LNG tanker

An LNG tanker is a type of ship which is designed for transporting 'liquefied natural gas' (LNG). These ships can transport huge amounts of LNG. The biggest LNG tankers can carry up to 266,000 m³ of LNG. There are two types of LNG tankers, the 'Moss type' with ball shaped tanks and the 'membrane type' with tanks with 8 walls. The only difference between the two types is the shape of the tanks. The last few years the number of LNG tankers has greatly increased because LNG is greatly promoted as a much cleaner fuel than other fossil fuels.

LNG is natural gas which is super cooled until it reaches its liquid form. The temperature at which this happens depends on the composition of the gas. Methane is the gas form which has the lowest condensation temperature which is -161.5°C. So the gas is always cooled to approximately -162°C. The great advantage of liquidizing the gas is that LNG has only 1/600th of the volume than it has in its gas state. So six hundred m³ of natural gas becomes 1 m³ liquid LNG after cooling.

During the voyage the LNG in the tanks will boil. The great advantage of boiling is that this takes heat away from the rest of the cargo. The gas that boils off is gathered and is mainly used as fuel for the engine or to drive a generator for electric power on the ship. Loading and discharging of LNG happens almost the same as handling oil. The only difference is that the product which is moved is now -162°C and if heated the cargo will change back into its gas state. So the main things to worry about are to keep the gas liquefied and to make sure there are absolutely no leaks. LNG can easily form an explosive mixture in the air.



Figure 7 *'Membrane type' tanker*



Figure 8 'moss type' tanker

As said before a LNG tanker is just a ship like any other. The ship's structure has a double hull like most oil tankers so in the event of a collision or a stranding the ship's hull is not immediately penetrated. Even if the ship's hull is breached the tank itself should still be intact. The tanks are, most of the time, constructed in a ball like shape. This makes sure that the stresses on the walls are evenly distributed. Because of this shape near the double bottom there is a large void space. This void is the smallest at the main deck. Because a ball like tank is not very space efficient there are also tankers with tanks with 8 sides. The tank itself is made from aluminium and insulated with polyurethane foam which is purged with nitrogen. The outer shell of the tanks is made out of steel. So the LNG cargo is pretty well protected from damage done by beaching, collisions or running aground.

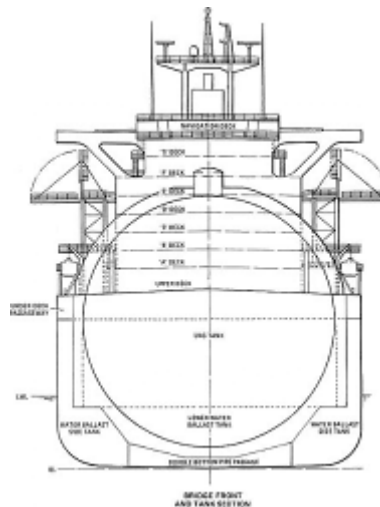


Figure 9 typical 'Moss type' tank lay out

In the unlikely event of a collision situation on a LNG tanker this can be very dangerous. There are no special sailing rules for these tankers but crew is, of course, well aware of the danger their cargo brings along.

If the hull of the ship and the hull of the tank are breached the consequences can be devastating.

If only the hull of the ship is breached the same things can happen as in the case of running aground. If the leak in the hull is above the waterline the water in the ballast or fuel tank can leak out and might cause a list.

LNG-tankers are like any other ship the only thing that's different is its cargo. In distress situations it's important that the best decisions are made based on the human element, environment and economics. The main goal should be human life. Because LNG-tankers transport a dangerous cargo the crew should first determine if human life is threatened. If

human life is threatened the crew should always secure it even if the environment is endangered. If the crew still has got time to take actions to protect the environment and thus the economy these actions should always be taken.

10.6 Fishing vessels.

There are a lot of different kinds of fishing vessels. Stern Trawlers and Beam trawlers will be discussed in more detail as these are commonly used seagoing fishing vessels.

Beam Trawlers

A beam trawler is a trawler that tows its fishing gear by outrigger booms. These ships have a maximum crew of eight persons. Normally these ships stay at sea for not longer than 5 days. This means these ships do not take much fuel to sea. Most of the beam trawlers run on marine diesel oil, but more and more fishing vessels are switching to heavy fuel oil, due the fact HFO is cheaper than MDO

Photo 1

Beam Trawler



Stern Trawlers

A stern trawler is a ship that tows its fishing gear over the stern of the ship. The nets can be towed more than a kilometre behind the ship, this situation leads to difficulties in the manoeuvrability. The main engines use heavy fuel oil and the auxiliary engines run on marine diesel oil. The main engines are being used for the propulsion and to run the shaft generator. The auxiliary engine is used for the complete refrigeration plant onboard the vessel. The size of stern trawlers vary, the biggest Dutch-flagged vessel can carry 375.000 cartons of fish each of approximately twenty kilos. The time these types of vessels are at sea can vary between two and eight weeks, the number of crew is about thirty persons and the bigger stern trawlers may have a crew of fifty persons.

Photo 2

Stern trawler



10.7 Passenger vessel / Cruise ship

A passenger ship is a ship whose primary function is to carry passengers. Passenger ships include ferries, which are vessels for day or overnight short-sea trips moving passengers and vehicles (whether road or rail), ocean liners, which typically are passenger or passenger-cargo vessels transporting passengers and often cargo on longer line voyages and cruise ships, which often transport passengers on round-trips, in which the trip itself and the attractions of the ship and ports visited are the principal attraction.

Until recently virtually all ocean liners were able to transport mail, package freight and express and other cargo in addition to passenger luggage, and were equipped with cargo holds and derricks, kingposts, or other cargo-handling gear for that purpose. Only in more recent ocean liners and in virtually all cruise ships this cargo capacity has been eliminated.



Photo 4 Ferry

For a long time cruise ships were smaller than the old ocean liners had been, but in the 1980s this changed when Knut Kloster, the director of Norwegian Caribbean Lines, bought one of the biggest surviving liners, the SS France, and transformed her into a huge cruise ship, which he renamed the SS Norway. Her success demonstrated that there was a market for large cruise ships. Successive classes of ever-larger ships were ordered, until the Cunard liner Queen Elizabeth was finally dethroned from her 56-year reign as the largest passenger ship ever built (a dethronement that led to numerous further dethronements from the same position).



Photo 5 Cruise ship

Both the RMS Queen Elizabeth 2 (QE2) (1969) and her successor as Cunard's flagship RMS Queen Mary 2 (QM2), which entered service in 2004, are of hybrid construction. Like transatlantic ocean liners, they are fast ships and strongly built to withstand the rigors of the North Atlantic in line voyage service, but both ships are also designed to operate as cruise

ships, with the amenities expected in that trade. QM2 superseded the Explorer of the Seas of the Royal Caribbean line as the largest passenger ship ever built, and in turn was surpassed by Royal Caribbean's cruise ship Freedom of the Seas. The latter ship, and her sisters, were superseded by ships of the Oasis Class delivered in November 2009.