The present research is a statistical analysis of incidents of cellular containerships built after 1981 and with a Gross Tonnage (GT) over 999 for the period 1990-2011 with emphasis on the characteristics of IACS and non IACS classed ships

ANALYSIS OF INCIDENTS of CELLULAR CONTAINERSHIPS BUILT AFTER 1981 FOR THE PERIOD 1990-2011

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ATHENS 2013

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ACKNOWLEDGEMENTS

I would like to thank Prof. A. Papanikolaou who entrusted the preparation of this thesis to me and who was available and willing to help at any time. I am also grateful to Dr. Eleftheria Iliopoulou for her valuable assistance and guidance throughout the duration of this project. Finally I would like to especially thank Georgakopoulos Spiros and Konstantinou Agis for their assistance on creating the database.

1. INTRODUCTION

1.1 ABSTRACT

The current research is a statistical analysis of accidents that occurred during the period 1990- 2011 for cellular Containerships that were built after 1981 and with a gross tonnage (GT) greater than 999. The research consists of two parts, related to each other. The first part contains a detailed analysis of all the incidents involving ships that at the time of the accident were registered to members of the International Association of Classification Societies (IACS). The incidents are divided in eight categories, as follows:

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

In all categories a comparison of serious and non-serious accidents is conducted at the end of each paragraph. After all categories are analyzed, an aggregated paragraph follows for all the IACS Ships.

The second part consists of the analysis of serious accidents on ships that at the time of the incident were **not** registered to an IACS member and compared with serious accidents of ships registered to IACS members.

In both analyses the incidents caused either by unknown reasons or by piracy and war losses were not considered in the study.

All data used in this research were provided by the Germanischer Lloyd. Both parts of the study contain only the IHS Database.

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.

1.2 SCOPE OF ANALYSIS

In the current study only accidents of containerships built after 1981 and with a gross tonnage (GT) greater than 999 are included. The statistical analysis consists of two parts.

At first, ships that were registered to IACS members are being investigated. Each type of incident (see 1.1) is analyzed separately with a comparison for serious and non- serious accidents. A summarized analysis on all accidents follows.

In the second part of the study a contrast is carried out between ships that were registered to an IACS member at the time of the incident and those which were not. Only serious accidents are included.

The objective of the analysis is to emphasize on the consequences of the accidents on every aspect (loss of cargo, repairs, impact on human life, environmental effects). The results from the aforementioned comparison will be stated on the last paragraph (6. Conclusions). Furthermore, this risk analysis constitutes the second step of the Formal Safety Assessment (FSA) that will lead to the identification of the risk control options, as well as the financial cost for the prevention of such risks.

2. GENERAL INFORMATION

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

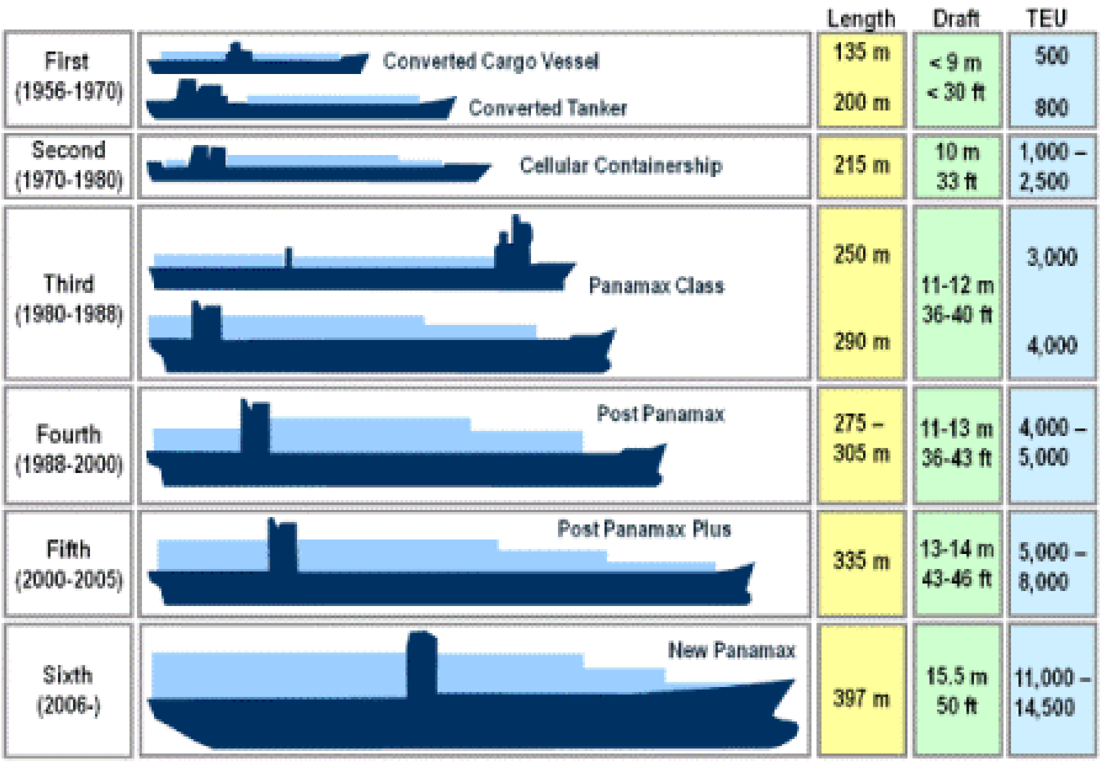
It has prevailed internationally the standardized ISO container with traverse cross-section 8 feet x 8 feet. The height 8 feet (or 2.435m) resulted from the being in effect limits for the road transport in the USA (and later worldwide) for the passage of vehicles under the bridges. Characteristic length 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]:

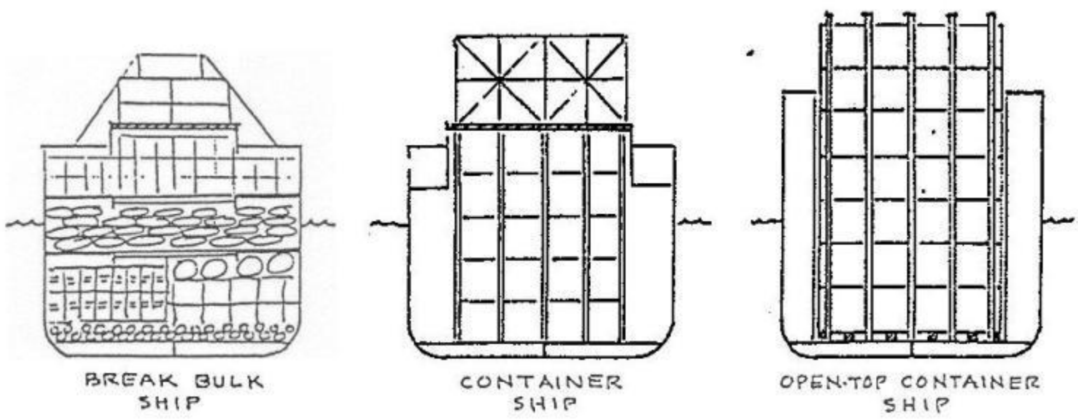
Group / Class	Number of TEU
Small Feeder	Up to 1000
Feeder	1001 – 2800
Panamax	2801 – 5100
Post-Panamax	5101 – 10000
New-Panamax	10001 – 14500
ULCV	14501 and higher

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 hatch-less 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 DATA

All Incidents' info was given by the Germanischer Lloyd. The database that was used is IHS Fairplay, evolved from the Lloyd's Register of Ships and is characterized as the world's largest maritime library.

3.1.1 IHS DATABASE

The database that was used consists of both Serious and Non-Serious Incidents, as well as Ships that at the time of the incident were registered to an IACS member or not. All the names of Tables that are henceforth mentioned, can be found in the NTUA-SDL database. The following table shows the basic distribution of data (the percentage in parenthesis is based on column's data, while the number under **Percentage** column refers to the total of the row data):

	IACS	Non IACS	Percentage
Serious	**1064(81.91%)**	**40(81.63%)**	**81.89%**
Non-Serious	**235(18.09%)**	**9(18.37%)**	**18.11%**
TOTAL	**1299**	**49**	**100%**

The first observation is the insignificant difference between the percentages of the Serious and Non-Serious incidents on IACS and Non IACS ships. The fact though that Non IACS ships are much less than IACS ships does not lead to a safe conclusion. Therefore a detailed analysis is required.

3.1.2 IACS AND NON IACS FLEET

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

The Fleet at risk for both IACS and Non IACS ships is shown in the following table and diagram:

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

Year	Fleet-IACS	Fleet-Non IACS	Fleet-Unknown	Fleet-Sum
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**

The decimals digits on any number are the result of the calculation of Fleet at Risk. For each year, the given number is the total sum of active ships per month- for all months- divided by 12. Therefore, if a ship was active in May of 1985, it would lead to a result of 0.67 for the specified year.

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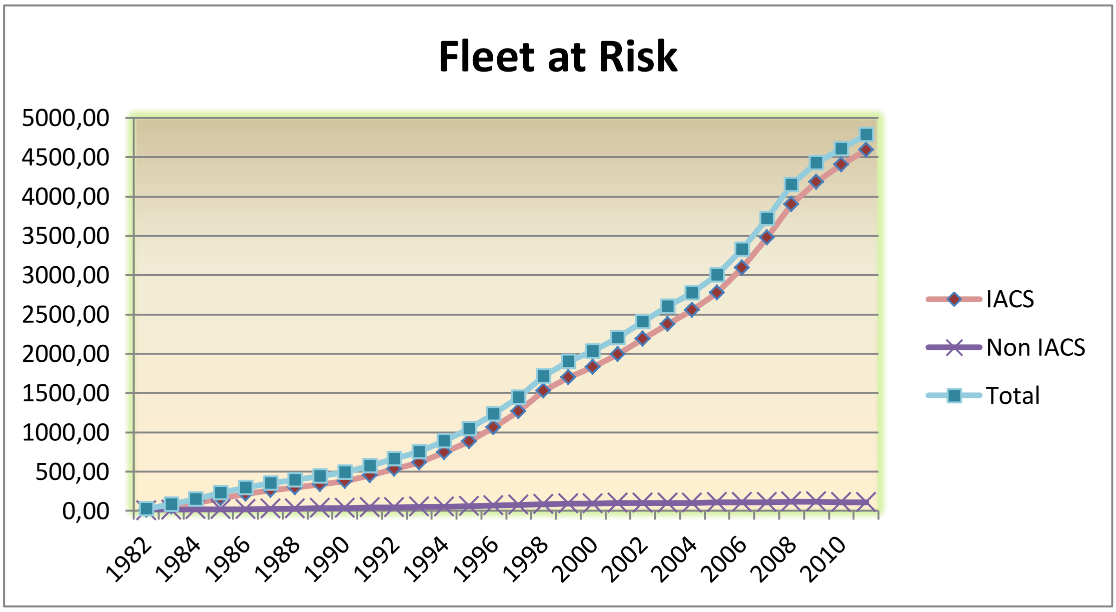
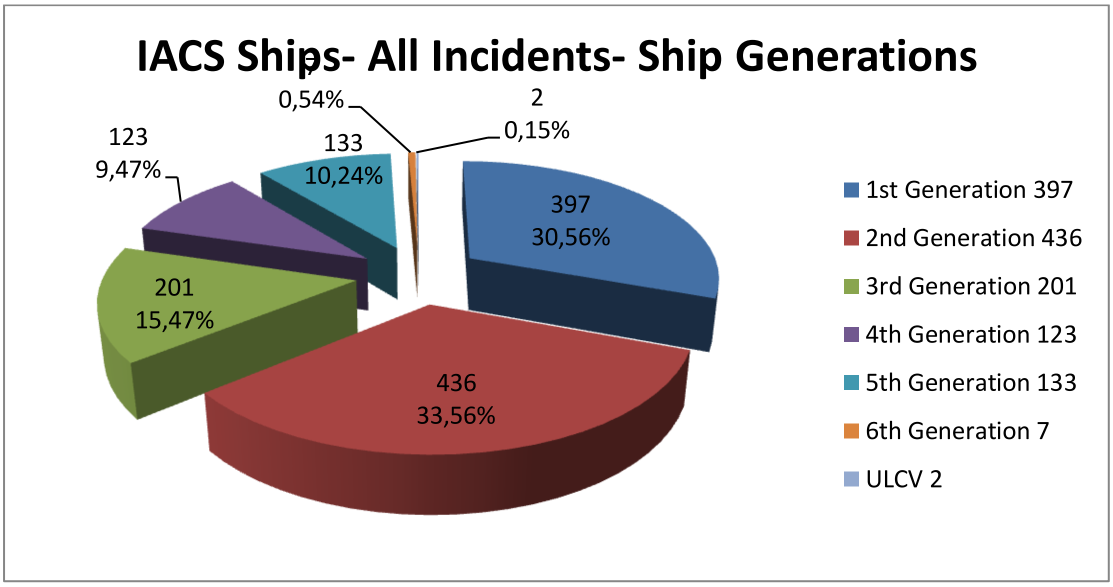
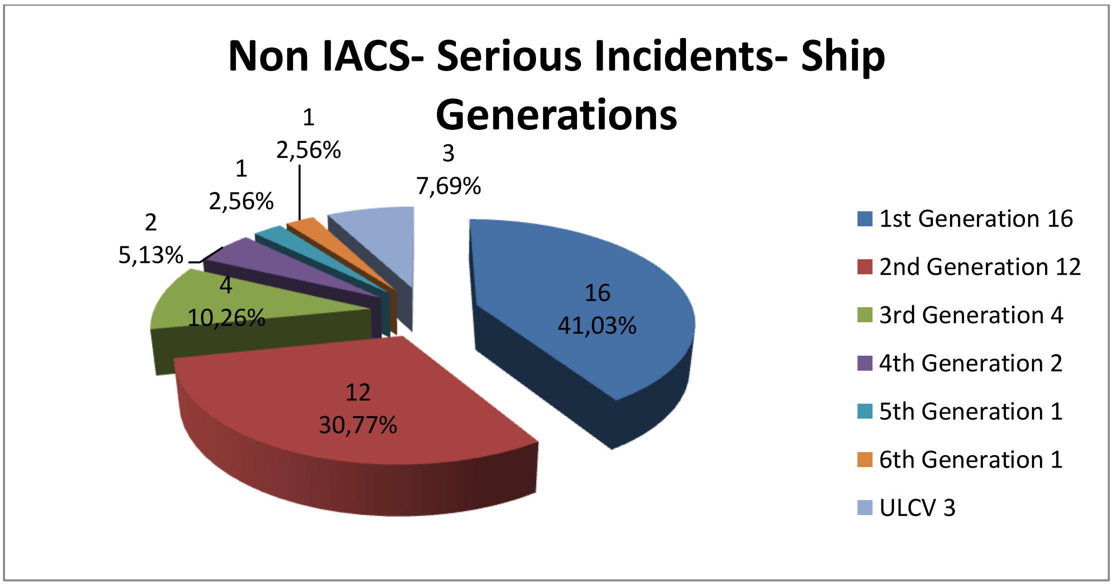


3.1.3 DISTRIBUTION OF INCIDENTS

As mentioned in paragraph 2.3, the Containerships that are under this study can be distributed in 7 categories by Generation and 6 categories by Ship Type.

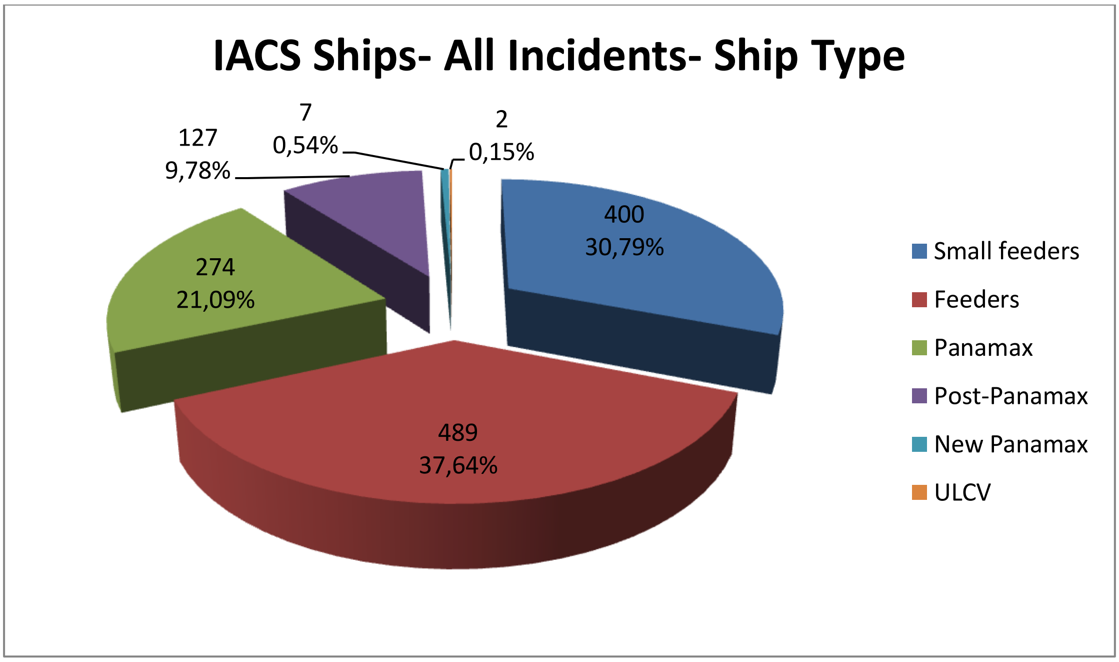
3.1.3.1 BY GENERATION

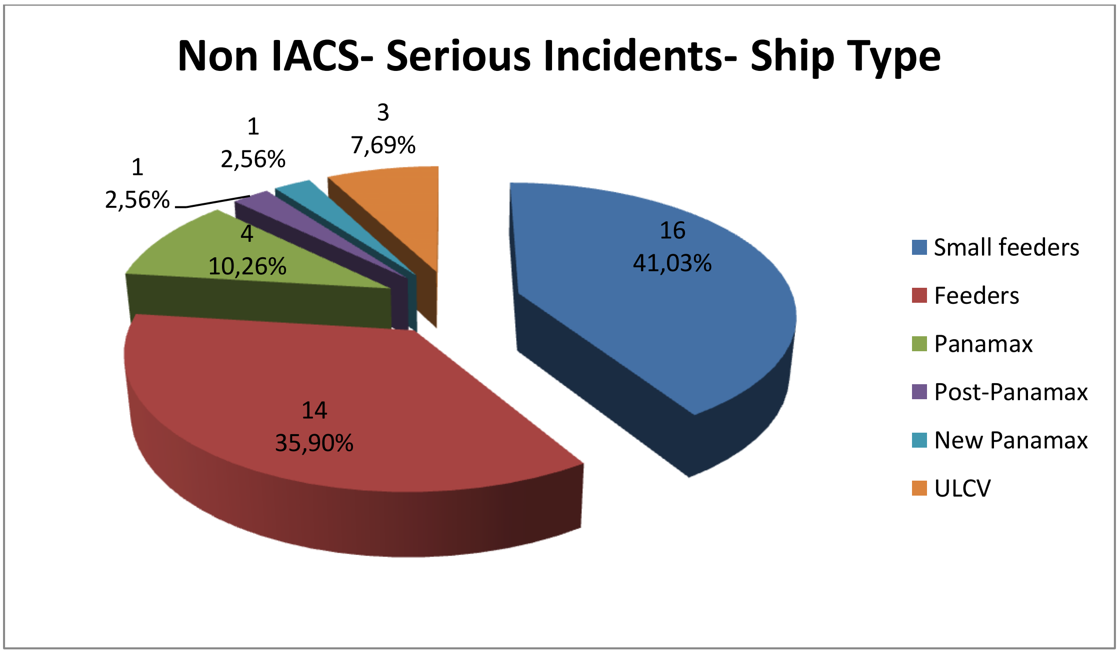




An important discrepancy is the large amount of 1st Generation's Non IACS Ships that leads to smaller percentages on 3rd, 4th, 5th and 6th Generation's Ships. The percentage on 2nd Generation's Ships is similar on both IACS and Non IACS Ships. The fact ULCV's percentage is much higher in Non IACS Ships, is probably because of the small sample of Ships.

3.1.3.2 BY SHIP TYPE





The above pie charts lead to the exact same conclusion as the ones from paragraph 3.1.3.1.

3.2 DEFINITIONS

3.2.1 RISK EVALUATION

In the analysis that follows, only the risk associated to the ship- that is under study- is being considered. Any hazard or injury on any other ship is noted on the relevant record, but is considered as external factor. For example, if a containership has a collision with another ship and the latter sinks or a crew member is missing after the accident, none of these is under investigation in the analysis.

3.2.2 MAIN ACCIDENT CATEGORIES

As mentioned above, the main categories of the analysis are eight (8) and every category is divided in subcategories:

1) **Collision**: Any incident that includes a containership and another vessel, regardless of the operational state.
   Subcategories- options: struck, striking, unknown
2) **Contact**: Any contact of a containership with an object that has no mechanical propulsion or steering system and therefore is not considered as a vessel
   Subcategories- options: floating objects, fixed installation
3) **Explosion**: Any incident that includes an explosion as the initial event
   Subcategories- options: explosion location, explosion ignition
   - *Explosion location*: in Aft area, on deck cargo area, in ballast tanks/void spaces, in hold cargo area, in Fore peak area
     - *In Aft area*: fuel tank, boiler, engine room, accommodation
   - *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
4) **Fire**: Any incident that includes a fire as the initial event
   Subcategories- options: fire starting location, fire ignition
   - *Fire starting location*: internal source, external source, lightning
     - *Internal source*: in Aft area, on deck cargo area, in ballast tanks/void spaces, in hold cargo area, in Fore peak area
       - *In Aft area*: on superstructure, other areas, engine room
         - *On superstructure*: accommodation, bridge
5) **Grounding**: being aground or hitting/touching shore or sea bottom
   Subcategories- options: drift, powered, unknown
   - *Drift grounding*: loss of power system, loss of steering system

Powered grounding: detected but not avoided, squat effect, not detected

6) **Hull fittings failure**: any damage to ship's hull-fitting equipment/outfitting, affecting ship's seaworthiness or efficiency

   Subcategories- options: 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.

7) **Machinery failure**: any technical failure of machinery or related system that affects vessel's seaworthiness

   Subcategories- options: steering system failure, propulsion system failure, rudder damage, propeller damage, bow thruster problem, turbo charger problem, other

8) **Non-accidental structural failure**: any incident caused by the existence of cracks and fractures on ship's hull, affecting ship's seaworthiness

   Subcategories- options: structural degradation, poor design/construction, excessive loading

   Excessive loading: operation in abnormal conditions, ballast related, cargo related

It is noted that any incident caused by unknown reasons as well as incidents associated with war losses or piracy are not considered in the study. Cases of occupational accidents are also not included.

3.2.3 OPERATIONAL STATE

In the NTUA- SDL database the operational state of the vessel under investigation is divided into eleven (11) categories: At Berth, Port, Anchorage, Port Approach, Coastal Waters (<12miles off), Shipyard, Archipelagos, Inland Waters, Canals, Rivers and Open Sea.

Based on the fact that in various operational states the restrictions on vessel's service speed are the same, we therefore divide the operational state into four (4) main categories:

- Terminal Areas: (At Berth, Port, Anchorage, Port Approach) The vessel is either at low service speed or stationary at Berth/ Port. As a result, the probability of a serious accident is low and the hazards of one are limited.

- Operation in Congested Waters: (Coastal Waters) This type of areas are marked as high traffic locations.
- Open Sea: (Open Sea, Archipelagos) The vessel is at full service speed, but has the capability of manoeuvring to avoid accidents with other ships.
- Limited Waters: (Inland Waters, Canals, Rivers) Vessel is on reduced speed and has restrictions on manoeuvers that can be operated.

3.2.4 LOWI OCCURRENCE

The probability of hull breaching in case of an accident is considered essential for the sequence of events and consequences of an 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 a number of collision incidents, LOWI was not occurred because the involved vessel was small in comparison to the containership (i.e. fishing vessel) or it is clearly stated that the containership did not sustain damage.

In contact or grounding incidents, the containership sustained propeller damage due to contact with an object 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:

- “No damage reported” is stated.
- The point of impact is above the main deck planting (i.e. superstructure).
- There is no relevant information regarding renewal of side shell planting.
- The containership sustains only minor or slight damage.

LOWI occurrence:

- “Extent of damage was not known” is stated.
- “The damage is below/ above waterline” is stated.

3.3 NTUA - SDL SHIP ACCIDENTS DATABASE

Over the years, the marine incident databases, which have evolved, 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. Consequently, 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. The accidents of both LMIU and GISIS will not be investigated in the present analysis.

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.

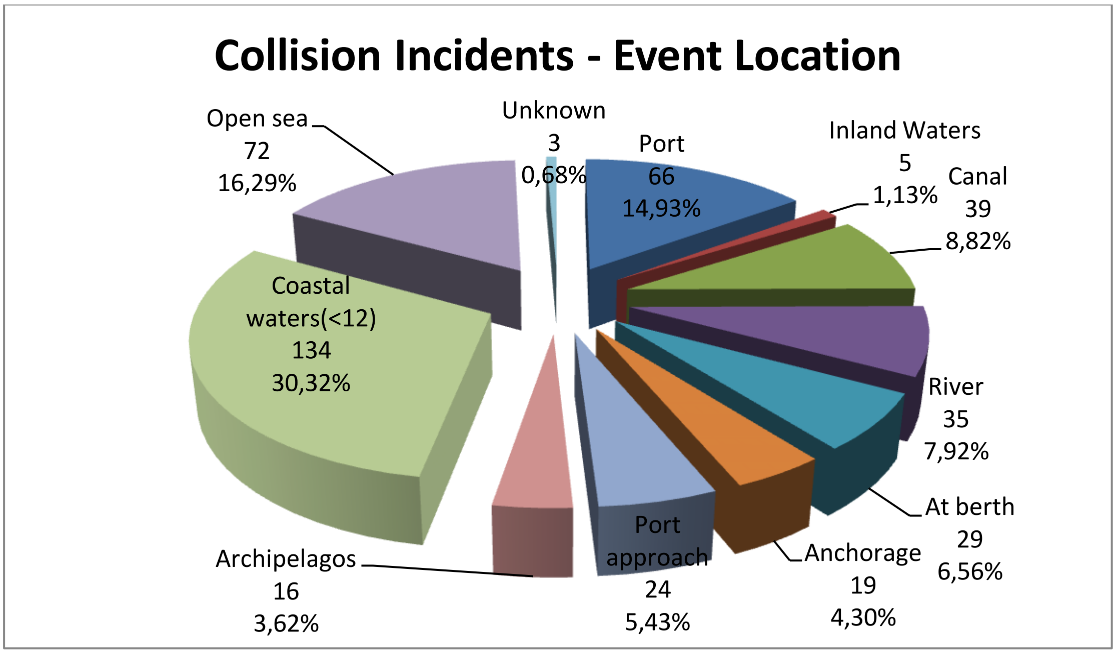
The results of the analysis are presented in the following chapters. A manual of the SDL-database can be found in Annex I.

4. ANALYSIS OF IACS SHIPS' INCIDENTS

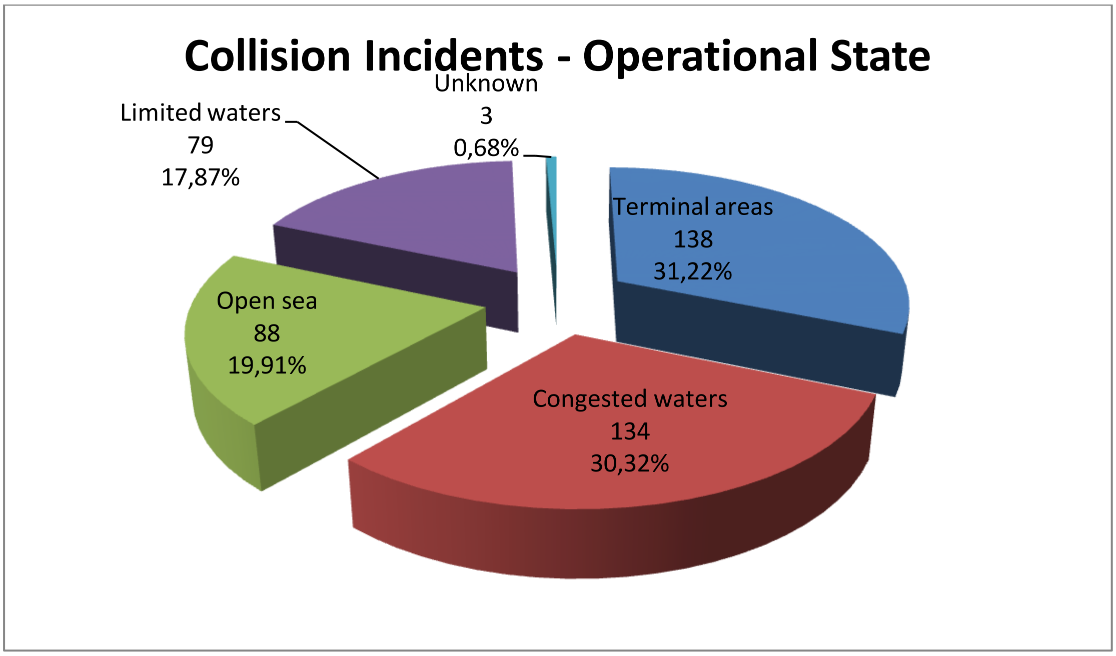
4.1 COLLISION INCIDENTS

4.1.1 CONDITIONS OF COLLISION ACCIDENTS

Event Location

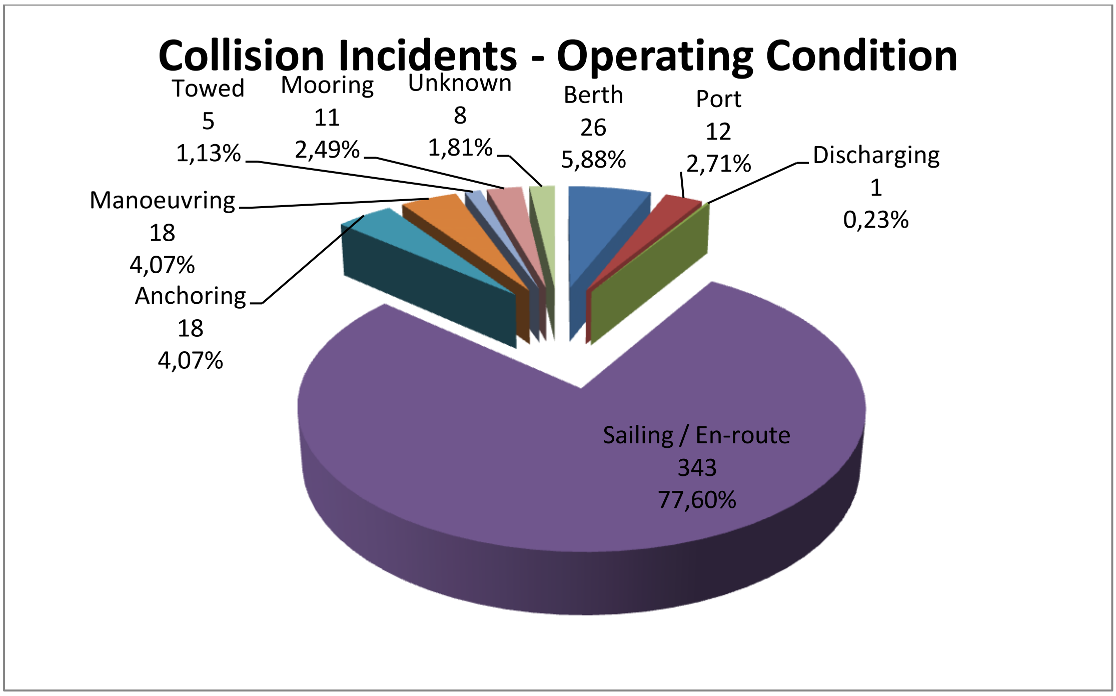


Operational State



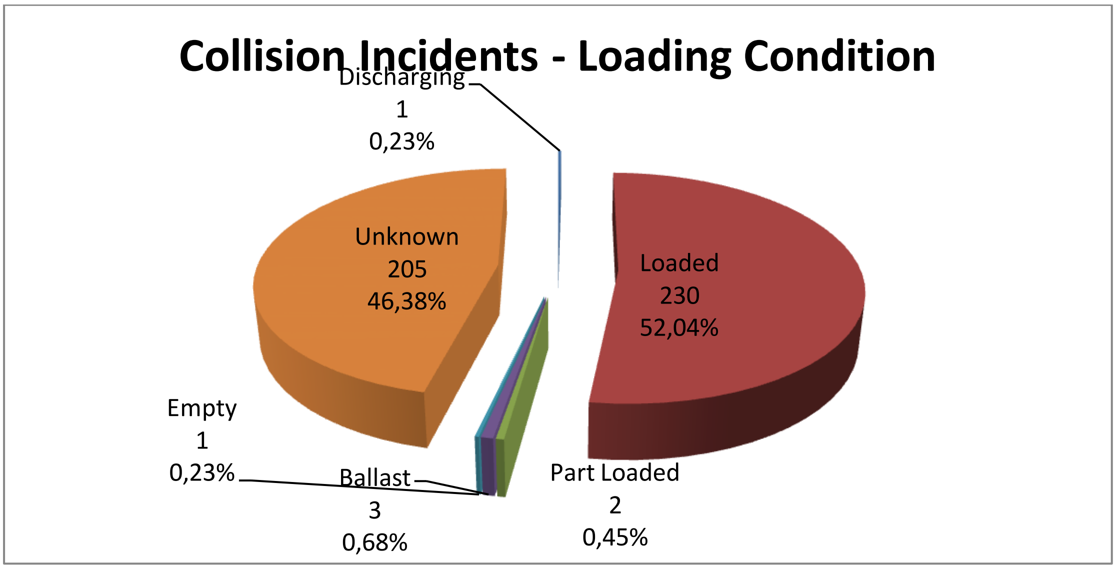
As expected, the majority of collision incidents take place at congested waters and terminal areas, where a serious number of vessels are overcrowded. The limit of space- and the need to manoeuver within it- in such places seems to overcome the restrictions on speed of ships.

Operating Condition

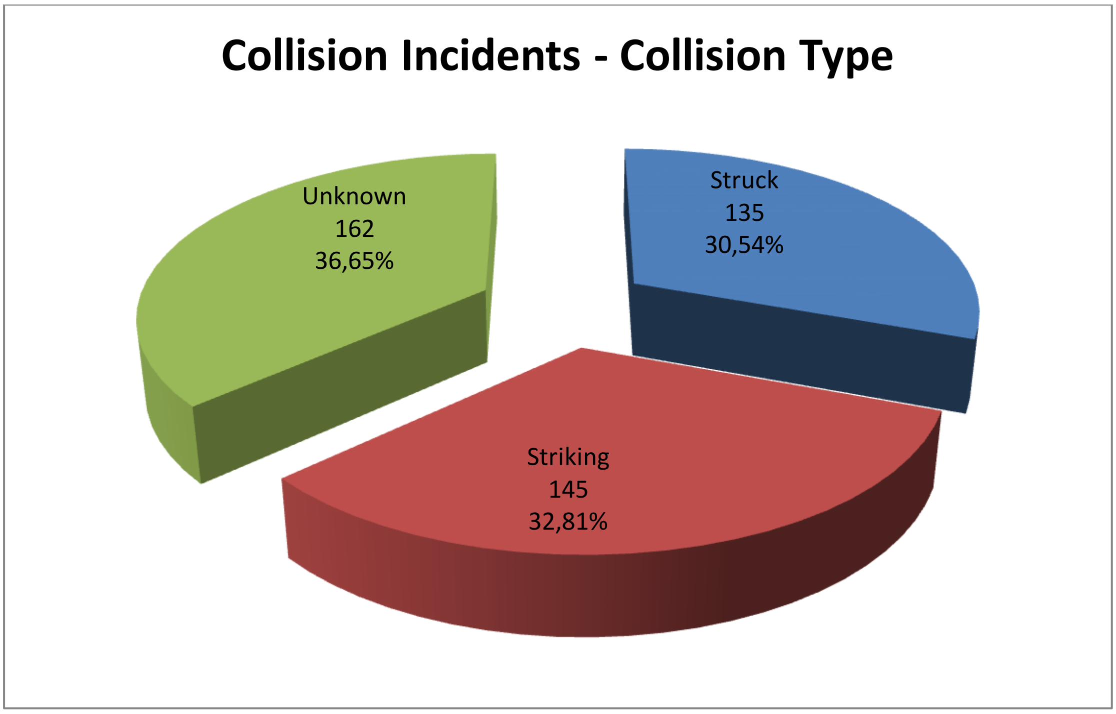


In the chart above, it is obvious that most of the ships involved in a collision are en-route (nearly 78%), whether the accident occurred because of weather conditions or human error.

Loading Conditions

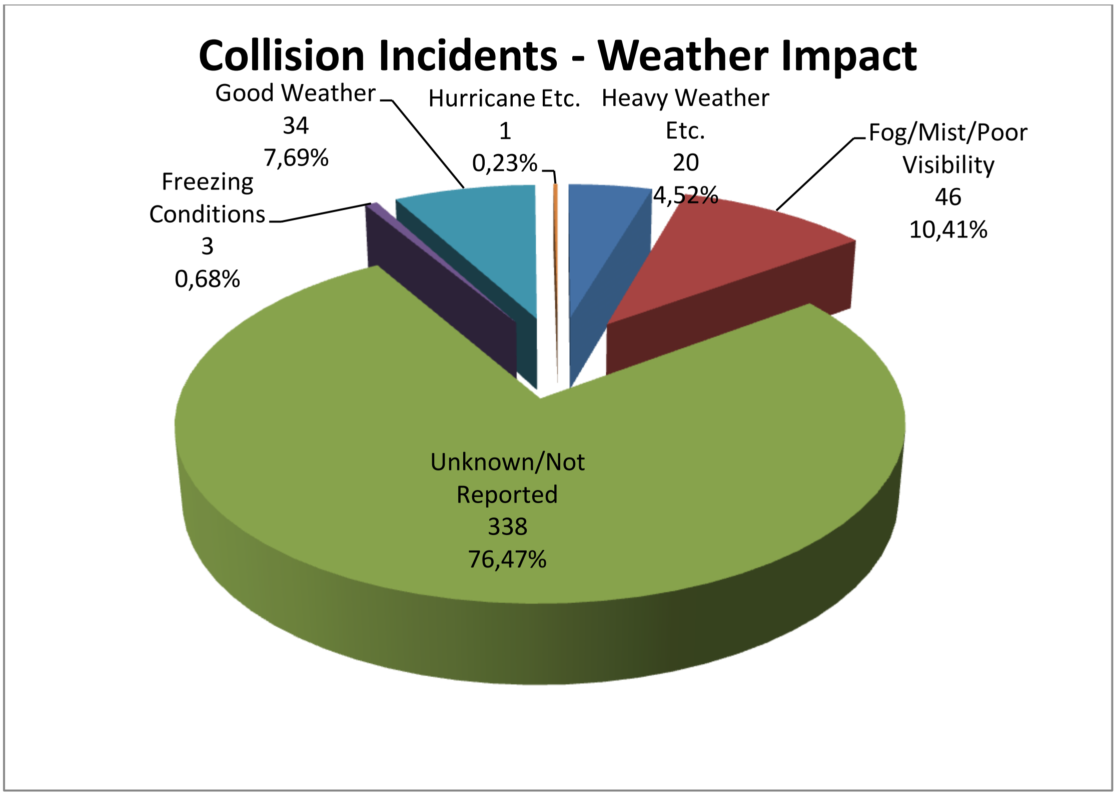


Collision Type



As it can be seen, the percentages between the three cases are close to each other and no conclusion can be drawn.

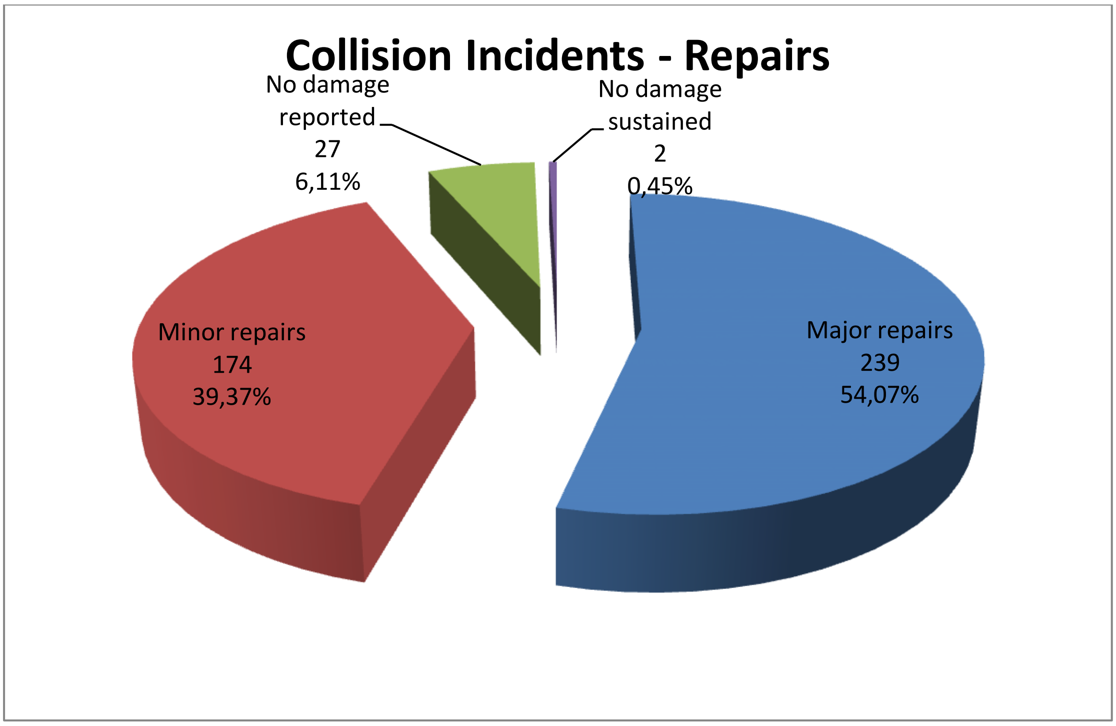
Weather Impact



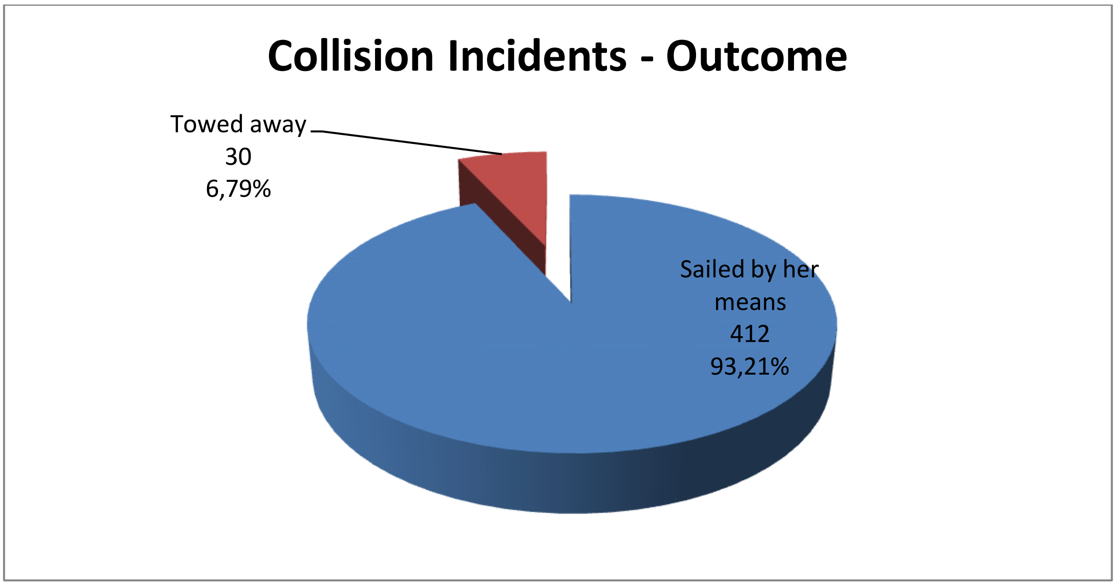
The fact that 76.47% of the incidents have no information about the weather reported could be a parameter that should be investigated in the future. On the other hand, this might be an indication that weather is not such an important factor that is why it is not reported.

