NATIONAL TECHNICAL UNIVERSITY OF ATHENS

SCHOOL OF NAVAL ARCHITECTURE AND MARINE ENGINEERING

DIVISION OF SHIP DESIGN AND MARITIME TRANSPORT

DIPLOMA THESIS

ANALYSIS OF SERIOUS INCIDENTS ON IACS-CELLULAR CONTAINERSHIPS

BUILT AFTER 1981 FOR THE PERIOD 1990-2011

SUPERVISOR

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1. INTRODUCTION

1.1 Abstract

The object of the present research is the statistical analysis of the incidents on cellular containerships built after 1981 and with a Gross Tonnage (GT) over 999 for the period 1990-2011. In this research will be examined only the serious events of cellular containerships which at the time of incidents were registered to members of the International Association of Classification Societies (IACS). The incidents are divided into eight categories for the purpose of this research:

- Collision incidents
- Contact incidents
- Grounding incidents
- Fire incidents
- Explosion incidents
- Non-accidental structural failure incidents
- Hull fittings failure incidents
- Machinery failure incidents

Note that scenarios due to unknown reasons as well as incidents associated with piracy or war losses are not considered in the study.

All the necessary data was provided by the Germanischer Lloyd. The database that is commonly used is the IHS. There were also some incidents from the LMIU and GISIS databases that weren't recorded in the IHS database. These incidents are examined as well. A comparison of these databases is executed as long as the severity degree is concerned.

For the purpose of this analysis the SDL (Ship Design Laboratory) database was created at the NTUA (National Technical University of Athens). A manual of the NTUA-SDL database can be found in Annex I. Each incident category is analyzed independently and the results of the focused analysis are compared to those of the SAFEDOR Formal Safety Assessment (FSA).

The occupational incidents are analyzed individually because of their nature, resulting to the fault tree which shows the source of danger for crew members on board.

1.2 Scope of the diploma thesis

The object of the master thesis is the statistical analysis of the incidents on cellular containerships built after 1981 and with a Gross Tonnage (GT) over 999 for the period 1990-2011. In the current research will be examined only the serious events of cellular containerships which at the time of incidents were registered to IACS society. The aim is to extract useful information as far as the nature of the accidents is concerned which will contribute in the prevention or the decrease of similar occurrences in the future.

The commercial activities of containerships involve potential hazards. Ships, crew and cargo are exposed to certain risks such as potential injuries/loss of life or loss of property. These risks need first to be identified and then evaluated and controlled. The identification of hazards is a prerequisite for modeling and quantifying the risk. In order to identify relevant hazards for containerships, all relevant operation modes and accident categories need to be listed and considered. The analysis will be achieved through the recording of the causes of each incident, the location where the accident took place, the operating condition of the ship, the prevailing weather condition / weather impact, the consequences of the incident on the ship and the crew on board and the pollution of the environment or the loss of cargo if occurred.

The results from the current risk analysis are generally the best estimate of the actual risk level for the various incident categories. The risk analysis constitutes the first step of the Formal Safety Assessment (FSA) and its results will lead to the risk assessment, which is the second part of the FSA. Further steps of the FSA that will be executed in following studies are the identification of risk control options, the cost benefit assessment and finally recommendations for decision making.

2. GENERAL INFORMATION ABOUT CONTAINERSHIPS

2.1 Historical background

There are two main types of dry cargo: *bulk cargo* and *break bulk cargo*. Bulk cargoes, like grain or coal, are transported unpackaged in the hull of the ship, generally in large volume [1]. Break-bulk cargoes, on the other hand, are transported in packages, and are generally manufactured goods [2]. Before the advent of containerization in the 1950s, break-bulk items were loaded, lashed, unlashed and unloaded from the ship one piece at a time. Afterwards the successful application in the land transports, the use of containers was extended in the coastal transports and by the dues of the 50s in the open sea transports with the refit/conversion of existing cargo ships. By the means of the 60s is observed an explosive development in the designing and manufacture of a specialized type of ship for the transport of containers, the known today containership. Containerization has increased the efficiency of moving traditional break-bulk cargoes significantly, reducing shipping time by 84% and costs by 35% [3]. Cargo that once arrived in cartons, crates, bales, barrels or bags now comes in factory sealed containers, with no indication to the human eye of their contents, except for a product code that machines can scan and computers trace. This system of tracking has been so exact that a two week voyage can be timed for arrival with an accuracy of less than fifteen minutes. It has resulted in such revolutions as *on time guaranteed delivery* and *just in time manufacturing*.

2.2 Containerization of cargo

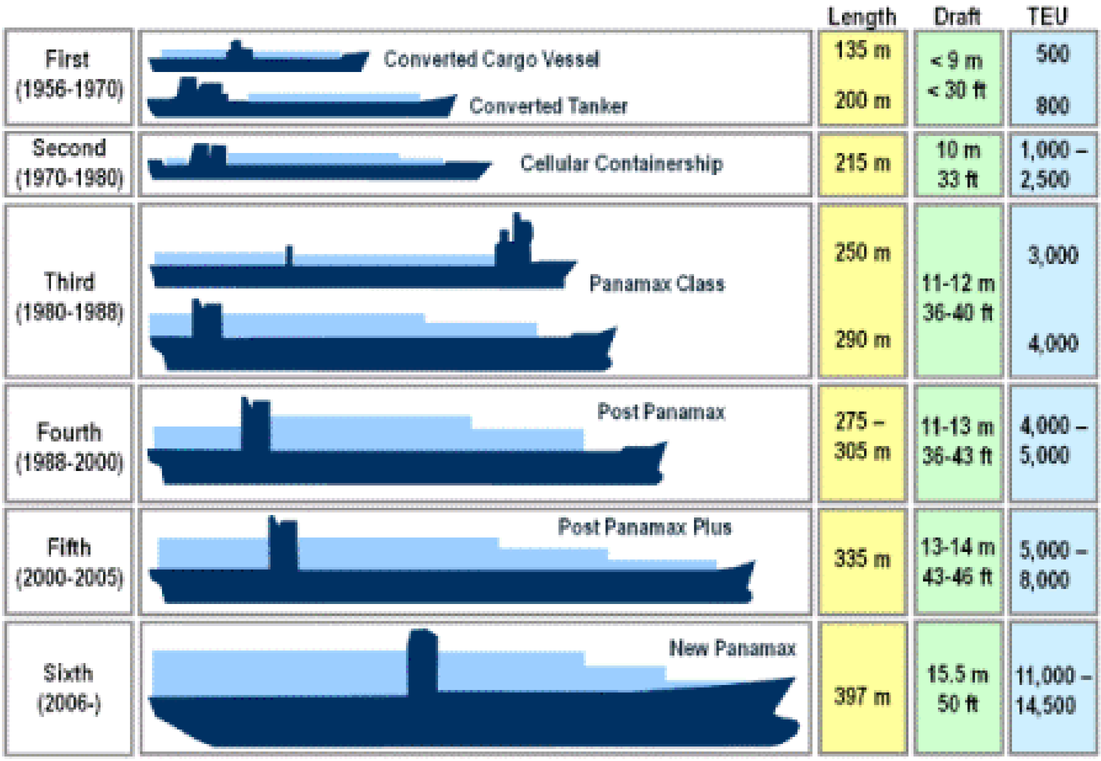
It has prevailed internationally the standardized ISO container with traverse cross-section 8 feet x 8 feet. The height 8 feet (or 2.435m) resulted from the being in effect limits for the road transport in the USA (and later worldwide) for the passage of vehicles under the bridges. Characteristic length of the standardized ISO containers is 20 feet (*TEU*: Twenty feet Equivalent Unit container, type ISO – 1C). There have been standardized also other sizes of containers - multiple or submultiple of the length of the basic TEU – such as containers 40 feet (*FEU*: Forty feet Equivalent Unit container, type ISO – 1A) and the preferred from certain companies in USA containers 30 feet (type ISO – 1B), 10 feet (type ISO – 1D) and $6^{2/3}$ feet. TEUs require clean volume of hulls 38.19 c.m. Two TEUs with intermediary gap of 3 inches correspond in the length of one FEU, which corresponds in the classic length of hulls of the containerships [4].

In the following table there is a summary of all types of containers that are in use nowadays (standardized ISO container) [5]:

Designation	Length			Height			Width			Maximum gross weight	
	mm	ft	in	mm	ft	in	mm	ft	in	kg	lb
1A	12,192	40		2,438	8		2,438	8		30,480	67,200
1AA	12,192	40		2,591	8	6	2,438	8		30,480	67,200
1B	9,125	29	$11^{1/4}$	2,438	8		2,438	8		25,400	56,000
1BB	9,125	29	$11^{1/4}$	2,591	8	6	2,438	8		25,400	56,000
1C	6,058	19	$11^{1/4}$	2,438	8		2,438	8		20,320	44,800
1CC	6,058	19	$11^{1/4}$	2,591	8	6	2,438	8		20,320	44,800
1D	2,991	9	$9^{1/4}$	2,438	8		2,438	8		10,160	22,400
1E	1,968	6	$5^{1/2}$	2,438	8		2,438	8		7,110	15,700
1F	1,460	4	$9^{1/2}$	2,438	8		2,438	8		5,080	11,200

2.3 Generations of containerships

Containerships are distinguished nowadays into six generations: The *first generation* of containerships was composed of *modified bulk vessels or tankers* that could transport up 1,000 TEUs. Once the container began to be massively adopted at the beginning of the 1970s, the construction of the *first cellular containerships* **(***second generation***)** entirely dedicated for handling containers started. All these ships were much faster (20-25 knots) and were composed of cells lodging containers in stacks of different height depending on the capacity. Capacity was increased as a result of the removal of cranes. Economies of scale rapidly pushed for the construction of larger containerships in the 1980s. The size limit of the Panama Canal, which came to be known as the *panamax standard*, was achieved in 1985 with a capacity of about 4,000 TEUs (*third generation*). By 1996 full-fledged *fourth generation* of containerships were introduced and capacities reached 6,600 TEUs. Once the panamax threshold was breached, ship size quickly went to the *fifth generation* (Post Panamax Plus) with capacities reaching 8,000 TEUs ("S Class"). By 2006, *sixth generation* containerships came online when the maritime shipper Maersk introduced a new class having a capacity in the range of 11,000 to 14,500 TEUs, the Emma Maersk, (E Class). This generation will take two specifications. The first will take the shape of "New Panamax", with ships designed to fit exactly in the locks of the expanded Panama Canal, expected to open in 2014, and which confers capacity of up to 12,500 TEU. The second can be dubbed "Post New Panamax" since these ships are bigger than the expanded Panama Canal specifications and can handle up to about 18,000 TEU (Triple E Class). It remains to be seen which routes and ports these ships would service, but they are limited [6].



Depending on the TEU size and hull dimensions, containers vessels can be also divided into the following main groups or classes [7]:

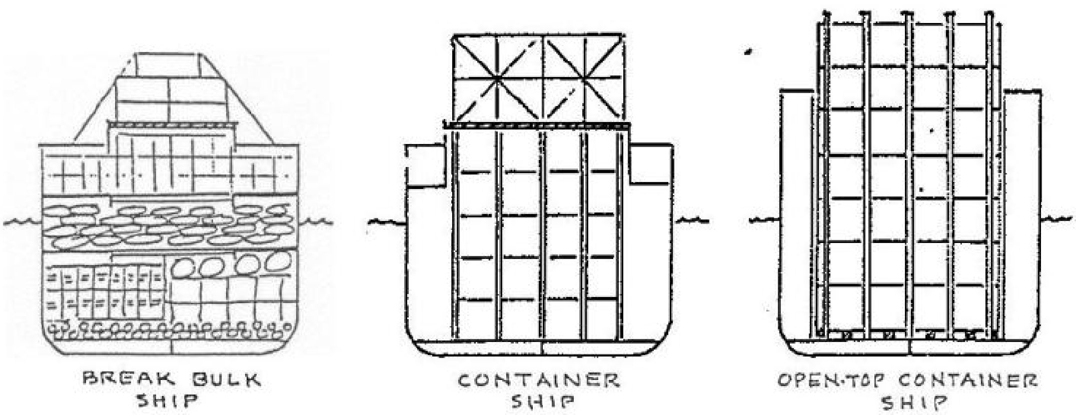
Group / Class	Number of TEU
Small Feeder	Up to 1000
Feeder	1001 – 2800
Panamax	2801 – 5100
Post-Panamax	5101 – 10000
New-Panamax	10001 – 14500
ULCV	14501 and higher

According to Containerization International, the world's container ship fleet as May 2011 is [8]:

Size range (TEU)	Vessel number	Total capacity (TEU)
Less than 1,499	1,869	1,504,327
1,500-2,999	1,298	2,804,212
3,000-4,999	935	3,766,532
5,000-7,999	593	3,576,182
8,000-9,999	232	198,399
10,000-12,499	43	464,784
over 12,500	50	667,466

2.4 Design issues

There have been some significant changes over the years as far as the containerships are concerned. In the 60s the break-bulk ships were supplanted by the containerships. Today another change maybe at hand, namely the advent of the open top containership. This kind of ship is also known as a hatchless ship.



There are several advantages for the hatchless ships:

- The elimination of hatch covers – and therefore their weight – results in an increase of the deadweight. Furthermore, since the hatch covers were located high in the ship, their removal significantly improves stability.

- The removal of hatch covers reduces time (open/close of hatches) and the cargo operation costs.
- There is a better securing for the containers stowed above deck. Furthermore, there is no need for manually installed lashing cables or rods.
- Individual vertical stocks are easily accessible.
- Security gear for hatches becomes unnecessary.

Normally, the International Convention of Load Lines (ILLC) doesn't allow ships without hatches but the Convention provides exemptions from this restriction:

"The Administration may exempt any ship which embodies features of a novel kind from any of the provisions of this Convention the application of which might seriously impede research into the development of such features and their incorporation in ships engaged on international voyages.

The Administration which allows any exemption under this Article shall communicate to the International Maritime Organization (IMO). An International Load Line Exemption Certificate shall be issued to any ship to which an exemption has been granted." [9]

2.5 Safety issues

The shipping stresses that are observed during a voyage can be divided into two main categories: the avoidable which are due to the human influence and the unavoidable which are determined by the nature of the transport operation. These stresses are:

- Static: According to CTUs guideline: "Stowage planning should take account of the fact that CTUs are generally designed and handled assuming the cargo to be evenly distributed over the entire floor area. Where substantial deviations from uniform packing occur, special advice for preferred packing should be sought."
  Maximum floor loading values for TEUs are 14kN/m^2 and for FEUs 10kN/m^2.

- Dynamic: A primary distinction is drawn between vibration and jolting. Vibration comprises periodic oscillations whereas jolting occasional events. Vibration and jolting of the equipment used, together with the fundamental vibration of goods, is of great significance. The magnitude of the pulses (duration of forces) play a very important role. In the high frequency range, where up to few hundred g have been measured, the cargo thanks to the mass inertia of the cargo shipping is not in danger by such short duration impacts. But in the low frequency range, longer period of action may lead to shifting of the cargo and consequent mechanical damage.

- Mechanical

Linear motion	Rotational motion
Surge: motion along the longitudinal axis	Roll: motion around the longitudinal axis
Sway: motion along the transverse axis	Pitch: motion around the transverse axis
Heave: motion along the vertical axis	Yaw: motion around the vertical axis

During surging and swaying, the hull may be subjected to considerable torsion forces. Heaving has been observed that has an effect on the containers and the cargo inside. Yawing does not cause any shipping damage. As far as pitching is concerned, it has been noticed that during upward motion the stack pressures rise, whereas during downward motion the pressures fall. Rolling up to 30^o isn't unusual in the open sea and all the containers must be adequate secured. Both rolling and pitching may result in cargo slippage. It has been estimated that container ships lose between 2,000 and 10,000 containers at sea each year, costing $370 million per year.

At this point it must be pointed out that are not always the hazards of the sea which cause the damage but most commonly the home-grown accelerations of the cargo, which are forces arising from shortcomings in packing and securing. Such home-grown accelerations may lead to bulges (i.e. forces acting from the inside outwards). Generally, goods are exposed to stress from the extremely low oscillations generated by sea conditions and by higher frequency machinery and propeller vibration. Also during slamming vibration is transferred to cargo.

The absolute acceleration values on the ships are even than on the road but the frequency with which motion occurs is important. According to CTU's guidelines: "All shipping packages must accordingly be constructed so as to be able to withstand 0.8 times the weight of all adjacently stored cargo and twice the mass of the cargo loaded on top. If this not the case, appropriate protective measures must be taken." [11]

2.6 Lashing systems

Numerous systems are used to secure containers aboard ships, depending on factors such as the type of ship, the type of container and the location of the container. The stresses resulting from the ship's movements and wind pressure must be taken into account. Forces resulting from breaking-wave impact can only be taken into account to a certain degree. All the containers on board must be secured against slippage and toppling.

Containers are usually stowed lengthwise fore and aft on board. This stowage method is sensible as far as the stresses in rough seas and the loading capacity of containers are concerned. Stresses in rough seas are greater athwartships than fore and aft and the loading capacity of container side walls is designed to be higher that of the end walls. However, on many ships containers are also stowed athwartships on board. This stowage method is not sensible with regard to the stresses in the rough seas. It is less possible that containers are stowed both ways on board. This stowage method requires greater effort during packing and securing operations. Various ways of securing containers in holds and on deck:

- Securing in vessel holds by cell guides alone
  The greatest stress the containers are exposed to stems from stack pressure. Lateral stress is transmitted by each container to the cell guides and therefore the risk of damage is kept within tight limits. The rails of the cell guides are useful for the guidance of the containers during loading and unloading.

- Securing in vessel holds by cell guides and pins
  This securing method is appropriate for the carriage of containers of different dimensions.

- Securing in vessel holds by conventional securing and stacked stowage
  The containers are connected together by single or double stacking cones and or twist locks and the entire stack is lashed through lashing wires or rods and turnbuckles. This system is not as safe as that with cell guides and was used mainly on old, conventional general cargo vessels and multipurpose freighters.

- Securing in vessel holds by block stowage and stabilization
  This method is still found on some conbulkers and other multipurpose freighters. Containers are interconnected horizontally and vertically using stacking cones. The top tiers are connected by means of bridge fittings and to the side ''pressure/tension elements'' are used. The entire block can move constantly in rough seas and if an individual container breaks, the whole block will be affected.

- Securing on deck using container guides
  On some ships, containers are secured on deck in cell guides and/or lashing frames. In certain ships, cell guides can be pushed hydraulically over the hatch as soon as the hatches have been covered up.

- Securing on deck using block stowage securing
  This securing method is not economically efficient nowadays but is being used increasingly in very large containerships. Socket elements or fixed cones are used for the positioning of the containers in the bottom layer and all the containers are held together by cross lashings.

- Securing on deck using stacked stowage securing
  This method is the most frequent an its advantage is the cargo handling flexibility. The containers are stacked one on top of the other, connected with twist locks and lashed vertically.

In order to locate an individual container in the ship, the bay-row-tier system is being used (relating to length, width and height). [10]

2.7 Containerized cargo and hazards

Assessing the risks associated with containerized cargo transport is challenging due to the variability and range of cargo that can be present on the container ship. Most containerships comply with SOLAS regulations regarding construction and equipment requirements for carriage of dangerous goods, for at least some of the holds and open deck spaces. However, the type and amount of dangerous goods carried can vary considerably for individual ships and routes. The hazards associated with each class of dangerous goods are also varied and are related to the inherent characteristics of the dangerous goods themselves. They include properties such as corrosiveness, explosiveness, toxicity, radioactivity and flammability. The carriage of dangerous goods can affect the probability for fire and explosion on a containership and the consequences of incidents where the cargo is released. In some cases dangerous goods may be the high-level cause of an incident. Undeclared dangerous goods have been identified as the cause of a number of serious accidents, such as the fire that broke out on the container vessel Kitano on 22 March 2001 when it was sailing en route from New York to Halifax, Canada. According to the Transport Safety Board of Canada report, the following occurred:

The fire originated in an above deck container, which held active carbon pellets that were transported as undeclared cargo. The fire spread to four containers but was eventually extinguished with assistance from firefighters from a salvage company after the vessel anchored in Halifax harbor. As part of the accident investigation, tests were carried out on the activated carbon pellets to determine whether the pellets should have been classified as dangerous goods. The UN N.4 test results for the substance were consistent with the classification of Class 4.2 (substances liable to spontaneous combustion), Packing Group III, when transported in volumes greater than 3 m^3. The packages carried on the Kitano were less than 3 m^3 and thus did not need to be declared as dangerous goods. There were no crew injuries as a result of this fire. In total 15 containers in the area of the fire suffered some degree of smoke, fire, or water damage. The only apparent damage to the vessel was superficial damage to the coating on the hatch cover.

The accidental release of dangerous cargo as a result of container damage, fire, leaks, etc. can result in human consequences for the crew and potentially for third parties, environmental impacts and damage to the vessel. The extent of consequences depends on the type and quantity of goods released. Some goods such as toxic gases will have a more serious implication for crew health and safety, as well potential for third party impacts if the vessel is in port near populated areas. Some dangerous goods are marine pollutants while others are quite innocuous if release to the marine environment. [12]

3. APPROACH AND METHODOLOGY

3.1 Source of information on containership accidents (raw data)

All the necessary data for this research was provided by the Germanischer Lloyd. In this research will be examined only the serious accidents of cellular containerships which at the time of incidents were registered to the International Association of Classification Societies (IACS).

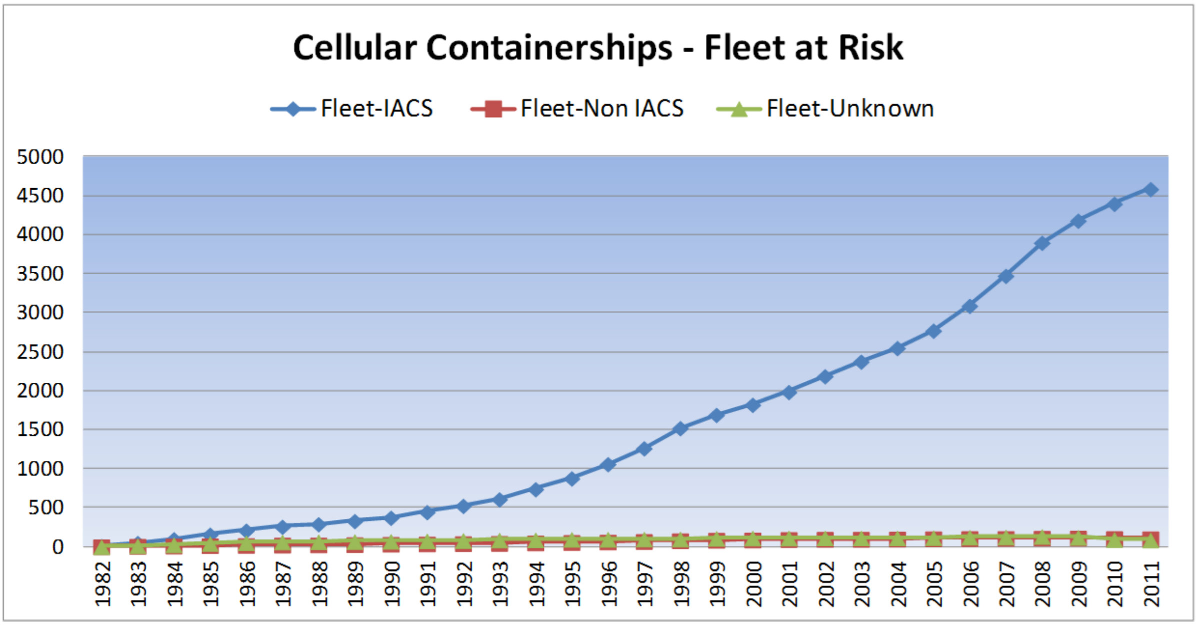
IACS

The International Association of Classification Societies (IACS) consists nowadays of 13 member societies, details of which are listed below. The directory of IACS is on a rotational basis with each member society taking a turn.

Class Long	Class
American Bureau of Shipping	ABS
Bureau Veritas	BV
China Class Society	CCS
Croatian Register	CRS
Det Norske Veritas	DNV
Germanischer Lloyd	GL
Indian Register of Shipping	IRS
Korean Register of Shipping	KR
Lloyd’s Register	LR
Nippon Kaiji Kyokai	NK
Polish Register of Shipping	PRS
Registro Italiano Navale	RINA
Russian Maritime Register of Shipping	RS

Fleet-IACS at risk

The fleet at risk for the IACS-containerships built after 1981 and with a Gross Tonnage > 999 is presented in the diagram. As can be seen, the fleet at risk for each year is a decimal number as a result of its calculation every month.



Year	Fleet-IACS	Fleet-Non IACS	Fleet-Unknown	Fleet-Sum
1982	14,58	5,00	5,41	24,99
1983	54,07	12,50	17,90	84,47
1984	102,25	15,75	32,00	150,00
1985	160,47	19,83	47,65	227,96
1986	212,32	23,00	57,82	293,13
1987	262,06	27,25	66,74	356,05
1988	294,58	29,58	70,00	394,15
1989	334,65	33,33	73,07	441,05
1990	377,39	38,66	75,58	491,63
1991	449,13	41,75	82,00	572,88
1992	529,57	46,83	87,00	663,40
1993	613,36	50,58	91,66	755,61
1994	742,93	56,00	94,92	893,84
1995	881,19	60,67	101,16	1043,01
1996	1064,03	66,58	103,12	1233,72
1997	1267,03	73,66	103,92	1444,62
1998	1525,28	84,25	105,63	1715,16
1999	1694,93	89,50	114,41	1898,84
2000	1824,87	92,75	118,00	2035,62
2001	1988,25	99,74	118,33	2206,32
2002	2190,20	101,33	119,00	2410,54
2003	2377,70	103,00	119,00	2599,69
2004	2551,48	104,75	119,58	2775,82
2005	2774,13	108,74	122,33	3005,20
2006	3092,08	111,33	128,40	3331,81

2007	3476,73	112,66	130,99	3720,38
2008	3900,48	116,16	138,13	4154,76
2009	4183,71	117,64	127,51	4428,86
2010	4399,86	110,64	100,03	4610,53
2011	4587,88	108,81	93,64	4790,33
Total	47797,61	2062,28	2764,93	52754,39

Casualty databases

Casualty databases are important tools for gauging the safety and the environmental performance of the industry. They can be used to study and analyze the historic accident scenarios and to find the vulnerable operational or design problems. They can be used also to guide the regulatory process so that the regulations that are being produced may be focused so as to address the weakest links in the safety and environmental prevention chain, and also they can be used to provide alerts for areas of design, operation and training which may be in need of additional attention or of a new approach.

There are many casualty databases, most well-known the Lloyds Register Fairplay (IHS) and Lloyds Maritime Intelligent Unit (LMIU) which are and will be the largest international ships' accident database for the foreseeable future. Another casualty database is the Global Integrated Shipping Information System (GISIS) of International Maritime Organization (IMO). This is a recent attempt of IMO to gather important information about maritime incidents.

The casualty database that is commonly used in the present study is the IHS database. Most data used throughout this research are taken from IHS. There were also some incidents from the LMIU and GISIS databases that weren't recorded in the IHS database. These incidents are examined as well. The number of the incidents taken into account such as their distribution is available below:

Casualty database	**Number of incidents**
IHS	1064
LMIU	33
GISIS	39
Total	1136

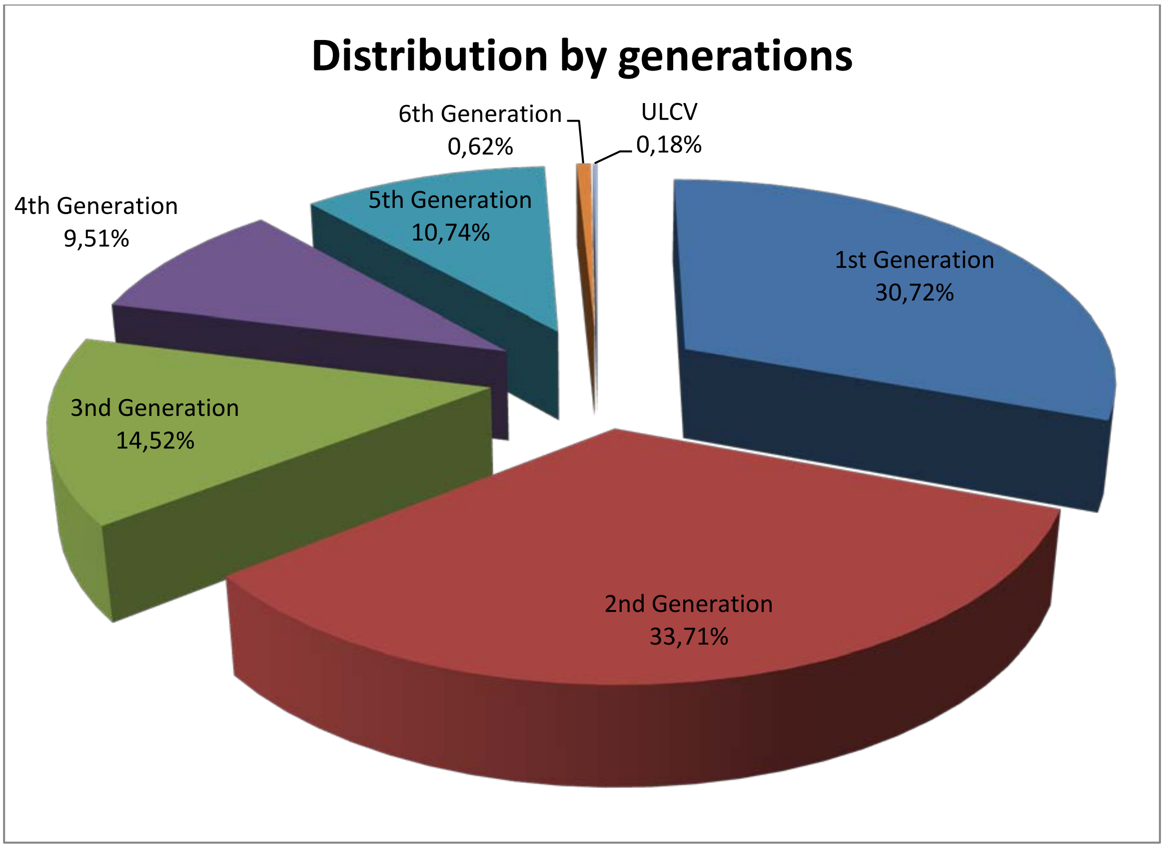
IHS database

Incident severity	Number of incidents	Percentage
Serious	1110	81,98%
Not serious	244	18,02%
Total	1354	100,00%

The IHS database holds in total 1354 incidents. The vast majority of the incidents are recorded as serious. The severity degree of the IHS database, such as those of LMIU and GISIS databases, will be analyzed later. From these incidents, 1306 occurred on containerships that were registered to members of IACS at the time of incident. The percentage of the IACS containerships is calculated at 96,45%. This percentage is extremely high but it is in accordance with the information on the fleet at risk for IACS and Non-IACS containerships. For instance, for the year 2011 the fleet at risk for IACS containerships is 4587,88 whereas the fleet for Non-IACS and unknown containerships is 108,81 (2,37%) and 93,64 (2,04%) respectively.

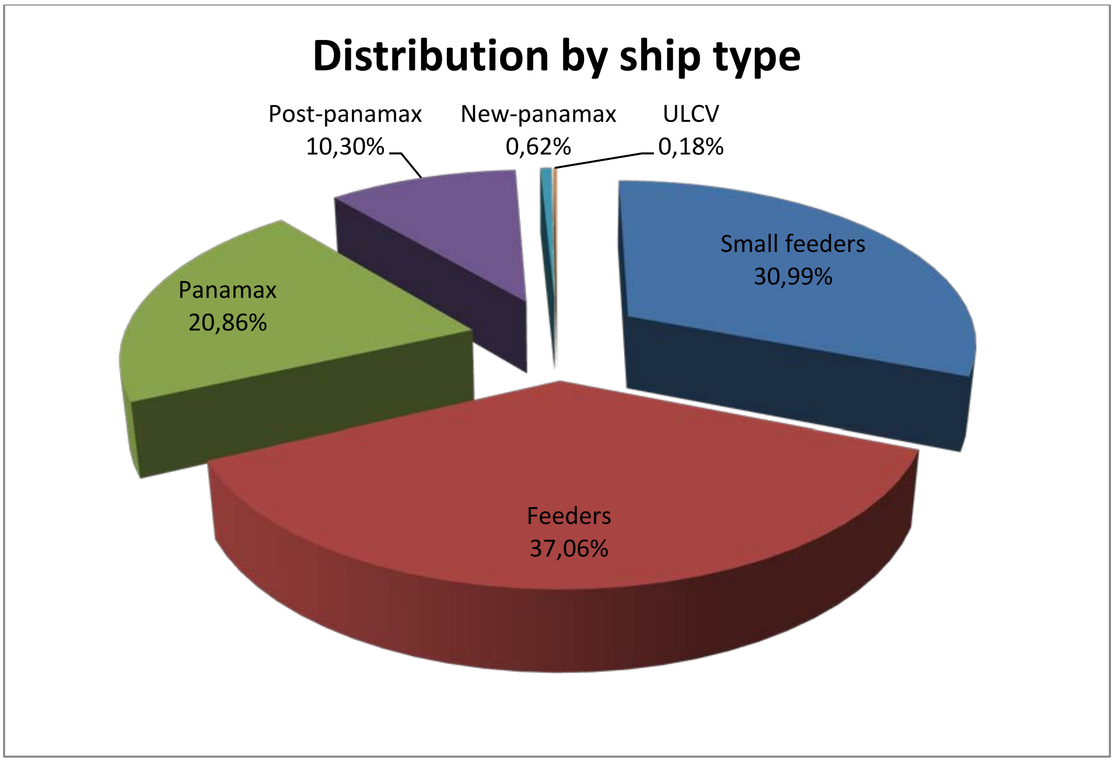
Incidents distribution by generations

Generation	Number of ships	Percentage
1st Generation	349	30,72%
2nd Generation	383	33,71%
3rd Generation	165	14,52%
4th Generation	108	9,51%
5th Generation	122	10,74%
6th Generation	7	0,62%
ULCV	2	0,18%
Total	1136	100,00%



Incidents distribution by ship type

Ship type	Number of ships	Percentage
Small feeders	352	30,99%
Feeders	421	37,06%
Panamax	237	20,86%
Post-panamax	117	10,30%
New-panamax	7	0,62%
ULCV	2	0,18%
Total	1136	100,00%



It can be noticed that the distribution of the incidents by generations and by ship type is almost similar. The percentages of the incidents on ships 1st generation's (30,72%) and 2nd generation's (33,71%) are similar to those on small feeders (30,99%) and feeders (37,06%). The panamax ships (20,86%) are divided into two generations, the 3rd (14,52%) and the 4th (9,51%). Some feeders belong to the 3rd generation. The percentage of incidents on post-panamax ships (10,30%) is practically the same with this on ships 5th generation's (10,74%). The ships 6th generation's clearly stand for the new-panamax (0,62%). Finally, only two incidents are recorded for ULCV-containerships.

3.2 Comparison IHS-LMIU-GISIS databases

IHS-LMIU databases

Unfortunately, the marine incident/accident databases, which have evolved over the years, were not designed with the application of a possible risk assessment in mind, and therefore suffer from a number of serious limitations which make their usage in engineering projects problematic. Weaknesses in IHS and LMIU databases are:

- "Fire and explosions" are treated as one category in both casualty databases. Upon the examining the causes and consequences of fire and explosion accidents, it is realized that these differ considerably. It was considered essential to define accurately the first, initiating event. Therefore, in the NTUA-SDL database there are two different categories, "Fire" and "Explosion".
- The same applies to "Hull and machinery". This category, which can be found in both databases, incorporates structural failures, failures of propulsion and machinery devices and failure of hull and deck fittings. All the above should be individually examined and analyzed as they are associated with different causes and consequences. As a result, three separated categories were developed in the NTUA-SDL database, "Machinery failure", "Structural failure" and "Failure of hull fittings".
- Both databases contain information regarding the causes and consequences of the incident within complementary texts. In the way this information is registered, it cannot be easily retrieved and systematically analyzed. Therefore, the development of the NTUA-SDL database was essential for the analysis of the incidents.
- In some cases, the quality of the complementary text is poor without any technical information.
- In several cases, the description of the consequences is very qualitative. It is stated that with respect to severity of ship damage no information was "not reported". This doesn't mean that ship does not sustain damage.
- Regarding the loss of cargo as a result of the accident, in some cases although it is stated that loss of cargo occurred there is no information about the exact number of TEUs that were destroyed or lost overboard.
- The same applies for some cases where it is stated that an oil spill occurred because of the accident. There is no information regarding the amount quantity released to sea environment.
- The degree of incidents' severity differs in both databases. The definition of the severity degree of each database is given below:

IHS severity degree

An incident is considered serious if one of the following situations applies:

- Structural damage, rendering the ship unseaworthy, such as penetration of hull underwater, immobilization of main engines, extensive damage etc.
- Breakdown
- Actual total loss

- Any other undefined situation resulting in damage or financial loss which is considered to be serious.

Attention must be paid to the “any other undefined situation resulting in damage or financial loss which is considered to be serious”. This definition is relative and it is clearly up to the user/analyst of the IHS-database to determine the severity degree. Furthermore, the term “financial loss” isn’t determined.

LMIU severity degree

An event is considered serious if one of the following situations applies:

- Serious structural or machinery damage likely to result in a vessel being declared a constructive total loss
- Structural or machinery damage rendering a vessel unseaworthy or requiring extensive repairs
- Disablement or breakdown, resulting in a vessel requiring assistance of salvors or the abandonment of the voyage or a vessel being taken out of service for a reasonable period
- Any other incident resulting in damage considered serious enough to prevent a vessel from continuing in service.

Hence, a serious event is a breakdown resulting in the ship being towed or requiring assistance from ashore, flooding of any compartment, or structural/mechanical/electrical damage requiring repairs before the ship can continue trading.

It is obvious that this definition of severity degree is stricter than this of the IHS-database.

Comparison of the severity degree of IHS-LMIU databases

As can be noticed, the IHS database has more flexible criterias for the definition of the serious degree than LMIU. In fact, in IHS database there are cases where an accident is considered serious even if minor damages were sustained and/or the repairs lasted only a couple of days. On the other hand, LMIU pays attention only to the seaworthiness of the ship, regardless of oil spills, loss of cargo and even LOWI (Loss Of Water Integrity) sometimes. A great number of incidents that were recorded in both databases were further examined in order to compare the severity degree. The following findings are made:

- LOWI: When LOWI occured, IHS database considers this accident serious (regardless of the amount of the water). LMIU counts these accidents as serious only if the LOWI that occured was extensive and influenced the seaworthiness of the ship.

- Repairs: If the repairs took place in a shipyard or took several days to be completed, for IHS database this is considered a serious accident. LMIU database demands also that severe damages were sustained and extensive repairs were needed.

- Human losses/injuries: In general, both databases consider accidents with human losses/injuries serious. But in cases, where ship sustained minor damages and therefore didn't need repairs and was seaworthy, these accidents are considered not serious. For instance, there was an accident where 3 crew members were killed and another 3 were seriously injured due to an explosion in the engine room and it was recorded as not serious.

- Loss of cargo: As mentioned above, loss of cargo isn't considered a serious accident for LMIU database. For example, there was an accident where 400 containers were lost overboard and another 555 were damaged because of lashing failure due to extreme weather and it was recorded as not serious. On the contrary, IHS database counts accidents with a significant number of lost containers as serious.

- Enviromental pollution: In case of an enviromental pollution, such as oil leakage or release of hazardous cargo, the accident is considered serious for IHS database. LMIU database demands also that heavy oil pollution took place.

GISIS database

The GISIS database is a recent attempt of IMO to gather important information on maritime incidents. Its structure is very efficient and helpful for the analyst because it contains all the necessary information with details. For a great amount of incidents, their investigation reports are also available. As a result, Fault Trees and Event Trees can be filled up easily. The only disadvantage of the GISIS database is that still contains only few incidents, something reasonable if the "age" of this database is taken into consideration. But if this database expands in the following years, it is certain that the GISIS database will be a helpful tool for any analyst.

3.3 Definitions

Risk evaluation

For the purpose of the particular study, only the associated risk to crew's life of the studied ship and health and to local environment will be considered. Risk to crew and passengers onboard of other vessel, i.e. in case of collision, are out of the scope.

The likelihood of exposure to security risks, that contains terrorist attacks or being struck by missiles, isn't negligible, but is considered out of the scope of this study since it is related with safety issues.

Occupational hazards with the potential of injuring, or in special circumstances even kill, individual crew members are not within the purpose of the particular risk analysis. Occupation incidents will be analyzed individually in chapter 7.

The risk analysis of the containerships will be limited to study the operational phase of a containership's life cycle. Thus, risk associated with the vessel being in shipyards, in dry-dock and in scrapping phase is considered out of the scope.

Major hazards/accident categories

In the following the major hazards are defined along with a further categorisation level:

- *Collision*: striking or being struck by another ship, regardless of whether under way, anchored or moored. This category does not include striking underwater wrecks.
  Further categorisation level: struck, striking, unknown.

- *Contact*: striking any fixed or floating objects other than those included under collision or grounding.
  Further categorisation level: fixed installation, floating objects.

- *Grounding*: being aground or hitting/touching shore or sea bottom.
  Further categorisation level: drift, powered, unknown.
  Drift grounding: loss of propulsion system, loss of steering system.
  Powered grounding: detected but not avoided, squat effect, not detected.

- *Fire*: incidents where fire is the initial event.

Starting location: internal source, external source, by lightning.
Internal source: in aft area, on deck cargo area, in ballast tanks/void spaces, in hold cargo area, in fore peak area.
Fire in aft area: on superstructure, other areas, engine room, pump room.
Fire on superstructure: accommodation, bridge.
Fire ignition: electrostatic charges, cooking related, heating equipment, hot works, smoking related, electrical faults, broken fuel pipe, self-ignition, containers' content, engine's crankcase, unknown.

- *Explosion*: incidents where explosion is the initial event.
  Explosion location: in aft area, on deck cargo area, in ballast tanks/void spaces, in hold cargo area, in fore peak area.
  Explosion in aft area: fuel tank, boiler, accommodation, pump room, engine room.
  Explosion ignition: electrostatic charges, cooking related, heating equipment, hot works, smoking related, electrical faults, broken fuel pipe, self-ignition, containers' content, engine's crankcase, unknown.

- *Non-accidental structural failure*: when the hull presents cracks and fractures, affecting ship's seaworthiness.
  Further categorisation level: structural degradation, poor design/construction, excessive loading.

- *Hull fittings failure*: damage to ship's hull-fitting equipment/outfitting, affecting ship's seaworthiness or efficiency.
  Further categorisation level: equipment failure, misuse of equipment.
  Equipment failure: failure of closing systems, chain locker failure, manhole failure, water leakage through ventilation lines, outfitting failure, lashing failure.
  Misuse of equipment: misuse of chain locker, manhole left open, ventilation lines incorrectly open, misuse of loading equipment.

- *Machinery failure*: where a technical failure of machinery or related system affects vessel's seaworthiness.
  Further categorisation level: steering system failure, propulsion system failure, rudder damage, propeller damage, bow thruster problem, turbo charger problem, other.

Note that scenarios due to unknown reasons as well as incidents associated with piracy or war losses are not considered in the study.

Operational state

In the setup database, the registration of casualty's location is based on the IMO relevant description on event location, namely at Berth, Anchorage, Port, Port Approach, Inland waters, Canals, Rivers, Archipelagos, Coastal (<12 miles off) and Open Sea.

Based on the above categorisation, four different operational states –associated with four different operational speed ranges- were identified as the basic categorisation for the risk analysis of different events. The four different operational states are further related to different type of sea areas with different conditions for rescue efforts and environmental pollution, namely:

- *Terminal areas* (Port, Anchorage, Port Approach and at Berth). The ship lies at berth/ port or is operating at low speed because of port or berth approaching or anchorage operations. The low speed generally reduces the severity of the consequences. Manoeuvring operations during pilot boarding are also related with increased collision probability.
- *Operation in congested waters* (Coastal (<12 miles off) or restricted waters). Areas within congested waters are characterised by high density traffic.
- *En route at sea* (Open Sea (≥12 miles off) & Archipelagos). Ship has her full operational speed.
- *Operation in limited waters* (Rivers, Canals and Inland waters).

LOWI occurrence

The probability of hull breaching in case of an accident is considered essential for the sequence of events and consequences of the accident. For the purpose of this study, the NTUA-SDL database is used to determine this probability with respect to the navigational accidents. In some cases, it is clear from the complementary texts of the database that LOWI occurred.

In some collision incidents, LOWI was not occurred because the other involved ship was small in comparison to the containership (i.e. fishing vessel) or it is clearly stated that the containership does not sustain damage.

In some contact or grounding incidents, the containership sustained propeller damage due to the contact or grounding. These cases are considered as incidents with no LOWI occurrence.
When there was no clear statement, the following assumptions were taken into consideration in order to calculate the probability of hull breaching.

No LOWI occurrence:

- When it is stated "No damage reported".
- When the point of impact is above the main deck planting (i.e. superstructure).
- When there is no relevant information regarding renewal of side shell planting.
- When the containership sustains only minor or slight damage in relation to non-serious degree of accident's severity.

LOWI occurrence:

- When it is stated that "extent of damage was not known", it is assumed LOWI occurrence.
- When it is stated that the damage is below and above waterline.

3.4 NTUA- SDL Ship Accidents Database

As mentioned above, the marine incident/accident databases, which have evolved over the years, were not designed with the application of a possible risk assessment in mind, and therefore suffer from a number of serious limitations which make their usage in engineering projects problematic. Hence, the development of the NTUA-SDL Ship Accidents Database was necessary.

Initially, only the IHS database was available. All the incidents of the IHS database were searched individually on the web in order to gather more information on every incident. If the source was reliable, the information would be populated. This process was very helpful because we also became familiar with the nature of the incidents on containerships.

The next step was to develop the NTUA-SDL Ship Accidents Database. The respective database of the tankers was very useful as far as the structure of the new database for the containerships is concerned. In the meantime, general information regarding the containerships was searched.

Afterwards, the LMIU and GISIS databases became also available. All the records were double-checked in order to find out which incidents weren't recorded in the IHS database. All these incidents were also searched individually on the web. All this process was laborious because all the new data had to be checked over and over again. Moreover, the NTUA-SDL database was refreshed frequently and its structure changed many times until its final form.

Germanischer Lloyd also provided us with the investigation reports of some incidents from GISIS database. This was very helpful because these reports contained all the necessary information with details. Furthermore, this will be useful for the filling up of the Fault Trees and Event Trees in the next studies. Among these casualty reports were also reports from occupational accidents. Therefore, it was decided to conduct a separate analysis for the occupational accidents. This can be found in chapter 7.

The analysis will be achieved through the recording of the causes of each incident, the location where the accident took place, the operating condition of the ship, the prevailing weather condition / weather impact, the consequences of the incident on the ship and the crew on board, and the pollution of the environment or the loss of cargo if occurred.

The results of the analysis are presented in the following chapters. A manual of the SDL-database can be found in Annex I.

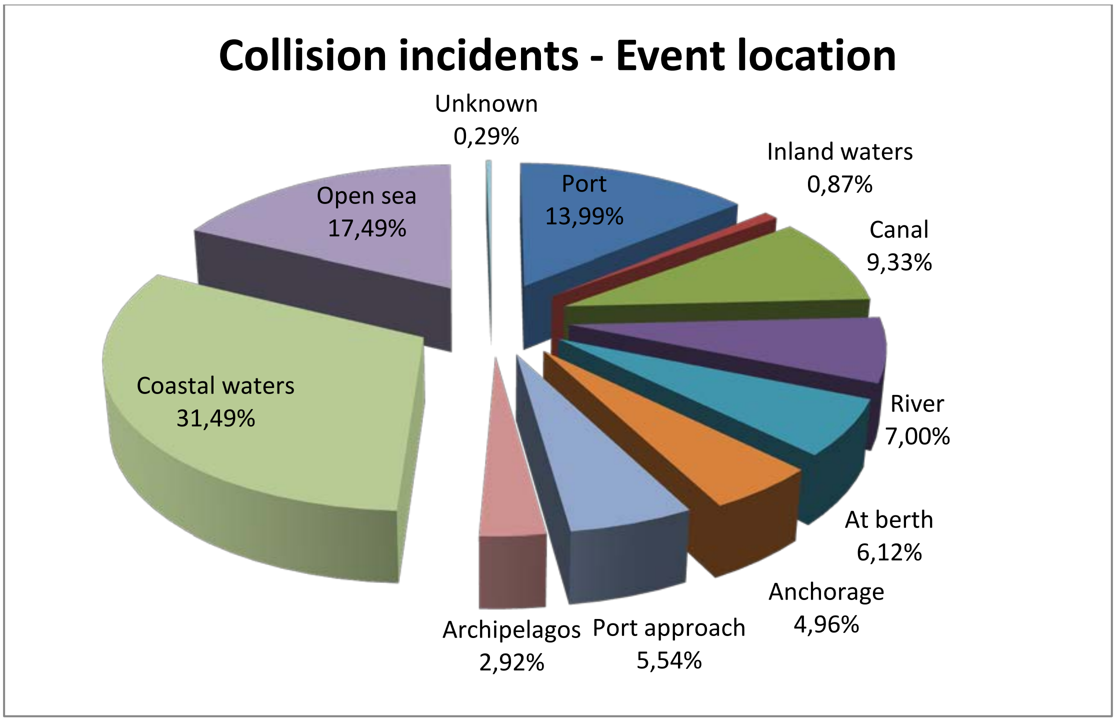
4. ANALYSIS OF INCIDENTS AND ACCIDENTS

4.1 Collision incidents

4.1.1 Conditions of collision incidents

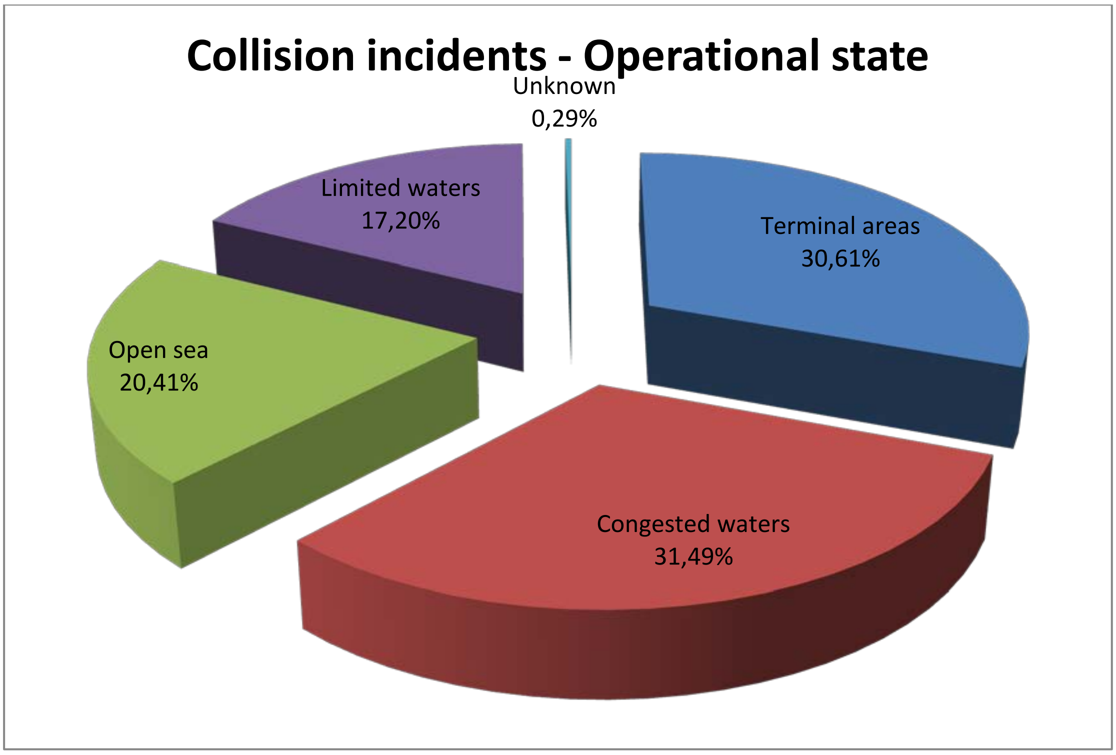
Event location

Event location	Number	Percentage
Port	48	13,99%
Inland waters	3	0,87%
Canal	32	9,33%
River	24	7,00%
At berth	21	6,12%
Anchorage	17	4,96%
Port approach	19	5,54%
Archipelagos	10	2,92%
Coastal waters	108	31,49%
Open sea	60	17,49%
Unknown	1	0,29%
Total	343	100,00%



Operational state

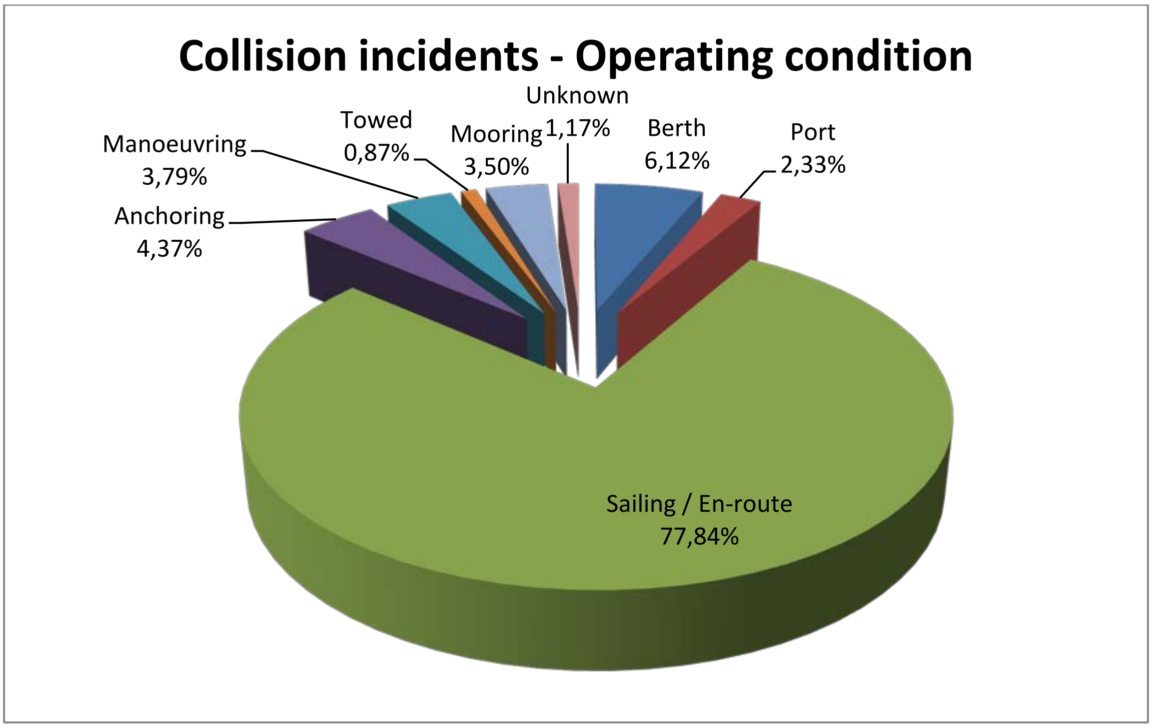
Operational state	Number	Percentage
Terminal areas	105	30,61%
Congested waters	108	31,49%
Open sea	70	20,41%
Limited waters	59	17,20%
Unknown	1	0,29%
Total	343	100,00%



It is obvious that the vast majority of the collision incidents take place in congested waters and terminal areas where dense ship traffic prevails. Moreover, these areas constitute crossing route with large ship speed variations. 20,41% of the collision incidents take place in open sea. These were incidents where containerships collided with much smaller vessels, such as fishing vessels, and in many cases the crew on board of the containership didn't even realize that a collision had occurred.

Operating condition

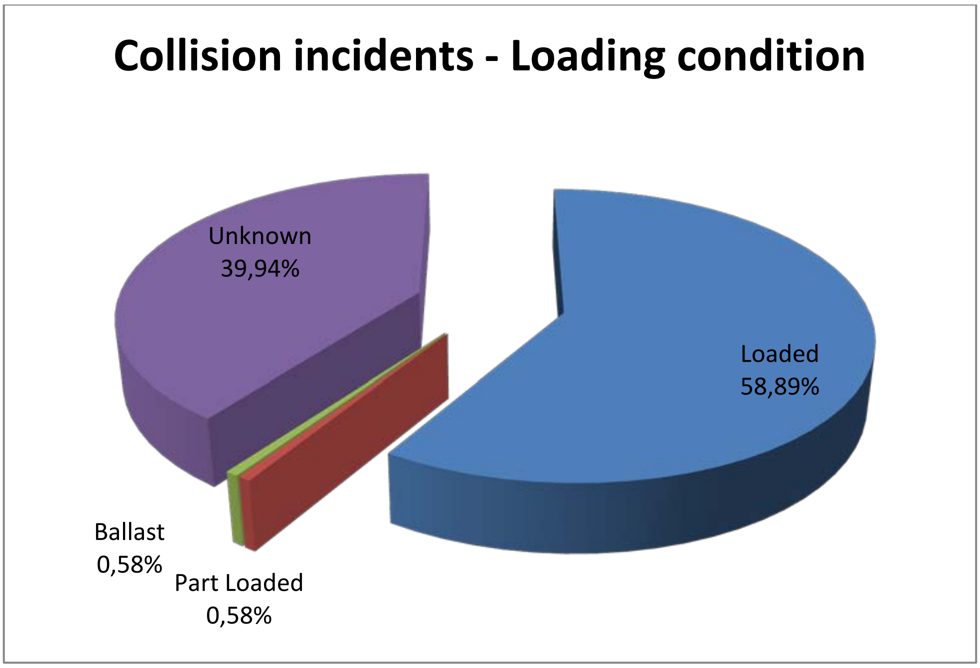
Operating condition	Number	Percentage
Berth	21	6,12%
Port	8	2,33%
Sailing / En-route	267	77,84%
Anchoring	15	4,37%
Manoeuvring	13	3,79%
Towed	3	0,87%
Mooring	12	3,50%
Unknown	4	1,17%
Total	343	100,00%



Almost 25% of the collision incidents occur during the different operating conditions of the ship. Human errors like lack of communication, no proper lookout or navigational mistakes are frequently identified as important causes for collision events. The issue of human error seems to play a significant role considering that more than 75% of the incidents take place when the ship is en-route.