4.1.2 CONSEQUENCES OF COLLISION ACCIDENTS

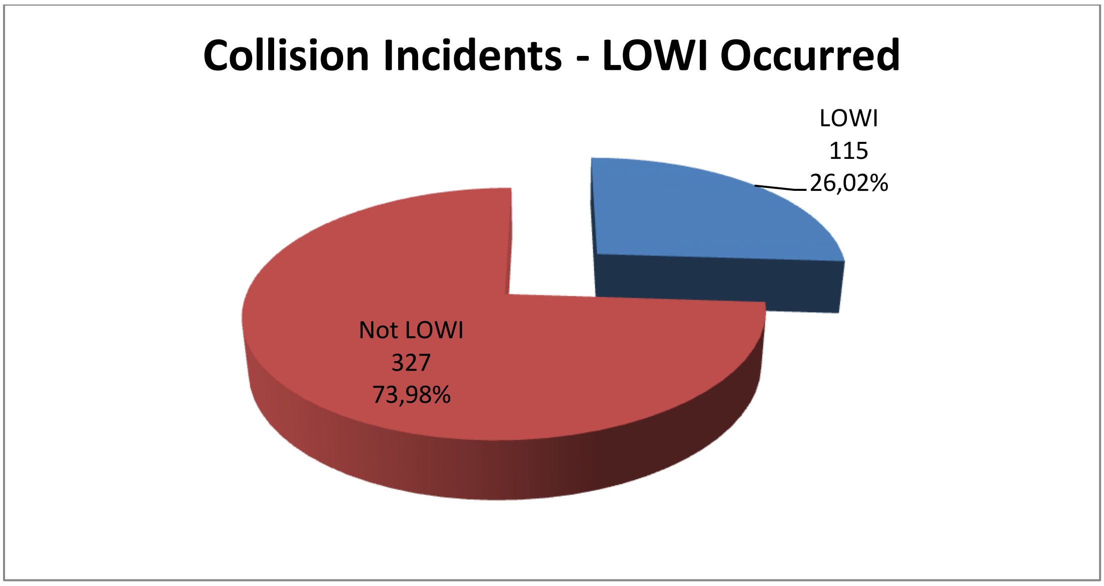
Repairs



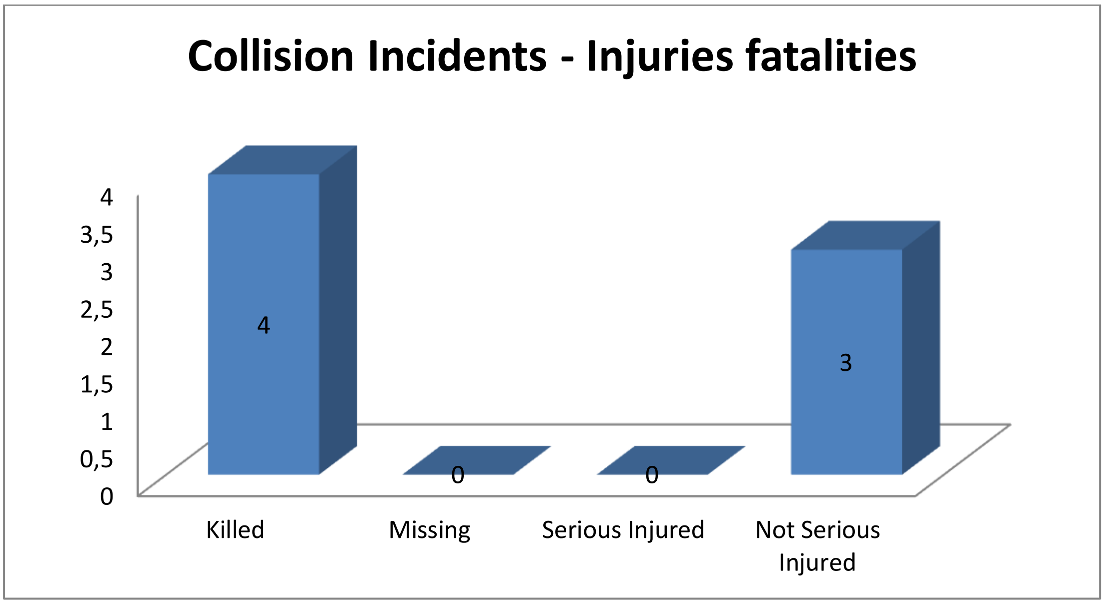
Outcome



LOss of Water Integrity(LOWI)



Injuries/ Fatalities

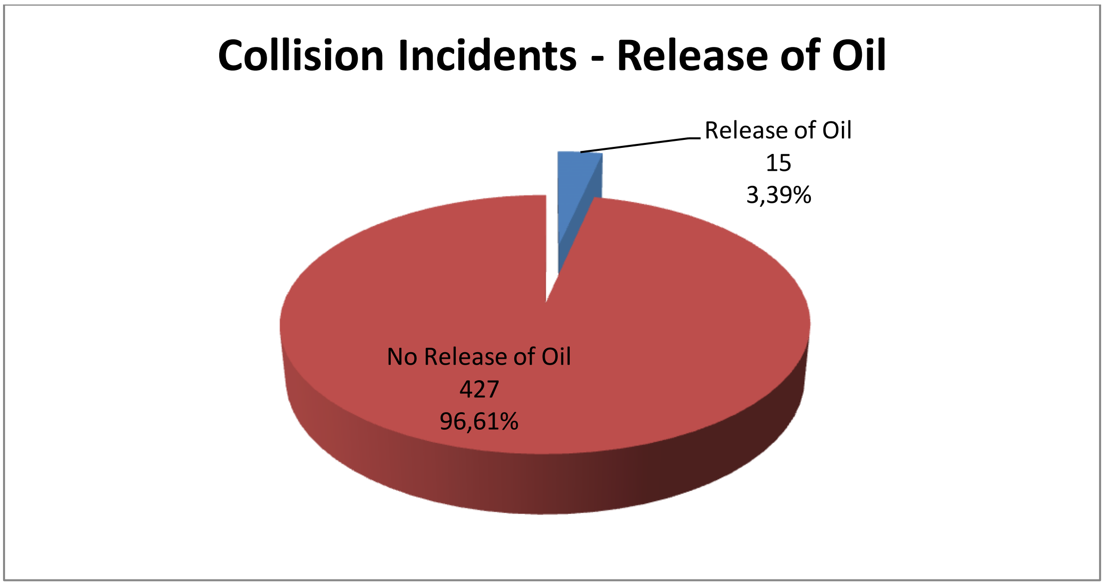


The above statistics concern only three accidents out of a total of 442 collision incidents and all of them considered as serious.

Loss of Payload

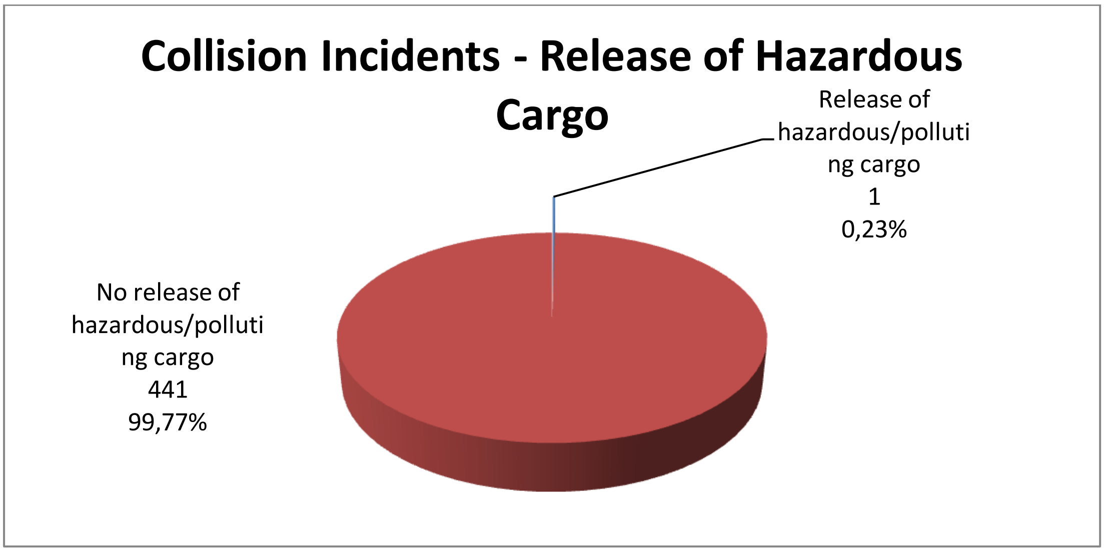
In total, 250 containers were lost overboard, despite the fact that only 15 incidents involved Loss of Payload.

Release of Oil



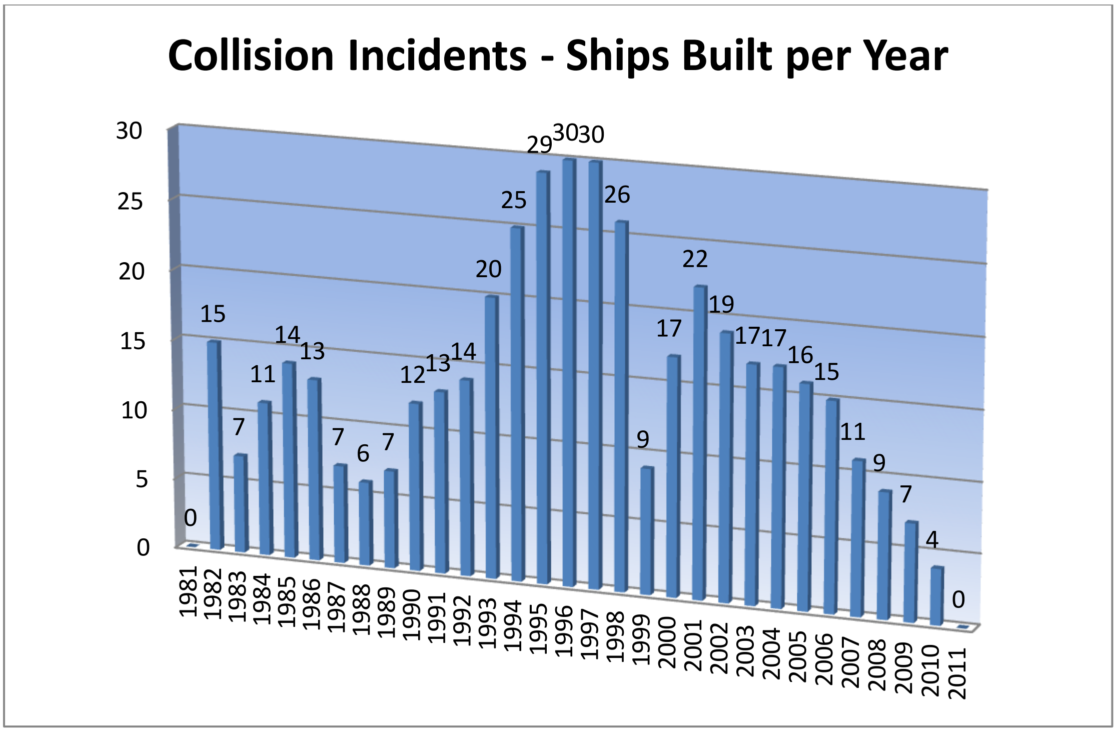
The release of Oil is minor as a percentage, but considerable as an amount of 620 tonnes.

Release of hazardous Cargo

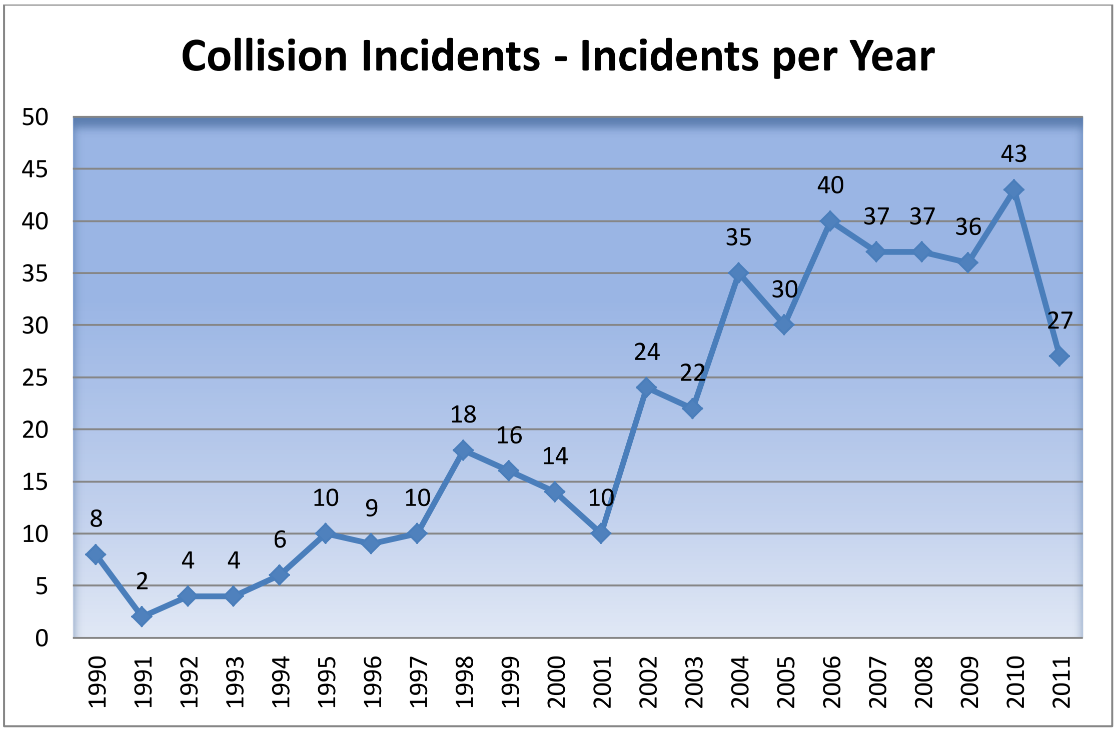


So is the release of cargo that can be harmful to the environment or human.

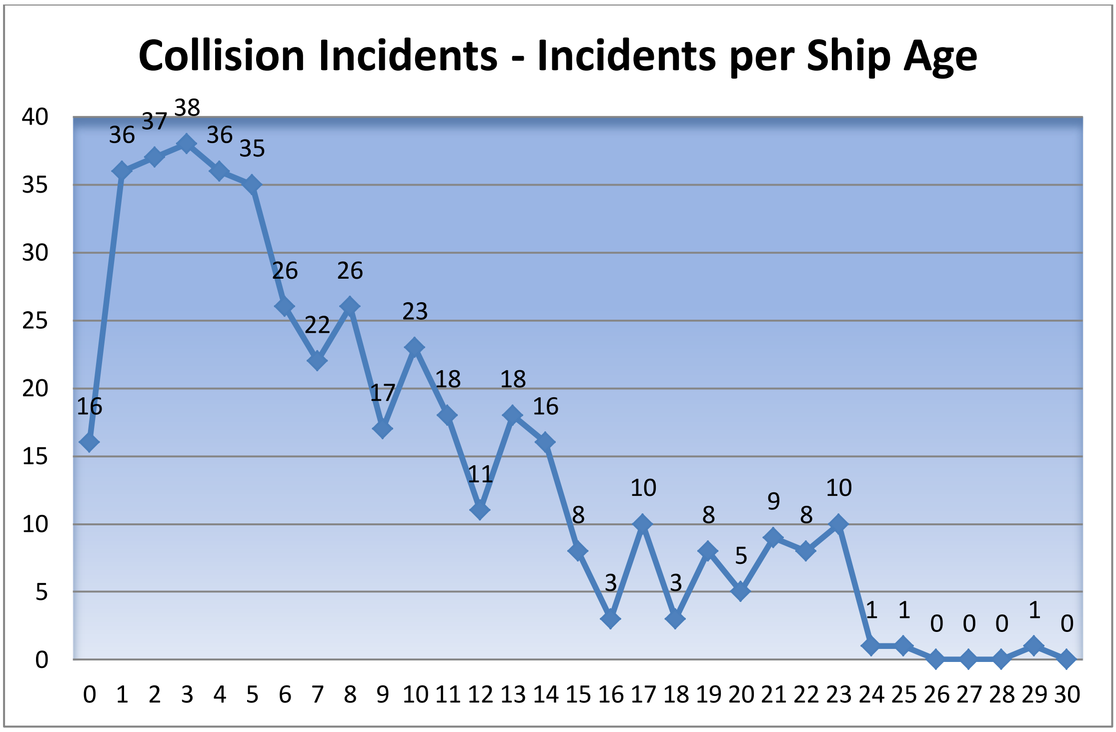
4.1.3 FREQUENCIES OF COLLISION ACCIDENTS



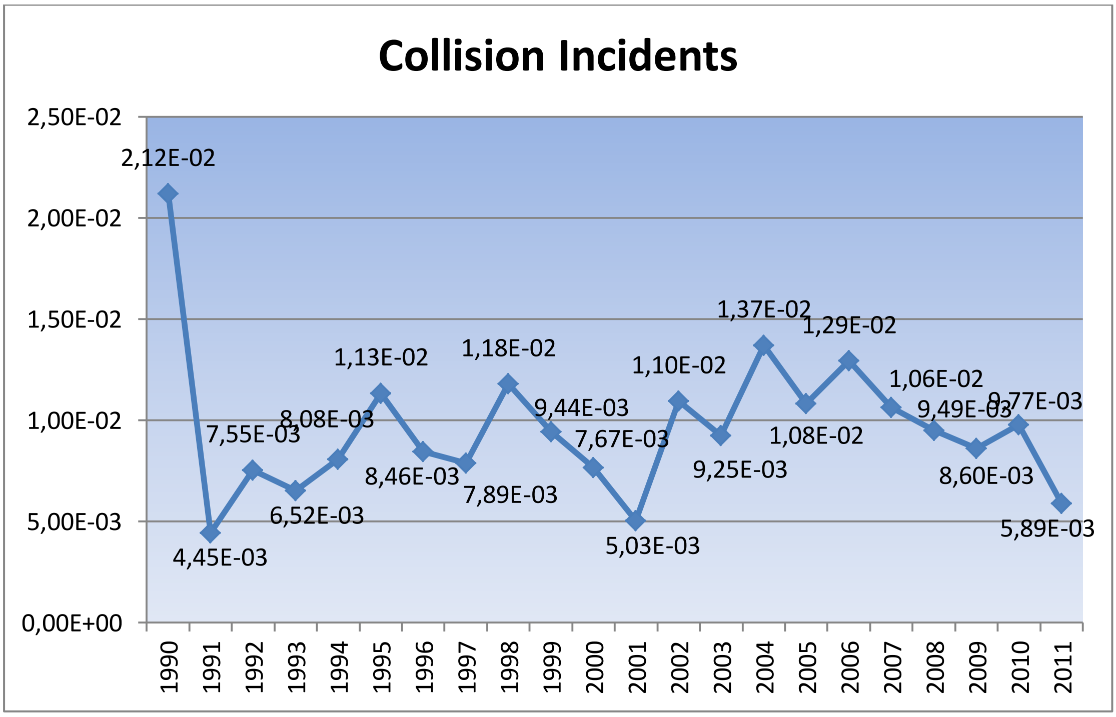
As it can be seen, most ships were built during the period 1993- 2003 with a peak on 1996- 1997.



The number of accidents tends to increase over the years, a fact that is also explained by the following diagram.

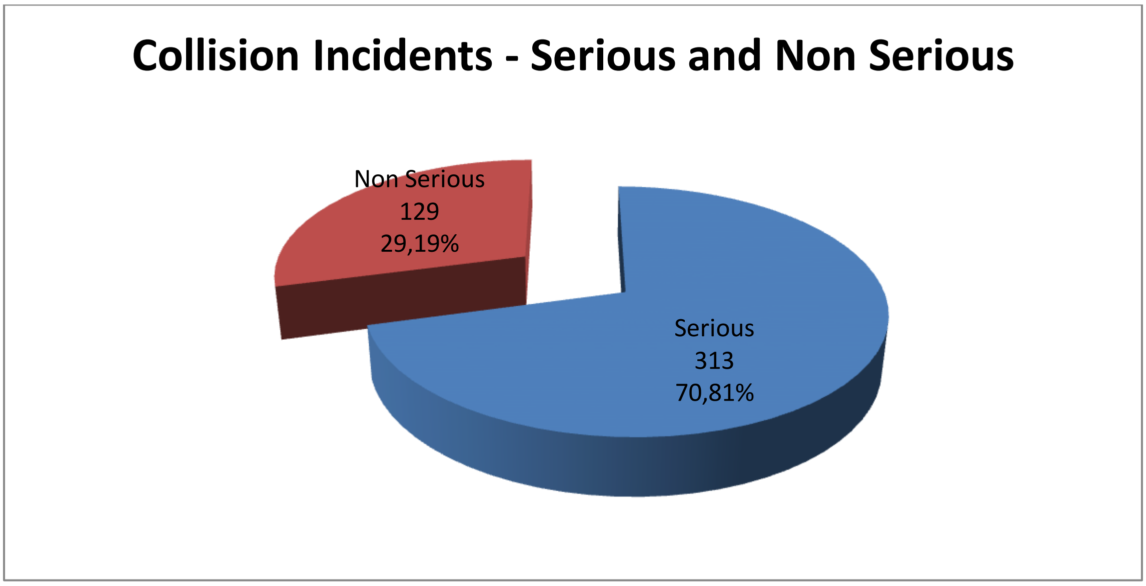


The increased number of ships leads to more accidents, but it is noticeable that the younger ships have the most.



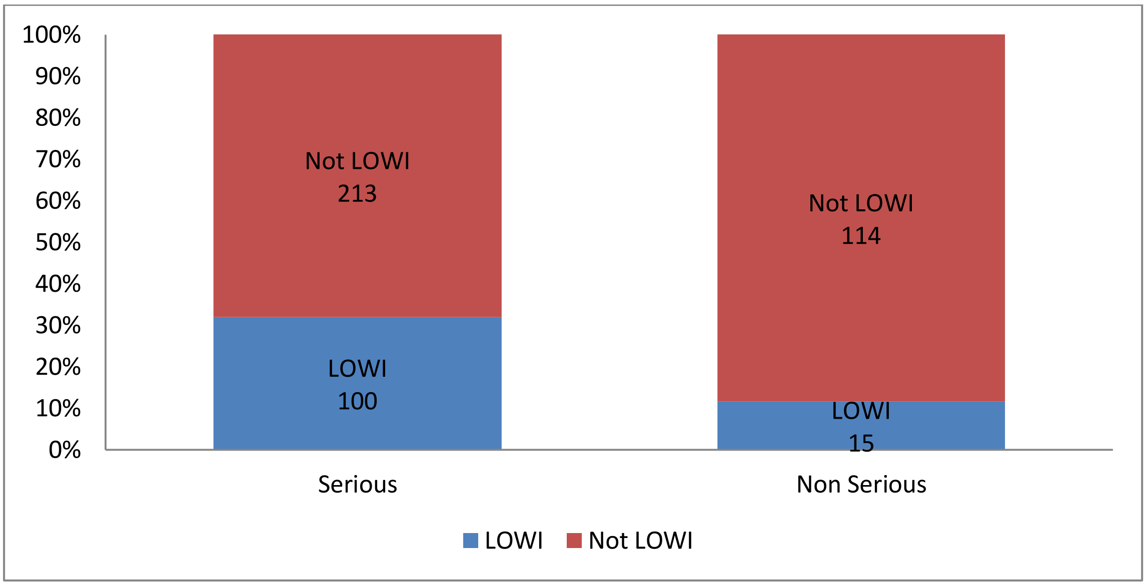
With an exception during 2004- 2006, the frequencies of collision incidents are around 1% of the fleet.

4.1.4 COMPARISON OF SERIOUS AND NON-SERIOUS ACCIDENTS

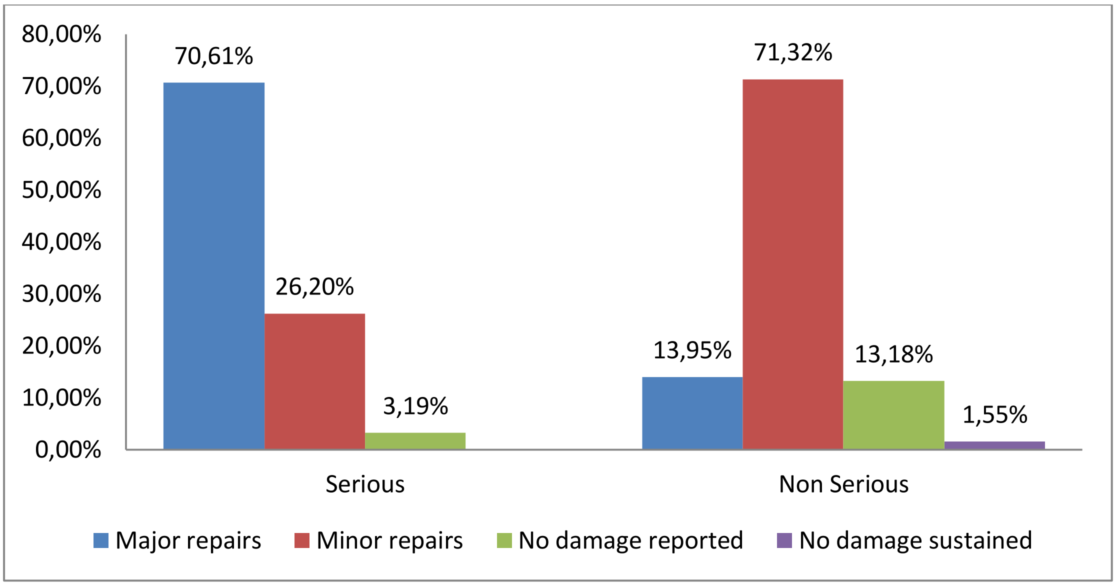


As far as the severity of the accidents, the majority of them are considered as serious.

The following chart indicates the distribution of LOWI and Non LOWI accidents for different severity.



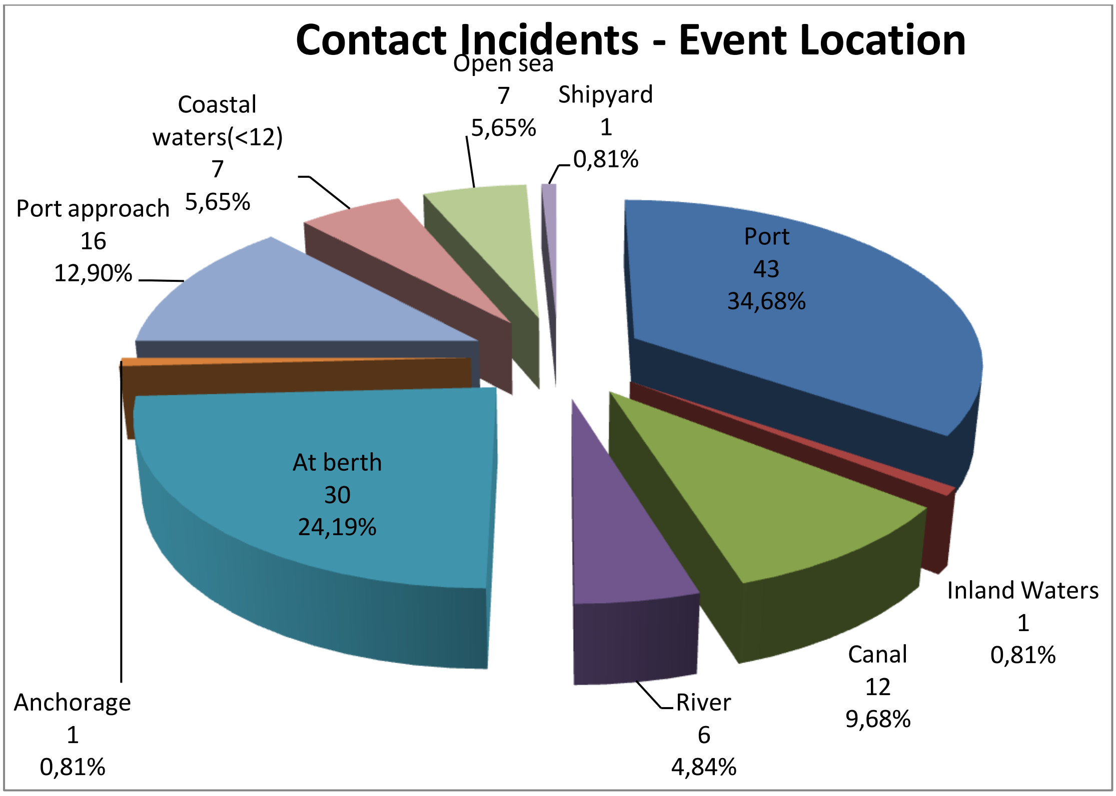
Every accident that involved release of Oil or Hazardous cargo was considered as serious.



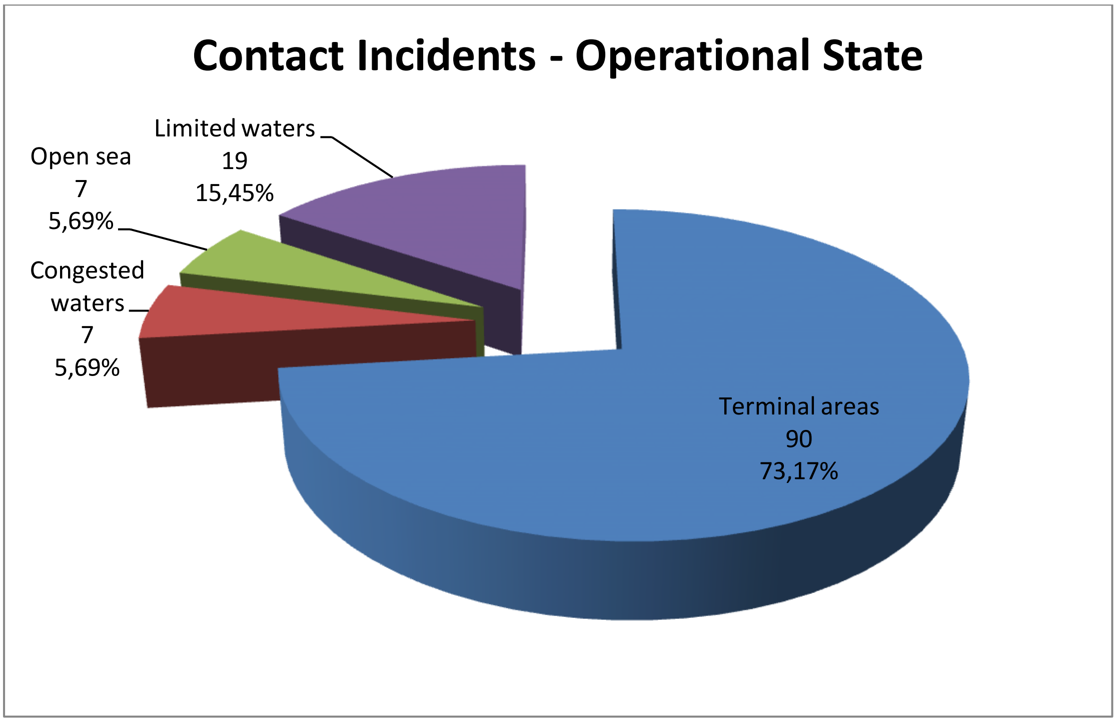
4.2 CONTACT INCIDENTS

4.2.1 CONDITIONS OF CONTACT ACCIDENTS

Event Location

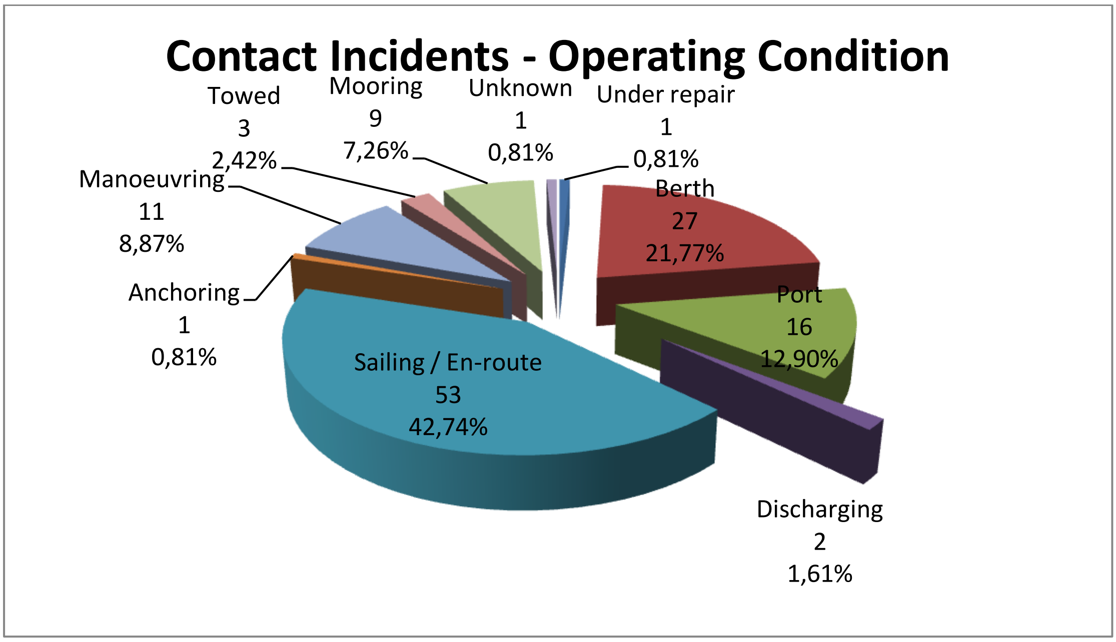


Operational State



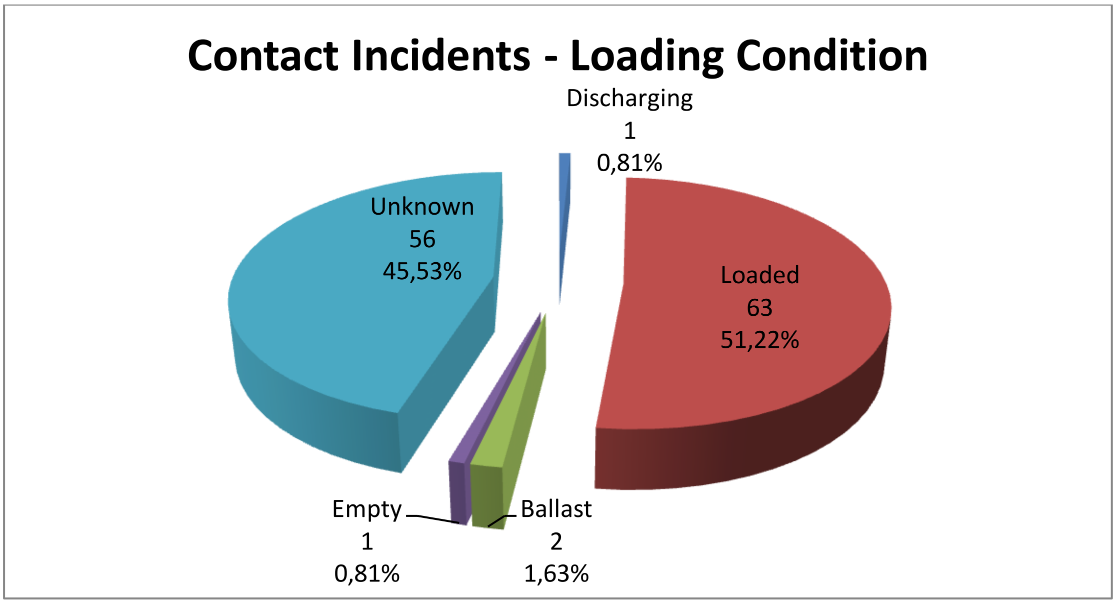
The majority of contact incidents take place at terminal areas and limited waters.

Operating Condition

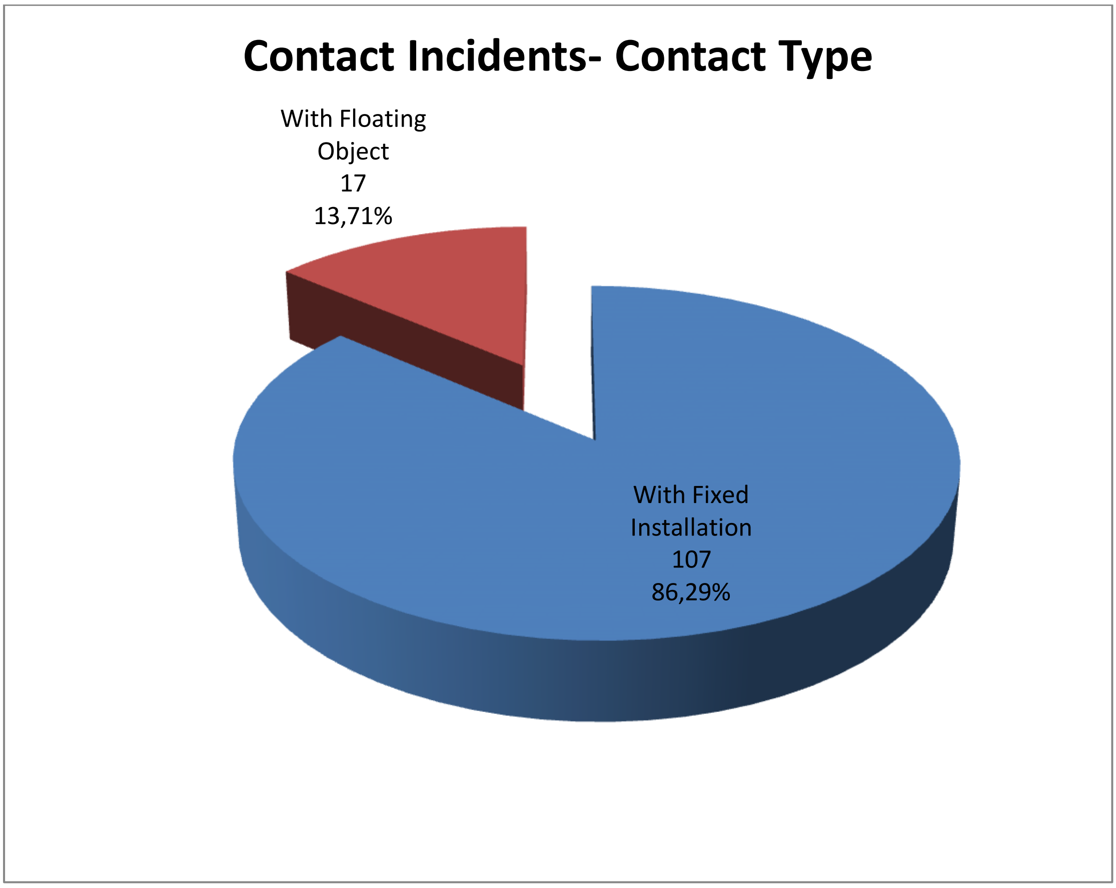


Sailing and at berth accidents are the main categories on operating conditions.

Loading Conditions

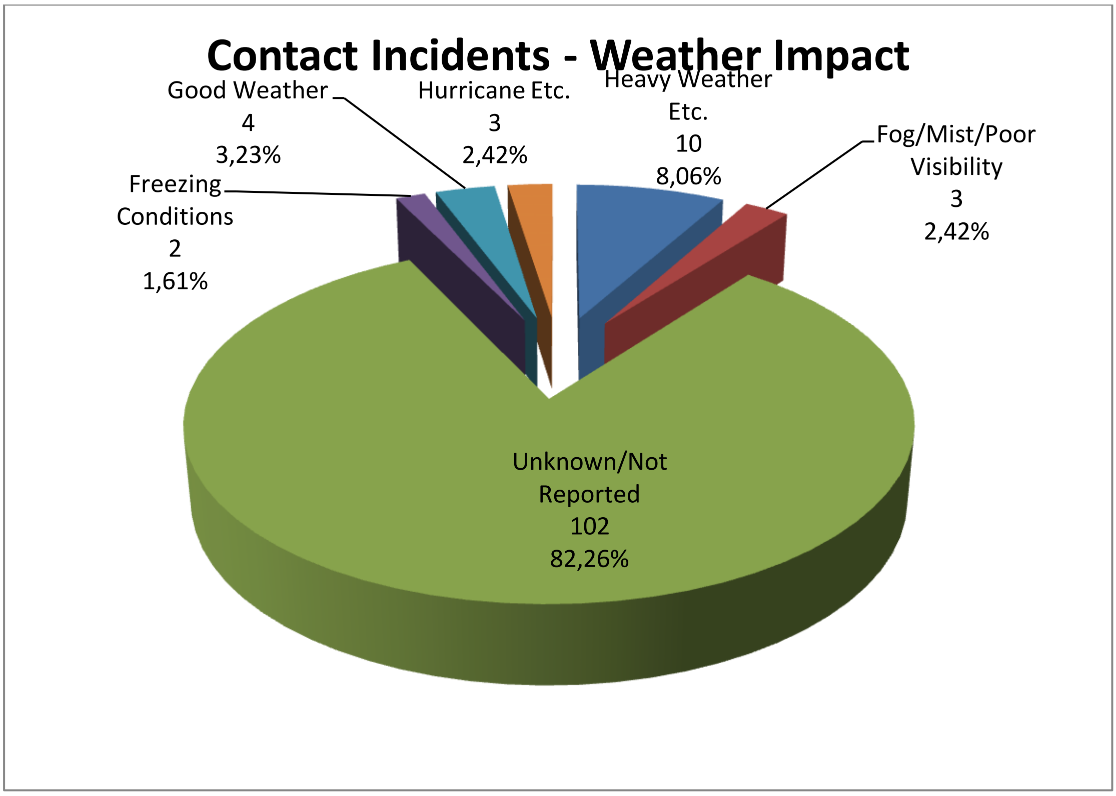


Contact Type



Contact accidents mainly occur due to contact with fixed installations and secondarily with floating objects.

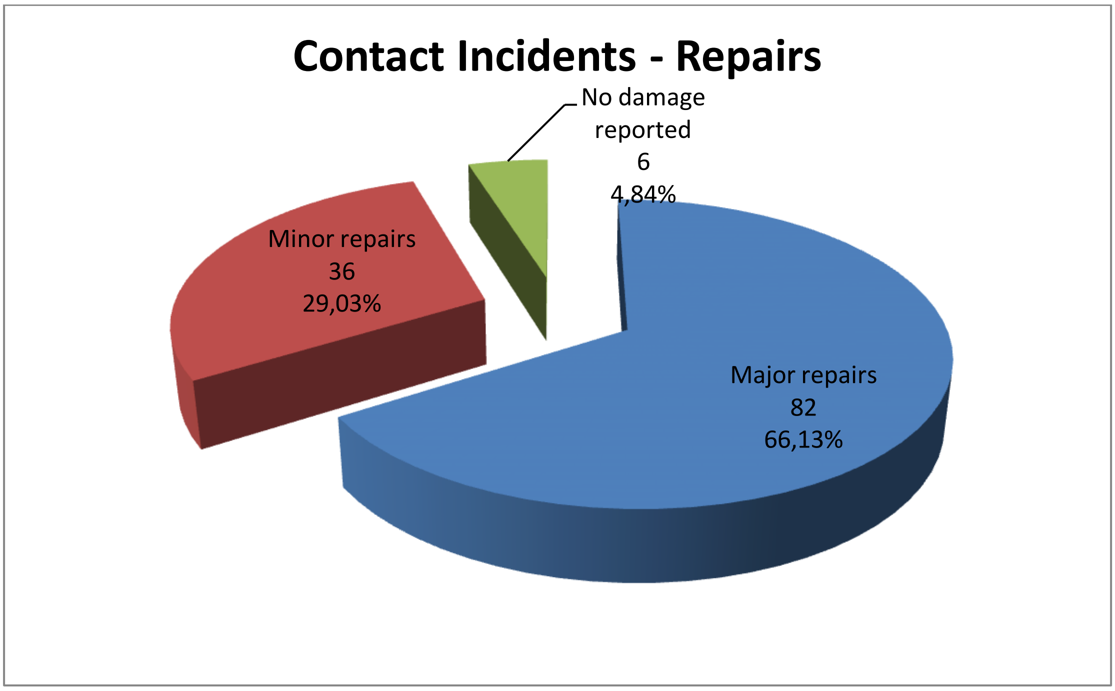
Weather Impact



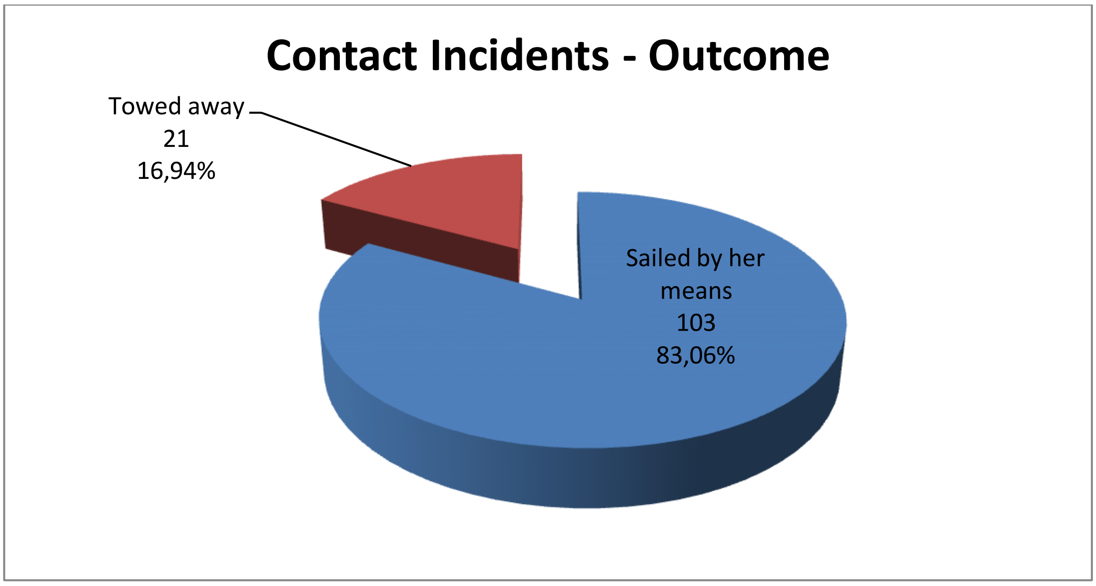
The parameter of weather here is unknown for most of the incidents.