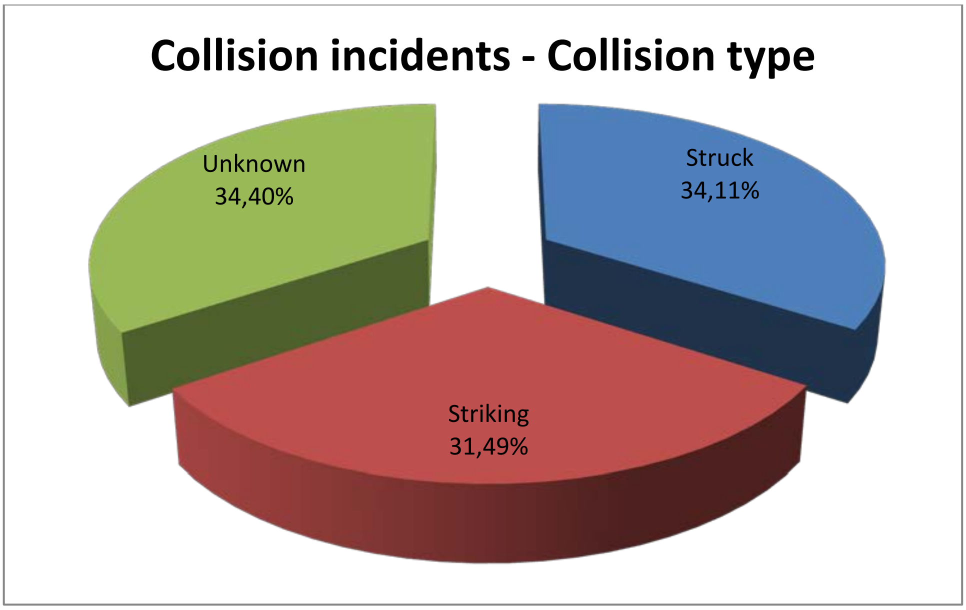
Loading condition

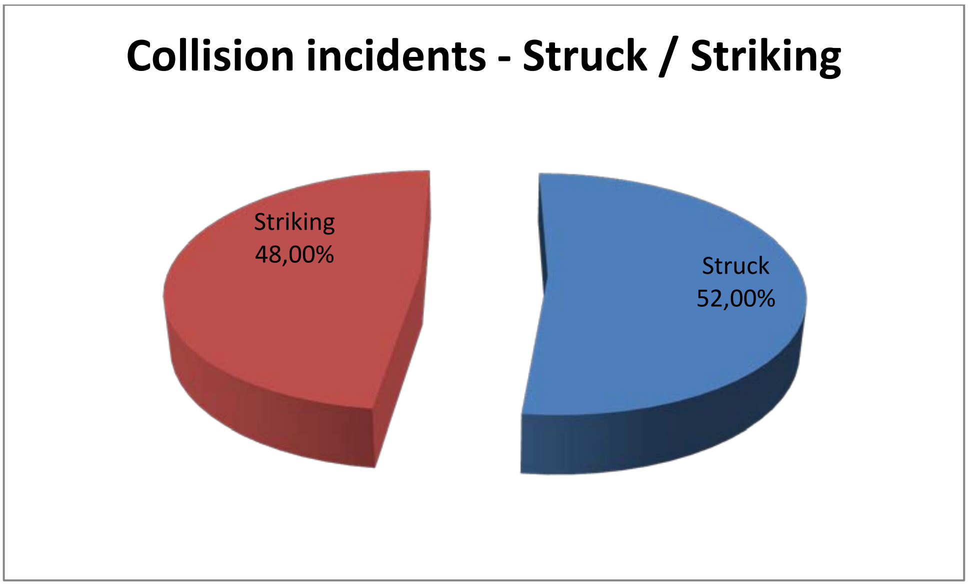
Loading condition	Number	Percentage
Loaded	202	58,89%
Part Loaded	2	0,58%
Ballast	2	0,58%
Unknown	137	39,94%
Total	343	100,00%



Collision type

Collision type	Number	Percentage
Struck	117	34,11%
Striking	108	31,49%
Unknown	118	34,40%
Total	343	100,00%

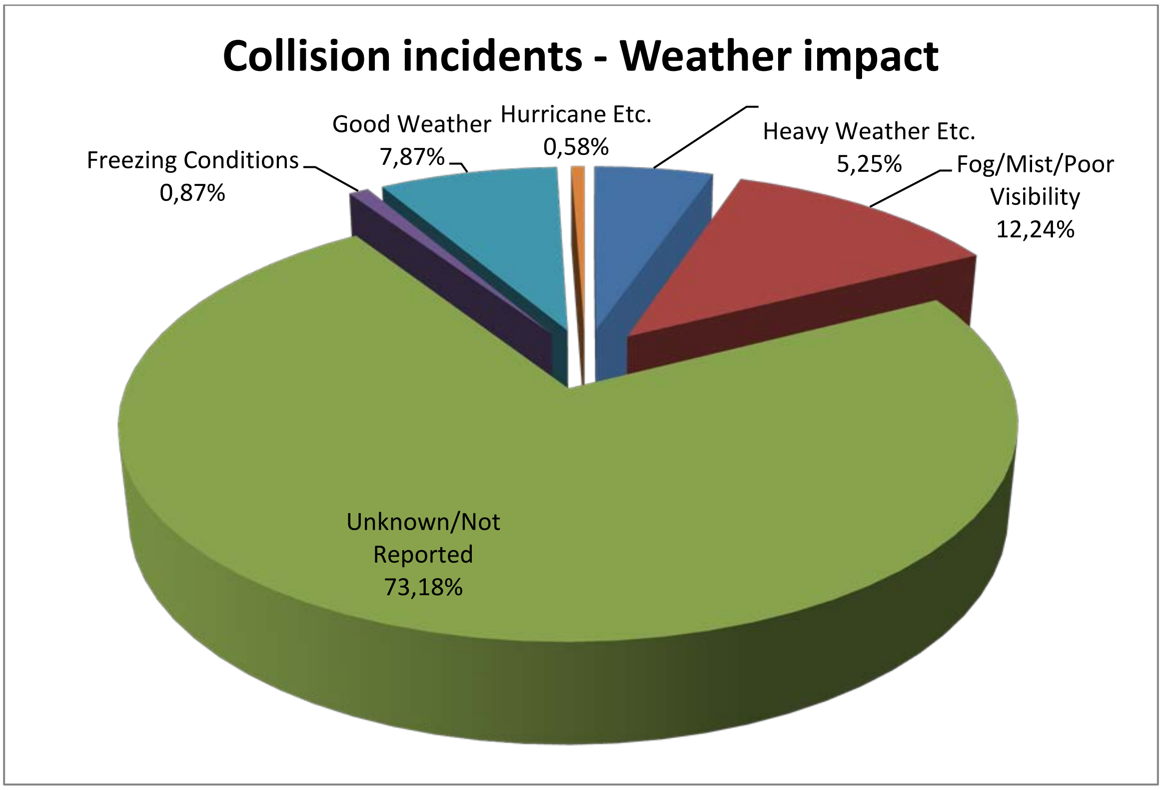




It appears that the percentages of the striking and struck ships are almost the same. Containerships generally operate at higher speed than many other vessel types. Therefore, it would be expected that striking ships hold a higher percentage than struck ships. According to the DNV study presented on 2012 in GOALDS D5.1 the percentage for striking containerships is between 66% and 61% whereas that of the struck ships is between 34% and 39% [13]. But if we take also into account that for 34,40% of the collision incidents there is no information available, this could be really the case.

Weather impact

Weather impact	Number	Percentage
Heavy Weather Etc.	18	5,25%
Fog/Mist/Poor Visibility	42	12,24%
Unknown/Not Reported	251	73,18%
Freezing Conditions	3	0,87%
Good Weather	27	7,87%
Hurricane Etc.	2	0,58%
Total	343	100,00%

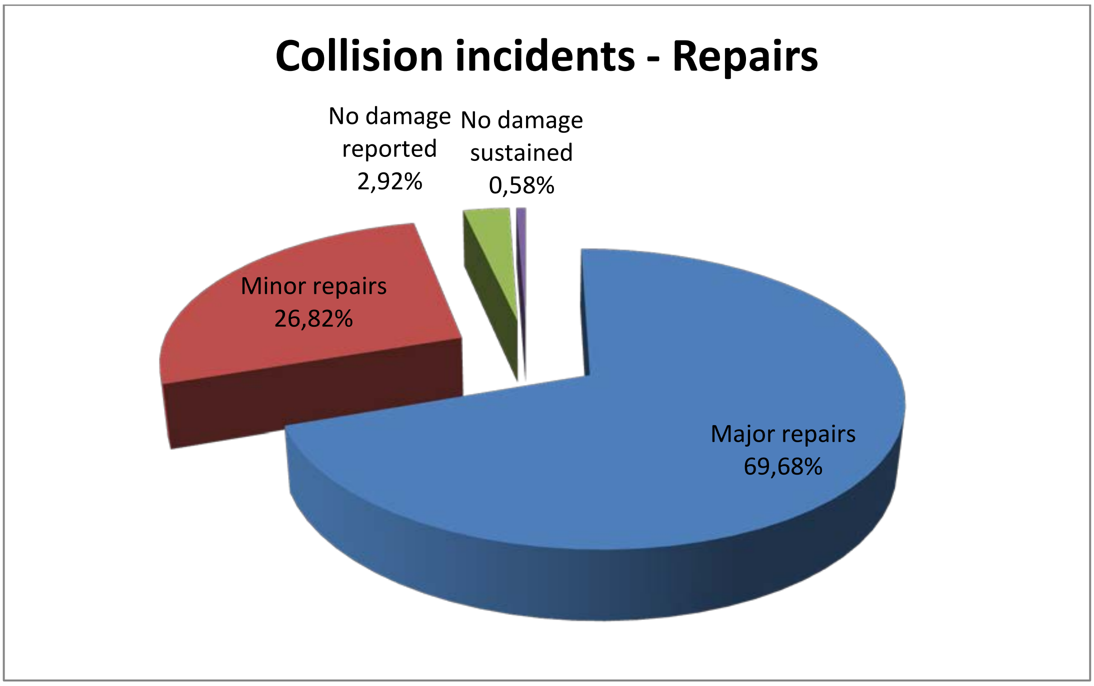


There is no information for almost 75% of the collision incidents as far as the weather impact is concerned. Where information is available, it is obvious that the low visibility is a contributing factor for many collision incidents.

4.1.2 Consequences of collision incidents

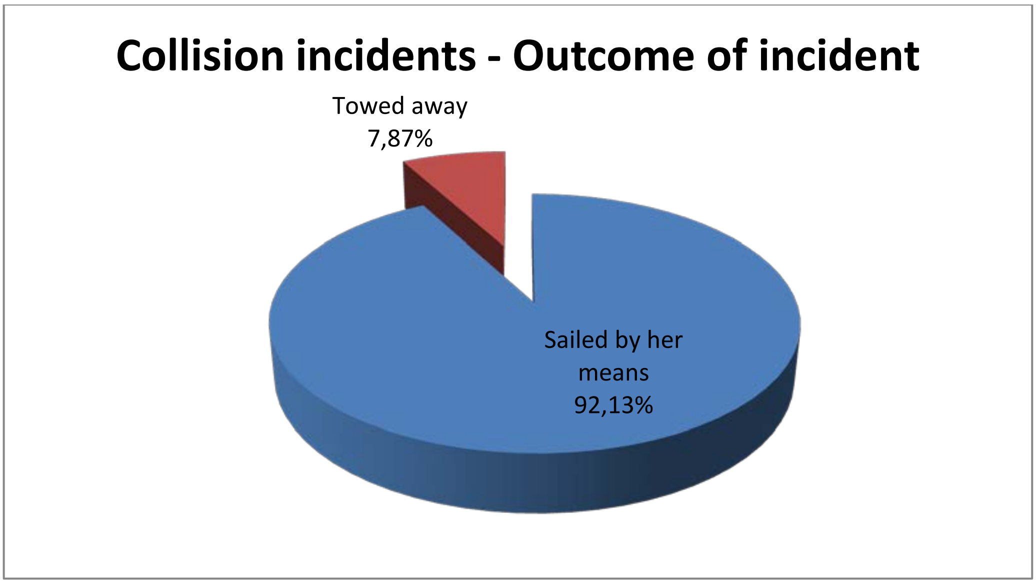
Repairs

Repairs	Number	Percentage
Major repairs	239	69,68%
Minor repairs	92	26,82%
No damage reported	10	2,92%
No damage sustained	2	0,58%
Total	343	100,00%



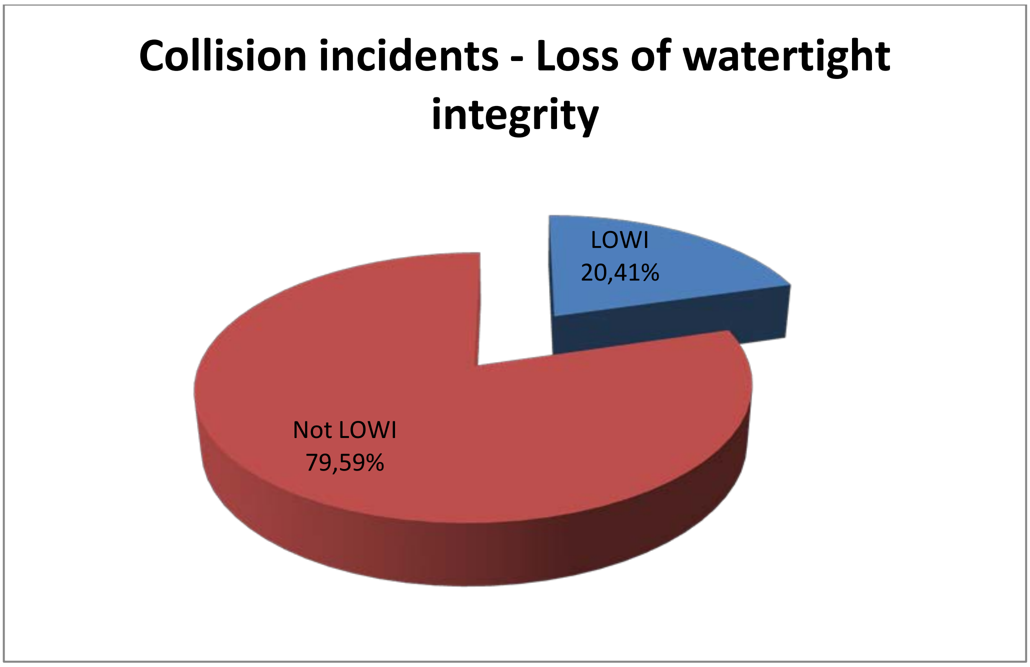
Outcome

Outcome	Number	Percentage
Sailed by her means	316	92,13%
Towed away	27	7,87%
Total	343	100,00%



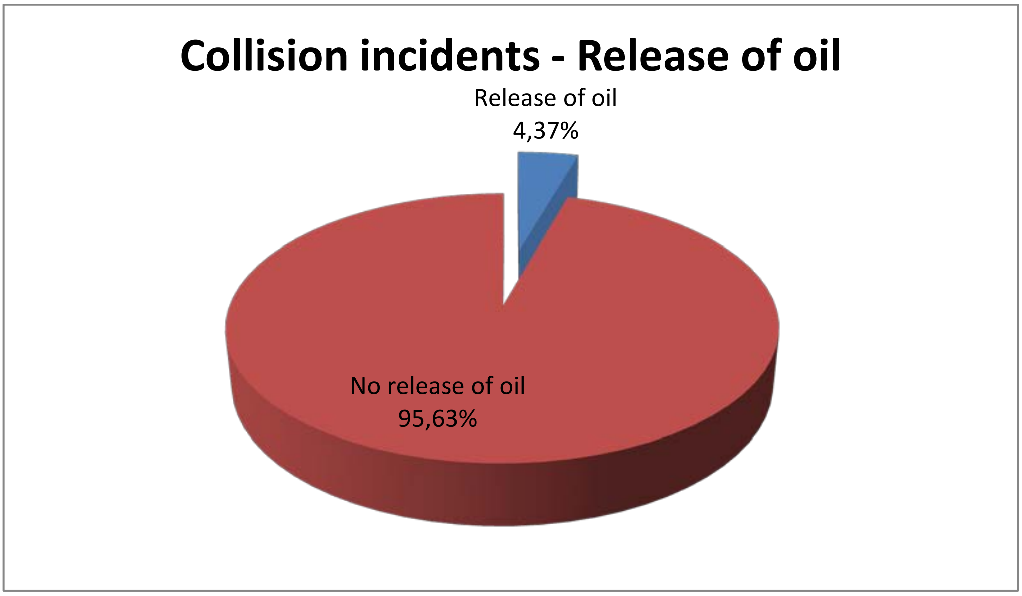
Loss of watertight integrity

LOWI	Number	Percentage
Yes	70	20,41%
No	273	79,59%
Total	343	100,00%



Release of oil

Release of oil	Number	Percentage
Yes	15	4,37%
No	328	95,63%
Total	343	100,00%



In 8 accidents, 720 tonnes of oil were released. The complementary texts don't provide information about the rest of the accidents regarding the amount of oil that was released into the sea.

Release of hazardous / polluting cargo

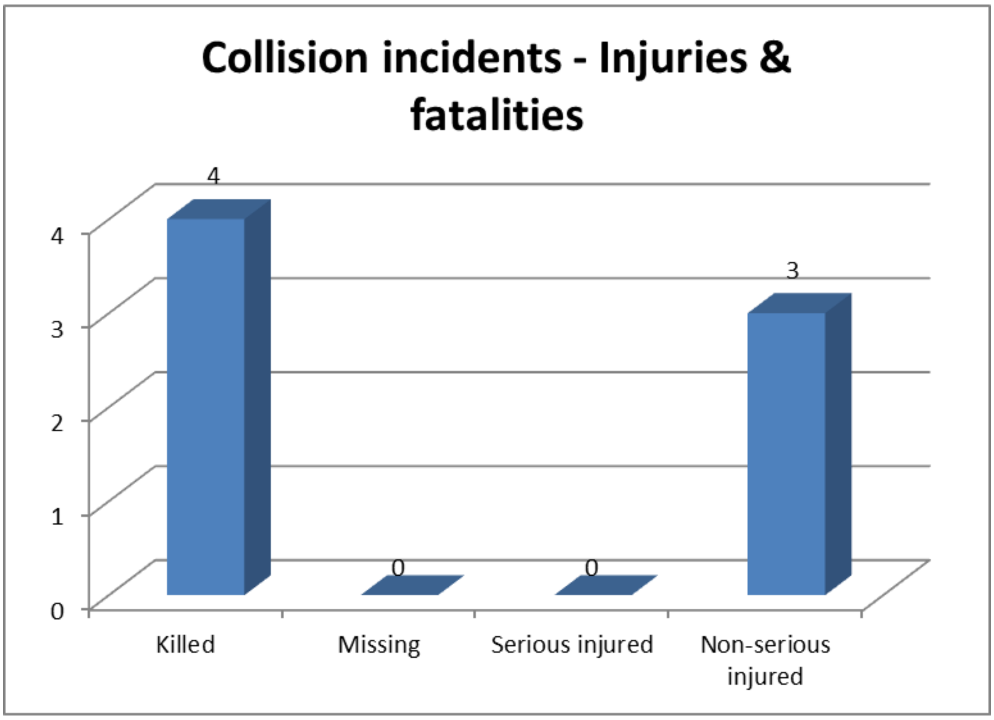
Release of hazardous / polluting cargo	Number	Percentage
Yes	2	0,58%
No	341	99,42%
Total	343	100,00%

Loss of cargo

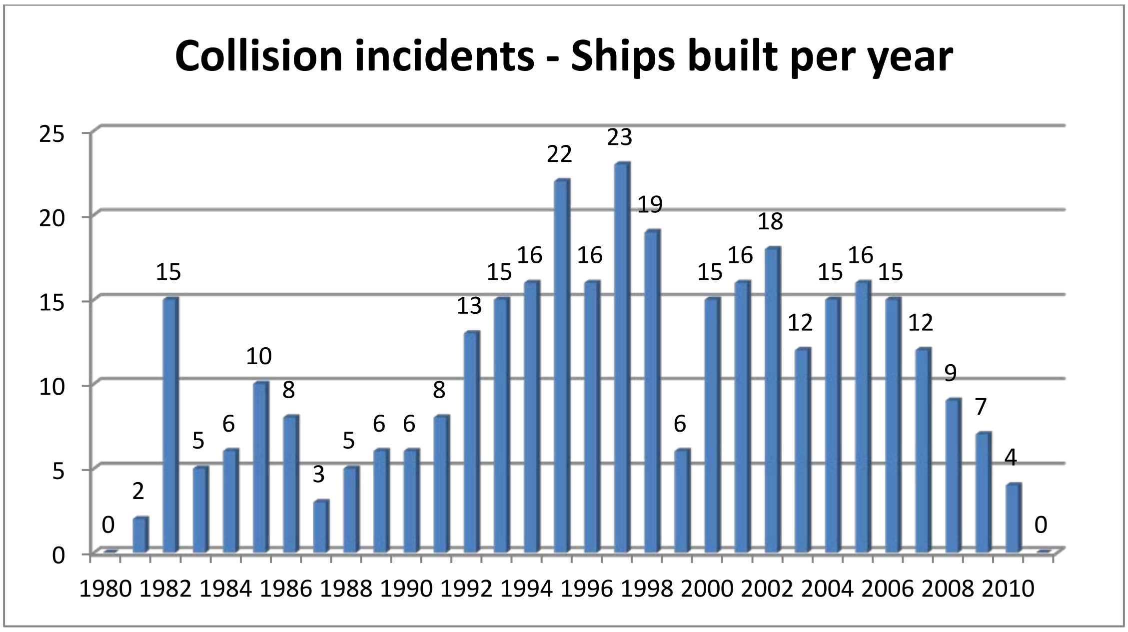
In 15 accidents, 230 containers were lost during the studied period as a result of the collision events.

Injuries and fatalities

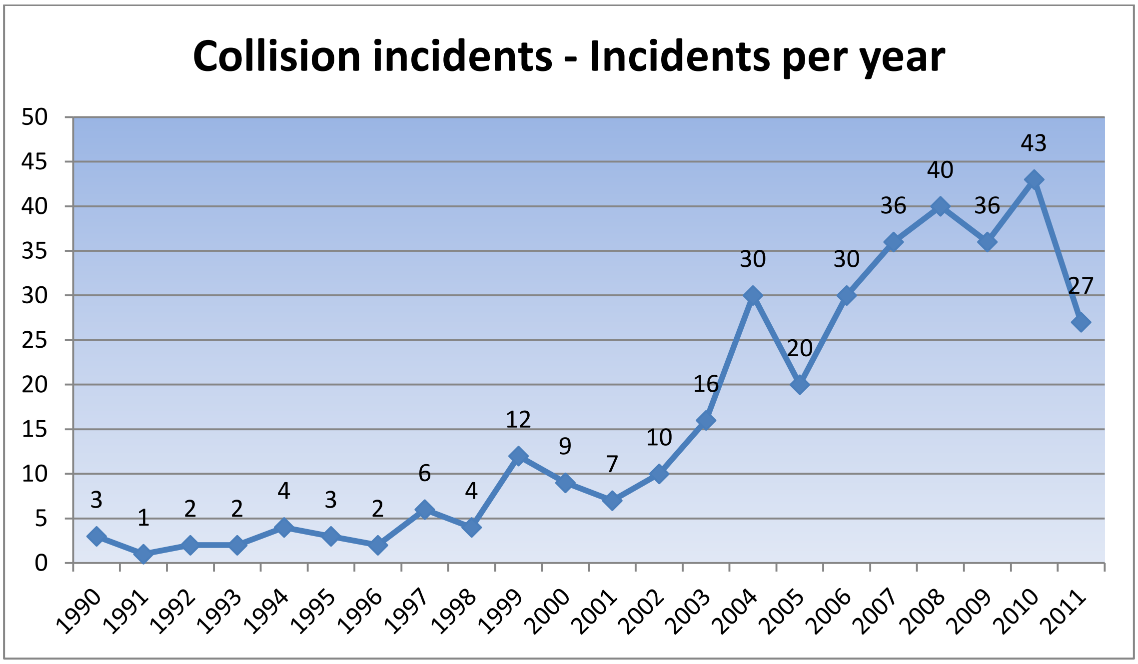
In 3 accidents the following fatalities and injuries happened:



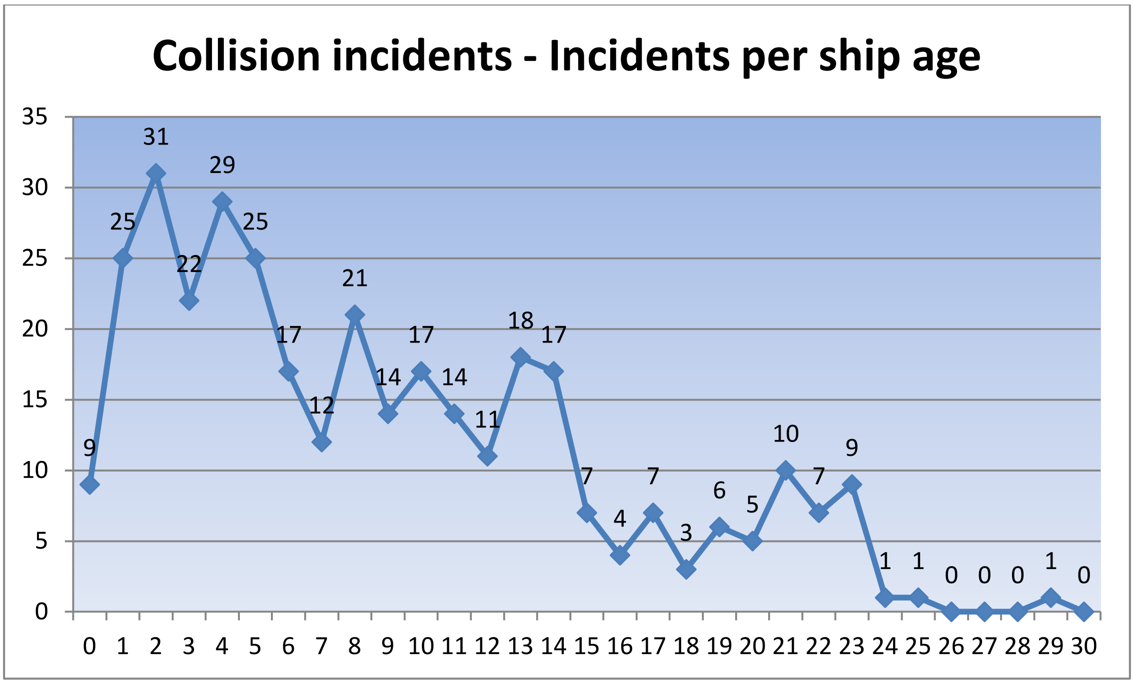
4.1.3 Frequencies of collision incidents



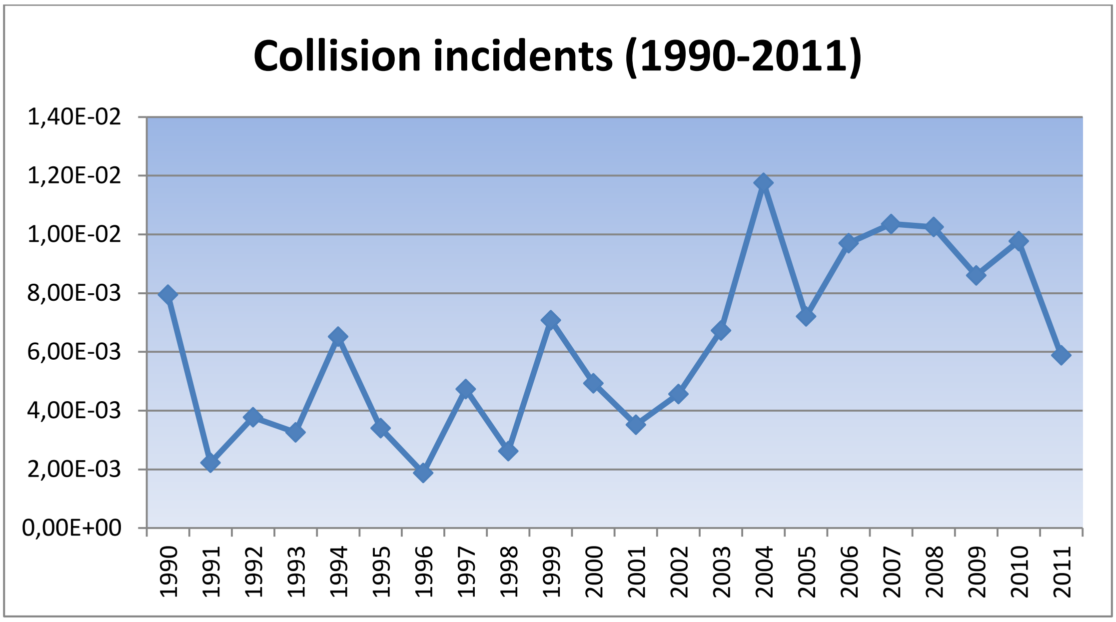
The majority of the ships that are included in the present study were built during the decade 1994-2004.



As expected, we note that many collision incidents take place from 2004 and on.



Many collision incidents occur in the first operational years of the ship and especially the first five years.



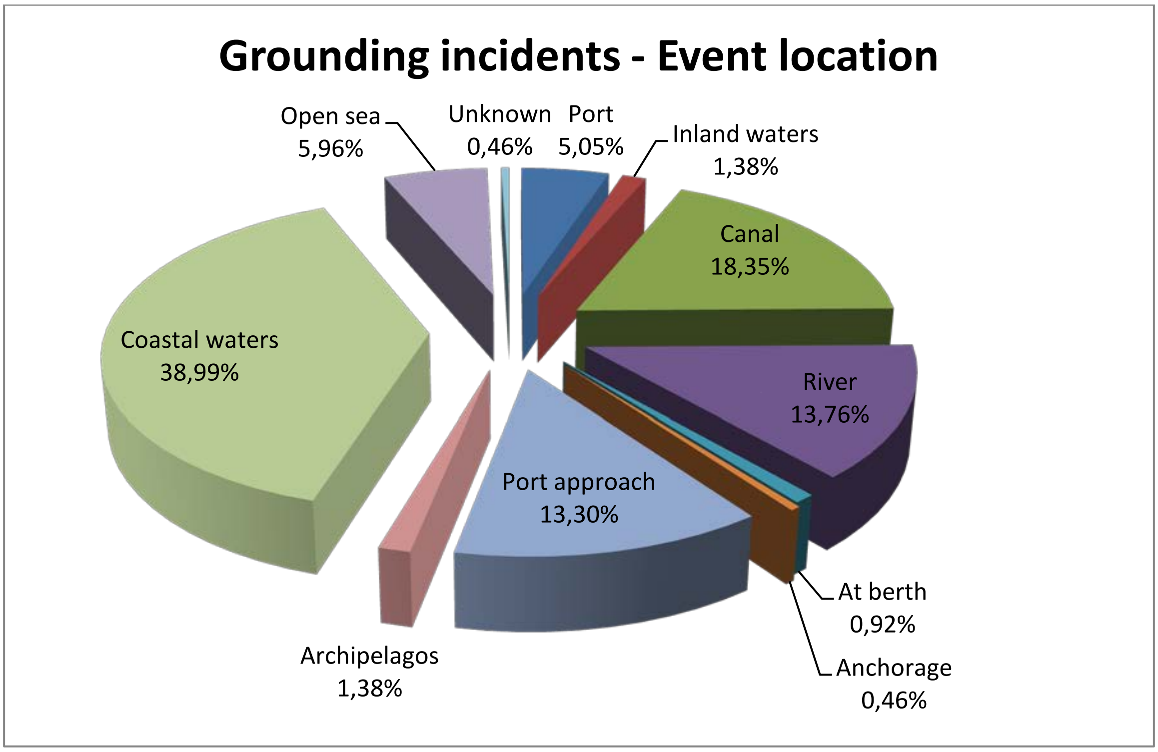
Regularly, it would be expected a decrease of the collision incidents over the years with all the new regulations in force. But if we take into consideration that the majority of the ships were built during the decade 1994-2004, this small increase is rather logical. However, we note that the frequencies of the collision events nowadays revert to the same levels as before 2004.

4.2 Grounding incidents

4.2.1 Conditions of grounding incidents

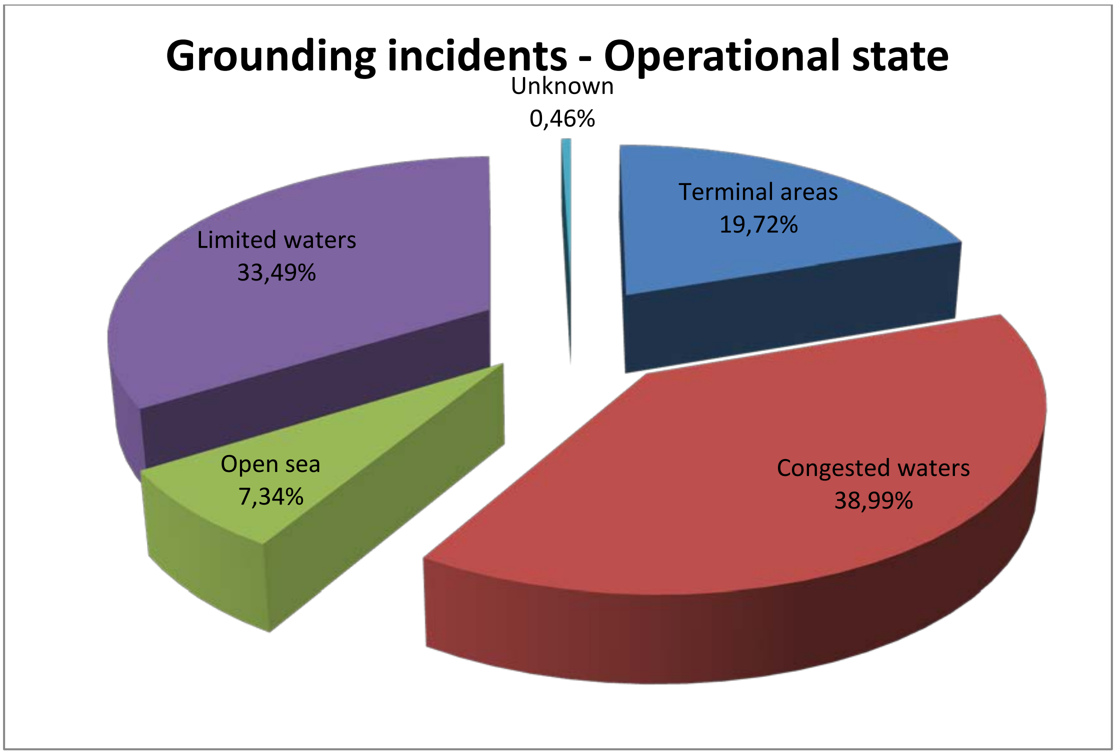
Event location

Event location	Number	Percentage
Port	11	5,05%
Inland waters	3	1,38%
Canal	40	18,35%
River	30	13,76%
At berth	2	0,92%
Anchorage	1	0,46%
Port approach	29	13,30%
Archipelagos	3	1,38%
Coastal waters	85	38,99%
Open sea	13	5,96%
Unknown	1	0,46%
Total	218	100,00%



Operational state

Operational state	Number	Percentage
Terminal areas	43	19,72%
Congested waters	85	38,99%
Open sea	16	7,34%
Limited waters	73	33,49%
Unknown	1	0,46%
Total	218	100,00%



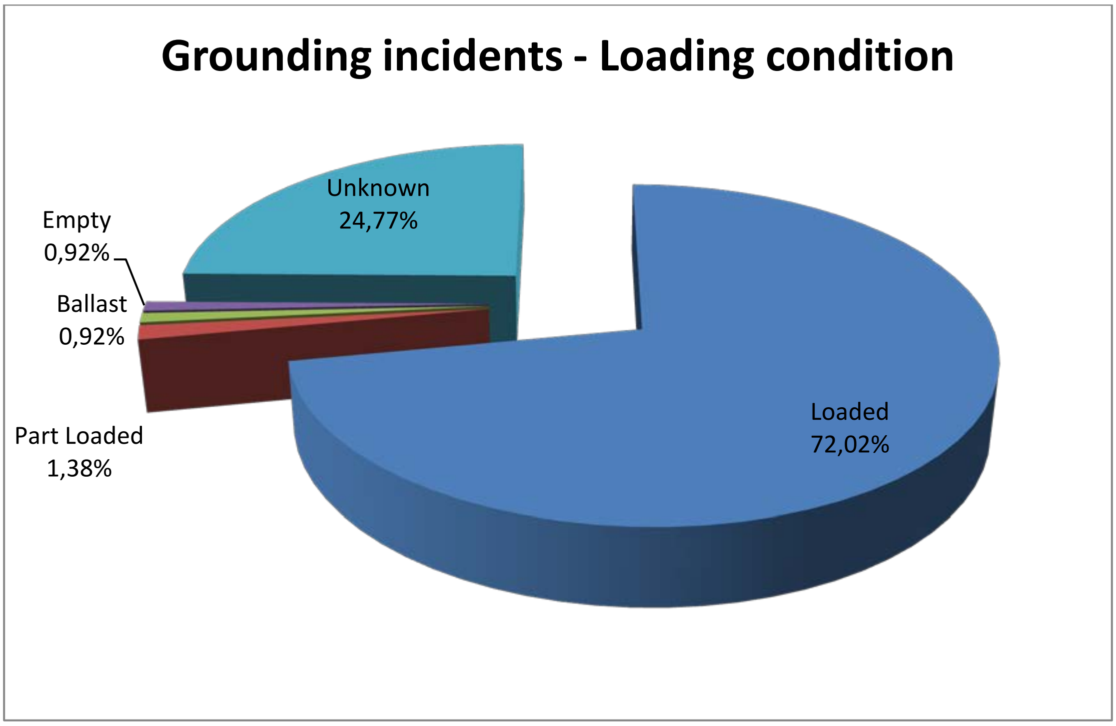
The vast majority of the grounding incidents take place in limited waters and congested waters where the foregone routes are near the coast, waters are rather shallow and there is no much free space for manoeuvring.

Operating condition

Operating condition	Number	Percentage
Berth	1	0,46%
Port	4	1,83%
Sailing / En-route	209	95,87%
Anchoring	1	0,46%
Manoeuvring	1	0,46%
Towed	1	0,46%
Mooring	1	0,46%
Total	218	100,00%

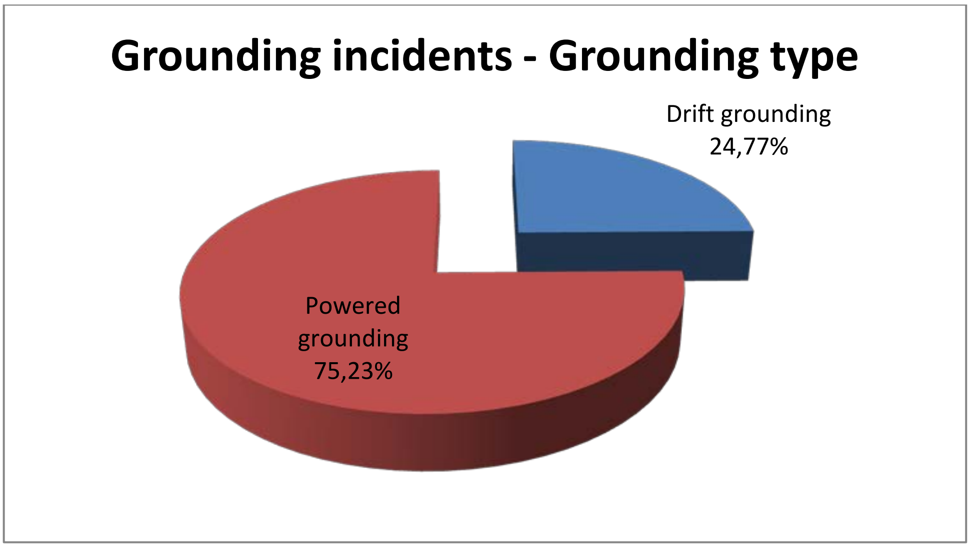
Loading condition

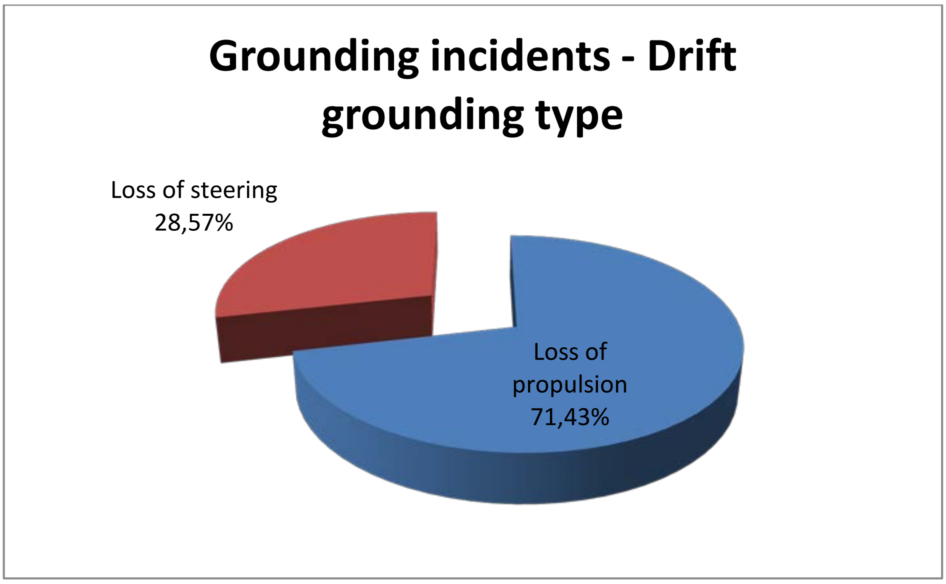
Loading condition	Number	Percentage
Loaded	157	72,02%
Part Loaded	3	1,38%
Ballast	2	0,92%
Empty	2	0,92%
Unknown	54	24,77%
Total	218	100,00%



Grounding type

Grounding type	Number	Percentage
Drift grounding	54	24,77%
Powered grounding	164	75,23%
Total	218	100,00%

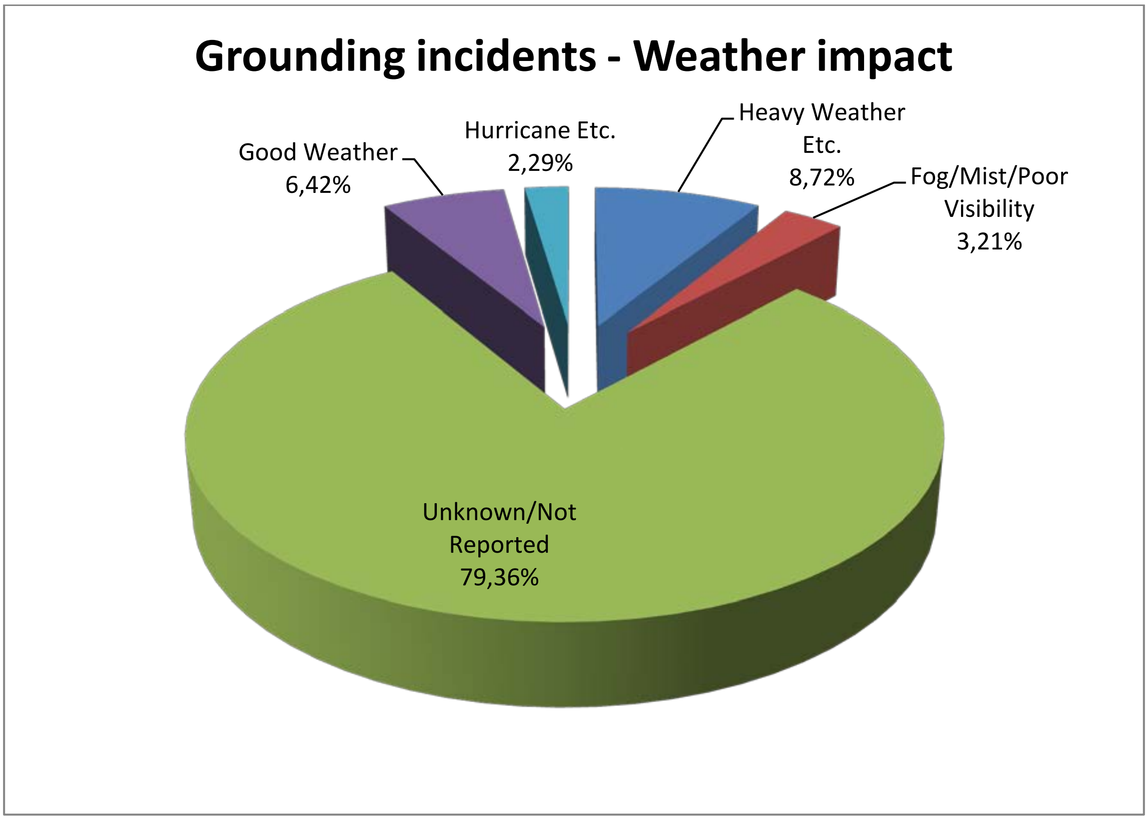




For grounding accident to happen a ship must be on a grounding course and no proper action is taken to avoid the grounding. Powered grounding includes situations such as wrong action or no action is taken by the crew and failure of navigational equipment. Drift grounding means inability for manoeuvring due to severe machinery failure or extreme weather conditions.

Weather impact

Weather impact	Number	Percentage
Heavy Weather Etc.	19	8,72%
Fog/Mist/Poor Visibility	7	3,21%
Unknown/Not Reported	173	79,36%
Good Weather	14	6,42%
Hurricane Etc.	5	2,29%
Total	218	100,00%

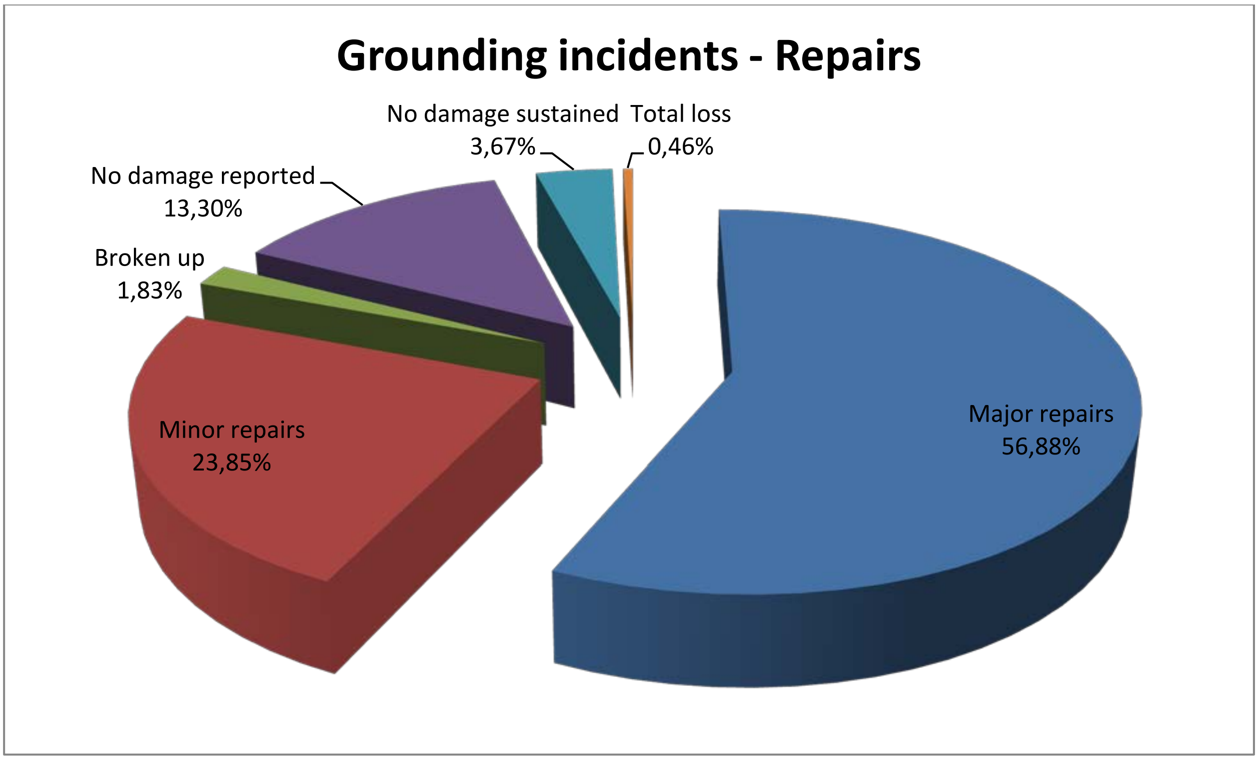


There is no information for almost 80% of the grounding incidents as far as the weather impact is concerned. Where information is available, it is obvious that bad environmental conditions are a contributing factor for many grounding incidents.

4.2.2 Consequences of grounding incidents

Repairs

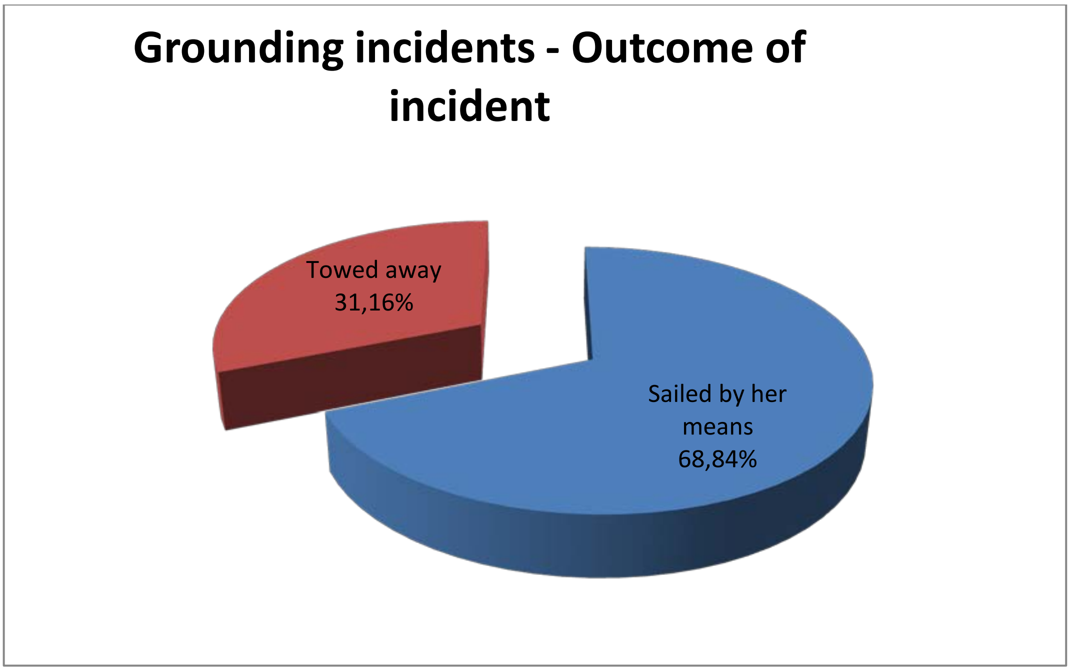
Repairs	Number	Percentage
Major repairs	124	56,88%
Minor repairs	52	23,85%
Broken up	4	1,83%
No damage reported	29	13,30%
No damage sustained	8	3,67%
Total loss	1	0,46%
Total	218	100,00%



There were 4 ships that were broken up as a result of the accident and 1 actual total loss within the studied period.

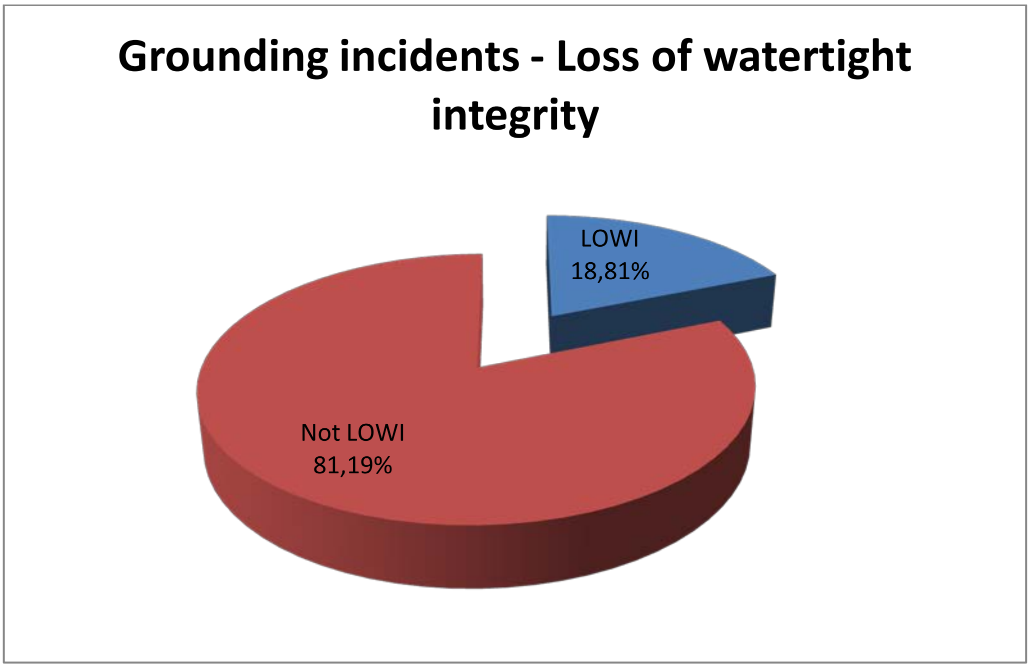
Outcome

Outcome	Number	Percentage
Sailed by her means	148	68,84%
Towed away	67	31,16%
Total	215	100,00%



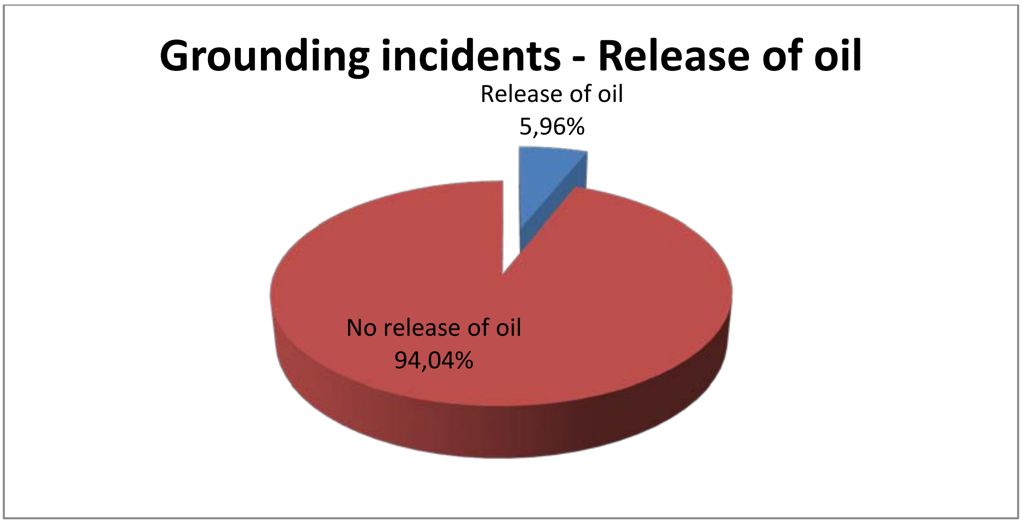
Loss of watertight integrity

LOWI	Number	Percentage
Yes	41	18,81%
No	177	81,19%
Total	218	100,00%



Release of oil

Release of oil	Number	Percentage
Yes	13	5,96%
No	205	94,04%
Total	218	100,00%



In 4 known cases, 780 tonnes of oil were released into the sea.

Release of hazardous / polluting cargo

Release of hazardous / polluting cargo	Number	Percentage
Yes	0	0,00%
No	218	100,00%
Total	218	100,00%

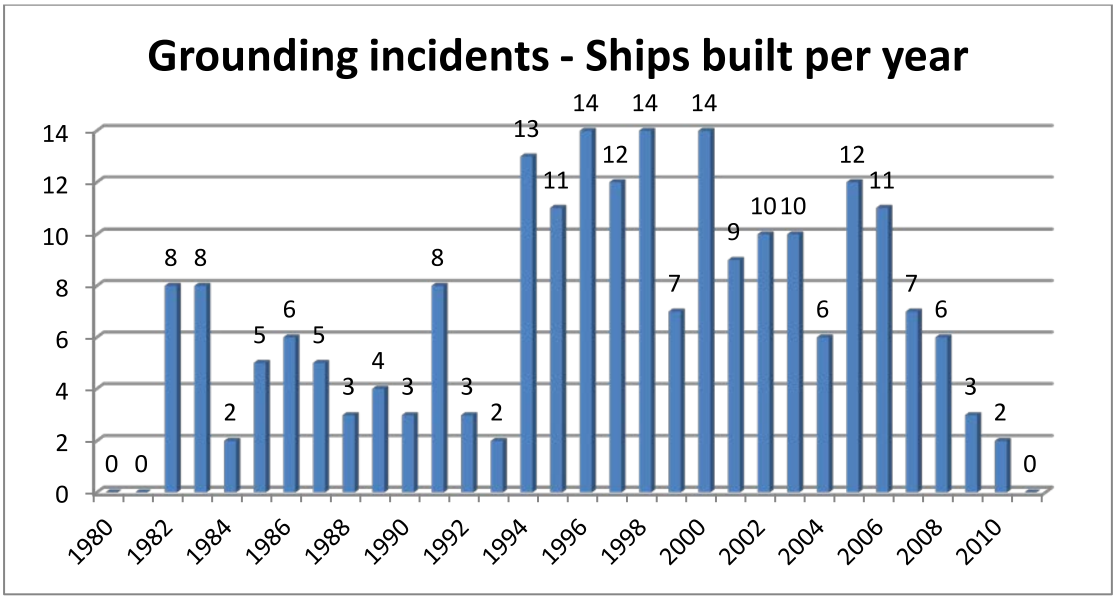
Loss of cargo

In 1 case it was reported that 4 containers were lost.

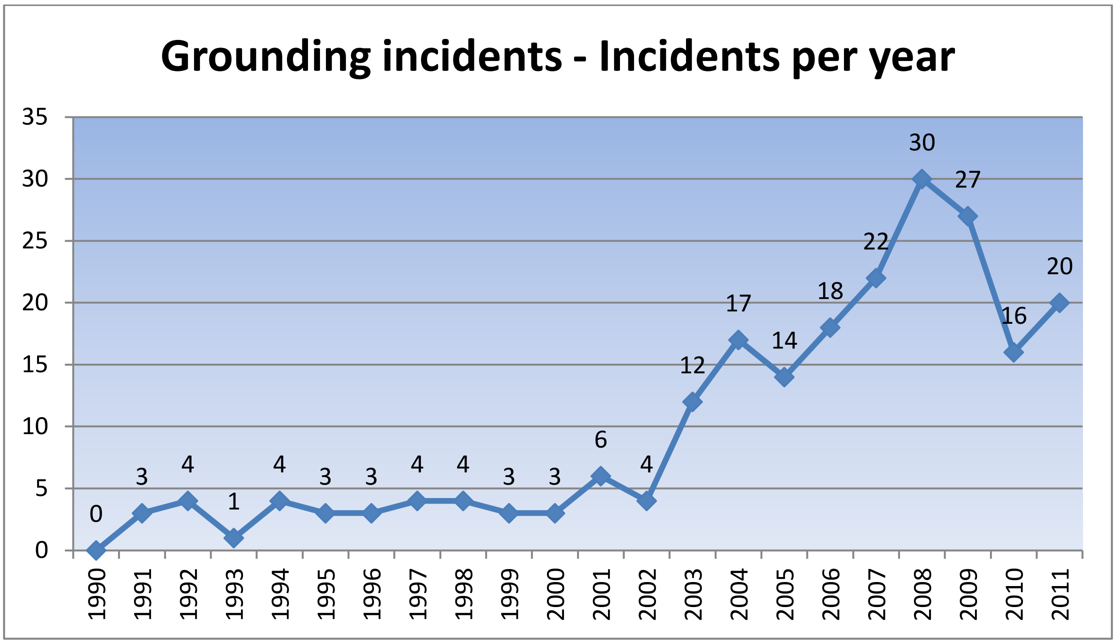
Injuries and fatalities

1 fatality was reported because of the groundings within the studied period.

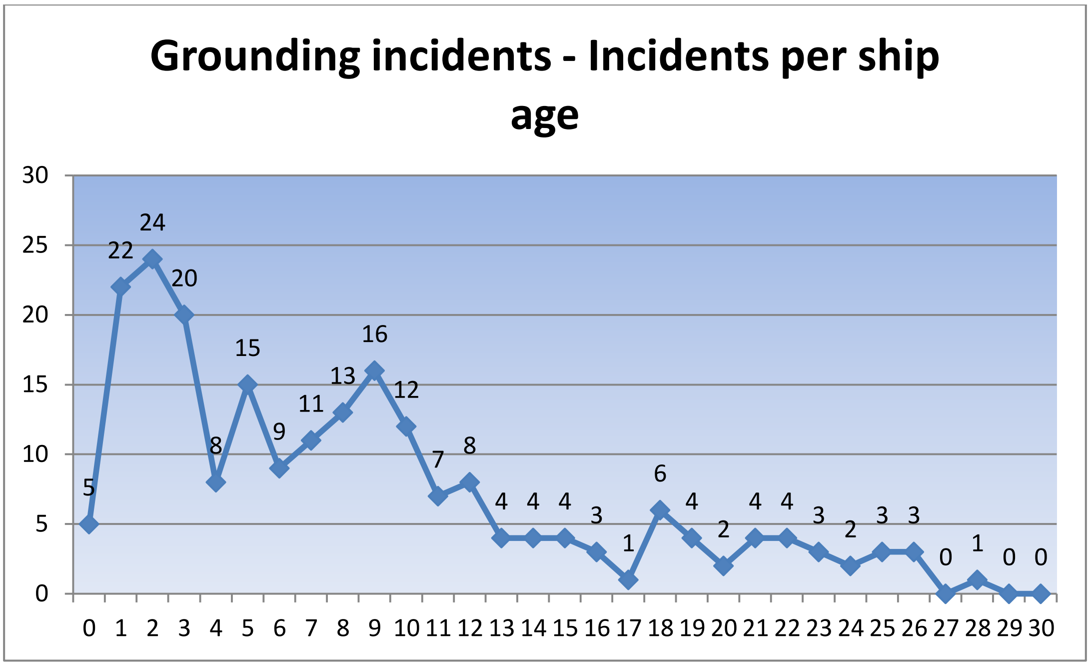
4.2.3 Frequencies of grounding incidents



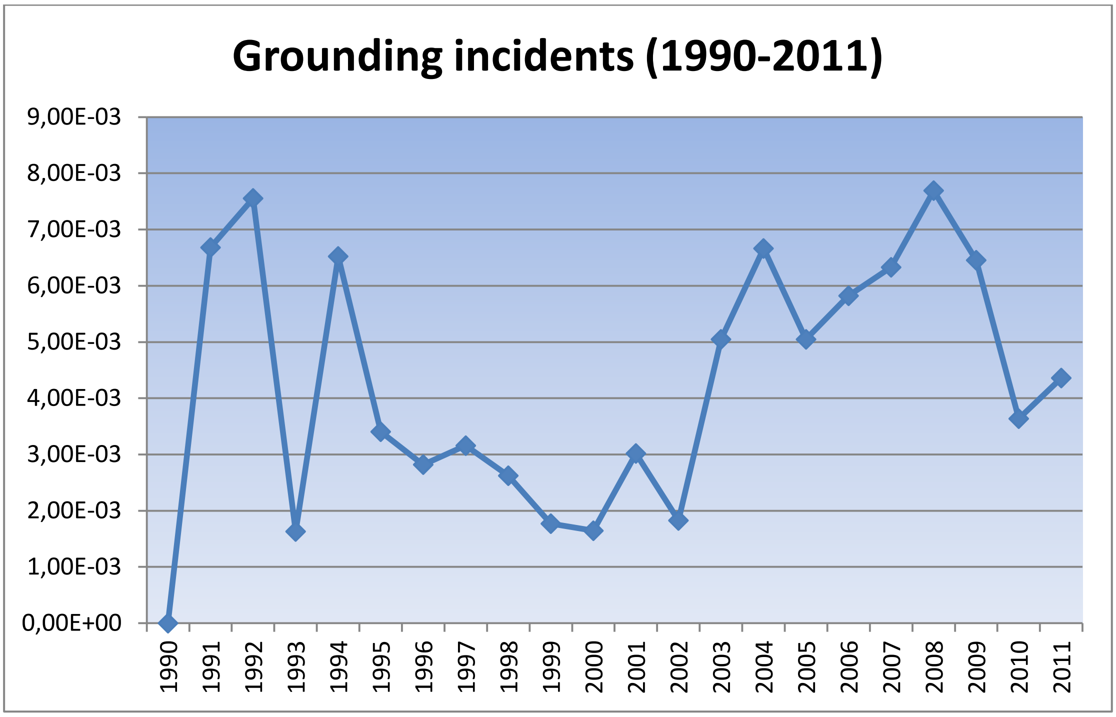
The vast majority of the ships that are examined in the current study were built during 1994-2006.



Many grounding incidents take place from 2003 and on. This is reasonable if we take into account that by that time the fleet was importantly increased.



Many grounding incidents occur in the first operational years of the ship and especially the first three years.



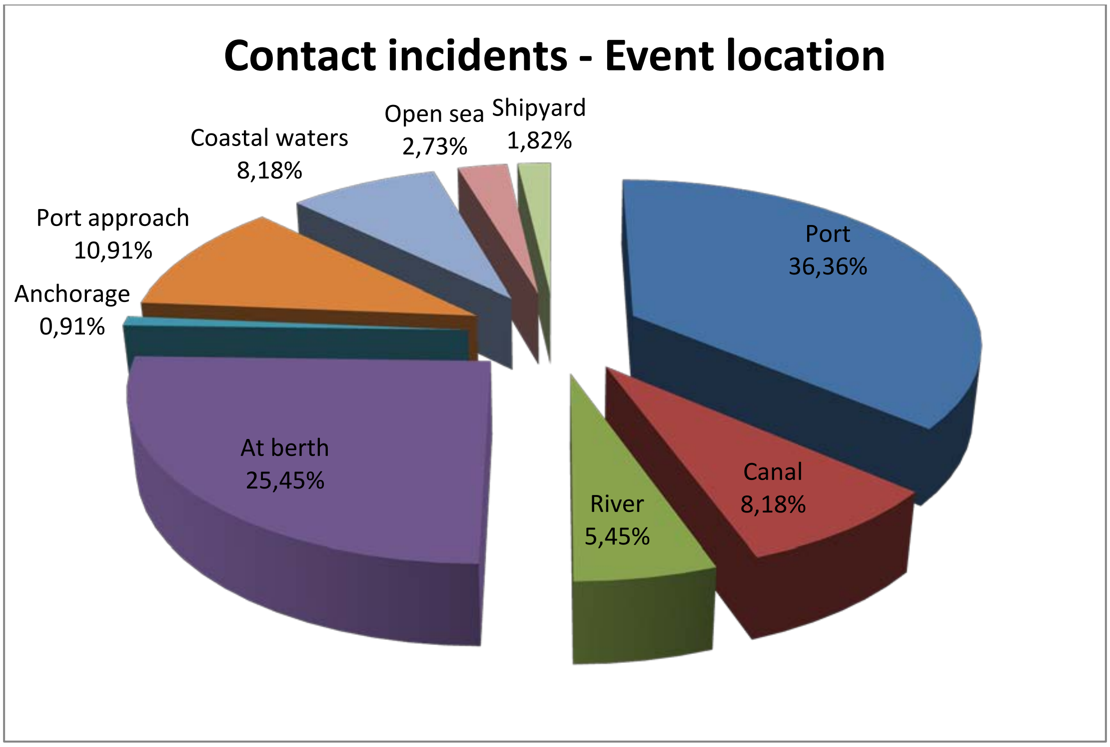
It would be expected a decrease of the grounding incidents over the years thanks to the navigational equipment available nowadays. On the other side, congestion of traffic in some areas may lead to the opposite trend. However, we note that the frequencies of the grounding events have been decreasing over the last two years.

4.3 Contact incidents

4.3.1 Conditions of contact incidents

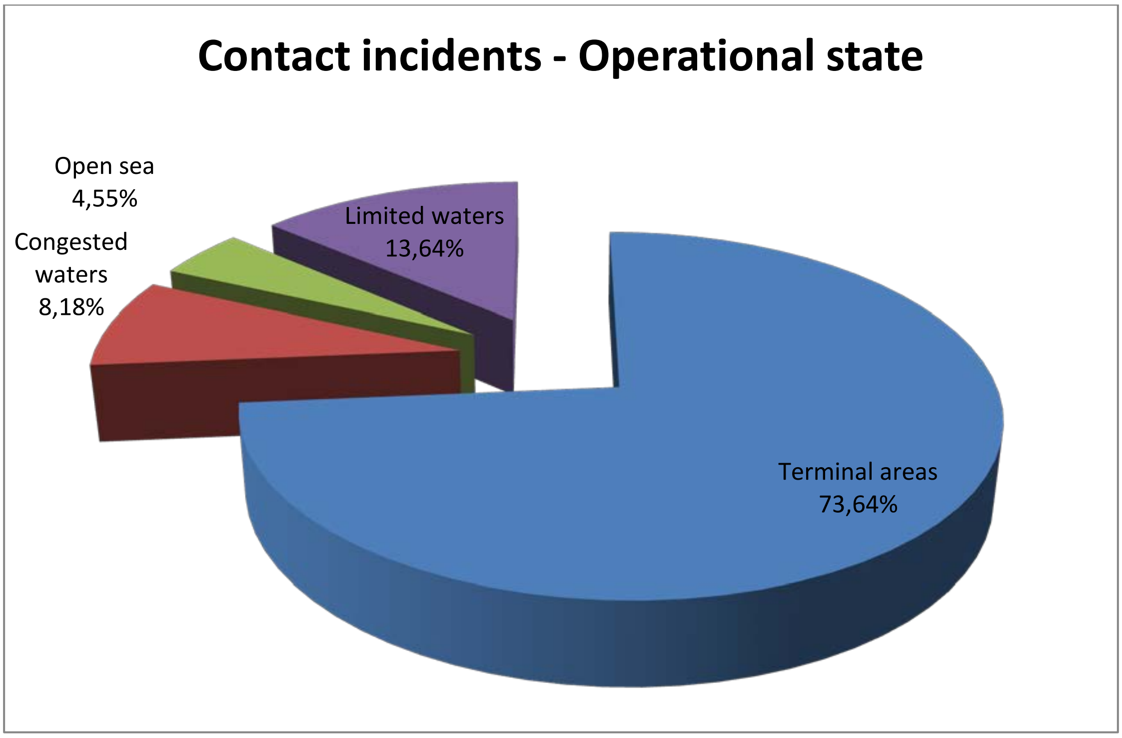
Event location

Event location	Number	Percentage
Port	40	36,36%
Canal	9	8,18%
River	6	5,45%
At berth	28	25,45%
Anchorage	1	0,91%
Port approach	12	10,91%
Coastal waters	9	8,18%
Open sea	3	2,73%
Shipyard	2	1,82%
Total	110	100,00%



Operational state

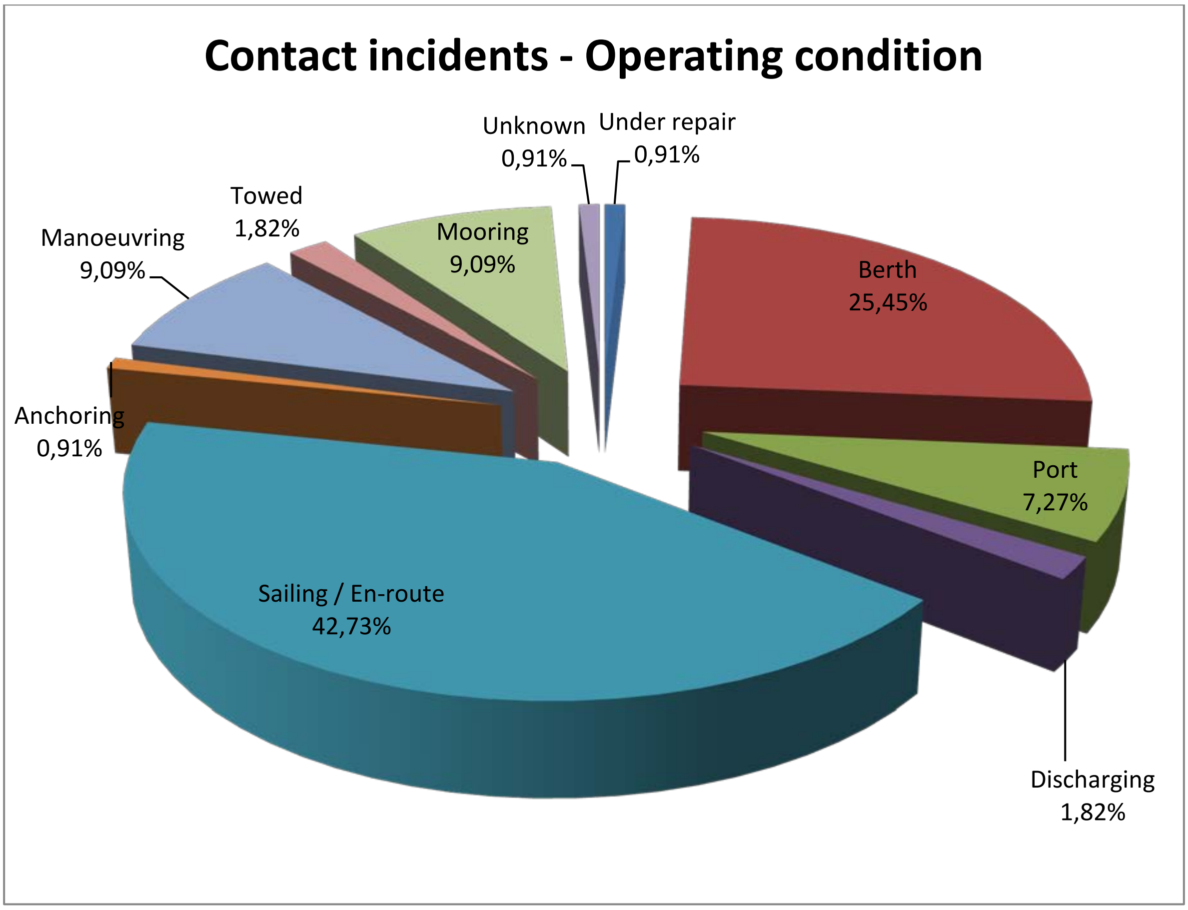
Operational state	Number	Percentage
Terminal areas	81	73,64%
Congested waters	9	8,18%
Open sea	5	4,55%
Limited waters	15	13,64%
Total	110	100,00%



The presence of objects likely to be struck in contact scenarios is higher in port areas than in open sea. Therefore, almost 75% of the contact incidents occur in terminal areas. Terminal areas include port, port approach, anchorage and berth.

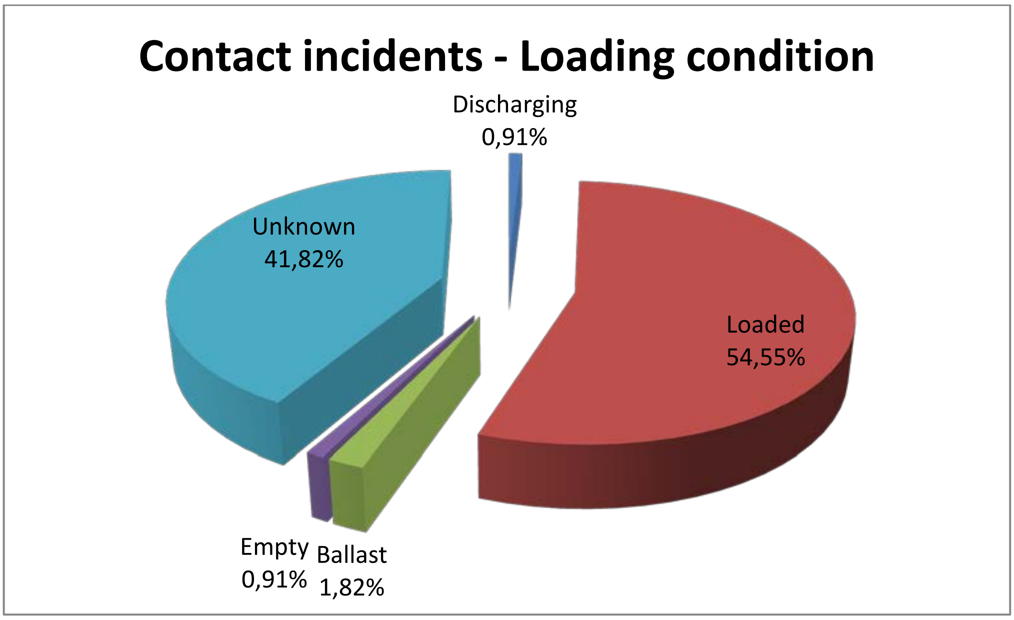
Operating condition

Operating condition	Number	Percentage
Under repair	1	0,91%
Berth	28	25,45%
Port	8	7,27%
Discharging	2	1,82%
Sailing / En-route	47	42,73%
Anchoring	1	0,91%
Manoeuvring	10	9,09%
Towed	2	1,82%
Mooring	10	9,09%
Unknown	1	0,91%
Total	110	100,00%



Loading condition

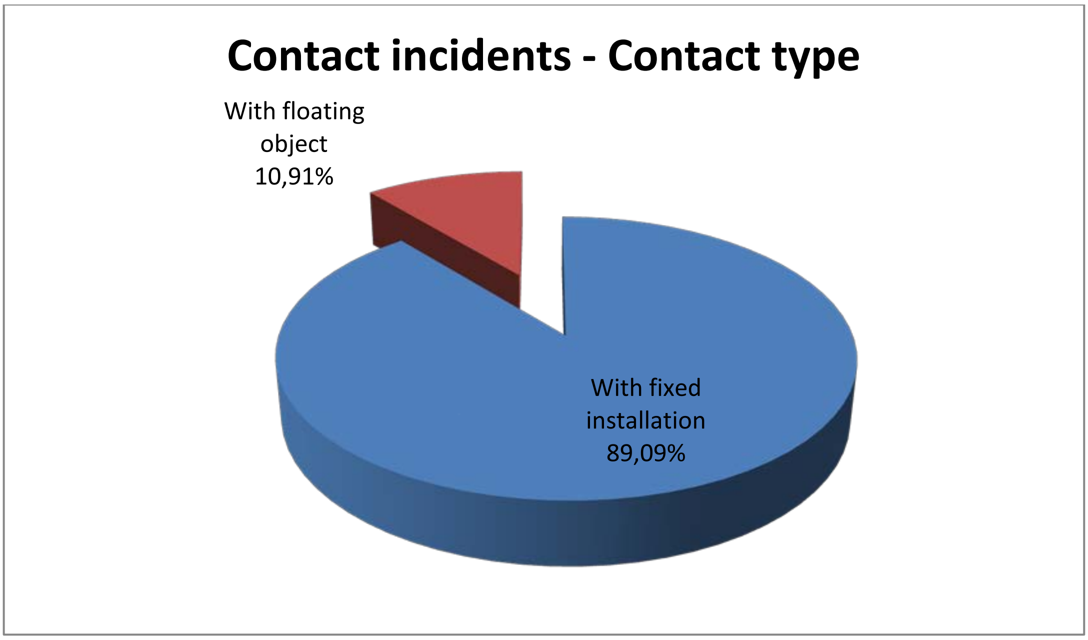
Loading condition	Number	Percentage
Discharging	1	0,91%
Loaded	60	54,55%
Ballast	2	1,82%
Empty	1	0,91%
Unknown	46	41,82%
Total	110	100,00%



Contact type

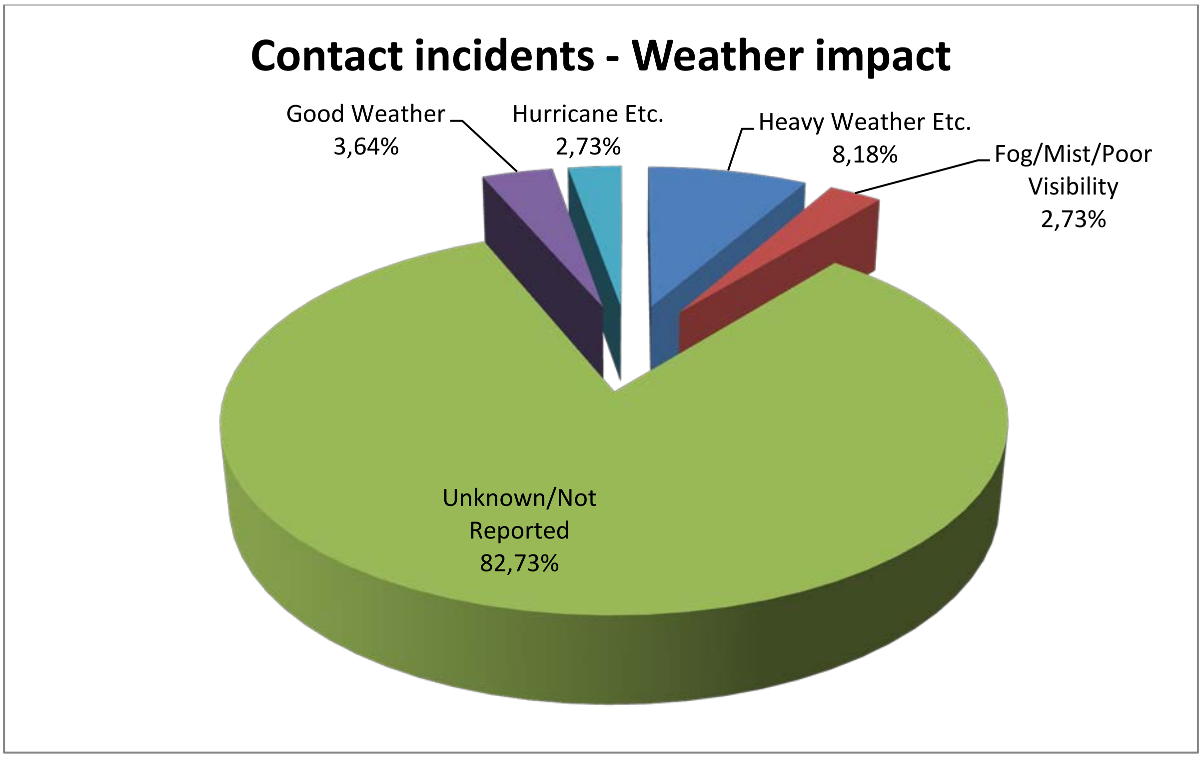
Contact type	Number	Percentage
With fixed installation	98	89,09%
With floating object	12	10,91%
Total	110	100,00%

The fact that almost 90% of the contact incidents were with fixed installation indicates that the issue of human error such as the malfunction/failure of the navigational equipment seem to play a significant role.



Weather impact

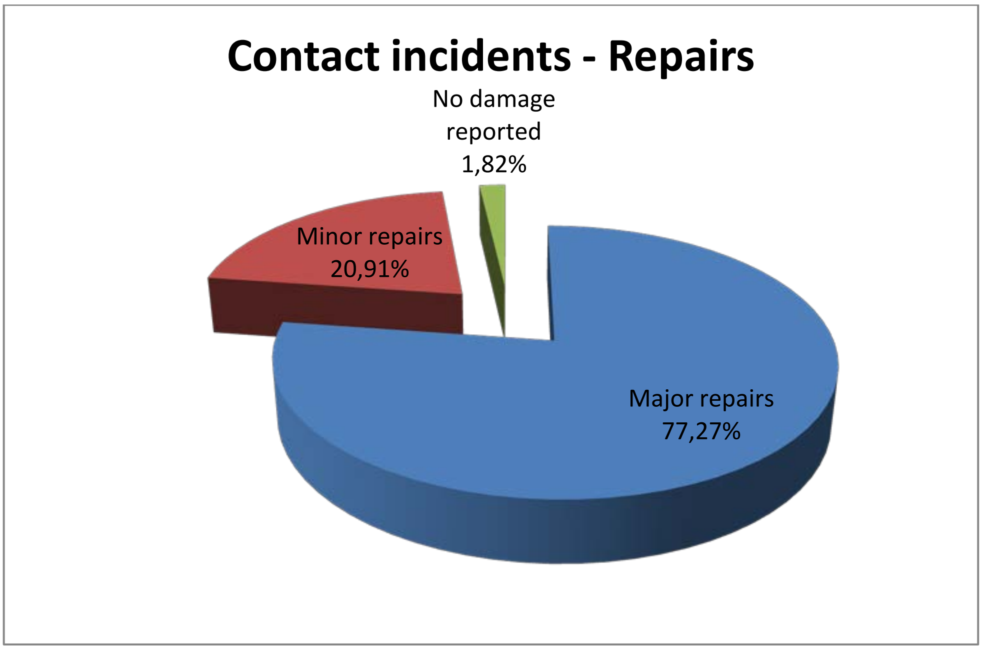
Weather impact	Number	Percentage
Heavy Weather Etc.	9	8,18%
Fog/Mist/Poor Visibility	3	2,73%
Unknown/Not Reported	91	82,73%
Good Weather	4	3,64%
Hurricane Etc.	3	2,73%
Total	110	100,00%



4.3.2 Consequences of contact incidents

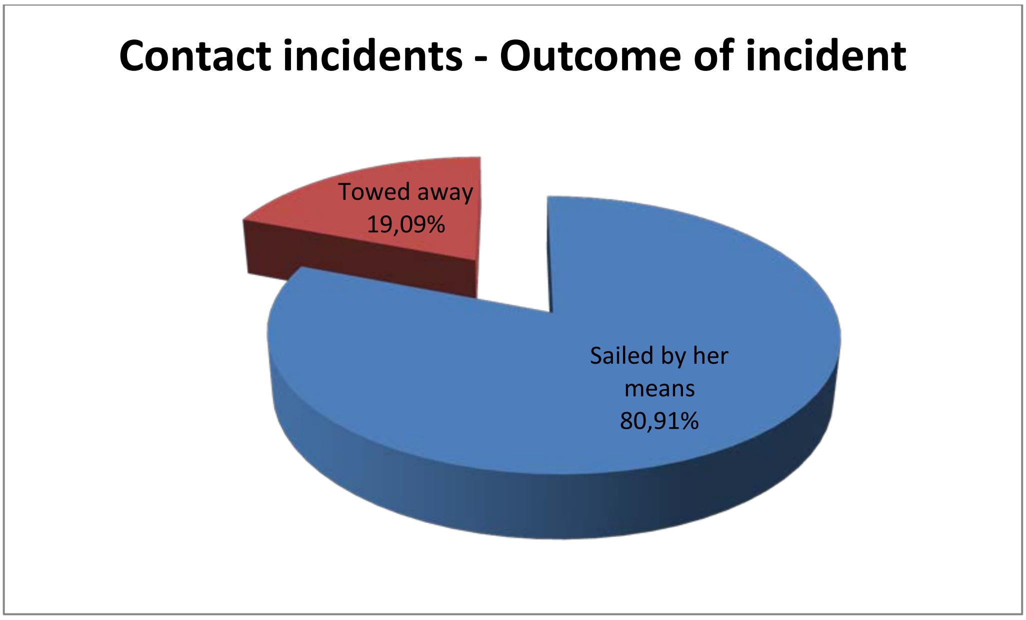
Repairs

Repairs	Number	Percentage
Major repairs	85	77,27%
Minor repairs	23	20,91%
No damage reported	2	1,82%
Total	110	100,00%



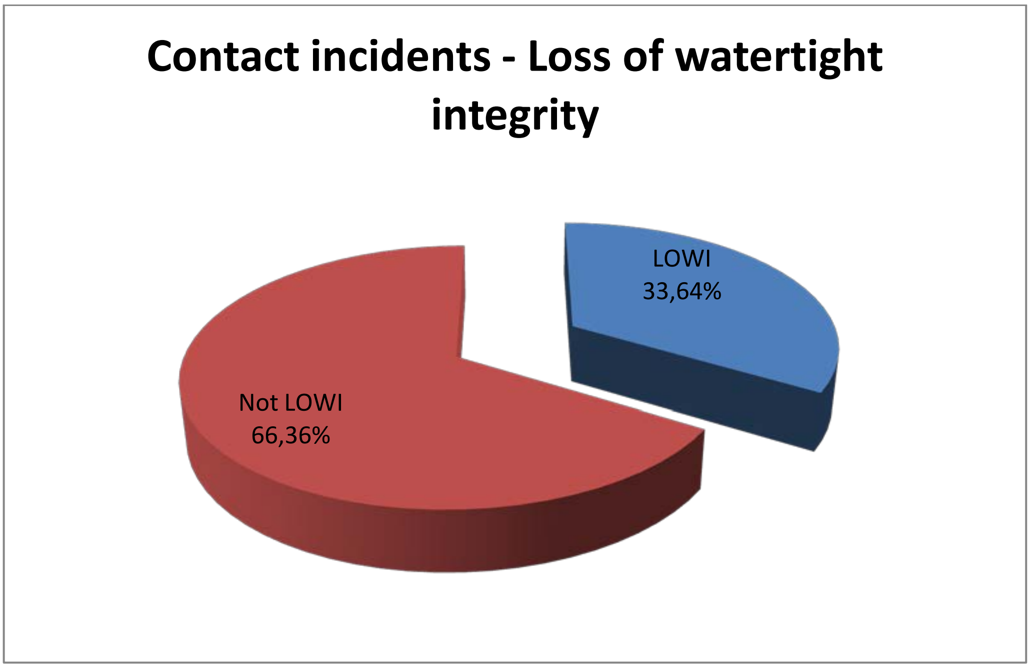
Outcome

Outcome	Number	Percentage
Sailed by her means	89	80,91%
Towed away	21	19,09%
Total	110	100,00%



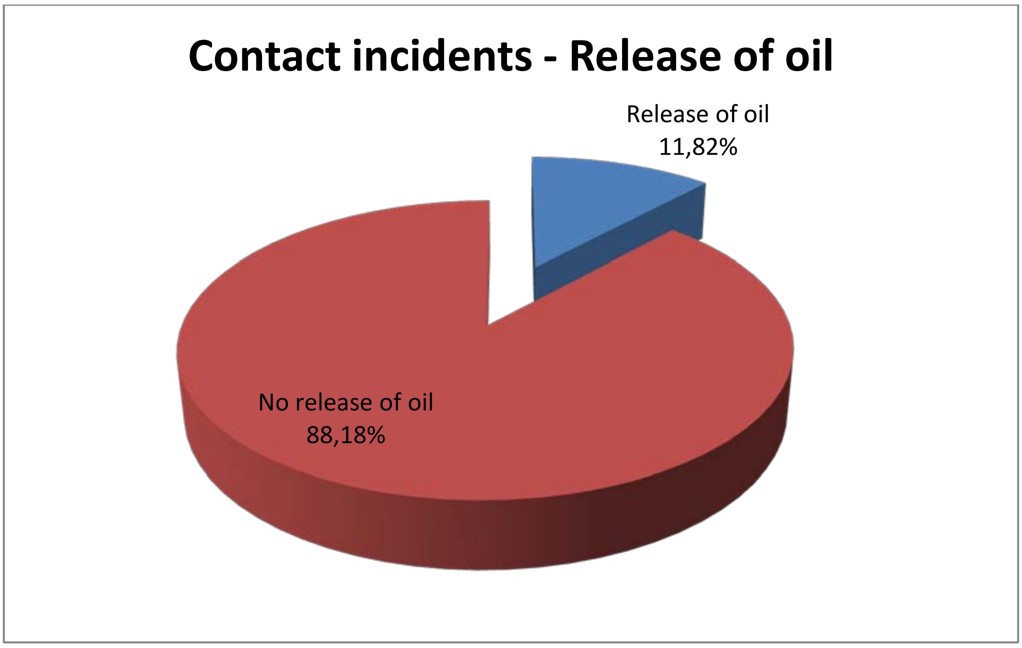
Loss of watertight integrity

LOWI	Number	Percentage
Yes	37	33,64%
No	73	66,36%
Total	110	100,00%



Release of oil

Release of oil	Number	Percentage
Yes	13	11,82%
No	97	88,18%
Total	110	100,00%



In 8 known cases, 1883 tonnes of oil were released into the sea in total.

Release of hazardous / polluting cargo

Release of hazardous / polluting cargo	Number	Percentage
Yes	1	0,91%
No	109	99,09%
Total	110	100,00%

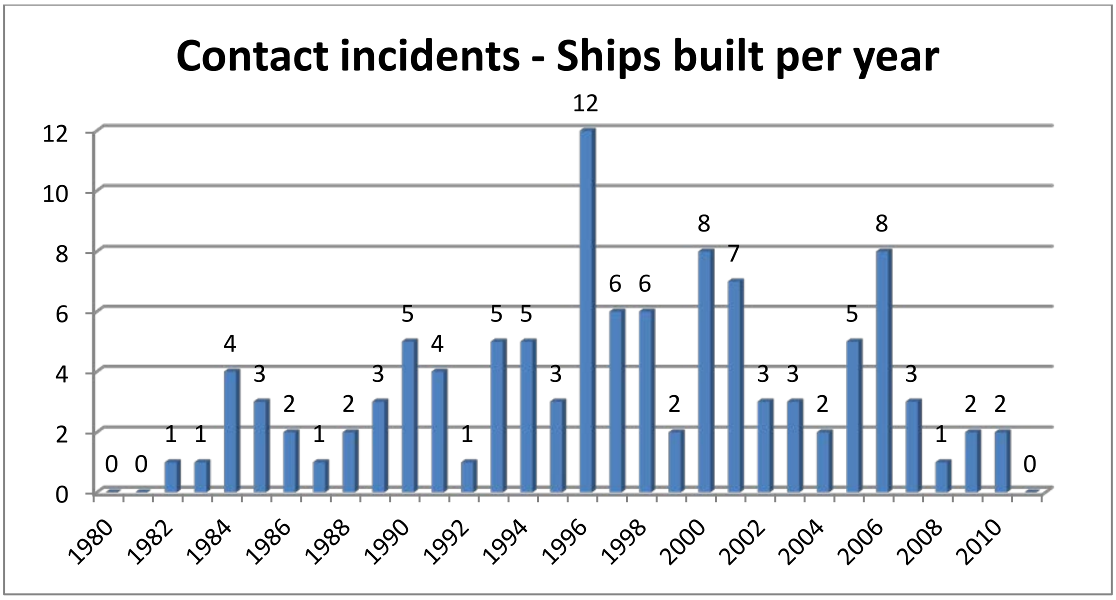
Loss of cargo

In 1 case, 14 containers were lost within the studied period.

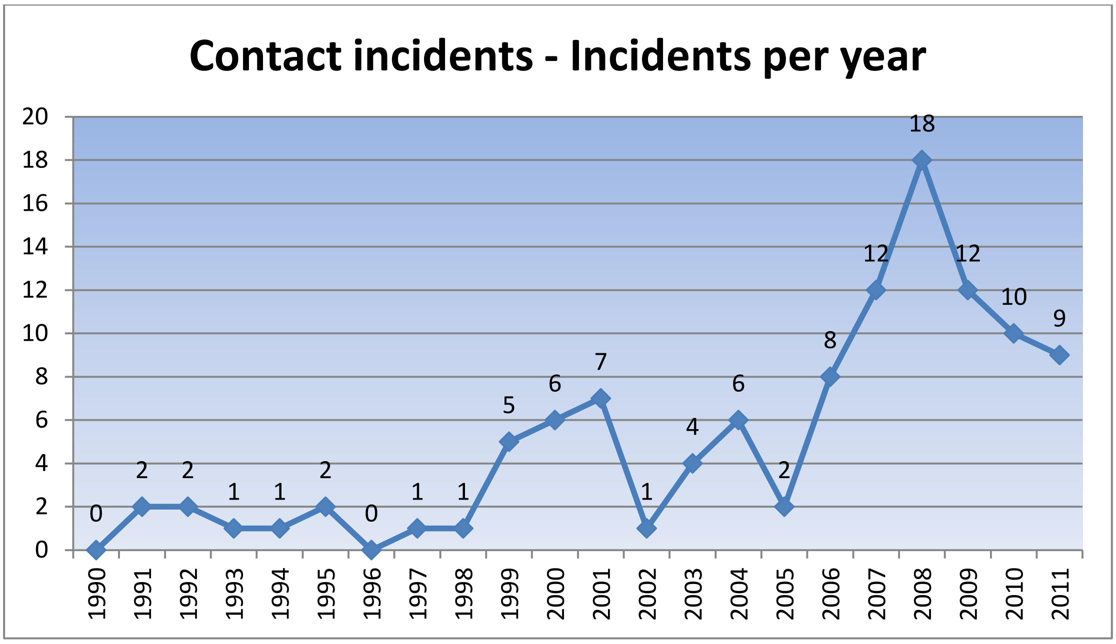
Injuries and fatalities

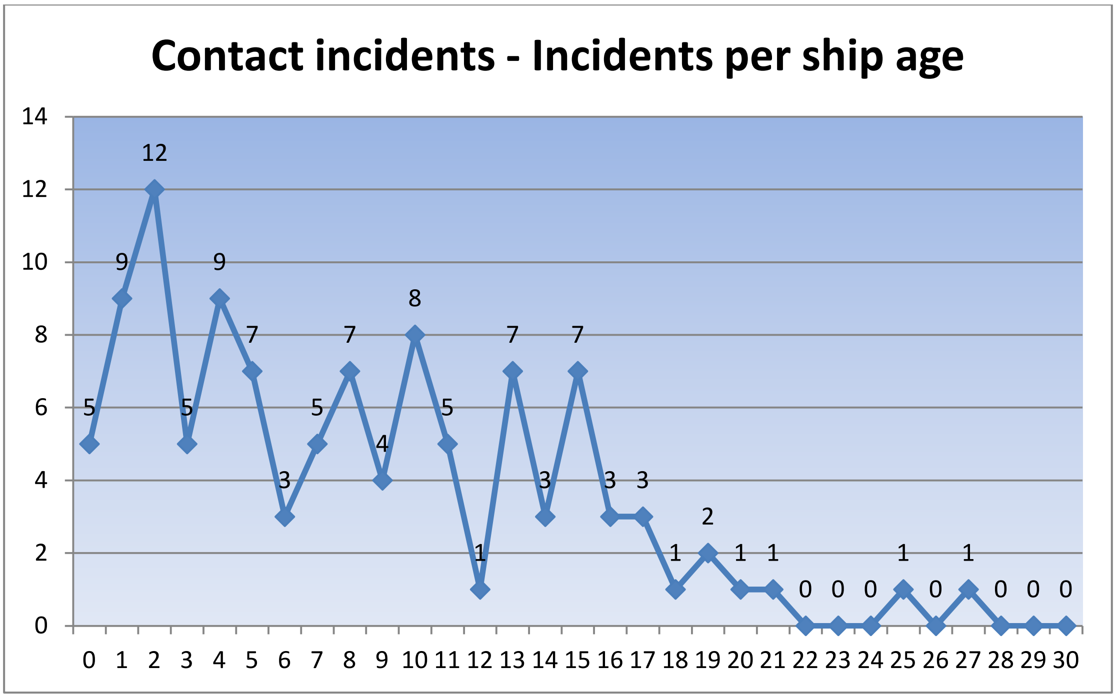
There wasn't any injury or fatality recorded.

4.3.3 Frequencies of contact incidents

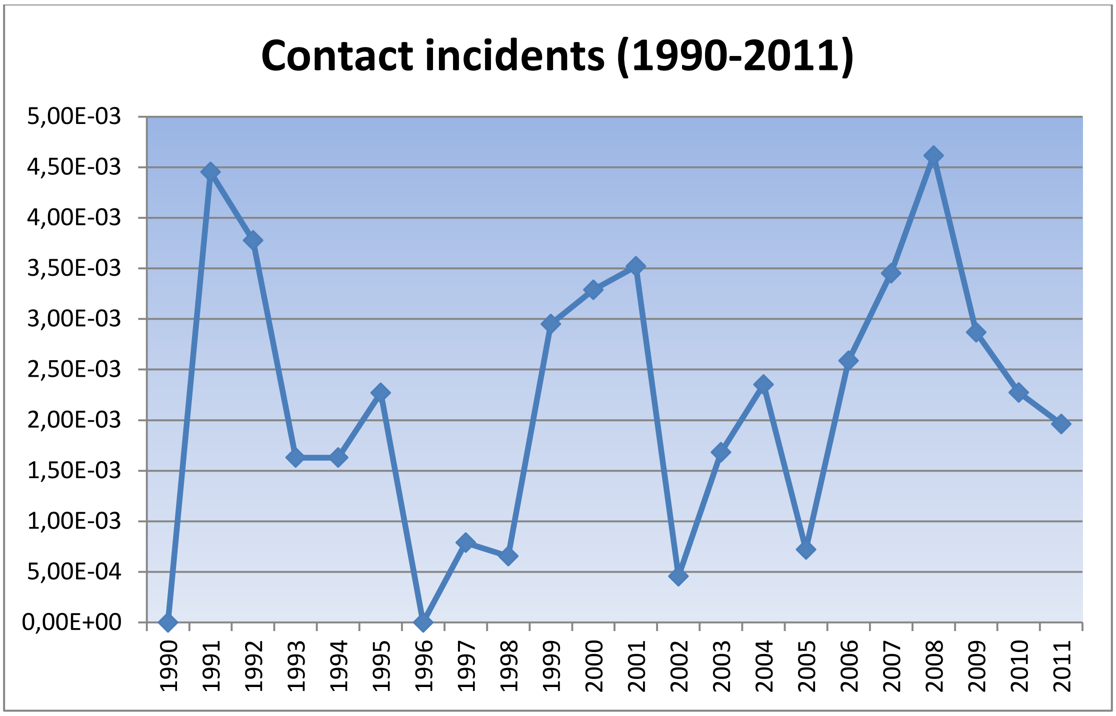


With the exception of the year 1996, we note dispersion as far as the ships built per year are concerned.





The majority of the contact incidents occur in the first operational years of the ship.



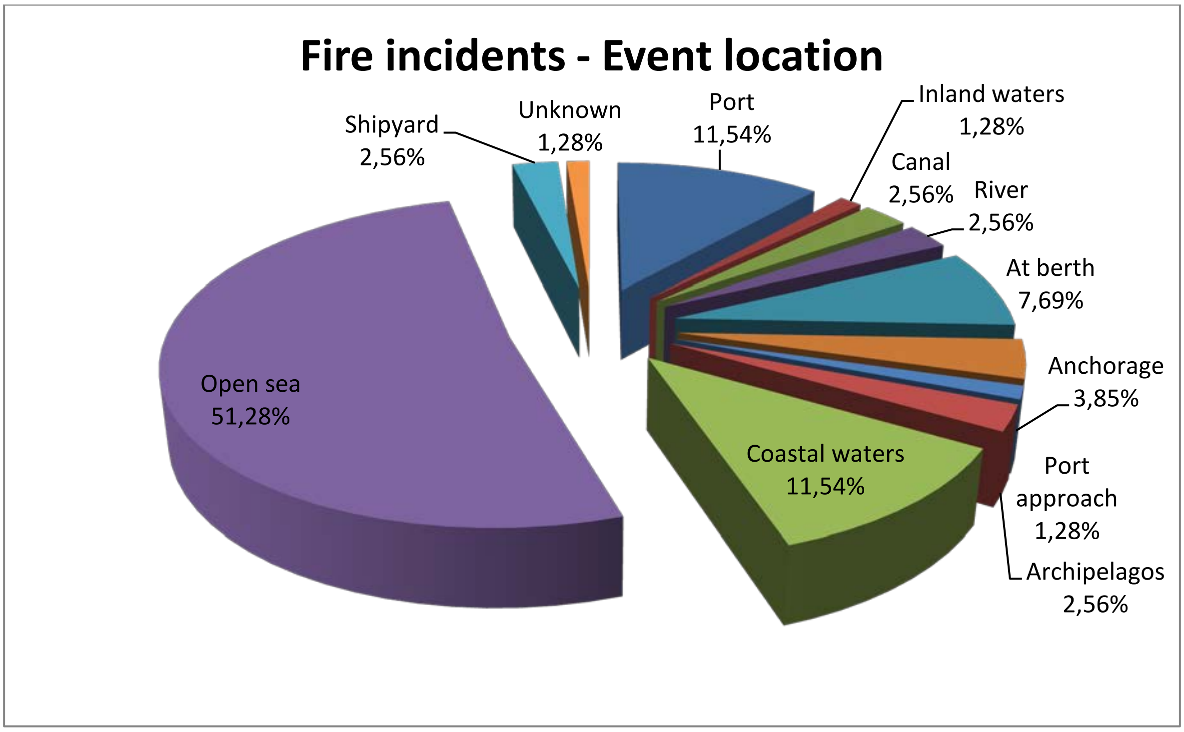
The frequencies of the contact incidents for the period 1990-2011 appear problematic. Fluctuations of the frequencies are observed throughout the years. We should also bear in mind that in the present study only the serious incidents are examined.

4.4 Fire incidents

4.4.1 Conditions of fire incidents

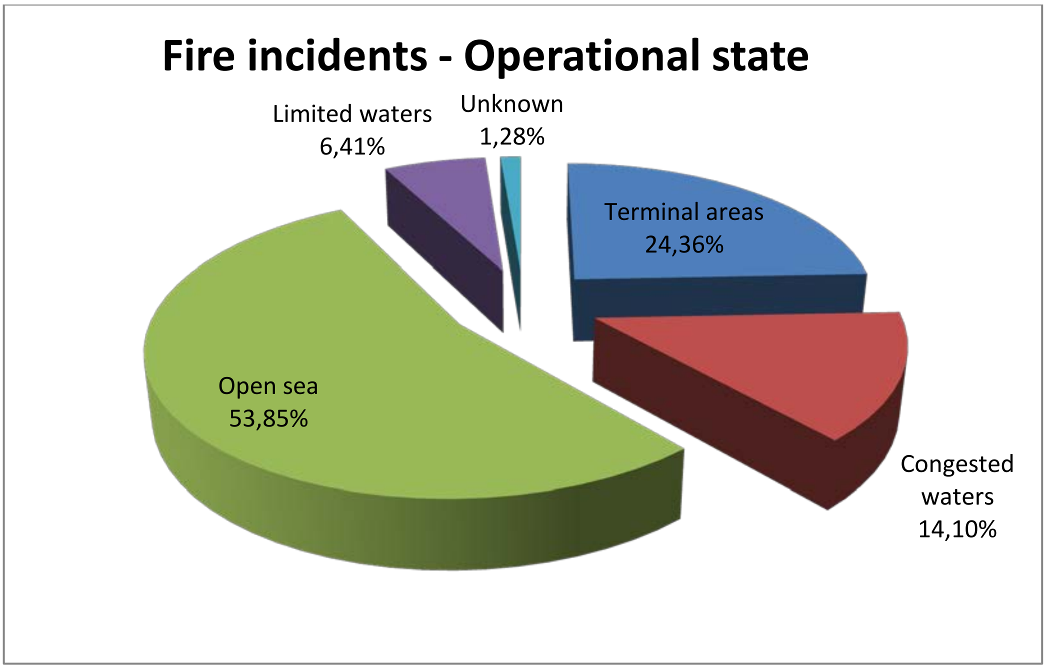
Event location

Event location	Number	Percentage
Port	9	11,54%
Inland waters	1	1,28%
Canal	2	2,56%
River	2	2,56%
At berth	6	7,69%
Anchorage	3	3,85%
Port approach	1	1,28%
Archipelagos	2	2,56%
Coastal waters	9	11,54%
Open sea	40	51,28%
Shipyard	2	2,56%
Unknown	1	1,28%
Total	78	100,00%



Operational state

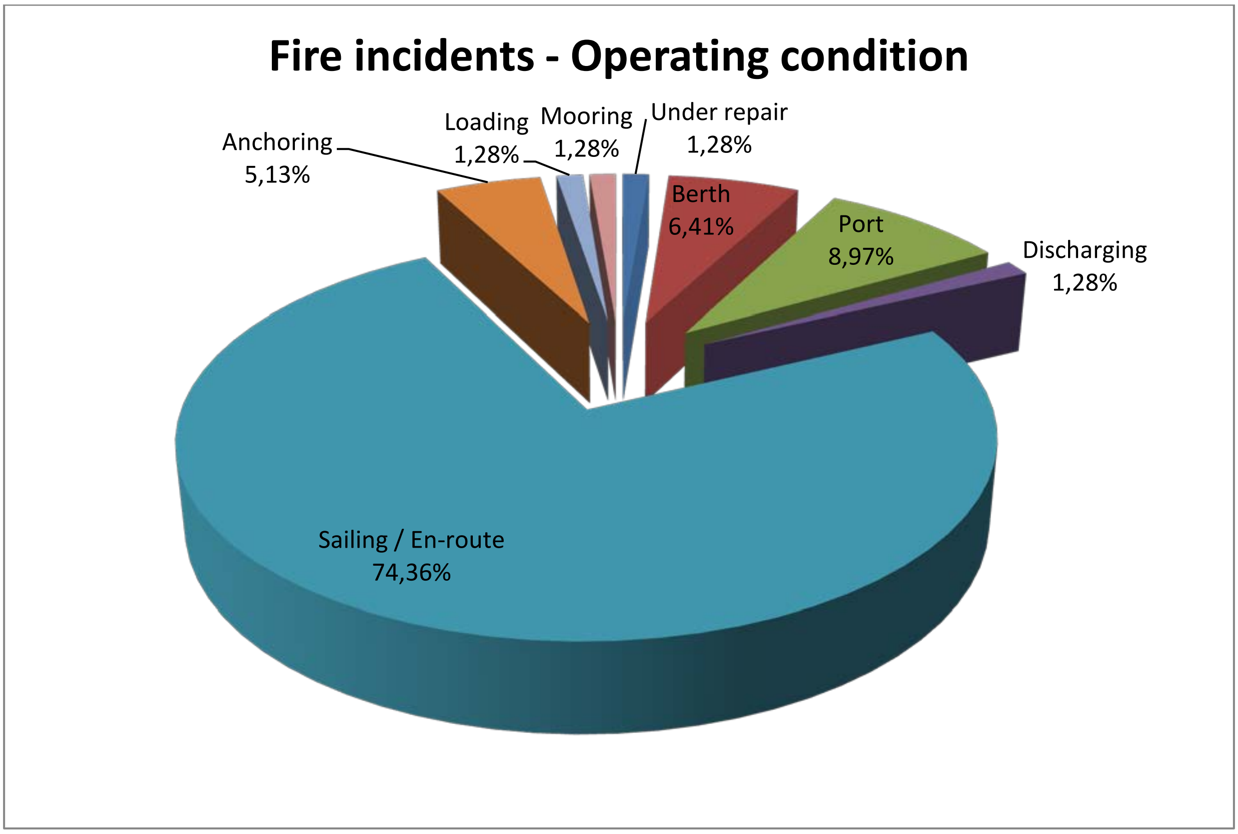
Operational state	**Number**	**Percentage**
Terminal areas	19	24,36%
Congested waters	11	14,10%
Open sea	42	53,85%
Limited waters	5	6,41%
Unknown	1	1,28%
Total	78	100,00%



The majority of the fire incidents happen in open sea where the machinery equipment is in operation and containers are exposed to the prevailing environmental conditions.

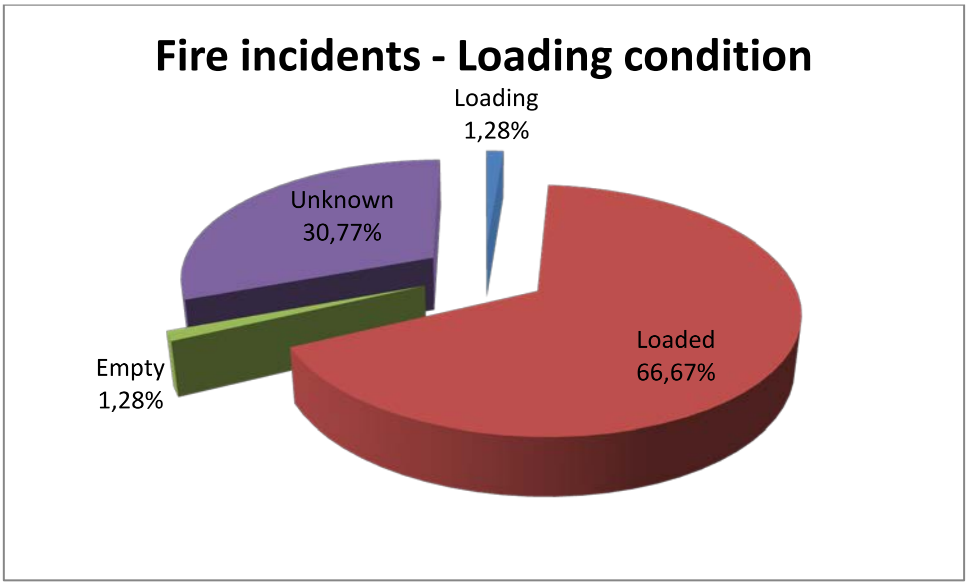
Operating condition

Operating condition	Number	Percentage
Under repair	1	1,28%
Berth	5	6,41%
Port	7	8,97%
Discharging	1	1,28%
Sailing / En-route	58	74,36%
Anchoring	4	5,13%
Loading	1	1,28%
Mooring	1	1,28%
Total	78	100,00%

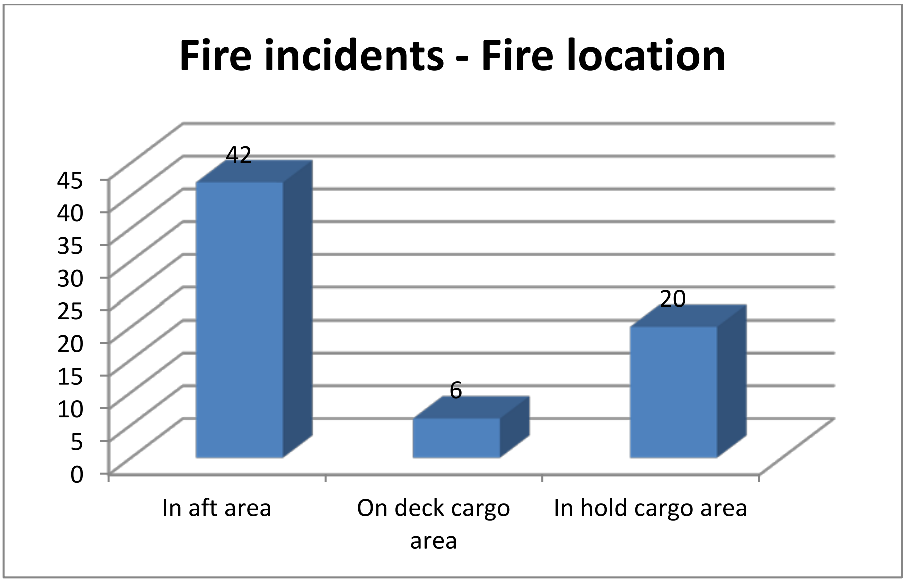


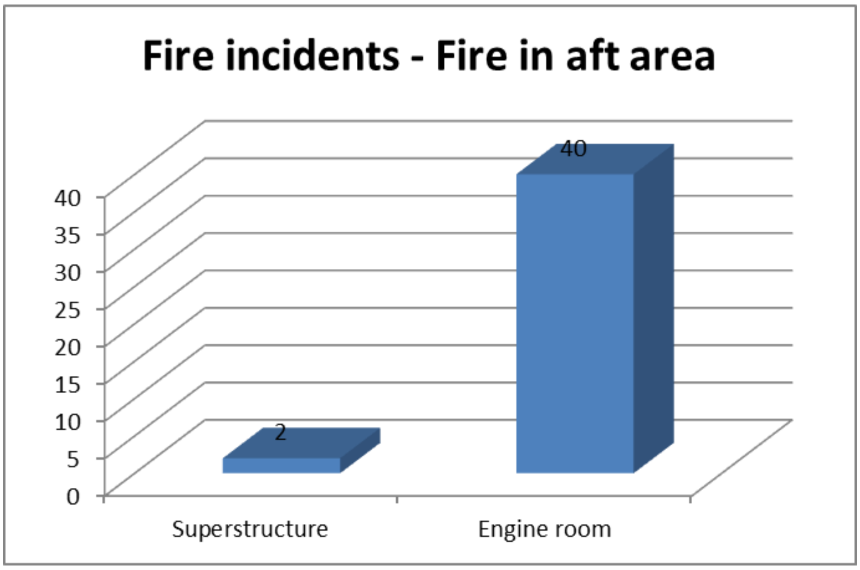
Loading condition

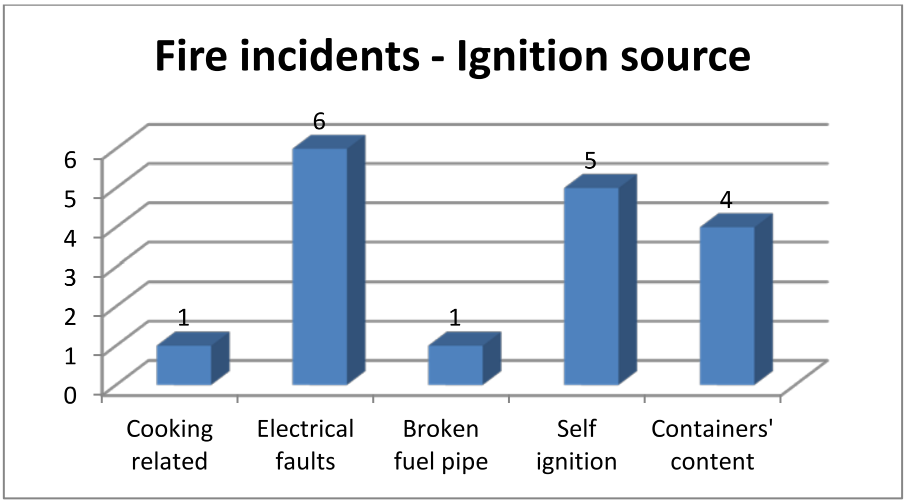
Loading condition	Number	Percentage
Loading	1	1,28%
Loaded	52	66,67%
Empty	1	1,28%
Unknown	24	30,77%
Total	78	100,00%



Fire type







Followed explosion	Number	Percentage
Yes	2	2,56%
No	76	97,44%
Total	78	100,00%

It is obvious that the majority of fires on containerships begin in the engine room or machinery spaces. The cargo area composes the second most dangerous area for the break out of the fire. Rarely the fire was followed by an explosion.

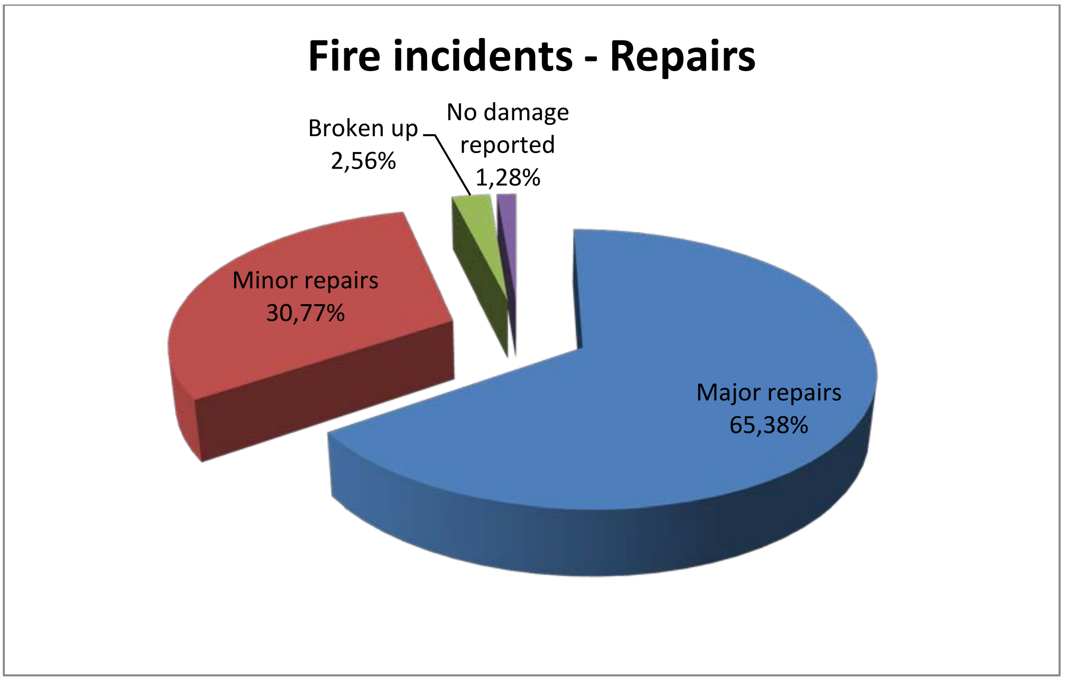
Weather impact

Weather impact	Number	Percentage
Heavy Weather Etc.	3	3,85%
Unknown/Not Reported	73	93,59%
Good Weather	2	2,56%
Total	78	100,00%

4.4.2 Consequences of fire incidents

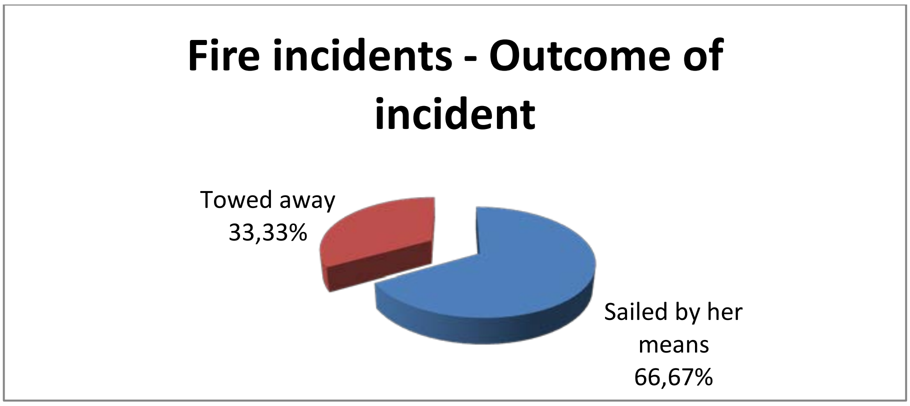
Repairs

Repairs	Number	Percentage
Major repairs	51	65,38%
Minor repairs	24	30,77%
Broken up	2	2,56%
No damage reported	1	1,28%
Total	78	100,00%



Outcome

Outcome	Number	Percentage
Sailed by her means	52	66,67%
Towed away	26	33,33%
Total	78	100,00%



Loss of watertight integrity

In none case LOWI was reported.

Release of oil

No release of oil because of fire events within the studied period.