4.2.2 CONSEQUENCES OF CONTACT ACCIDENTS

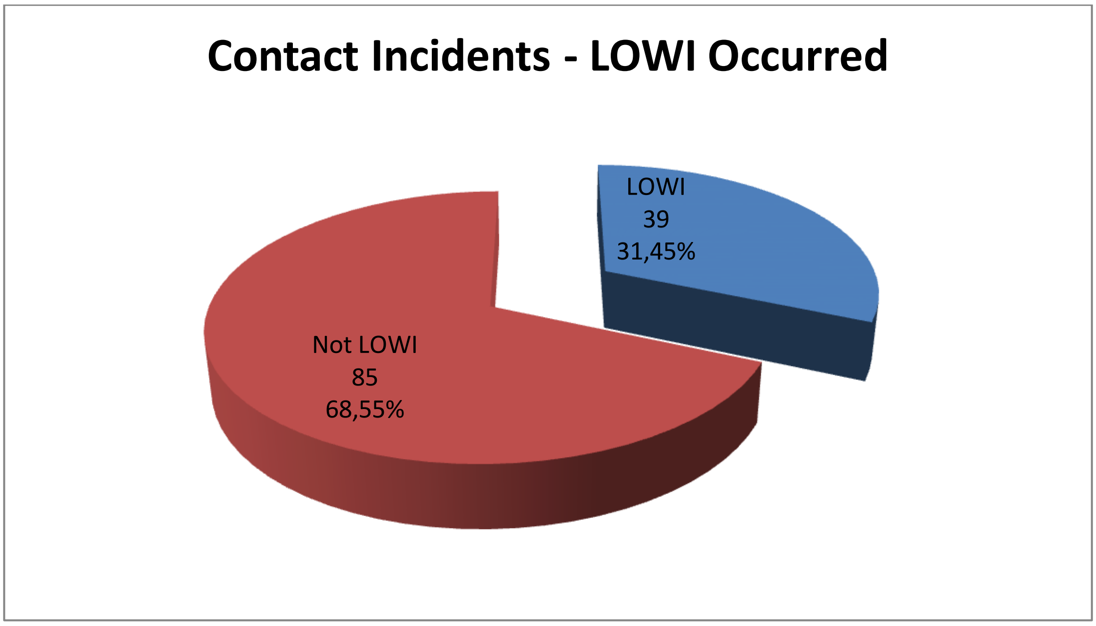
Repairs



Outcome



LOss of Water Integrity(LOWI)



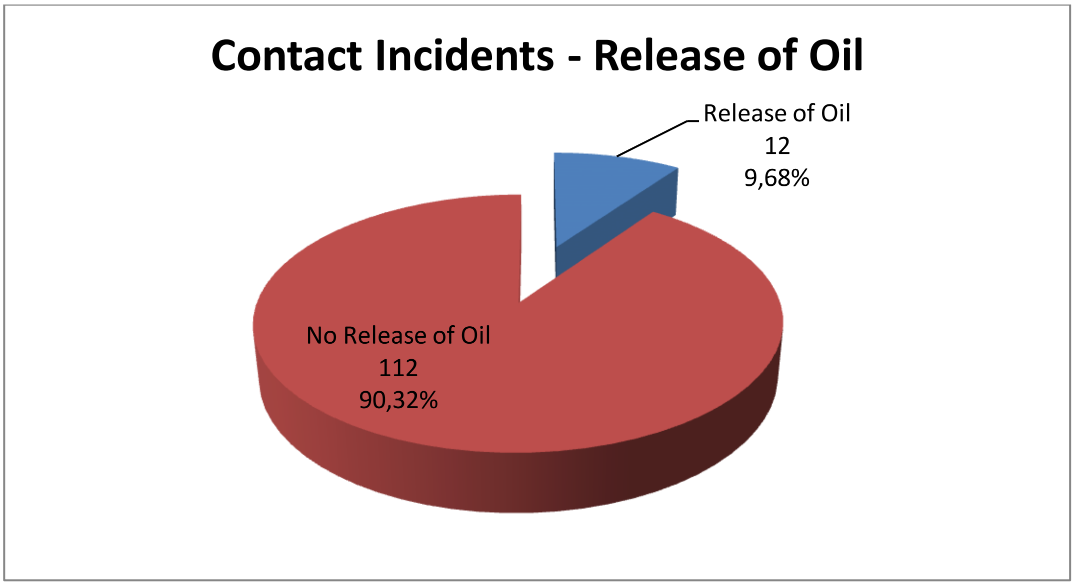
Injuries/ Fatalities

No injury or fatality occurred.

Loss of Payload

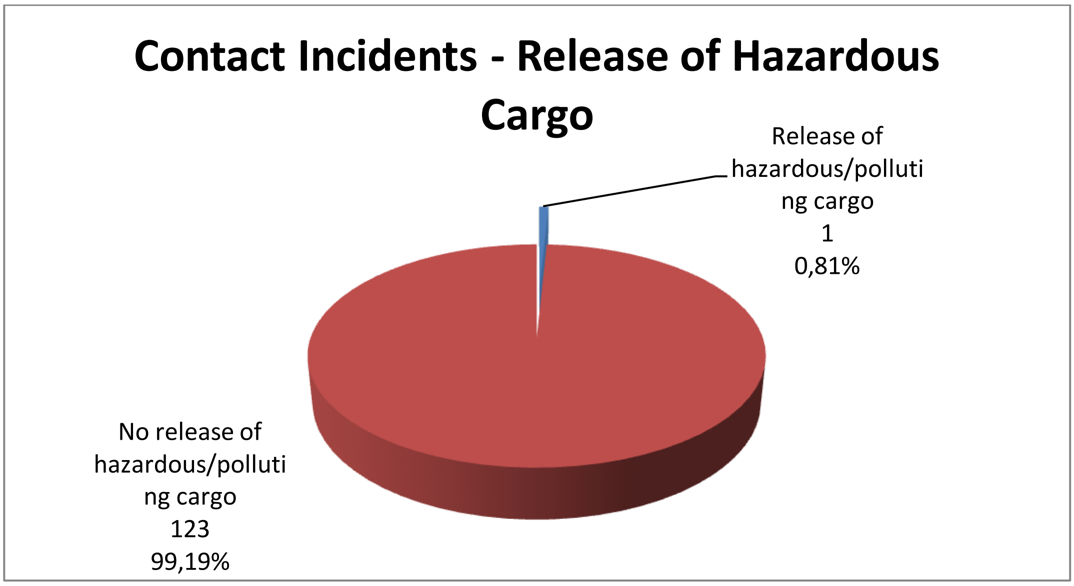
Only 1 accident led to loss of Payload, with a total number of 14 TEUs included.

Release of Oil

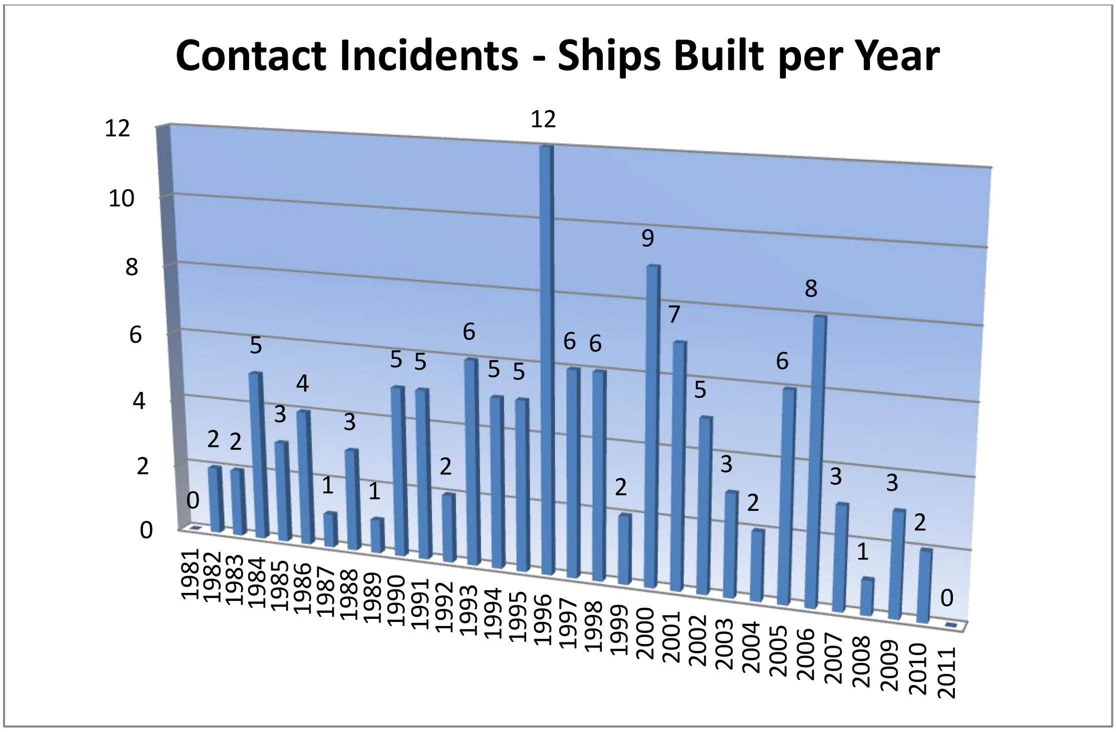


The release of Oil is minor as a percentage, but considerable as an amount of 1833 tonnes.

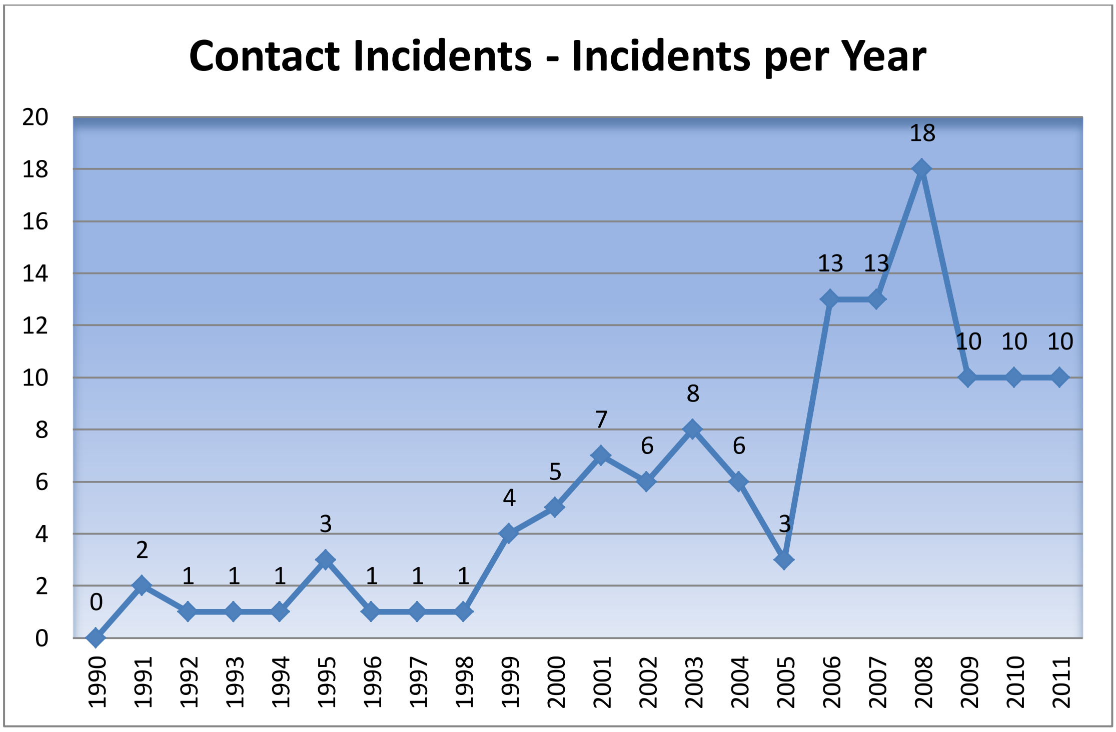
Release of hazardous Cargo



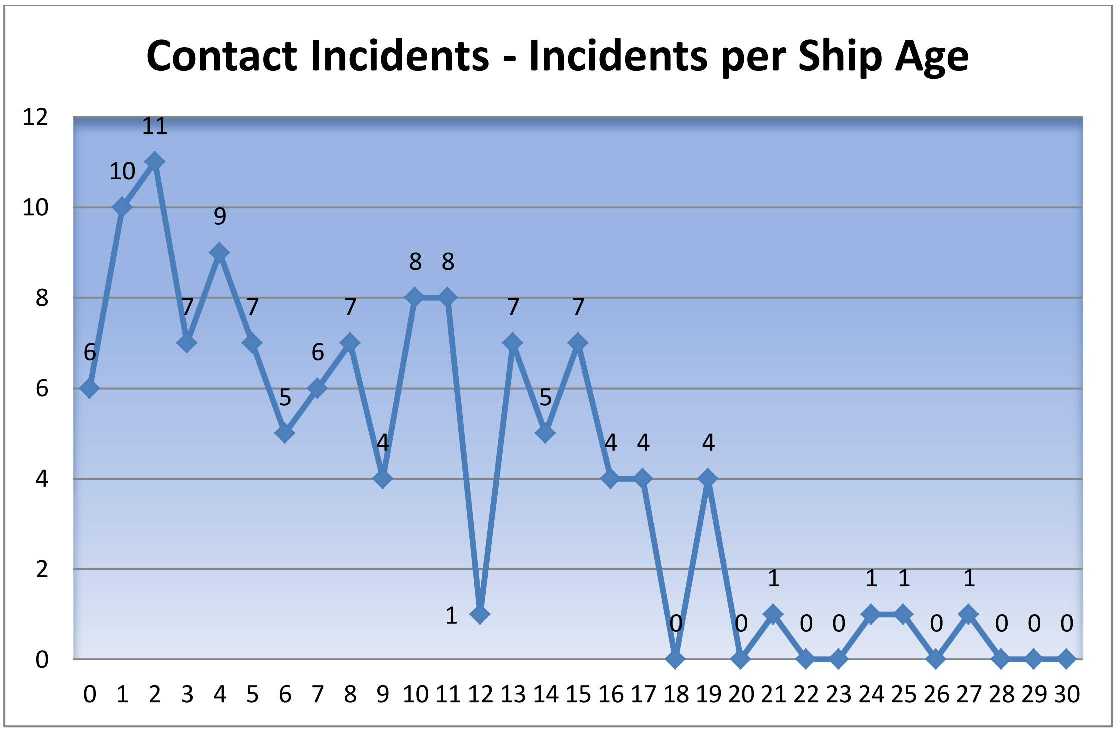
4.2.3 FREQUENCIES OF CONTACT ACCIDENTS



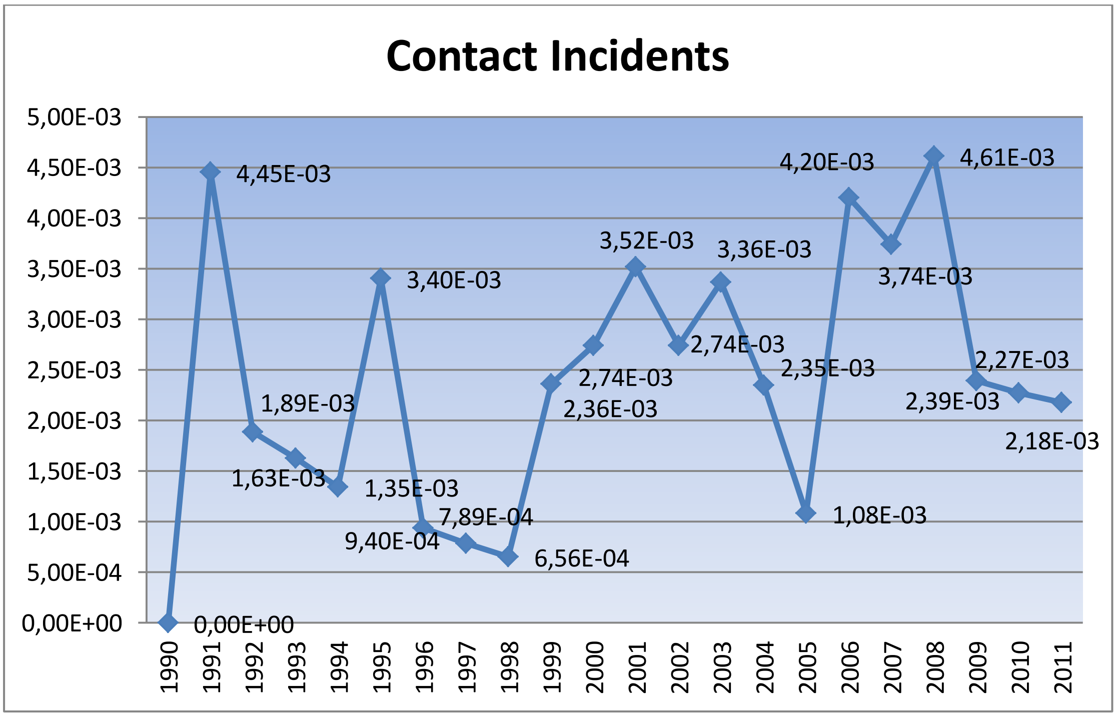
1996 is the year with the most ships built.



Since 1999 and 2006 there is a big increase in contact incidents. Average for the years 1993- 1998 is 1.66 incidents per year, while for 1999- 2005 and 2006- 2011 it is 5.57 and 12.33 respectively.

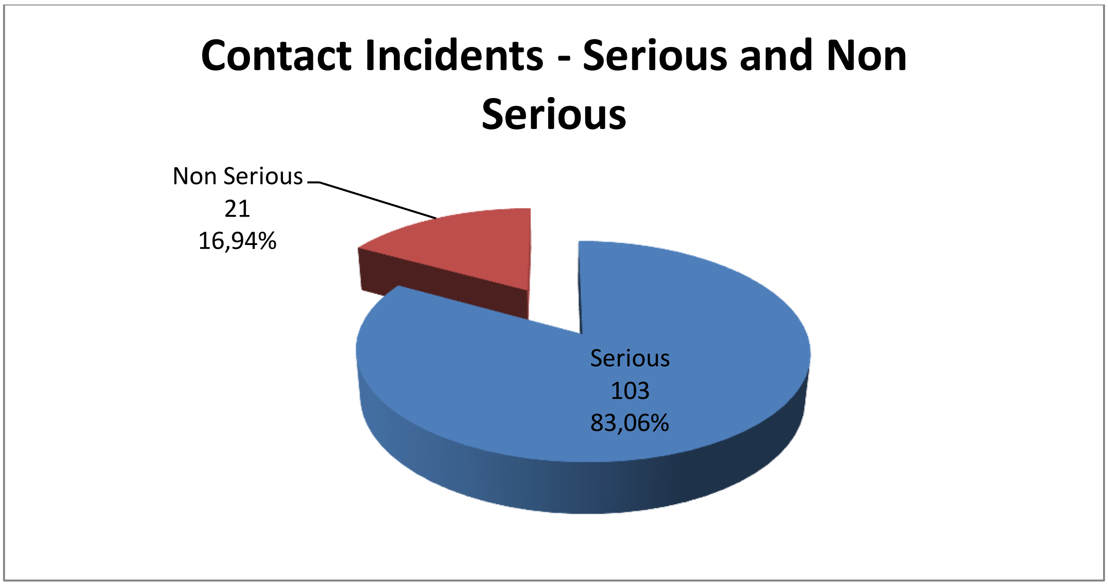


Ships built after 1994 tend to have more contact accidents.

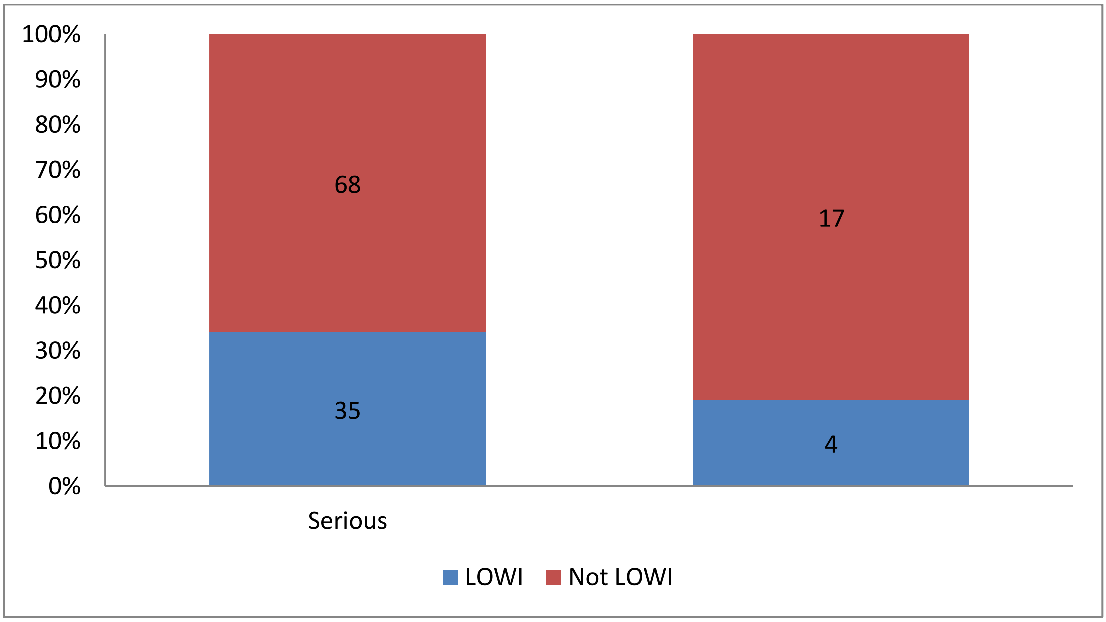


Contact incidents do not have a steady, increasing or decreasing, progress that could lead to a conclusion.

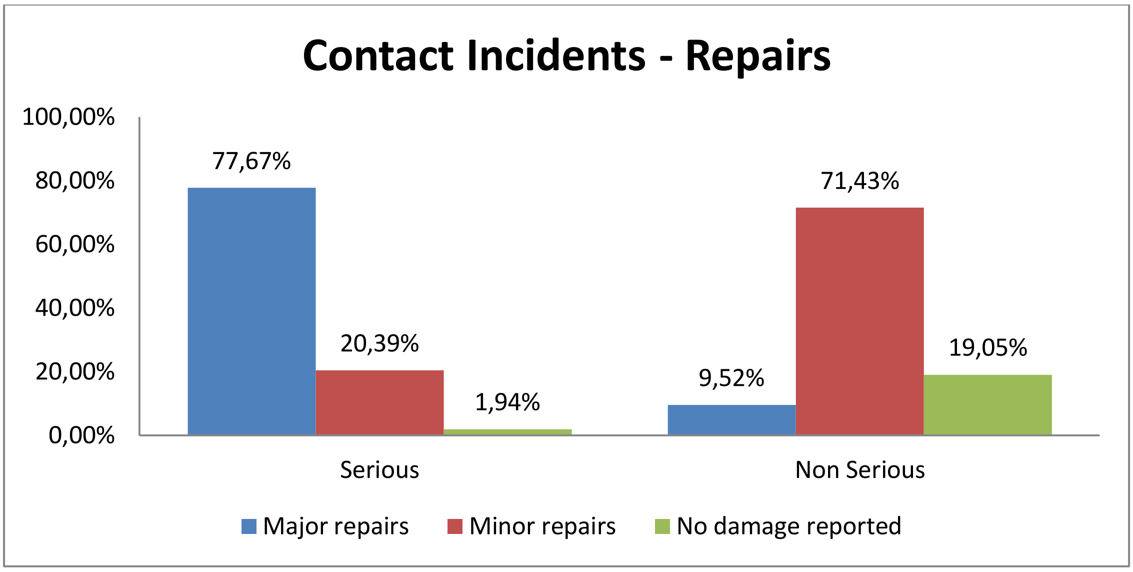
4.2.4 COMPARISON OF SERIOUS AND NON-SERIOUS ACCIDENTS



Non-serious incidents (17%) are significantly lesser than serious incidents (83%).



The rates of LOWI are similar for serious and not serious incidents.

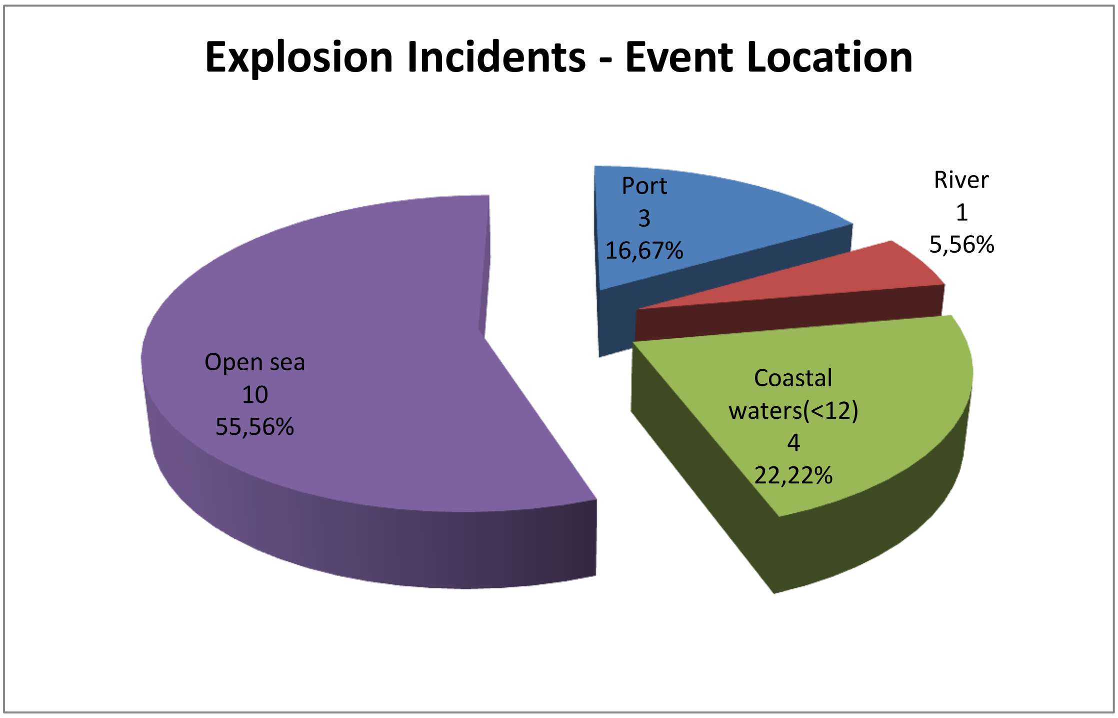


The difference between serious and non-serious accidents is obvious in this chart. Major repairs for serious accidents are up to 77.67% when for non-serious are only 9.52%. The same conclusion emerges for minor repairs, 20.39% and 71.43% respectively.

4.3 EXPLOSION INCIDENTS

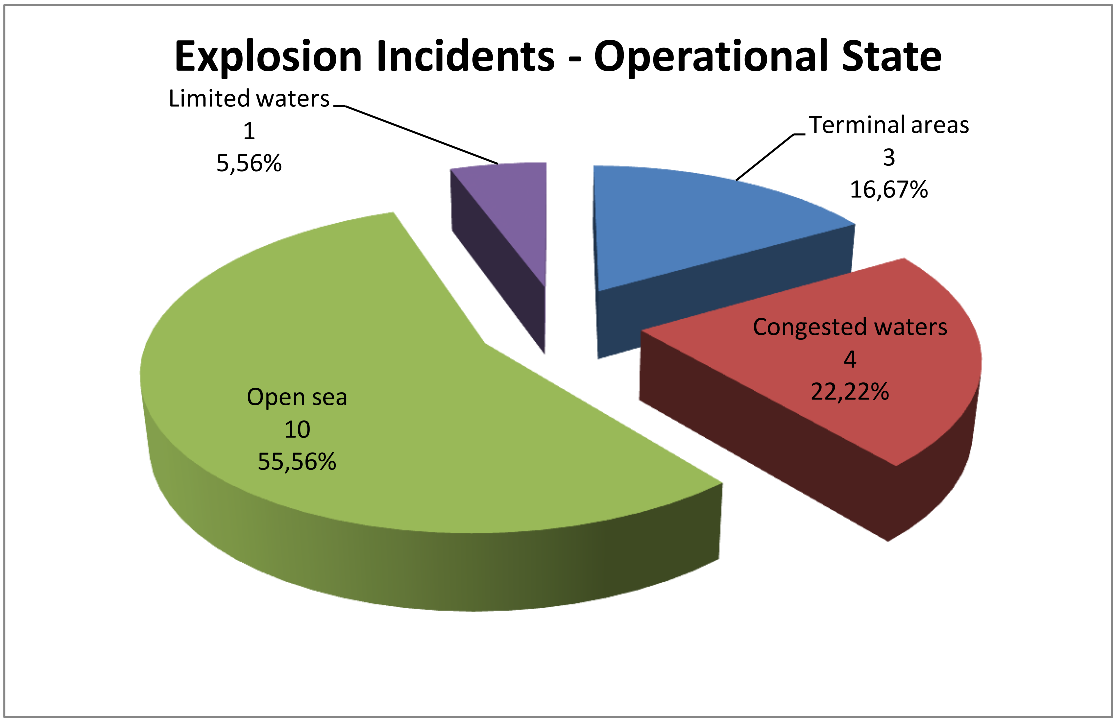
4.3.1 CONDITIONS OF EXPLOSION ACCIDENTS

Event Location

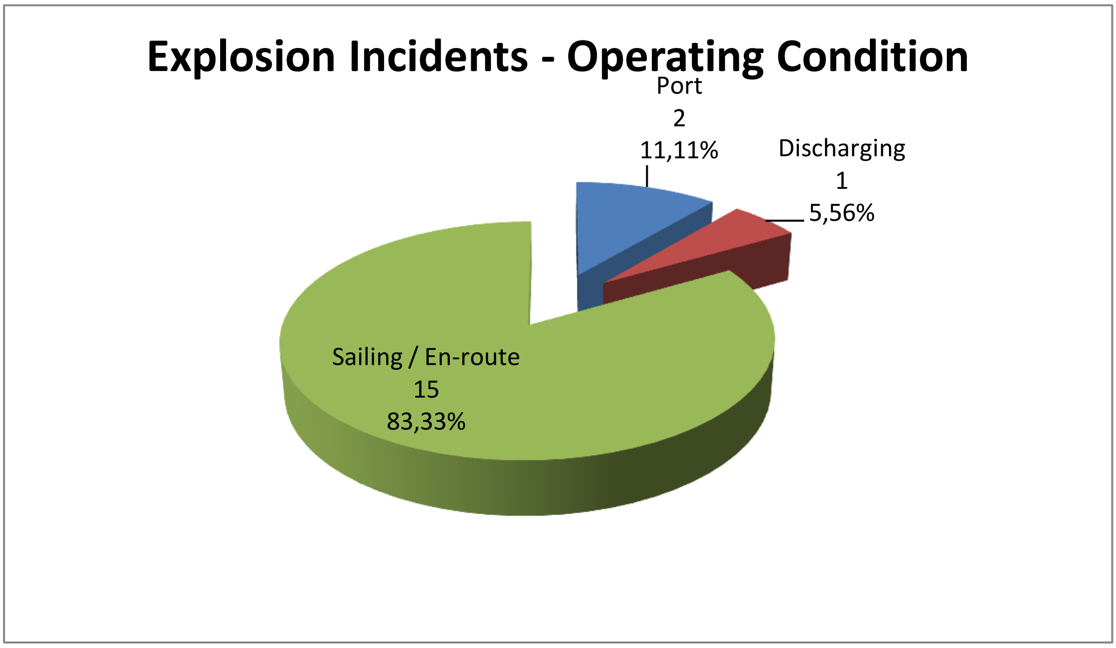


Explosion events are irrelevant to existance of facilities and congested waters, that is why no conclusion is emerged.

Operational State

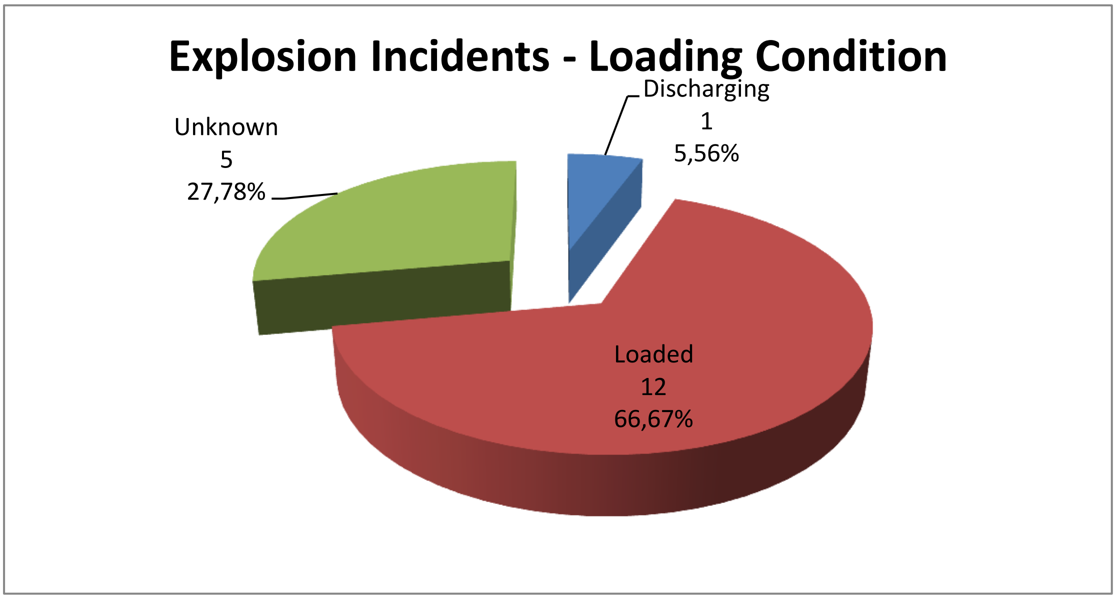


Operating Condition

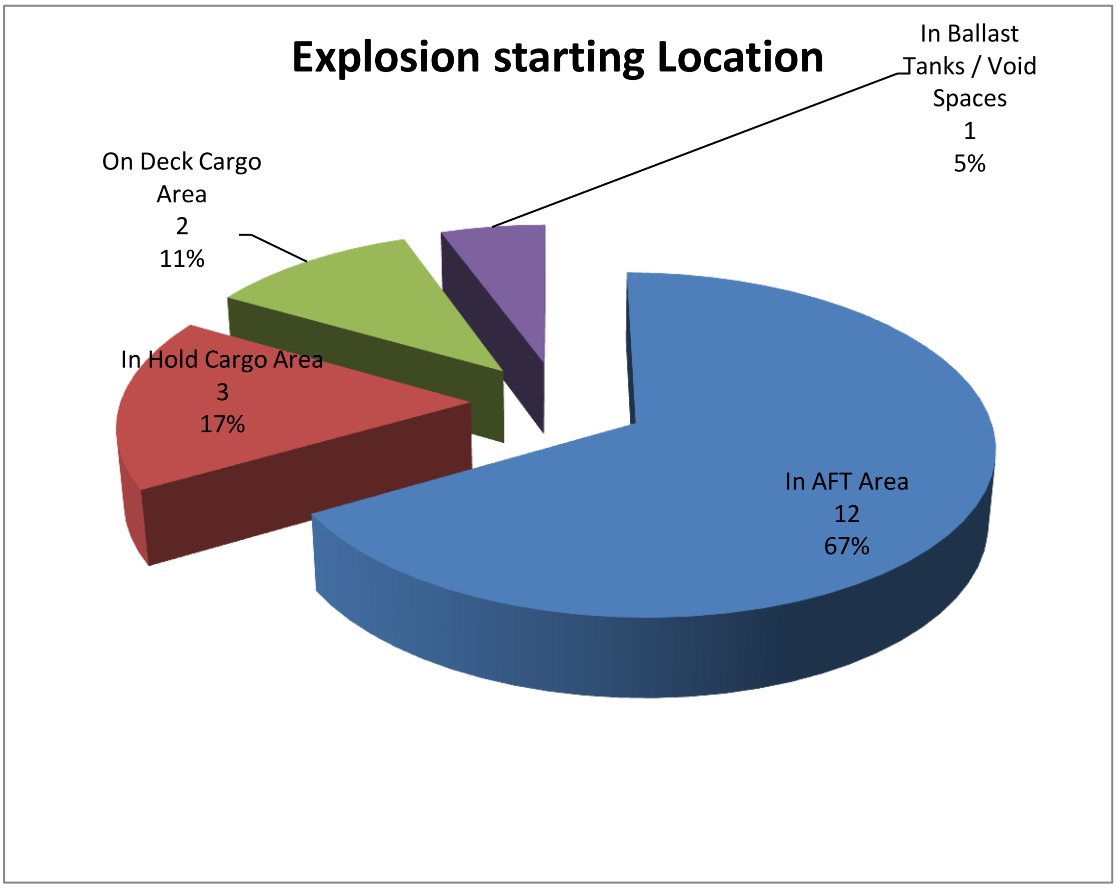


Accidents mainly occur during the voyage and away from any port facility.

Loading Conditions

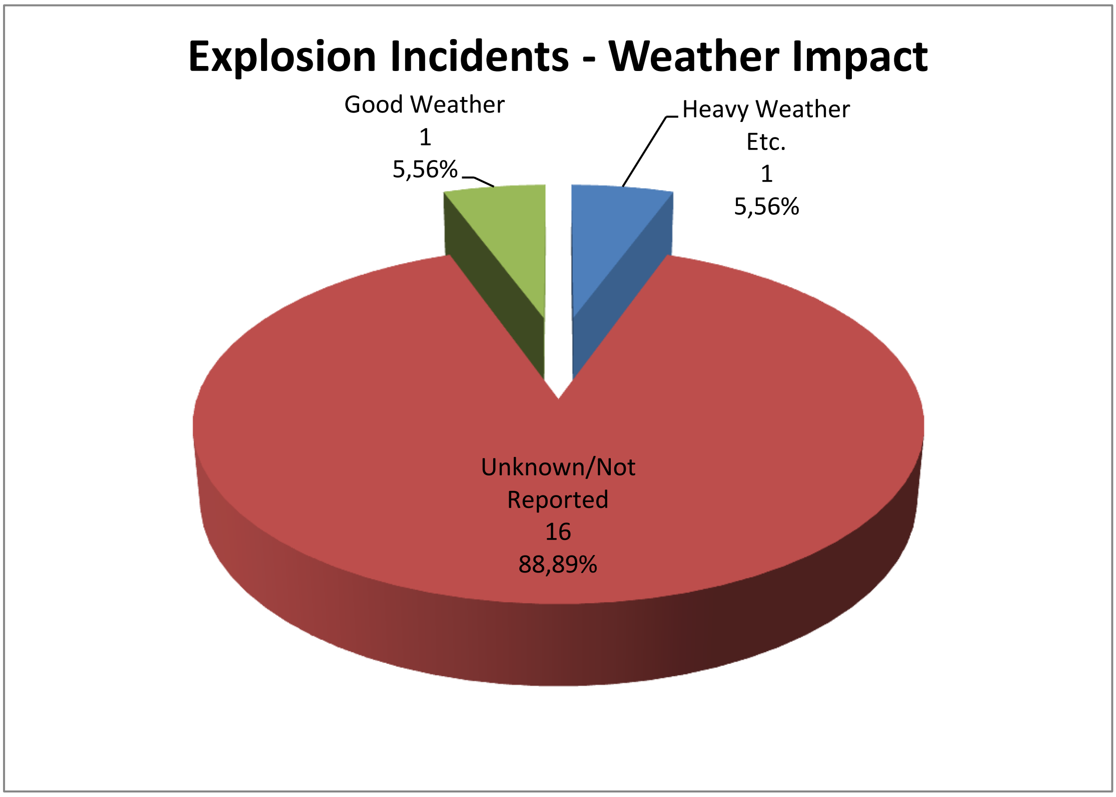


Explosion starting Location



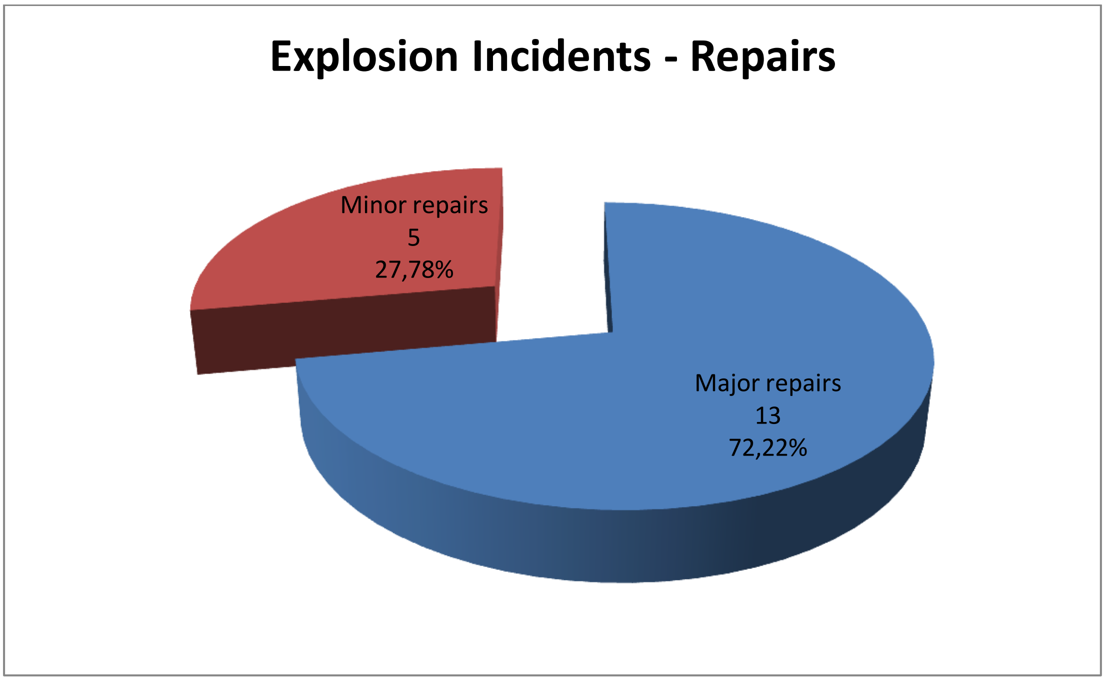
The main area where explosions happen is the AFT area and especially the engine room.

Weather Impact



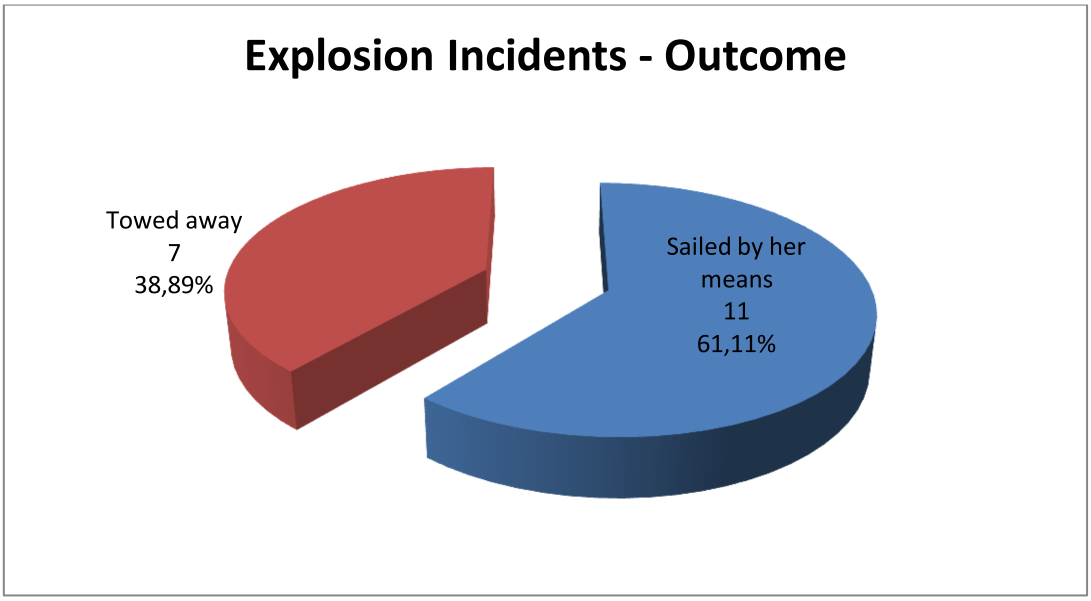
4.3.2 CONSEQUENCES OF EXPLOSION ACCIDENTS

Repairs



Explosion have a lot of casualties as it can be seen on the diagram above and on the diagram of injuries/ fatalities following.

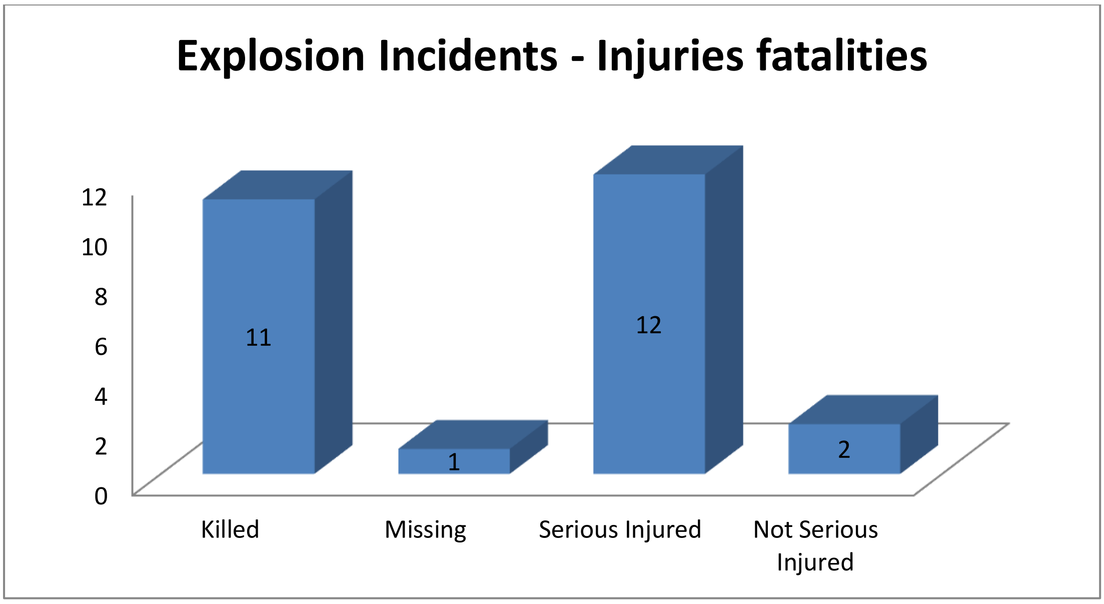
Outcome



LOss of Water Integrity (LOWI)

None of the explosion accidents led to loss of water integrity.

Injuries/ Fatalities



The statistics above concern 10 accidents 8 of which included at least one person killed or serious injured.

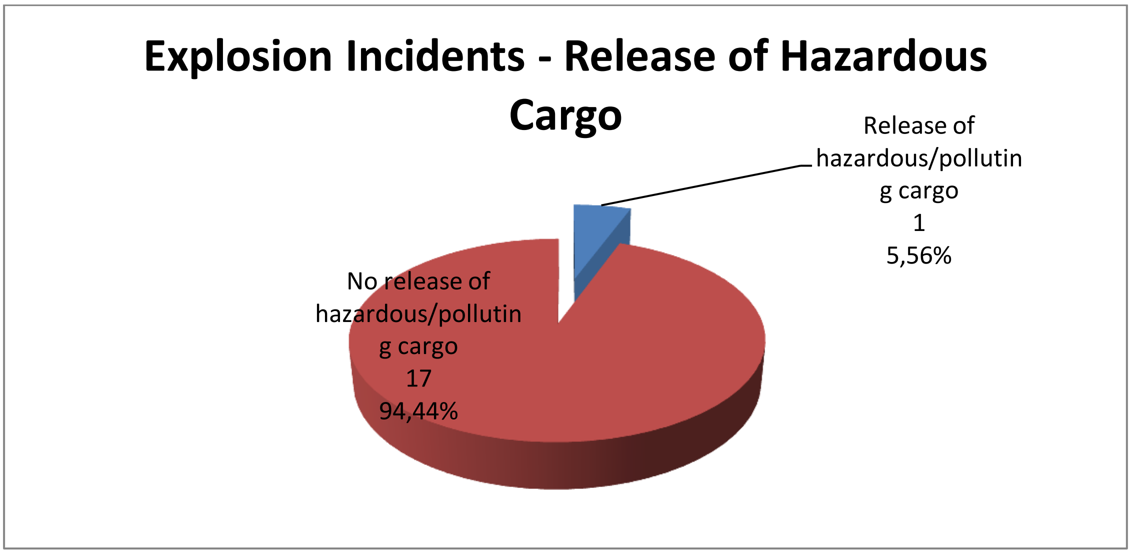
Loss of Payload

No loss of Payload.

Release of Oil

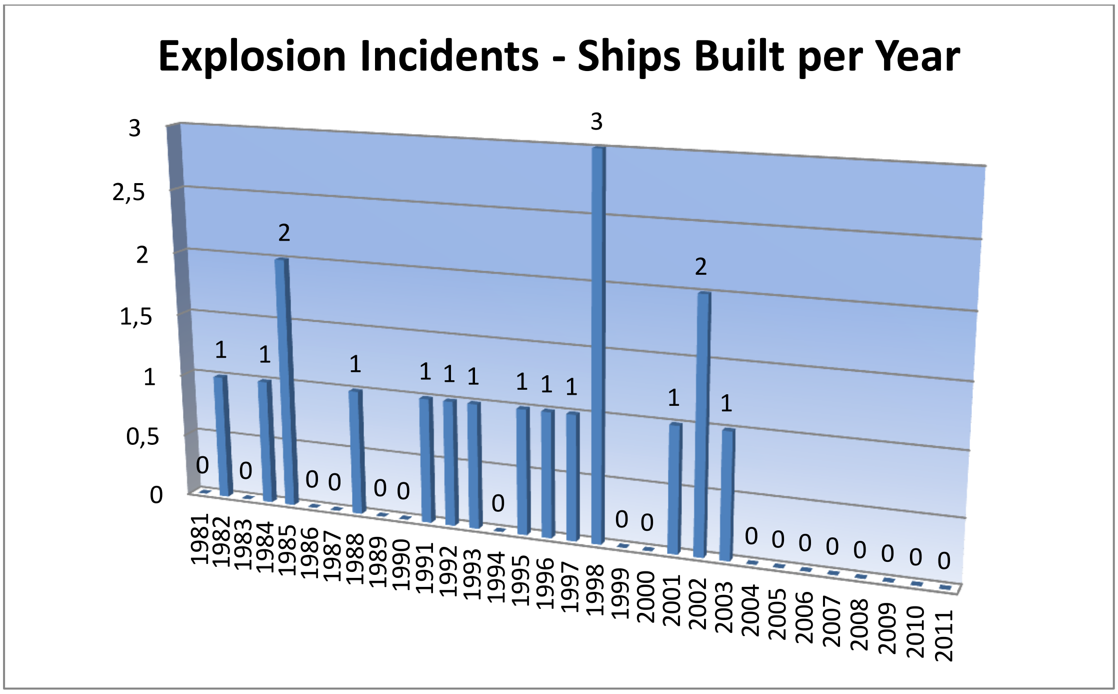
No release of Oil.

Release of hazardous Cargo

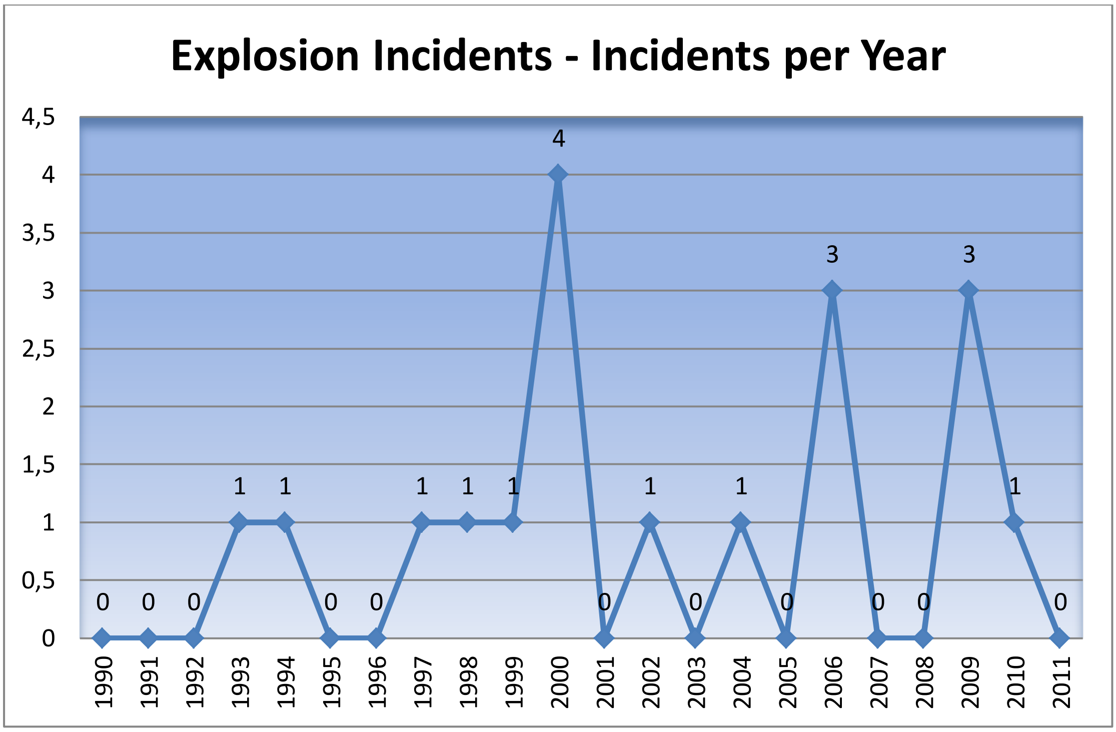


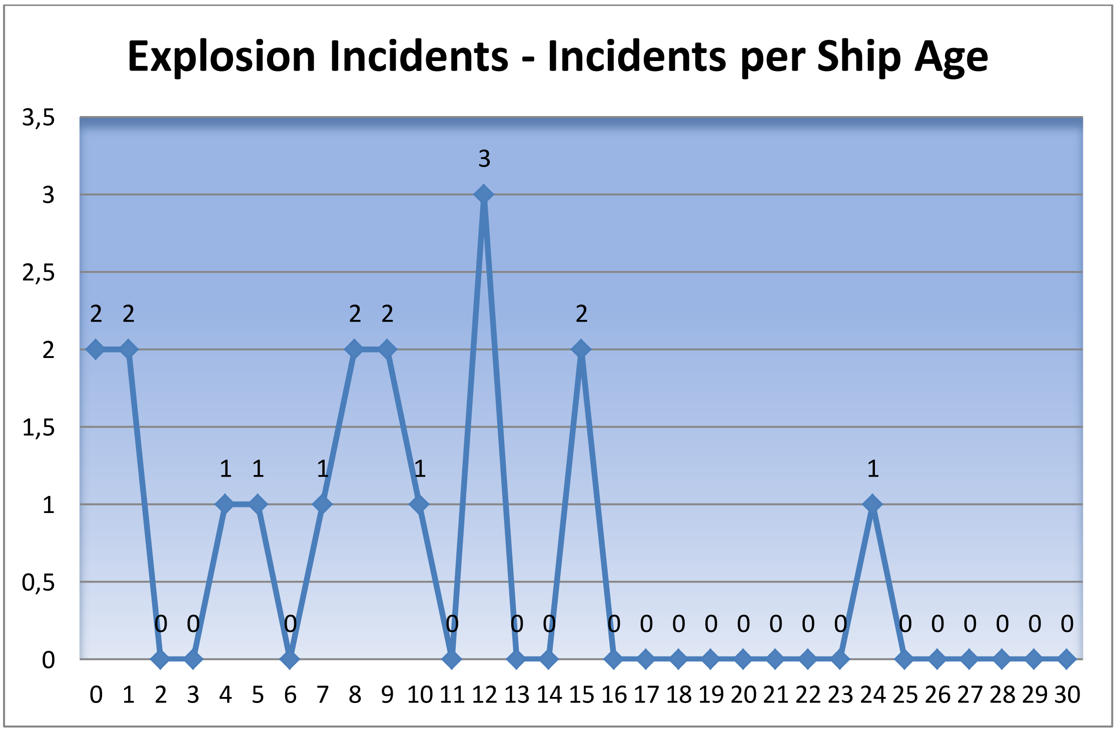
One event led to release of hazardous cargo, that of a container with undeclared dangerous chemicals.

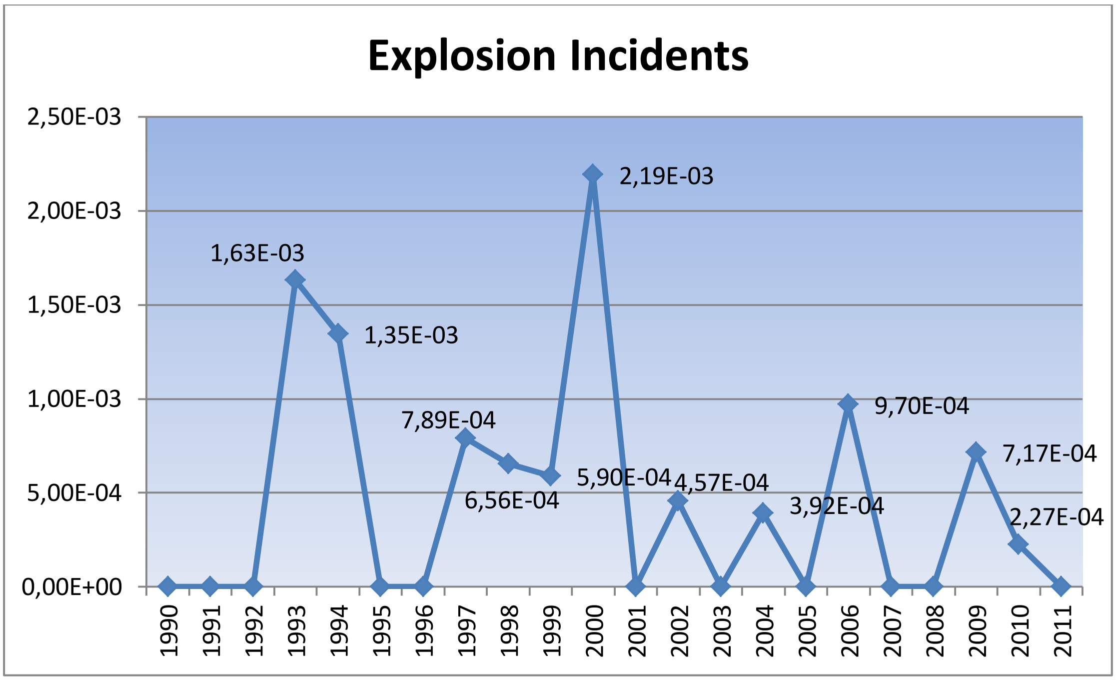
4.3.3 FREQUENCIES OF EXPLOSION ACCIDENTS



Explosion incidents seem to be eliminated since 2004. Significant role to this might have played new regulations in force.

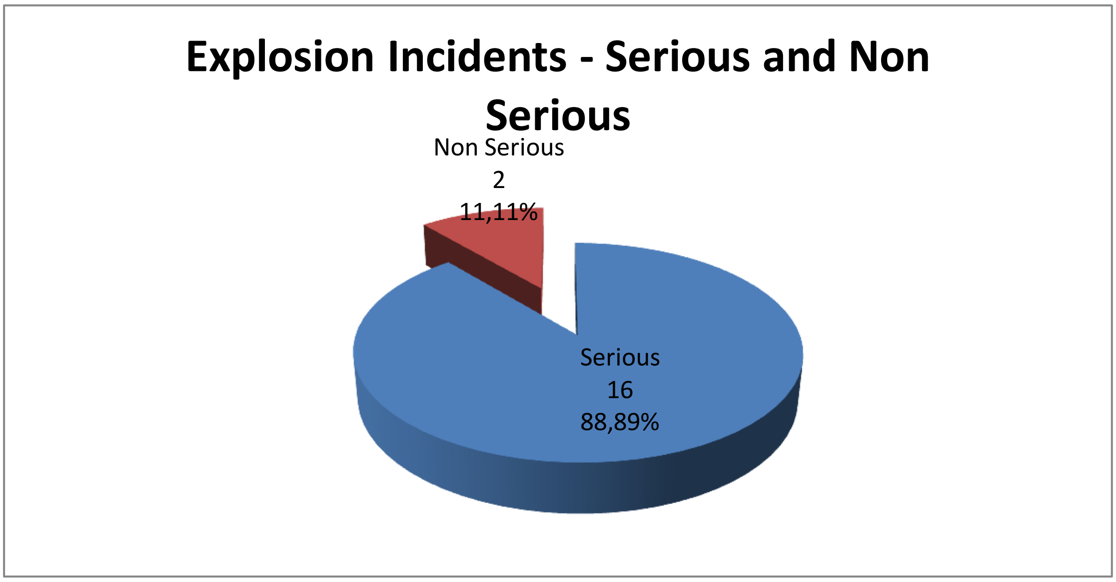






All three charts indicate that explosion events onboard are random incidents and only measures to avoid them can be taken. The fact that most of them occurred at AFT area signifies that there are a lot of initiating factors stored at this area of vessel.

4.3.4 COMPARISON OF SERIOUS AND NON-SERIOUS ACCIDENTS



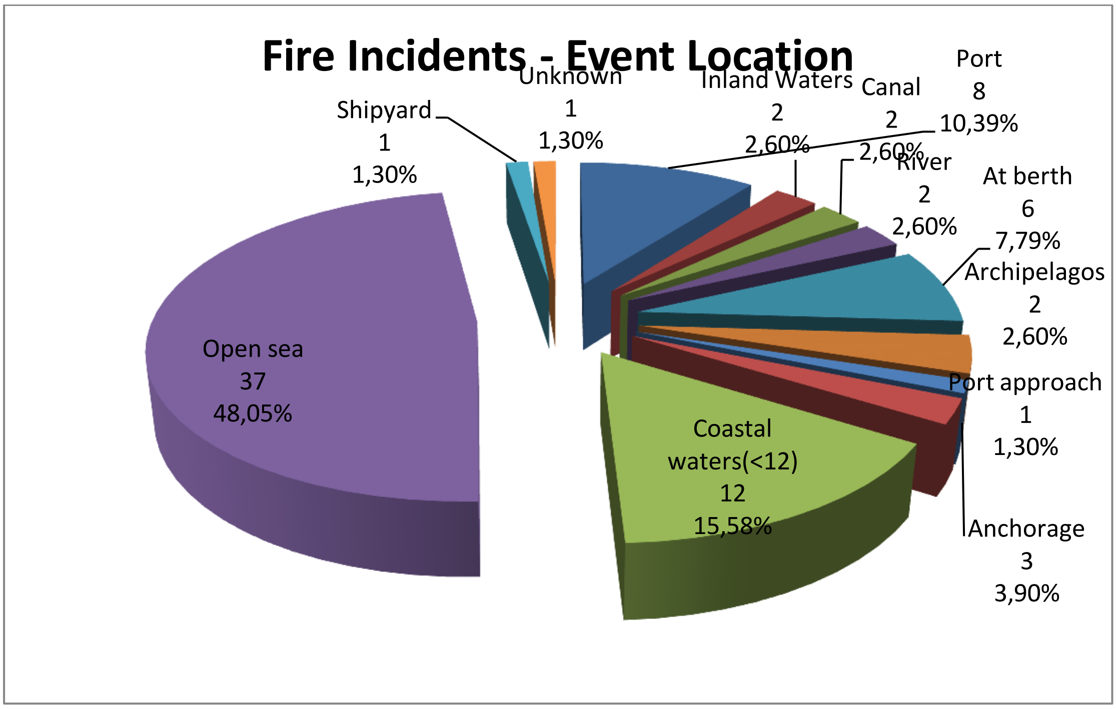
No LOWI occurred on any accident. Major repairs were needed only on serious accidents in a percentage of 81.25% (13 out of 16 accidents).

Number of non- serious accidents is small compared to serious accidents, therefore, it is wise to assume that rates of outcome in serious accidents are similar to that of all explosion incidents. Vessels involved in non- serious accidents all sailed by their means.

4.4 FIRE INCIDENTS

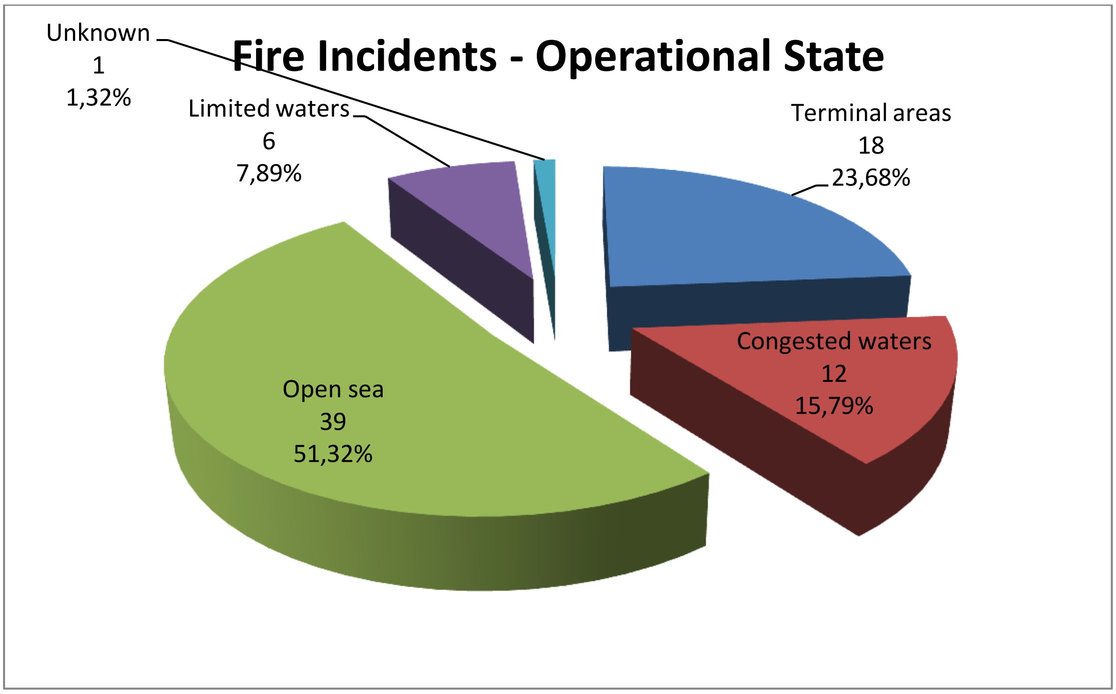
4.4.1 CONDITIONS OF FIRE ACCIDENTS

Event Location

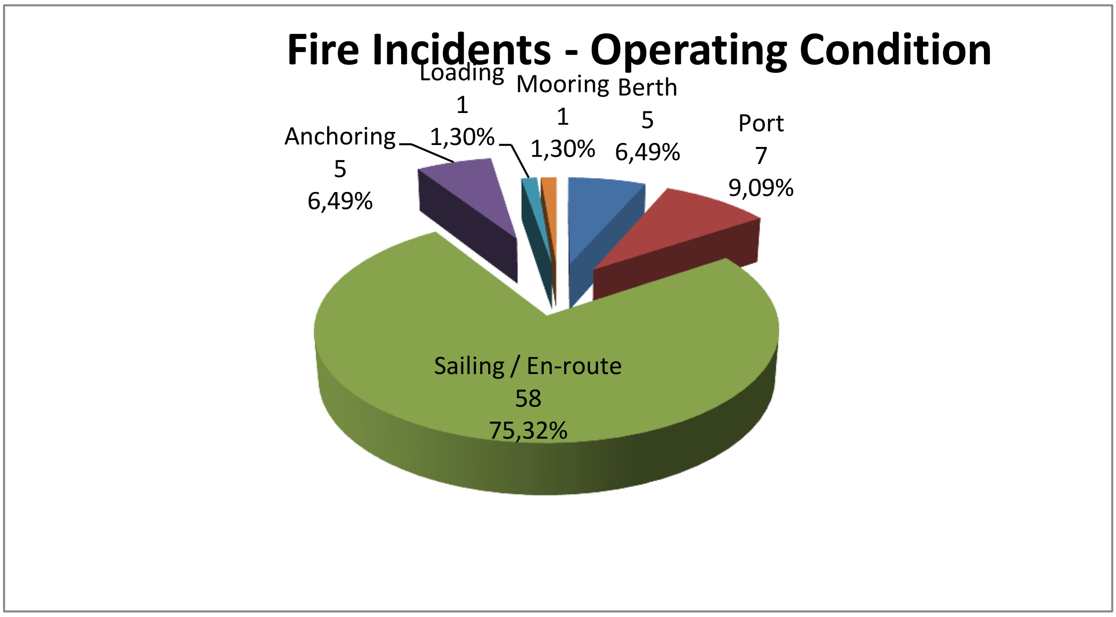


Almost half the fire incidents occur on open sea.

Operational State

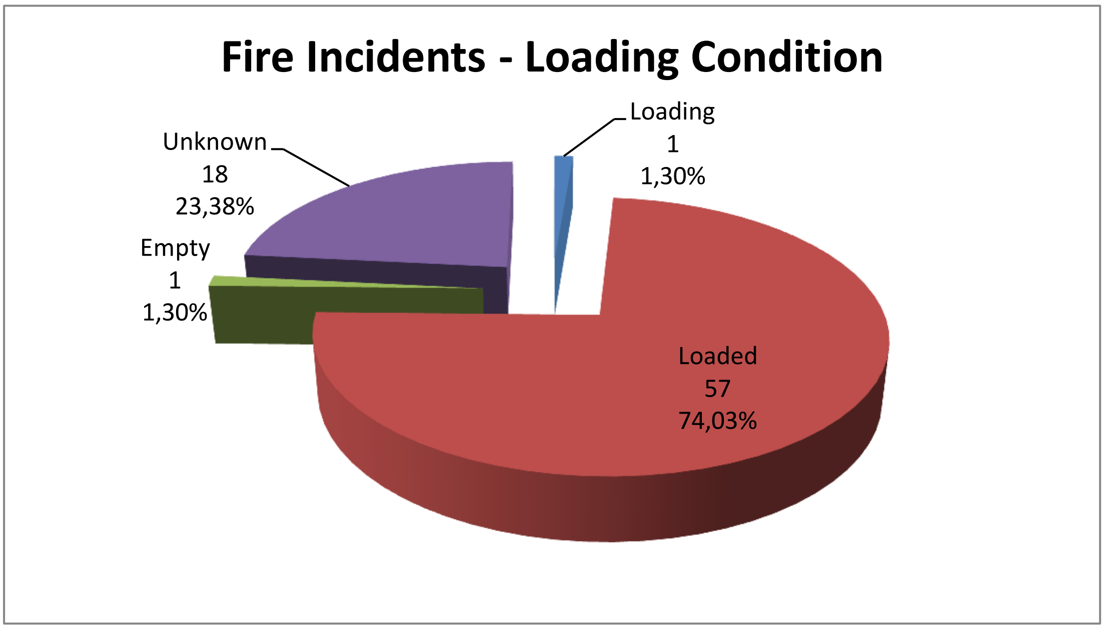


Operating Condition

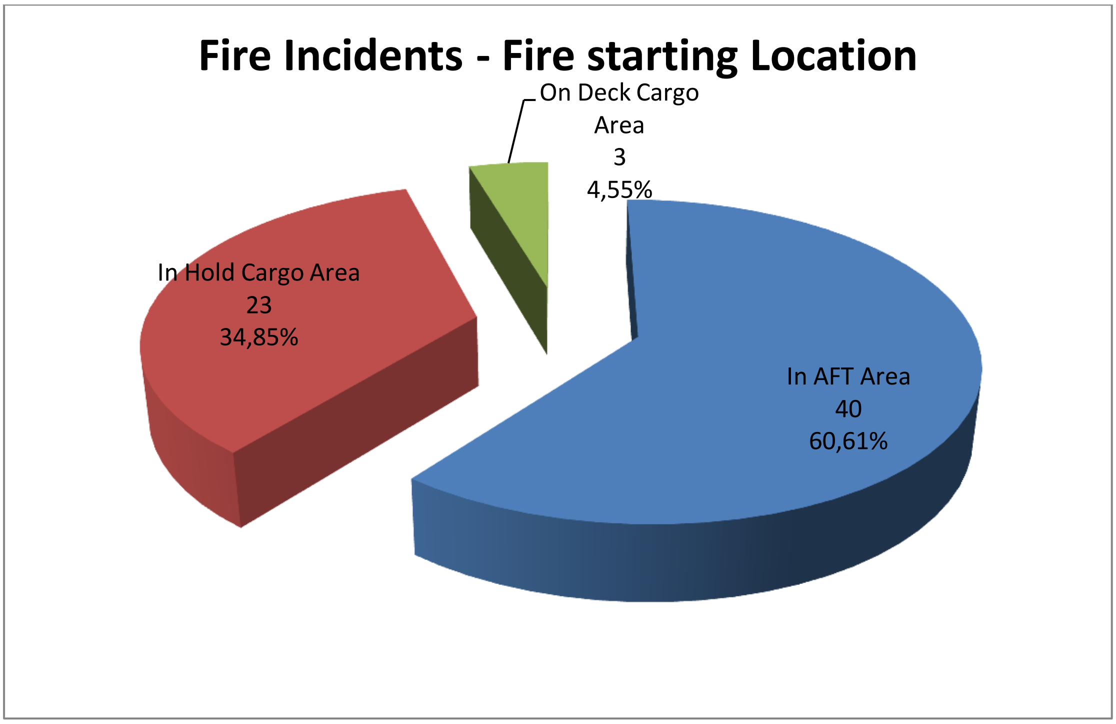


Accidents mainly occur during the voyage and away from any port facility, as the ones initiated by an explosion.

Loading Conditions

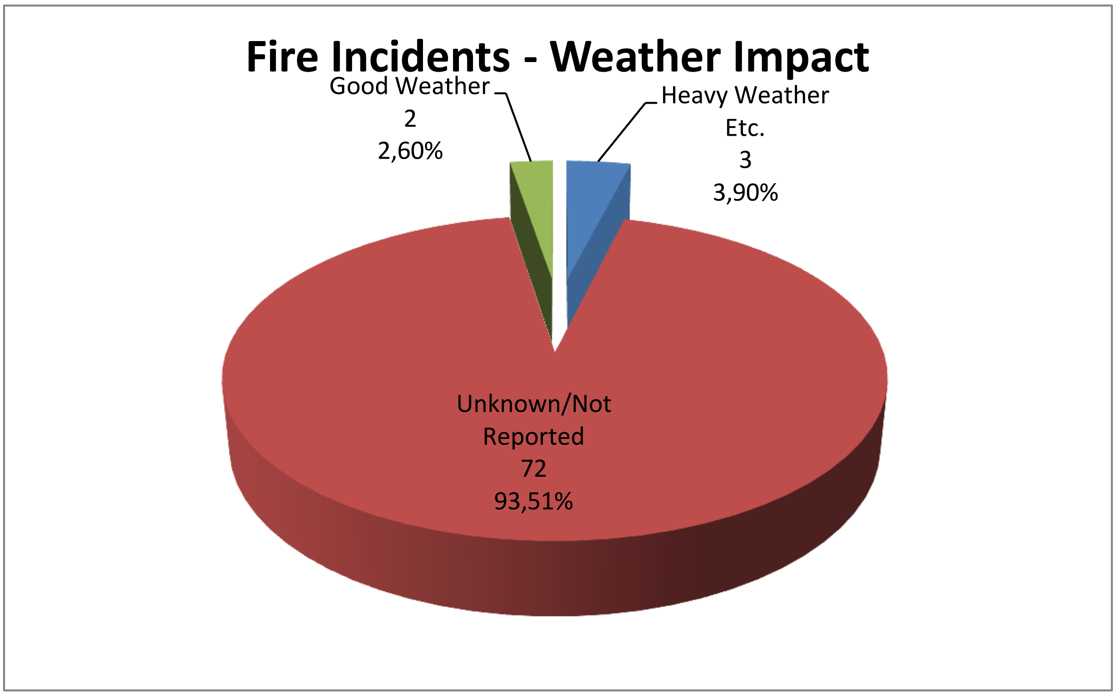


Fire starting Location (Internal source- External- by lightning)



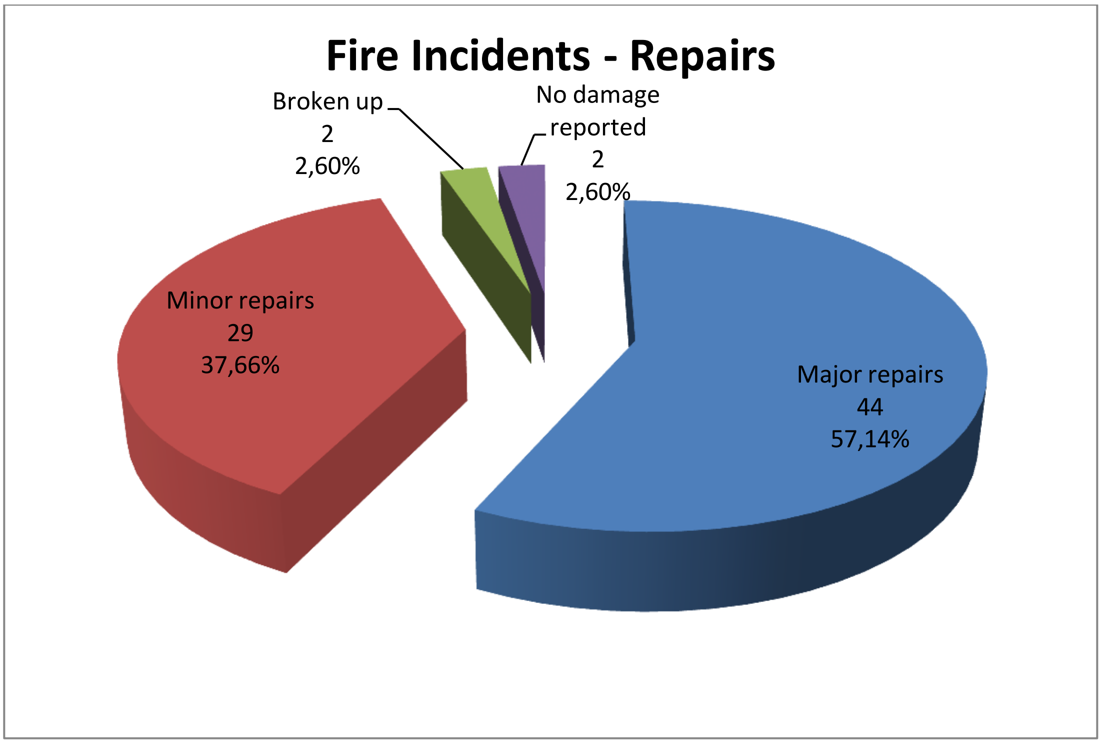
The main area where fires ignite is the AFT area and especially the engine room. The above chart refers to 66 out of 77 fire accidents, because there is no relevant information on the remaining 11.

Weather Impact

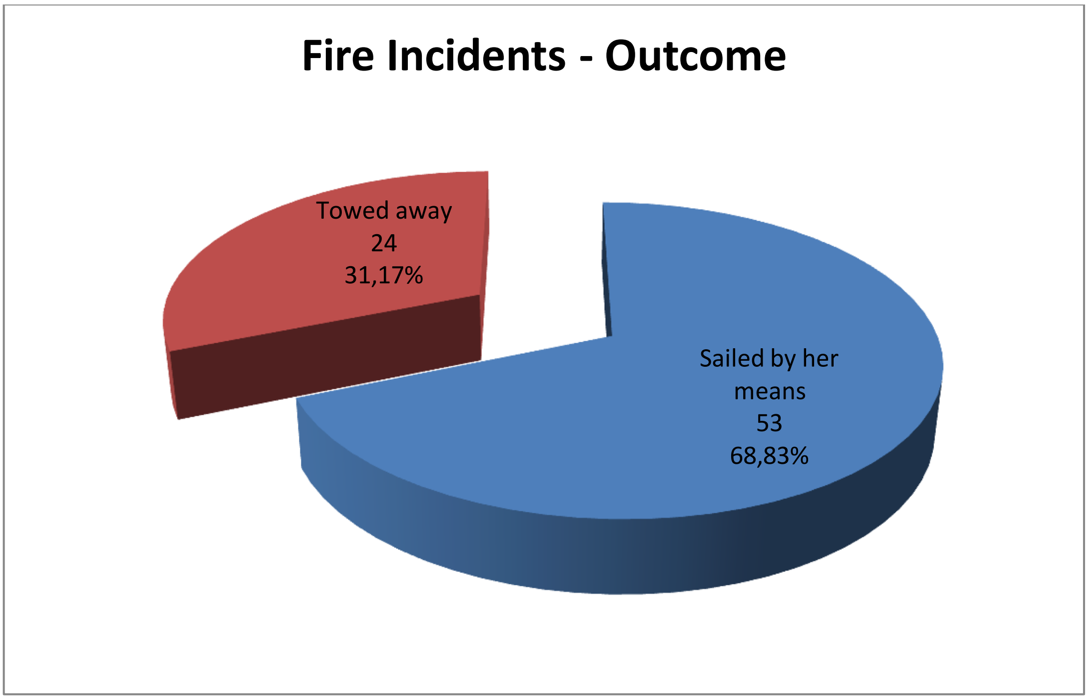


4.4.2 CONSEQUENCES OF FIRE ACCIDENTS

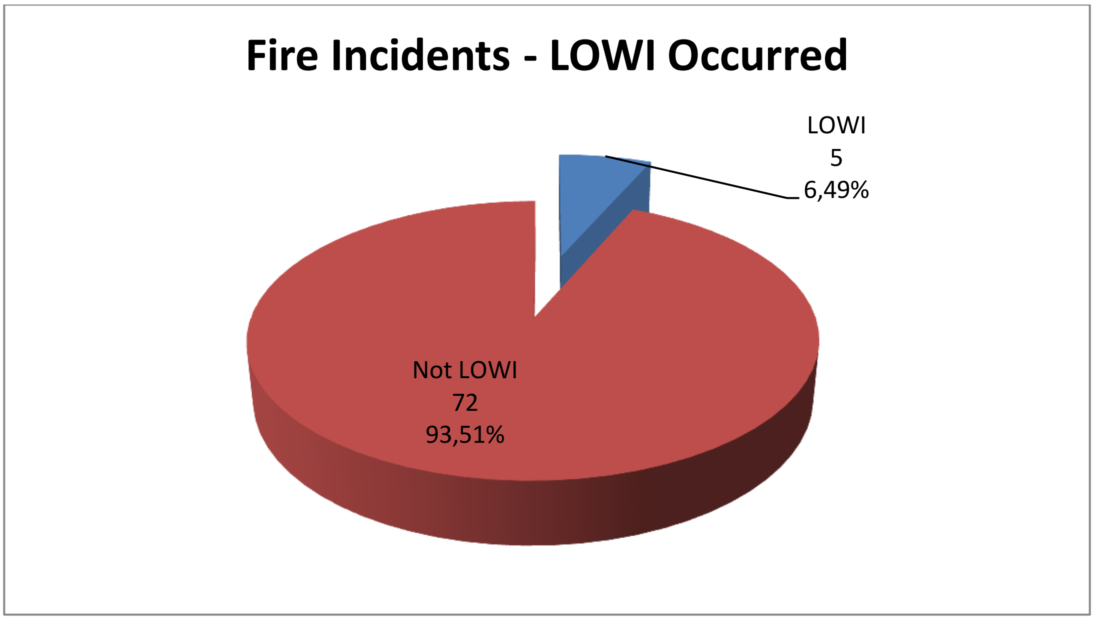
Repairs



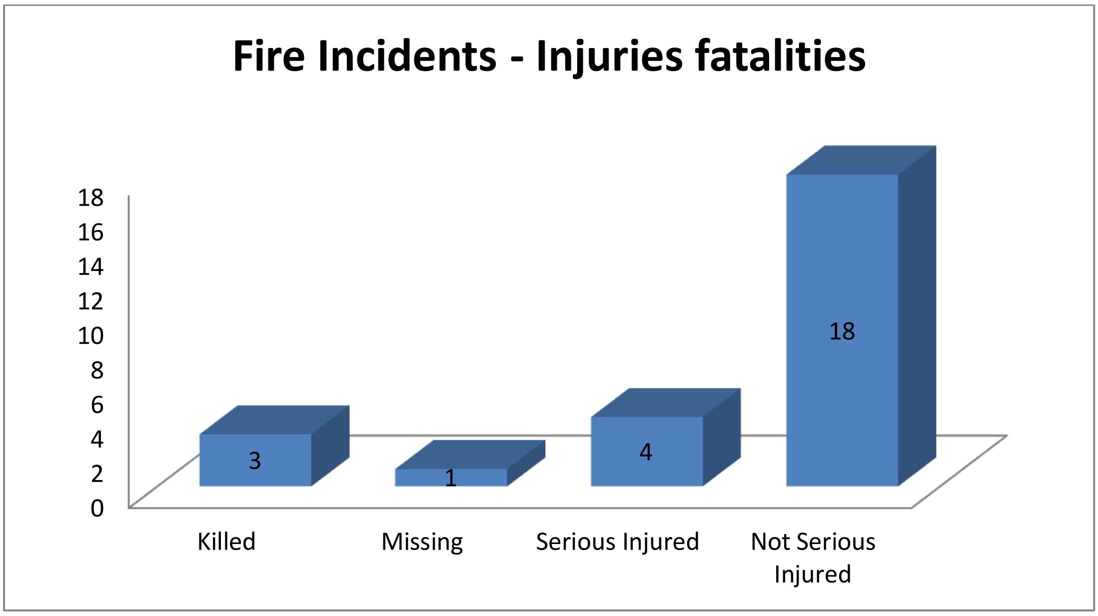
Outcome



LOss of Water Integrity (LOWI)



Injuries/ Fatalities



Fire incidents have similar consequences to the crew members of the vessel as explosion incidents, but not as fatal as the latter (significant number of injuries, small amount of deaths).

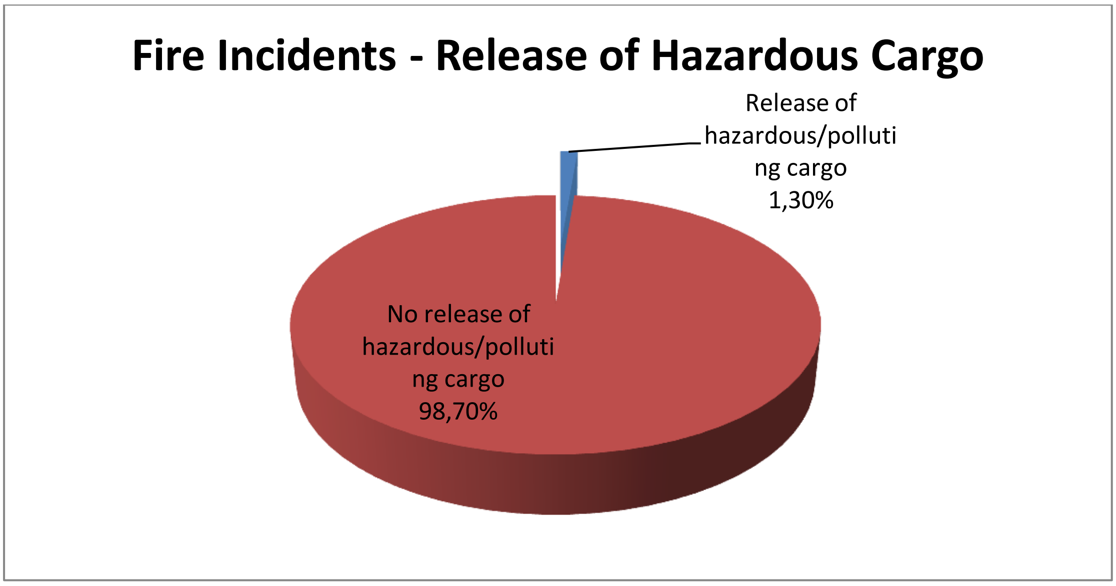
Loss of Payload

The fact that 4 incidents had a result of 372 damaged TEUs is remarkable.

Release of Oil

No release of Oil.

Release of hazardous Cargo



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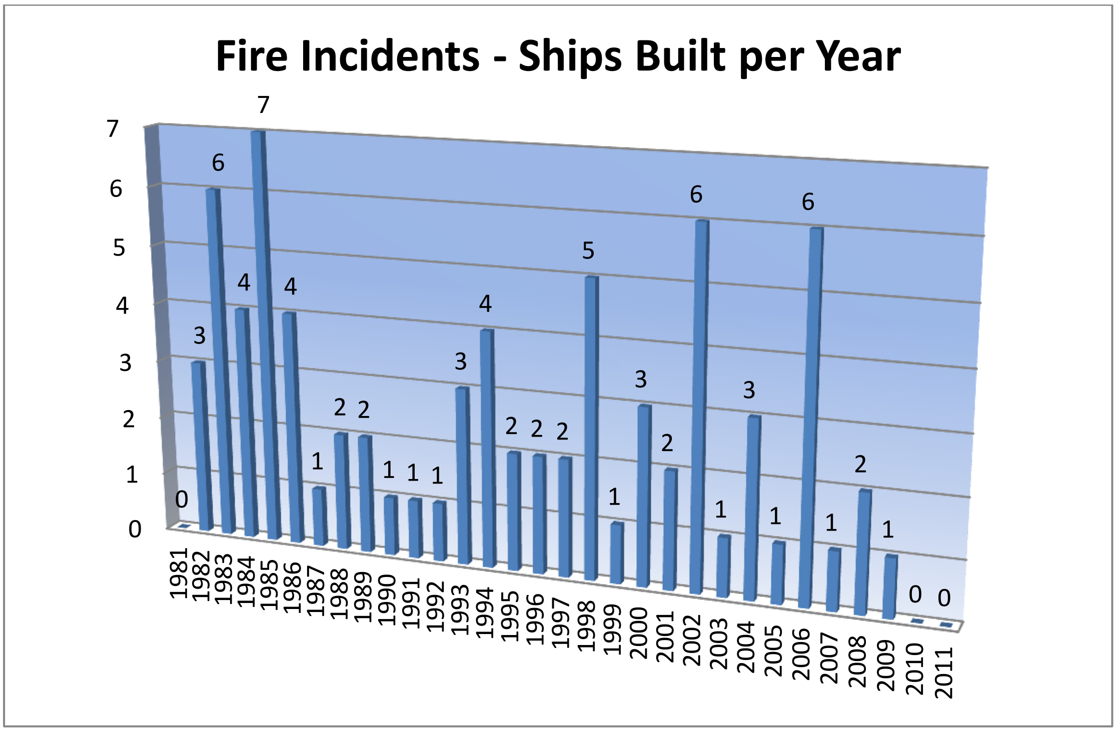
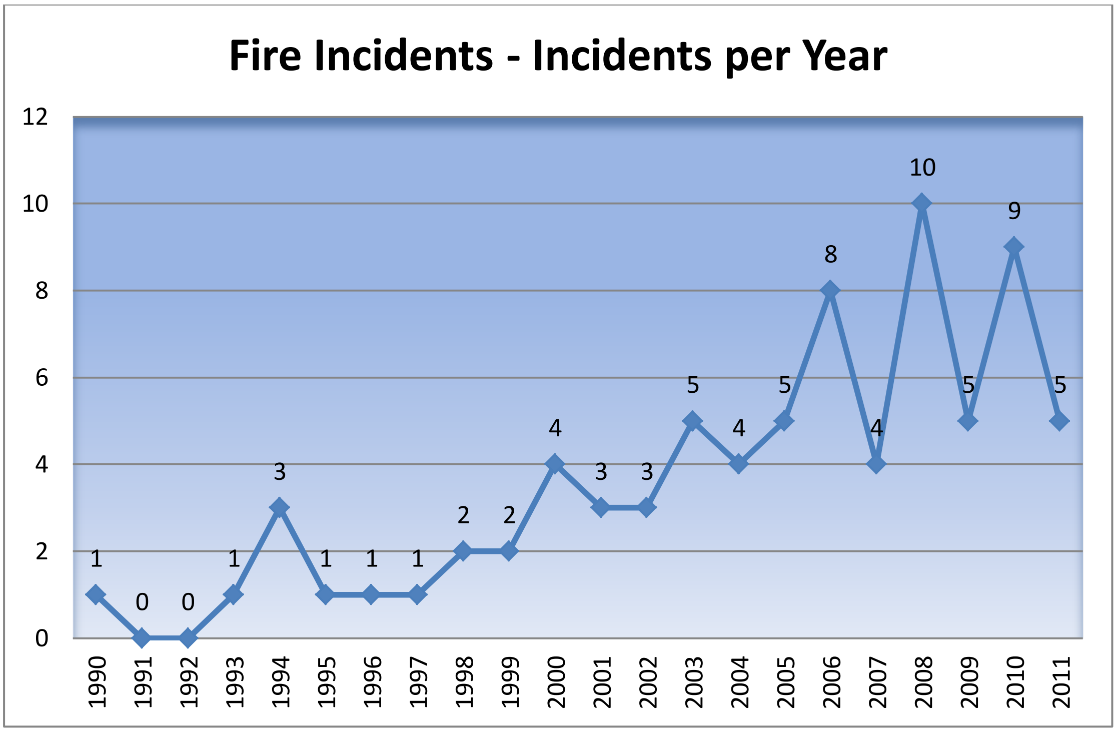
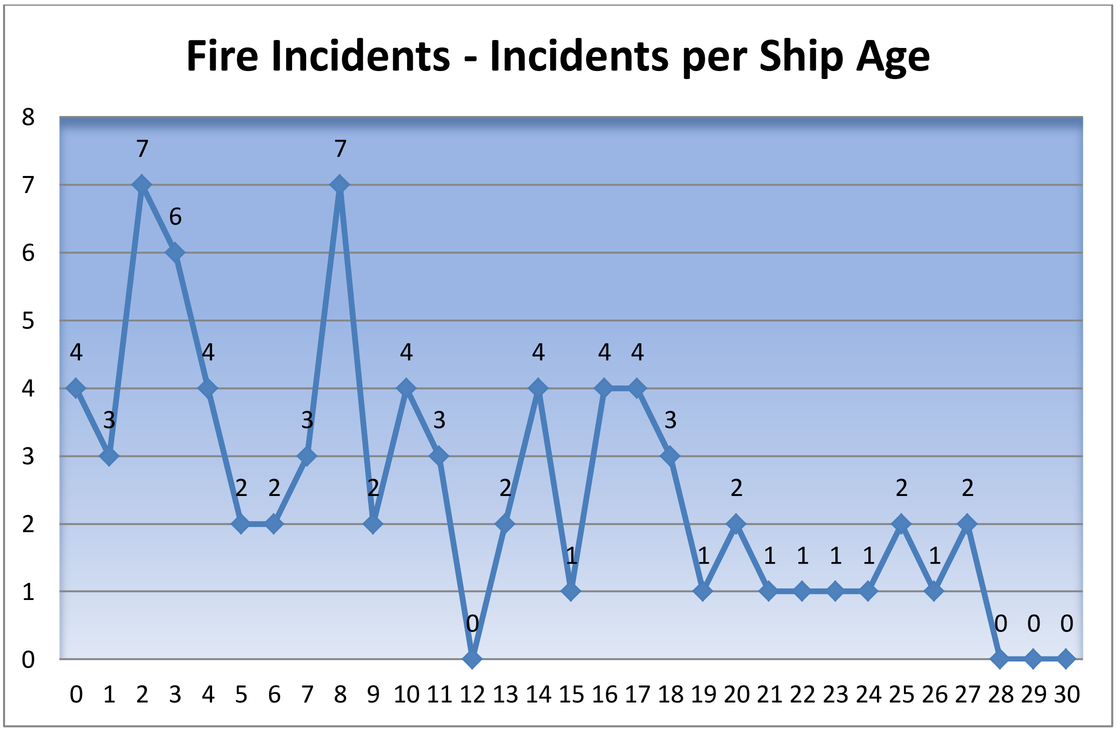
4.4.3 FREQUENCIES OF FIRE ACCIDENTS



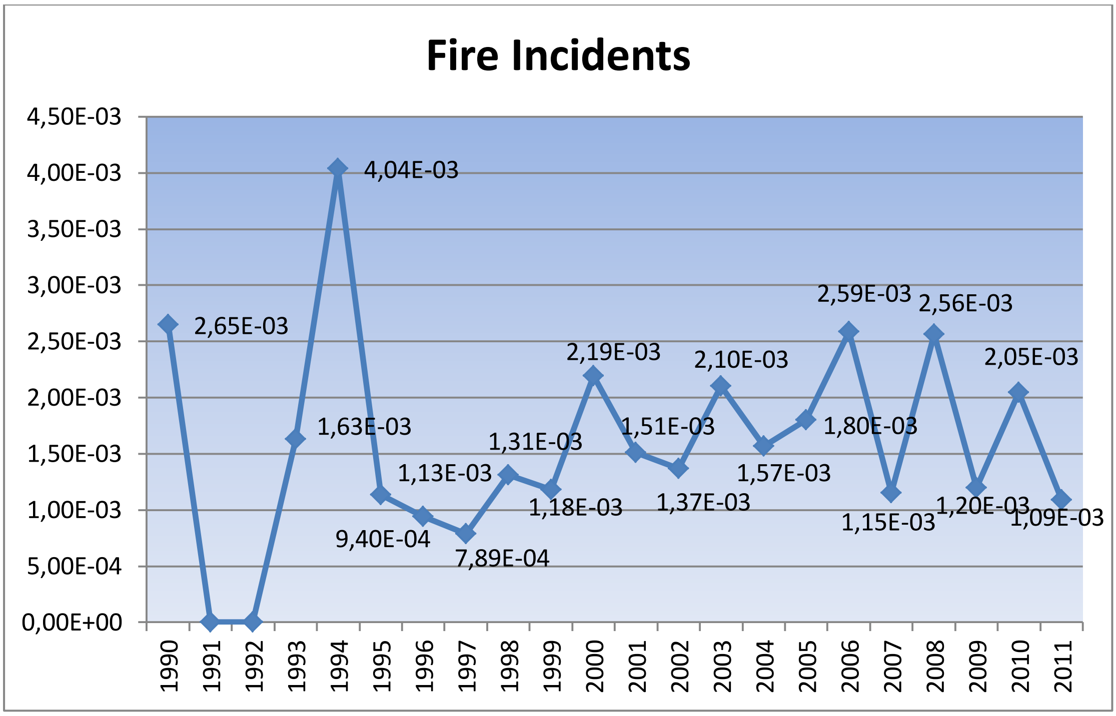
Ships built between 1982 and 1991 have more accidents caused by fire with an average of 3.1 accidents per year, when for the periods 1992- 2001 and 2002- 2009 the average is nearly 2.6.