Release of hazardous / polluting cargo

In 1 accident there was release of polluting cargo.

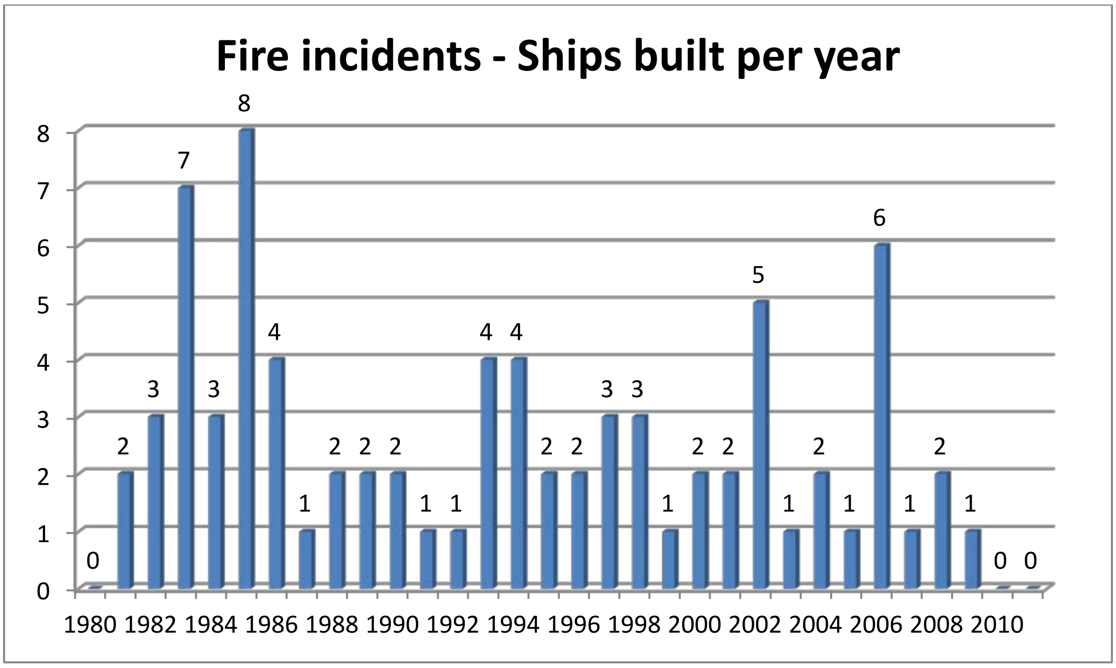
Loss of cargo

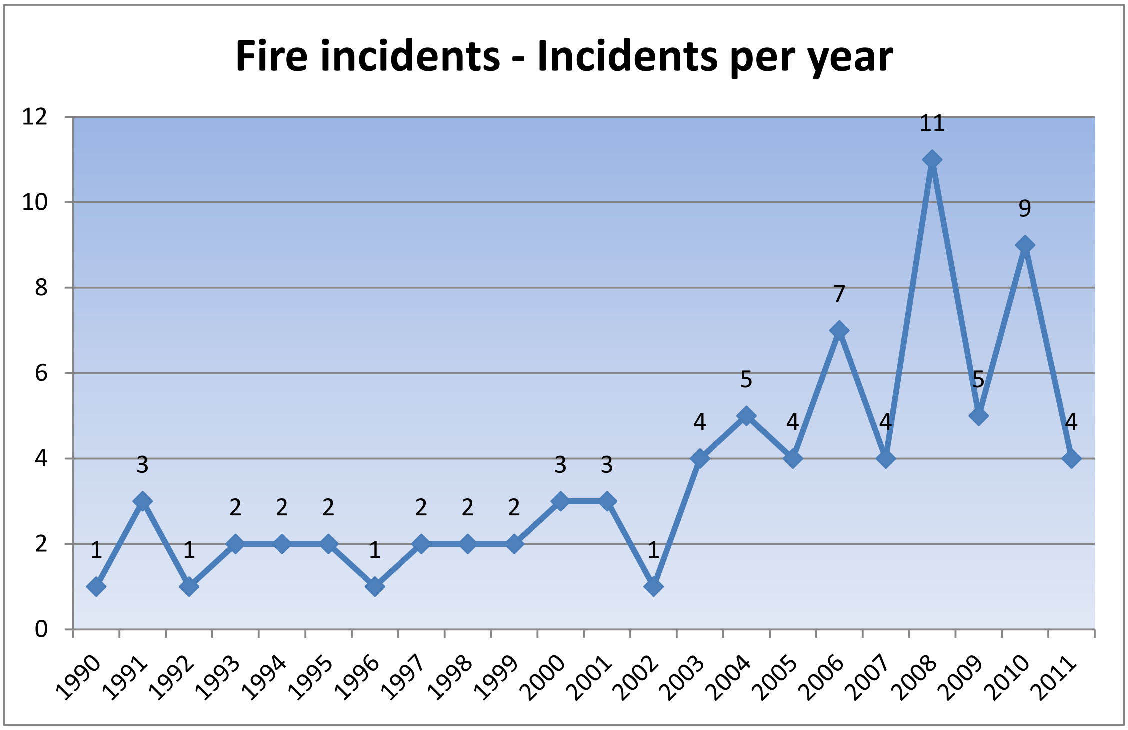
In 4 cases, 372 containers were damaged because of the fire.

Injuries and fatalities

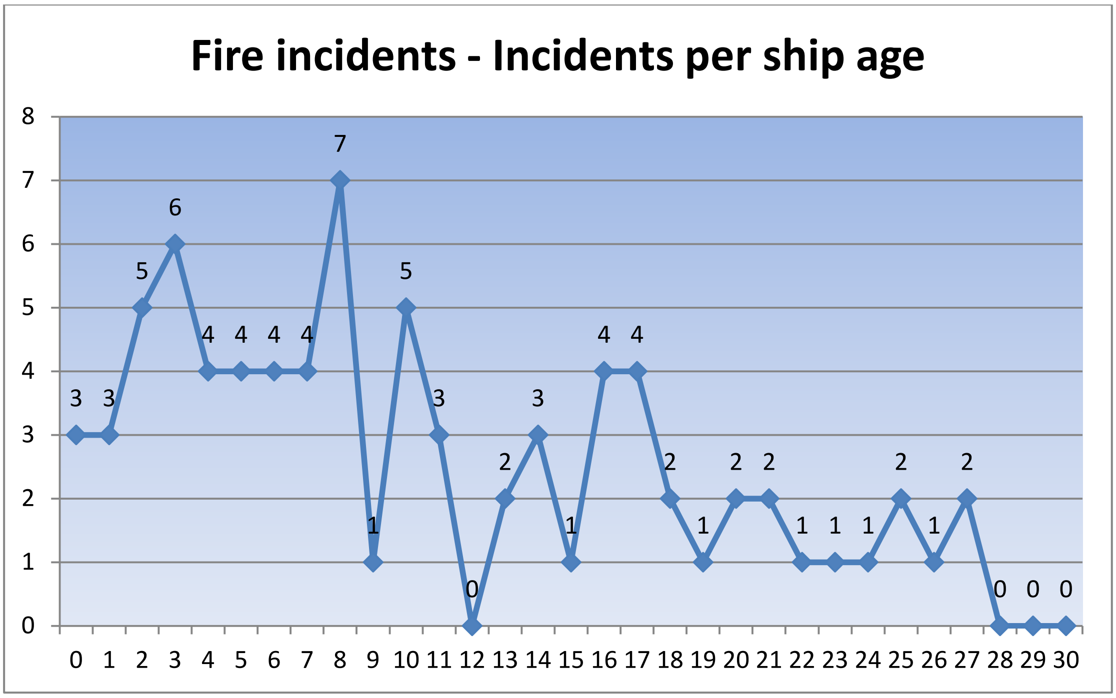
6 accidents occurred with either fatalities or injuries:

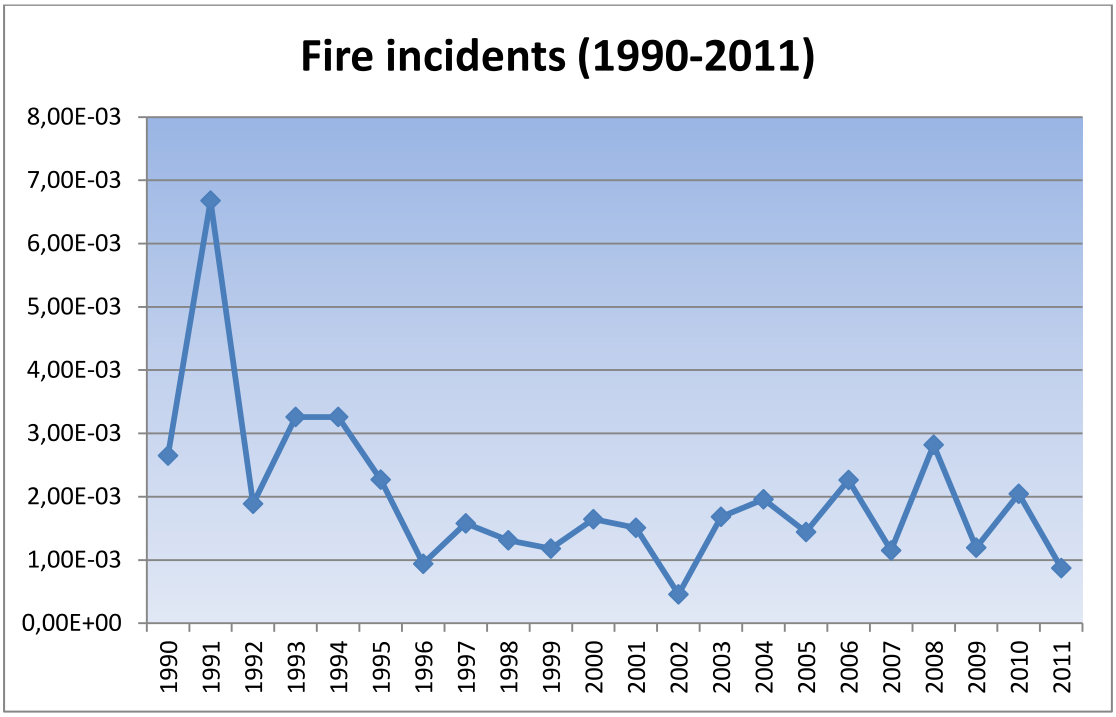
4.4.3 Frequencies of fire incidents





A slightly greater number of fire incidents took place after 2008. Nevertheless, the fleet at risk was increased at that time.





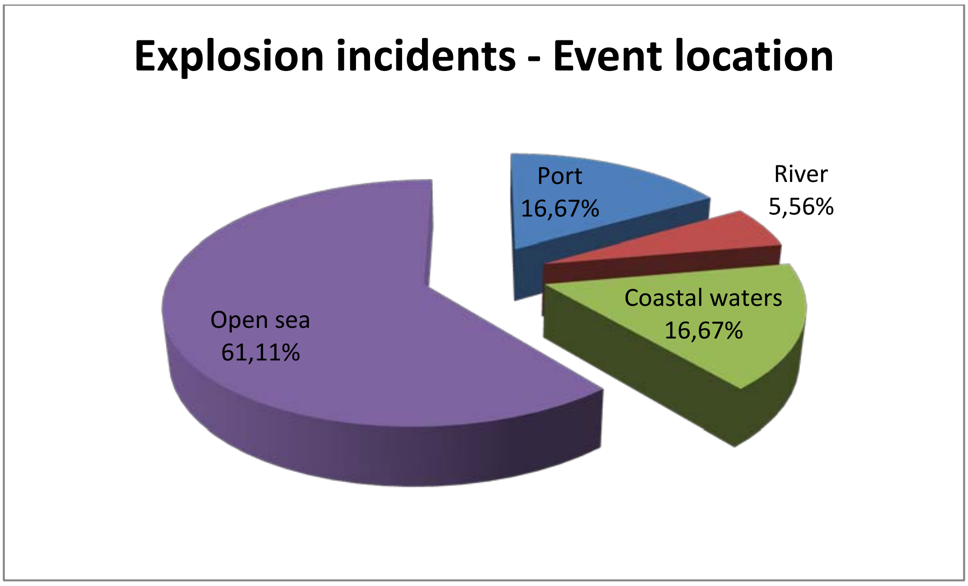
Fire incidents demonstrate a graduated decrease over the years. This is thanks to the new regulations and all the precaution and safety measures against fire on board, such as the stricter controls over the containers' content.

4.5 Explosion incidents

4.5.1 Conditions of explosion incidents

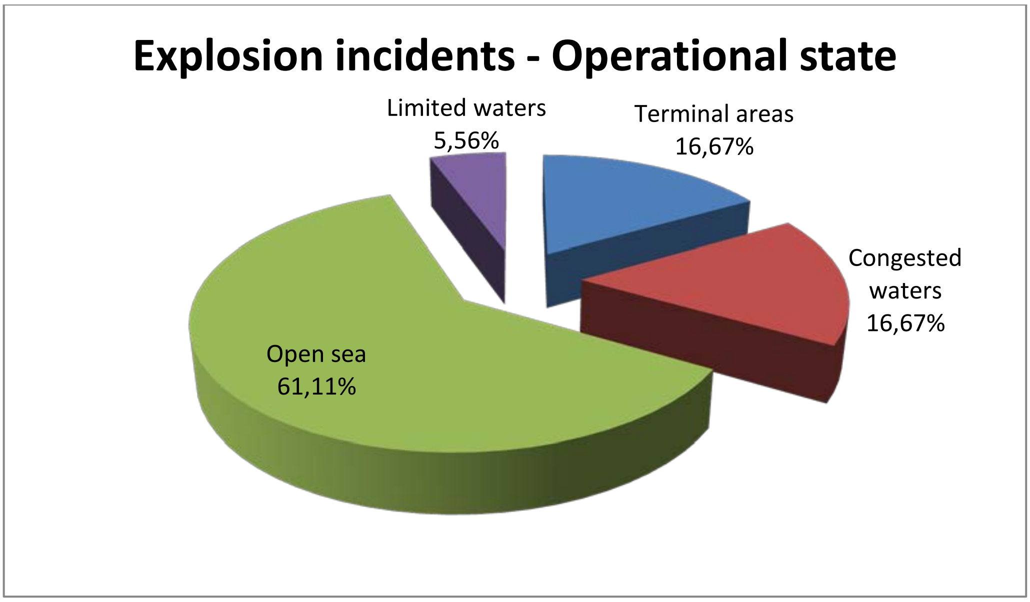
Event location

Event location	Number	Percentage
Port	3	16,67%
River	1	5,56%
Coastal waters	3	16,67%
Open sea	11	61,11%
Total	18	100,00%



Operational state

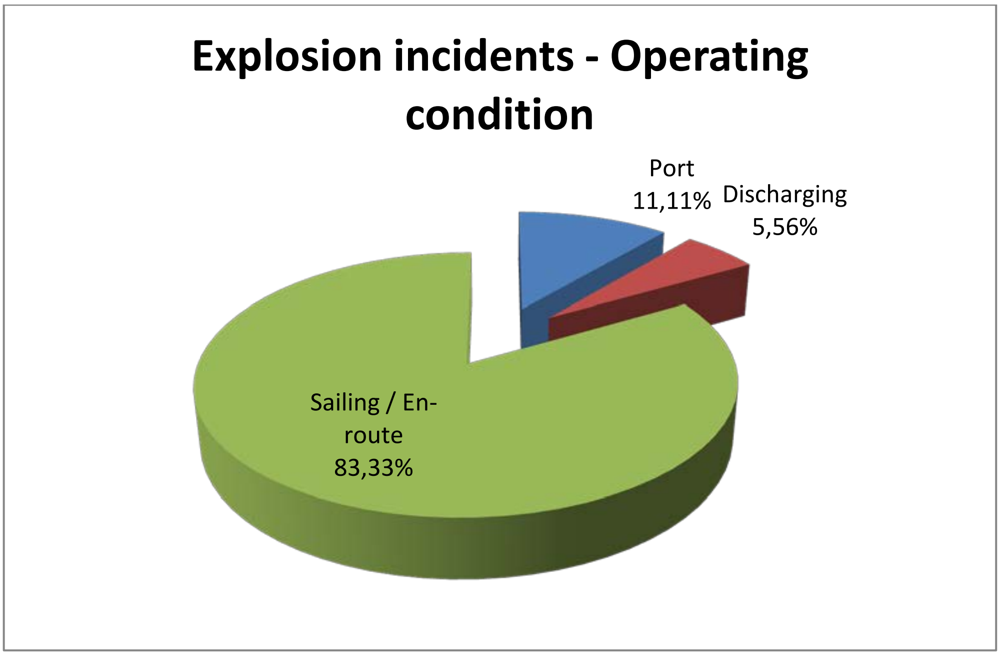
Operational state	Number	Percentage
Terminal areas	3	16,67%
Congested waters	3	16,67%
Open sea	11	61,11%
Limited waters	1	5,56%
Total	18	100,00%



Like the fire incidents, the majority of the explosion incidents happen in open sea where the machinery equipment is in operation and TEUs are exposed to the prevailing environmental conditions.

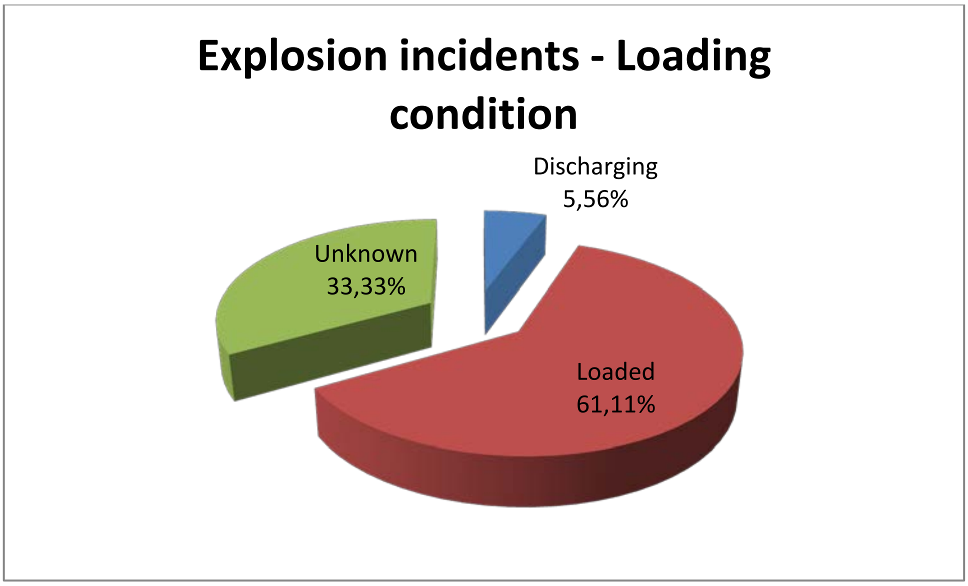
<u>Operating condition</u>

Operating condition	Number	Percentage
Port	2	11,11%
Discharging	1	5,56%
Sailing / En-route	15	83,33%
Total	18	100,00%

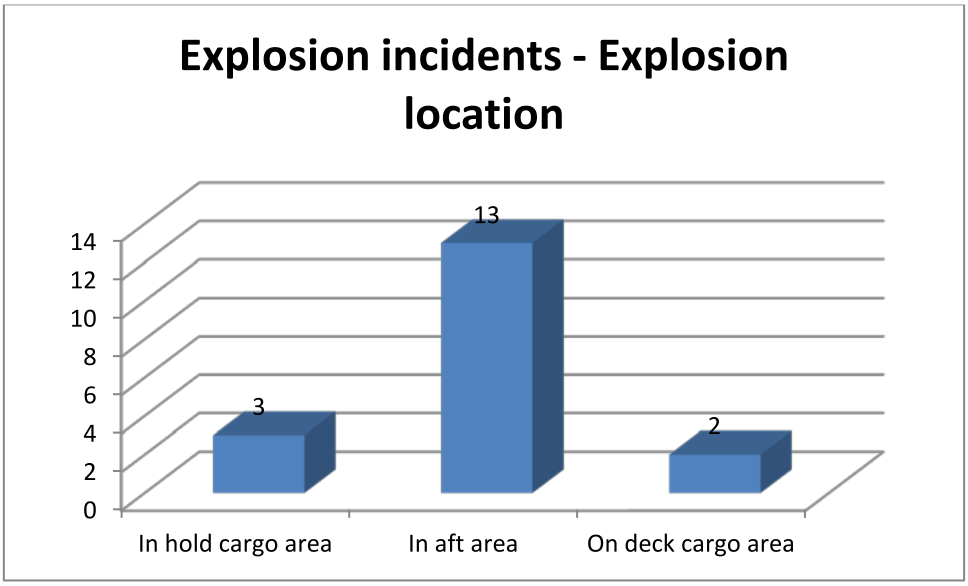


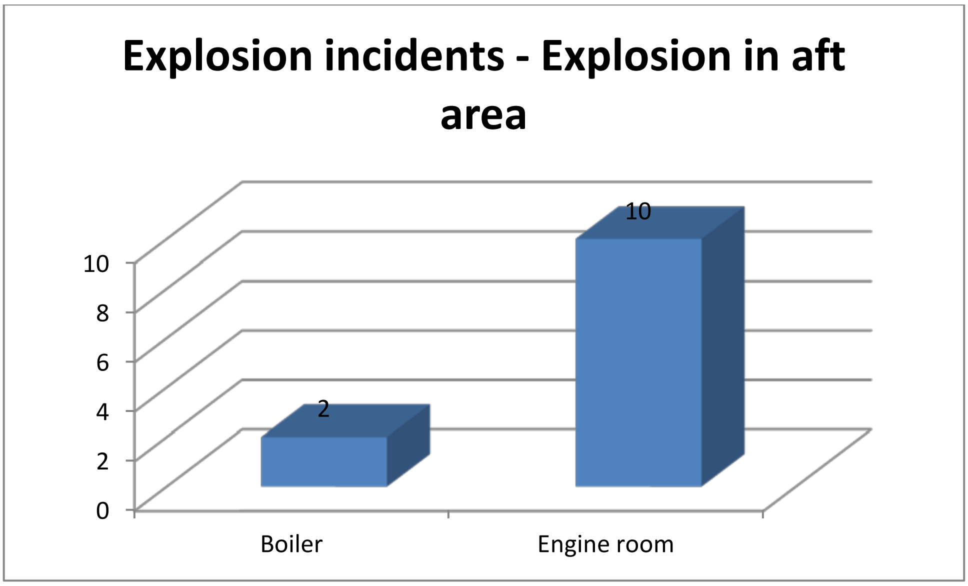
Loading condition

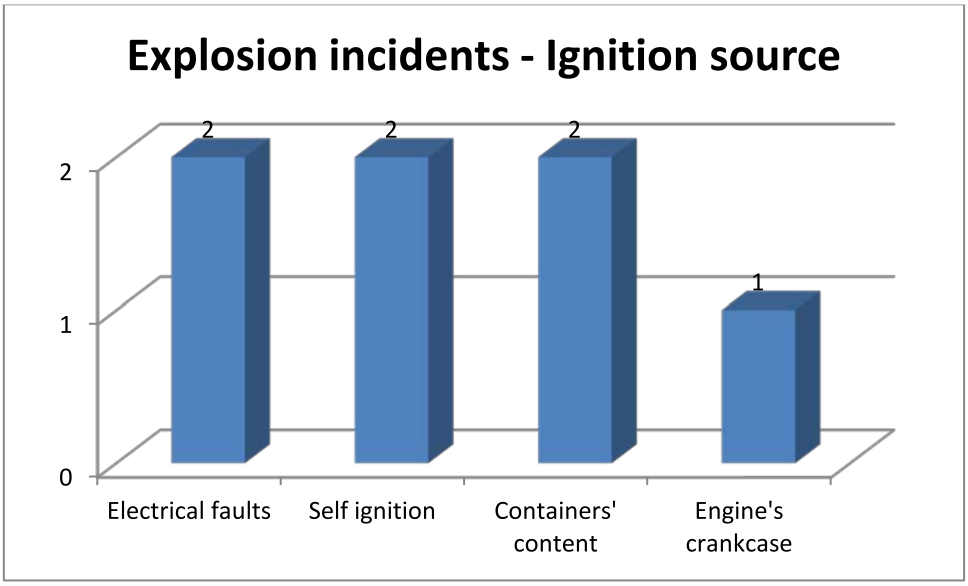
Loading condition	Number	Percentage
Discharging	1	5,56%
Loaded	11	61,11%
Unknown	6	33,33%
Total	18	100,00%



Explosion type



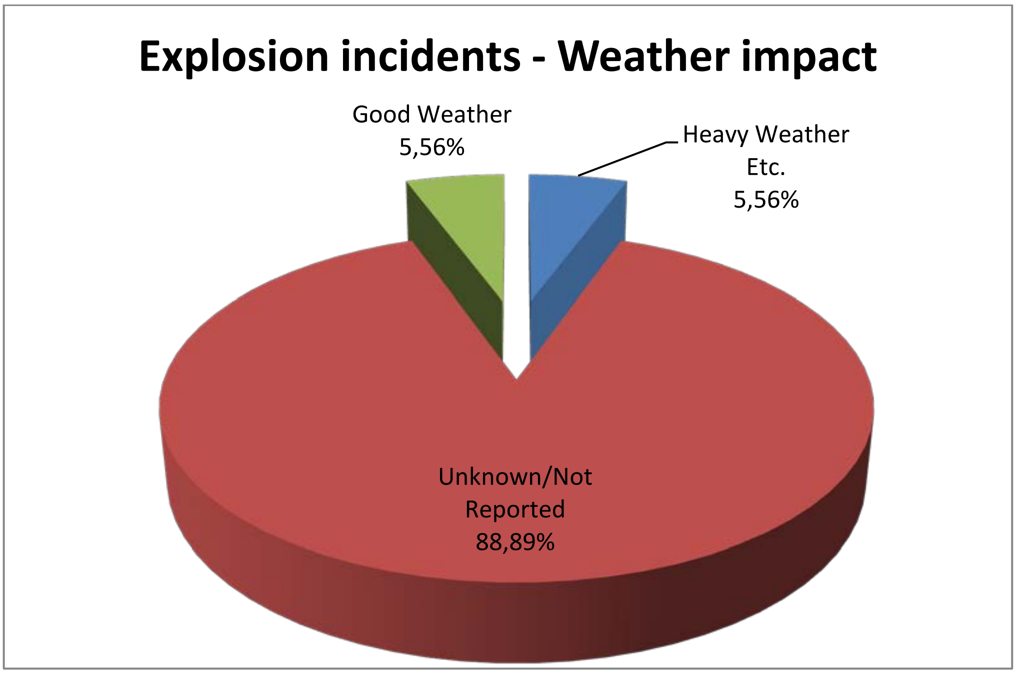




It is obvious that the majority of explosions on containerships begin in the engine room or machinery spaces. The cargo area composes the second most dangerous area for the start of the fire. Unlike the fire incidents, in half of the cases the explosion was followed by fire.

Weather impact

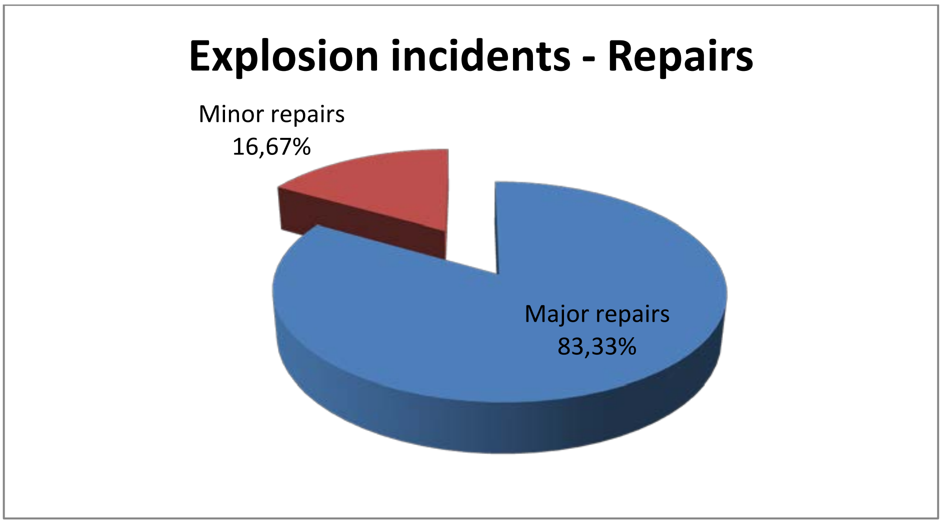
Weather impact	Number	Percentage
Heavy Weather Etc.	1	5,56%
Unknown/Not Reported	16	88,89%
Good Weather	1	5,56%
Total	18	100,00%



4.5.2 Consequences of explosion incidents

Repairs

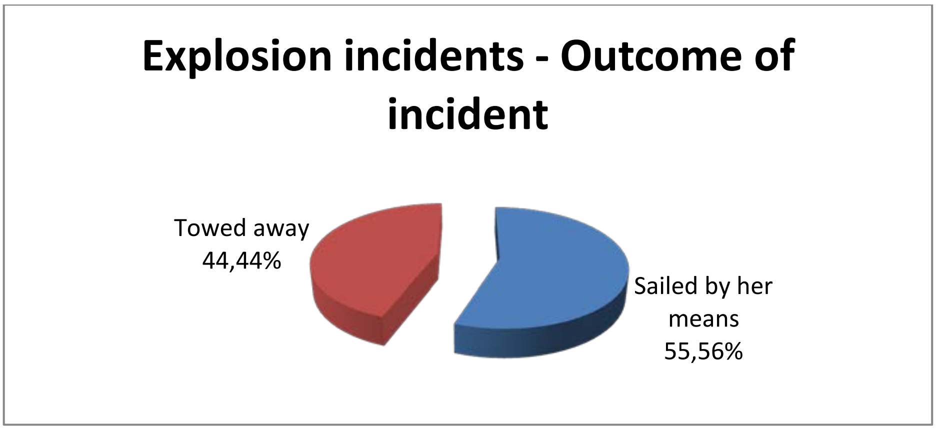
Repairs	Number	Percentage
Major repairs	15	83,33%
Minor repairs	3	16,67%
Total	18	100,00%



The percentage of the ships that needed major repairs after the accident is very high. Hence, we understand the impact of explosions on the containership.

Outcome

Outcome	Number	Percentage
Sailed by her means	10	55,56%
Towed away	8	44,44%
Total	18	100,00%



Loss of watertight integrity

LOWI	Number	Percentage
Yes	0	0,00%
No	18	100,00%
Total	18	100,00%

Release of oil

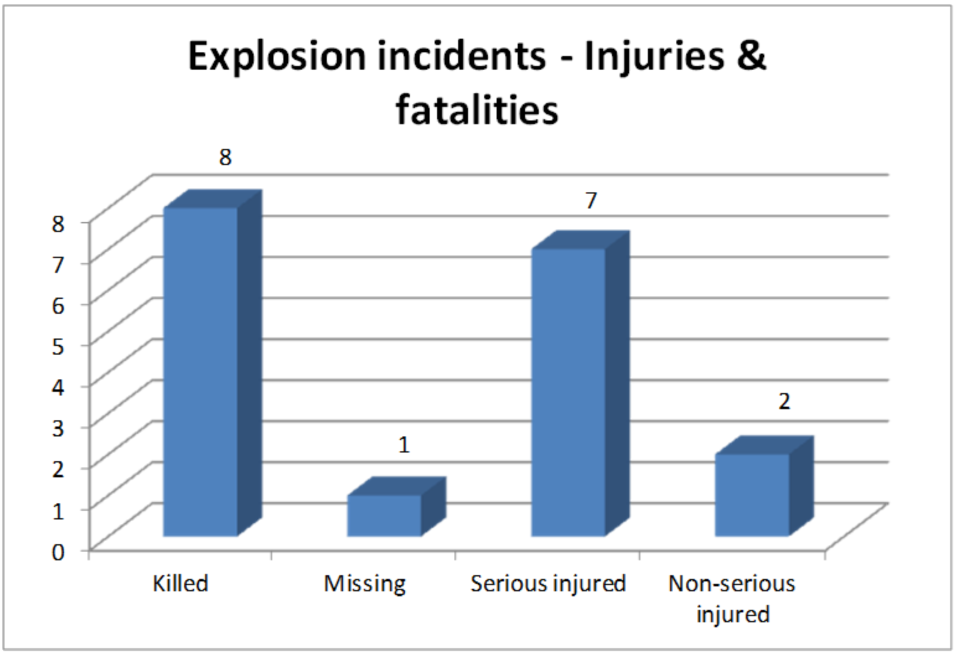
Release of oil	Number	Percentage
Yes	0	0,00%
No	18	100,00%
Total	18	100,00%

Release of hazardous / polluting cargo

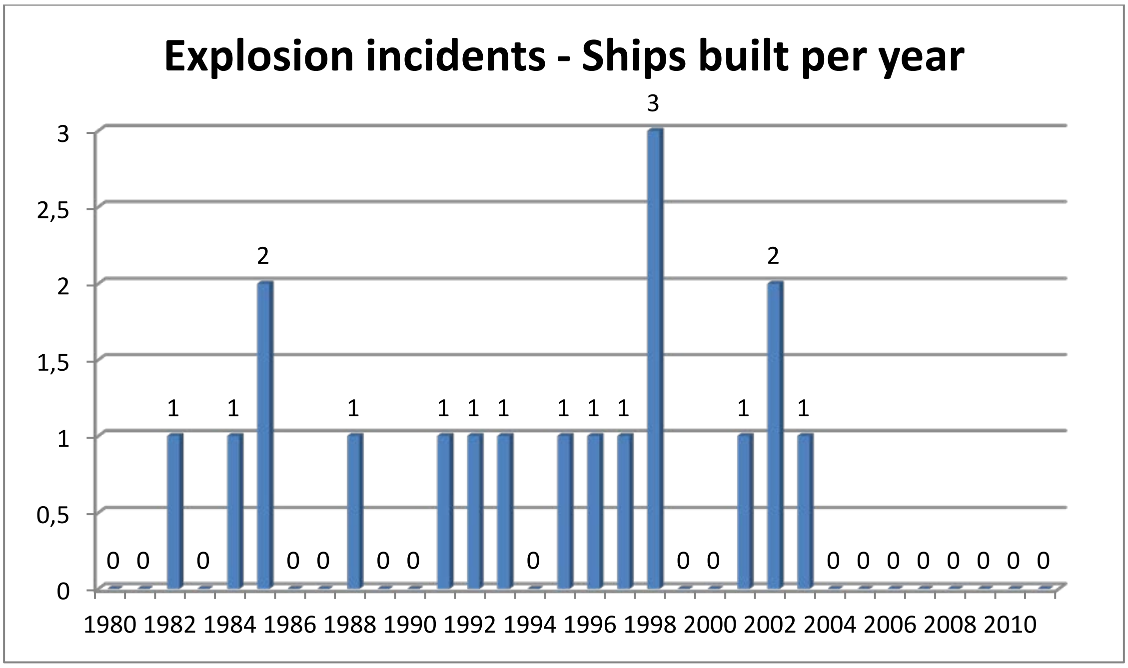
Release of hazardous / polluting cargo	Number	Percentage
Yes	1	5,56%
No	17	94,44%
Total	18	100,00%

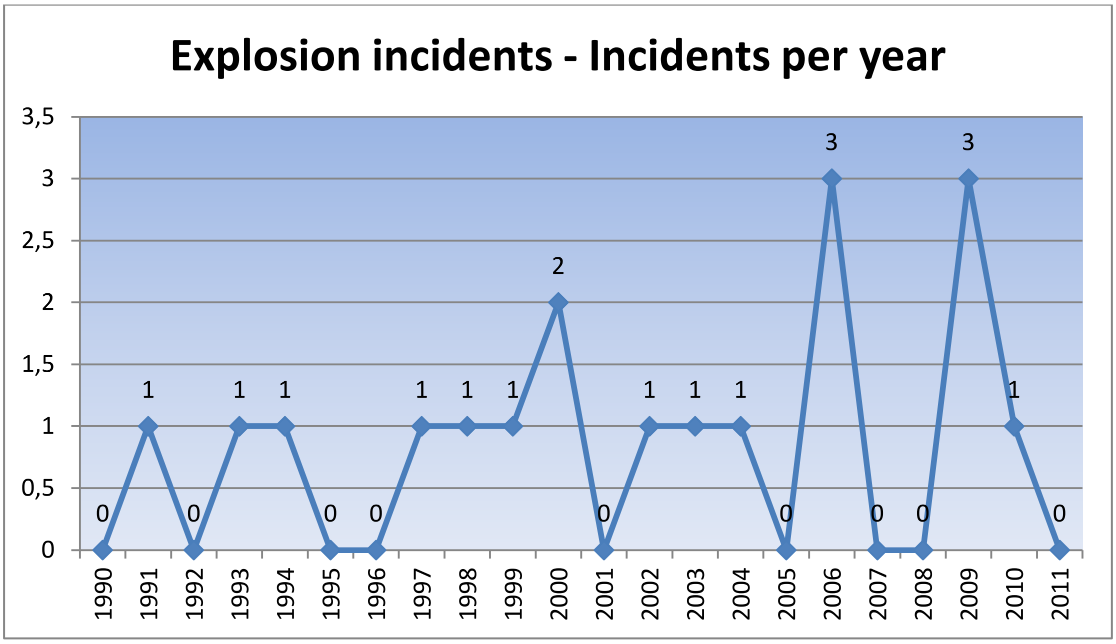
Injuries and fatalities

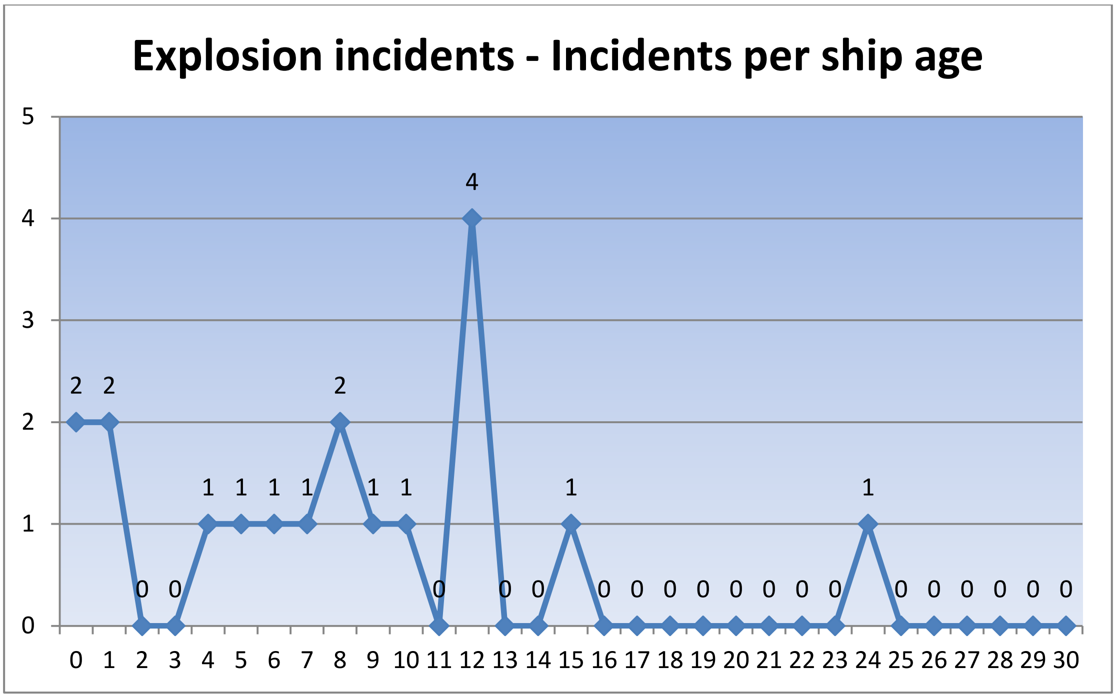
9 accidents happened with either injuries or fatalities. The persons killed due to explosion events (totally 18 cases) are more than the number of fatalities because of fire events (totally 78 cases). It is obvious that explosion incidents have a major impact on the human factor.

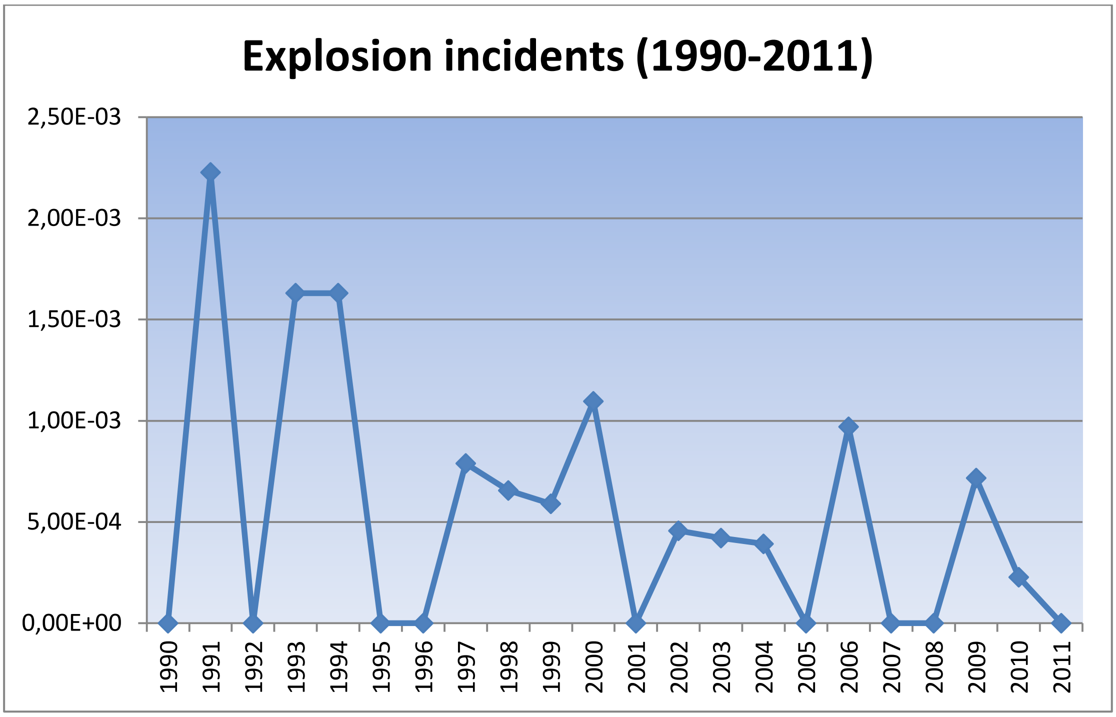


4.5.3 Frequencies of fire incidents









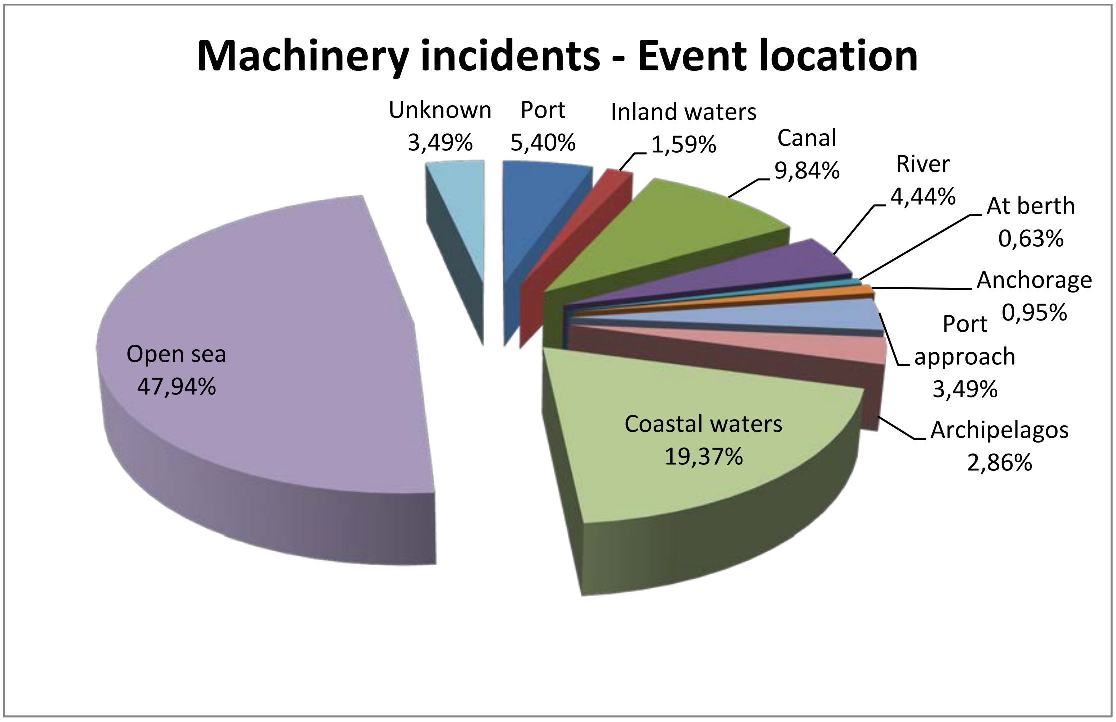
Explosion incidents, like fire incidents, demonstrate a decreasing tendency over the years. This is thanks to the new regulations and all the precaution and safety measures against explosion on board, such as the stricter controls over the containers' content.

4.6 Machinery failure incidents

4.6.1 Conditions of machinery incidents

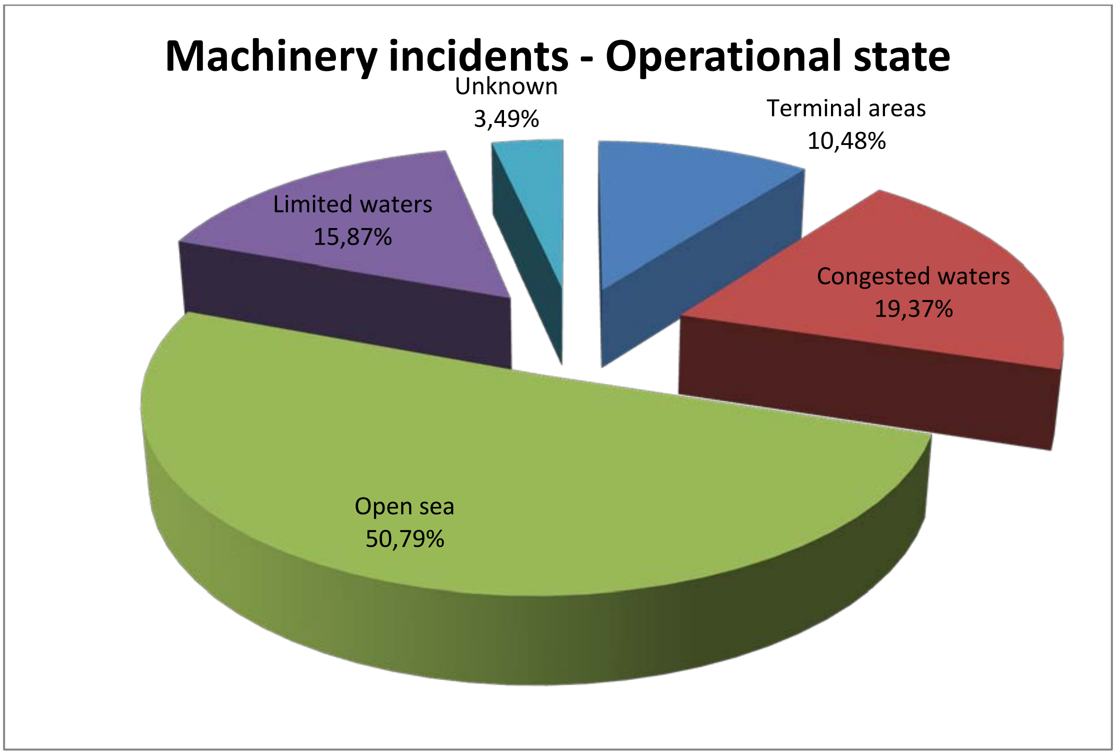
Event location

Event location	Number	Percentage
Port	17	5,40%
Inland waters	5	1,59%
Canal	31	9,84%
River	14	4,44%
At berth	2	0,63%
Anchorage	3	0,95%
Port approach	11	3,49%
Archipelagos	9	2,86%
Coastal waters	61	19,37%
Open sea	151	47,94%
Unknown	11	3,49%
Total	315	100,00%



Operational state

Operational state	Number	Percentage
Terminal areas	33	10,48%
Congested waters	61	19,37%
Open sea	160	50,79%
Limited waters	50	15,87%
Unknown	11	3,49%
Total	315	100,00%



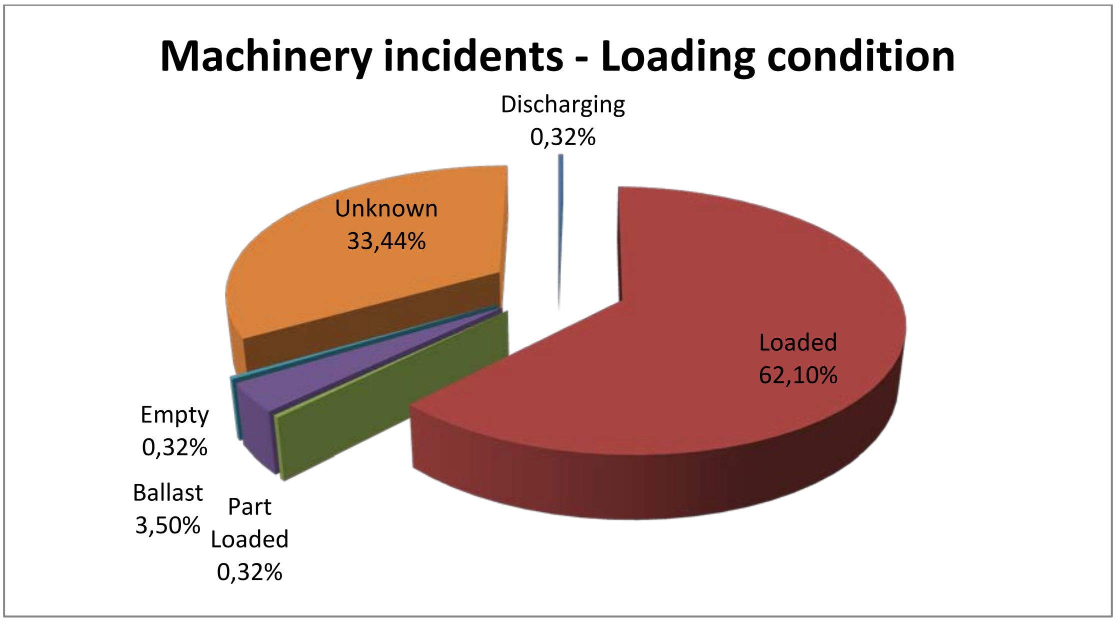
Operating condition

Operating condition	Number	Percentage
Berth	1	0,32%
Port	9	2,86%
Sailing / En-route	299	94,92%
Anchoring	4	1,27%
Unknown	2	0,63%
Total	315	100,00%

The vast majority of the machinery failure incidents occur in open sea where the ship is en route and all the machinery equipment is in operation.

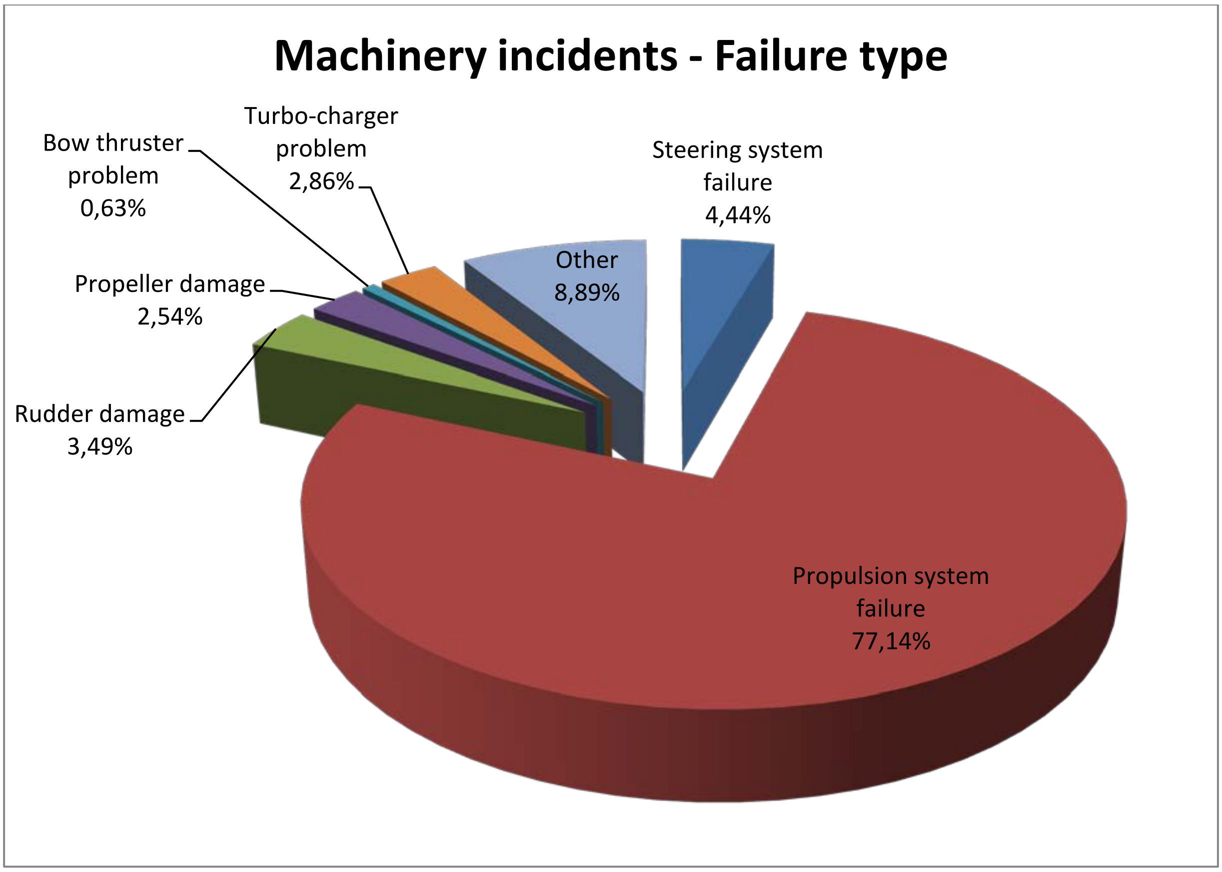
Loading condition

Loading condition	Number	Percentage
Discharging	1	0,32%
Loaded	195	61,90%
Part Loaded	1	0,32%
Ballast	11	3,49%
Empty	1	0,32%
Unknown	106	33,65%
Total	315	100,00%



Machinery failure type

Machinery failure type	Number	Percentage
Steering system failure	14	4,44%
Propulsion system failure	243	77,14%
Rudder damage	11	3,49%
Propeller damage	8	2,54%
Bow thruster problem	2	0,63%
Turbo-charger problem	9	2,86%
Other	28	8,89%
Total	315	100,00%



It is obvious that the most sensitive part of the machinery equipment is the propulsion system of the ship.

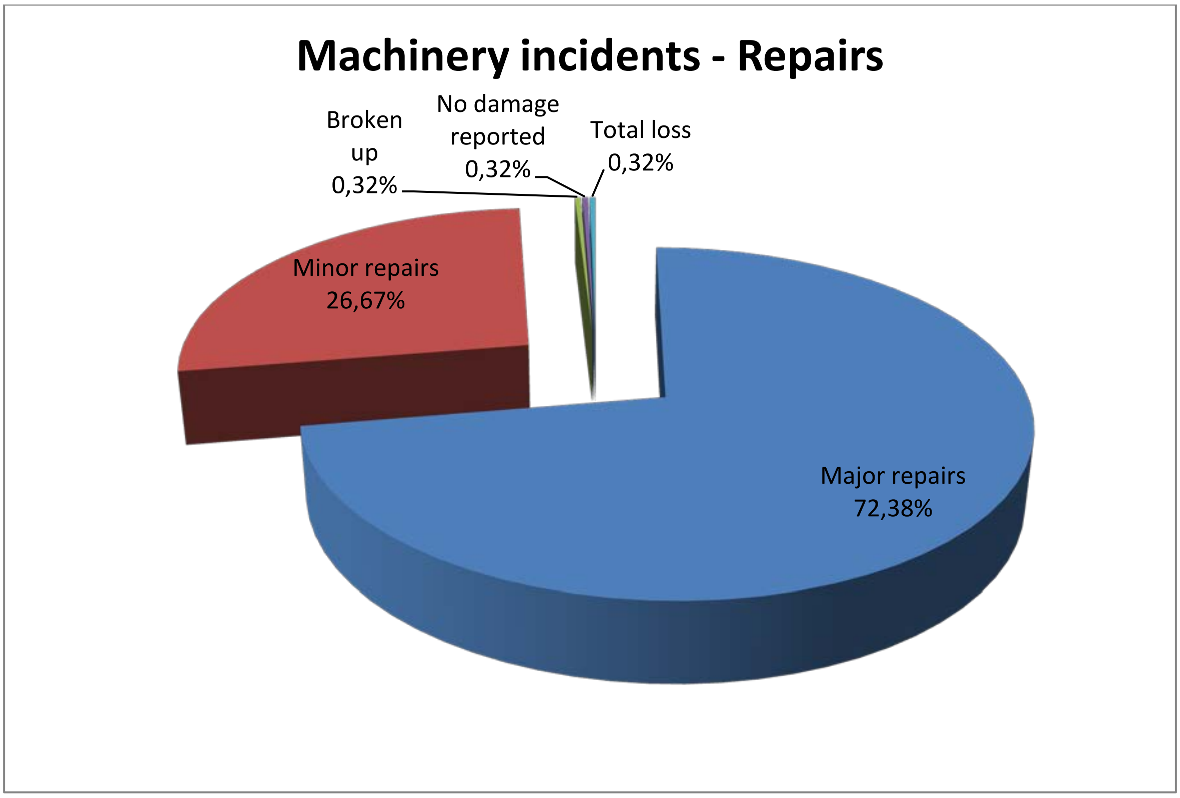
Weather impact

Weather impact	Number	Percentage
Heavy Weather Etc.	17	5,40%
Fog/Mist/Poor Visibility	1	0,32%
Unknown/Not Reported	282	89,52%
Freezing Conditions	2	0,63%
Good Weather	11	3,49%
Hurricane Etc.	2	0,63%
Total	315	100,00%

4.6.2 Consequences of machinery failure incidents

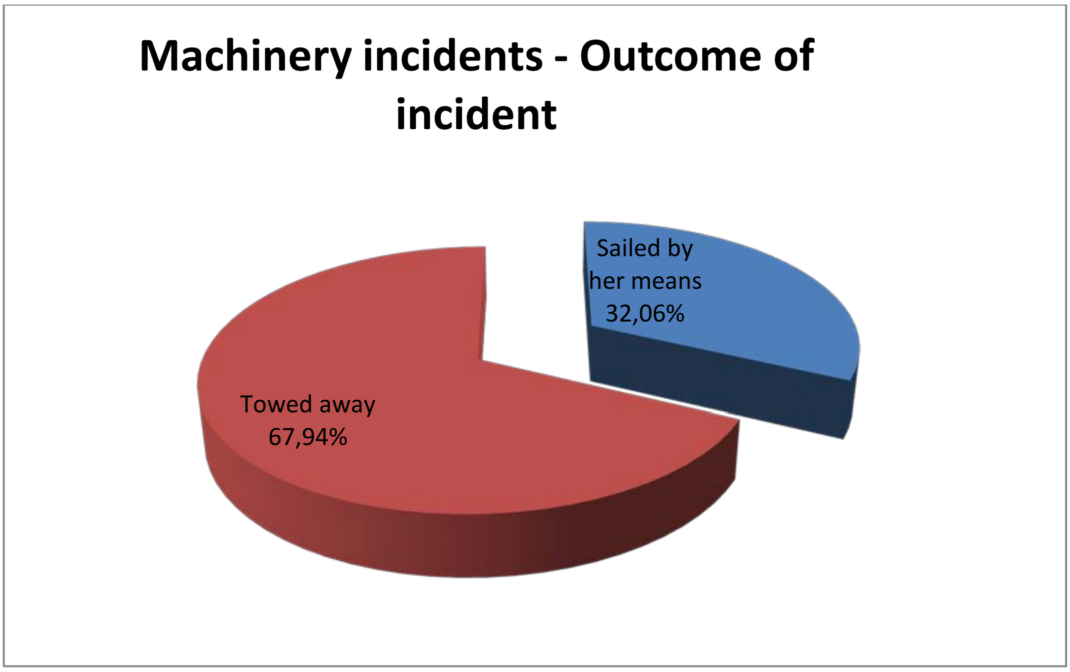
Repairs

Repairs	Number	Percentage
Major repairs	228	72,38%
Minor repairs	84	26,67%
Broken up	1	0,32%
No damage reported	1	0,32%
Total loss	1	0,32%
Total	315	100,00%



Outcome

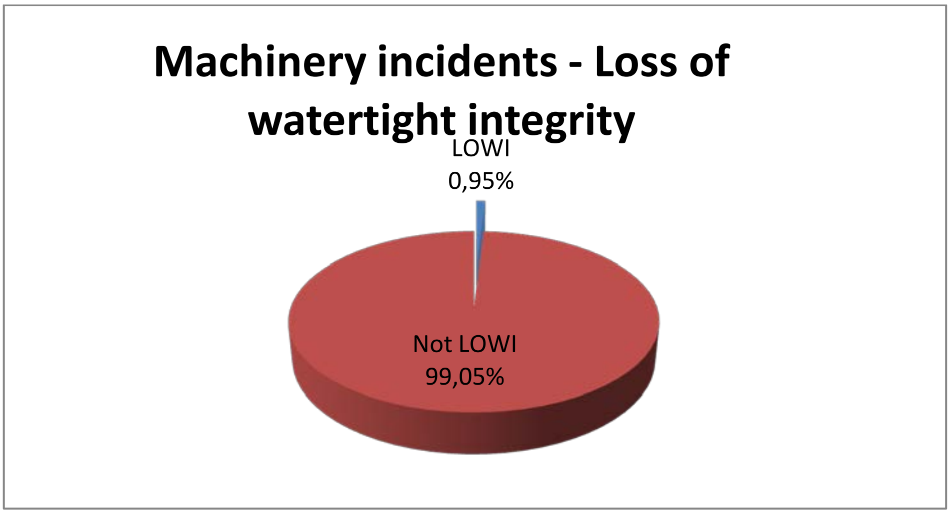
Outcome	Number	Percentage
Sailed by her means	101	32,06%
Towed away	214	67,94%
Total	315	100,00%



The percentage of the ships that required assistance after the accident is very high (the highest of every incident category). This is something we wait because almost all events are related to the propulsion system of the containership.