Fire incidents have an ascending tendency. That is abnormal considering the new regulations in force against fire.

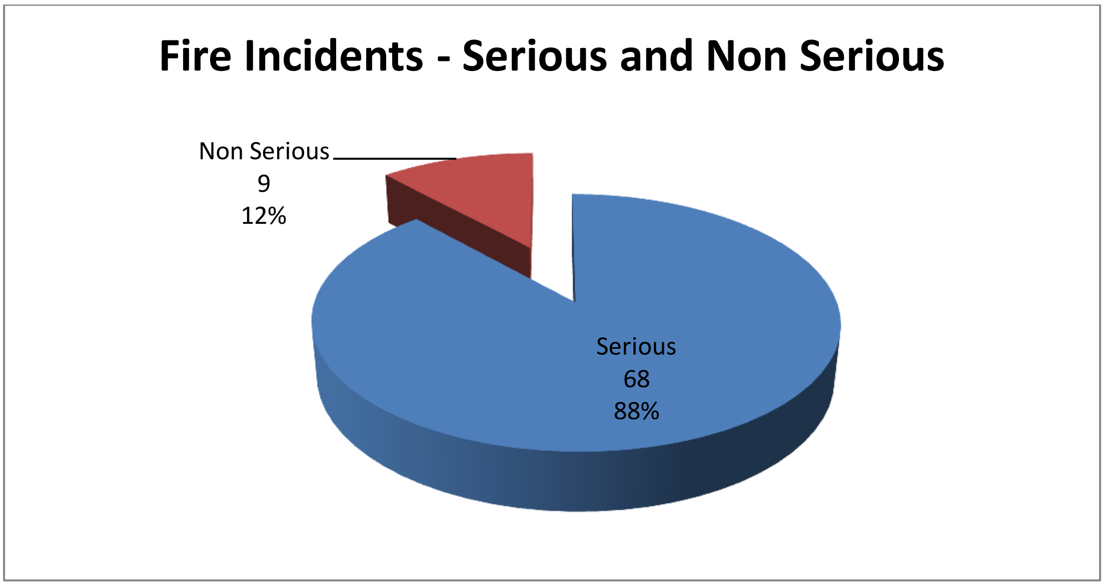


Vessels have fire incidents onboard mainly on their first decade of activation.

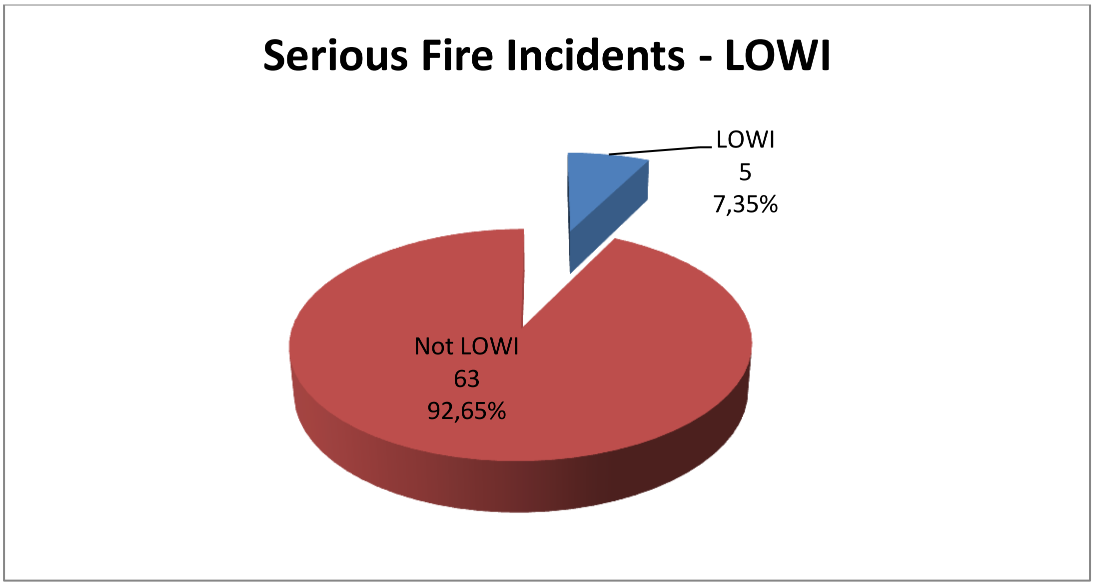


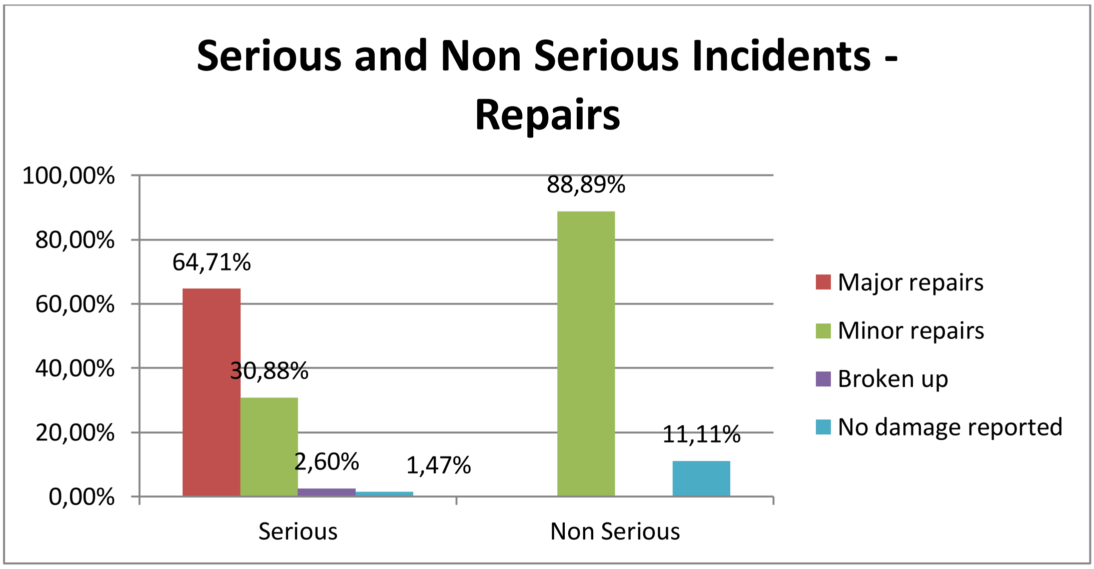
The frequency of fire incidents is stable between 0.1- 0.3%.

4.4.4 COMPARISON OF SERIOUS AND NON-SERIOUS ACCIDENTS

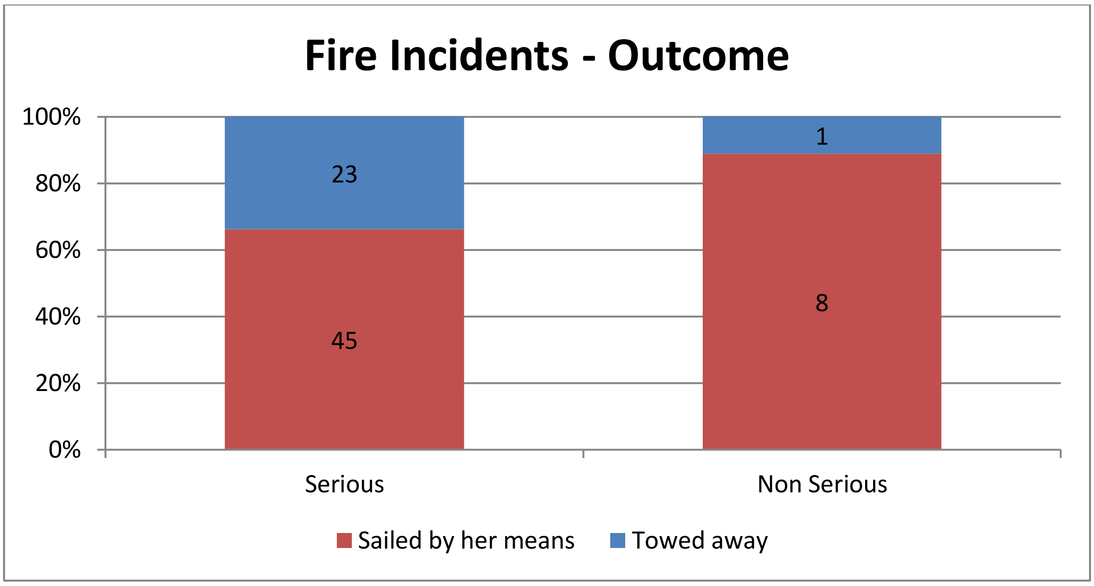


None of the non- serious accidents led to LOWI.





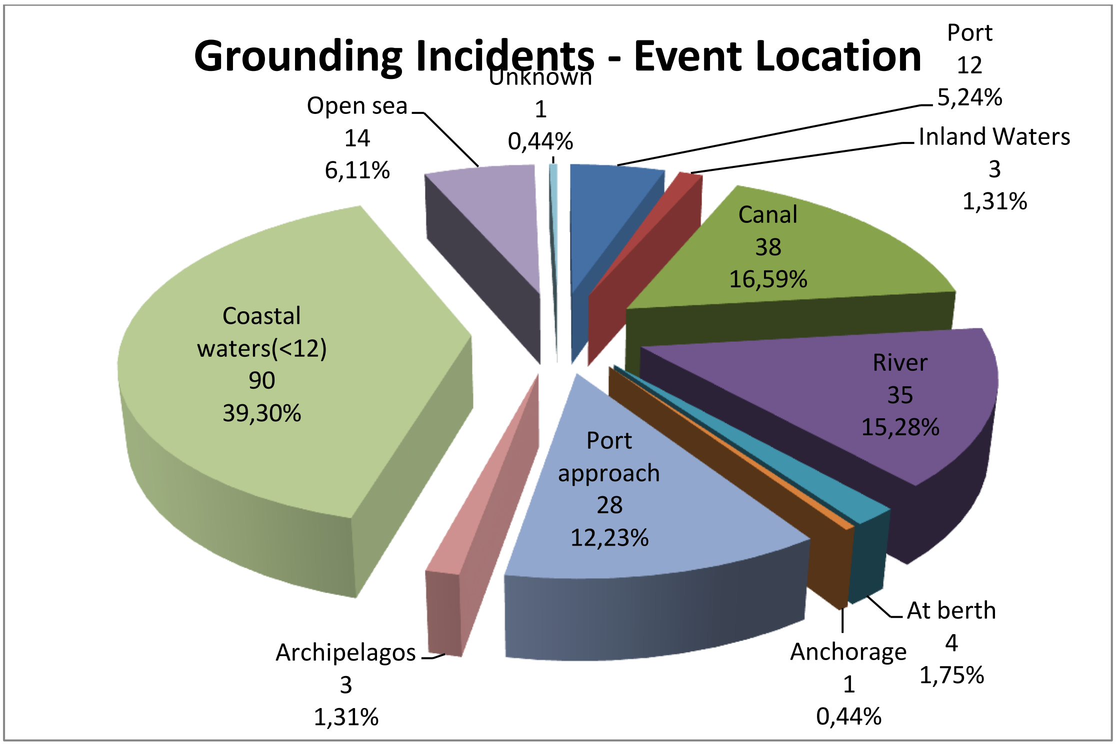
Fire accidents mainly result in injuries or fatalities rather than major repairs on the vessel. Most of the times repairs concern wiring facilities and not structural issues.



4.5 GROUNDING INCIDENTS

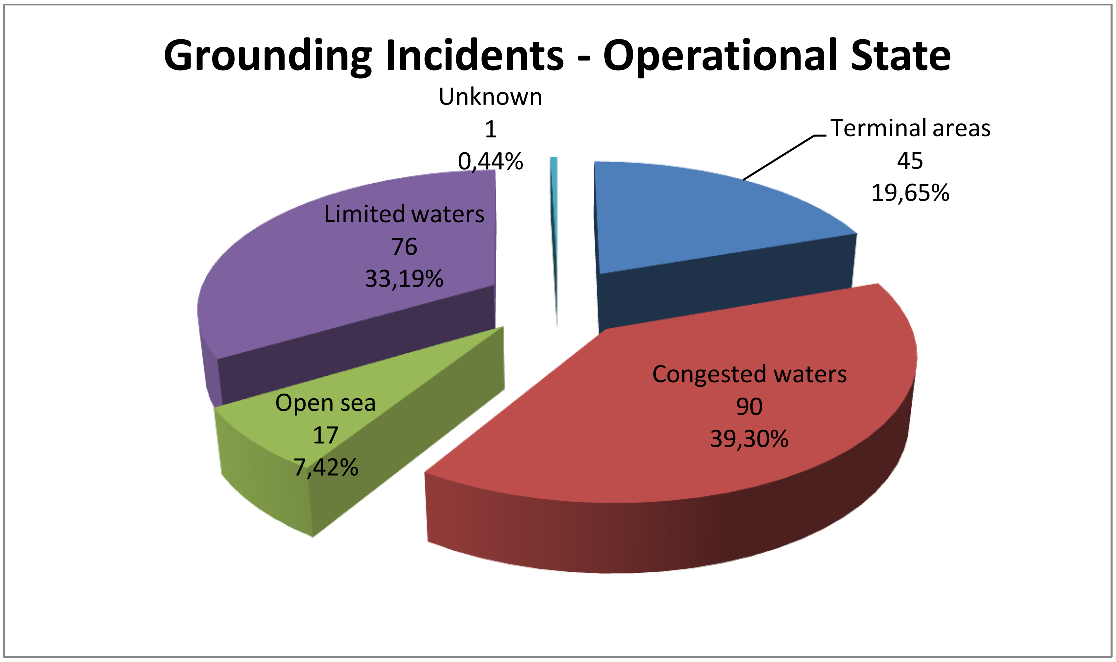
4.5.1 CONDITIONS OF GROUNDING ACCIDENTS

Event Location

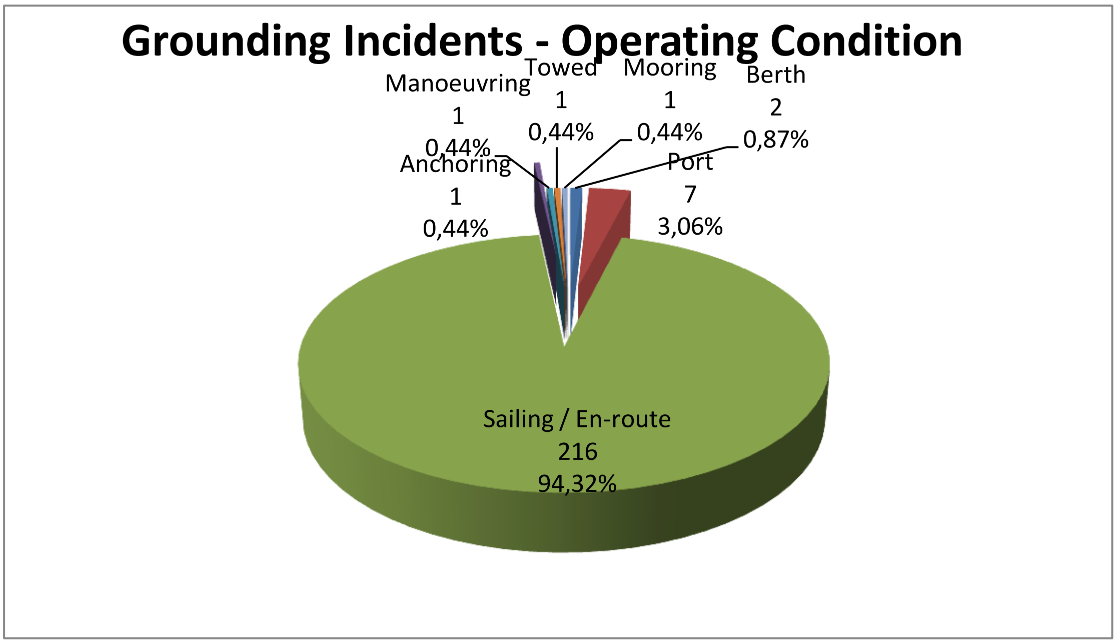


As expected areas with shallow waters are extremely common in grounding incidents.

Operational State

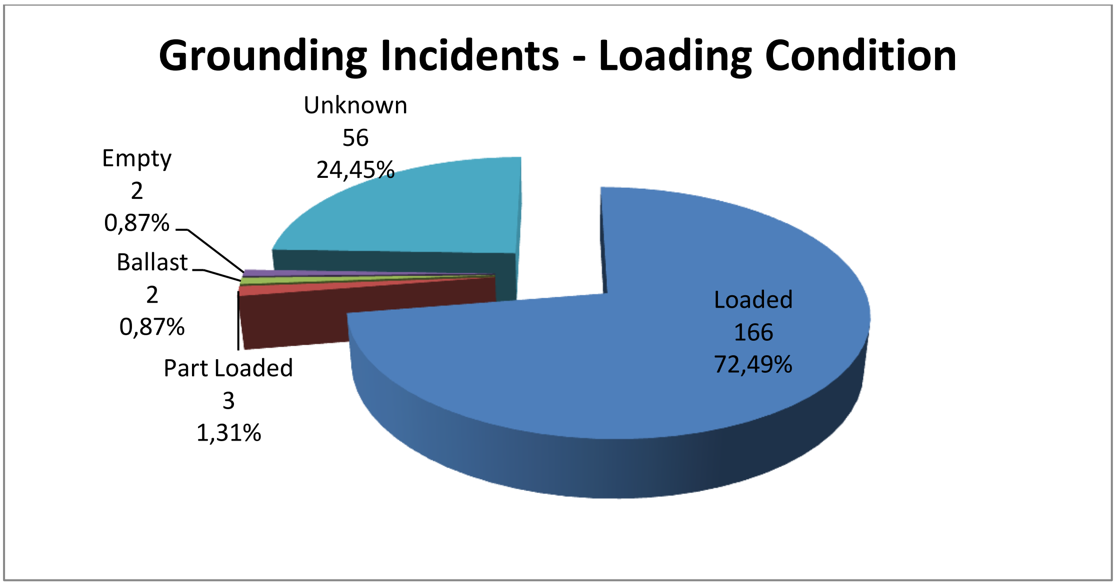


Operating Condition



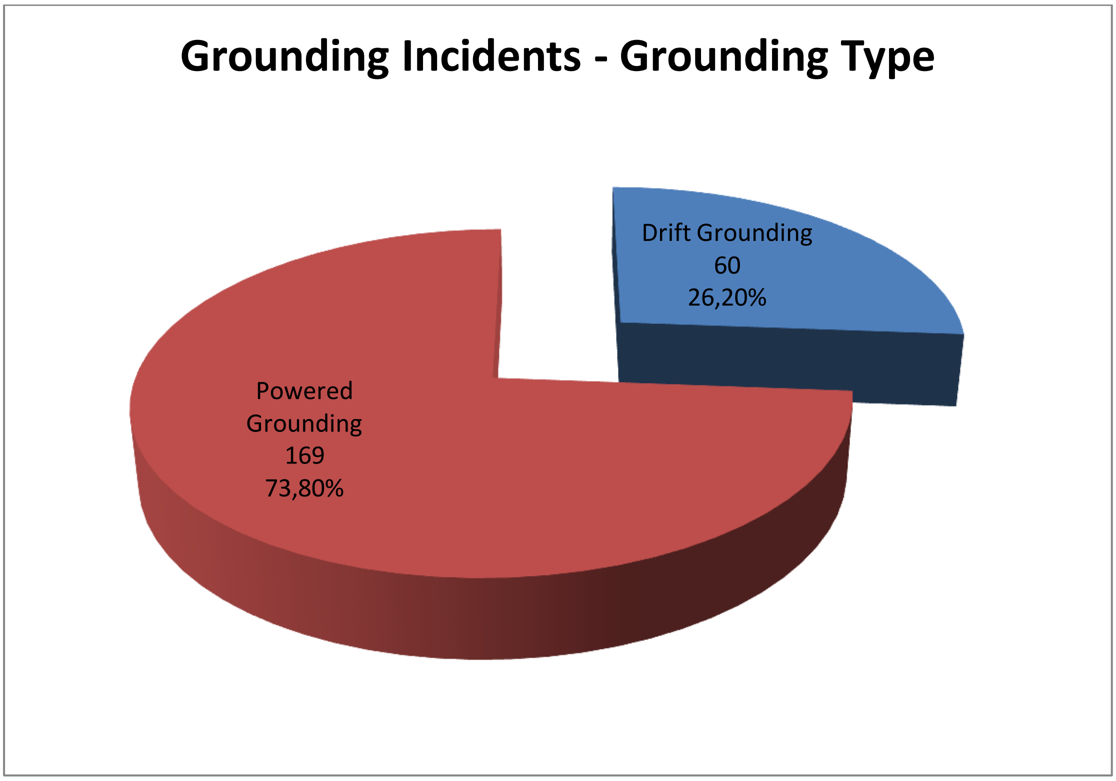
There is no doubt about the fact that most accidents happen because of navigational problems, whether it is by human mistake or because of uncharted areas.

Loading Conditions



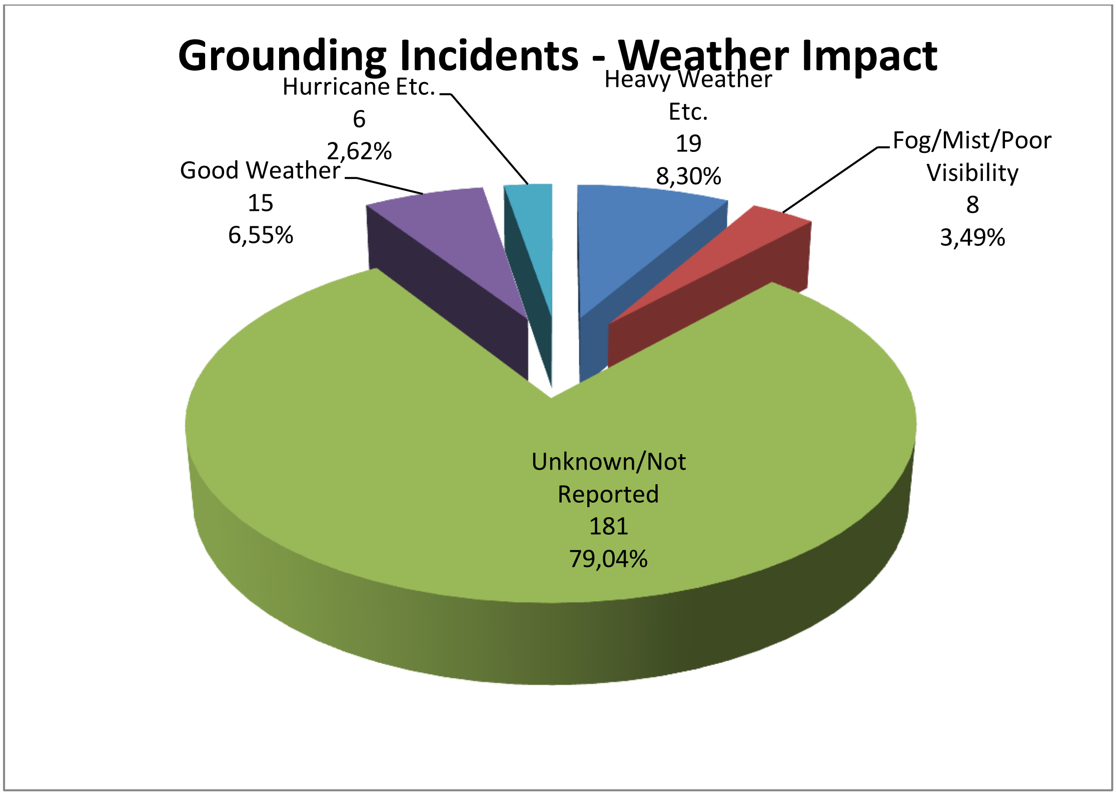
Almost all vessels were loaded at the time of the incident. The fact that vessel's draught is maximized when fully loaded may have led to grounding.

Grounding Type



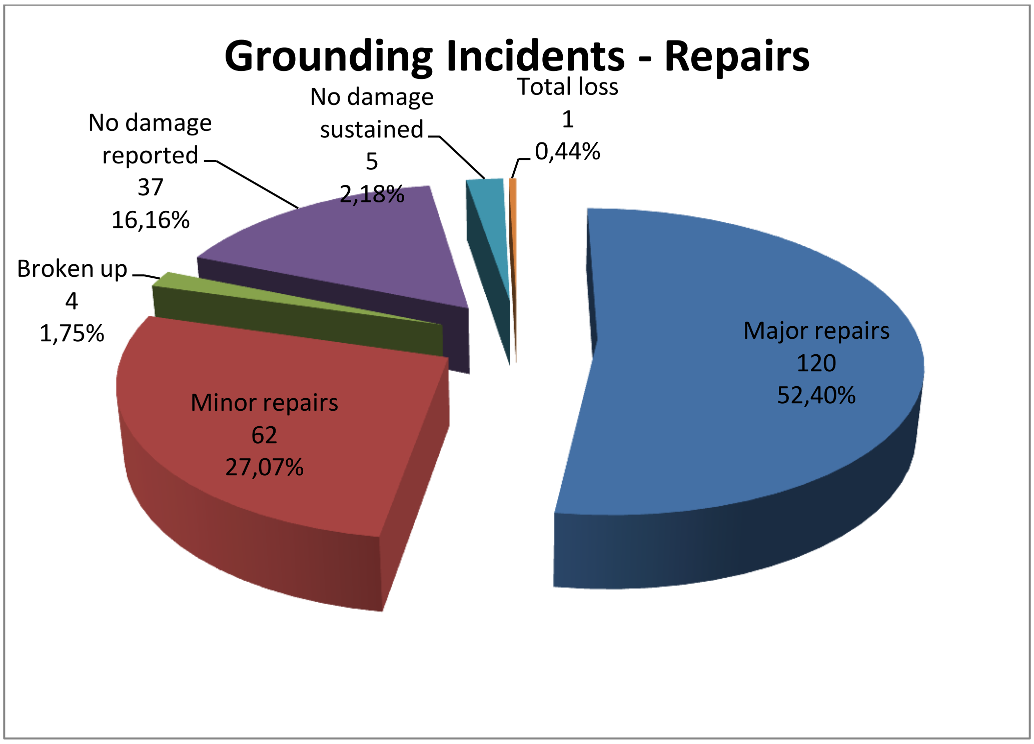
It is obvious that grounding accidents occur mostly with the vessel capable of steering and course correction if needed.

Weather Impact

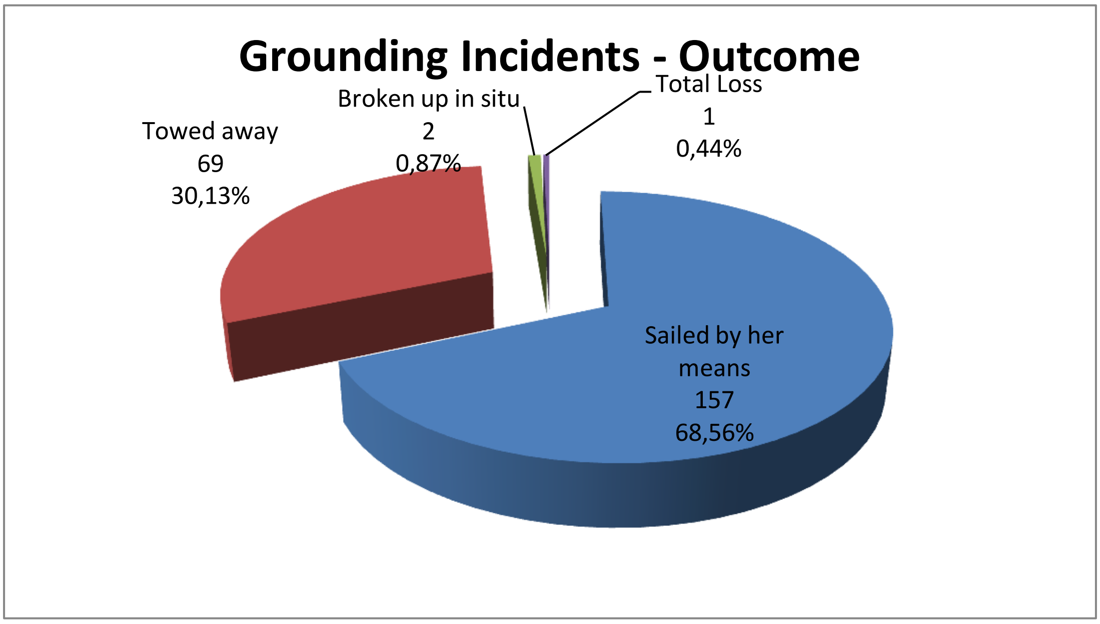


4.5.2 CONSEQUENCES OF GROUNDING ACCIDENTS

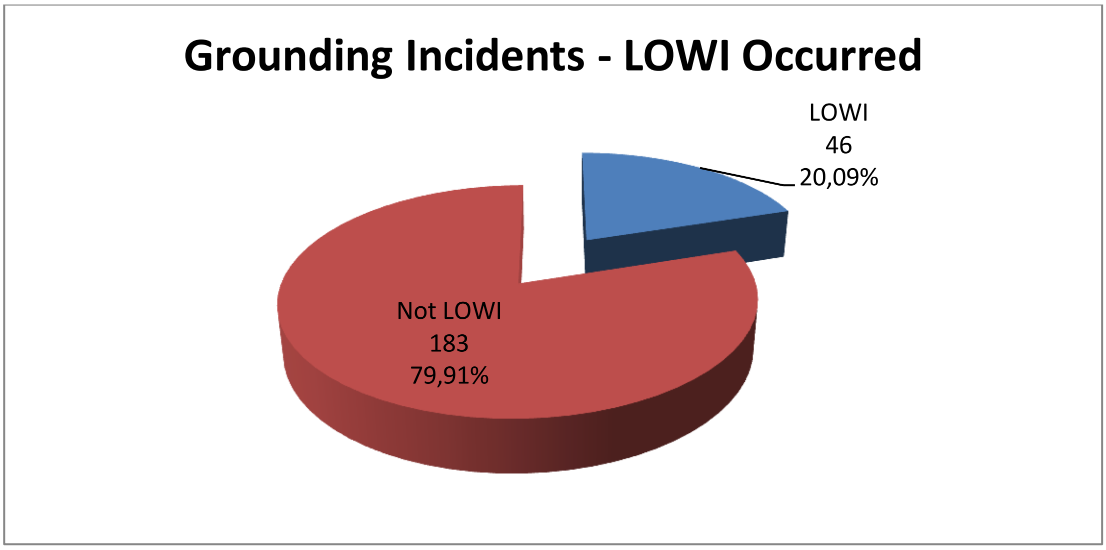
Repairs



Outcome



LOss of Water Integrity (LOWI)



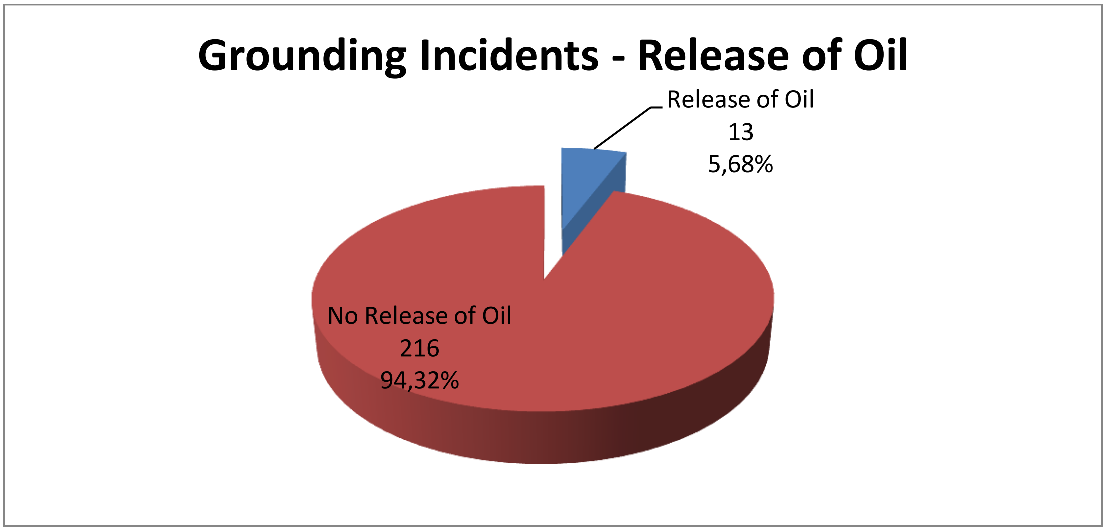
Injuries/ Fatalities

Only one crew member died on grounding incidents.

Loss of Payload

There were minor casualties of 4 TEUs in one accident.

Release of Oil

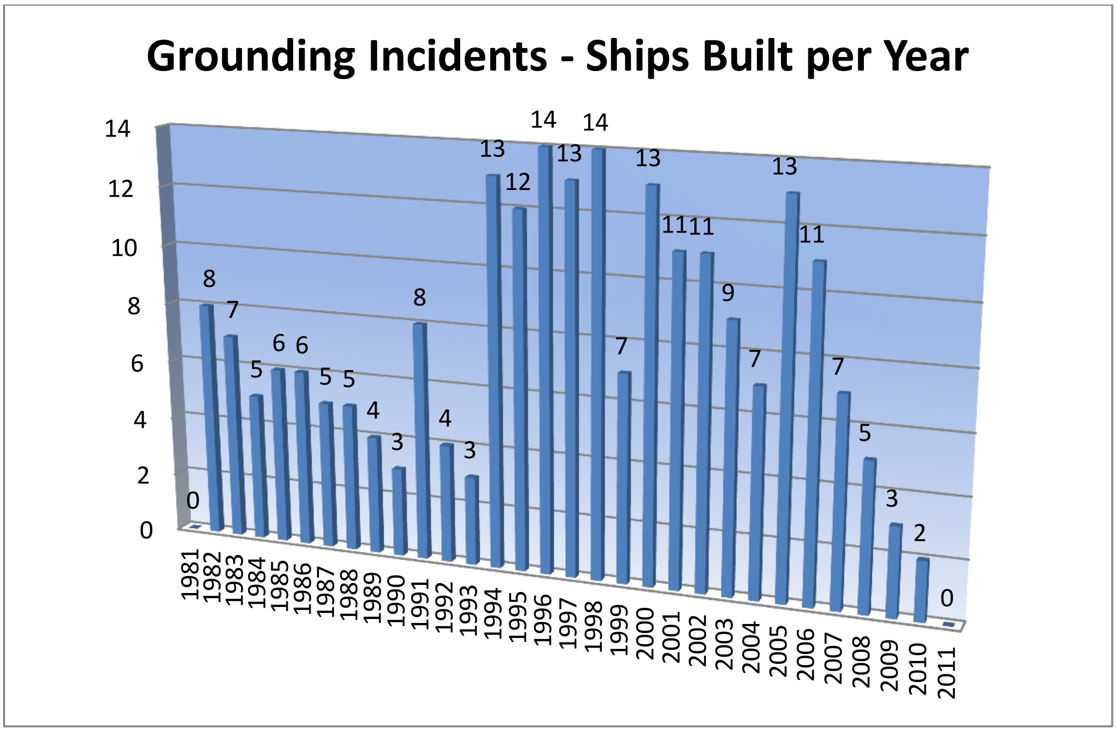


A considerable amount of 780 tonnes of oil was released.

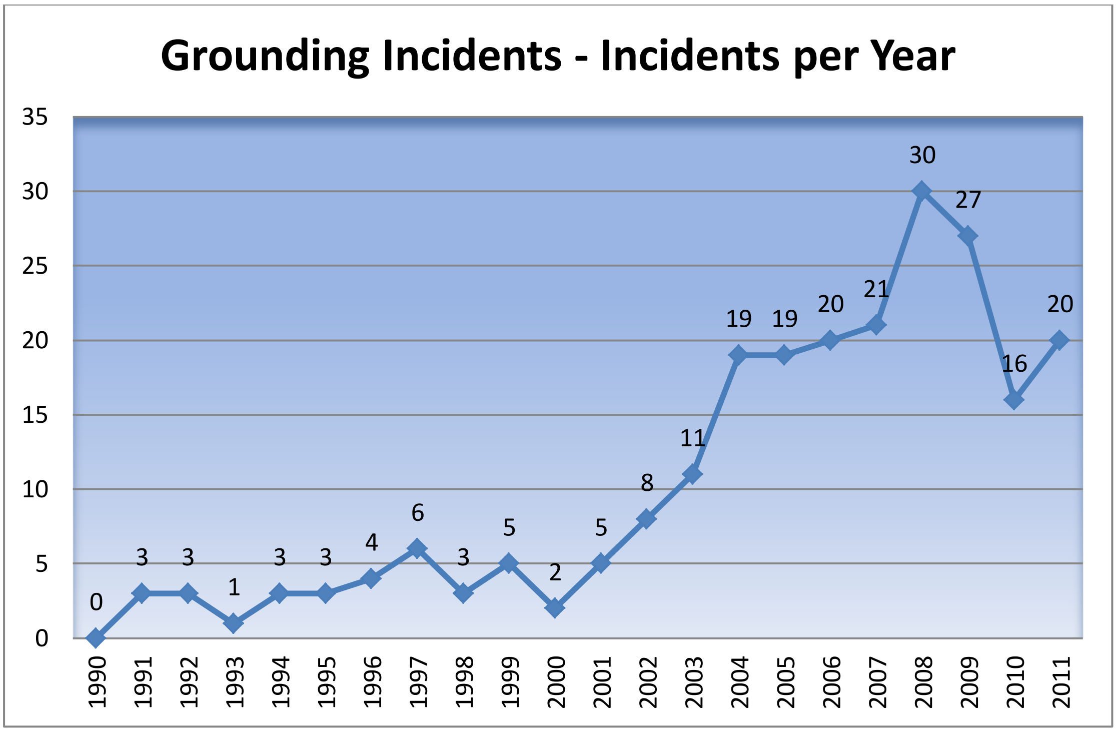
Release of hazardous Cargo

No release of hazardous cargo.

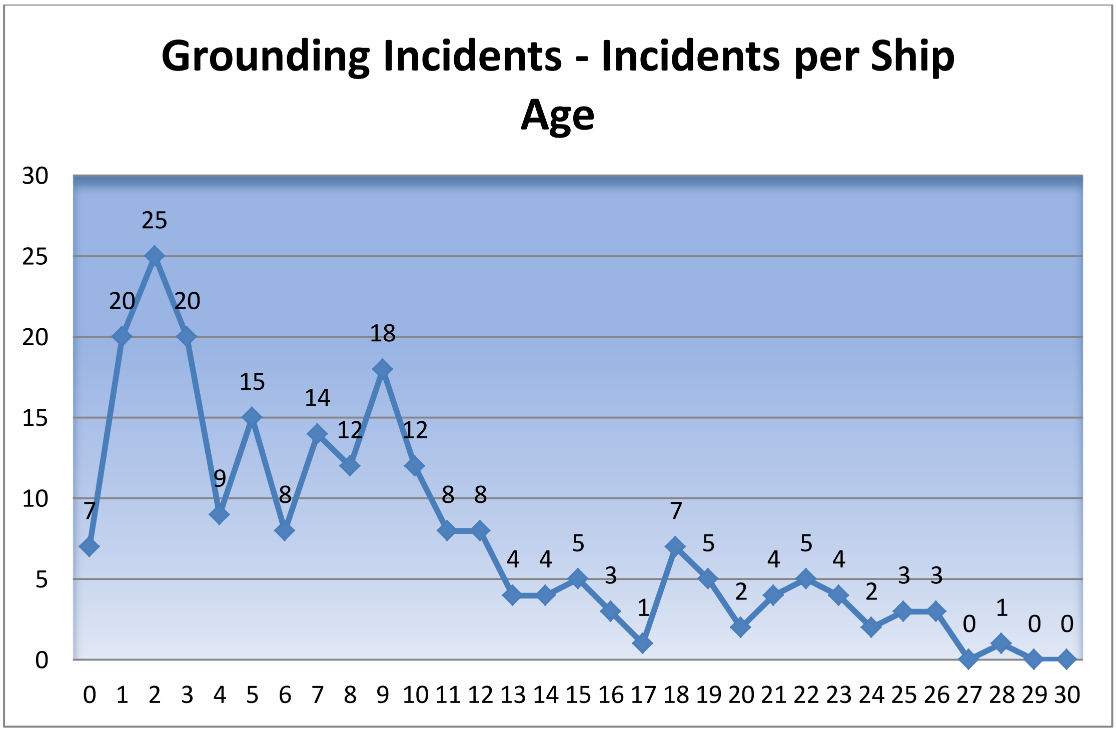
4.5.3 FREQUENCIES OF GROUNDING ACCIDENTS

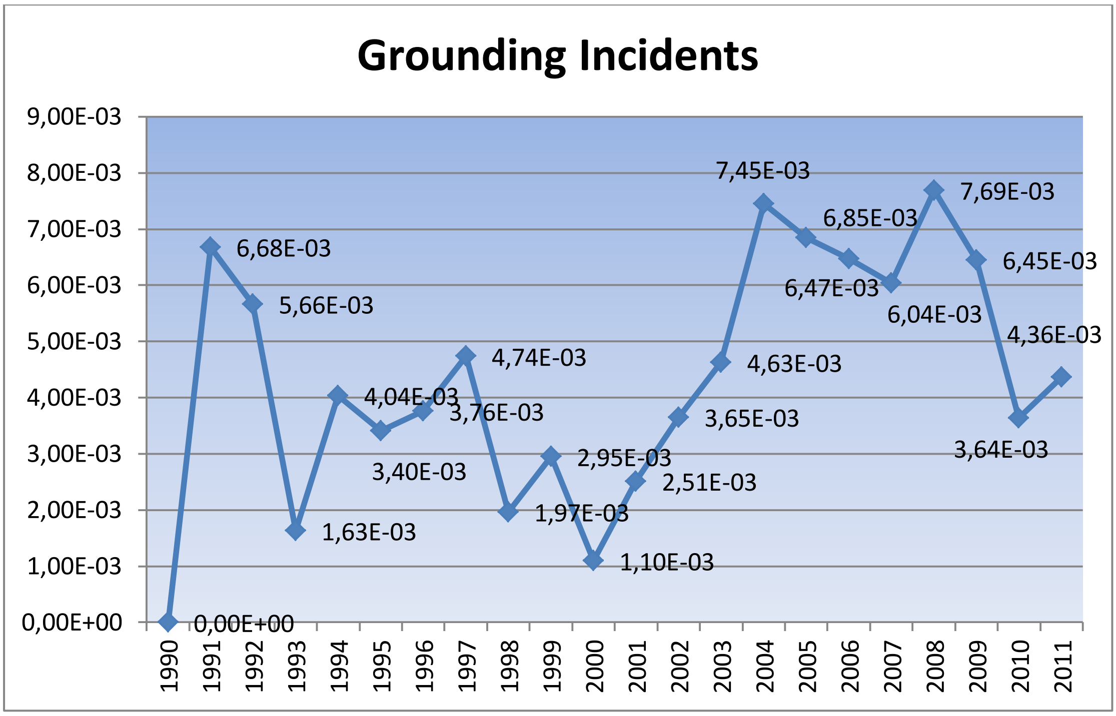


Vessels built in 1994- 1998 tend to have more accidents related to grounding.