Loss of watertight integrity

LOWI	Number	Percentage
Yes	3	0,95%
No	312	99,05%
Total	315	100,00%



Release of oil

Release of oil	Number	Percentage
Yes	0	0,00%
No	315	100,00%
Total	315	100,00%

Release of hazardous / polluting cargo

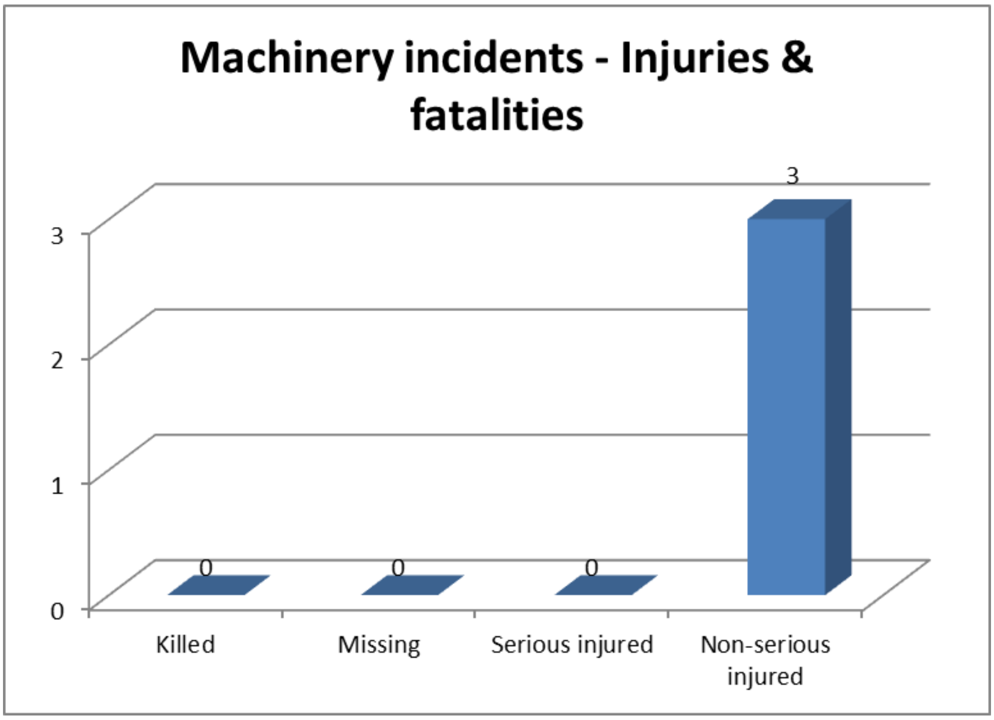
Release of hazardous / polluting cargo	Number	Percentage
Yes	0	0,00%
No	315	100,00%
Total	315	100,00%

Loss of cargo

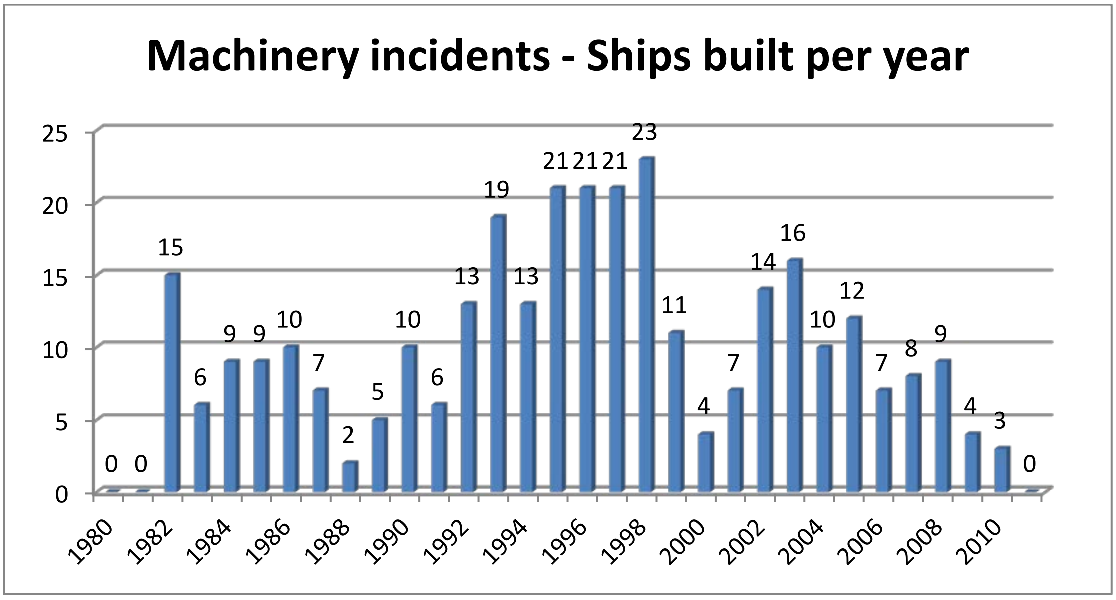
In 1 case, 110 containers were lost because ship remained without power in heavy weather conditions.

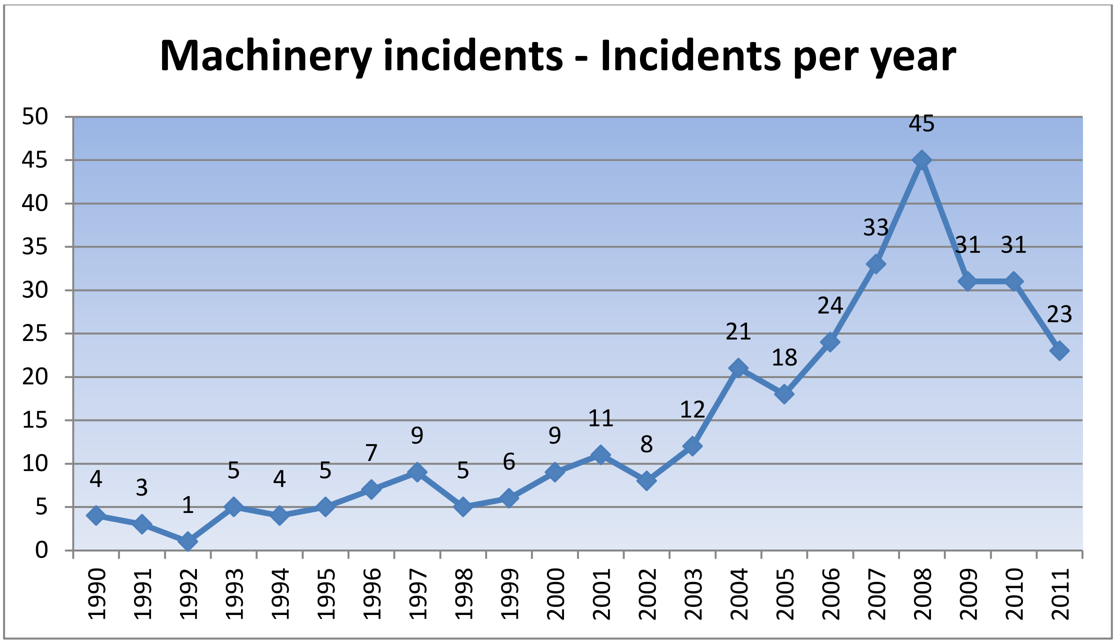
Injuries and fatalities

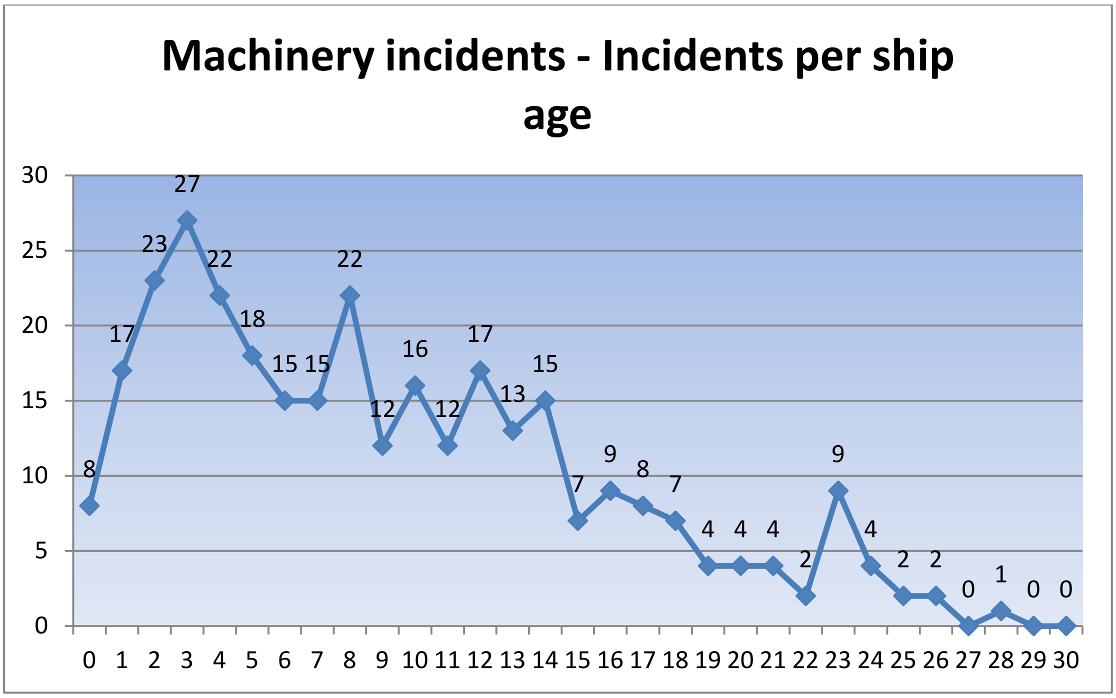
1 accident with injuries was recorded within the studied period.

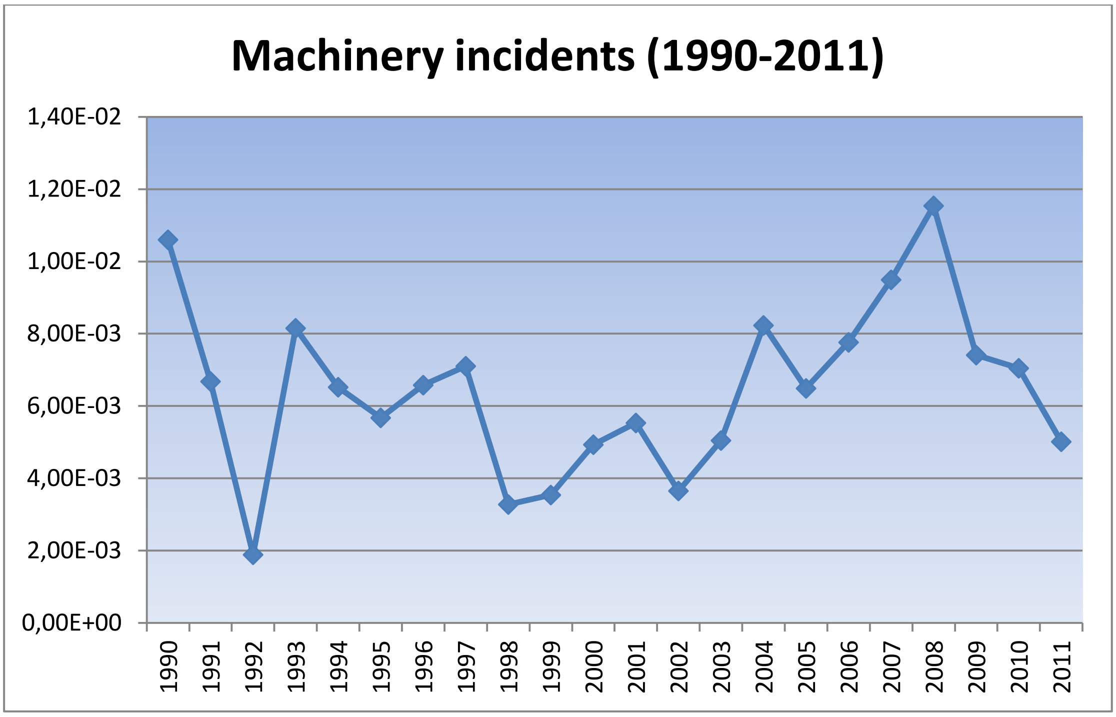


4.6.3 Frequencies of machinery failure incidents






Machinery incidents - Incidents per ship age
30
25
20
15
10
5
0
8 17 23 27 22 18 15 15 22 12 16 12 17 13 15 7 9 8 7 4 4 4 2 9 4 2 2 0 1 0 0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30

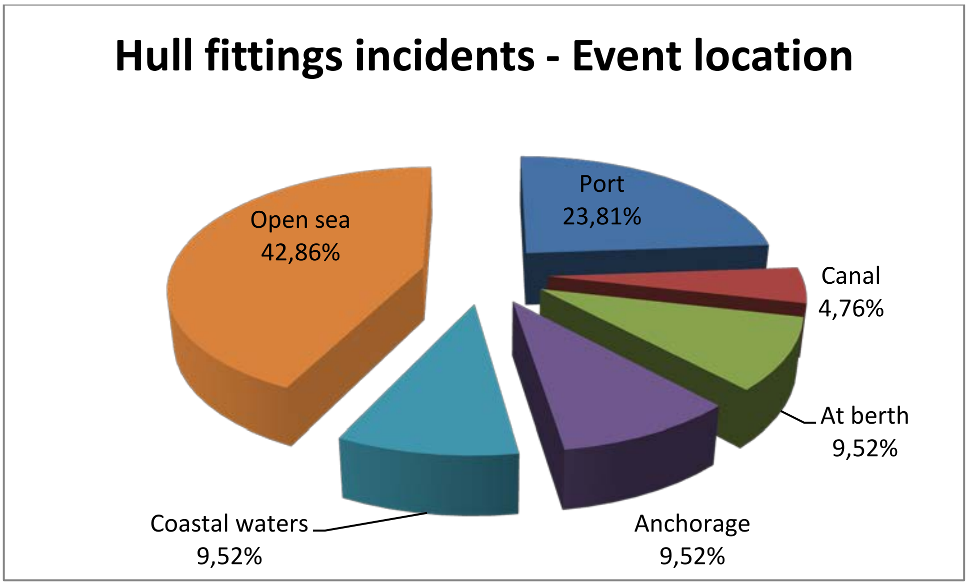

Machinery incidents (1990-2011)
1,40E-02
1,20E-02
1,00E-02
8,00E-03
6,00E-03
4,00E-03
2,00E-03
0,00E+00
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

4.7 Hull fittings failure incidents

4.7.1 Conditions of hull fittings incidents

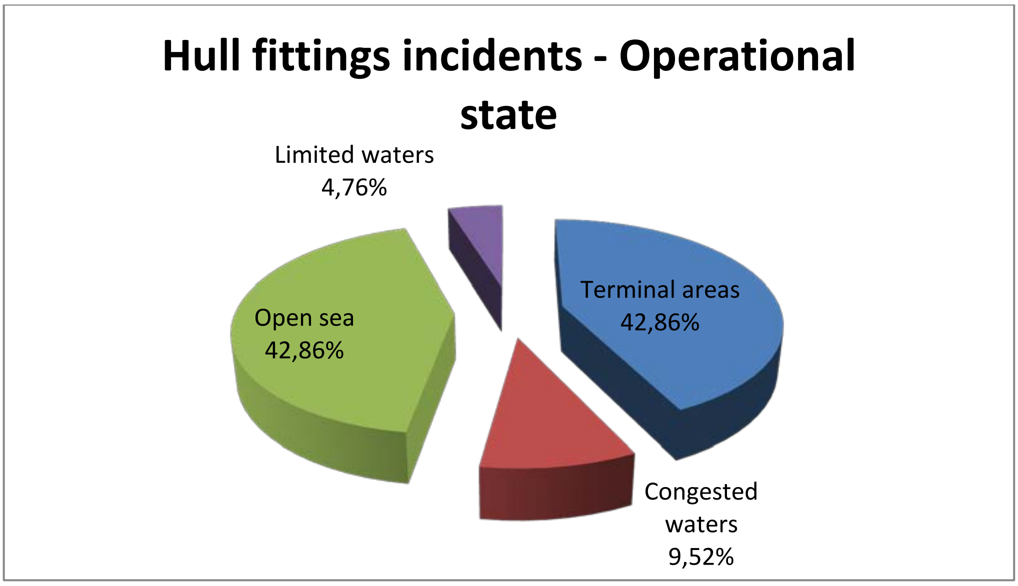
Event location

Event location	Number	Percentage
Port	5	23,81%
Canal	1	4,76%
At berth	2	9,52%
Anchorage	2	9,52%
Coastal waters	2	9,52%
Open sea	9	42,86%
Total	21	100,00%



Operational state

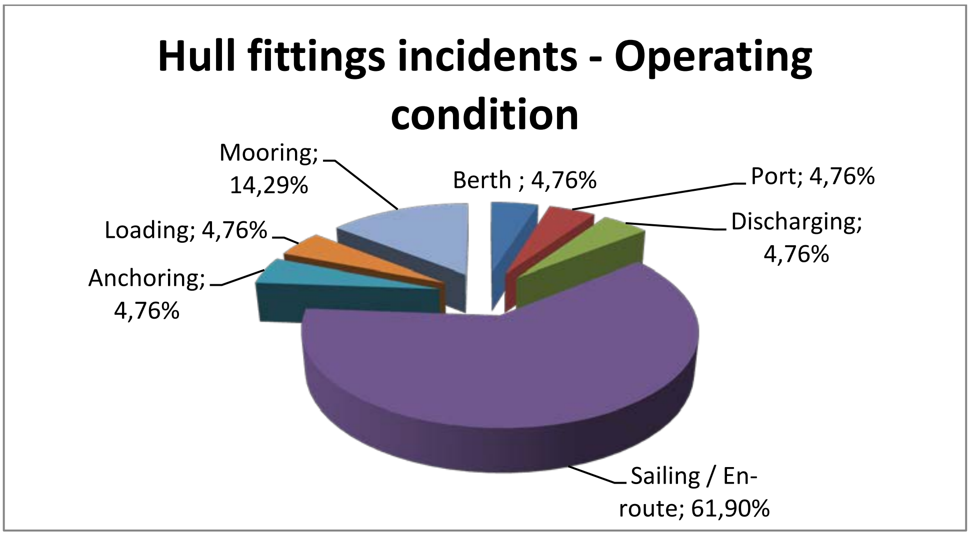
Operational state	Number	Percentage
Terminal areas	9	42,86%
Congested waters	2	9,52%
Open sea	9	42,86%
Limited waters	1	4,76%
Total	21	100,00%



Most events take place either in open sea under the prevailing weather conditions or in terminals during loading and unloading procedures.

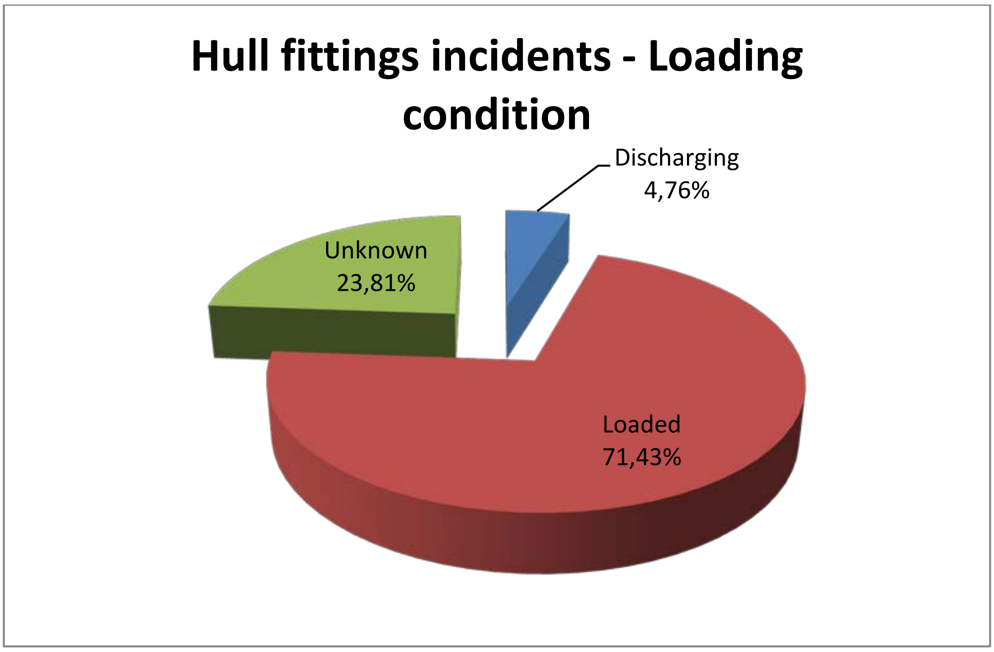
<u>Operating condition</u>

Operating condition	Number	Percentage
Berth	1	4,76%
Port	1	4,76%
Discharging	1	4,76%
Sailing / En-route	13	61,90%
Anchoring	1	4,76%
Loading	1	4,76%
Mooring	3	14,29%
Total	21	100,00%



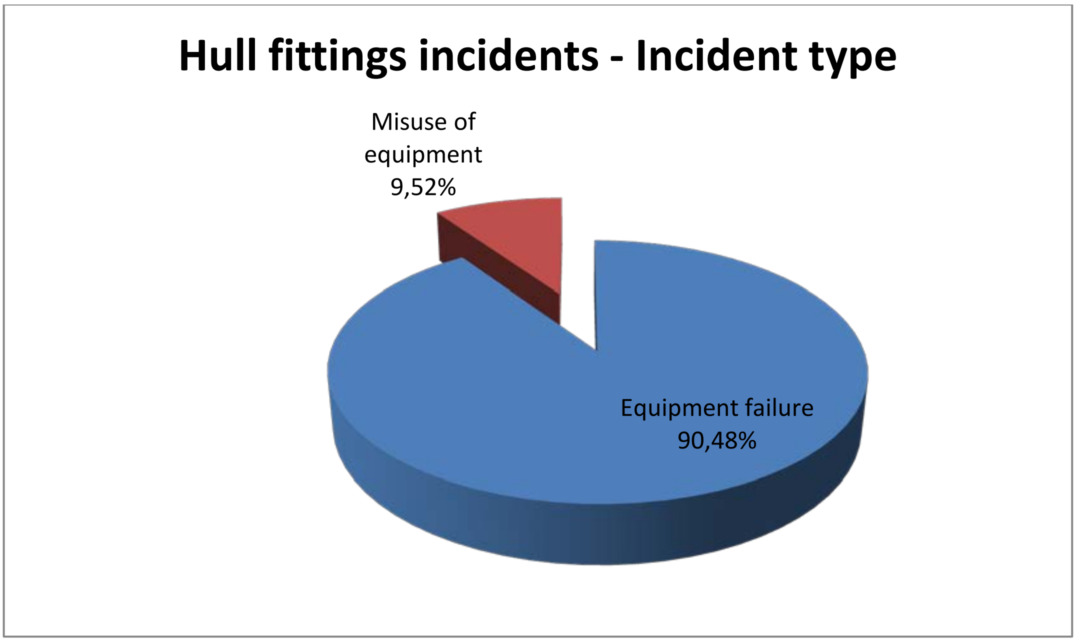
Loading condition

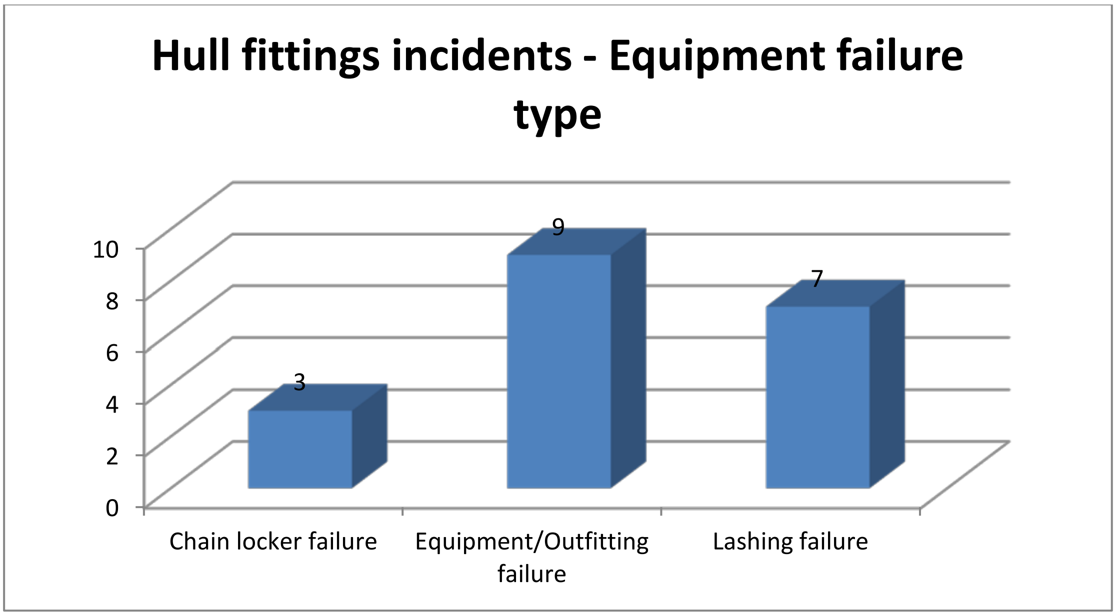
Loading condition	Number	Percentage
Discharging	1	4,76%
Loaded	15	71,43%
Unknown	5	23,81%
Total	21	100,00%

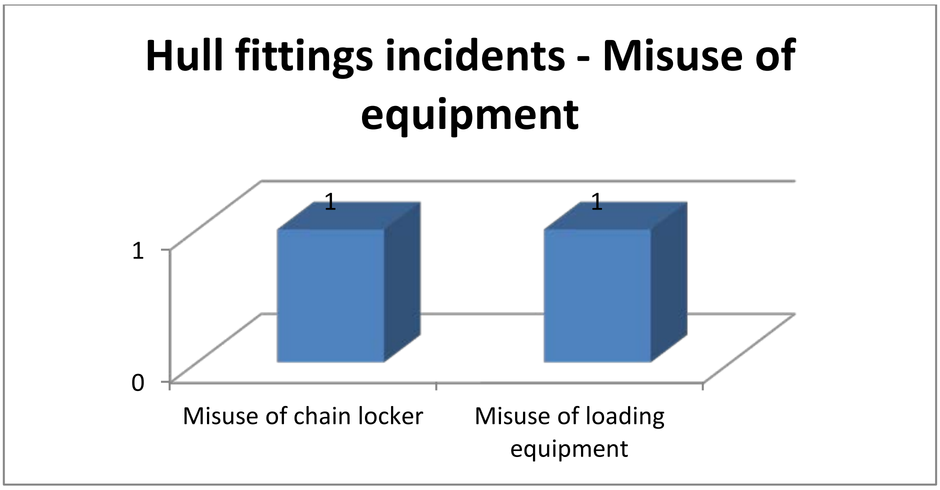


Hull fittings failure type

Machinery failure type	Number	Percentage
Equipment failure	19	90,48%
Misuse of equipment	2	9,52%
Total	21	100,00%

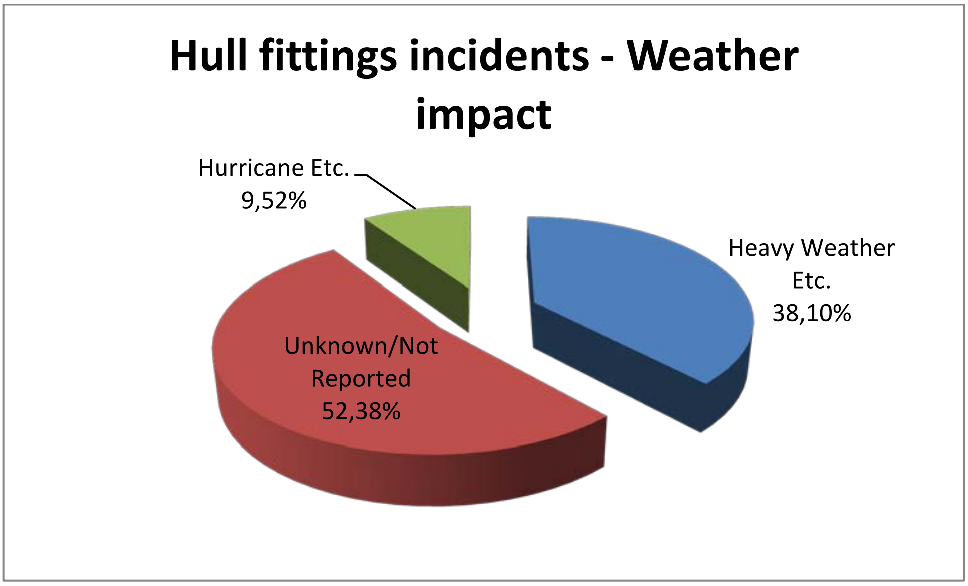

Hull fittings incidents - Incident type
Misuse of equipment 9,52%
Equipment failure 90,48%


Hull fittings incidents - Equipment failure type
10
8
6
4
2
0
3
9
7
Chain locker failure
Equipment/Outfitting failure
Lashing failure



Weather impact

Weather impact	Number	Percentage
Heavy Weather Etc.	8	38,10%
Unknown/Not Reported	11	52,38%
Hurricane Etc.	2	9,52%
Total	21	100,00%

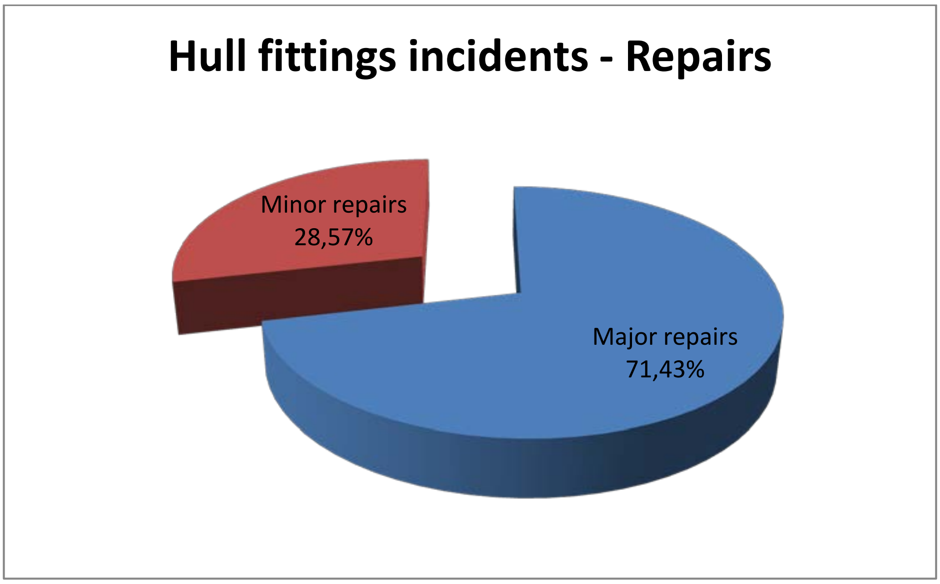


Failure of hull fittings is the category that is most influenced by the prevailing weather conditions. In almost all the cases, where information on the weather impact was available, the accident occurred in heavy weather.

4.7.2 Consequences of hull fittings failure incidents

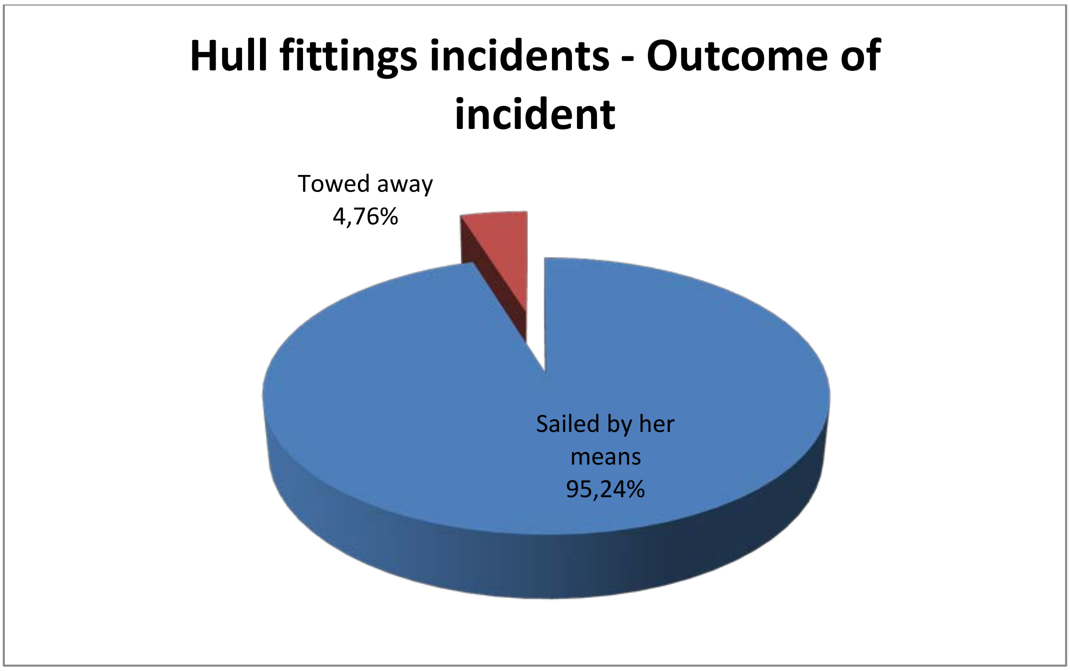
Repairs

Repairs	Number	Percentage
Major repairs	15	71,43%
Minor repairs	6	28,57%
Total	21	100,00%



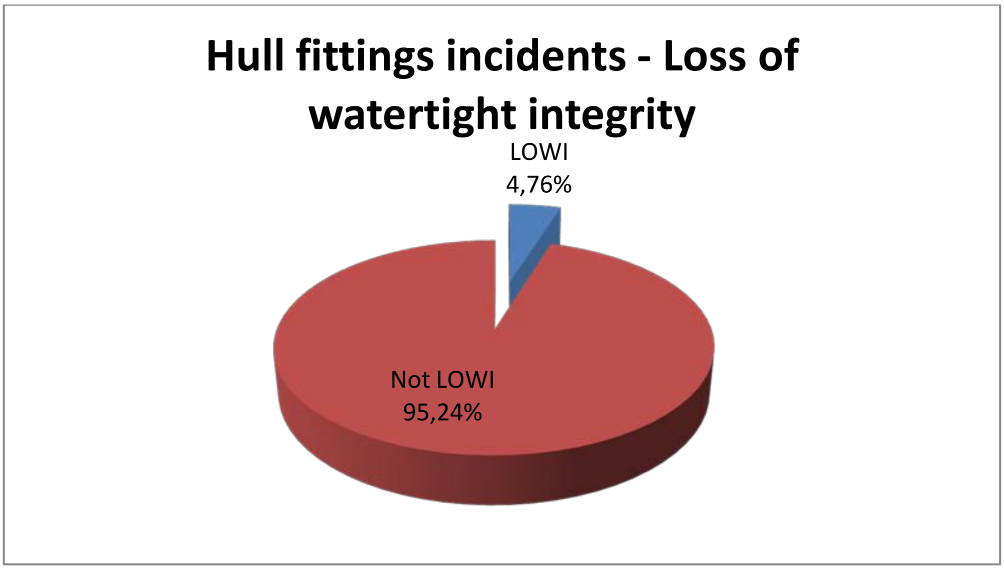
Outcome

Outcome	Number	Percentage
Sailed by her means	20	95,24%
Towed away	1	4,76%
Total	21	100,00%



Loss of watertight integrity

LOWI	Number	Percentage
Yes	1	4,76%
No	20	95,24%
Total	21	100,00%

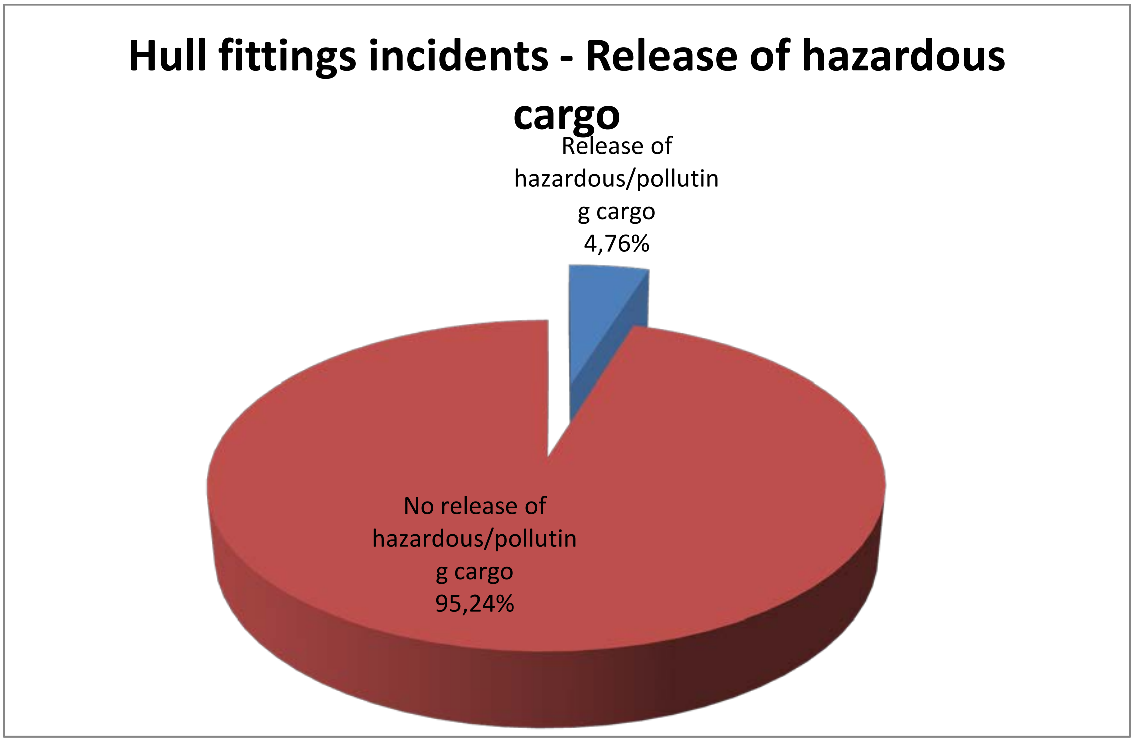


Release of oil

Release of oil	Number	Percentage
Yes	0	0,00%
No	21	100,00%
Total	21	100,00%

Release of hazardous / polluting cargo

Release of hazardous / polluting cargo	Number	Percentage
Yes	1	4,76%
No	20	95,24%
Total	21	100,00%

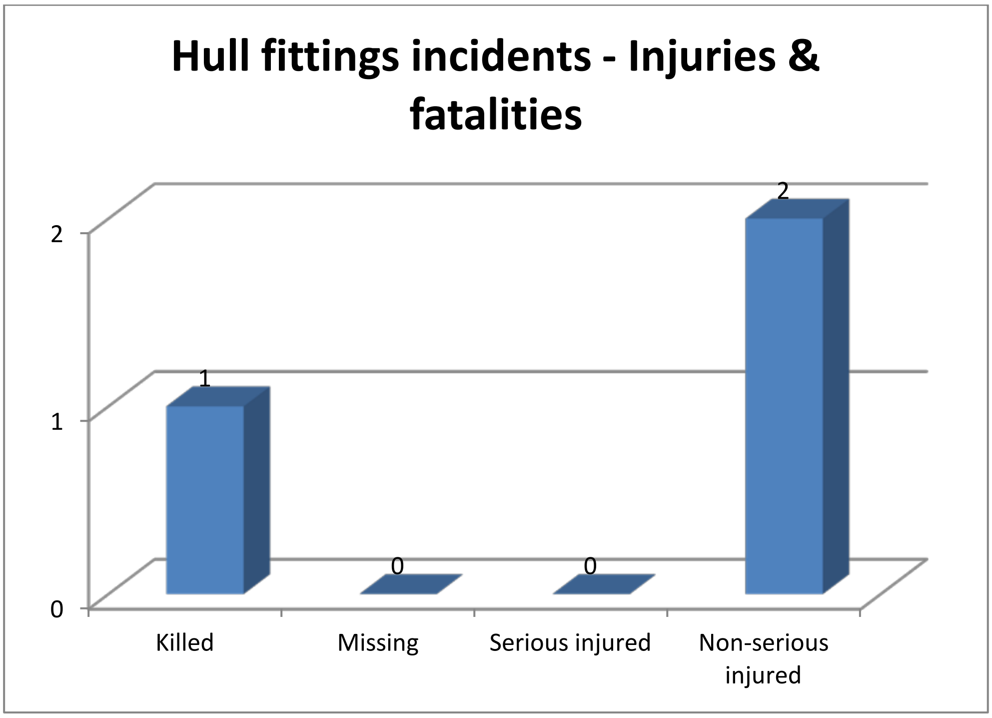


Loss of cargo

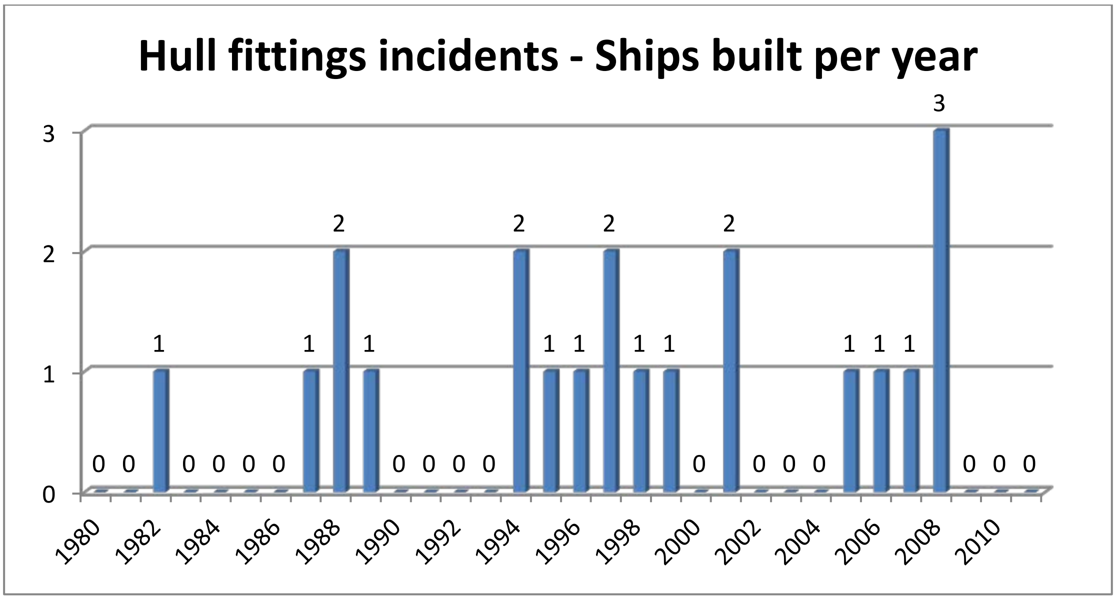
7 incidents were registered where failure of lashing equipment occurred. In all cases the lashing failure was due to extreme weather conditions. Only for 5 accidents the exact amount of containers that were lost overboard is also known. 198 containers were lost due to the lashing failure.

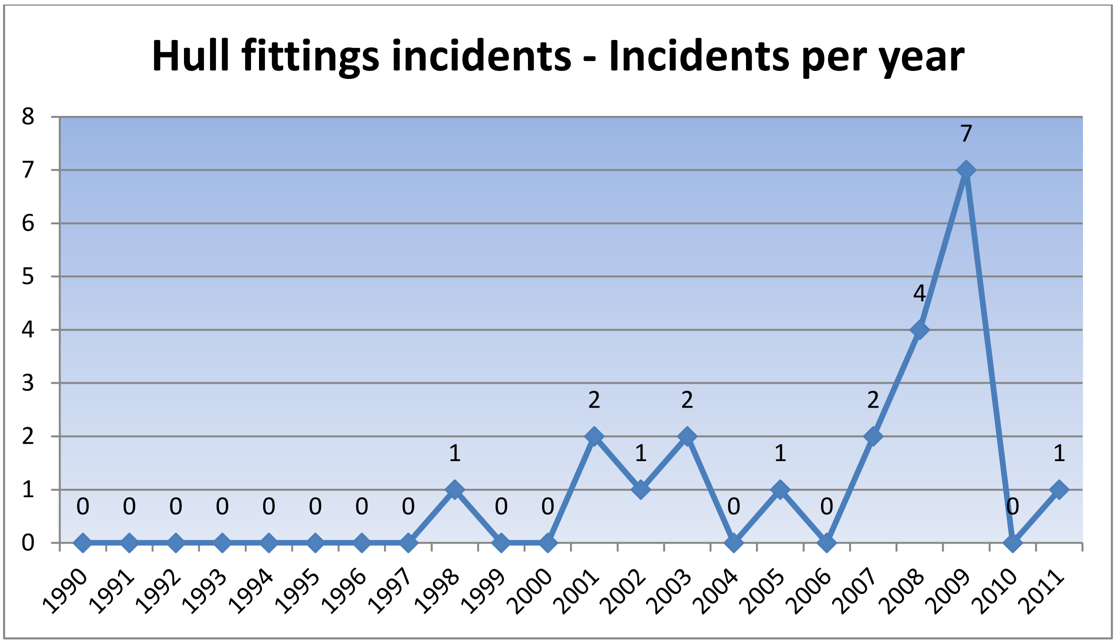
Injuries and fatalities

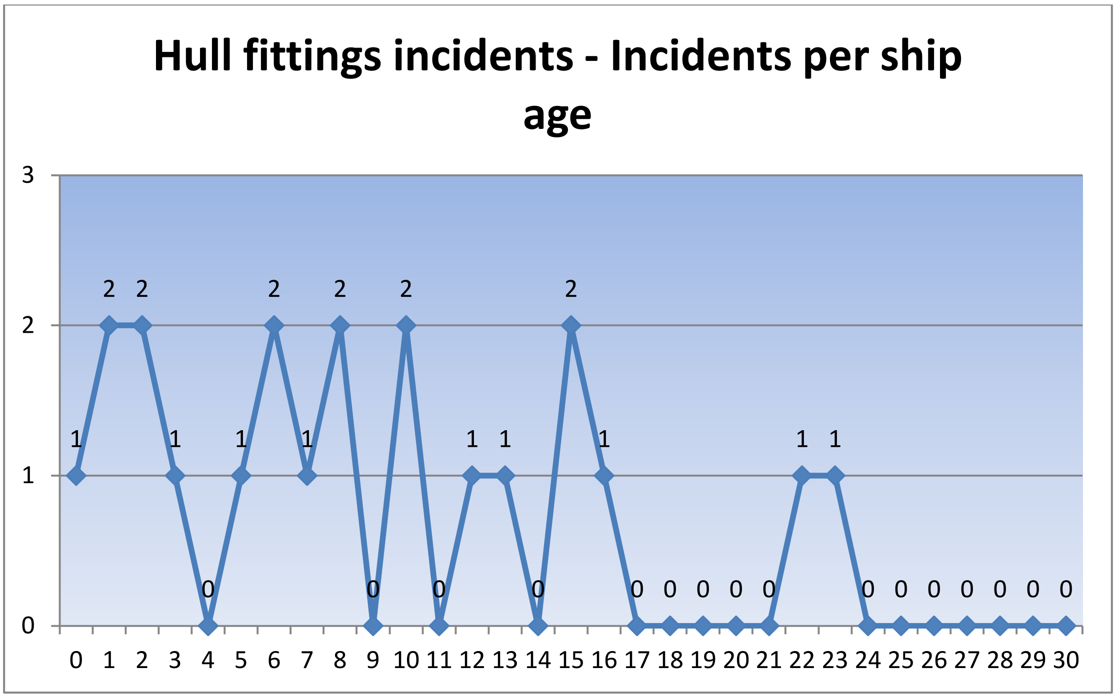
In 2 accidents the following fatalities and injuries were recorded within the studied period.



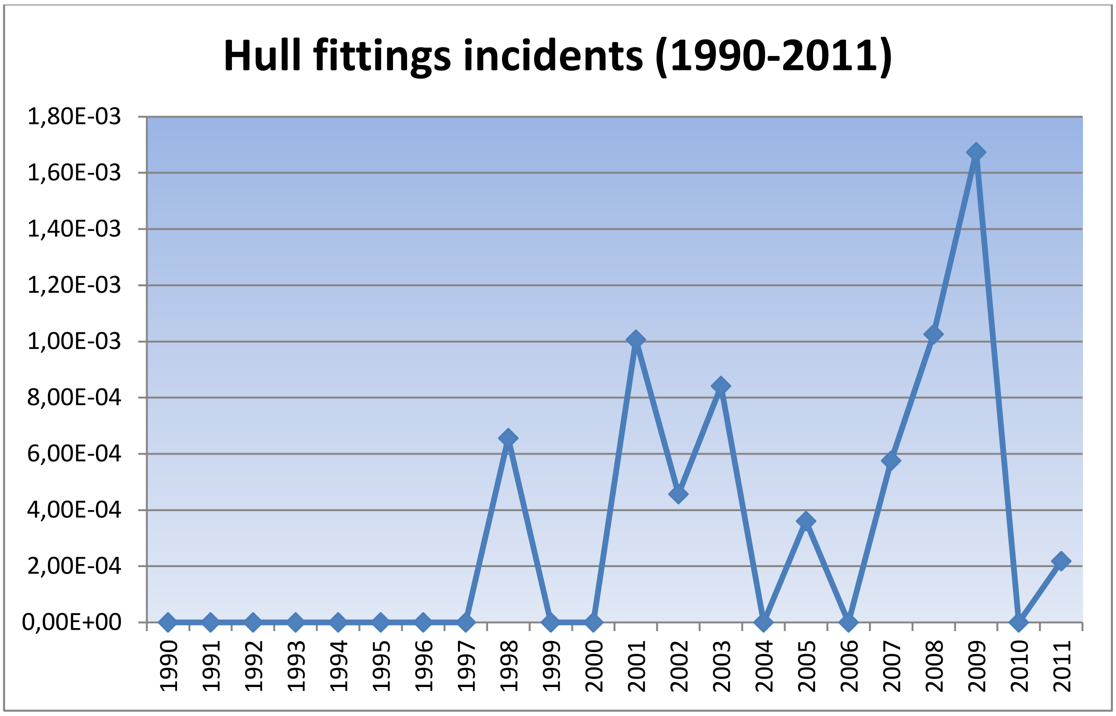
4.7.3 Frequencies of hull fittings failure incidents







It appears that the hull fittings incidents don't depend on the ship's age.

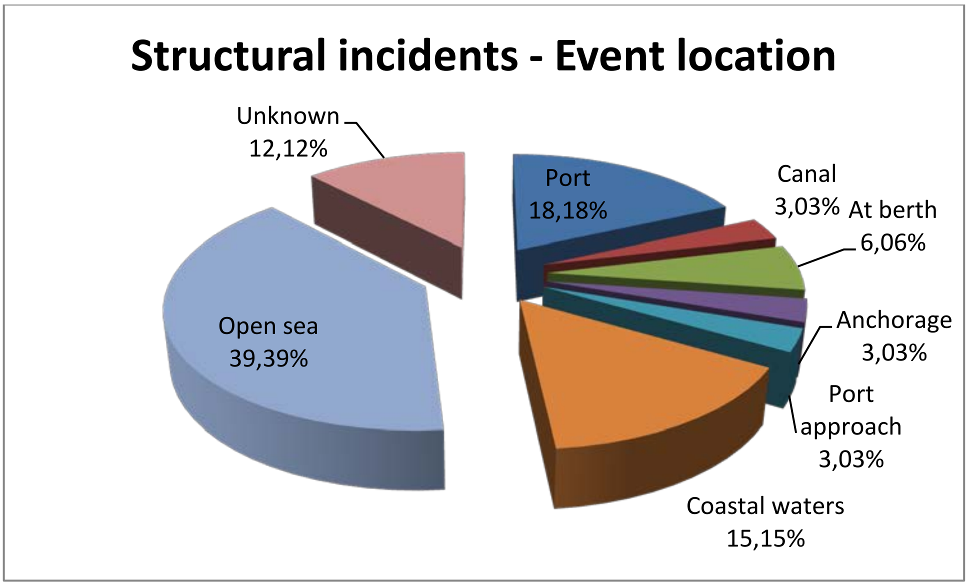


4.8 Structural failure incidents

4.8.1 Conditions of structural incidents

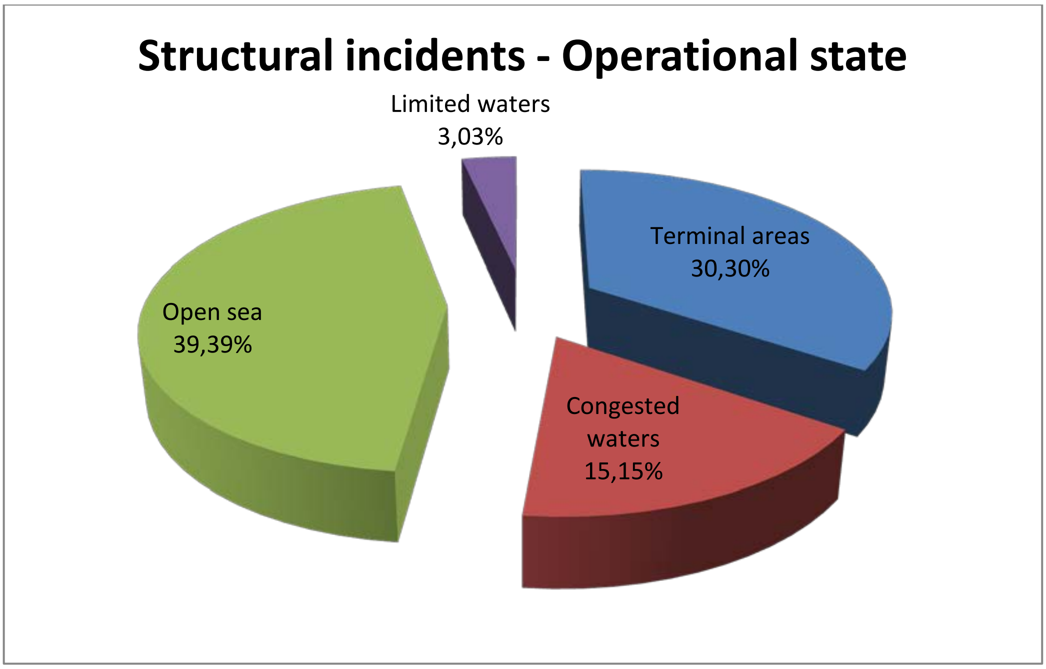
Event location

Event location	Number	Percentage
Port	6	18,18%
Canal	1	3,03%
At berth	2	6,06%
Anchorage	1	3,03%
Port approach	1	3,03%
Coastal waters	5	15,15%
Open sea	13	39,39%
Unknown	4	12,12%
Total	33	100,00%



Operational state

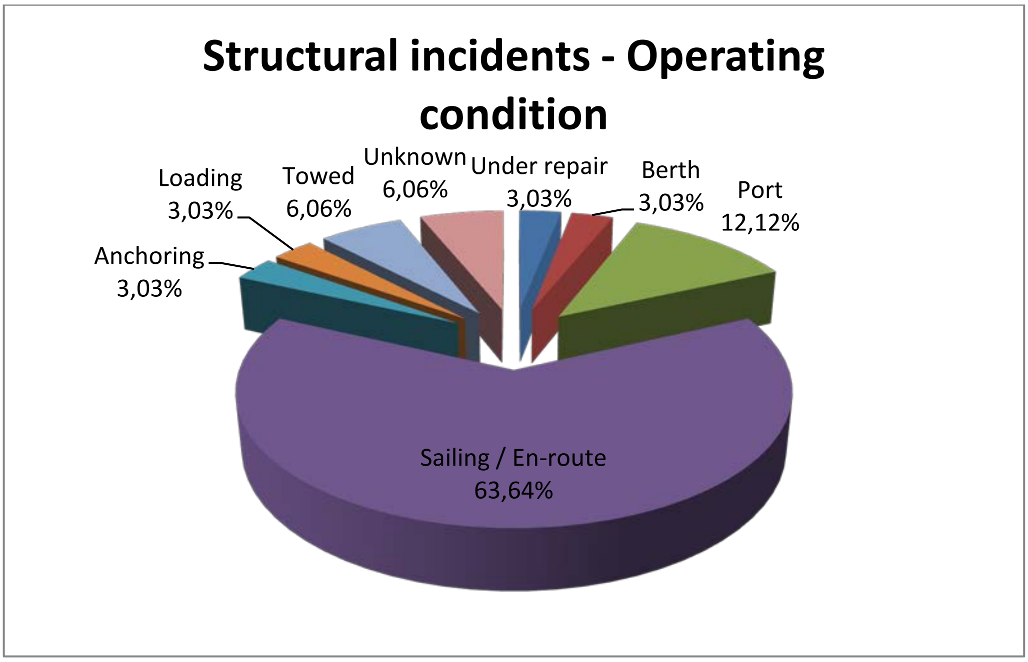
Operational state	Number	Percentage
Terminal areas	10	30,30%
Congested waters	5	15,15%
Open sea	13	39,39%
Limited waters	1	3,03%
Unknown	4	12,12%
Total	33	100,00%



Like the hull fittings incidents, most events take place either in open sea under the prevailing weather conditions or in terminals during loading and unloading procedures.

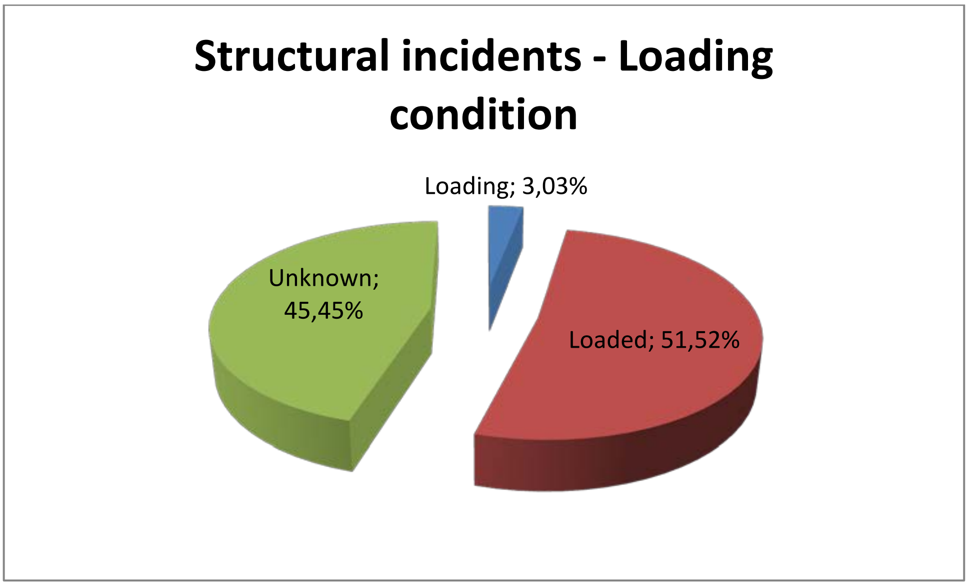
Operating condition

Operating condition	Number	Percentage
Under repair	1	3,03%
Berth	1	3,03%
Port	4	12,12%
Sailing / En-route	21	63,64%
Anchoring	1	3,03%
Loading	1	3,03%
Towed	2	6,06%
Unknown	2	6,06%
Total	33	100,00%



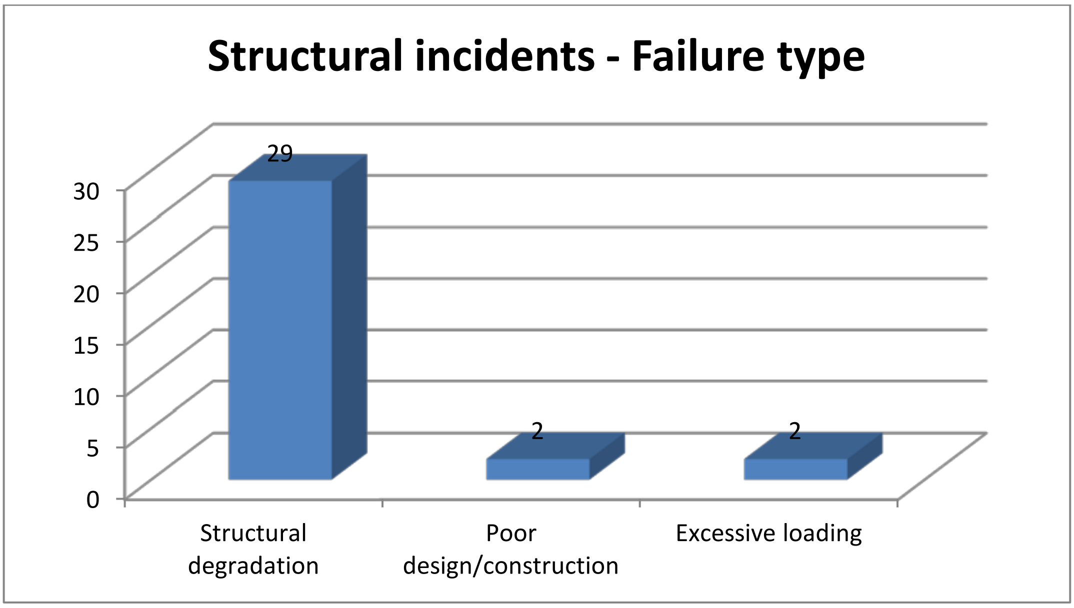
Loading condition

Loading condition	Number	Percentage
Loading	1	3,03%
Loaded	17	51,52%
Unknown	15	45,45%
Total	33	100,00%



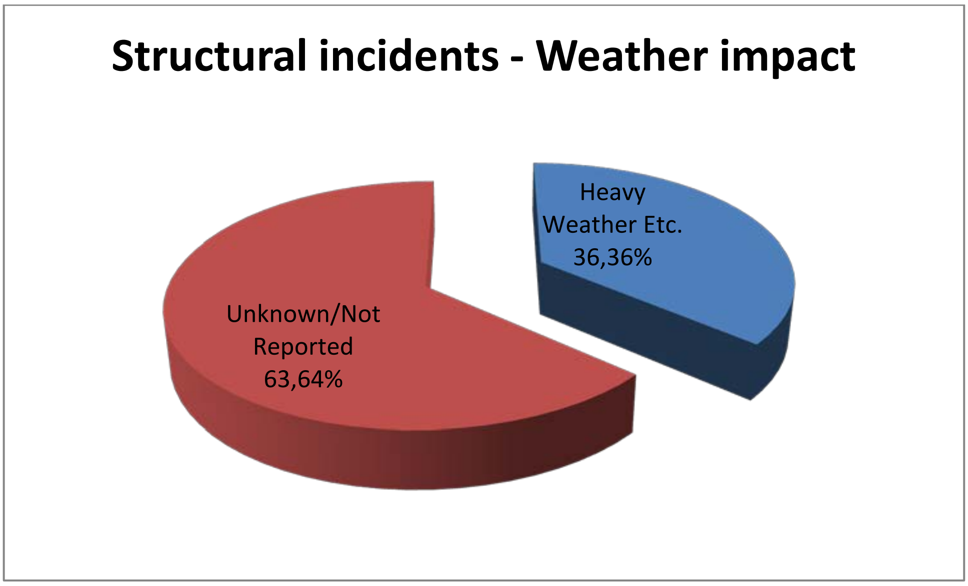
Structural failure type

Structural failure type	Number	Percentage
Structural degradation	29	87,88%
Poor design/construction	2	6,06%
Excessive loading	2	6,06%
Total	33	100,00%



Weather impact

Weather impact	Number	Percentage
Heavy Weather Etc.	12	36,36%
Unknown/Not Reported	21	63,64%
Total	33	100,00%

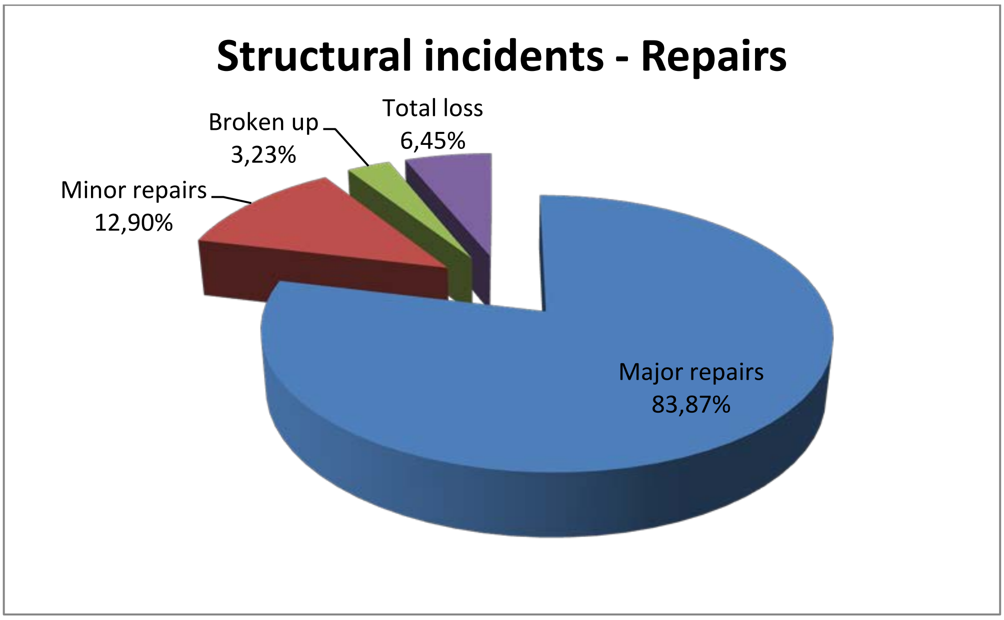


Non-accidental structural failure events consist of scenarios where the hull presents cracks and fractures, affecting ship's seaworthiness. Many incidents happened in heavy weather conditions (36,36%). If we take into account that there isn't available information on every incident as far as the weather conditions are concerned, this percentage may be even higher. Of course this doesn't mean that the weather condition is a cause of non-accidental structural failures.

4.8.2 Consequences of structural failure incidents

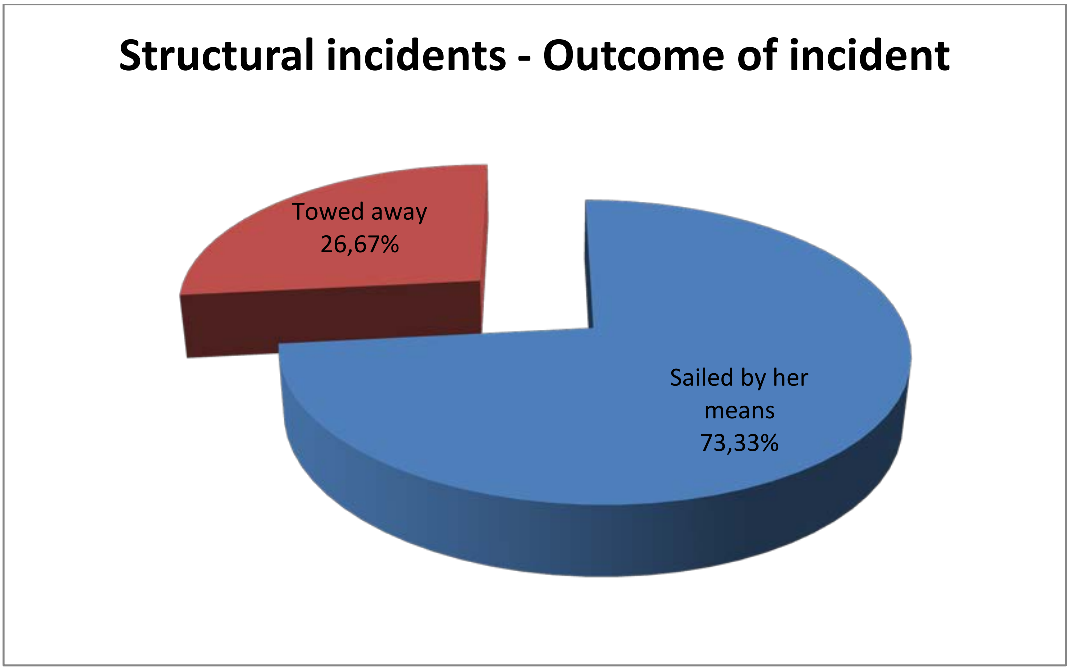
Repairs

Repairs	Number	Percentage
Major repairs	26	83,87%
Minor repairs	4	12,90%
Broken up	1	3,23%
Total loss	2	6,45%
Total	33	100,00%



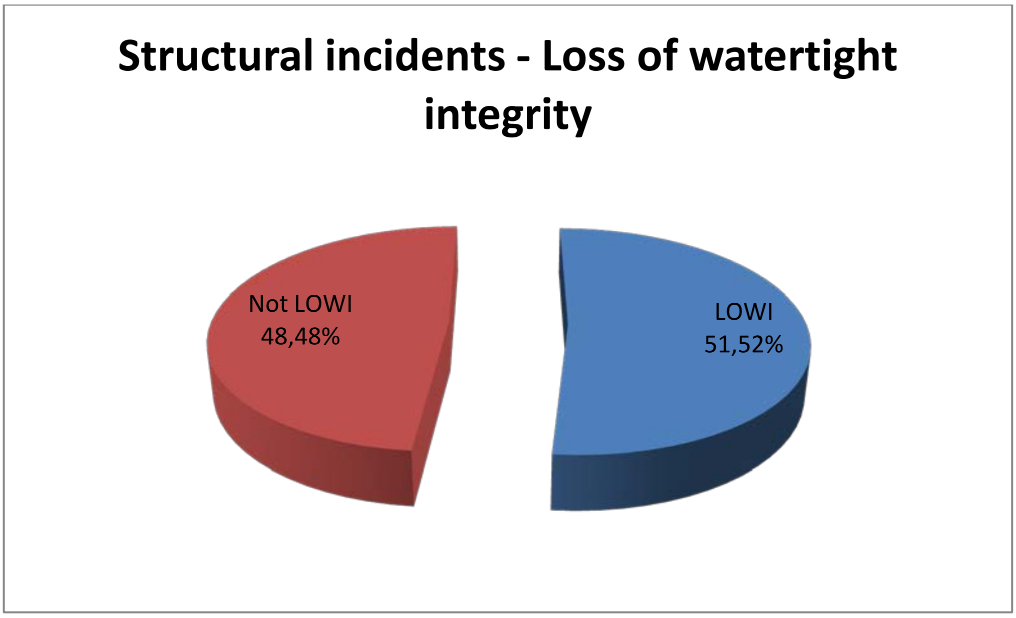
Outcome

Outcome	Number	Percentage
Sailed by her means	22	73,33%
Towed away	8	26,67%
Total	30	100,00%



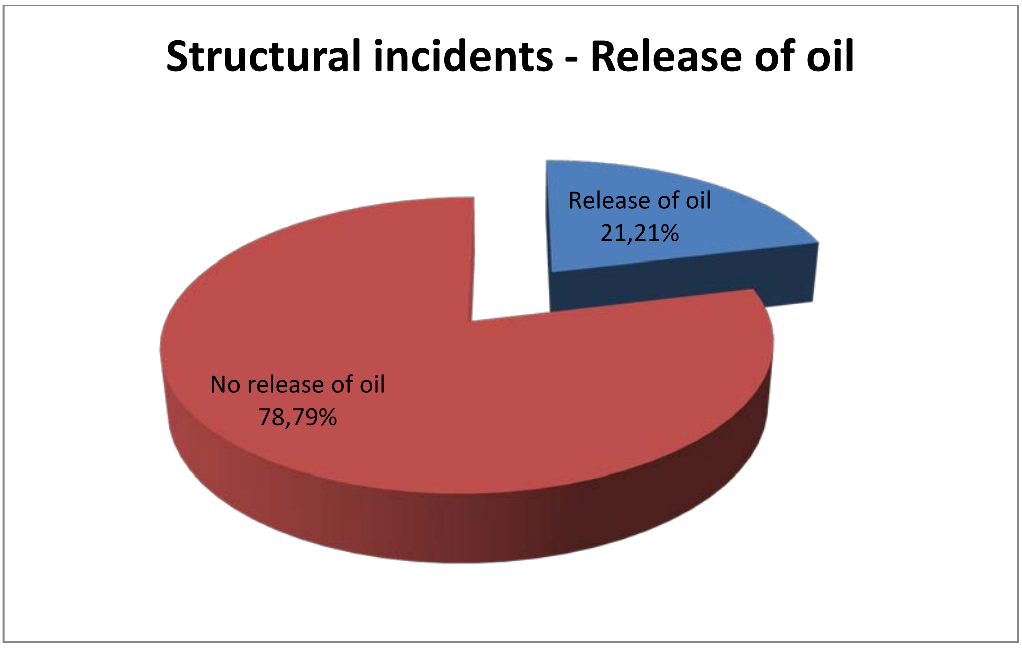
Loss of watertight integrity

LOWI	Number	Percentage
Yes	17	51,52%
No	16	48,48%
Total	33	100,00%



Release of oil

Release of oil	Number	Percentage
Yes	7	21,21%
No	26	78,79%
Total	33	100,00%



In 3 known cases, 265 tonnes of oil were released into the sea.

Release of hazardous / polluting cargo

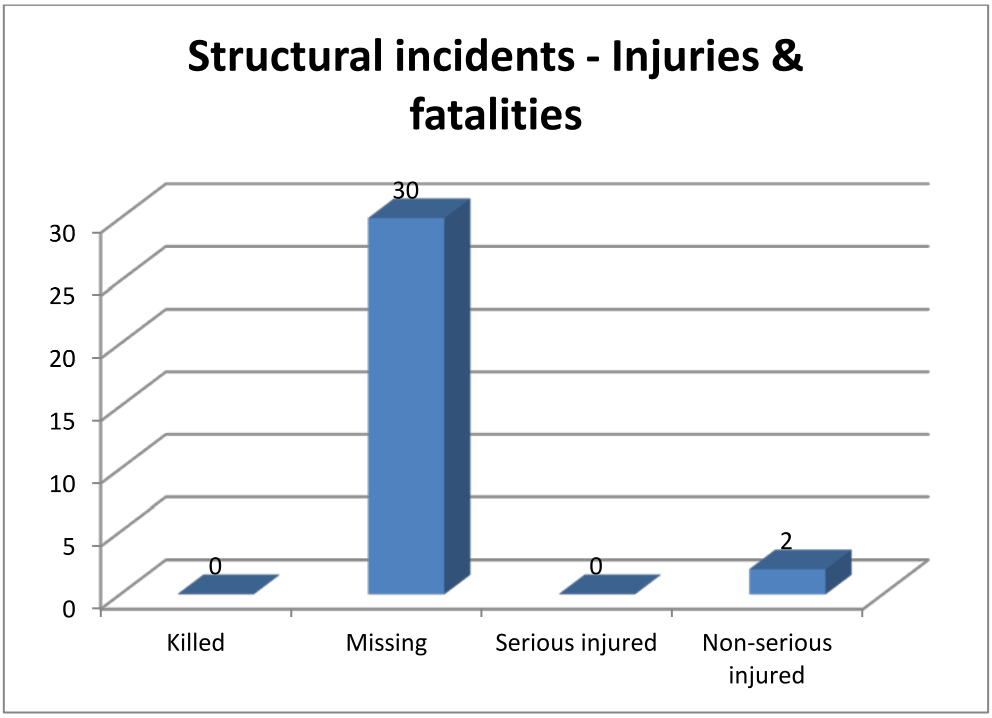
Release of hazardous / polluting cargo	Number	Percentage
Yes	2	6,06%
No	31	93,94%
Total	33	100,00%

Loss of cargo

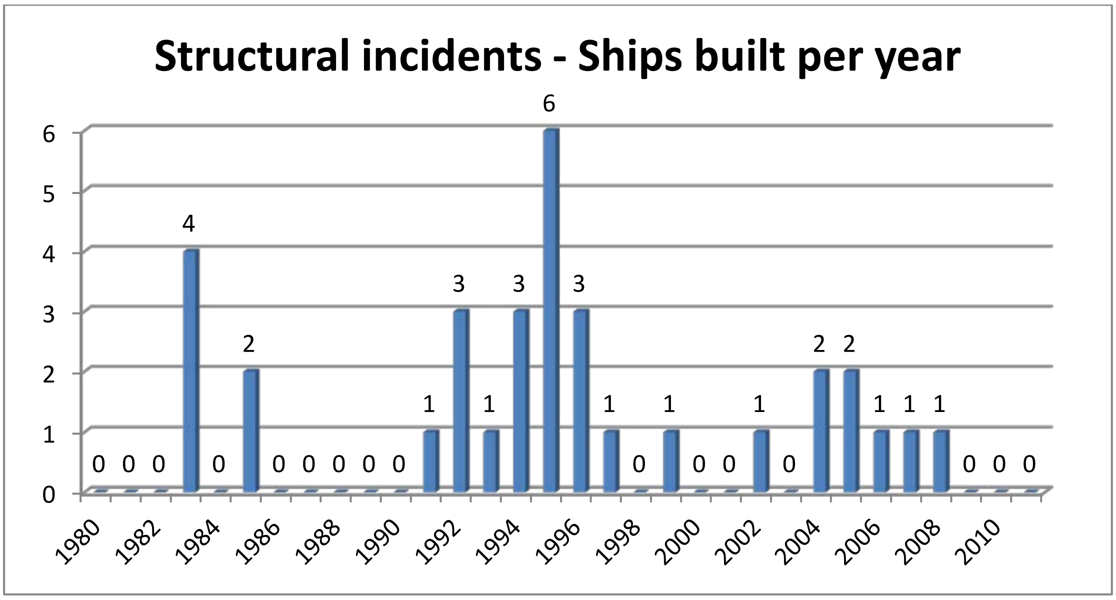
In 3 cases, 548 containers were lost due to structural failure in heavy weather conditions.

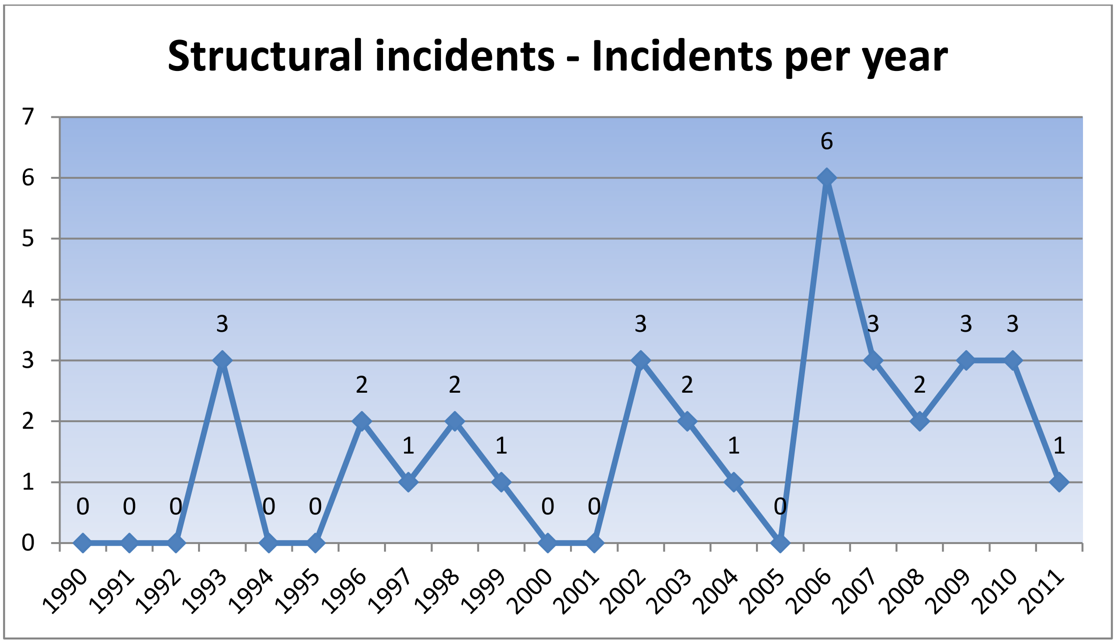
Injuries and fatalities

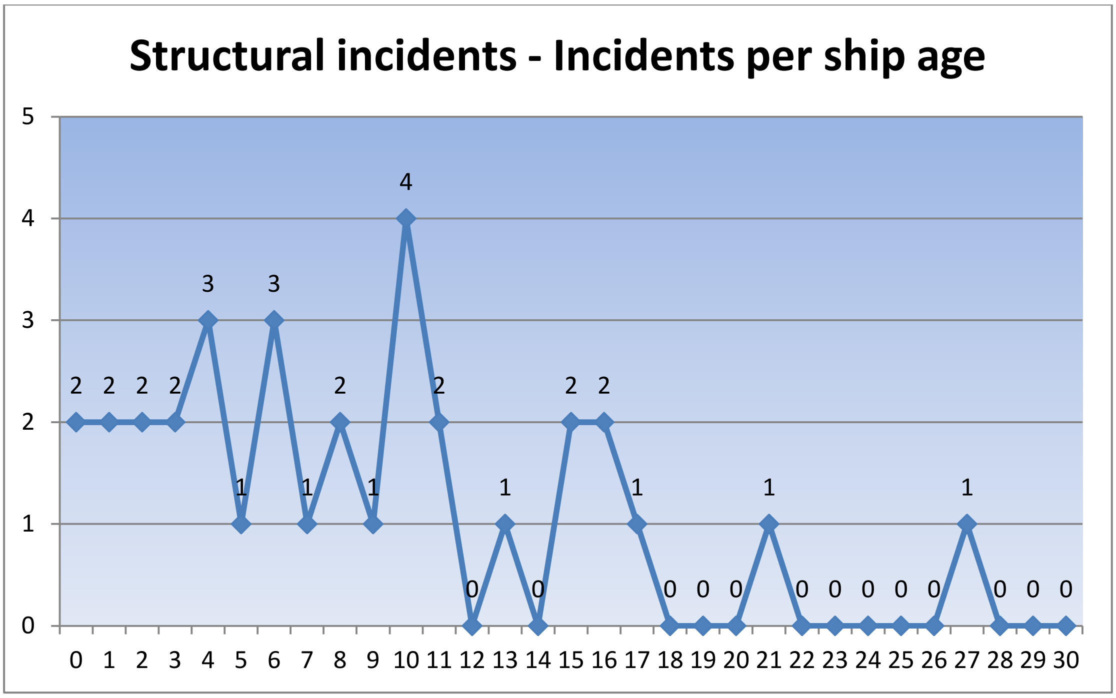
A total loss of ship led to the 30 fatalities. In another accident 2 crew members were slightly injured.

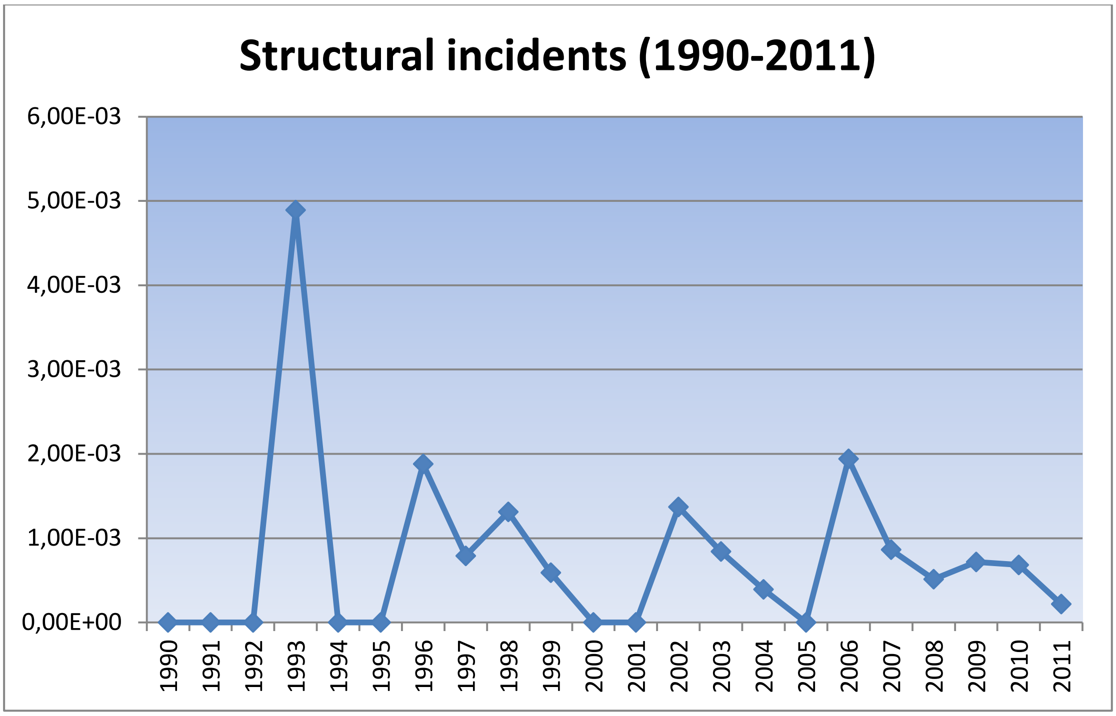


4.8.3 Frequencies of structural failure incidents






Structural incidents - Incidents per ship age
0
1
2
3
4
5
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
2 2 2 2 3 1 3 1 2 1 4 2 0 1 0 2 2 1 0 0 0 1 0 0 0 0 0 1 0 0 0

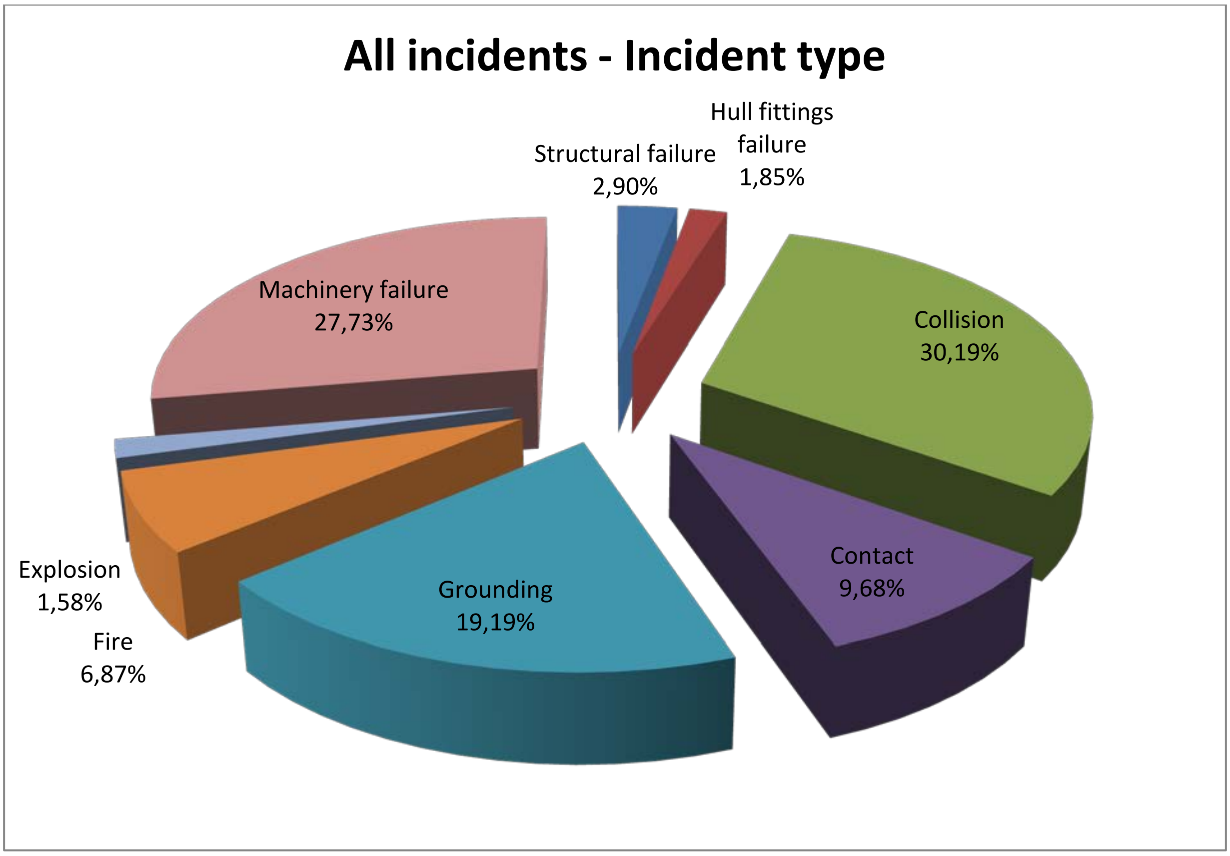

Structural incidents (1990-2011)
0,00E+00
1,00E-03
2,00E-03
3,00E-03
4,00E-03
5,00E-03
6,00E-03
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011

5. FOCUSED ANALYSIS OF INCIDENTS

5.1 Conditions of all incidents

Incident type

Incident type	Number	Percentage
Structural failure	33	2,90%
Hull fittings failure	21	1,85%
Collision	343	30,19%
Contact	110	9,68%
Grounding	218	19,19%
Fire	78	6,87%
Explosion	18	1,58%
Machinery failure	315	27,73%
Total	1136	100,00%



Marden Grid

Marsden Grid	Number of incidents	Percentage	Location
0	133	11,71%	Unknown
1	2	0,18%	W. Africa Coast
6	1	0,09%	N. Atlantic
8	12	1,06%	W. Indies
16	1	0,09%	N. Pacific
24	1	0,09%	S. China & E. Indies
26	44	3,87%	S. China & E. Indies
27	1	0,09%	Bay of Bengal
28	5	0,44%	Bay of Bengal
29	10	0,88%	Gulf
31	1	0,09%	E. African Coast
36	8	0,70%	W. Africa Coast
38	1	0,09%	W. Africa Coast
39	1	0,09%	N. Atlantic
42	1	0,09%	N. Atlantic
43	8	0,70%	W. Indies
44	7	0,62%	W. Indies
45	3	0,26%	W. Indies
46	2	0,18%	Gulf of Mexico
54	1	0,09%	N. Pacific
60	7	0,62%	S. China & E. Indies
61	2	0,18%	S. China & E. Indies
62	7	0,62%	S. China & E. Indies
63	2	0,18%	Bay of Bengal
65	4	0,35%	Gulf
66	1	0,09%	Gulf
67	2	0,18%	Gulf
68	4	0,35%	Red Sea
74	1	0,09%	W. Africa Coast
78	1	0,09%	U.S. Eastern Sea Board
80	1	0,09%	U.S. Eastern Sea Board
81	6	0,53%	Gulf of Mexico
82	6	0,53%	Gulf of Mexico
83	1	0,09%	N. America Pacific Coast
85	1	0,09%	N. America Pacific Coast
88	2	0,18%	N. Pacific
96	15	1,32%	S. China & E. Indies
97	29	2,55%	S. China & E. Indies
99	7	0,62%	Bay of Bengal
100	4	0,35%	Bay of Bengal
101	1	0,09%	Gulf

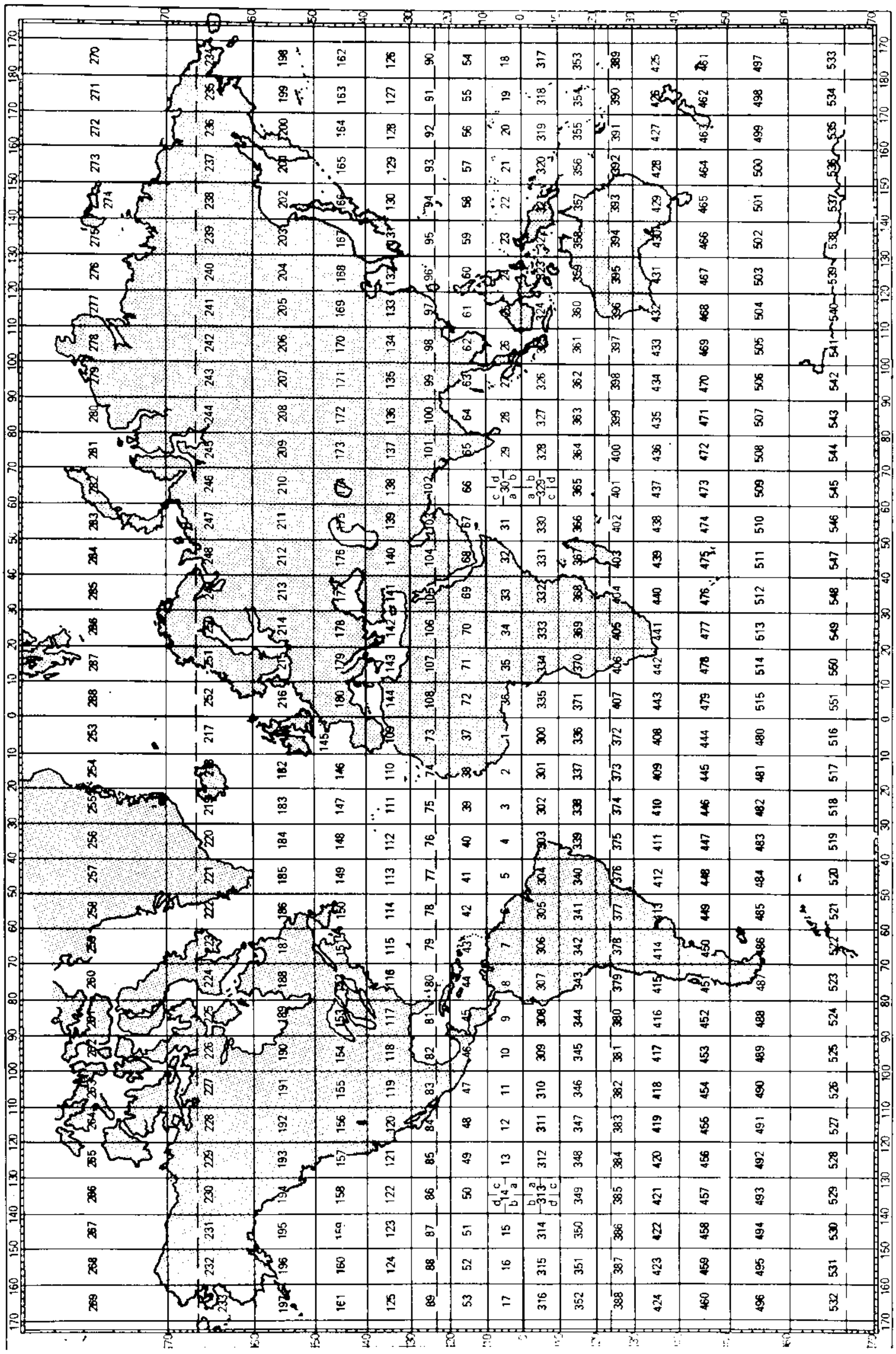
102	7	0,62%	Gulf
103	8	0,70%	Gulf
104	2	0,18%	Red Sea
105	13	1,14%	Red Sea
109	22	1,94%	W. Africa Coast
110	5	0,44%	W. Africa Coast
111	5	0,44%	N. Atlantic
116	7	0,62%	U.S. Eastern Sea Board
117	7	0,62%	Gulf of Mexico
118	2	0,18%	Gulf of Mexico
120	8	0,70%	N. America Pacific Coast
121	6	0,53%	N. America Pacific Coast
124	1	0,09%	N. Pacific
125	1	0,09%	N. Pacific
126	1	0,09%	N. Pacific
129	2	0,18%	Japan & Korea
130	2	0,18%	Japan & Korea
131	45	3,96%	Japan & Korea
132	57	5,02%	Japan & Korea
133	2	0,18%	Japan & Korea
140	1	0,09%	E. Mediterranean & Black Sea
141	32	2,82%	E. Mediterranean & Black Sea
142	36	3,17%	E. Mediterranean & Black Sea
143	11	0,97%	W. Mediterranean
144	1	0,09%	W. Mediterranean
145	27	2,38%	N. Sea & Bay of Biscay
146	1	0,09%	N. Sea & Bay of Biscay
150	1	0,09%	Newfoundland
151	5	0,44%	Newfoundland
152	22	1,94%	Great Lakes
157	23	2,02%	N. America Pacific Coast
158	1	0,09%	N. Pacific
160	2	0,18%	N. Pacific
162	1	0,09%	N. Pacific
165	1	0,09%	Japan & Korea
166	2	0,18%	Japan & Korea
167	1	0,09%	Japan & Korea
168	1	0,09%	Japan & Korea
177	3	0,26%	E. Mediterranean & Black Sea
178	28	2,46%	E. Mediterranean & Black Sea
179	4	0,35%	W. Mediterranean

180	11	0,97%	W. Mediterranean
181	17	1,50%	N. Sea & Bay of Biscay
182	1	0,09%	N. Sea & Bay of Biscay
184	1	0,09%	N. Atlantic
196	1	0,09%	Canadian Arctic & Alaska
201	1	0,09%	USSR. Arctic & Bearing Sea
213	2	0,18%	Baltic
214	2	0,18%	Baltic
215	51	4,49%	Kiel Canal
216	178	15,67%	Kiel Canal
217	1	0,09%	Iceland
218	1	0,09%	Iceland
219	3	0,26%	Iceland
222	2	0,18%	Canadian Arctic & Alaska
248	1	0,09%	USSR. Arctic & Bearing Sea
250	14	1,23%	USSR. Arctic & Bearing Sea
251	1	0,09%	Iceland
254	1	0,09%	Iceland
306	1	0,09%	S. Atlantic, E. Coast, S. America
307	2	0,18%	W. Coast, S. America
308	2	0,18%	W. Coast, S. America
321	1	0,09%	S. China & E. Indies
324	3	0,26%	S. China & E. Indies
325	3	0,26%	S. China & E. Indies
331	1	0,09%	E. African Coast
332	1	0,09%	E. African Coast
334	1	0,09%	W. Africa Coast
335	1	0,09%	W. Africa Coast
350	1	0,09%	S. Pacific
356	1	0,09%	Australasia
357	2	0,18%	Australasia
358	1	0,09%	Australasia
361	1	0,09%	Australasia
366	1	0,09%	E. African Coast
367	2	0,18%	E. African Coast
368	4	0,35%	E. African Coast
370	1	0,09%	W. Africa Coast
376	7	0,62%	S. Atlantic, E. Coast, S. America
391	2	0,18%	S. Pacific
392	5	0,44%	Australasia
402	3	0,26%	E. African Coast

404	8	0,70%	E. African Coast
406	2	0,18%	W. Africa Coast
413	5	0,44%	S. Atlantic, E. Coast, S. America
415	1	0,09%	W. Coast, S. America
426	5	0,44%	Australasia
428	2	0,18%	Australasia
429	2	0,18%	Australasia
431	1	0,09%	Australasia
432	1	0,09%	Australasia
441	5	0,44%	E. African Coast
442	8	0,70%	W. Africa Coast
450	1	0,09%	S. Atlantic, E. Coast, S. America
462	2	0,18%	Australasia
463	2	0,18%	Australasia
465	1	0,09%	Australasia
	1136	100,00%	

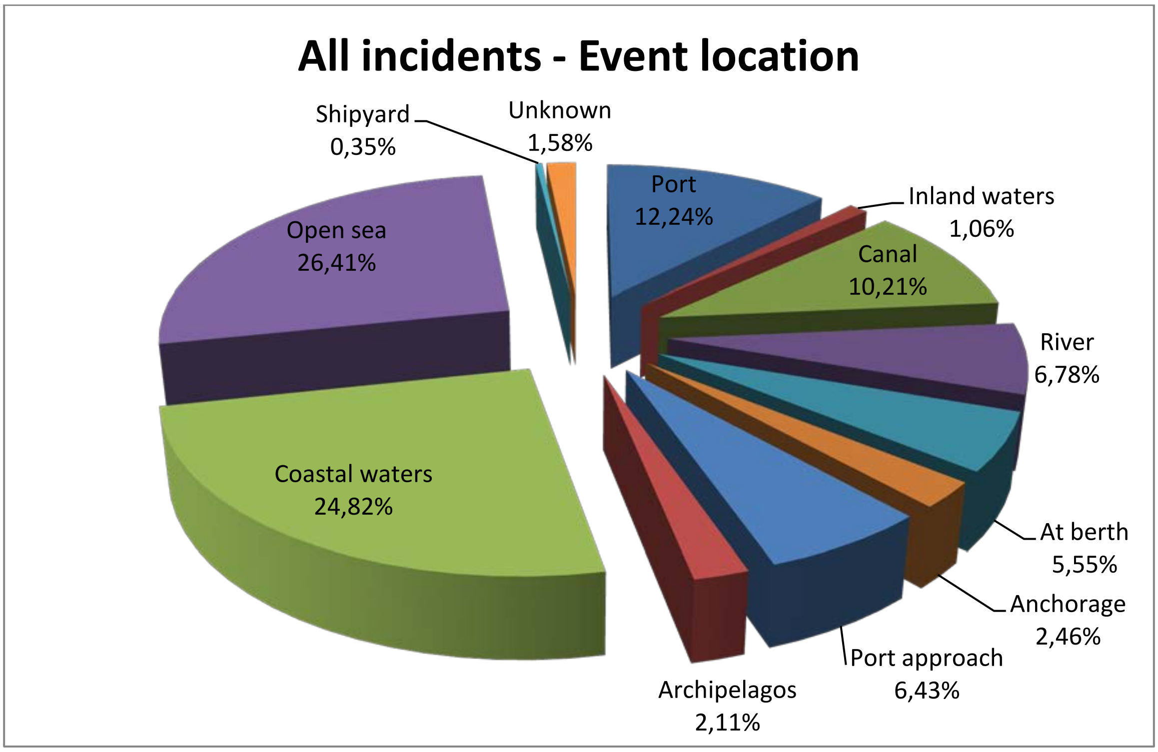
In the following map the areas where the incidents occurred have been flagged. Depending on the number of incidents that happened in this area, the appropriate color has been used. The criterions are:

- Yellow: 1-5 incidents
- Blue: 6-10 incidents
- Green: 11-15 incidents
- Orange: 16-20 incidents
- Purple: 21-25 incidents
- Red: >25 incidents



Event location

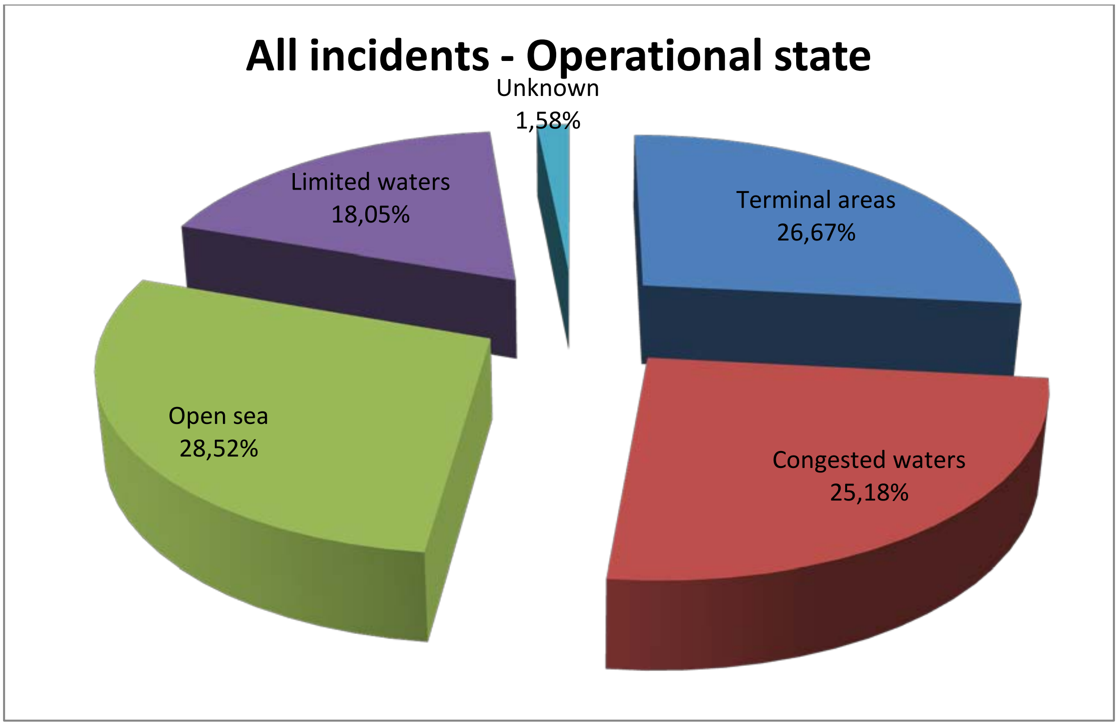
Event location	Number	Percentage
Port	139	12,24%
Inland waters	12	1,06%
Canal	116	10,21%
River	77	6,78%
At berth	63	5,55%
Anchorage	28	2,46%
Port approach	73	6,43%
Archipelagos	24	2,11%
Coastal waters	282	24,82%
Open sea	300	26,41%
Shipyard	4	0,35%
Unknown	18	1,58%
Total	1136	100,00%



Event location	Collision	Grounding	Contact	Fire	Explosion	Machinery	Structural	Hull fittings
Port	13,99%	5,05%	36,36%	11,54%	16,67%	5,40%	18,18%	23,81%
Inland waters	0,87%	1,38%	0,00%	1,28%	0,00%	1,59%	0,00%	0,00%
Canal	9,33%	18,35%	8,18%	2,56%	0,00%	9,84%	3,03%	4,76%
River	7,00%	13,76%	5,45%	2,56%	5,56%	4,44%	0,00%	0,00%
At berth	6,12%	0,92%	25,45%	7,69%	0,00%	0,63%	6,06%	9,52%
Anchorage	4,96%	0,46%	0,91%	3,85%	0,00%	0,95%	3,03%	9,52%
Port approach	5,54%	13,30%	10,91%	1,28%	0,00%	3,49%	3,03%	0,00%
Archipelagos	2,92%	1,38%	0,00%	2,56%	0,00%	2,86%	0,00%	0,00%
Coastal waters	31,49%	38,99%	8,18%	11,54%	16,67%	19,37%	15,15%	9,52%
Open sea	17,49%	5,96%	2,73%	51,28%	61,11%	47,94%	39,39%	42,86%
Shipyard	0,00%	0,00%	1,82%	2,56%	0,00%	0,00%	0,00%	0,00%
Unknown	0,29%	0,46%	0,00%	1,28%	0,00%	3,49%	12,12%	0,00%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Operational state

Operational state	Number	Percentage
Terminal areas	303	26,67%
Congested waters	286	25,18%
Open sea	324	28,52%
Limited waters	205	18,05%
Unknown	18	1,58%
Total	1136	100,00%

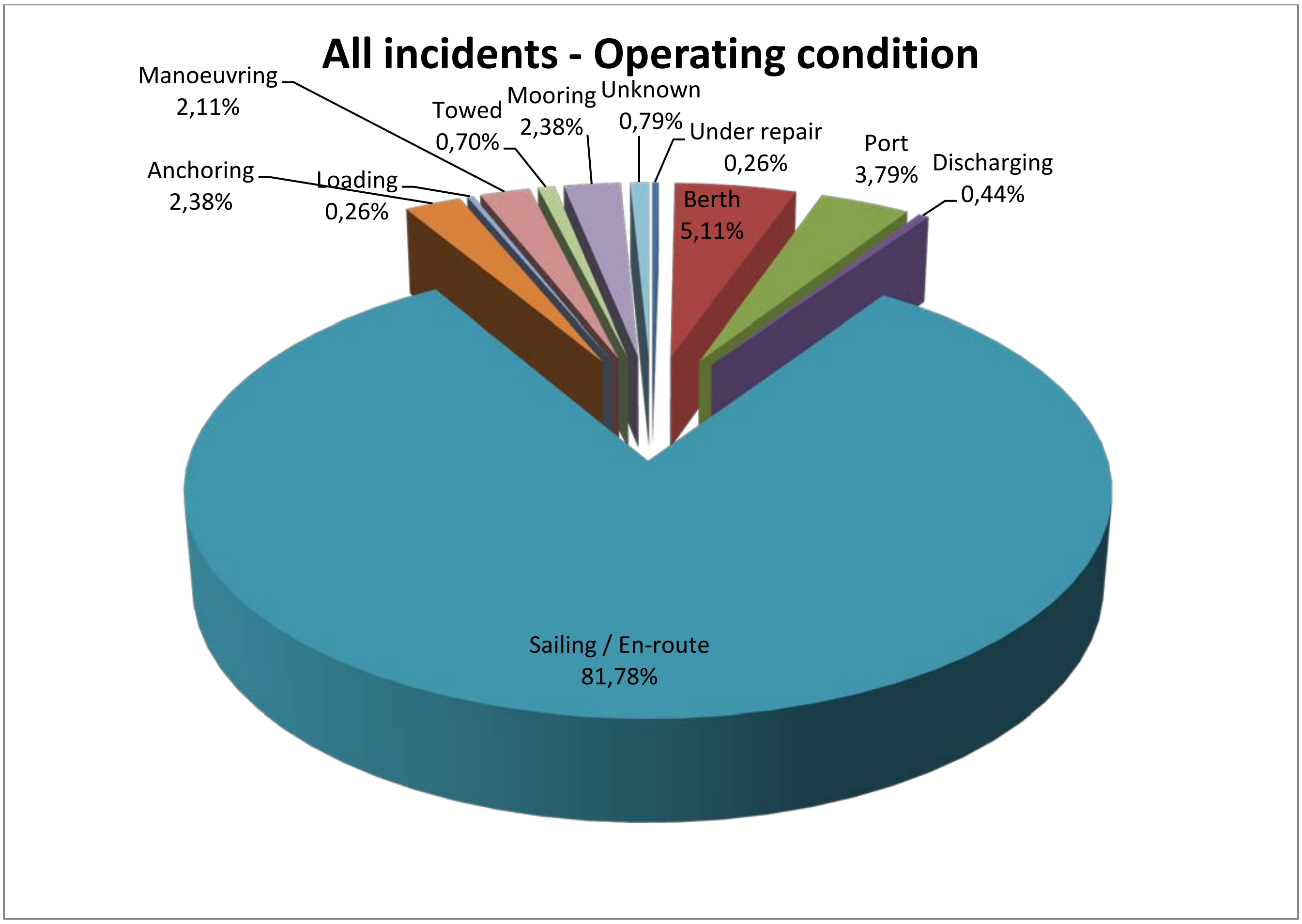


Operational state	Collision	Grounding	Contact	Fire	Explosion	Machinery	Structural	Hull fittings
Terminal areas	30,61%	19,72%	73,64%	24,36%	16,67%	10,48%	30,30%	42,86%
Congested waters	31,49%	38,99%	8,18%	14,10%	16,67%	19,37%	15,15%	9,52%
Open sea	20,41%	7,34%	4,55%	53,85%	61,11%	50,79%	39,39%	42,86%
Limited waters	17,20%	33,49%	13,64%	6,41%	5,56%	15,87%	3,03%	4,76%
Unknown	0,29%	0,46%	0,00%	1,28%	0,00%	3,49%	12,12%	0,00%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Collision and grounding incidents take place mainly in congested waters and terminal areas which constitute crossing route with large ship speed variations and where dense ship traffic prevails. Many accidents occur also in limited waters where the capability of maneuvering is rather limited. The vast majority of the contact incidents happen in terminal areas. The majority of the fire incidents happen in open sea where the machinery equipment is in operation and containers are exposed to the prevailing environmental conditions. Most cases of machinery failure occur as expected in open sea. Like the hull fittings incidents, structural failure events take place either in open sea under the prevailing weather conditions or in terminals during loading and unloading procedures.

Operating condition

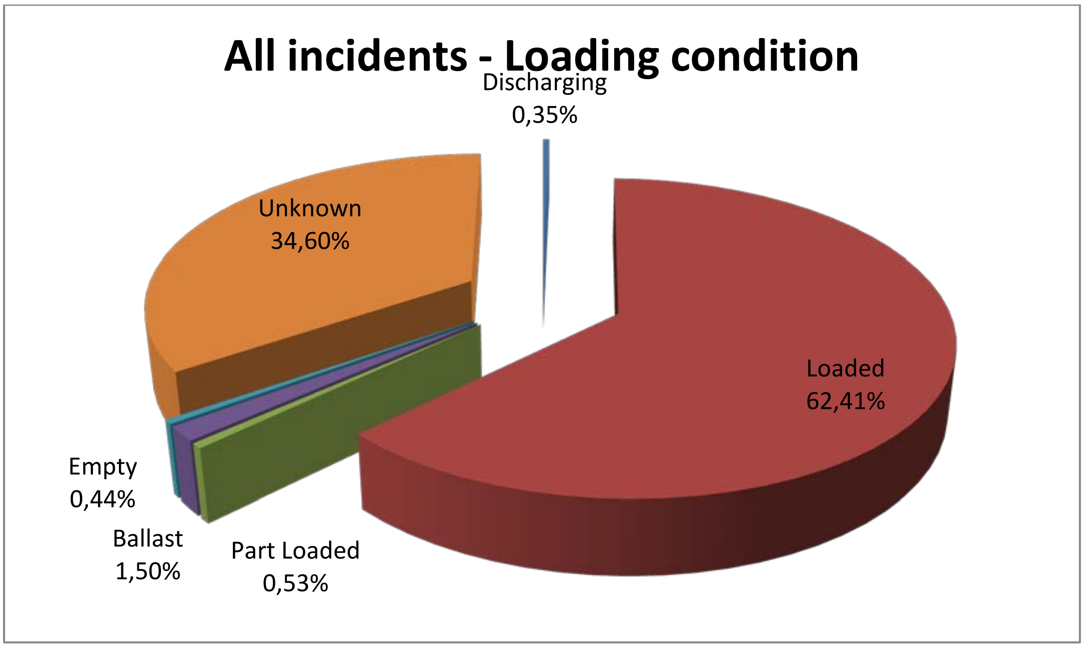
Operating condition	Number	Percentage
Under repair	3	0,26%
Berth	58	5,11%
Port	43	3,79%
Discharging	5	0,44%
Sailing / En-route	929	81,78%
Anchoring	27	2,38%
Loading	3	0,26%
Manoeuvring	24	2,11%
Towed	8	0,70%
Mooring	27	2,38%
Unknown	9	0,79%
Total	1136	100,00%



Operating condition	Collision	Grounding	Contact	Fire	Explosion	Machinery	Structural	Hull fittings
Under repair	0,00%	0,00%	0,91%	1,28%	0,00%	0,00%	3,03%	0,00%
Berth	6,12%	0,46%	25,45%	6,41%	0,00%	0,32%	3,03%	4,76%
Port	2,33%	1,83%	7,27%	8,97%	11,11%	2,86%	12,12%	4,76%
Discharging	0,00%	0,00%	1,82%	1,28%	5,56%	0,00%	0,00%	4,76%
Sailing / En-route	77,84%	95,87%	42,73%	74,36%	83,33%	94,92%	63,64%	61,90%
Anchoring	4,37%	0,46%	0,91%	5,13%	0,00%	1,27%	3,03%	4,76%
Loading	0,00%	0,00%	0,00%	1,28%	0,00%	0,00%	3,03%	4,76%
Manoeuvring	3,79%	0,46%	9,09%	0,00%	0,00%	0,00%	0,00%	0,00%
Towed	0,87%	0,46%	1,82%	0,00%	0,00%	0,00%	6,06%	0,00%
Mooring	3,50%	0,46%	9,09%	1,28%	0,00%	0,00%	0,00%	14,29%
Unknown	1,17%	0,00%	0,91%	0,00%	0,00%	0,63%	6,06%	0,00%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Loading condition

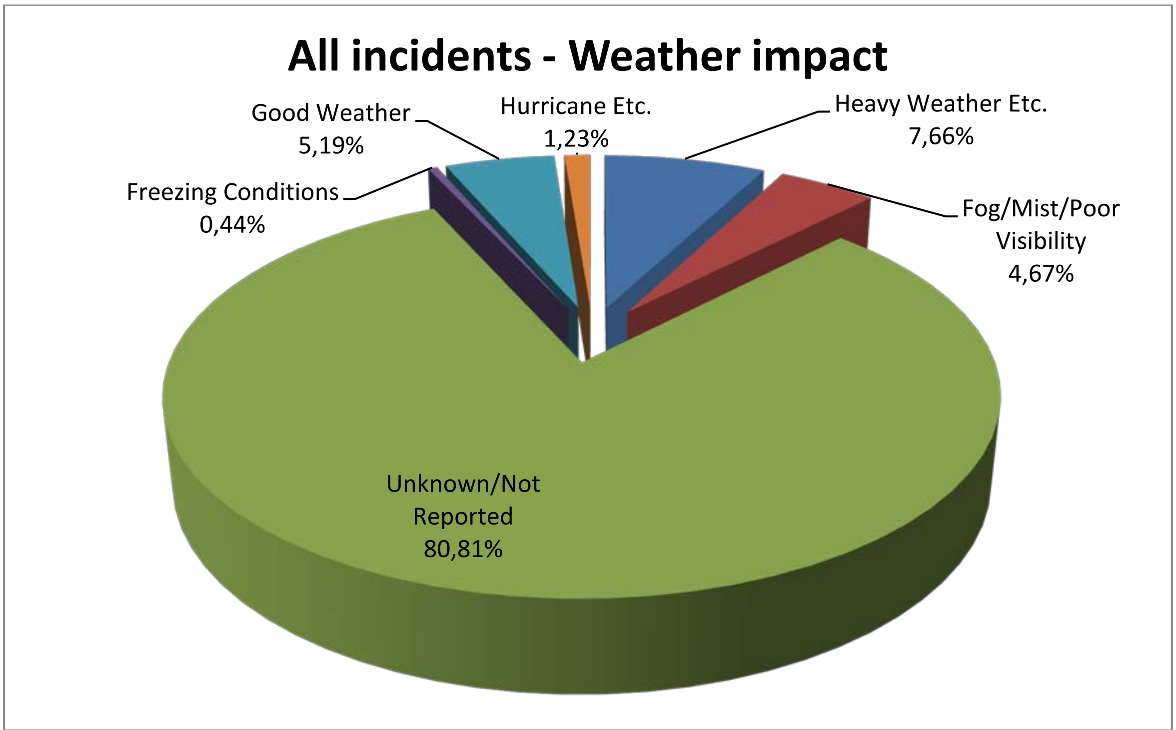
Loading condition	Number	Percentage
Loading	2	0,18%
Discharging	4	0,35%
Loaded	709	62,41%
Part Loaded	6	0,53%
Ballast	17	1,50%
Empty	5	0,44%
Unknown	393	34,60%
Total	1136	100,00%



Loading condition	Collision	Grounding	Contact	Fire	Explosion	Machinery	Structural	Hull fittings
Loading	0,00%	0,00%	0,00%	1,28%	0,00%	0,00%	3,03%	0,00%
Discharging	0,00%	0,00%	0,91%	0,00%	5,56%	0,32%	0,00%	4,76%
Loaded	58,89%	72,02%	54,55%	66,67%	61,11%	61,90%	51,52%	71,43%
Part Loaded	0,58%	1,38%	0,00%	0,00%	0,00%	0,32%	0,00%	0,00%
Ballast	0,58%	0,92%	1,82%	0,00%	0,00%	3,49%	0,00%	0,00%
Empty	0,00%	0,92%	0,91%	1,28%	0,00%	0,32%	0,00%	0,00%
Unknown	39,94%	24,77%	41,82%	30,77%	33,33%	33,65%	45,45%	23,81%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Weather impact

Weather impact	Number	Percentage
Heavy Weather Etc.	87	7,66%
Fog/Mist/Poor Visibility	53	4,67%
Unknown/Not Reported	918	80,81%
Freezing Conditions	5	0,44%
Good Weather	59	5,19%
Hurricane Etc.	14	1,23%
Total	1136	100,00%



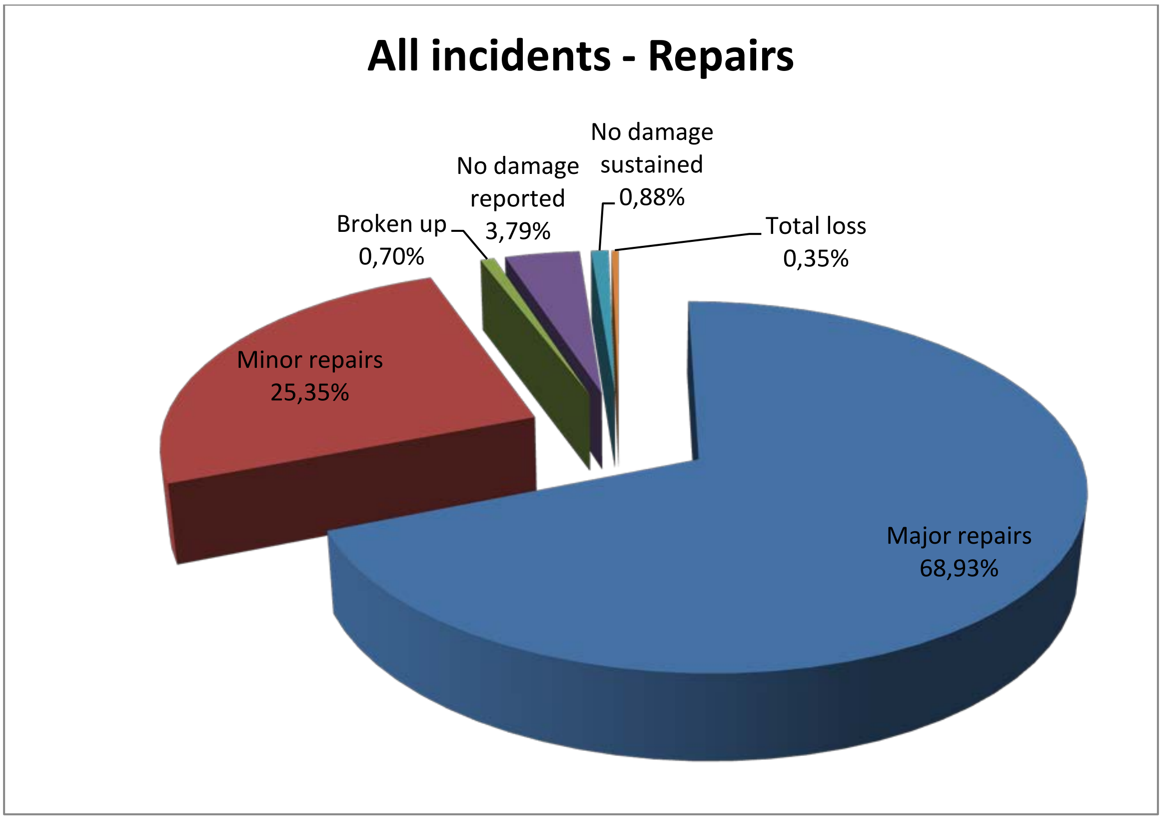
Weather impact	Collision	Grounding	Contact	Fire	Explosion	Machinery	Structural	Hull fittings
Heavy Weather Etc.	5,25%	8,72%	8,18%	3,85%	5,56%	5,40%	36,36%	38,10%
Fog/Mist/Poor Visibility	12,24%	3,21%	2,73%	0,00%	0,00%	0,32%	0,00%	0,00%
Unknown/Not Reported	73,18%	79,36%	82,73%	93,59%	88,89%	89,52%	63,64%	52,38%
Freezing Conditions	0,87%	0,00%	0,00%	0,00%	0,00%	0,63%	0,00%	0,00%
Good Weather	7,87%	6,42%	3,64%	2,56%	5,56%	3,49%	0,00%	0,00%
Hurricane Etc.	0,58%	2,29%	2,73%	0,00%	0,00%	0,63%	0,00%	9,52%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Structural failure and hull fittings failure are the two incidents categories that are most influenced by the prevailing weather conditions. In almost all the cases, where information about the weather impact was available, the accident occurred in heavy weather. Regarding the collision events poor visibility is a contributing factor.