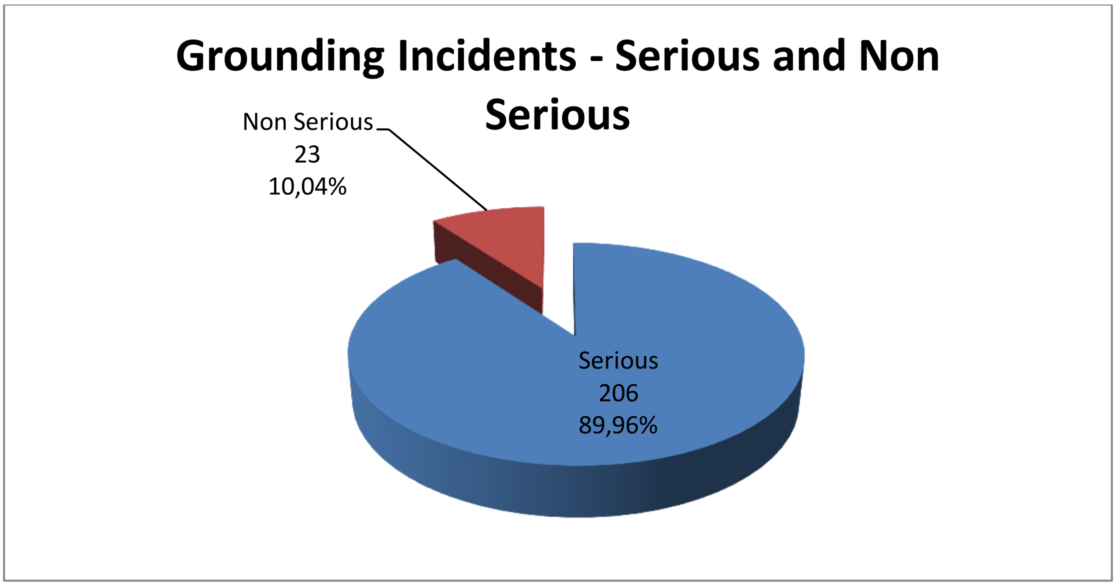


After 2002 ships seem to have an increasing tendency to grounding incidents. The remarkable is that since 1990 the range of this type of incidents was around 4 per year, when after 2002 increased dramatically to an average of 19. This is 4-5 times the previous average.

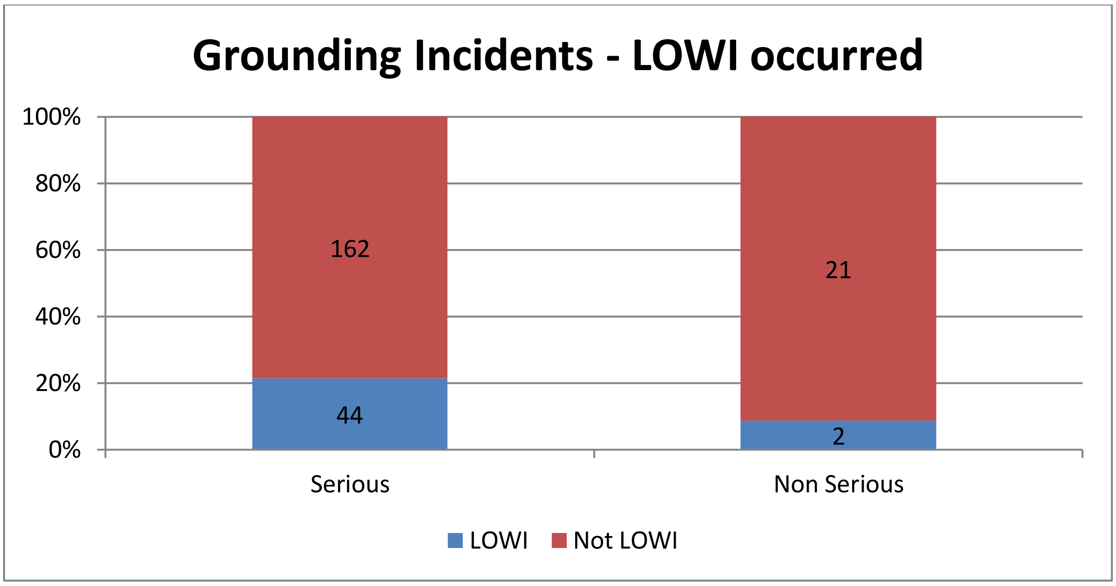




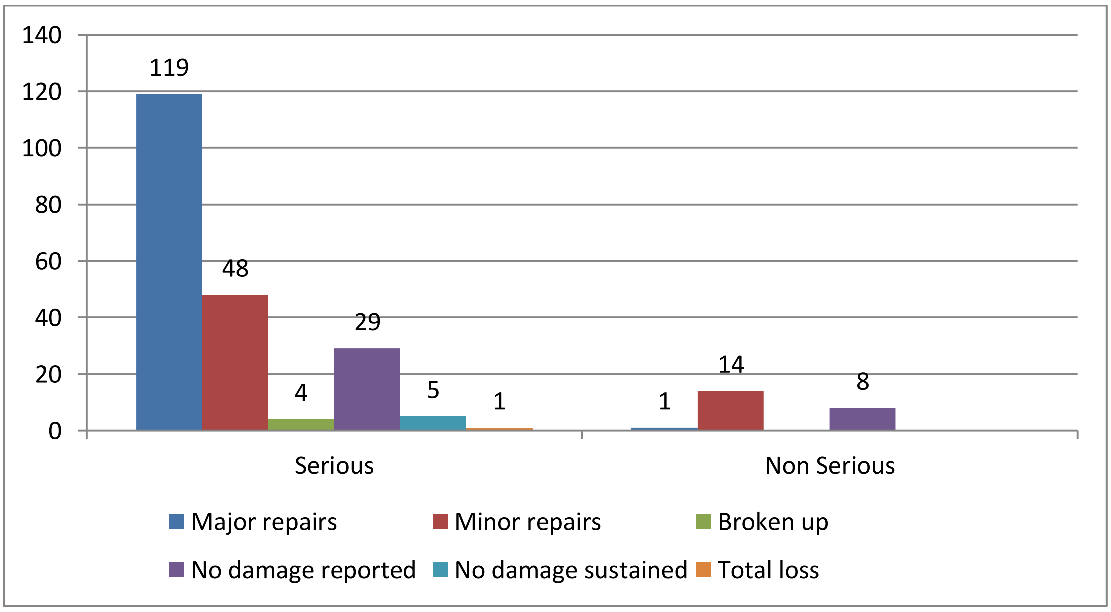
4.5.4 COMPARISON OF SERIOUS AND NON-SERIOUS ACCIDENTS

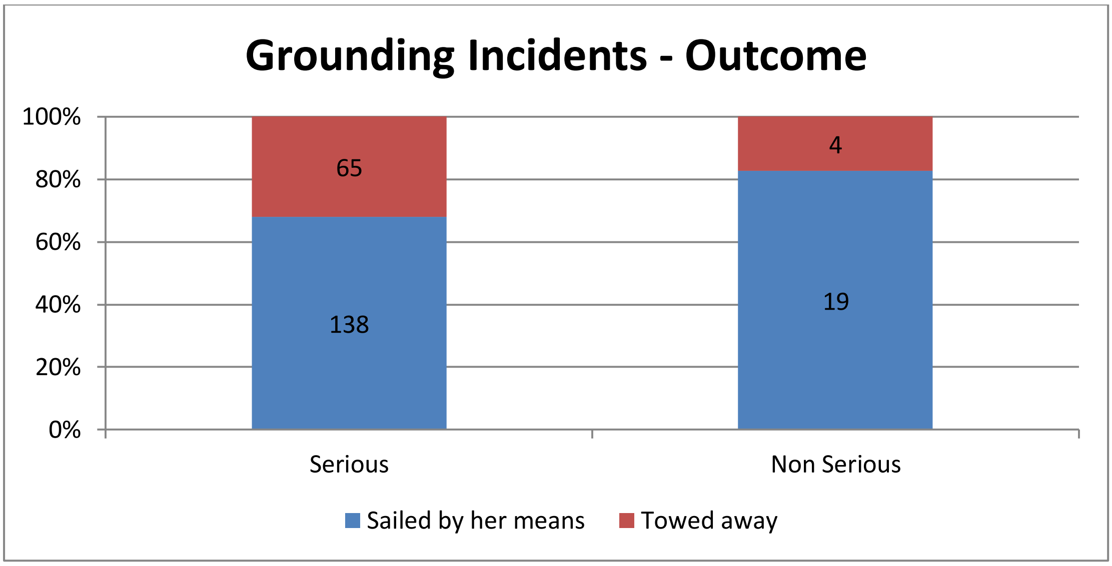


Grounding incidents are classified as serious incidents in their majority. In collaboration with the fact that most of the incidents occur when vessels are under power, it is understandable why extension of damage is great.



Despite the fact of extensive damages, vessels did not lose their integrity and seaworthiness.



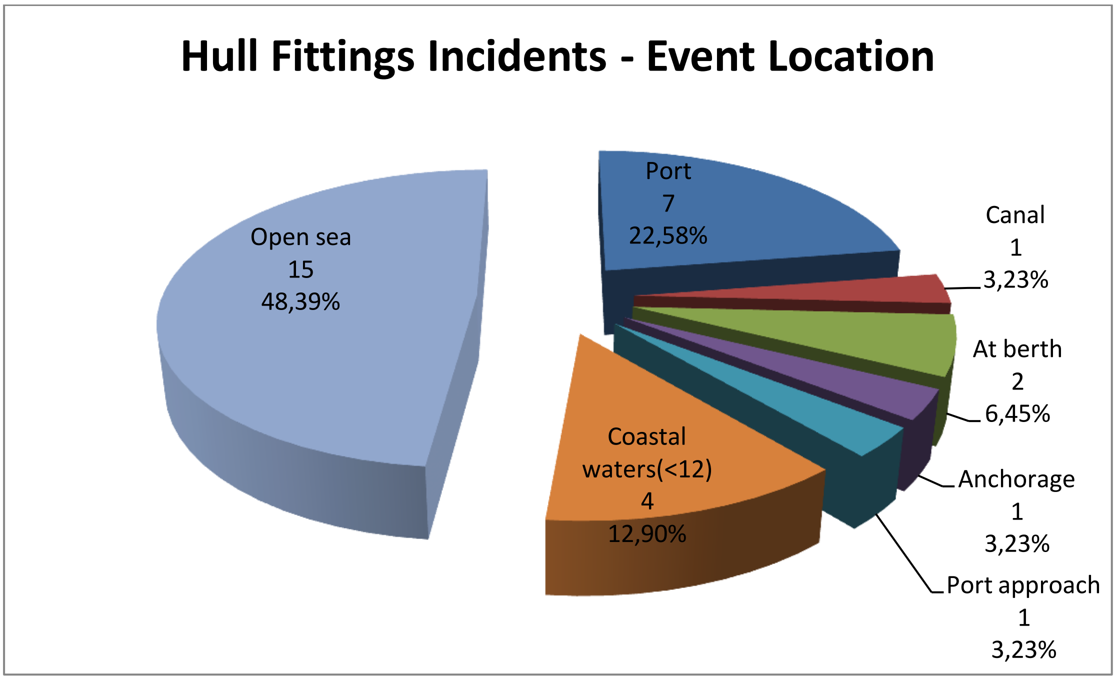


The last chart concerns 226 accidents in which the vessel departed from incidents' location and was taken for repairs.

4.6 HULL FITTINGS INCIDENTS

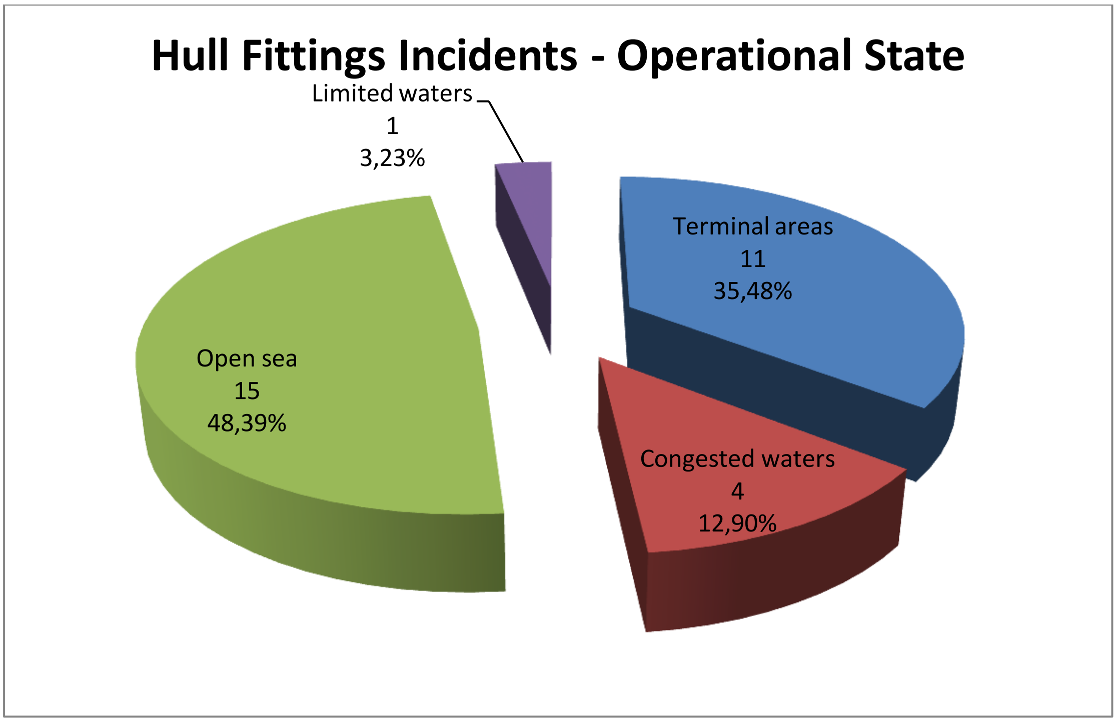
4.6.1 CONDITIONS OF HULL FITTINGS ACCIDENTS

Event Location

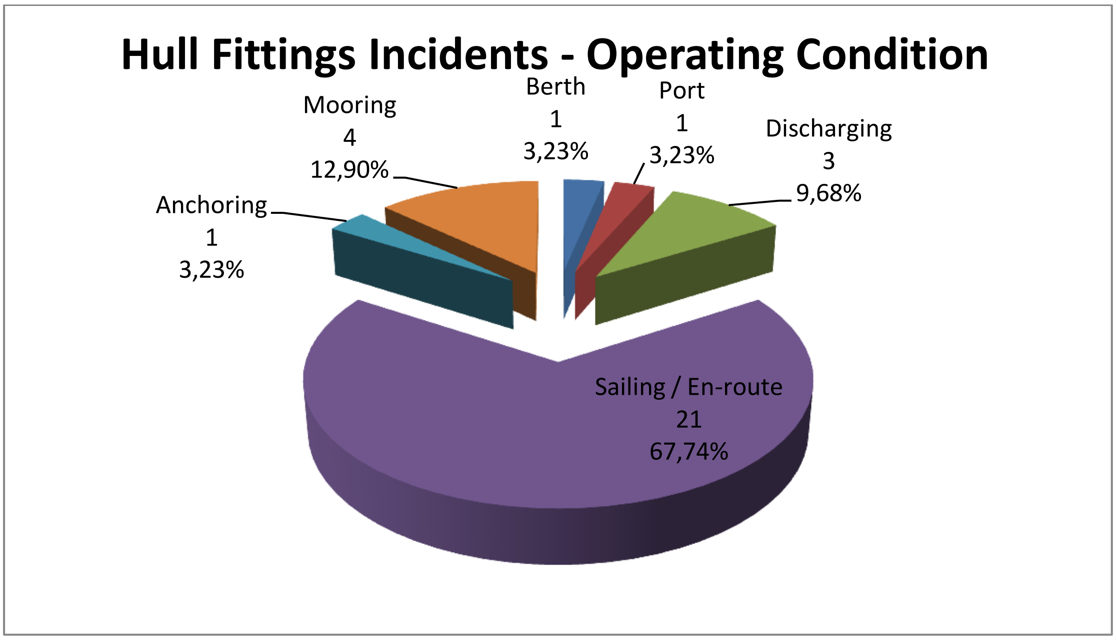


Almost half the incidents occurred at open sea, where weather is an important aspect.

Operational State

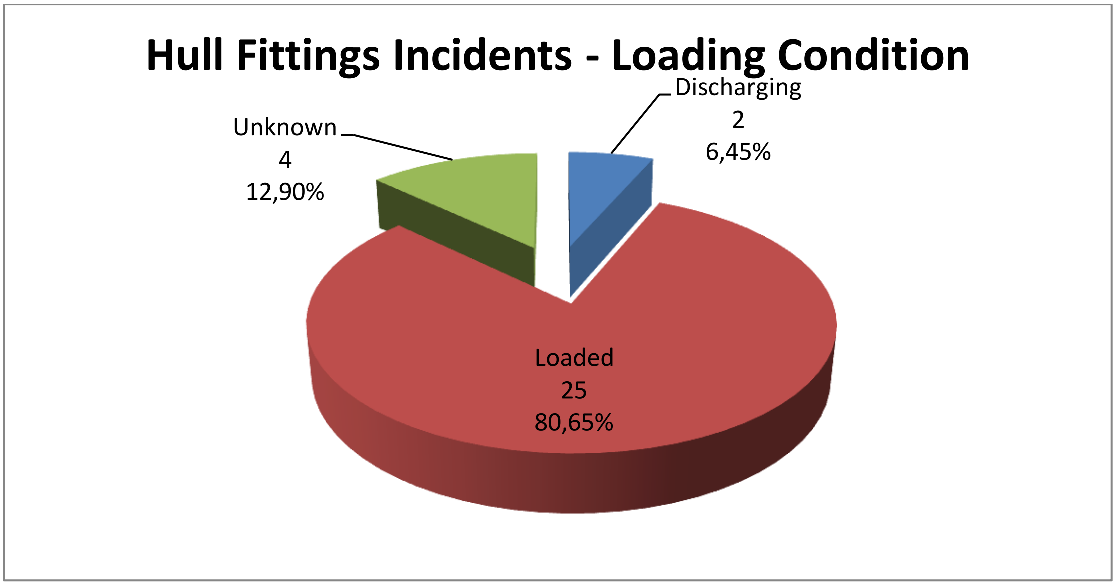


Operating Condition



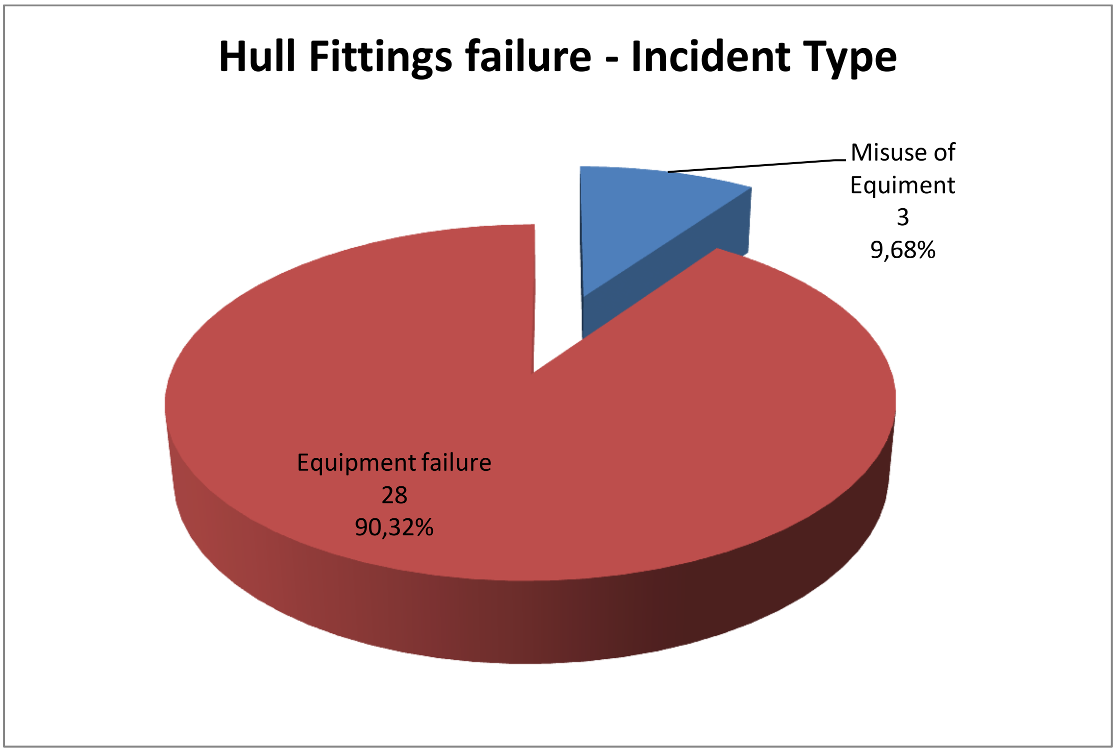
In port facilities incidents may occur due to human factor and misuse of equipment during loading or discharging TEUs.

Loading Conditions

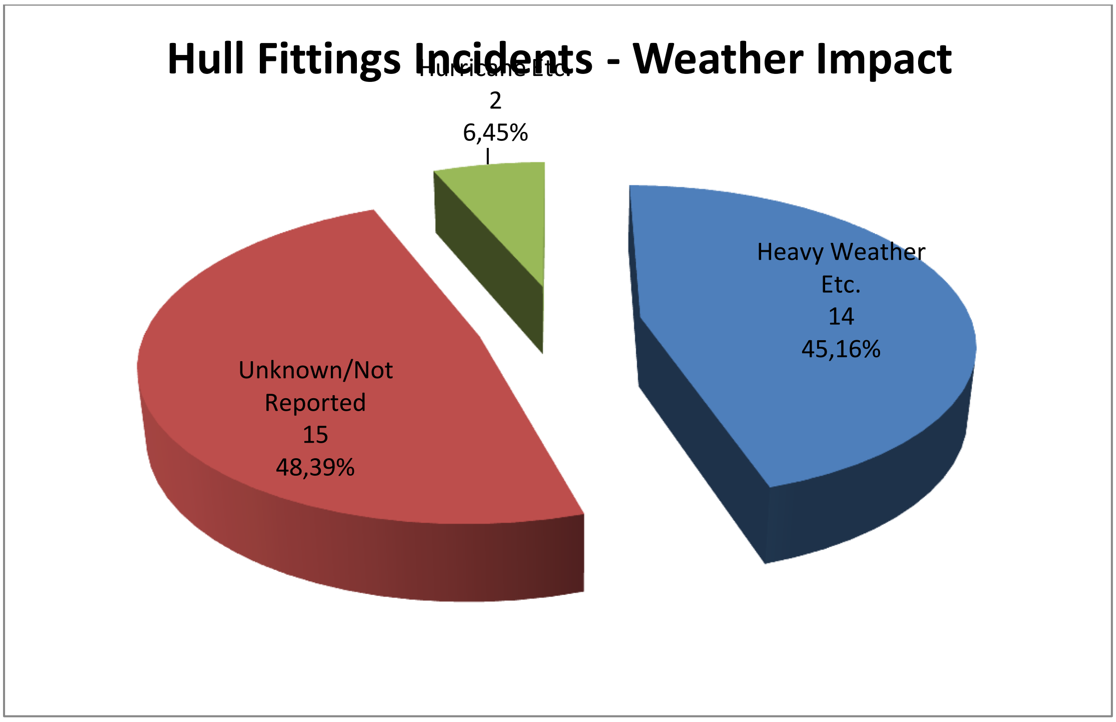


It is by this chart that this theory collapses. Only two incidents occurred during discharging of Payload and three in total that happened because of misuse of equipment.

<u>Hull Fittings failure Type</u>



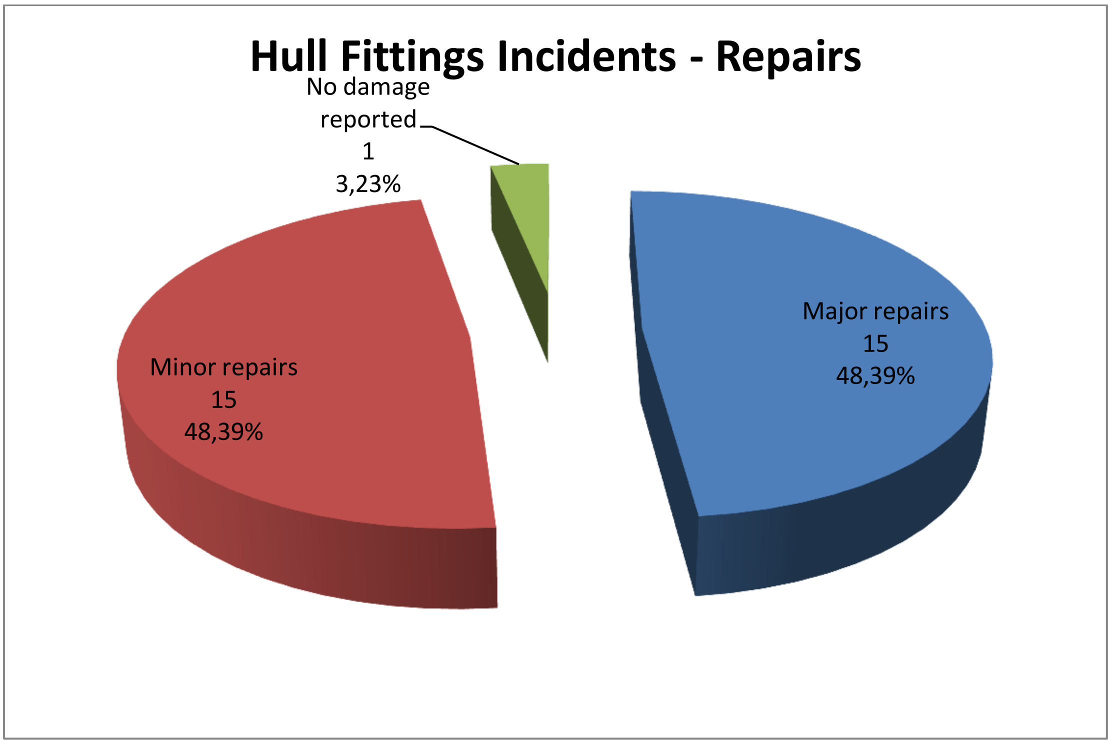
Weather Impact



At least 16 incidents out of 31 are caused due to heavy weather. This is a critical factor for TEUs and equipment that are susceptible of weather conditions.

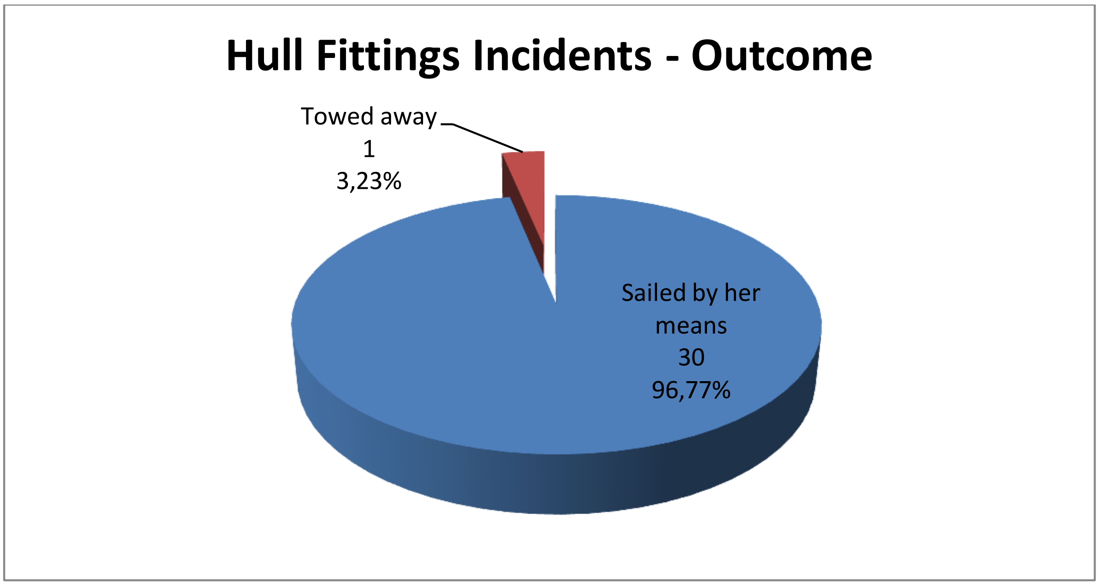
4.6.2 CONSEQUENCES OF HULL FITTINGS ACCIDENTS

Repairs

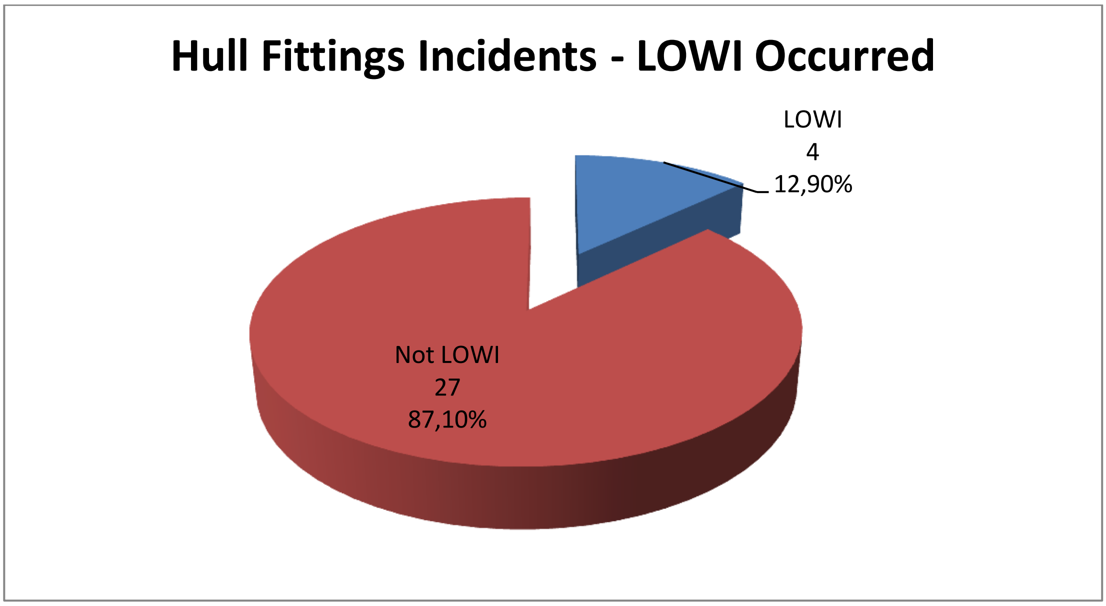


Minor and major repairs are evenly spread. A difference will be observed in the comparison of serious and non serious accidents.

Outcome



LOss of Water Integrity (LOWI)



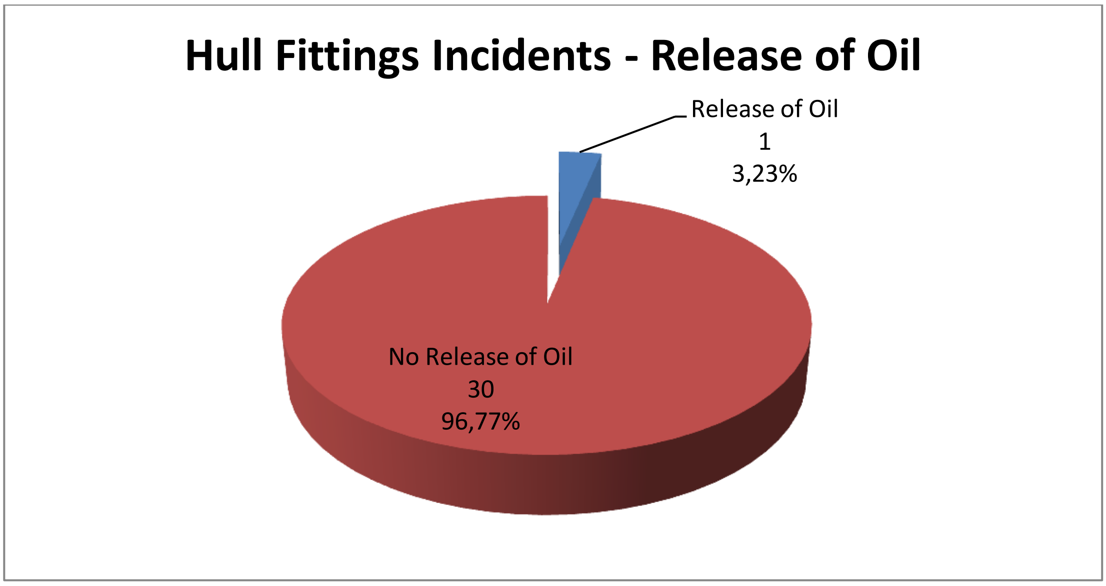
Injuries/ Fatalities

There have been only 4 non serious injuries.

Loss of Payload

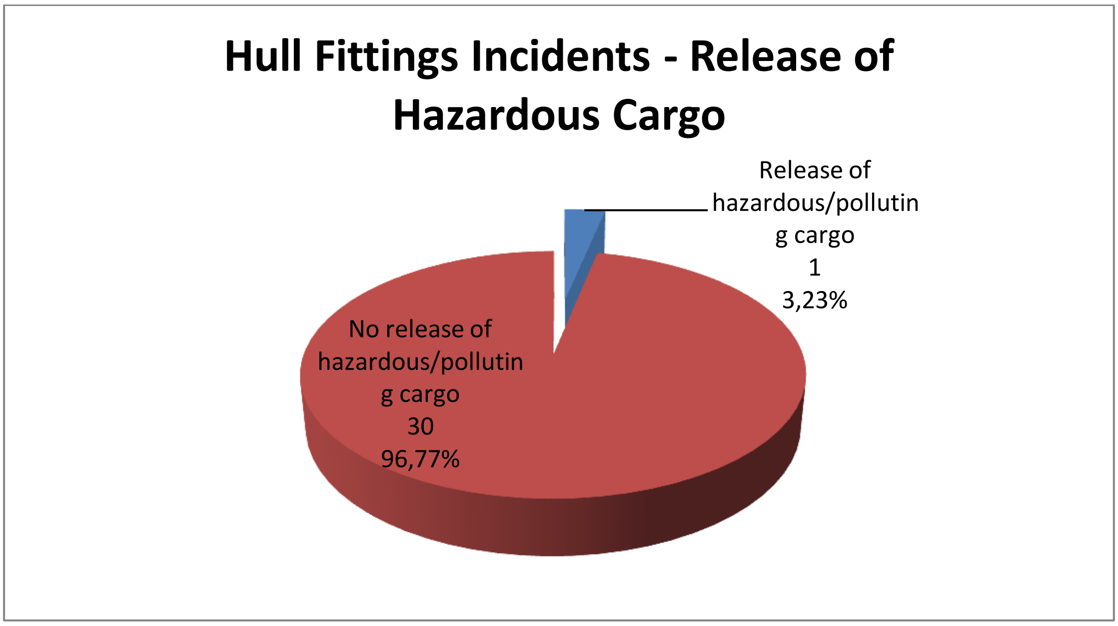
Hull fittings failure has a direct effect on TEU loss. Therefore, the loss of 1074 TEUs in 11 accidents is within expectations, especially when all of them are caused by lashing failure.

Release of Oil

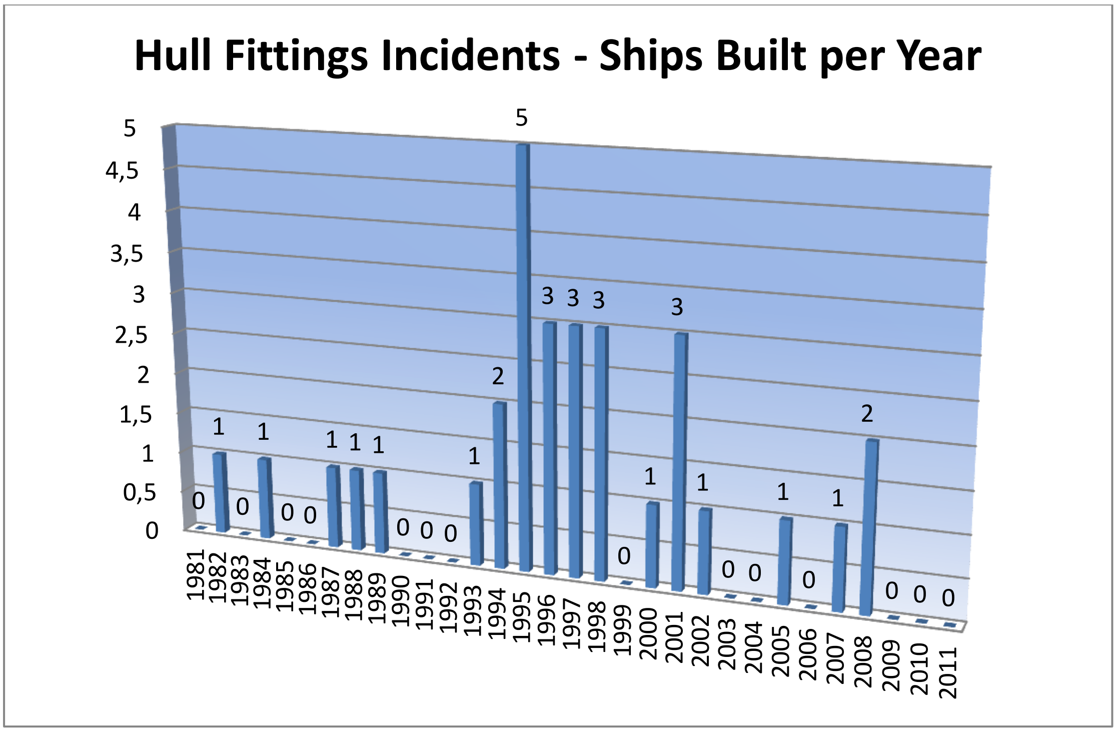


100 tonnes of oil were released.

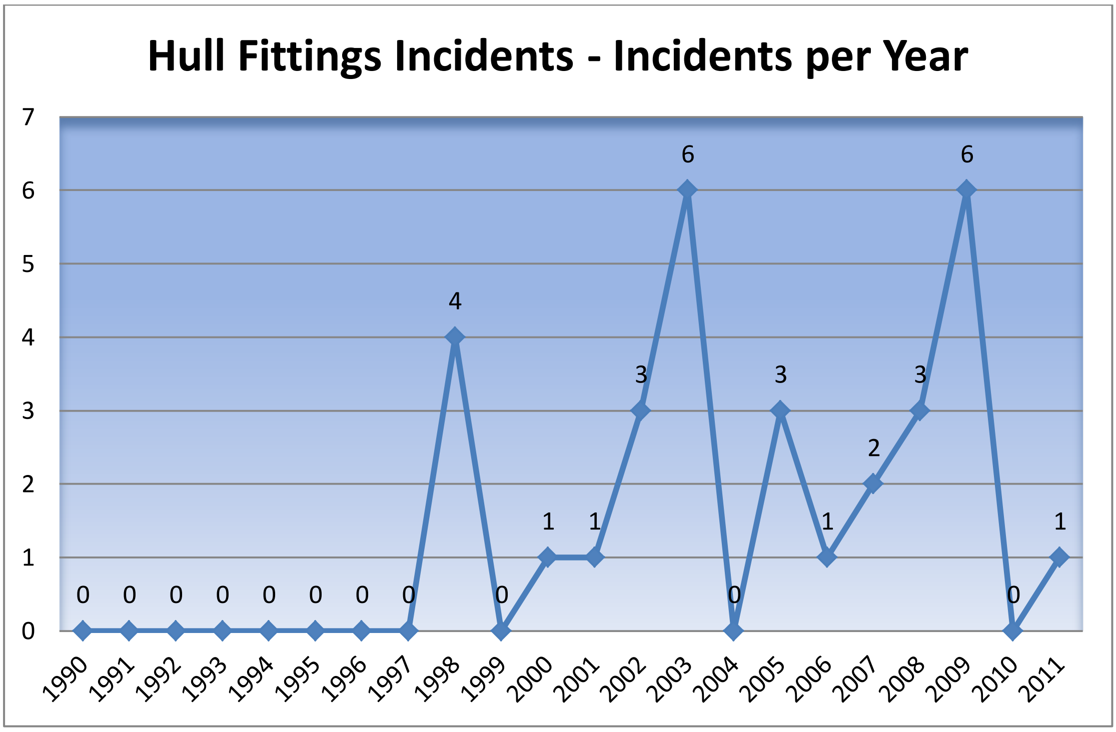
Release of hazardous Cargo

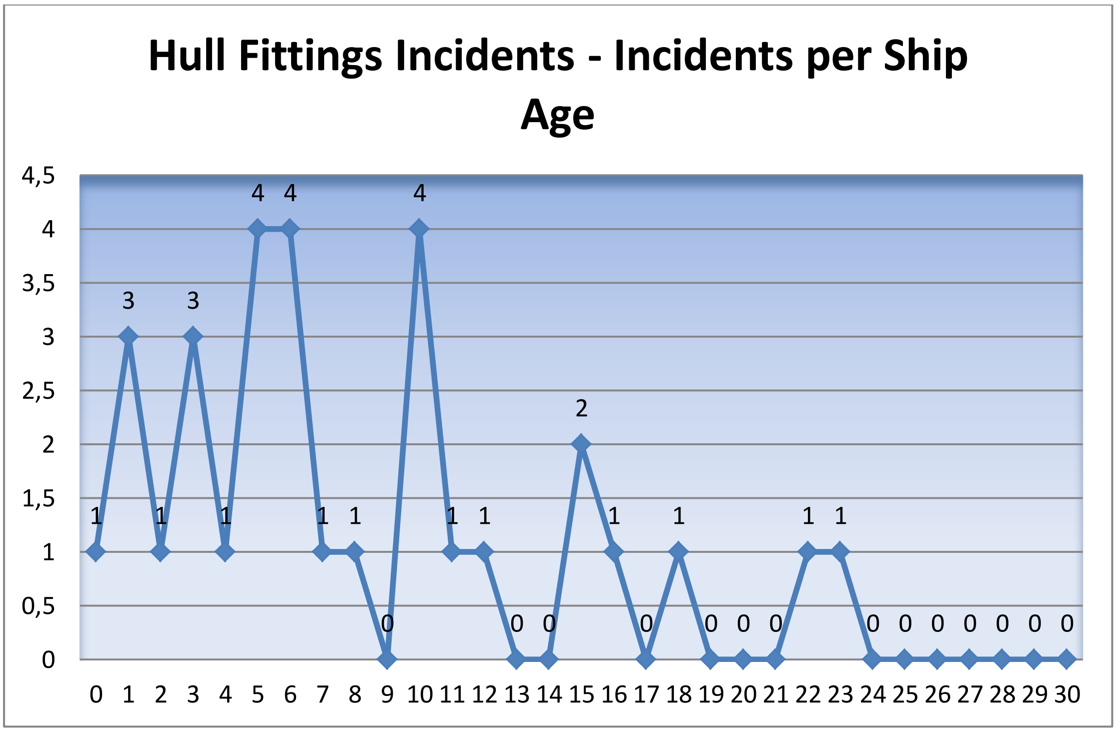


4.6.3 FREQUENCIES OF HULL FITTINGS ACCIDENTS

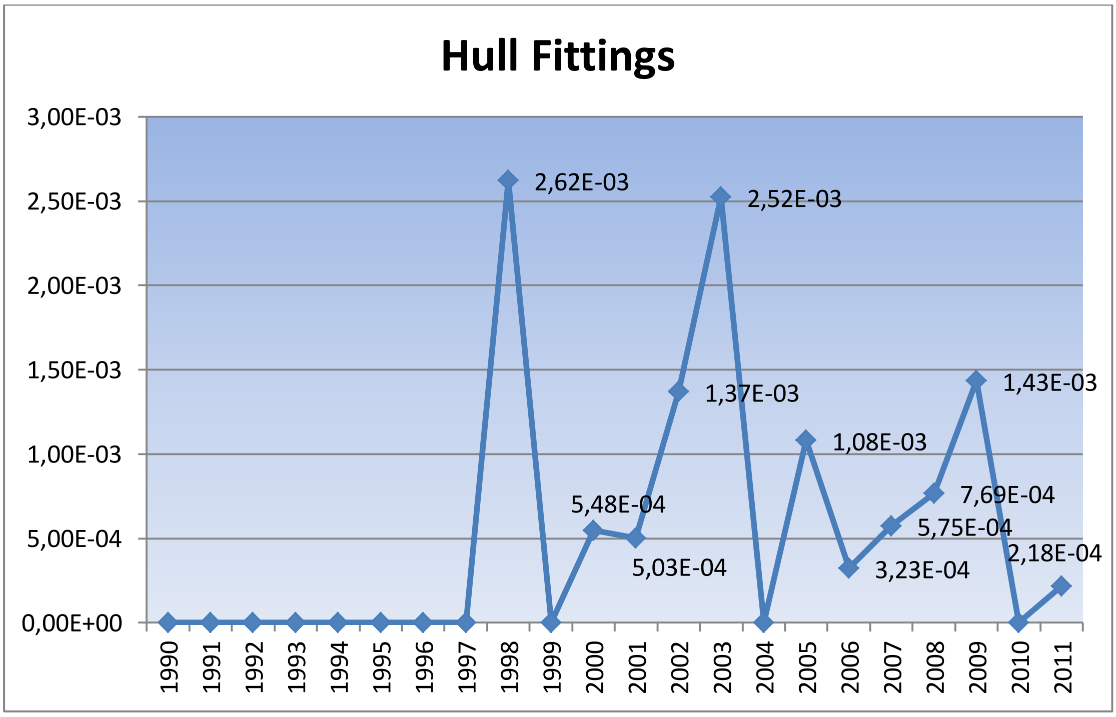


Ships built during the period 1994- 1998 have most incidents in this category.