5.2 Consequences of all incidents

Repairs

Repairs	Number	Percentage
Major repairs	783	68,93%
Minor repairs	288	25,35%
Broken up	8	0,70%
No damage reported	43	3,79%
No damage sustained	10	0,88%
Total loss	4	0,35%
Total	1136	100,00%

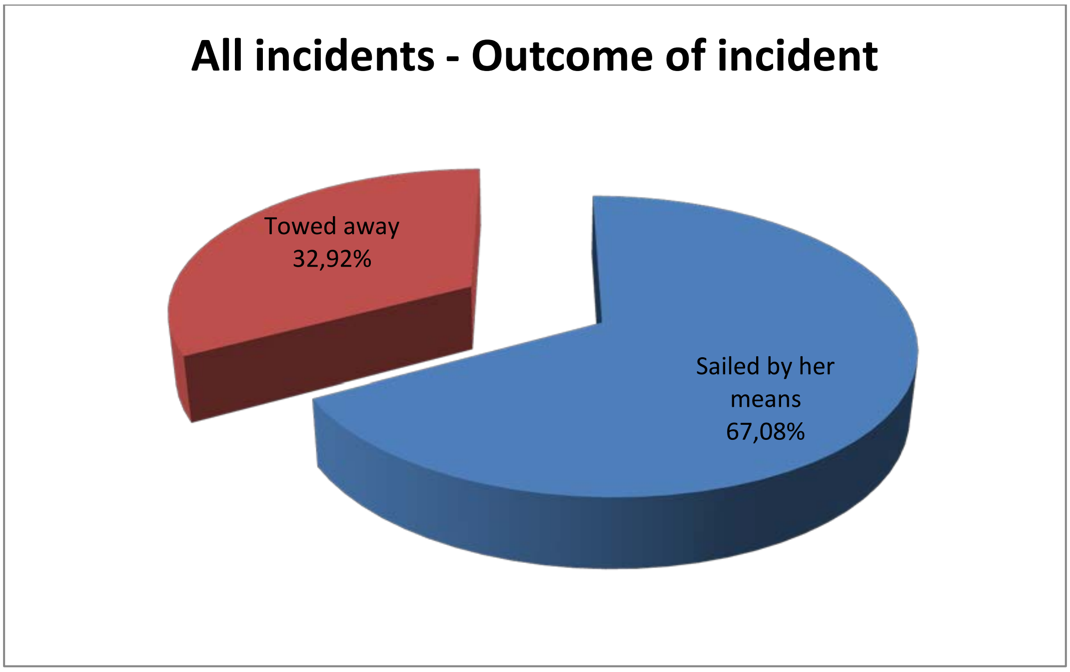


Repairs	Collision	Grounding	Contact	Fire	Explosion	Machinery	Structural	Hull fittings
Major repairs	69,68%	56,88%	77,27%	65,38%	83,33%	72,38%	83,87%	71,43%
Minor repairs	26,82%	23,85%	20,91%	30,77%	16,67%	26,67%	12,90%	28,57%
Broken up	0,00%	1,83%	0,00%	2,56%	0,00%	0,32%	3,23%	0,00%
No damage reported	2,92%	13,30%	1,82%	1,28%	0,00%	0,32%	0,00%	0,00%
No damage sustained	0,58%	3,67%	0,00%	0,00%	0,00%	0,00%	0,00%	0,00%
Total loss	0,00%	0,46%	0,00%	0,00%	0,00%	0,32%	6,45%	0,00%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

It is noted that explosions and events of structural events provoke extensive damages on more than 80% of the containerships involved in this study.

Outcome

Outcome	Number	Percentage
Sailed by her means	758	67,08%
Towed away	372	32,92%
Total	1130	100,00%

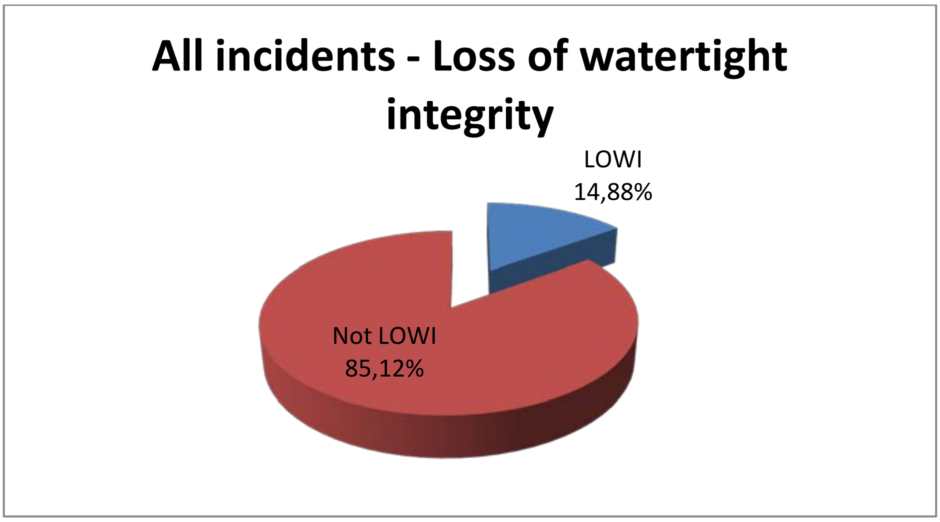


Outcome	Collision	Grounding	Contact	Fire	Explosion	Machinery	Structural	Hull fittings
Sailed by her means	92,13%	68,84%	80,91%	66,67%	55,56%	32,06%	73,33%	95,24%
Towed away	7,87%	31,16%	19,09%	33,33%	44,44%	67,94%	26,67%	4,76%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

The propulsion system is the most sensitive part of the machinery equipment. Therefore, in almost 70% of the machinery incidents, the containership needed to be towed away subsequently.

<u>Loss of watertight integrity</u>

LOWI	Number	Percentage
Yes	169	14,88%
No	967	85,12%
Total	1136	100,00%

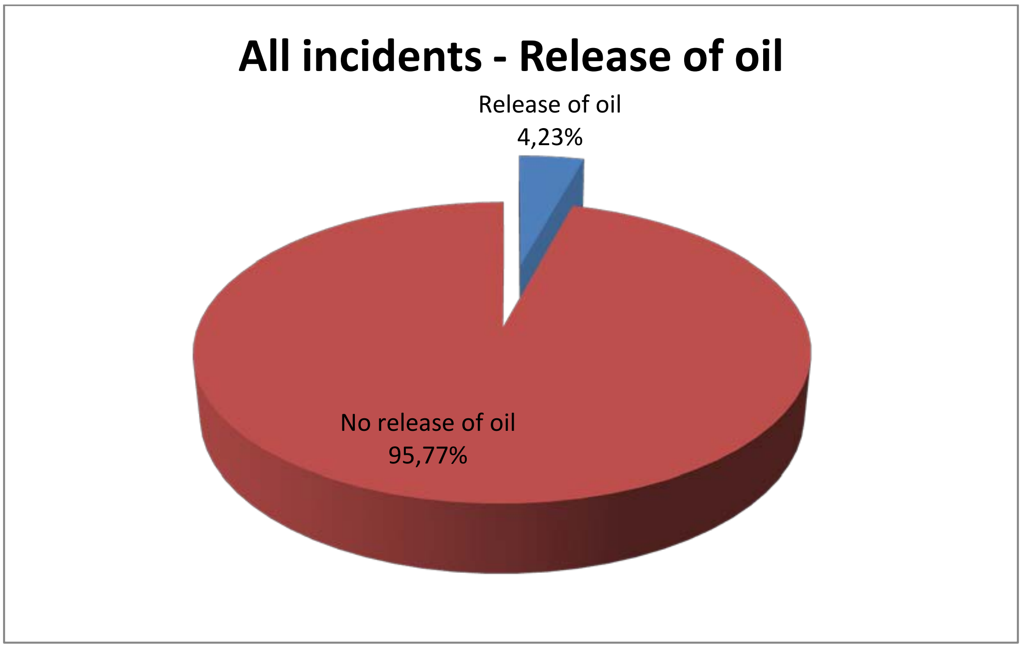


LOWI	Collision	Grounding	Contact	Fire	Explosion	Machinery	Structural	Hull fittings
Yes	20,41%	18,81%	33,64%	0,00%	0,00%	0,95%	51,52%	4,76%
No	79,59%	81,19%	66,36%	100,00%	100,00%	99,05%	48,48%	95,24%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

More than in half the cases, a consequence of a structural failure incident is the loss of the watertight integrity of the containership.

Release of oil

Release of oil	Number	Percentage
Yes	48	4,23%
No	1088	95,77%
Total	1136	100,00%

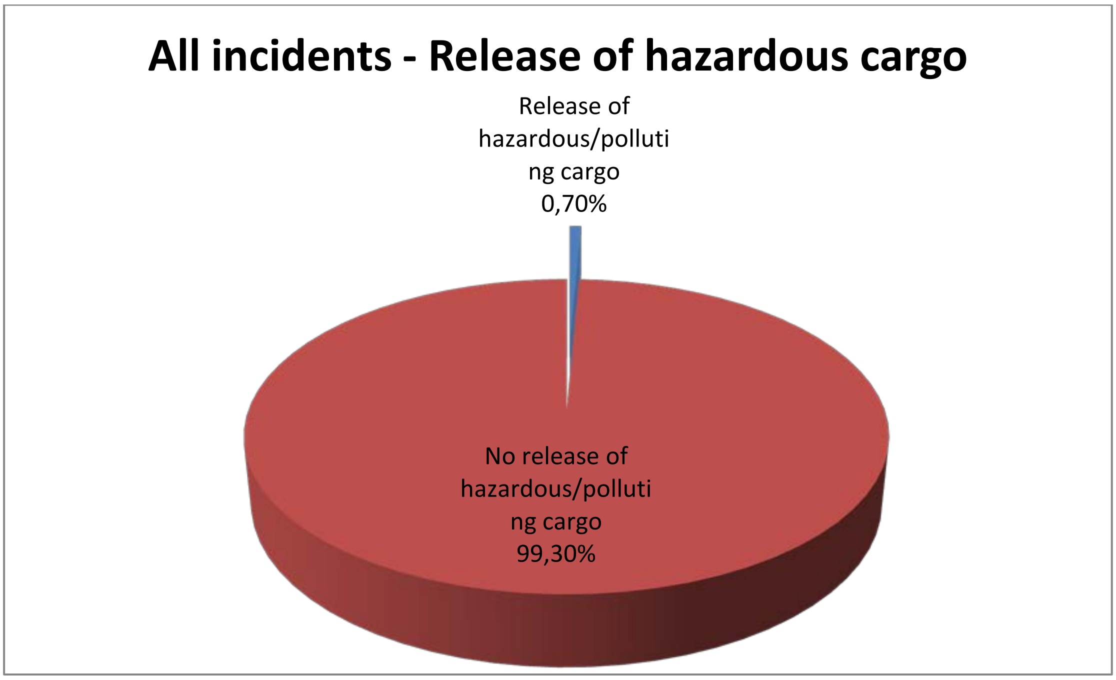


Release of oil	Collision	Grounding	Contact	Fire	Explosion	Machinery	Structural	Hull fittings
Yes	4,37%	5,96%	11,82%	0,00%	0,00%	0,00%	21,21%	0,00%
No	95,63%	94,04%	88,18%	100,00%	100,00%	100,00%	78,79%	100,00%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

In case of a structural failure, the percentage of ships that provoke an oil spill is more than 20% (highest rate of every incident category).

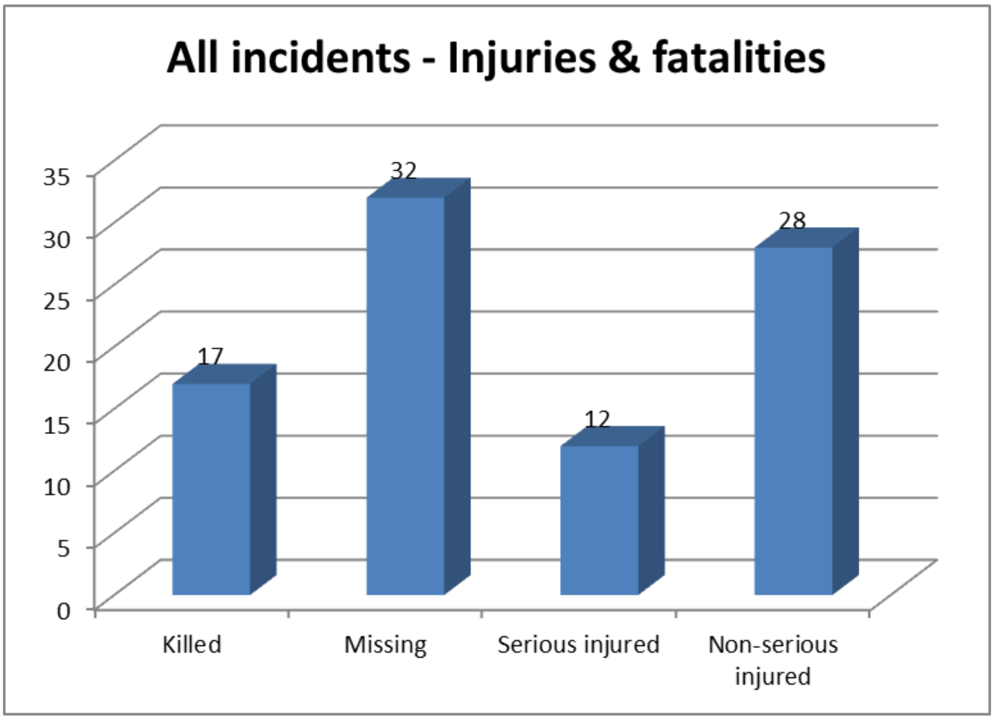
Release of hazardous / polluting cargo

Release of hazardous / polluting cargo	Number	Percentage
Yes	8	0,70%
No	1128	99,30%
Total	1136	100,00%



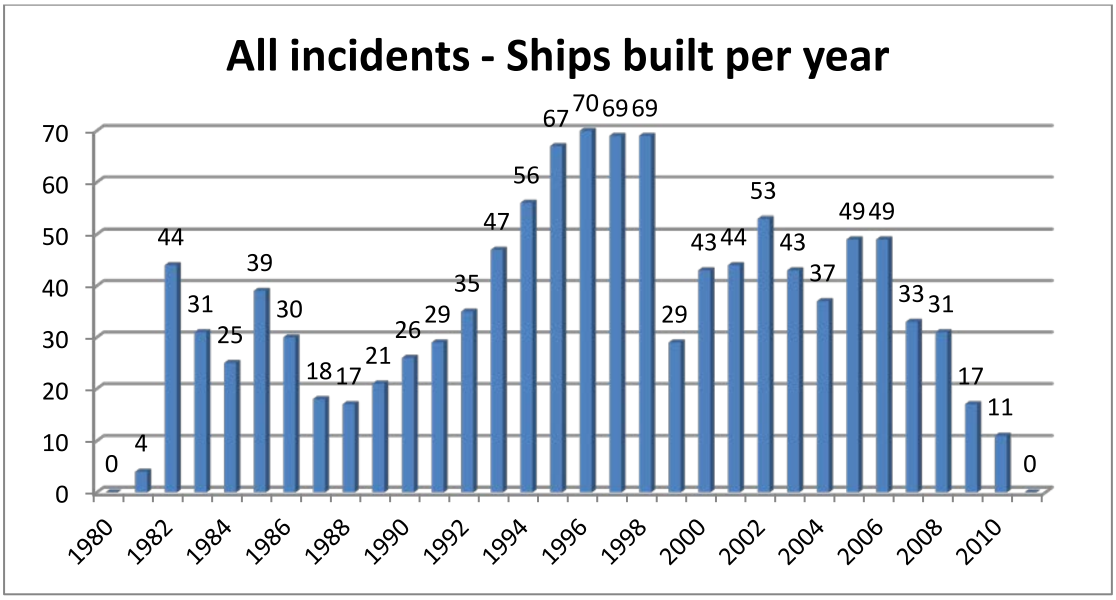
Release of hazardous cargo	Collision	Grounding	Contact	Fire	Explosion	Machinery	Structural	Hull fittings
Yes	0,58%	0,00%	0,91%	1,28%	5,56%	0,00%	6,06%	4,76%
No	99,42%	100,00%	99,09%	98,72%	94,44%	100,00%	93,94%	95,24%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Injuries and fatalities

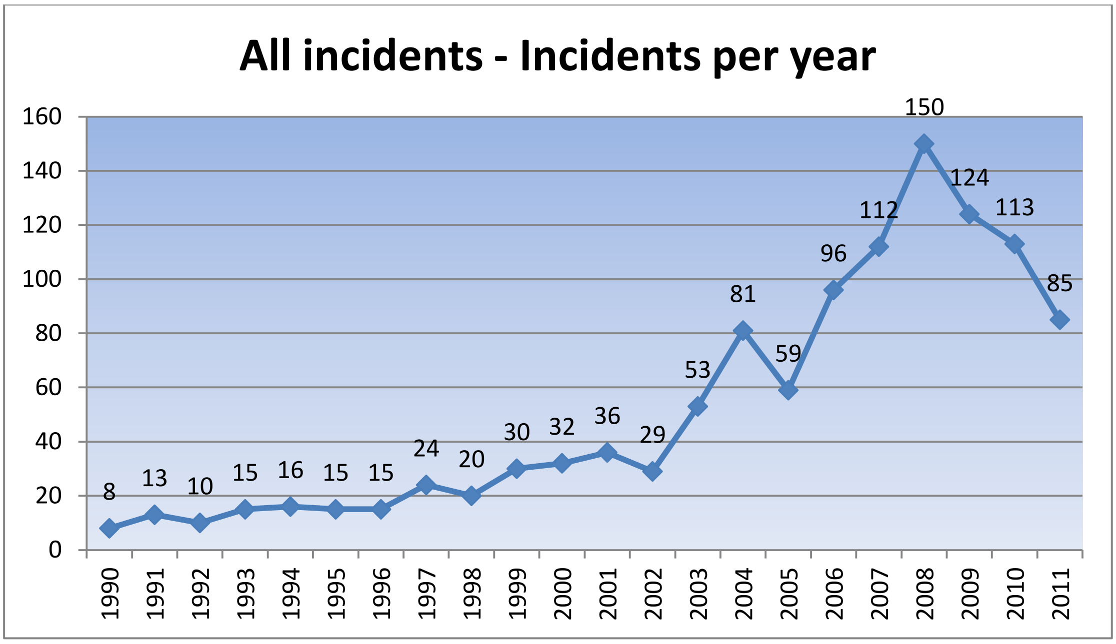


Generally, fire and explosion are the most hazardous categories as far as the human losses/injuries are concerned.

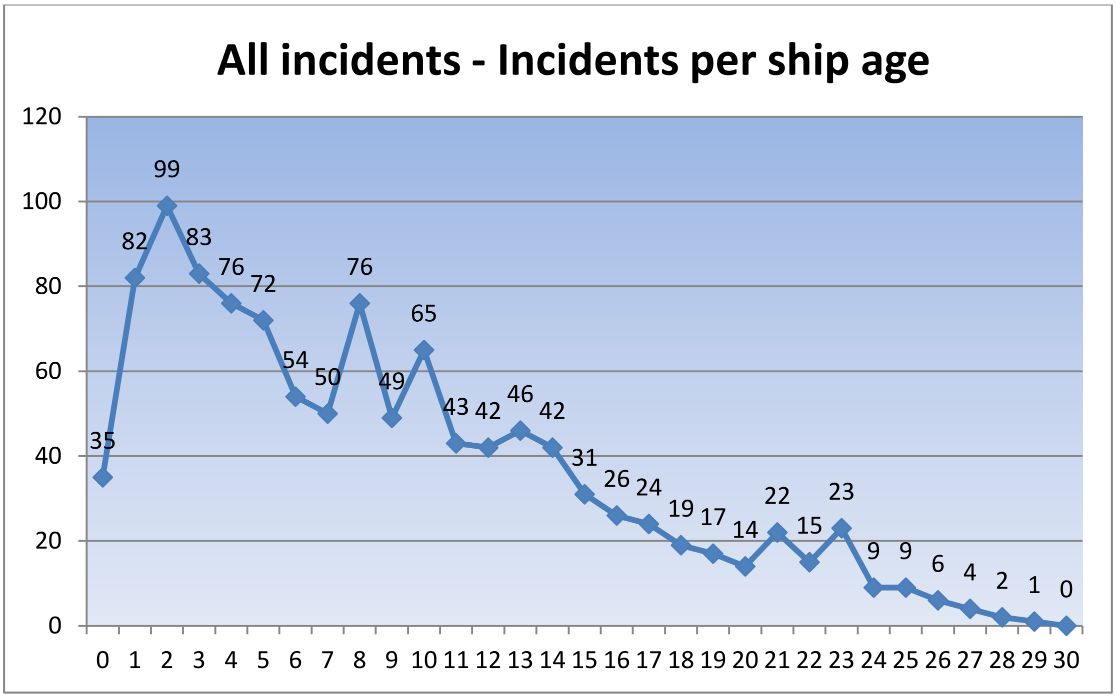
5.3 Frequencies of all incidents



Ships built per year	Collision	Grounding	Contact	Fire	Explosion	Machinery	Structural	Hull fittings
1981	2	0	0	2	0	0	0	0
1982	15	8	1	3	1	15	0	1
1983	5	8	1	7	0	6	4	0
1984	6	2	4	3	1	9	0	0
1985	10	5	3	8	2	9	2	0
1986	8	6	2	4	0	10	0	0
1987	3	5	1	1	0	7	0	1
1988	5	3	2	2	1	2	0	2
1989	6	4	3	2	0	5	0	1
1990	6	3	5	2	0	10	0	0
1991	8	8	4	1	1	6	1	0
1992	13	3	1	1	1	13	3	0
1993	15	2	5	4	1	19	1	0
1994	16	13	5	4	0	13	3	2
1995	22	11	3	2	1	21	6	1
1996	16	14	12	2	1	21	3	1
1997	23	12	6	3	1	21	1	2
1998	19	14	6	3	3	23	0	1
1999	6	7	2	1	0	11	1	1
2000	15	14	8	2	0	4	0	0
2001	16	9	7	2	1	7	0	2
2002	18	10	3	5	2	14	1	0
2003	12	10	3	1	1	16	0	0
2004	15	6	2	2	0	10	2	0
2005	16	12	5	1	0	12	2	1
2006	15	11	8	6	0	7	1	1
2007	12	7	3	1	0	8	1	1
2008	9	6	1	2	0	9	1	3
2009	7	3	2	1	0	4	0	0
2010	4	2	2	0	0	3	0	0
Total	343	218	110	78	18	315	33	21

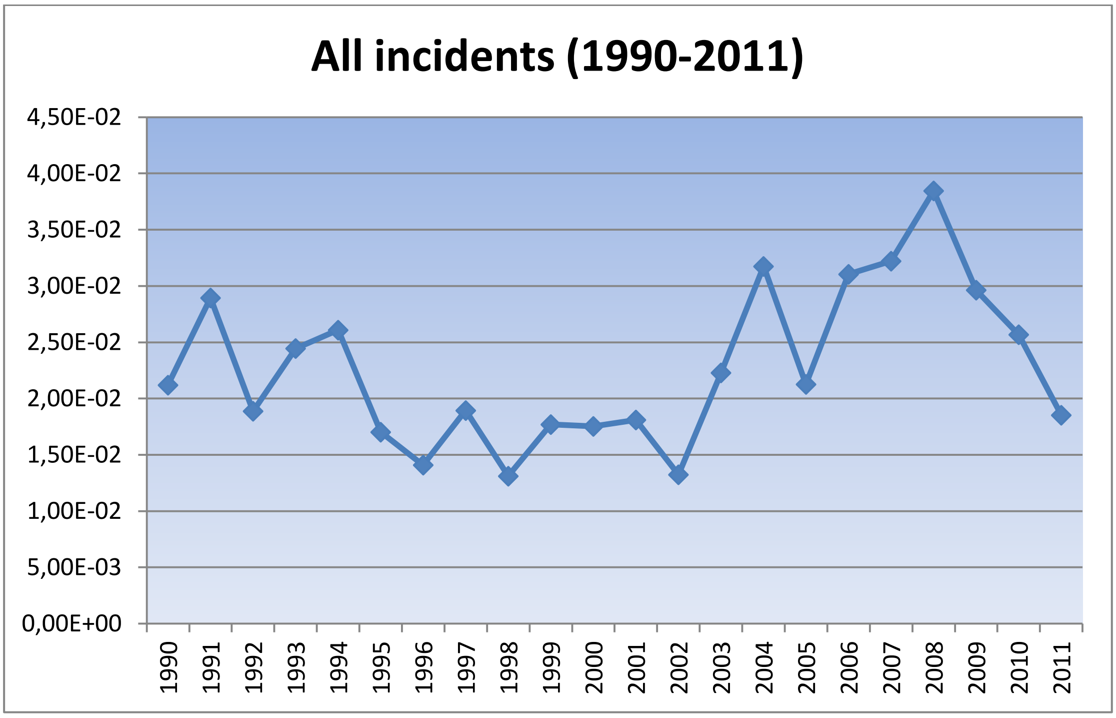


Incidents per year	Collision	Grounding	Contact	Fire	Explosion	Machinery	Structural	Hull fittings
1990	3	0	0	1	0	4	0	0
1991	1	3	2	3	1	3	0	0
1992	2	4	2	1	0	1	0	0
1993	2	1	1	2	1	5	3	0
1994	4	4	1	2	1	4	0	0
1995	3	3	2	2	0	5	0	0
1996	2	3	0	1	0	7	2	0
1997	6	4	1	2	1	9	1	0
1998	4	4	1	2	1	5	2	1
1999	12	3	5	2	1	6	1	0
2000	9	3	6	3	2	9	0	0
2001	7	6	7	3	0	11	0	2
2002	10	4	1	1	1	8	3	1
2003	16	12	4	4	1	12	2	2
2004	30	17	6	5	1	21	1	0
2005	20	14	2	4	0	18	0	1
2006	30	18	8	7	3	24	6	0
2007	36	22	12	4	0	33	3	2
2008	40	30	18	11	0	45	2	4
2009	36	27	12	5	3	31	3	7
2010	43	16	10	9	1	31	3	0
2011	27	20	9	4	0	23	1	1
Total	343	218	110	78	18	315	33	21



Incidents per ship age	Collision	Grounding	Contact	Fire	Explosion	Machinery	Structural	Hull fittings
0	9	5	5	3	2	8	2	1
1	25	22	9	3	2	17	2	2
2	31	24	12	5	0	23	2	2
3	22	20	5	6	0	27	2	1
4	29	8	9	4	1	22	3	0
5	25	15	7	4	1	18	1	1
6	17	9	3	4	1	15	3	2
7	12	11	5	4	1	15	1	1
8	21	13	7	7	2	22	2	2
9	14	16	4	1	1	12	1	0
10	17	12	8	5	1	16	4	2
11	14	7	5	3	0	12	2	0
12	11	8	1	0	4	17	0	1
13	18	4	7	2	0	13	1	1
14	17	4	3	3	0	15	0	0
15	7	4	7	1	1	7	2	2
16	4	3	3	4	0	9	2	1
17	7	1	3	4	0	8	1	0
18	3	6	1	2	0	7	0	0
19	6	4	2	1	0	4	0	0
20	5	2	1	2	0	4	0	0
21	10	4	1	2	0	4	1	0
22	7	4	0	1	0	2	0	1
23	9	3	0	1	0	9	0	1
24	1	2	0	1	1	4	0	0
25	1	3	1	2	0	2	0	0
26	0	3	0	1	0	2	0	0
27	0	0	1	2	0	0	1	0
28	0	1	0	0	0	1	0	0
29	1	0	0	0	0	0	0	0
Total	343	218	110	78	18	315	33	21

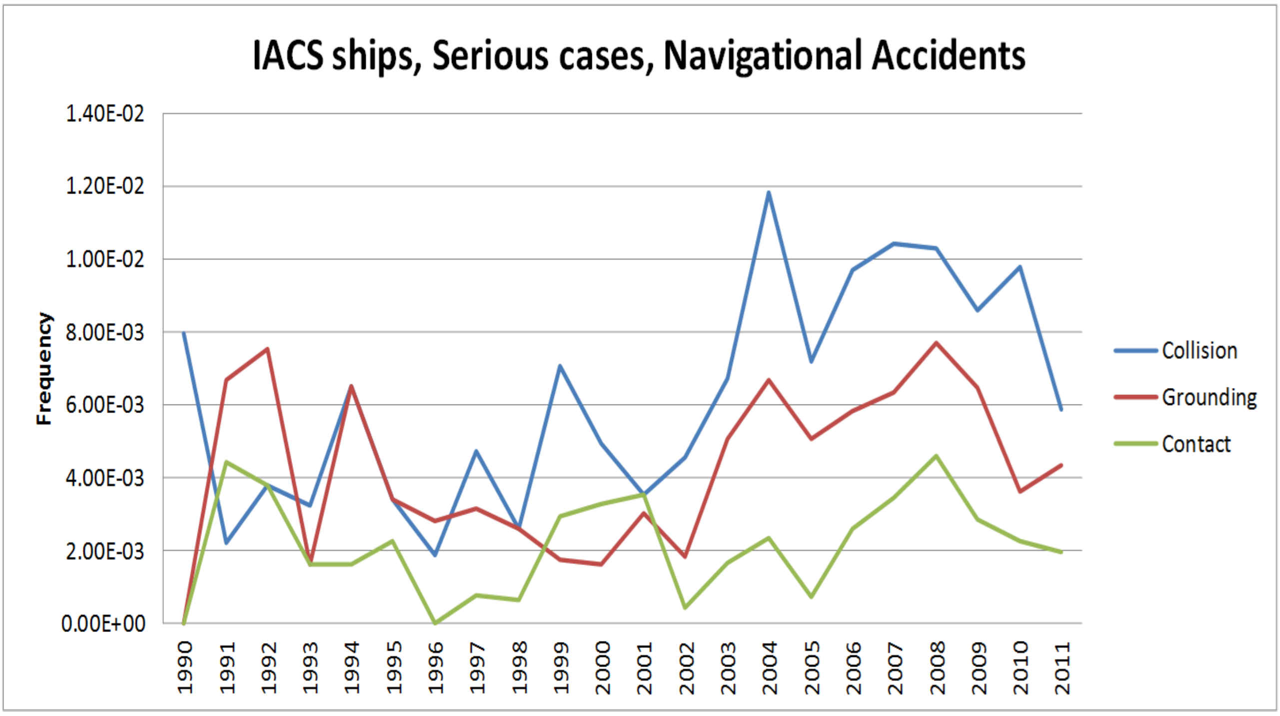
It is rather obvious that the majority of incidents occur during the first operational years of the containerships. This applies to all navigational incident categories and the machinery failure events.

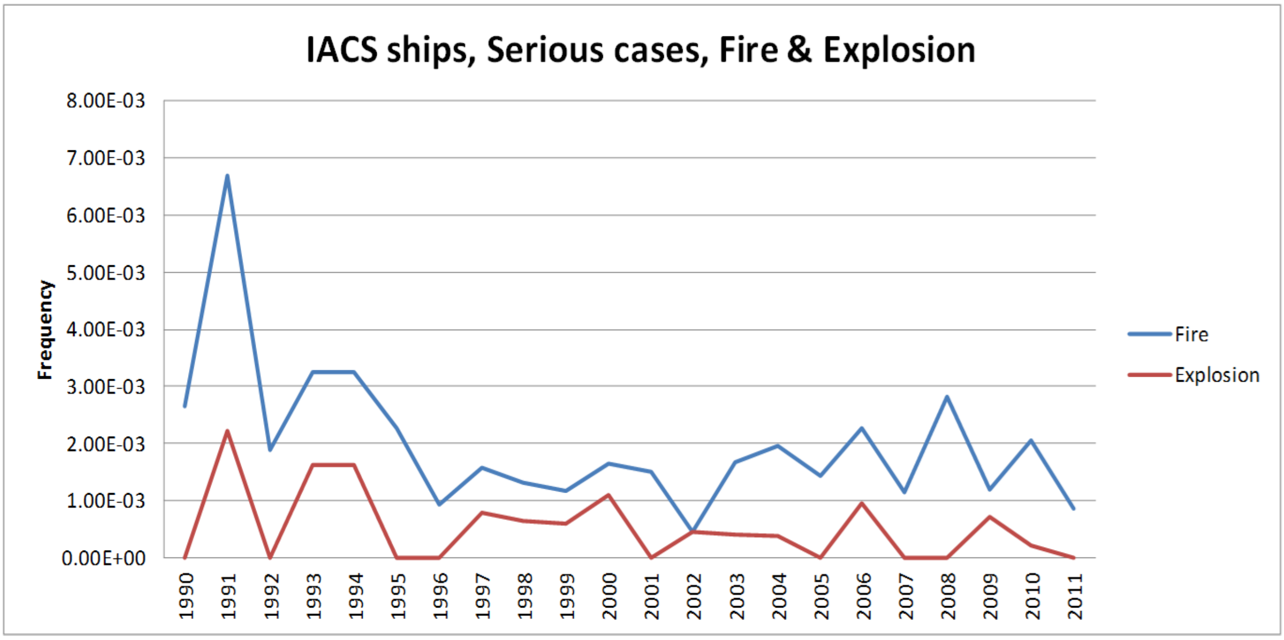


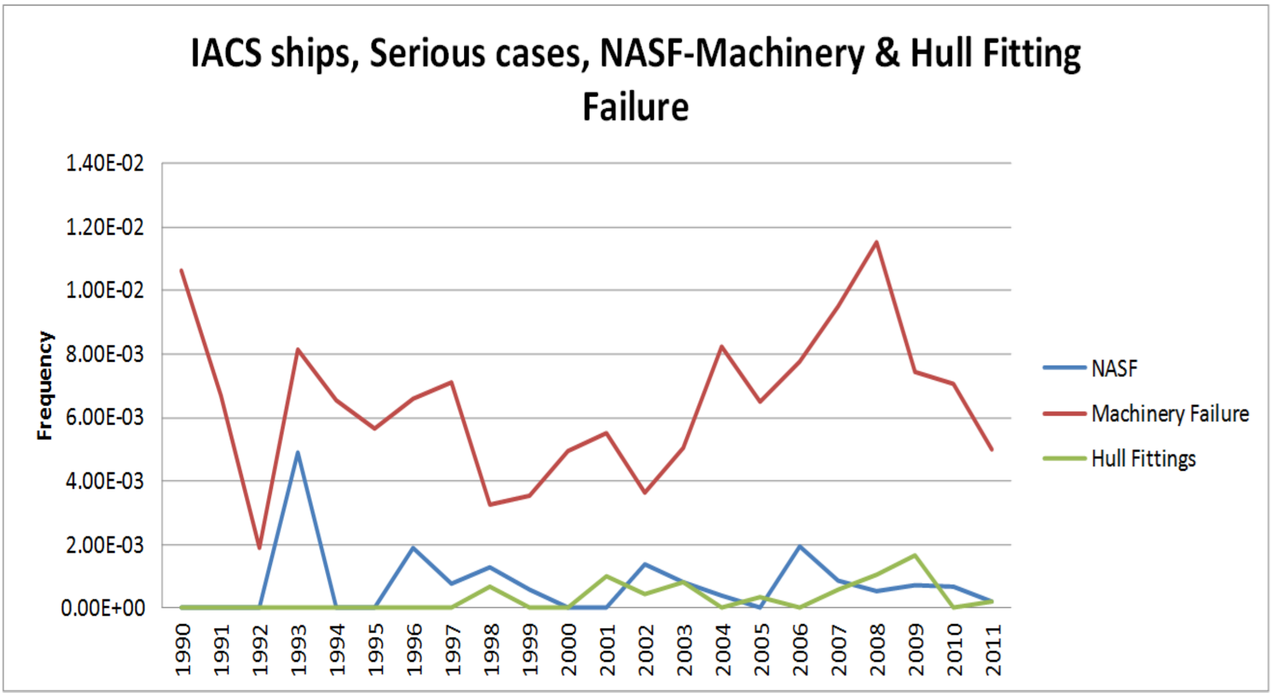
Frequencies	Collision	Grounding	Contact	Fire	Explosion	Machinery	Structural	Hull fittings
1990	7,95E-03	0,00E+00	0,00E+00	2,65E-03	0,00E+00	1,06E-02	0,00E+00	0,00E+00
1991	2,23E-03	6,68E-03	4,45E-03	6,68E-03	2,23E-03	6,68E-03	0,00E+00	0,00E+00
1992	3,78E-03	7,55E-03	3,78E-03	1,89E-03	0,00E+00	1,89E-03	0,00E+00	0,00E+00
1993	3,26E-03	1,63E-03	1,63E-03	3,26E-03	1,63E-03	8,15E-03	4,89E-03	0,00E+00
1994	6,52E-03	6,52E-03	1,63E-03	3,26E-03	1,63E-03	6,52E-03	0,00E+00	0,00E+00
1995	3,40E-03	3,40E-03	2,27E-03	2,27E-03	0,00E+00	5,67E-03	0,00E+00	0,00E+00
1996	1,88E-03	2,82E-03	0,00E+00	9,40E-04	0,00E+00	6,58E-03	1,88E-03	0,00E+00
1997	4,74E-03	3,16E-03	7,89E-04	1,58E-03	7,89E-04	7,10E-03	7,89E-04	0,00E+00
1998	2,62E-03	2,62E-03	6,56E-04	1,31E-03	6,56E-04	3,28E-03	1,31E-03	6,56E-04
1999	7,08E-03	1,77E-03	2,95E-03	1,18E-03	5,90E-04	3,54E-03	5,90E-04	0,00E+00
2000	4,93E-03	1,64E-03	3,29E-03	1,64E-03	1,10E-03	4,93E-03	0,00E+00	0,00E+00
2001	3,52E-03	3,02E-03	3,52E-03	1,51E-03	0,00E+00	5,53E-03	0,00E+00	1,01E-03
2002	4,57E-03	1,83E-03	4,57E-04	4,57E-04	4,57E-04	3,65E-03	1,37E-03	4,57E-04
2003	6,73E-03	5,05E-03	1,68E-03	1,68E-03	4,21E-04	5,05E-03	8,41E-04	8,41E-04
2004	1,18E-02	6,66E-03	2,35E-03	1,96E-03	3,92E-04	8,23E-03	3,92E-04	0,00E+00
2005	7,21E-03	5,05E-03	7,21E-04	1,44E-03	0,00E+00	6,49E-03	0,00E+00	3,60E-04
2006	9,70E-03	5,82E-03	2,59E-03	2,26E-03	9,70E-04	7,76E-03	1,94E-03	0,00E+00
2007	1,04E-02	6,33E-03	3,45E-03	1,15E-03	0,00E+00	9,49E-03	8,63E-04	5,75E-04
2008	1,03E-02	7,69E-03	4,61E-03	2,82E-03	0,00E+00	1,15E-02	5,13E-04	1,03E-03
2009	8,60E-03	6,45E-03	2,87E-03	1,20E-03	7,17E-04	7,41E-03	7,17E-04	1,67E-03
2010	9,77E-03	3,64E-03	2,27E-03	2,05E-03	2,27E-04	7,05E-03	6,82E-04	0,00E+00
2011	5,89E-03	4,36E-03	1,96E-03	8,72E-04	0,00E+00	5,01E-03	2,18E-04	2,18E-04

In general, it would be expected that the number and frequency of accidents for all types of ships (thus also of containerships) would have a decreasing trend over the years. This trend is clearly visible for tankers and can be attributed to enhanced safety regulations and improved technology/operation of the ships.

On the other side, congestion of traffic in some areas may lead to the opposite trend. This is in the present case visible with the increase of navigational incidents. For instance, collision incidents, that constitute one third of the incidents in total, were highly increased from 2004 and on. Totally, 262 collision incidents took place in this period whereas all collision incidents from 1990 are 343. However, the frequencies of these incidents nowadays revert to the same levels as before 2003.




IACS ships, Serious cases, Fire & Explosion
Frequency
8.00E-03
7.00E-03
6.00E-03
5.00E-03
4.00E-03
3.00E-03
2.00E-03
1.00E-03
0.00E+00
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Fire
Explosion


IACS ships, Serious cases, NASF-Machinery & Hull Fitting Failure
Frequency
1.40E-02
1.20E-02
1.00E-02
8.00E-03
6.00E-03
4.00E-03
2.00E-03
0.00E+00
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
NASF
Machinery Failure
Hull Fittings

6. COMPARISON OF RESULTS WITH SAFEDOR FSA

SAFEDOR FSA-Sampling plan

- Input database: LMIU
- Fully cellular containerships (UCC)
- Calculated period: 1993-2004
- Ships with minimum DWT are excluded (<100GT, LMIU provision).
- All incidents regardless the degree of accidents' severity.

Updated results-Sampling Plan

- Input databases: HIS, LMIU, GISIS
- Fully cellular containerships
- Calculated period: 1990-2011
- Excluded ships <999 GT
- Excluded ships built before 1980
- Included only IACS ships
- Only serious cases

SAFEDOR FSA-Investigated hazards

- Collision
- Contact
- Grounding
- Fire/Explosion
- Water ingress in container hold

Updated results-Investigated hazards

- Collision
- Contact
- Grounding
- Fire
- Explosion
- Non-accidental structural failure
- Hull Fittings failure
- Machinery failure

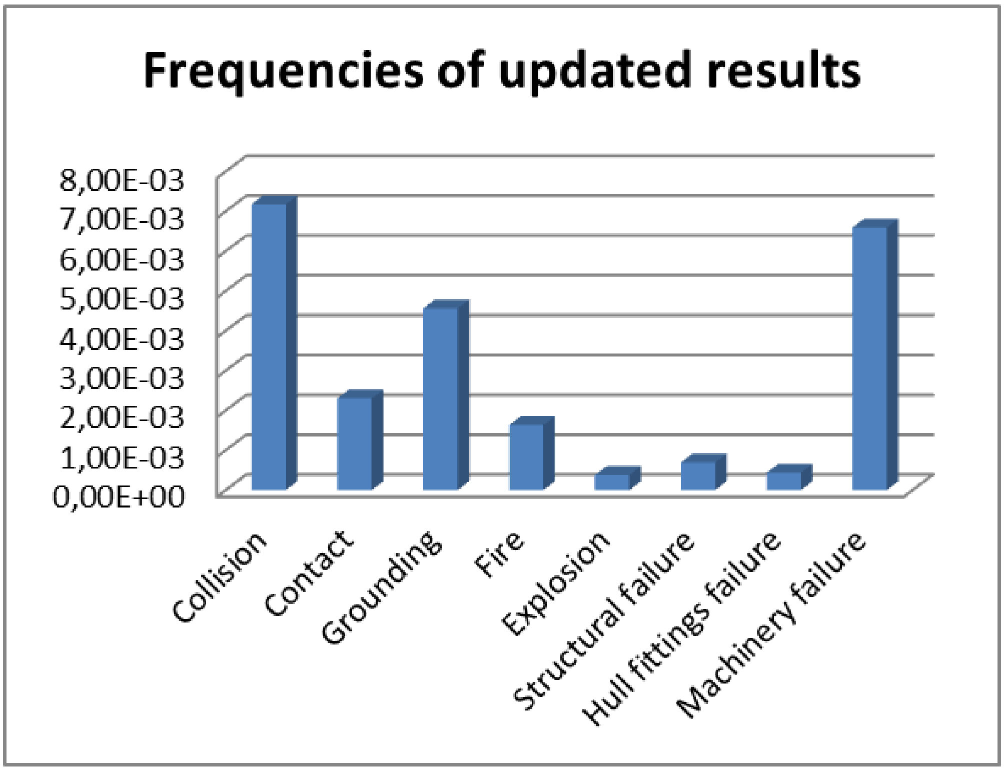
Incident type	Percentage	Incident type FSA	Percentage FSA
Structural failure	2,90%	Hull damage	3%
Hull fittings failure	1,85%		
Collision	30,19%	Collision	29%
Contact	9,68%	Contact	7%
Grounding	19,19%	Stranded	12%
Fire	6,87%	Fire/Explosion	5%
Explosion	1,58%		
Machinery failure	27,73%	Machinery	25%

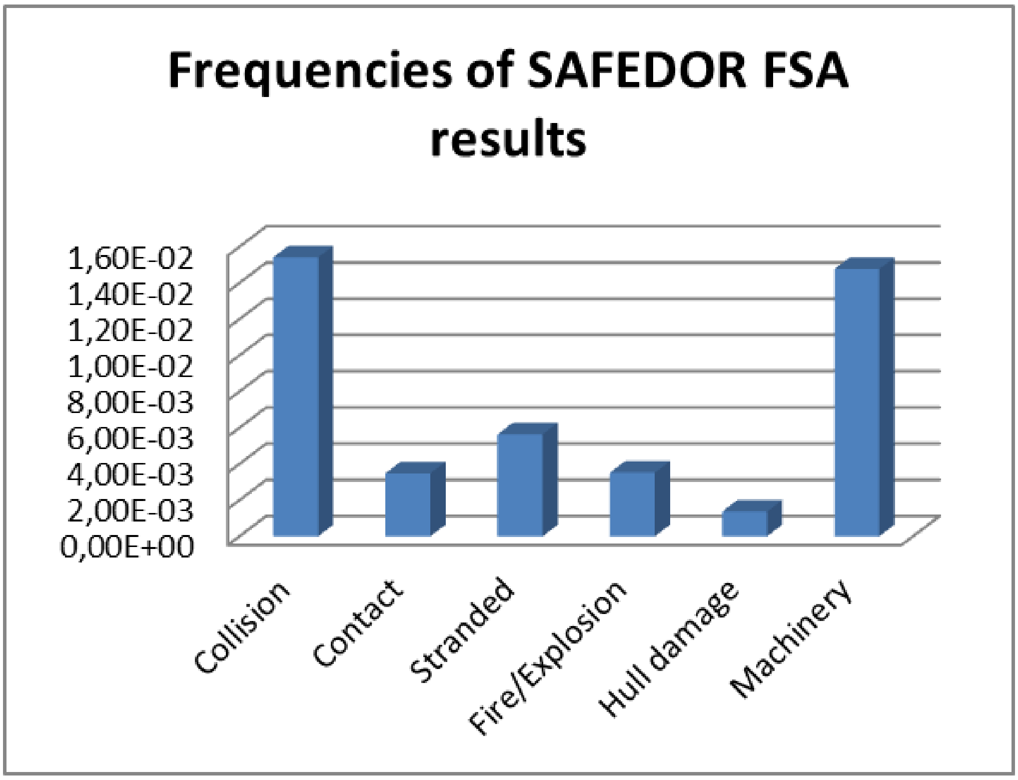
We note that almost all the percentages are similar. Only the grounding events seem to have been increased over the last years.

Incident type	No of incidents	Fleet	Frequency	Incident type FSA	No of incidents FSA	Fleet FSA	Frequency FSA
Structural failure	33	47798	6,90E-04	Hull damage	42	30682	1,37E-03
Hull fittings failure	21	47798	4,39E-04				
Collision	343	47798	7,18E-03	Collision	473	30682	1,54E-02
Contact	110	47798	2,30E-03	Contact	107	30682	3,49E-03
Grounding	218	47798	4,56E-03	Stranded	173	30682	5,64E-03
Fire	78	47798	1,63E-03	Fire/Explosion	108	30682	3,52E-03
Explosion	18	47798	3,77E-04				
Machinery failure	315	47798	6,59E-03	Machinery	453	30682	1,48E-02

It is clear that the frequencies of the incidents cannot be yet compared because in the current study only the serious events on IACS ships are examined. Nevertheless, the trends of the incidents frequency can be observed and seem to be very similar.

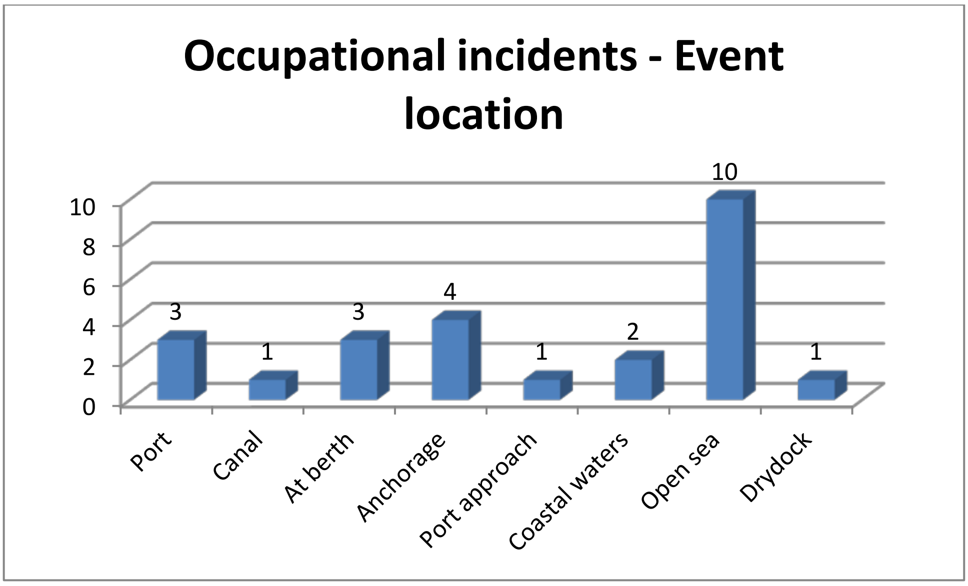
In case of consequence evaluation, particularly for calculating PLL values, special attention is needed because “serious accidents” of non-IACS ships may have significant number of fatalities.
i.e. In one case, the vessel was lost and the recorded number of fatalities was 11 persons. The particular accident is not accounted to the current study because the vessel was not IACS ship.

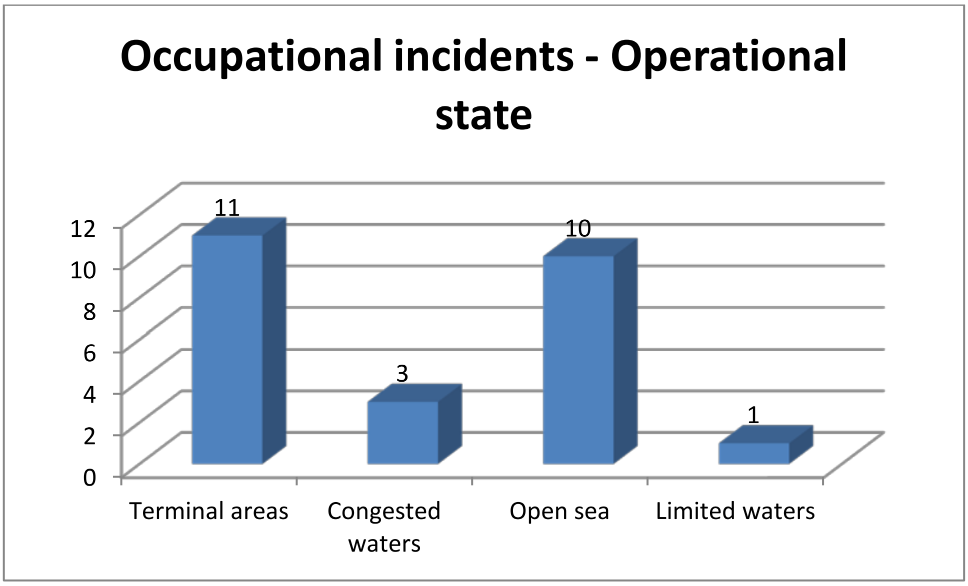

Frequencies of updated results
8,00E-03
7,00E-03
6,00E-03
5,00E-03
4,00E-03
3,00E-03
2,00E-03
1,00E-03
0,00E+00
Collision
Contact
Grounding
Fire
Explosion
Structural failure
Hull fittings failure
Machinery failure

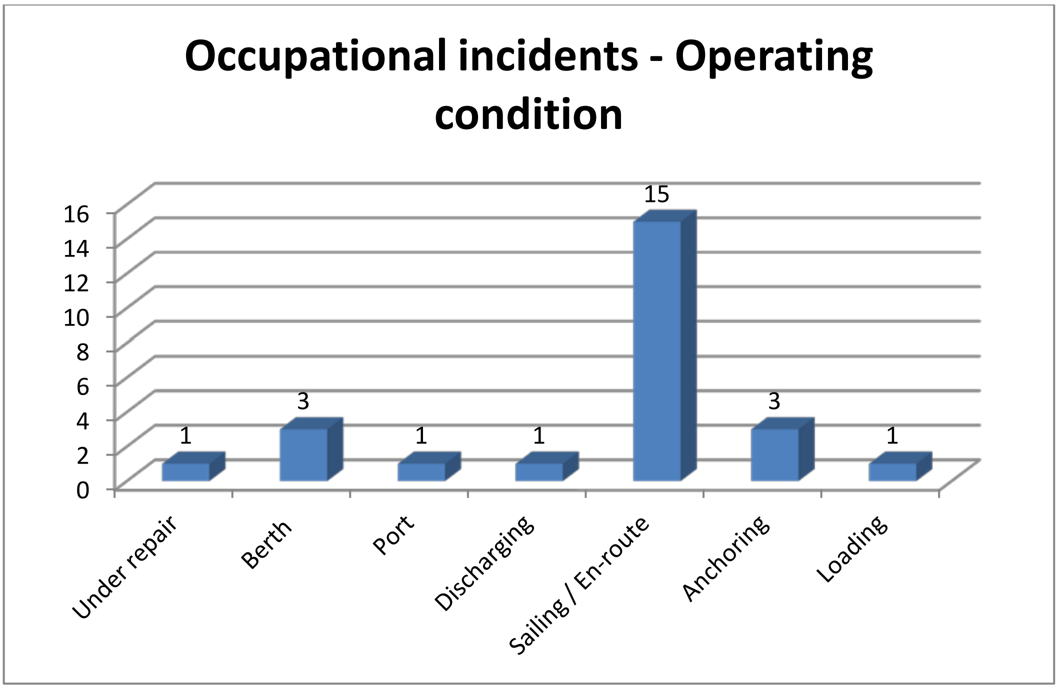

Frequencies of SAFEDOR FSA results
1,60E-02
1,40E-02
1,20E-02
1,00E-02
8,00E-03
6,00E-03
4,00E-03
2,00E-03
0,00E+00
Collision
Contact
Stranded
Fire/Explosion
Hull damage
Machinery

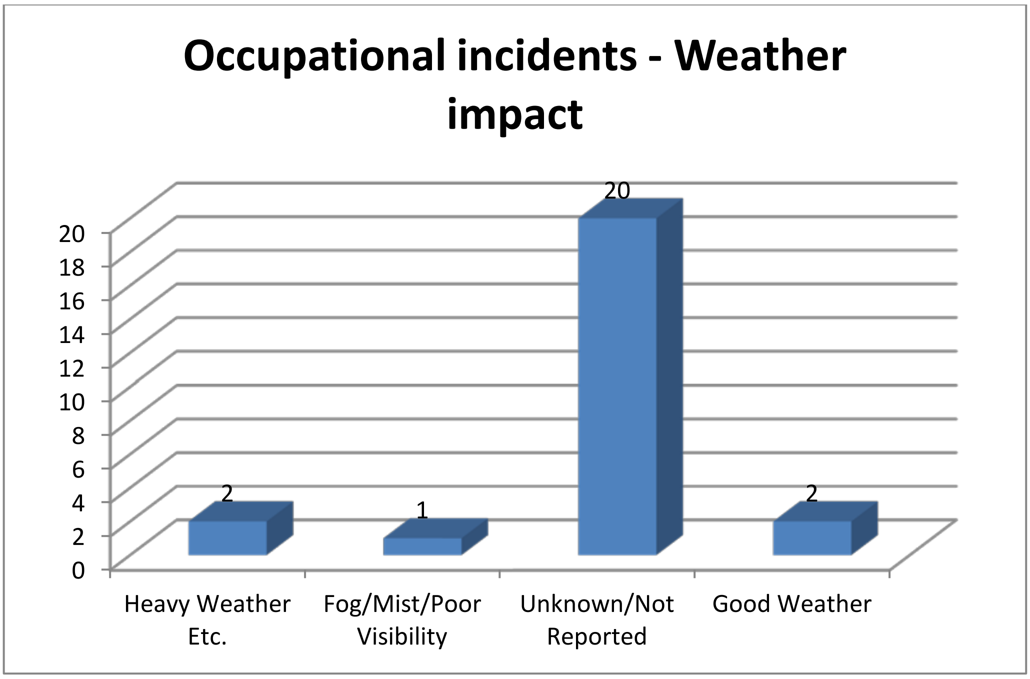
7. ANALYSIS OF OCCUPATIONAL INCIDENTS

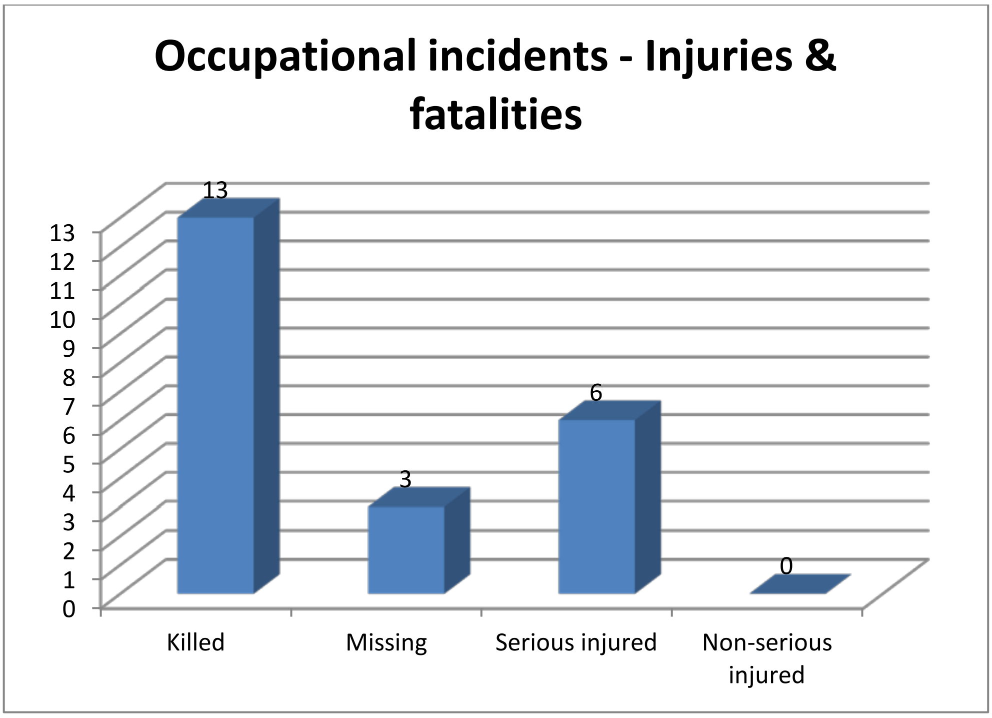
IHS and LMIU databases don't record purely occupational incidents. Injuries or fatalities of the crew onboard are only recorded as consequences of the incident. GISIS database includes also clearly occupational incidents. 25 investigation reports of occupational incidents were provided by Germanischer Lloyd. The study of these reports led to the Fault Tree analysis.





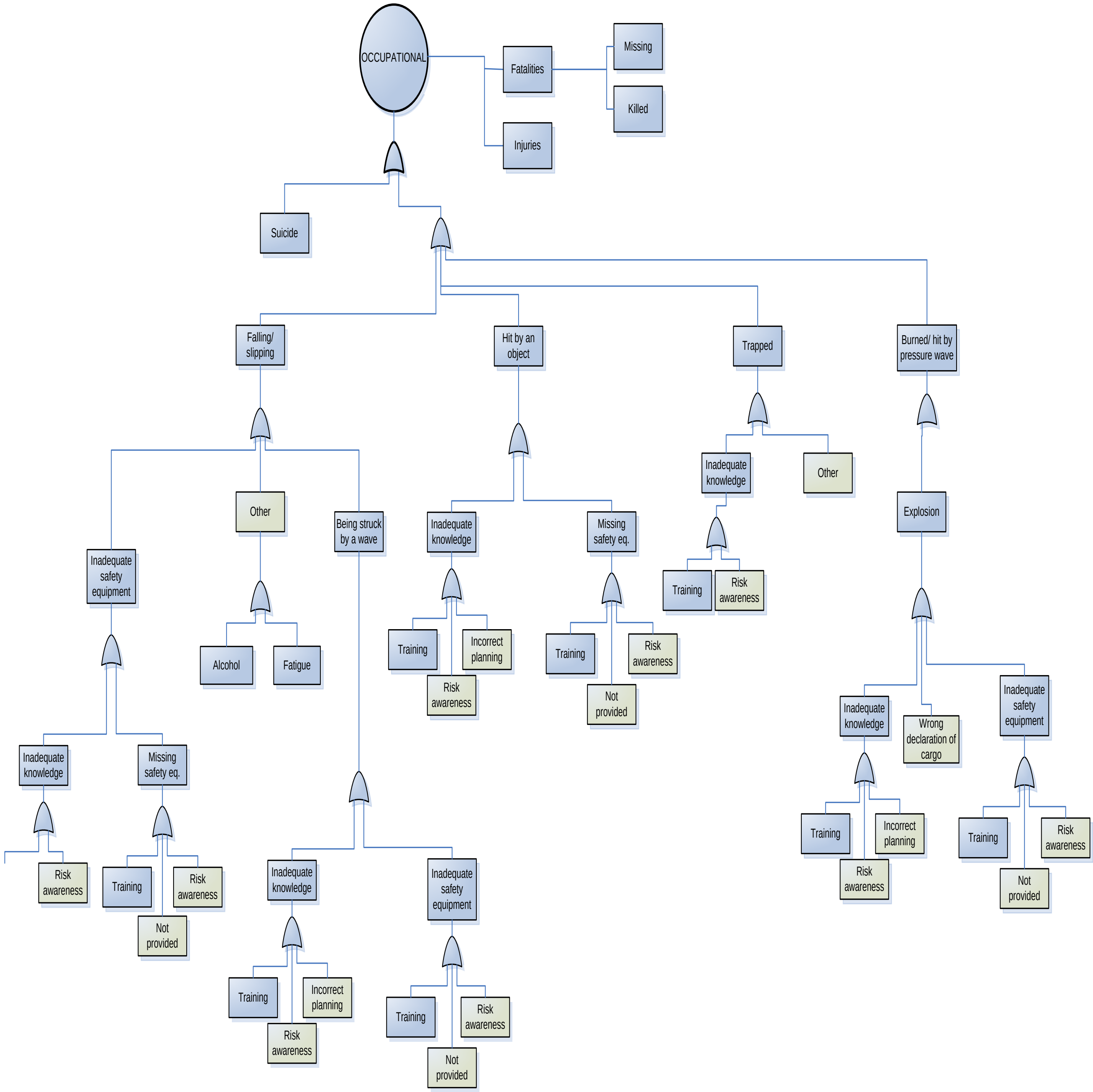

Occupational incidents - Operating condition
16
14
12
10
8
6
4
2
0
1
3
1
1
15
3
1
Under repair
Berth
Port
Discharging
Sailing / En-route
Anchoring
Loading


Occupational incidents - Weather impact
20
18
16
14
12
10
8
6
4
2
0
2
1
20
2
Heavy Weather Etc.
Fog/Mist/Poor Visibility
Unknown/Not Reported
Good Weather



Almost by half the cases of the occupational incidents the fault was either falling or slipping. In the majority of these incident cases a member of the crew was missing and didn’t report for duty. Therefore, it was assumed that the crew member fell into the sea while the ship was on voyage. There were also two incidents where the crew fell into sea because they were being struck by wave and on one occasion a crew member fell from the ladder as a result of intoxication. On four cases crew members were being hit by objects, such as rope. Three members were trapped during maintenance works. Finally, two persons were burned/hit by pressure wave (i.e. turbocharger). All the above information can be easily understood in the following fault tree of the occupational accidents that were examined.

Fault tree


OCCUPATIONAL
Fatalities
Missing
Killed
Injuries
Suicide
Falling/ slipping
Hit by an object
Trapped
Burned/ hit by pressure wave
Inadequate safety equipment
Other
Being struck by a wave
Inadequate knowledge
Missing safety eq.
Inadequate knowledge
Other
Explosion
Alcohol
Fatigue
Training
Incorrect planning
Risk awareness
Training
Risk awareness
Not provided
Training
Risk awareness
Inadequate knowledge
Missing safety eq.
Risk awareness
Training
Risk awareness
Not provided
Inadequate knowledge
Wrong declaration of cargo
Inadequate safety equipment
Training
Incorrect planning
Risk awareness
Training
Risk awareness
Not provided
Inadequate knowledge
Inadequate safety equipment
Training
Incorrect planning
Risk awareness
Training
Risk awareness
Not provided

8. CONCLUSIONS

After the completion of this study we have formed an opinion on the behavior of the containerships as far as the maritime incidents in the period 1990-2011 are concerned.

The casualty database that is commonly used in the present study is the IHS database. Most data used throughout this research are taken from IHS. There are also some incidents from the LMIU and GISIS database that weren't recorded in the IHS database. These incidents are examined as well.

IHS database has more flexible criterias for the definition of the serious degree than LMIU. A great number of incidents that were recorded in both databases were further examined in order to compare the severity degree. In most cases, the same incident was counted as serious in IHS database whereas in LMIU was counted as not serious. In fact, in IHS database there are cases where an accident is considered serious even if minor damages were sustained and/or the repairs lasted only a couple of days. On the other hand, LMIU pays attention only to the seaworthiness of the ship, regardless of oil spills, loss of cargo and even LOWI (Loss Of Watertight Integrity) sometimes. GISIS database is a recent attempt of IMO to gather important information about maritime incidents and therefore has only few incidents recorded. Its structure is very efficient and helpful for the analyst because it contains all the necessary information with details. For a great amount of incidents, their investigation reports are also available.

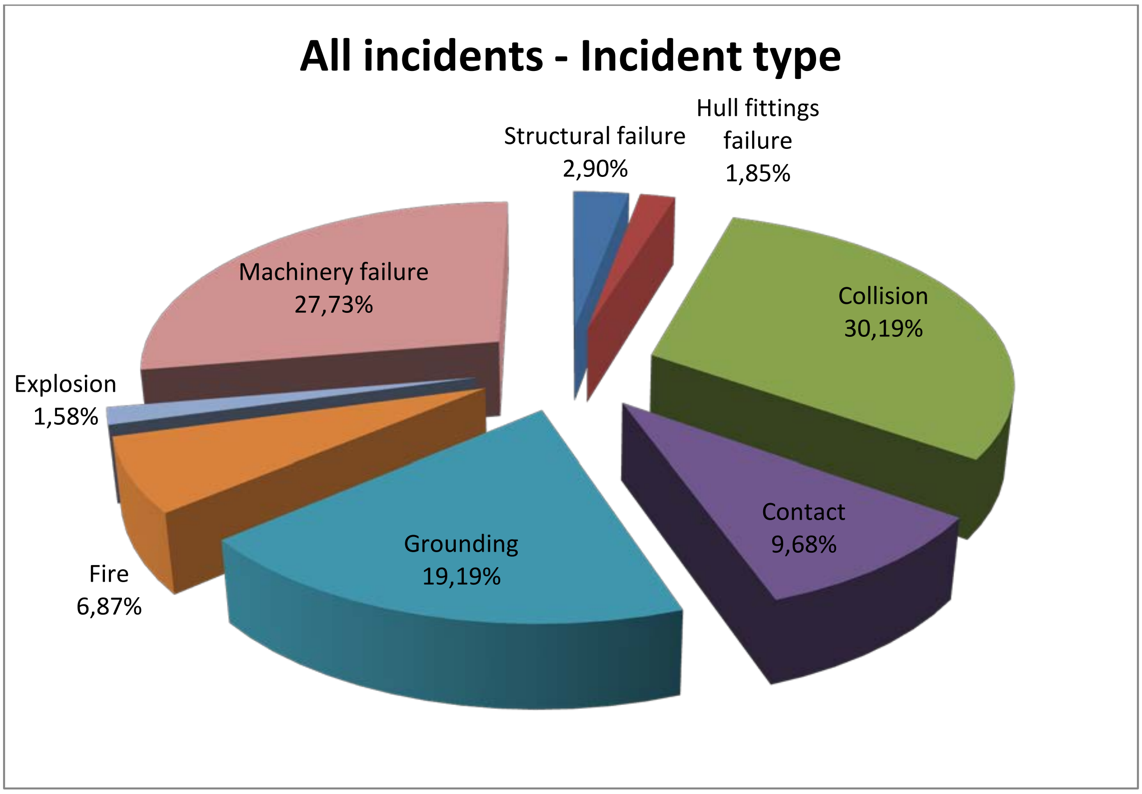
The IHS database holds in total 1354 incidents. The vast majority of the incidents are recorded as serious (82%). From these incidents, 1306 occurred on containerships that were registered to members of IACS at the time of incident. The percentage of the IACS containerships is calculated at 96,45%. This percentage is extremely high but it is in accordance with the information on the fleet at risk for IACS and Non-IACS containerships. For instance, for the year 2011 the fleet at risk for IACS containerships is 4587,88 whereas the fleet for Non-IACS and unknown containerships is 108,81 (2,37%) and 93,64 (2,04%) respectively.

Altogether 1136 incidents were examined for the period 1990-2011.

Casualty database	Number of incidents
IHS	1064
LMIU	33
GISIS	39
Total	1136

In this research were examined only the serious accidents of containerships which at the time of incidents were registered to IACS. The incidents were divided into eight categories for the purpose of this research: Collision (30,19%), Contact (9,68%), Grounding (19,19%), Fire (6,87%), Explosion (1,58%), Non-accidental structural failure (2,90%), Hull fittings failure (1,85%) and Machinery failure (27,73%).

Note that scenarios due to unknown reasons as well as incidents associated with piracy or war losses are not considered in the study. Collision, grounding and machinery failure incidents constitute almost 80% of the incidents in total.



These percentages are in accordance with those of the SAFEDOR FSA. Only the grounding incidents seem to have been increased over the last years.

Incident type	**Percentage**	**Incident type FSA**	**Percentage FSA**
Structural failure	2,90%	Hull damage	
Hull fittings failure	1,85%		3%
Collision	30,19%	Collision	29%
Contact	9,68%	Contact	7%
Grounding	19,19%	Stranded	12%
Fire	6,87%	Fire/Explosion	
Explosion	1,58%		5%
Machinery failure	27,73%	Machinery	25%

Collision (20% LOWI) and grounding (19% LOWI) incidents take place mainly in congested waters and terminal areas which constitute crossing routes with large ship speed variations and where dense ship traffic prevails. Many accidents occur also in limited waters where the capability of maneuvering is rather limited.

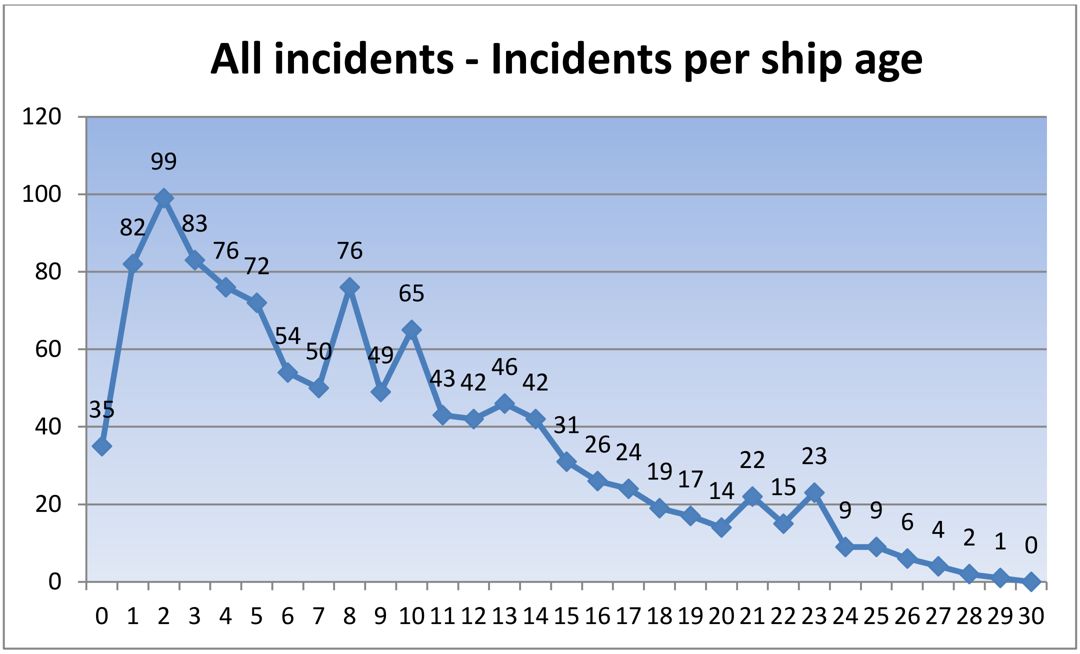
The vast majority of the contact incidents happen in terminal areas. More than 30% of the contact incidents are also followed by a loss of watertight integrity of the containership and 10% of release of oil.

Fire and explosion incidents take place mainly in the engine room. As a result, the containership often needs to be towed away subsequently. Some accidents occur also in the cargo area. Explosion incidents are followed by a fire in half the cases. Generally, fire and explosion are the most hazardous categories as far as the human losses/injuries are concerned. Fortunately, they demonstrate a decreasing tendency over the years. This is thanks to new regulations and all the precaution and safety measures that are being taken nowadays.

The vast majority of the machinery failure incidents occur in open sea where the ship is en route and all the machinery equipment is in operation. The propulsion system is the most sensitive part of the machinery equipment. Therefore, in almost 70% of the machinery incidents, the containership needed to be towed away subsequently.

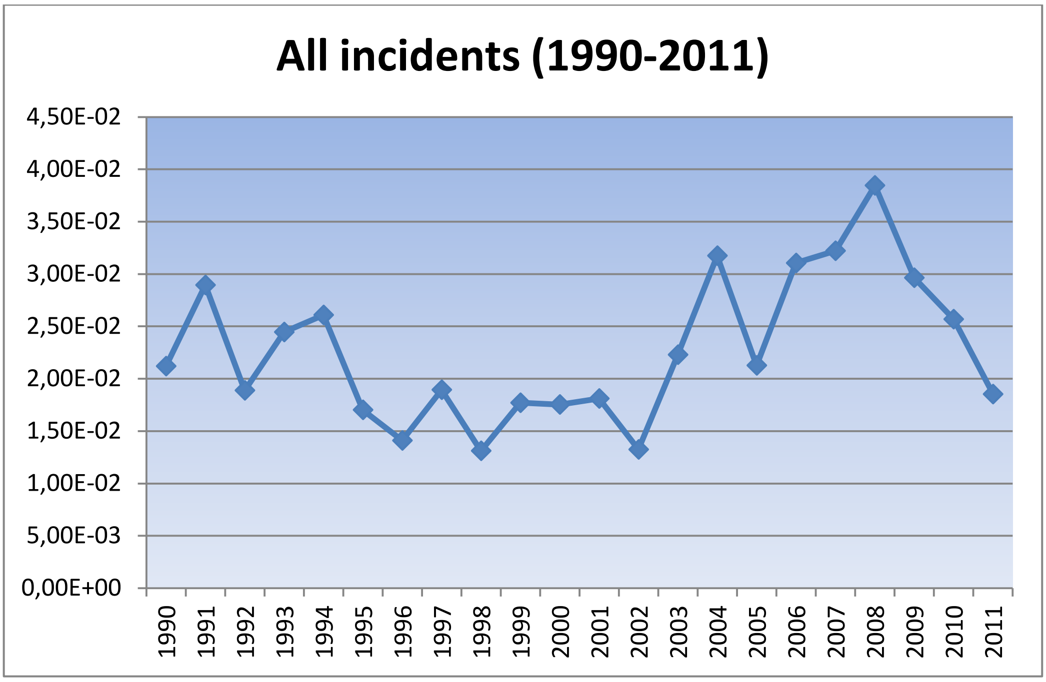
Structural failure and hull fittings failure are the two incidents categories that are most influenced by the prevailing weather conditions. In almost all the cases, where information on the weather impact was available, the accident occurred in heavy weather. Specifically, in the structural failure incident category are noted the highest percentages in loss of watertight integrity (51%) and release of oil (21%) as consequences of the accident.

The majority of the containerships that are included in the present research were built during 1994-2006. This is very important if we take also into account the fact that most incidents occur on containerships during the first operational years and especially the first five years.



In general, it would be expected that the number and frequency of accidents for all types of ships (thus also of containerships) would have a decreasing trend over the years. This trend is clearly visible for tankers and can be attributed to enhanced safety regulations and improved technology/operation of the ships.

On the other side, congestion of traffic in some areas may lead to the opposite trend. This is in the present case visible with the increase of navigational incidents. For instance, collision incidents, that constitute one third of the incidents in total, were highly increased from 2004 and on. Totally, 262 collision incidents took place in this period whereas all collision incidents from 1990 are 343. However, the frequencies of these incidents nowadays revert to the same levels as before 2003.



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INSTRUCTION MANUAL

inerships Incident Database

Ship Design Laboratory - National University of Athens

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CONTENTS

1. Preamble

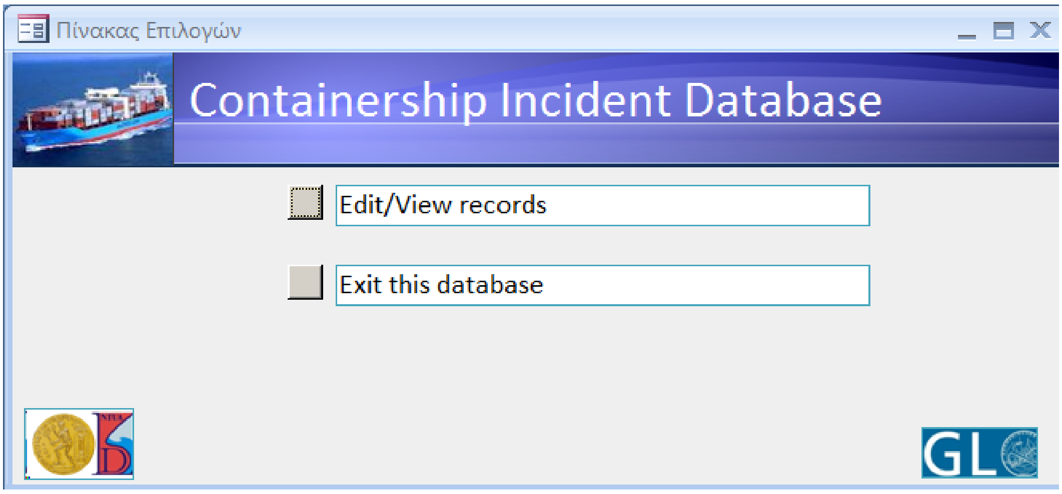
The Containerships Incident Database "**Container-Database.mde**" has been set-up by NTUA-SDL in MS ACCESS 2007 format and can run at any PC computer employing MS Office 2007 (and upwards). In its present form, the database includes accidental data of cellular containerships, as they were available to the Germanischer Lloyd. These data were imported into the database by NTUA-SDL to enable the further analysis of the data by both organisations. The present instructions manual aims at explaining some basic features of MS ACCESS 2007 and at supporting the analysis work of prospective Containerships Incident database users.

2. General Instructions

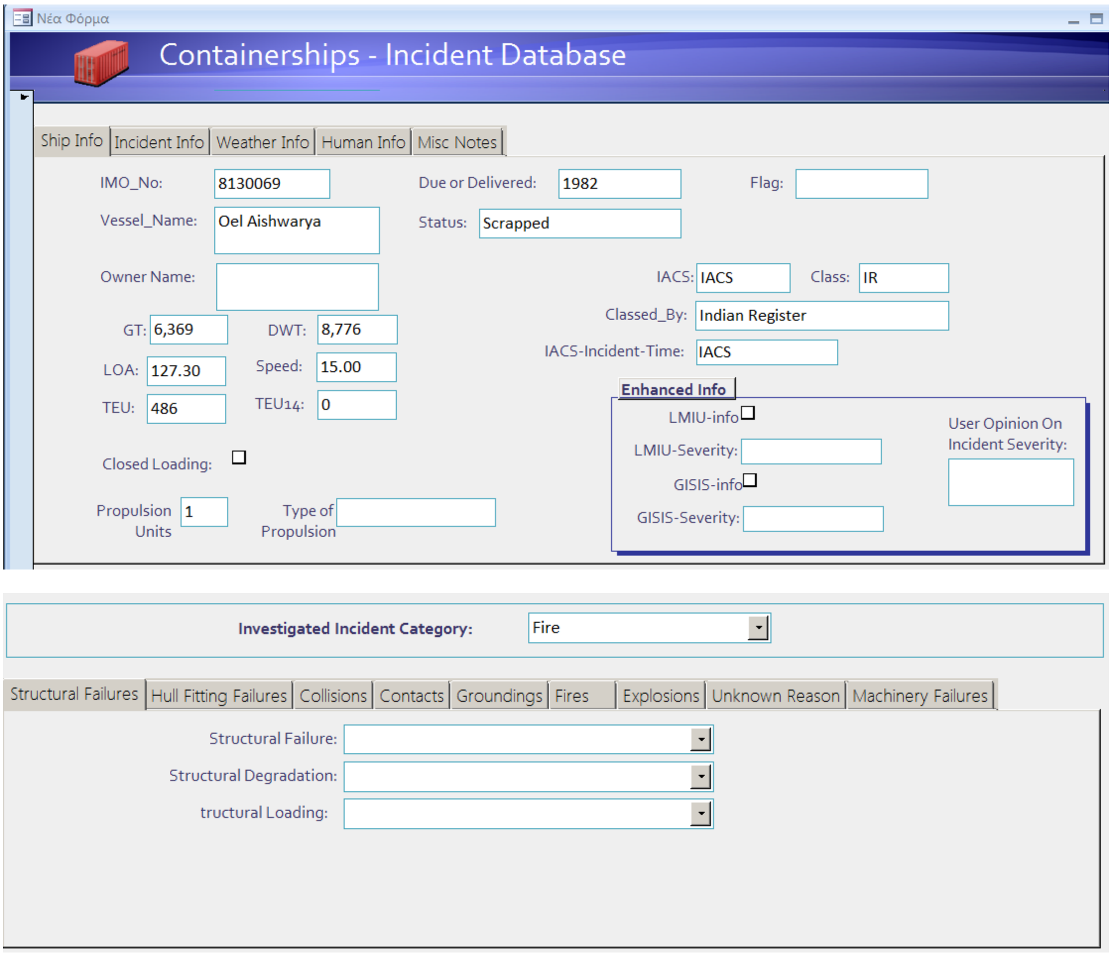
After opening the "**Container-Database.mde**" file, the Main Switchboard / menu appears, as shown in the figure below. It contains the following four options, namely:

i. Enter/View records

ii. Exit this database



By clicking on the button “**Enter/View Records**”, the casualties’ form appears.



The first part of the casualties’ form (General Data) contains five different tabs (Ship Info - Incident Info - Weather Info - Human Info - Misc Notes) and present general data, initially obtained by Germanischer Lloyd MS Excel files.

More specific:

Ship Info tab, contains general characteristics of the ship involved in the incident, following the definition of IHS Commercial Casualty Database.

In the right-down red box, the possibility of other initial source information is registered. In the vast majority of serious incidents’ recording the main source in IHS Commercial Casualty Database.

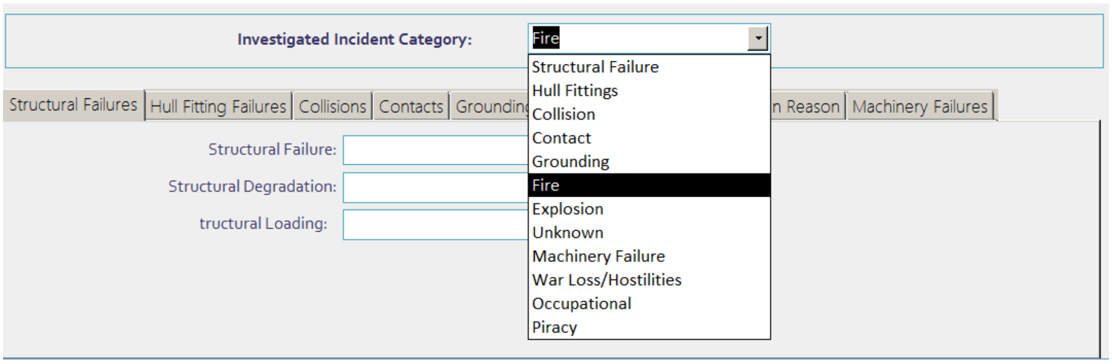
Notes:

- ✓ If the particular record is coming only from LMIU database then tick the box “LMIU-info”.

- ✓ If the particular record is coming from IHS but exists also in LMIU database then the accident's degree of severity according to LMIU is registered in the relevant box "LMIU-Severity".
- ✓ If the particular record is coming only from GISIS database then tick the box "GISIS-info".
- ✓ If the particular record is coming from IHS but exists also in GISIS database then the accident's degree of severity according to GISIS is registered in the relevant box "GISIS-Severity".
- ✓ Finally, in cases that there is no convergence on the categorisation of incident's severity then the user/analyst can register his personal opinion.

The tabs "**Incident Info**", "**Weather Info**", "**Human Life Info**" and "**Misc Notes**" are related to the incident event, to related weather conditions, to the loss of life because of the accident and general notes relevant to the incident. These tabs will be analysed in the next sections of this document.

After studying the available texts, the user/analyst should decide on the main accident/incident type. It is strongly recommended, when deciding on the main accident/incident type, to take into account the proposed categorization of the accident, as laid down in the box "Incident Category".



The user/analyst should then proceed and select by the drop-down menu one of the "Incident Category" fields, namely:

1. Structural Failure

As Non-Accidental Structural failure (NASF) is defined any hull damage such as cracks and fractures, affecting ship's seaworthiness or efficiency.

2. Hull Fittings

As Failure of Hull Fittings is defined any damage to ship's hull-fitting equipment/outfitting, affecting ship's seaworthiness or efficiency.

3. Collision

When the investigated vessel is the striking one or being struck by another ship, regardless of whether under way, anchored or moored. This category does not include striking wreck.

4. Contact

When the investigated vessel is striking any fixed or floating object other than those included under collision and grounding.

5. Grounding

When the investigated vessel being aground or hitting/touching shore, sea bottom or underwater objects (wrecks, etc.)

.

6. Fire

Where fire is the first initiating event reported.

7. Explosion

Where explosion is the first initiating event reported.

8. Machinery Failure

Where a technical failure of machinery or related system affecting ship's seaworthiness or efficiency. In addition, any damage to vessel's propeller, propeller portion or propeller adjoining parts is registered as machinery failure as well as any damage to a vessel rudder, or rudder-adjoining parts.

9. War Loss/Hostilities

10. Occupational

Occupational hazards with the potential of injuring, or in special circumstances even kill, individual crew members.

Once the selection of the main accident/incident type has been made, then the user/analyst should click on the relevant tab button (controller) of the particular main accident/incident type in order to proceed with the completion of the relevant fields.

For exiting the database form and returning to the Main Switchboard / menu, the user/analyst should tick the cross button of the database form window (the bold "x", but not the red coloured cross box of the MS Access above it, as this will lead to an exit from the database and no further actions can be taken).

Any data filled in the database form will be automatically saved when exiting. It is recommended before exiting the input session, to make sure that the input data are correct, as they will be automatically saved in the relevant MS Access database file. Revision of this data can be done any time since there is no "frozen action" operation of the database.

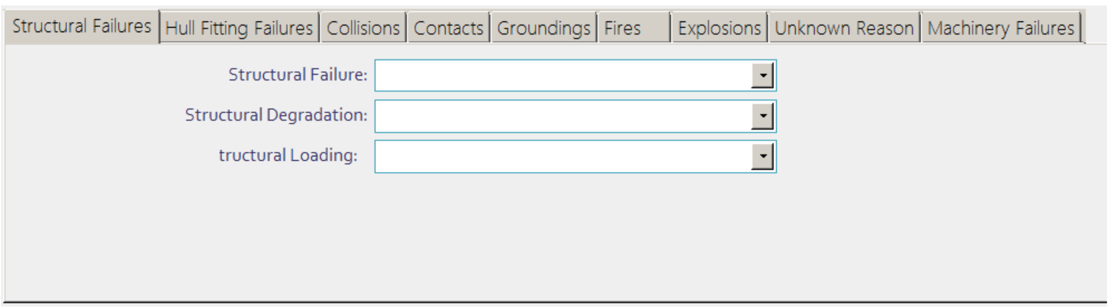
In the following, some guidance is provided for the proper interpretation of the laid-down FT scheme and the correct use of the database.

3. ACCIDENTAL CAUSAL DATA

3.1 FT-1: (Non-accidental) Structural Failure

If “**Structural Failure**” is selected, the user/analyst can choose from a drop-down menu one of the following three options:

- Structural degradation
- Poor design or construction
- Excessive loading



If the user/analyst chooses “Structural degradation”, the user/analyst should click on the one and only choice of the “Structural degradation” drop-down menu:

- Inadequate Maintenance / Ineffective Inspection AND Fatigue / Corrosion

If “Poor design or construction” is selected, then the user/analyst has no further choices/no further input requested.

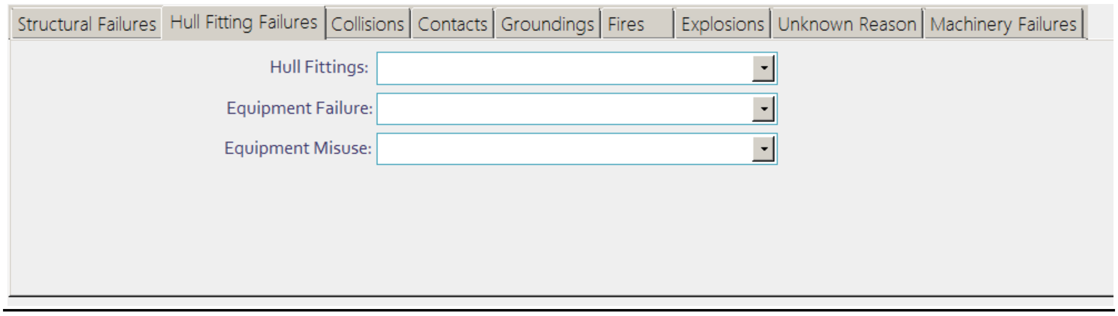
If the user/analyst chooses “Excessive loading”, the user/analyst should select one choice of the following drop-down menu:

- Operation in abnormal conditions
- Ballast related
- Cargo related

3.2 FT-2: Failure of Hull Fittings

If “**Failure of Hull Fittings**” is selected the user/analyst should choose from the “Failure of Hull Fittings” drop-down menu one of the following two options:

- Equipment Failure
- Misuse of equipment



If the user/analyst chooses “Equipment Failure”, the user/analyst should select one choice of the following drop-down menu:

- Failure of closing systems
- Chain locker failure
- Manhole failure
- Water Leakage through Ventilation Lines
- Equipment/Outfitting Failure
- Lashing Failure

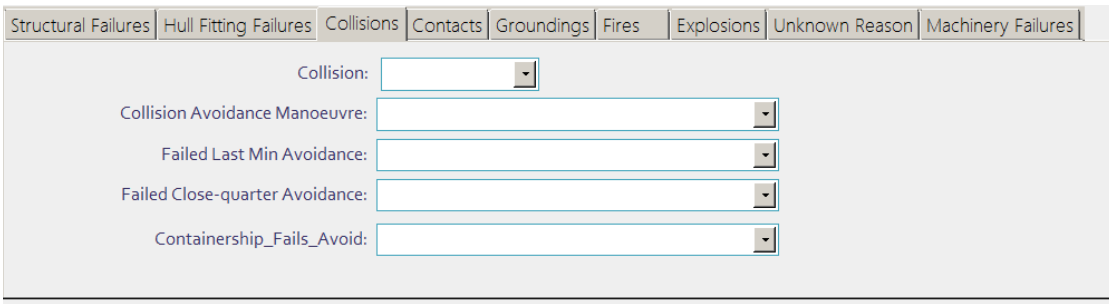
If the user/analyst chooses “Misuse of equipment”, the user/analyst should select one choice of the following drop-down menu:

- Misuse of Chainlocker
- Manhole left open
- Ventilation lines incorrectly open
- Misuse of Loading Equipment

3.3 FT-3 : Collision

If "**Collision**" is selected, the user/analyst then proceeds with choosing from the "Collision" drop-down menu the one and only choice:

- Struck
- Striking
- Unknown



If there are further details in the particular record, the user/analyst should choose one of the following options of the "Collision Avoidance Manoeuvre" drop-down menu:

- Failed Last Minute and Close-quarter avoidance

For the "Failed last-minute avoidance", the user/analyst can choose one of the following options of the drop-down menu:

- Combined avoidance causes collision
- Ship fails to avoid collision
- Internal communication Problem
- Crash stop failed

For the "Failed close quarter avoidance", the user/analyst can choose one of the following options of the drop-down menu:

- Ineffective early avoidance action
- Ship forced to accept collision hazard
- Own ship unaware of collision course

For the “Containership Fails Avoid”, the user/analyst can choose one of the following options of the drop-down menu:

- Failure to supervise route
- Failure of collision avoidance manoeuvre

3.4 FT-4: Contact

If “**Contact**” is selected, in the “Contact” tab the user/analyst should choose one of the following options of the “Contact” drop-down menu:

- With floating object
- With fixed installation

If “With floating object” is selected, the user/analyst should click one of the choices of the following drop-down menu:

- Object not detected
- Object detected but not avoided

If “Floating Object not detected” is selected, the user/analyst should click on the one and only choice of the following drop-down menu:

- No visual detection from bridge & Equipment Failure
- Human Error

Further on, the user/analyst has the possibility of choosing between the following two options on the “No Visual Detection Because” box:

- Environment (poor visibility)
- Watchkeeping failure

If “Object detected but not avoided” is selected, the user/analyst should click on one of the following options of the drop-down menu:

- Manoeuvring Avoidance Error
- Internal communication Failure
- Steering system failure
- Propulsion system failure
- Bad environmental conditions

If “With fixed installation” is selected:

If “Contact Fixed Installation Not Avoided” is selected, the user/analyst should click on one of the following options of the drop-down menu:

- Manoeuvring Avoidance Error
- Internal communication Failure
- Steering system failure
- Propulsion system failure
- Bad environmental condition

If “Object not detected” is selected, the user/analyst should select one of the following two options:

- Object Not mapped
- Ship unaware of striking hazards

If “Object not mapped” is chosen, then there are no further choices in this tab to be made.

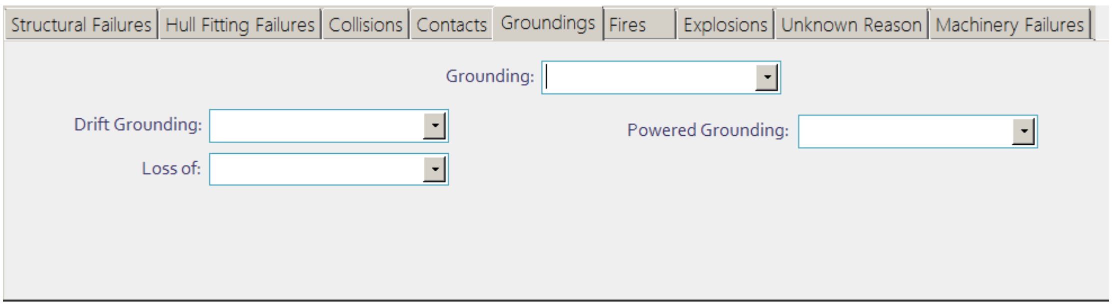
If “Ship unaware of striking hazard” is chosen, then the user/analyst should click on the one and only choice of the following drop-down menu:

- VTS Failure & Uncorrected Navigational Error & External Communication Failure

3.5 FT-5: Grounding

If "**Grounding**" is selected, the user/analyst should choose from a drop-down menu one of the following three choices:

- Drift Grounding
- Powered Grounding
- Unknown



Notes:

- ✓ Whenever "Low tide" is reported, the "Grounding" is considered as "Drift Grounding".
- ✓ Whenever no problem on propulsion or steering system is reported, the "Grounding" is considered as "Powered Grounding".
- ✓ When the "Towed Away" tick-box is ticked, then it should not be "Powered Grounding"
- ✓ When "Sailed By Her Means" is ticked, then it definitely concerns "Powered Grounding"

If "Drift Grounding" is selected, the user/analyst should click on one of the choices of the following drop-down menu:

- Propulsion / Steering System Loss & Drift to Shallow Water

The user/analyst should then proceed and make input to the following two options, to the extent feasible:

- Loss of propulsion system
- Loss of steering system

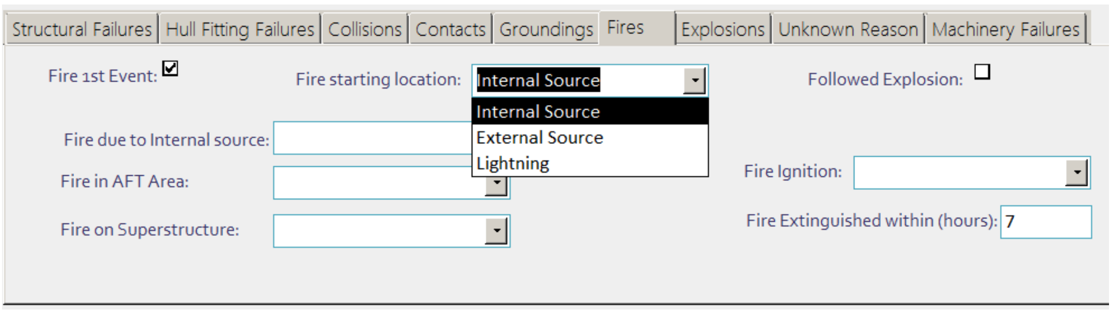
If “Powered Grounding” is selected, the user/analyst should click on one of the choices of the following drop-down menu:

- Detected but not avoided
- Squat Effect
- Not detected

3.6 FT-6: Fire

If “**Fire**” is selected as a first event, then the user/analyst should tick the field “Fire as a first event” in the relevant “Fire” tab. If there are available further data, then the user/analyst can proceed with choosing from the “Fire Starting Location” drop-down menu one of the following choices:

- Internal source
- External source
- By lightning



If the choice is “Internal source”, then there is the following drop-down menu:

- In Aft Area
- On Deck Cargo Area
- In Ballast Tanks/Void Spaces
- In Hold Cargo Area
- In Fore Peak Area

If the choice is “In Aft Area”, then there is the following drop-down menu:

- On superstructure
- Other Areas
- Engine Room

If the choice is "On superstructure", then there is the following drop-down menu:

- Accommodation
- Bridge

Then, the user/analyst should complete any information on "Ignition Source" box, where there is the following drop-down menu:

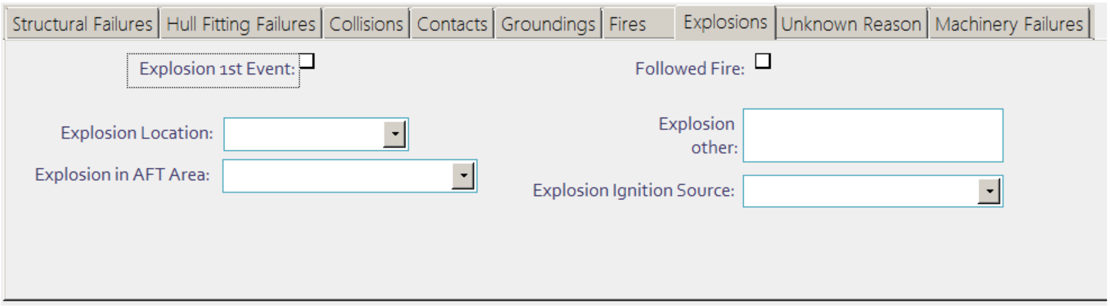
- Electrostatic charges
- Cooking related
- Heating equipment
- Hot works
- Smoking related
- Electrical faults
- Broken Fuel Pipe
- Self-Ignition
- Containers' Content
- Engine's Crankcase
- Unknown

Finally, the user/analyst should complete any available information on "Fire Extinguished within" box [in hours] and tick "YES" if the incident was followed by and explosion.

3.7 FT-7: Explosion

If "**Explosion**" is selected as a first event, then the user/analyst should tick the field "Explosion as a first event" in the relevant "Explosion" tab. If there are available further data, then the user/analyst can proceed with choosing from the "Explosion Location" drop-down menu one of the following choices:

- In Hold Cargo Area
- In Aft Area
- On Deck Cargo Area
- Ballast Tanks/Void spaces
- In Fore Peak Area



If the choice is "In AFT Area", then the other boxes (apart from "Ignition Source") freeze and there is the following drop-down menu:

- Fuel Tank
- Boiler
- Accommodation
- Engine Room

If the choice is "On Deck Cargo Area", all the boxes (apart from "Ignition Source") freeze and there are no further choices to be made.

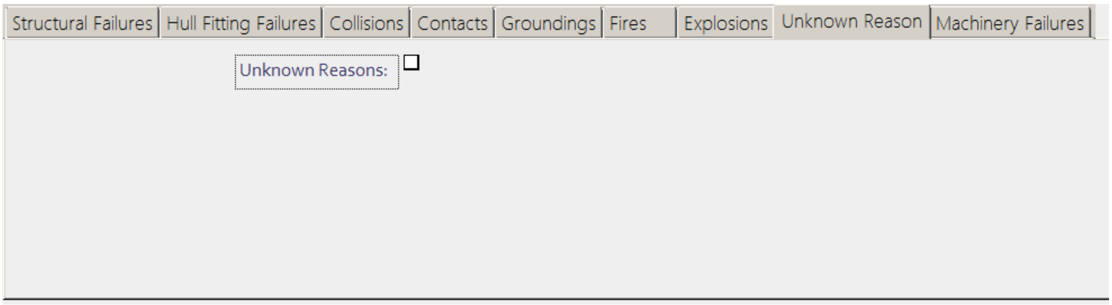
Then, the user/analyst should complete any information on "Ignition Source" box, where there is the following drop-down menu:

- Electrostatic charges
- Cooking related
- Heating equipment
- Hot works
- Smoking related
- Electrical faults
- Broken Fuel Pipe
- Self-Ignition
- Containers' Content
- Engine's Crankcase
- Unknown

Finally, the user/analyst should tick "YES" in the field "Followed Fire" in the relevant "Explosion" tab if the Incident was followed by fire.

3.8 FT-8: Unknown reasons

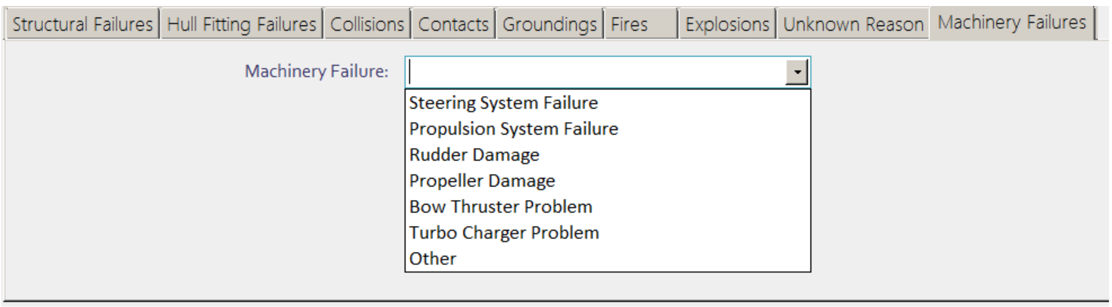
If "**Unknown reasons**" is selected, (due to e.g. lack of information), in the relevant tab the user/analyst should tick *"YES"*.



3.9 FT-9: Machinery Failure

If "**Machinery Failure**" is selected, in the relevant tab the user/analyst can choose from a drop-down menu one of the following three choices:

- Steering System Failure
- Propulsion System Failure
- Rudder Damage
- Propeller Damage
- Bow Thruster Damage
- Turbo Charger Problem
- Other



Notes:

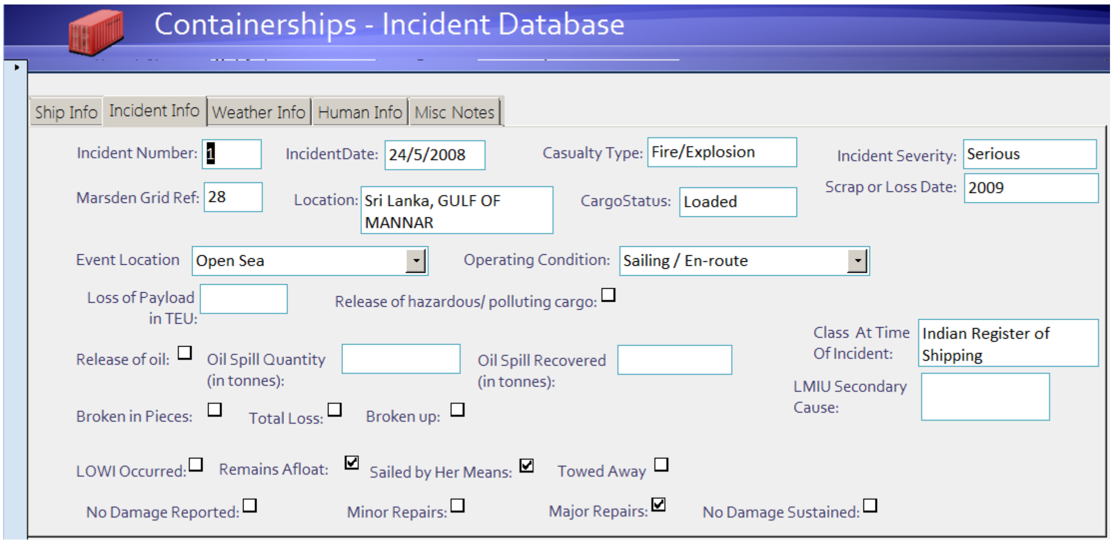
✓ The tailshaft is considered as part of the machinery and more particularly of the propulsion system. Thus, failure of tailshaft is a mechanical failure related to propulsion.

✓ It is also noted that in this accident type also belongs the Crankshaft failure. Furthermore, wherever the main engine crankshaft fails, "*propulsion failure*" should be checked; wherever the auxiliary engine crankshaft fails, "*other failure*" should be checked.

4. ACCIDENTAL CONSEQUENCES & OTHER DATA

After the accidental causal data according to the main accident/incident type and fault trees has been completed (to the extent feasible), the user/analyst is asked to complete any other information (consequences of accidents/incidents and general information about the accident/incident) that can be extracted by the texts available, namely:

4.1 Incident Info tab



Event Location: The user/analyst should complete the location of the ship at the time of the incident, as possibly reported in the relevant texts. The user/analyst has the following options:

1	Port
2	Inland waters
3	Canal
4	River
5	At berth
6	Anchorage

7 Port Approach

8 Archipelagos

9 Coastal waters (<12miles)

10 Open sea

11 Restricted Waters

12 Shipyard

13 Dry-dock

14 Unknown

Operating Condition: The user/analyst should complete the ship operation when the incident occurred, as possibly reported in the relevant texts. The user/analyst has the following options:

1 Under repair

2 Berth

3 Port

4 Discharging

5 Sailing / En-route

6 Anchoring

7 Ballasting

8 Bunkering

9 Loading

10 Manoeuvring

11 Towed

12 Mooring

13 Under construction

14 Unknown

Additionally, there are boxes to be checked (Weather Info tab) in case of availability of relevant environmental data, namely:

Outcome of the incident

The user/analyst should tick one or more of the following boxes, according to the information available:

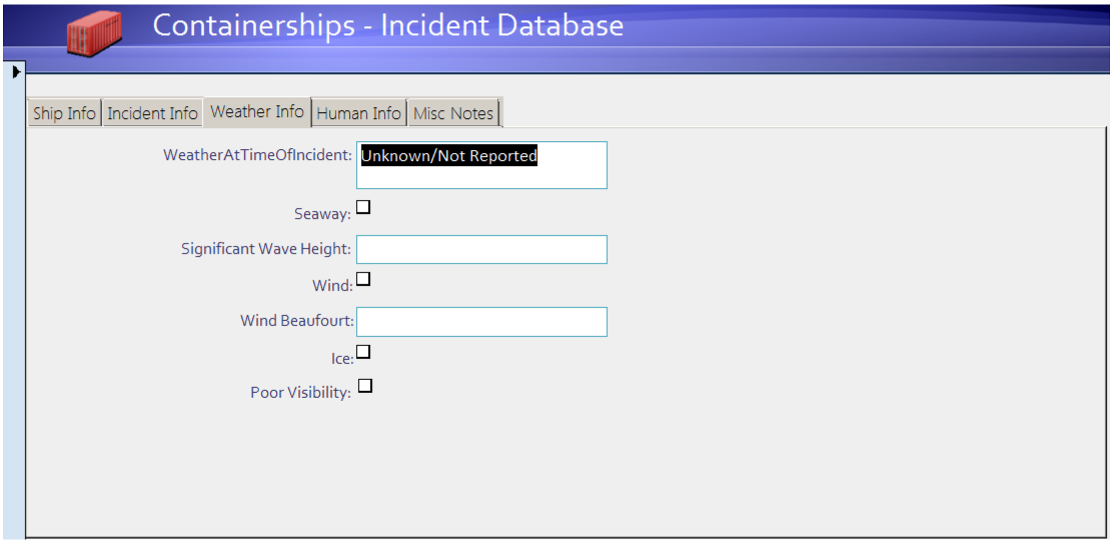
1. L.O.W.I. (**L**oss **O**f **W**atertight **I**ntegrity) occurred
2. Broken In (two or more) Pieces
3. Total Loss
4. Remains Afloat
5. Towed Away
6. Sailed By Her Means
7. Minor Repairs
8. Major Repairs
9. Broken Up
10. No Damage Reported
11. No Damage Sustained
12. Release of oil
13. Release of hazardous/polluting cargo

Notes

- ✓ It is noted that in the vast majority of records, whenever "Remains Afloat" is ticked, the "Sailed By Her Means" box is also ticked.
- ✓ Whenever the accident/incident took place while the ship was "Under repair", (*see "Operating Condition" field*) or the "Event Location" is either "Berth" or "Anchorage", the "Remains Afloat" tick-box should NOT be ticked.
- ✓ It is also noted that whenever "Broken Up" is ticked, the repairs are already considered as "Major", that's why the relative tick-box should not be ticked.
- ✓ A few conventions for deciding on whether a repair is major are presented below:
  - i. if it requires hull check by Class, it is major
  - ii. if it involves a shipyard, it would tend to be major
  - iii. if it takes a number of days for the repair, it is rather major (but bearing in mind that the ship may be idle for other reasons such as lack of business).

The user/analyst should also consult the IHS code on "Degree of severity" of the casualty to take a hint on the magnitude of the damage (and thus, of the repair).

4.2 Weather Info tab



Seaway condition, Significant Wave Height H_S [m]

If this tick-box is checked, because there is relevant information available, the significant wave height H_S [m] should be completed in the relevant text box.

In case of lack of definite H_S data, the following indicative convention should be adopted:

Seaway condition	H_S [m]
Calm sea	0
Mild sea	2.5
Moderate sea	5
Strong sea	7.5
Very rough sea	10
Abnormal sea	15

Notes:

- ✓ For calm sea conditions, or seaway conditions not affecting the incident/accident, the box "Seaway" is ticked and the following Hs text box should be set equal to zero value, $H_S = 0$ m.
- ✓ For heavy (or 'bad') weather, the tick box of "Seaway" should be checked and an indicative Hs = 7.5m.
- ✓ If it is reported "hurricane" or "typhoon", the user should tick the box "Abnormal sea". For in between the user should use 'common sense' to interpret situations like 'bad weather', 'heavy sea', etc.

Wind, Beaufort Force [Bf]

If this tick-box is checked, the relevant Beaufort force should be completed in the relevant text box.

For calm wind conditions, or wind condition not affecting the accident, it should be set equal to zero, Bf = 0.

The Beaufort Wind Scale is shown next:

Beaufort number	Wind Speed (knots)	WMO(*)description
1	< 1	Calm
2	1 - 3	Light air
3	4 - 6	Light breeze
4	7 - 10	Gentle breeze
5	11 - 16	Moderate breeze
6	17 - 21	Fresh breeze
7	22 - 27	Strong breeze
8	28 - 33	Near gale
9	34 - 40	Gale
10	41 - 47	Strong gale
11	48 - 55	Storm
12	56 - 63	Violent storm

For example, for "typhoon" is Bf = 11, for "hurricane" is Bf = 12, whereas "storm" starts at about Bf 7

Ice – Poor Visibility

This tick boxes should be checked, in case icing affected the accident or Poor Visibility.

(*)World Meteorological Organization

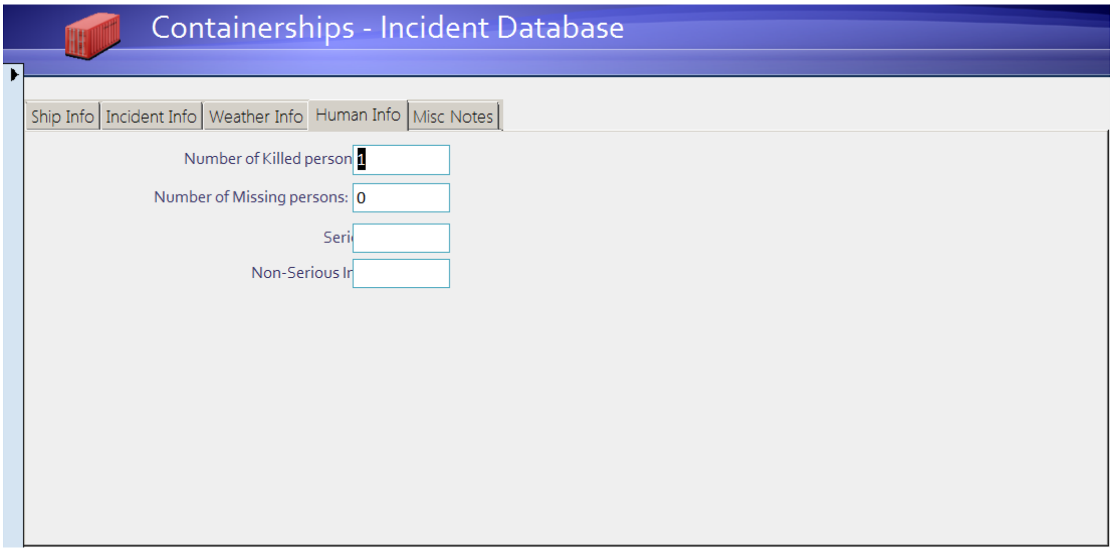
4.3 Human Info tab

No. of Serious Injuries: The user/analyst should complete the total number of seriously injured people, as possibly reported in the relevant texts.

- ✓ In case it is clearly reported that there are no seriously injured persons, the user/analyst should fill in the box with zero (0) value. In case there are no clues (unknown) on serious injuries, the box should remain empty.

No. of Non-Serious Injuries: The user/analyst should complete the total number of non-seriously injured people, as possibly reported in the relevant texts.

- ✓ In case it is clearly reported that there are no people who suffered from non-serious injuries, the user/analyst should fill in the box with zero (0) value. In case there are no clues (unknown) on non-serious injuries, the box should remain empty.



No. of Killed: The user/analyst should complete the number of killed people, as possibly reported in the relevant texts.

- ✓ In case it is clearly reported that there are no killed persons, the user/analyst should fill in the box with zero (0) value. In case there are no clues (unknown) on any deaths, the box should remain empty.
- ✓ Zero values should be inserted in case it is clearly deduced from the texts that no deaths are involved.

No. of Missing: The user/analyst should complete the number of missing people, as possibly reported in the relevant texts.

- ✓ In case it is clearly reported that there are no missing persons, the user/analyst should fill in the box with zero (0) value. In case there are no clues (unknown) on any missing persons, the box should remain empty.