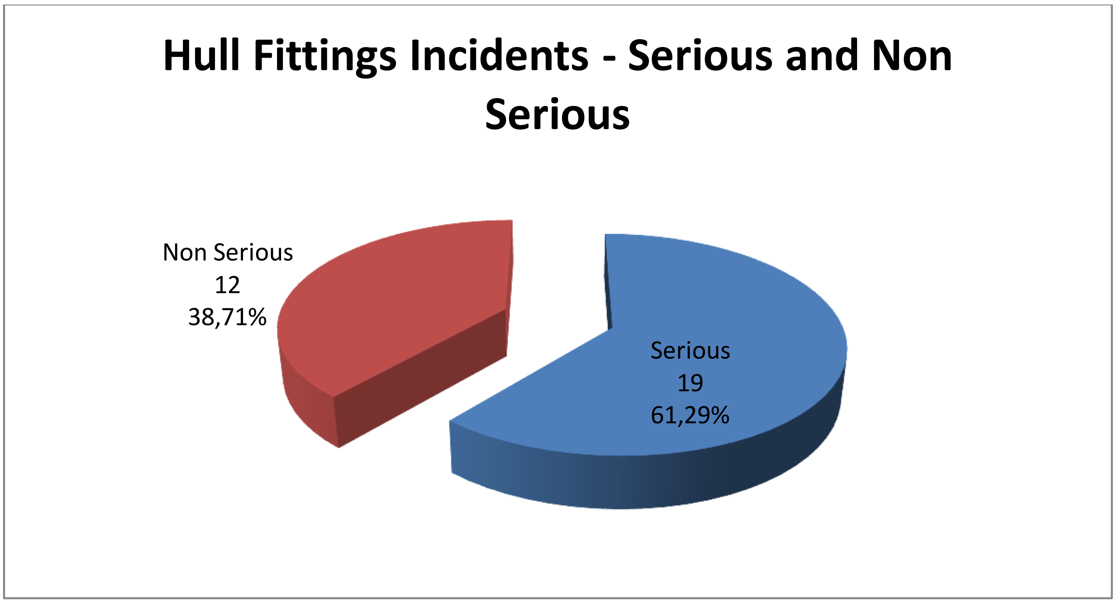


In this type of incidents also, accidents tend to happen in the first decade of the ship's activation.

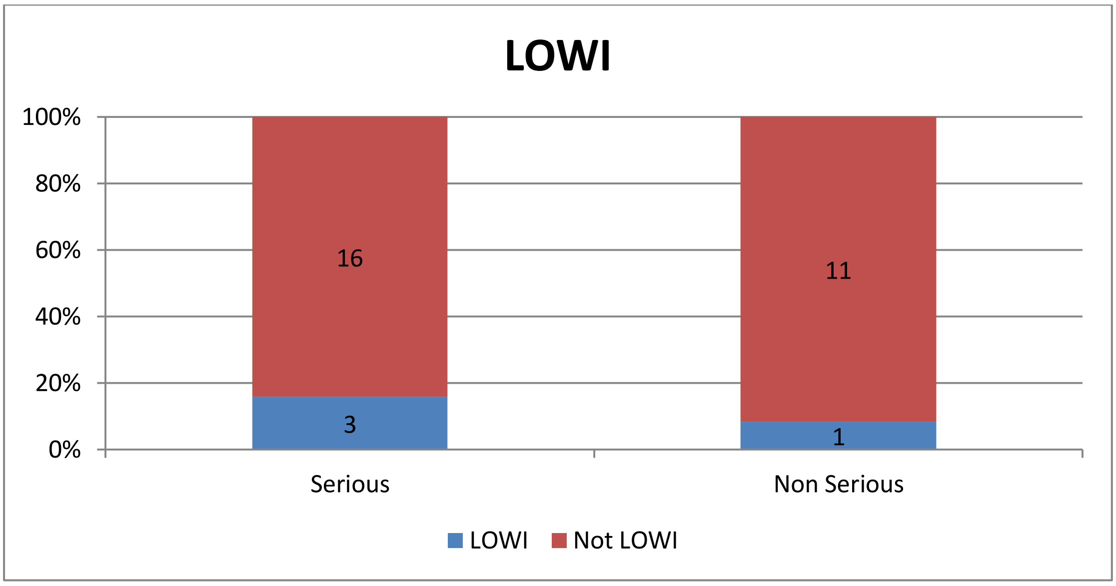


First of all, incidents related to hull fittings are limited to a small amoun. Furthermore, frequency of these incidents is not stable over the years. It varies between 0.05- 0.15%.

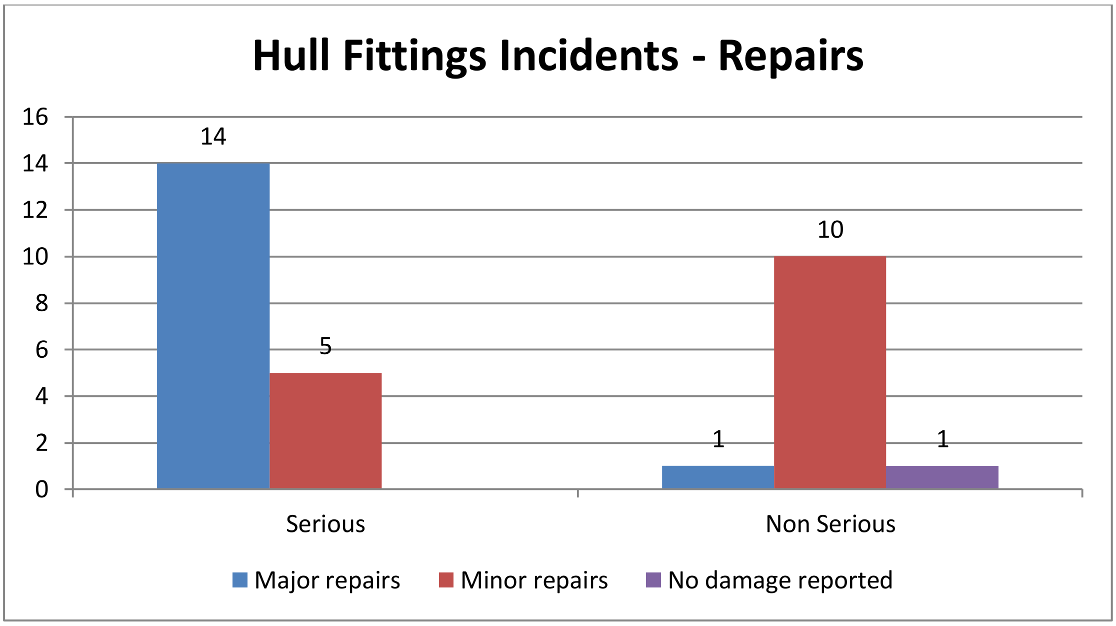
4.6.4 COMPARISON OF SERIOUS AND NON-SERIOUS ACCIDENTS



Serious accidents are more than non serious, but still comparable.



In general, loss of water integrity occurs in a minor percentage. Only 3 serious accidents and 1 non serious involved such a loss.



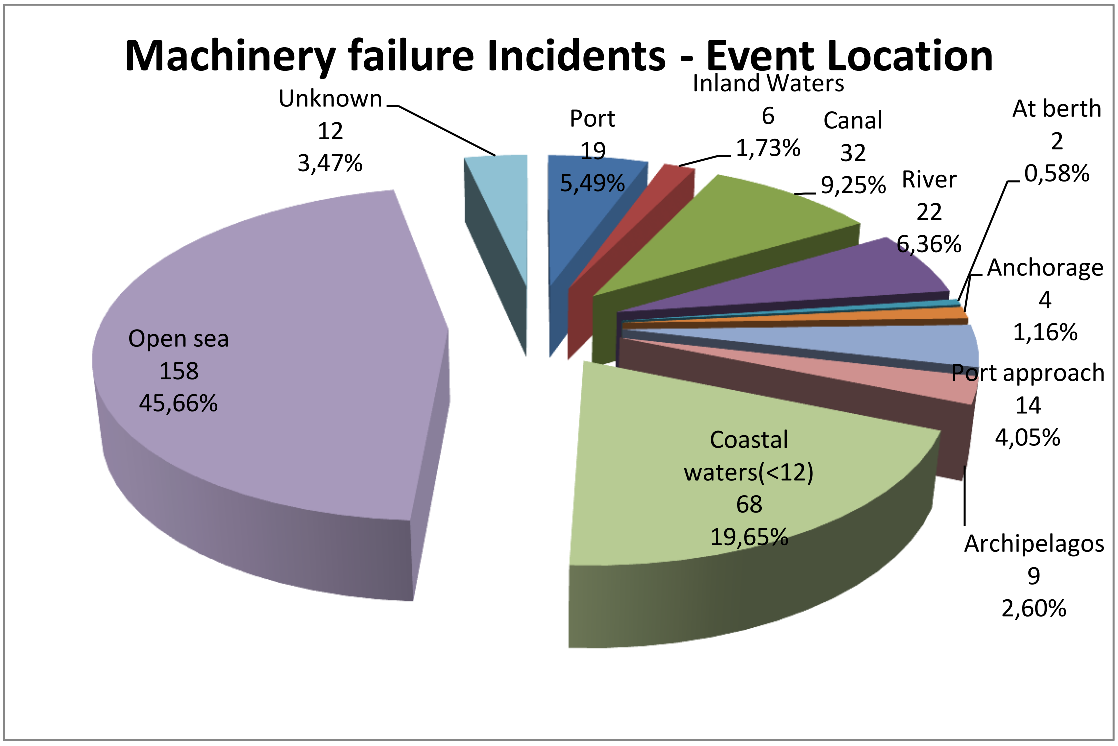
The segrecation of serious and non serious accidents is clear in the chart above. Most serious accidents led to major repairs, where non serious led to minor.

As far as it concerns the outcome of the accidents, all ships involved in non serious accidents sailed by their means. Only one ship with a serious accident had to be taken in tow for repairs.

4.7 MACHINERY FAILURE INCIDENTS

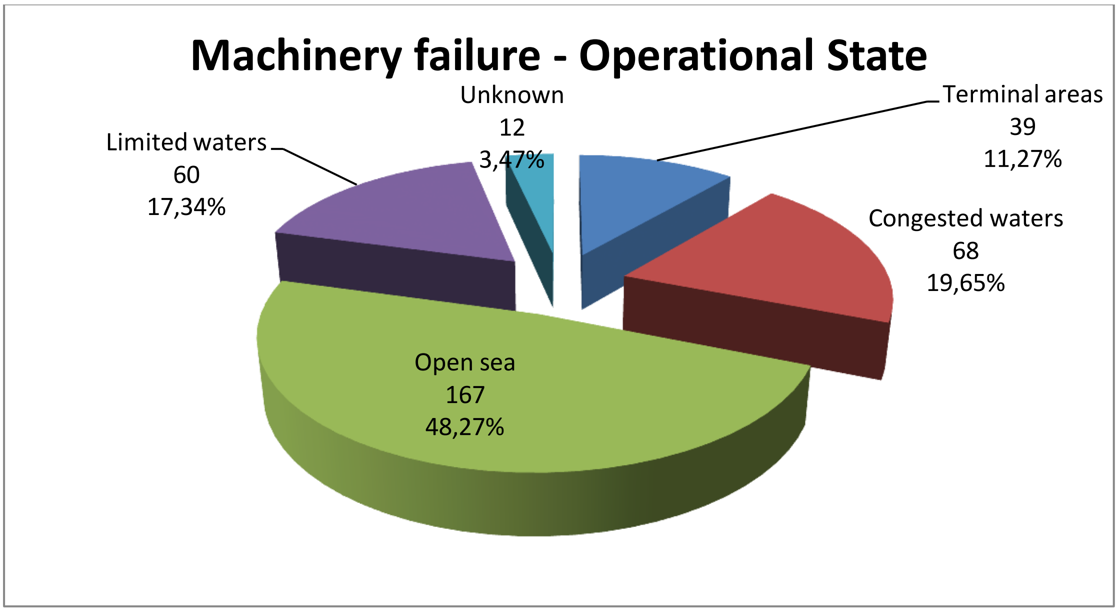
4.7.1 CONDITIONS OF MACHINERY FAILURE ACCIDENTS

Event Location

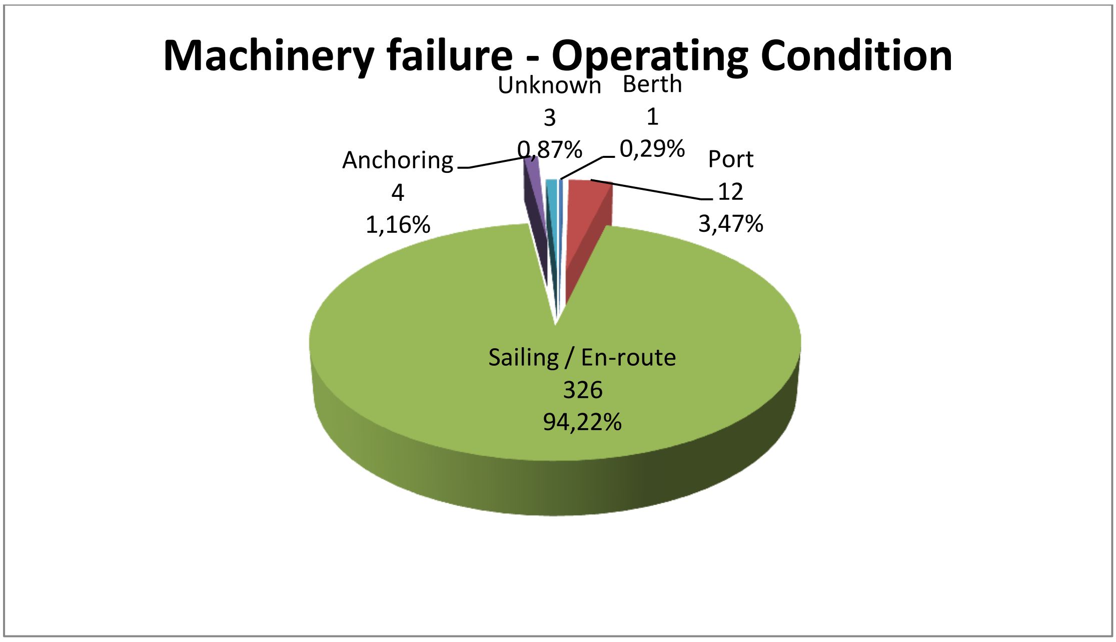


Machinery failure is irrelevant to the area the vessel is at the time of the incident. The only common factor is engine's and all relevant machinery operation.

Operational State

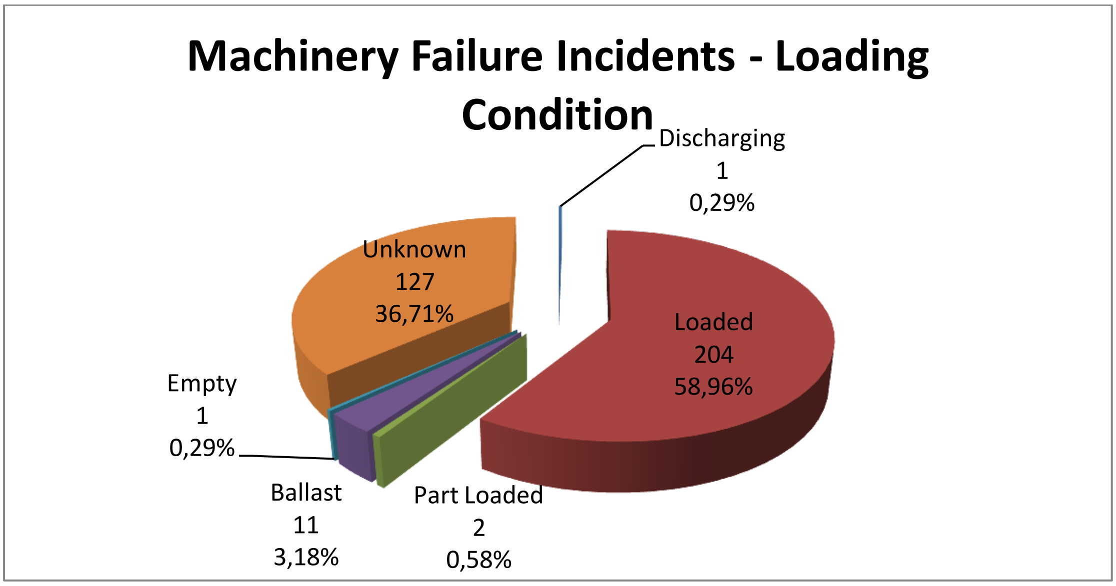


Operating Condition

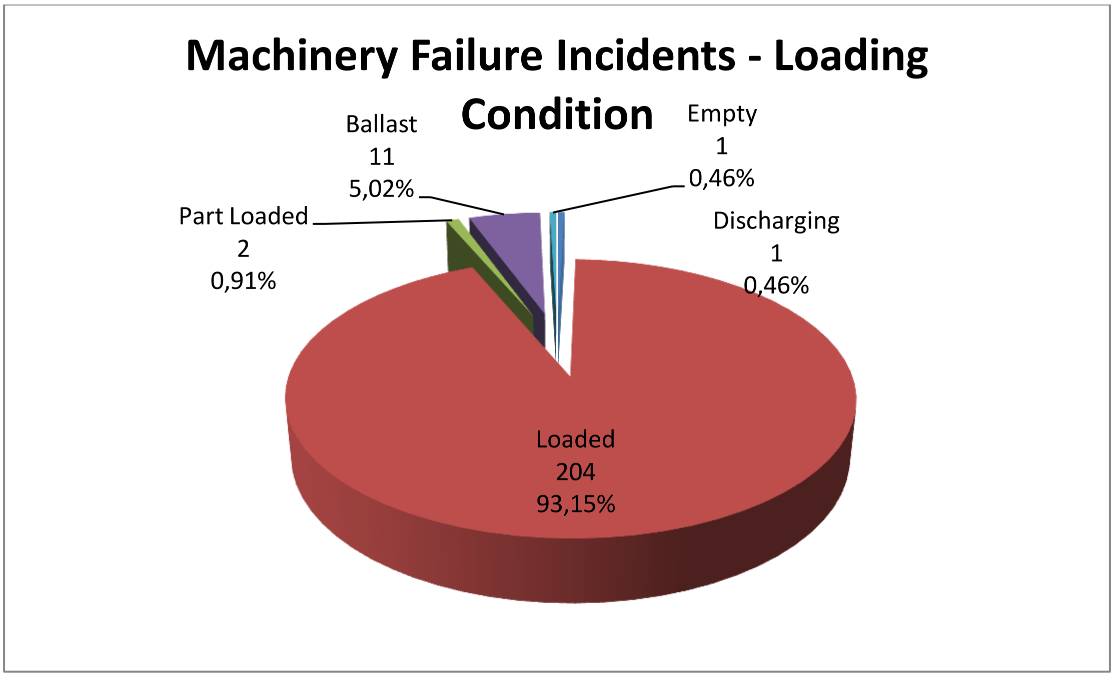


Nearly all incidents occur during voyage, a fact that complies with previous conclusion.

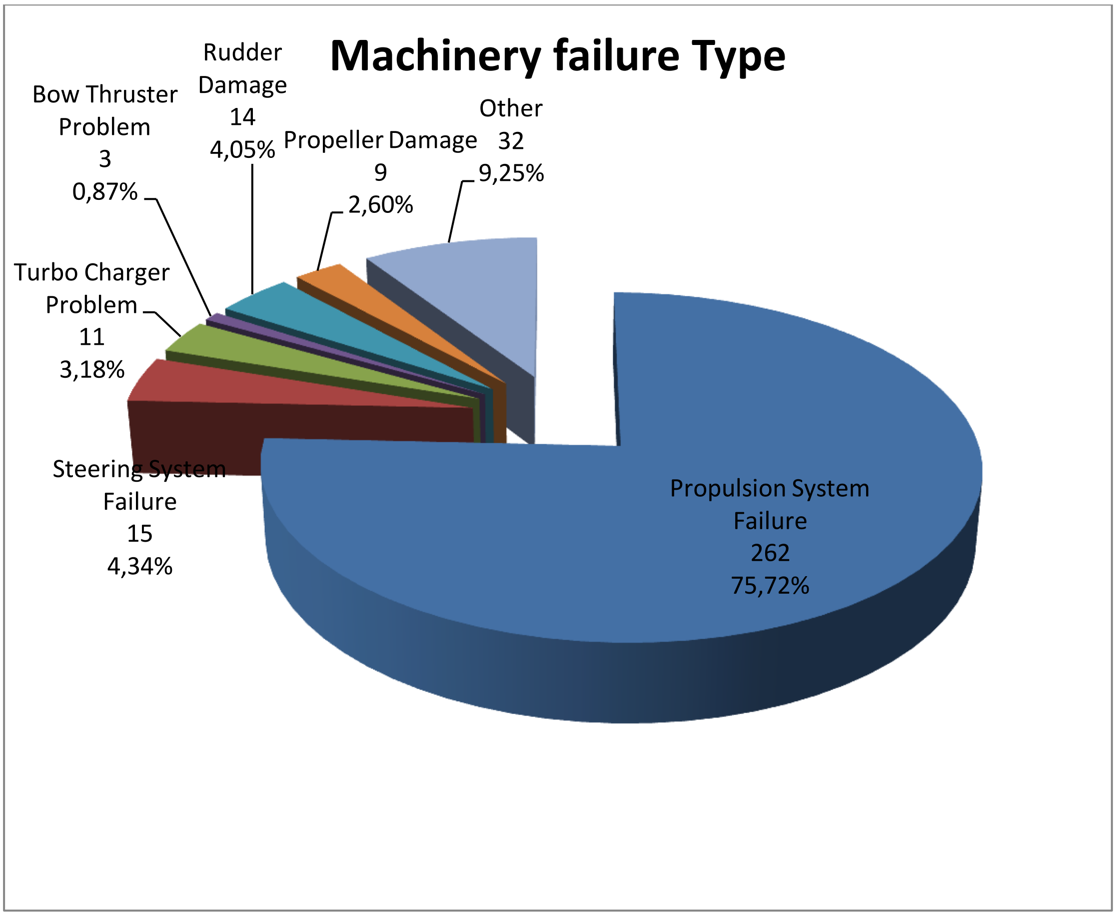
Loading Conditions



More than half of the vessels were loaded at the time of the incident. The "Unknown" percentage is considerable and indications suggest it should be added to other categories, so the following charts is more appropriate.

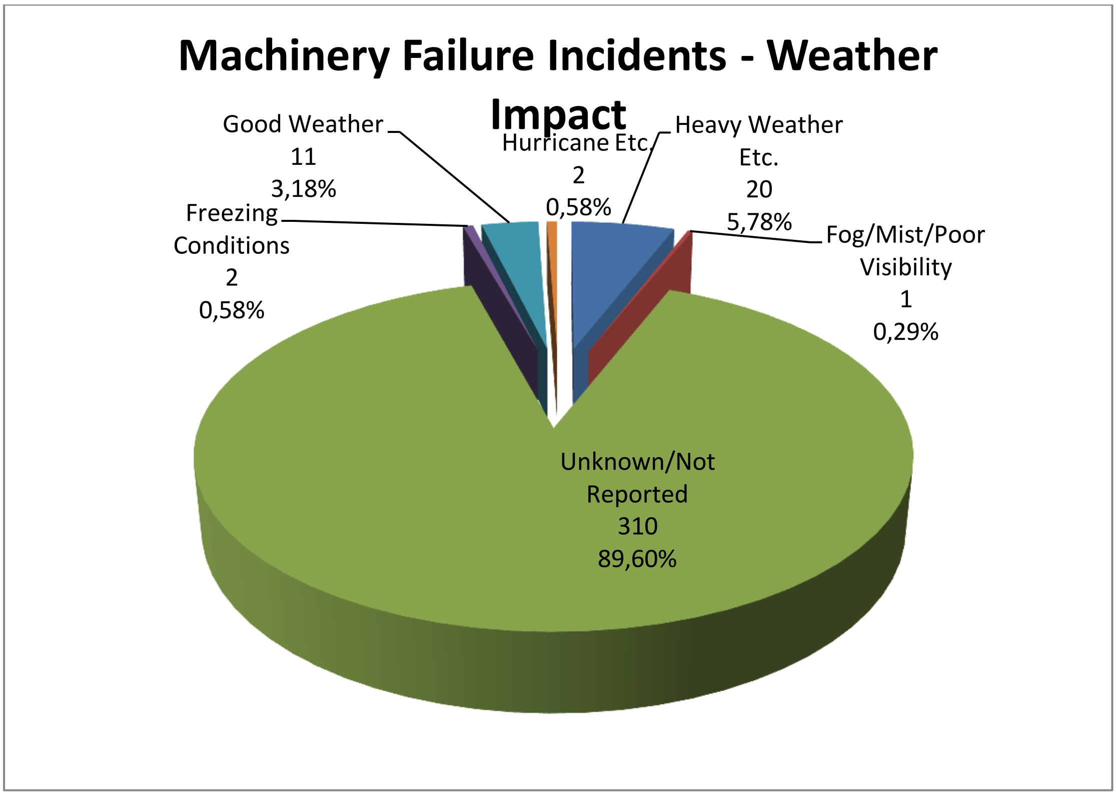


Machinery failure Type



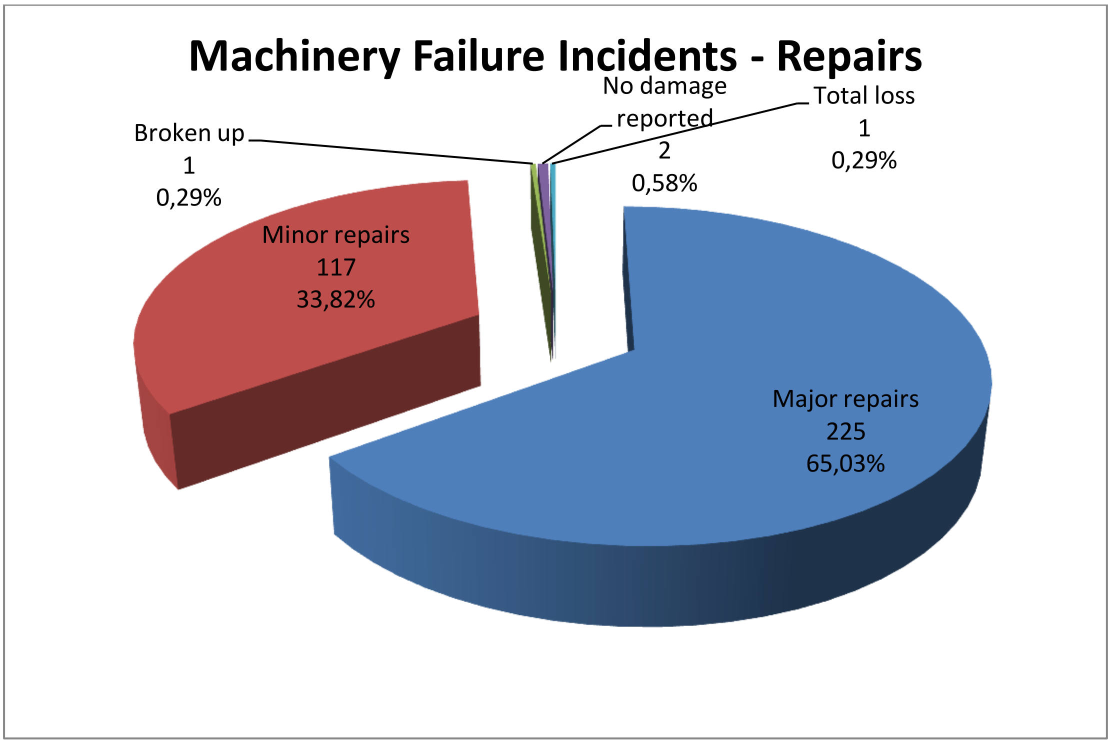
Propulsion system failure represents the majority of machinery failure incidents. All of them refer to main engine's or auxiliary machineries' problems.

Weather Impact

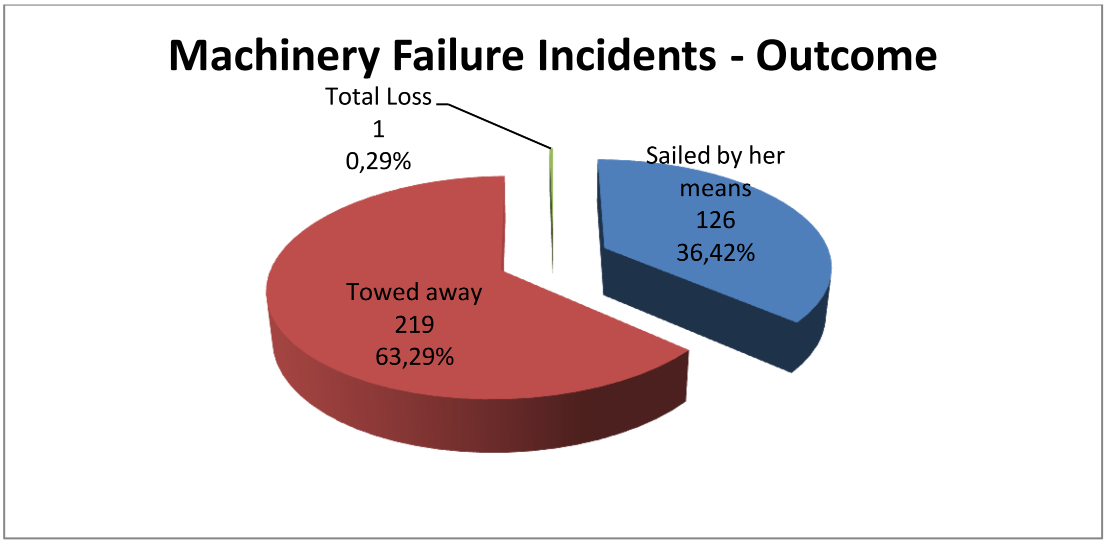


4.7.2 CONSEQUENCES OF MACHINERY FAILURE ACCIDENTS

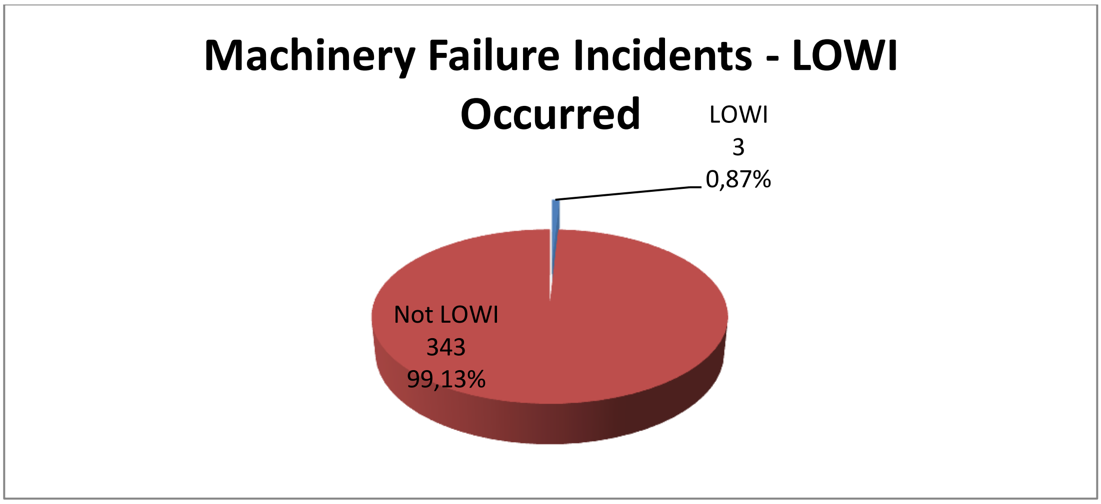
Repairs



Outcome



LOss of Water Integrity (LOWI)



Injuries/ Fatalities

Only four crew members injured on three machinery failure incidents.

Loss of Payload

110 TEUs were lost in one accident.

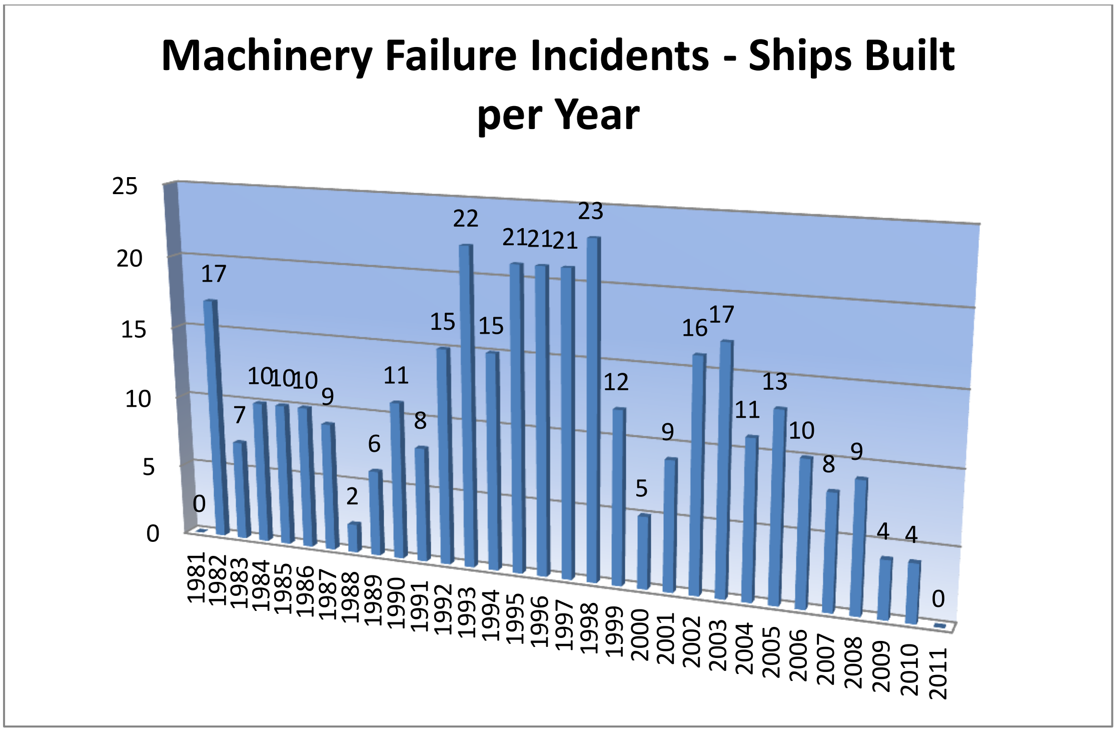
Release of Oil

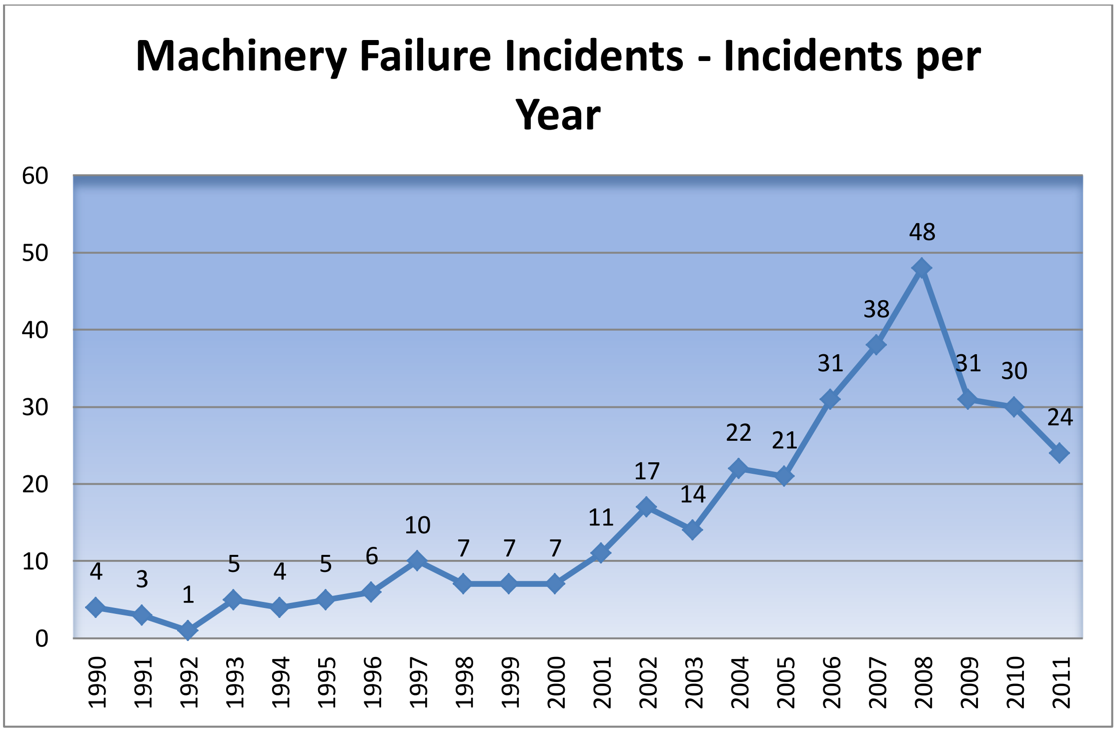
No release of oil.

Release of hazardous Cargo

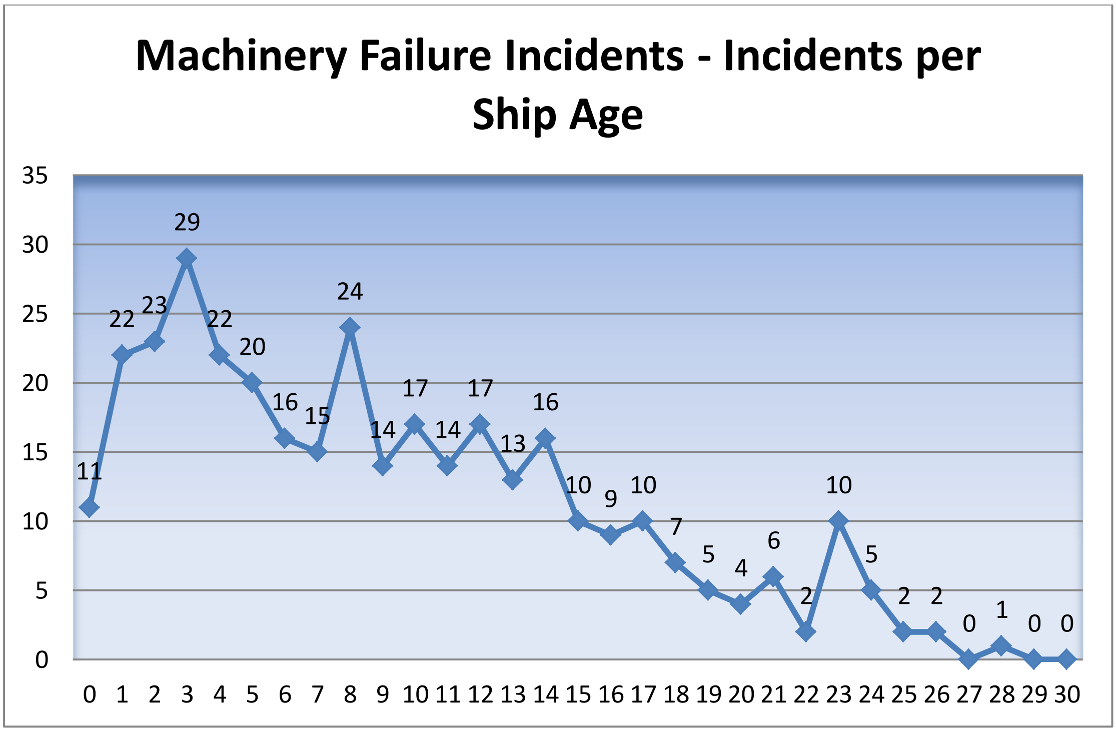
No release of hazardous cargo.

4.7.3 FREQUENCIES OF MACHINERY FAILURE ACCIDENTS

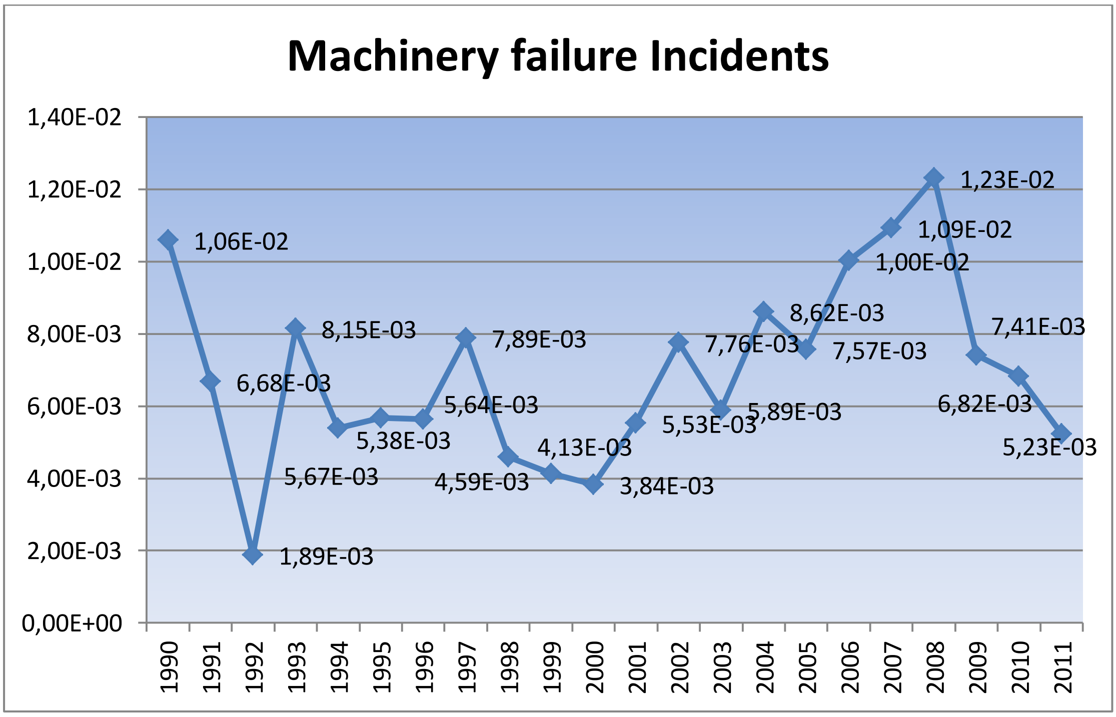




Machinery failure on modern vessels had an increasing tendency until 2008, especially since 2001.

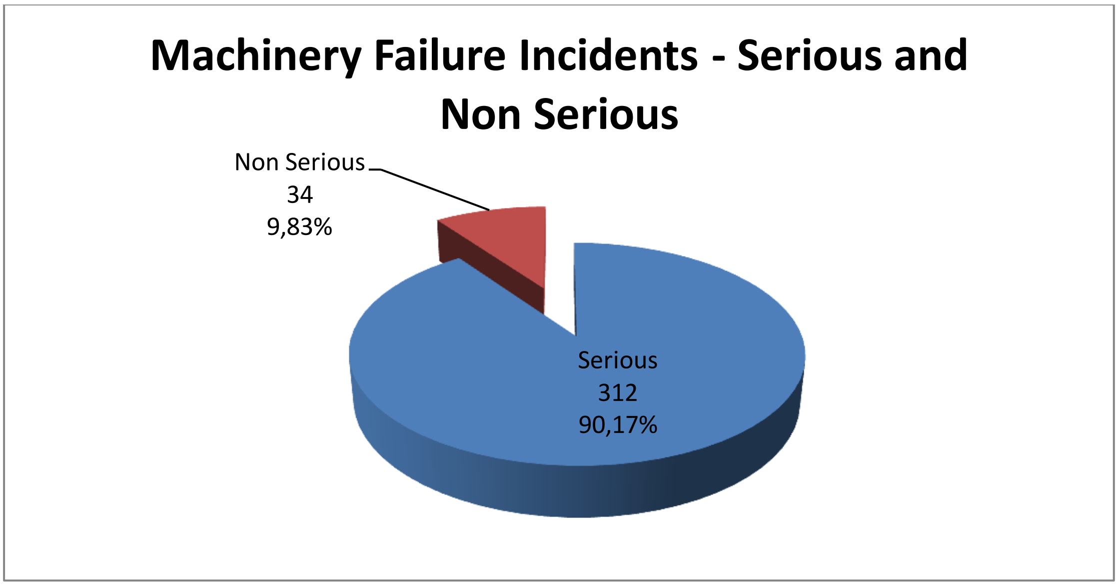


In general, as ships get older machinery failure incidents tend to decrease in number.



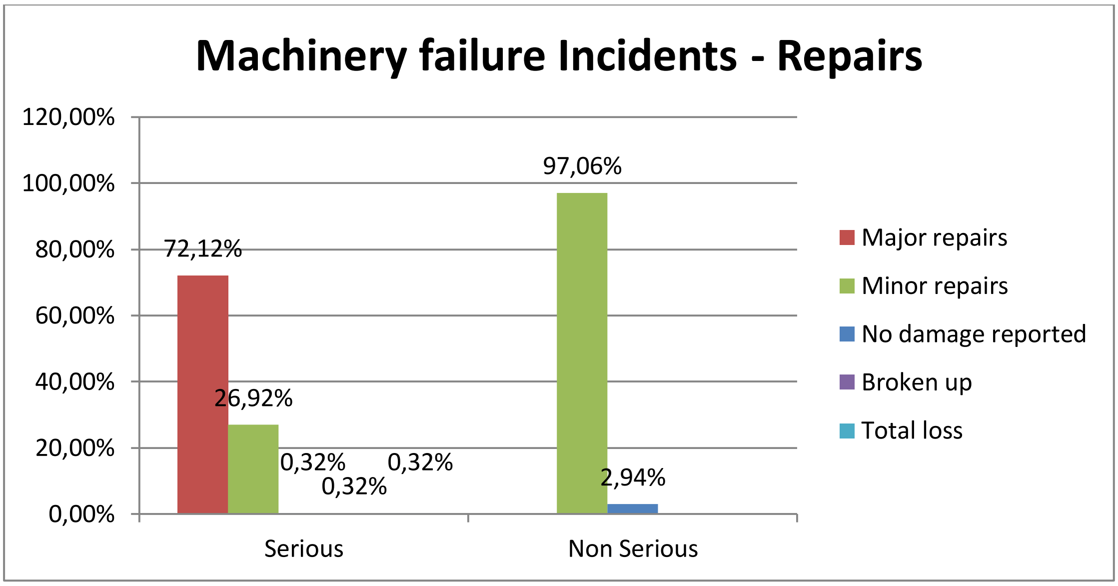
The frequency of such incidents seems to increase over the years, with no obvious cause. Although, in two years (1998 and 2009) the frequency decreased to almost half of what it was last year (1197 and 2008).

4.7.4 COMPARISON OF SERIOUS AND NON-SERIOUS ACCIDENTS

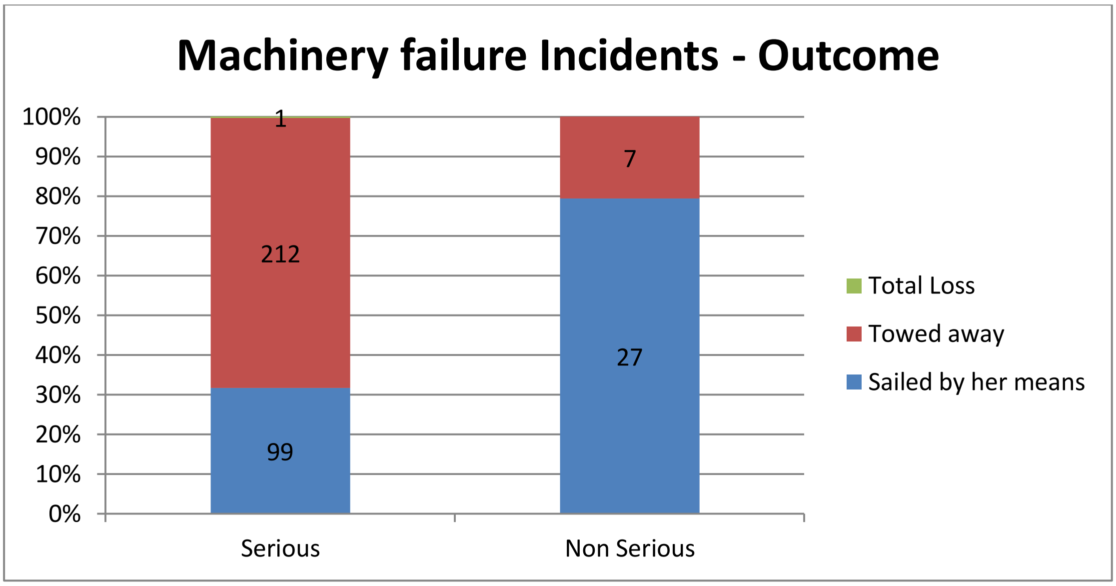


Non-serious accidents are significantly less than serious. Individually, machinery failure could not be assumed as a serious accident. Nevertheless, collateral damages such as fire in engine room and injuries caused by it as well as structural damages and delays for repairs, can be described as serious.

No LOWI occurred in non-serious accidents. Additionally only 3 serious accidents led to loss of water integrity.



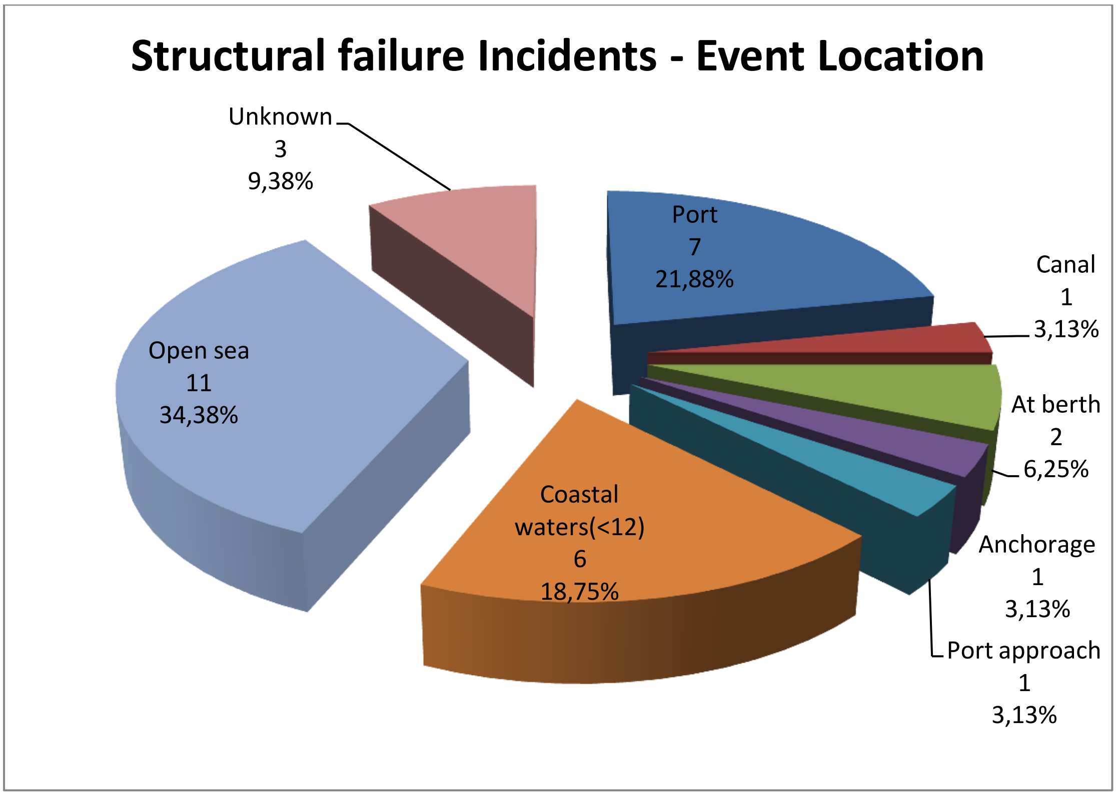
Because of the much smaller percentage of other categories, it should be mentioned that the last three numbers represent 1 accident for “No Damage Reported”, “Broken up” and “Total Loss” each.



4.8 STRUCTURAL FAILURE INCIDENTS

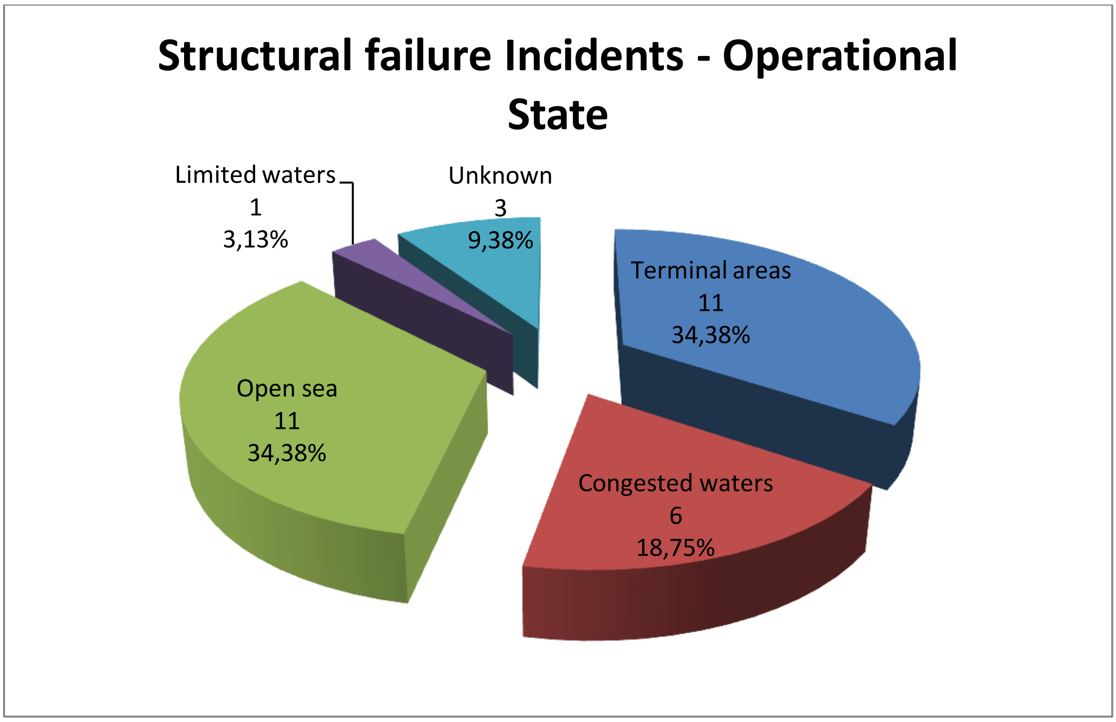
4.8.1 CONDITIONS OF STRUCTURAL FAILURE ACCIDENTS

Event Location

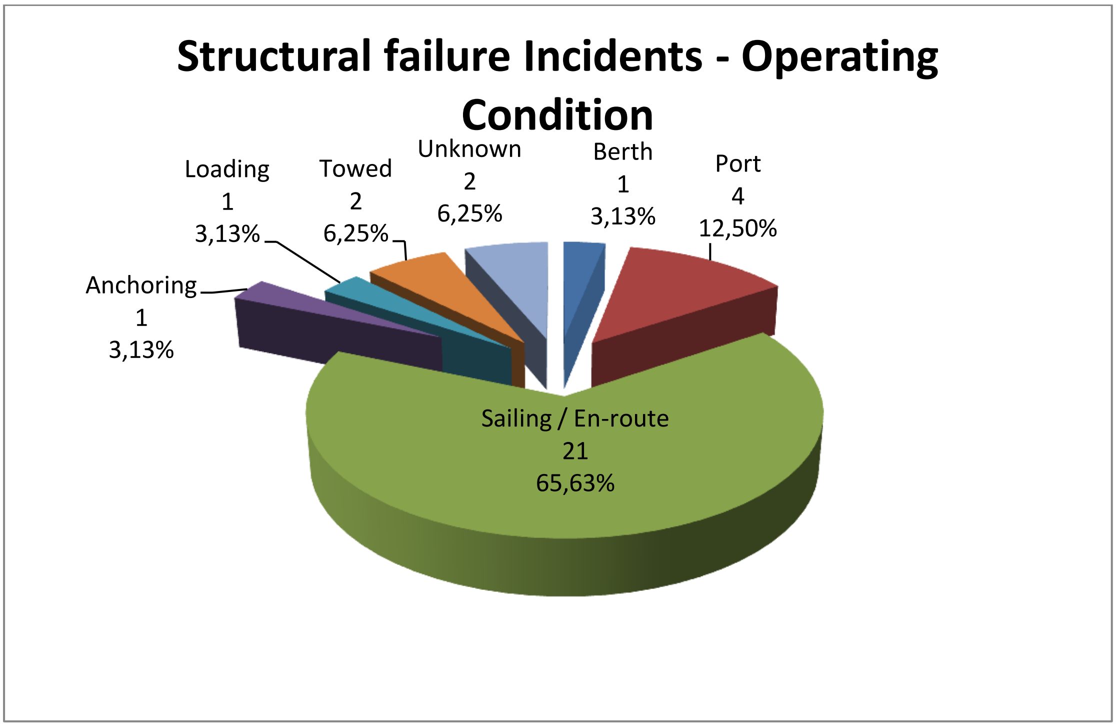


As in machinery failure incidents, structural failure is irrelevant to the location the vessel is at the time of the incident.

Operational State

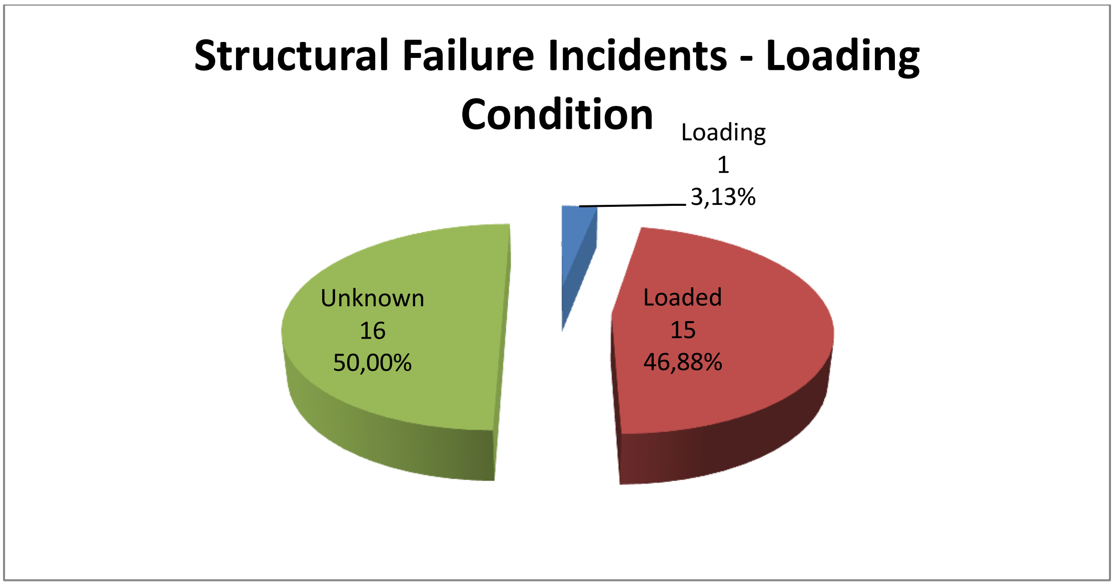


Operating Condition



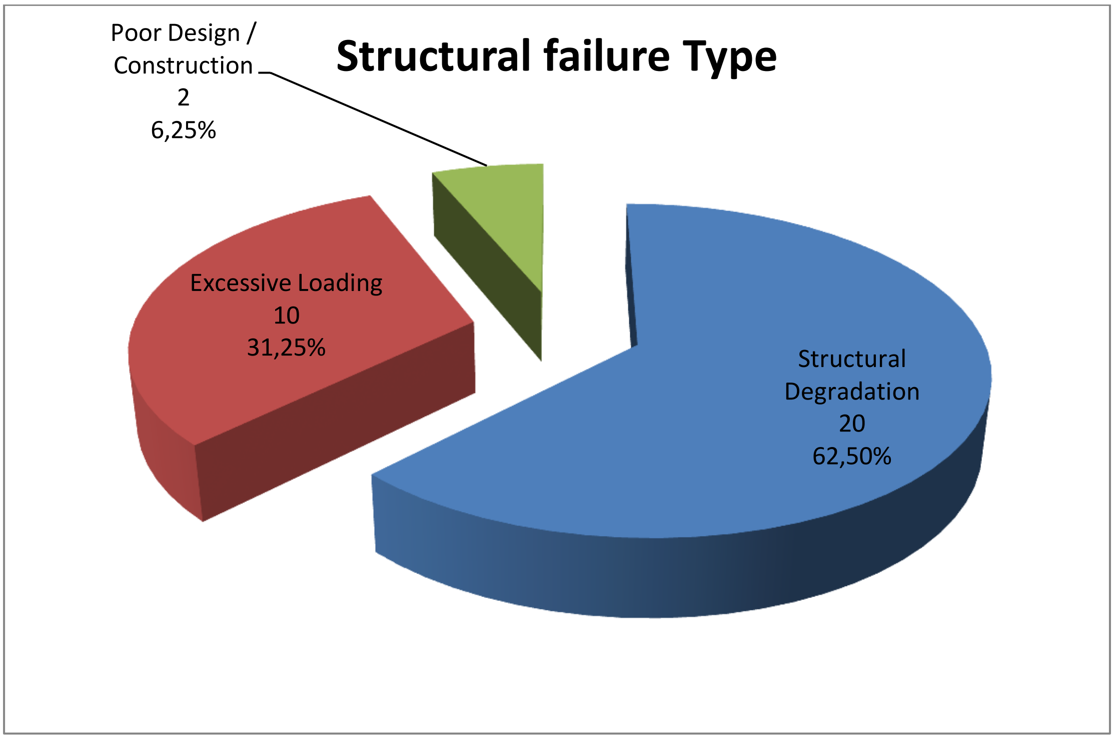
Proportion of incidents that occur during voyages is significantly greater than all other operating conditions.

Loading Conditions



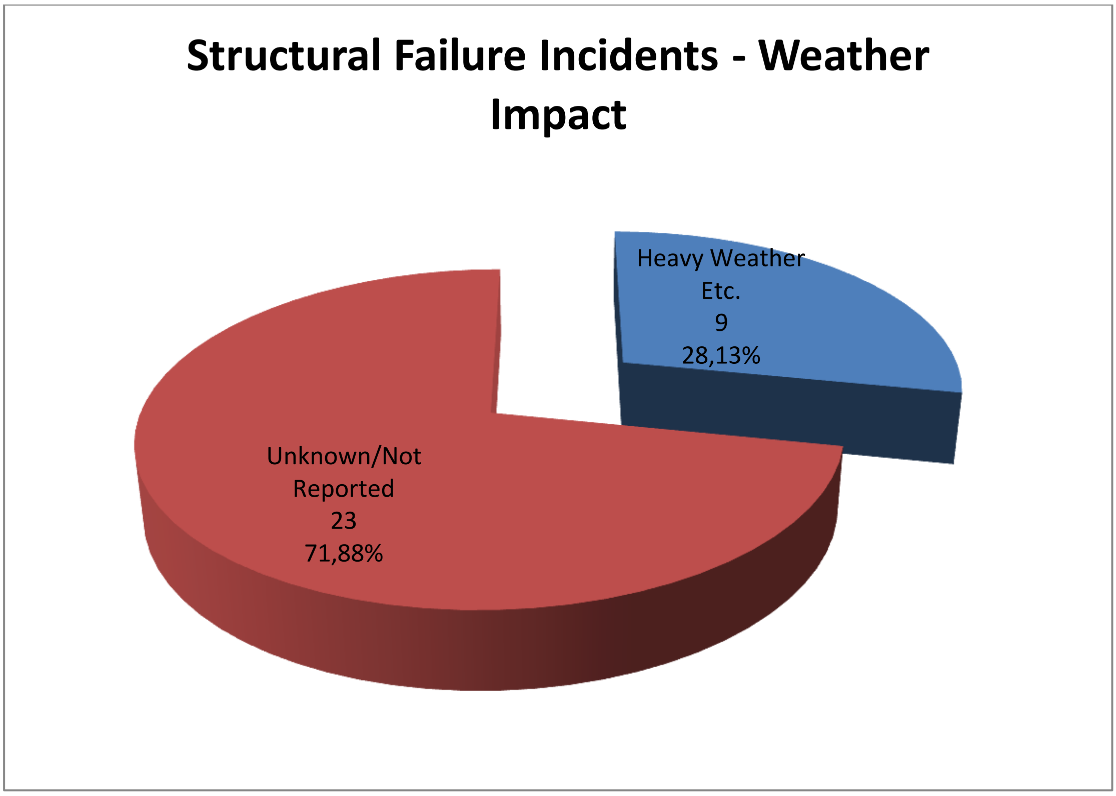
For half of the incidents the loading condition is unknown. For this reason it is beetter to assume that in the majority vessels were loaded at the time of the incident.

Structural failure Type



Structural degradation caused twice the accidents than excessive loading and it is considered the main reason for structural failure incidents. This is an issue that should concern IACS members and inspections being conducted onboard.

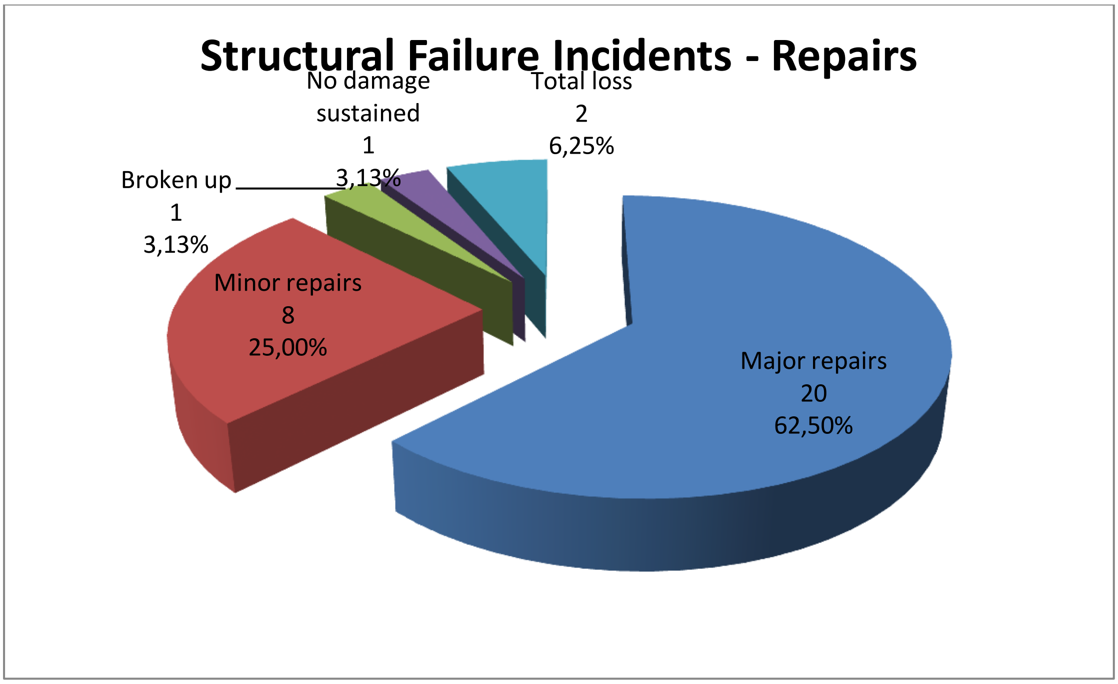
Weather Impact



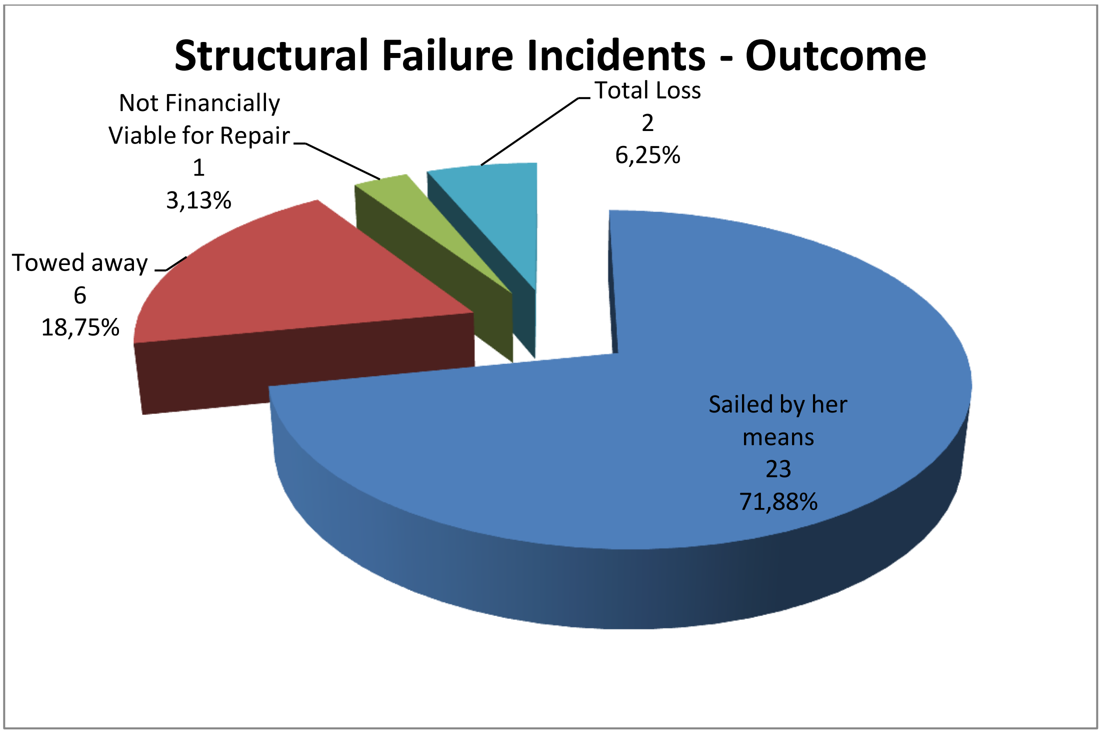
There is no information about the weather conditions in most of the accidents. For those that there is, heavy weather is the only reason for damages caused.

4.8.2 CONSEQUENCES OF STRUCTURAL FAILURE ACCIDENTS

Repairs

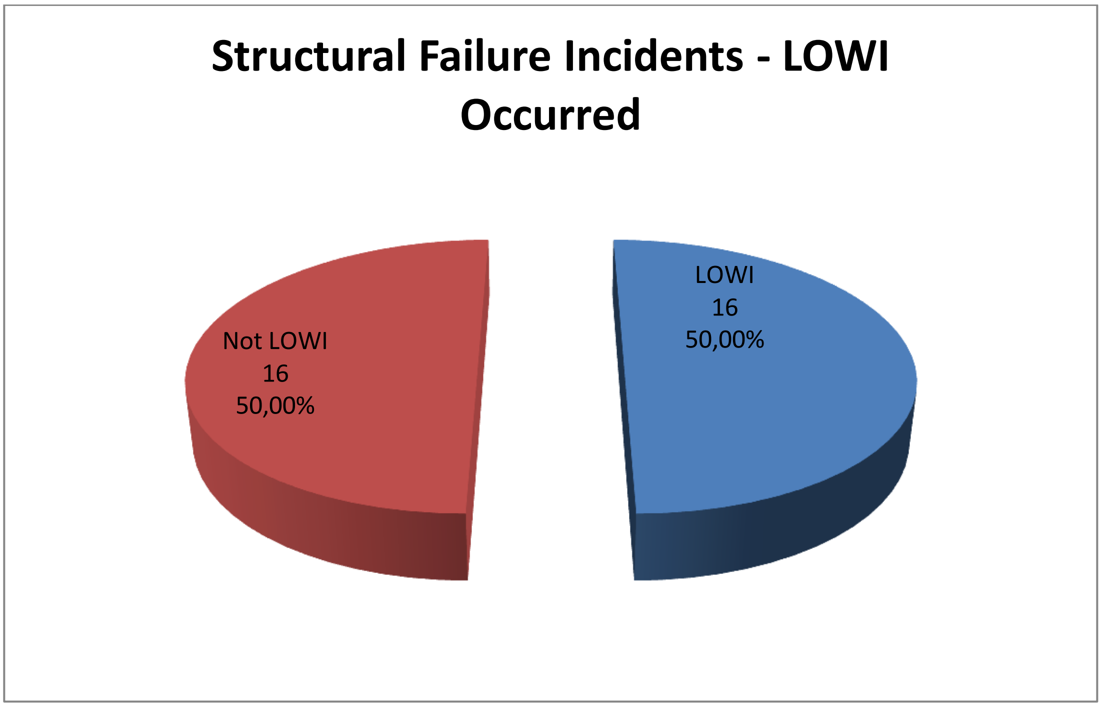


Outcome



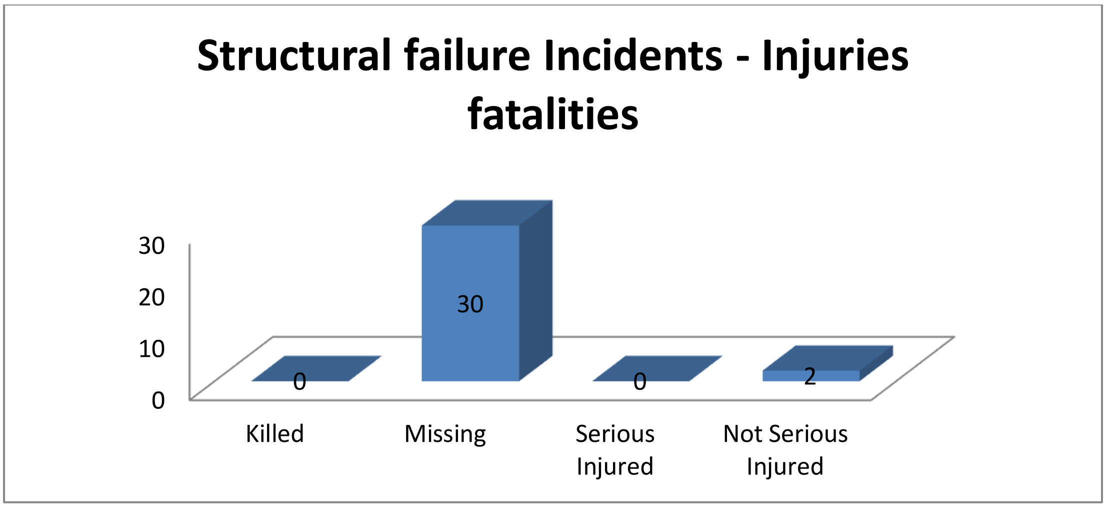
Although there three accidents led to a total loss, the majority of vessels was capable of sailing by own means.

LOss of Water Integrity (LOWI)



The two possible scenarios are equal separated.

Injuries/ Fatalities

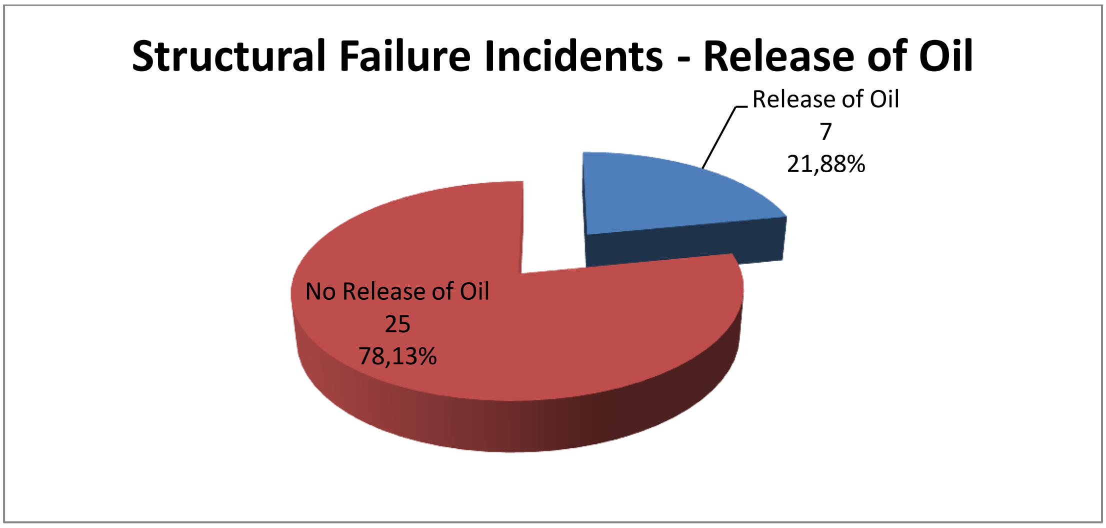


Despite the fact that a serious number of crew members were missing in this type of incidents, it is important to notice that these numbers concern only 2 accidents and 30 missing people regard to a total loss of the vessel.

Loss of Payload

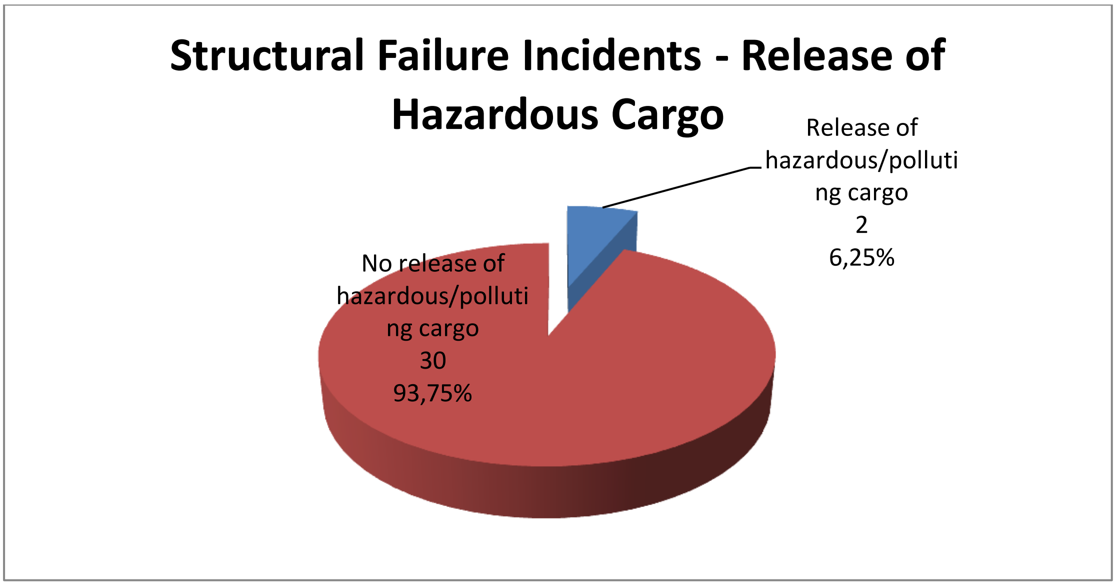
110 TEUs were lost in one accident.

Release of Oil

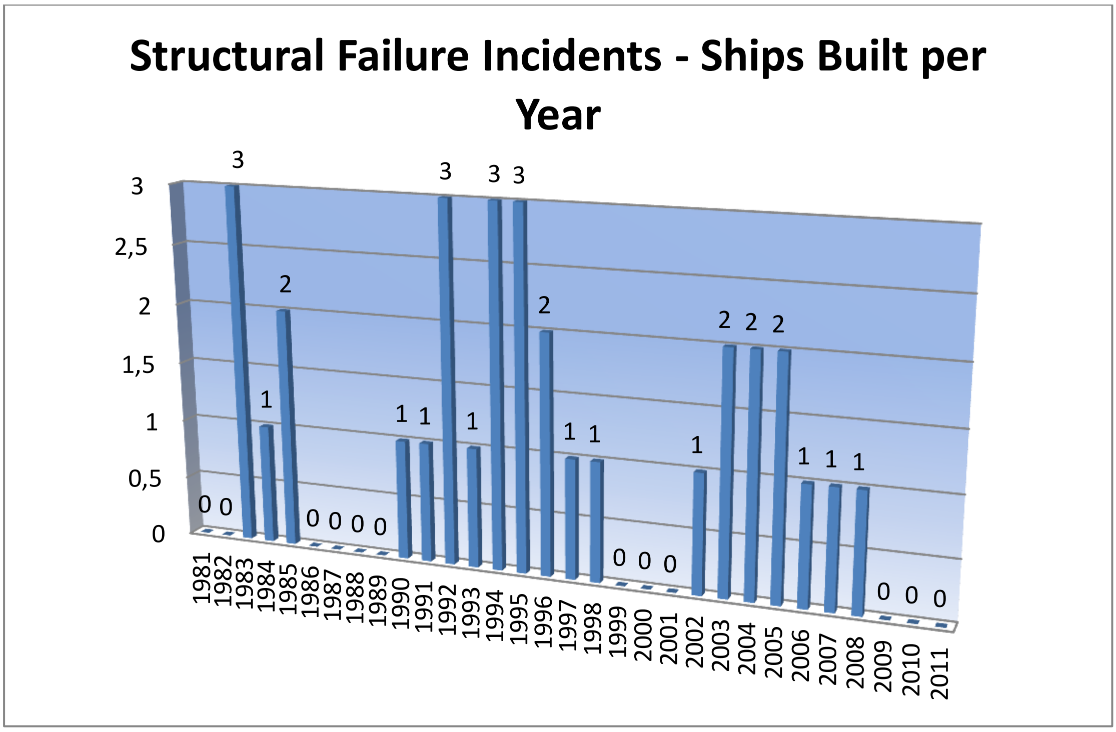


265 tonnes of oil were released in 7 structural failure incidents.

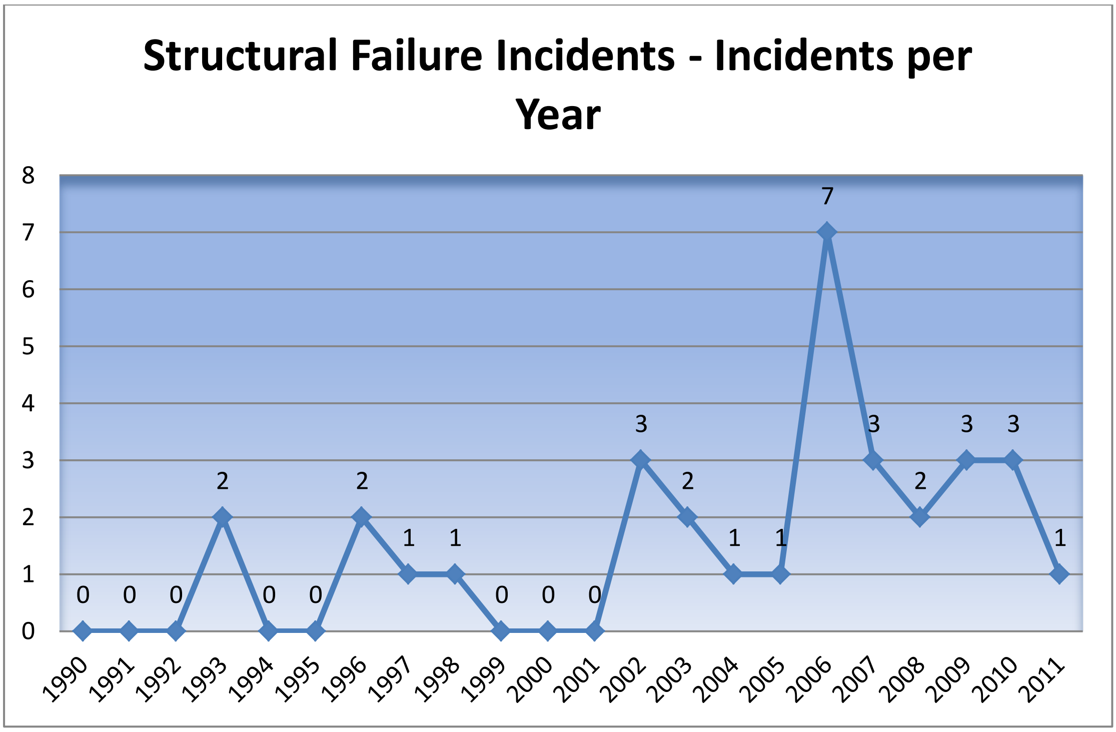
Release of hazardous Cargo

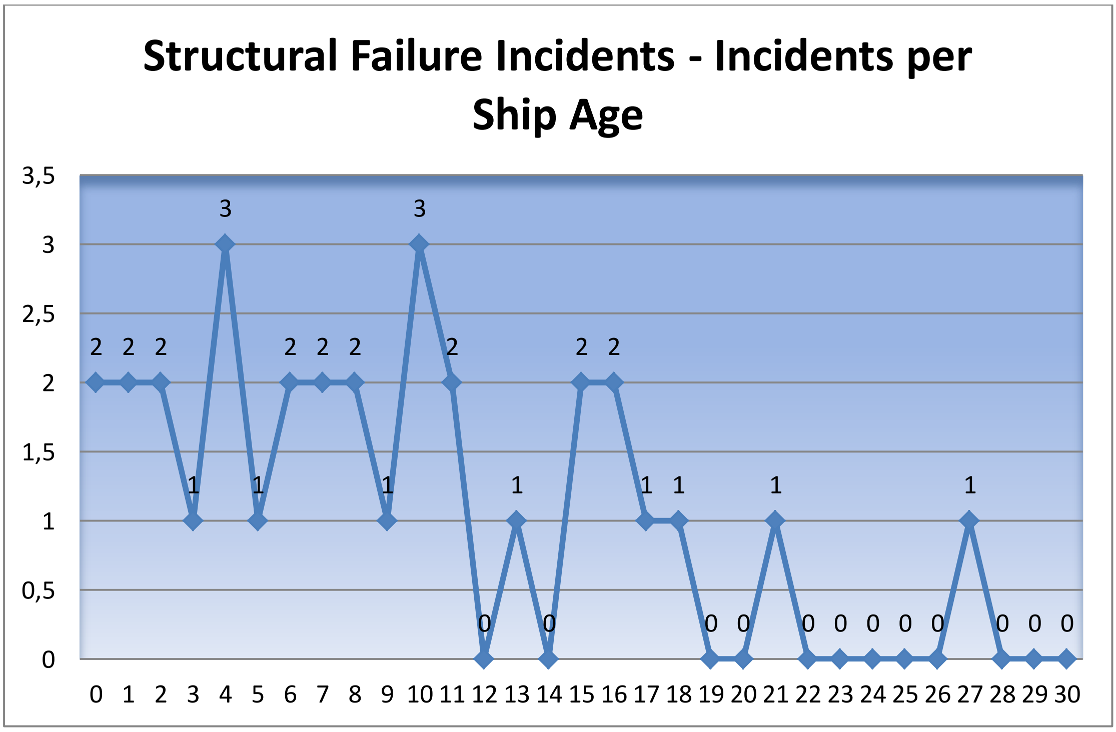


4.8.3 FREQUENCIES OF STRUCTURAL FAILURE ACCIDENTS

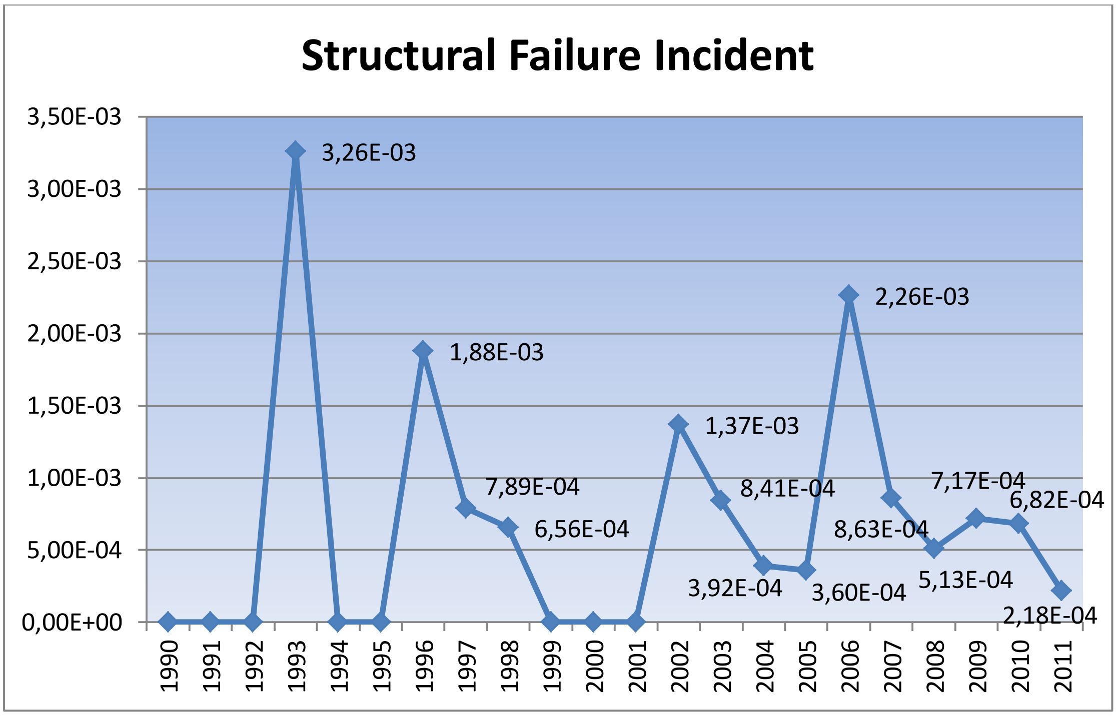


No fluctuation is observed on structural failure incidents, especially since maximum number of incidents per built year is low (3).



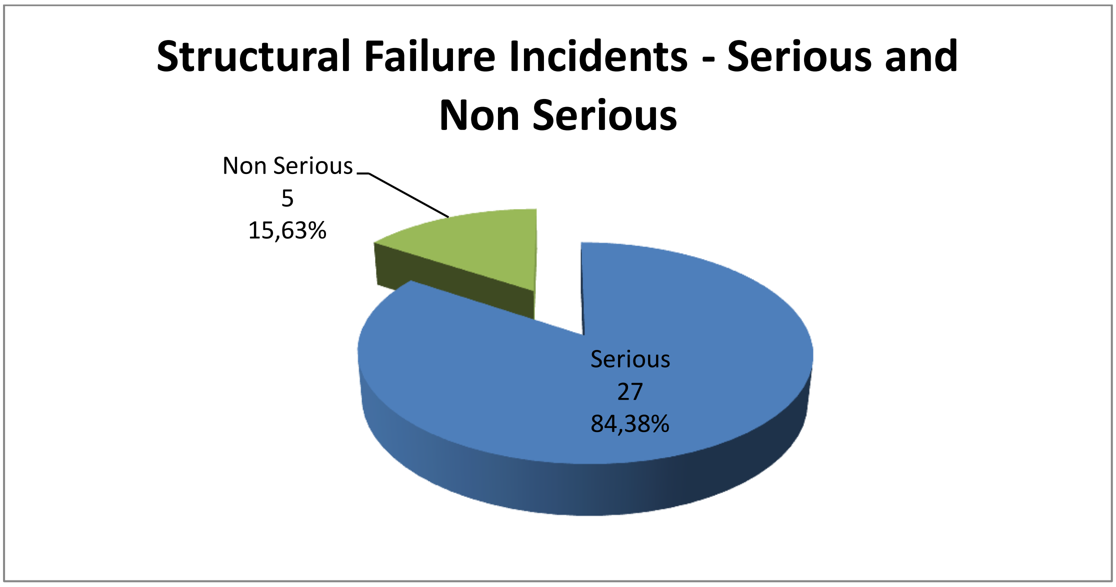


A small increase appears to exist on incidents per year. As in previous categories, accidents tend to occur in the first decade of activation.

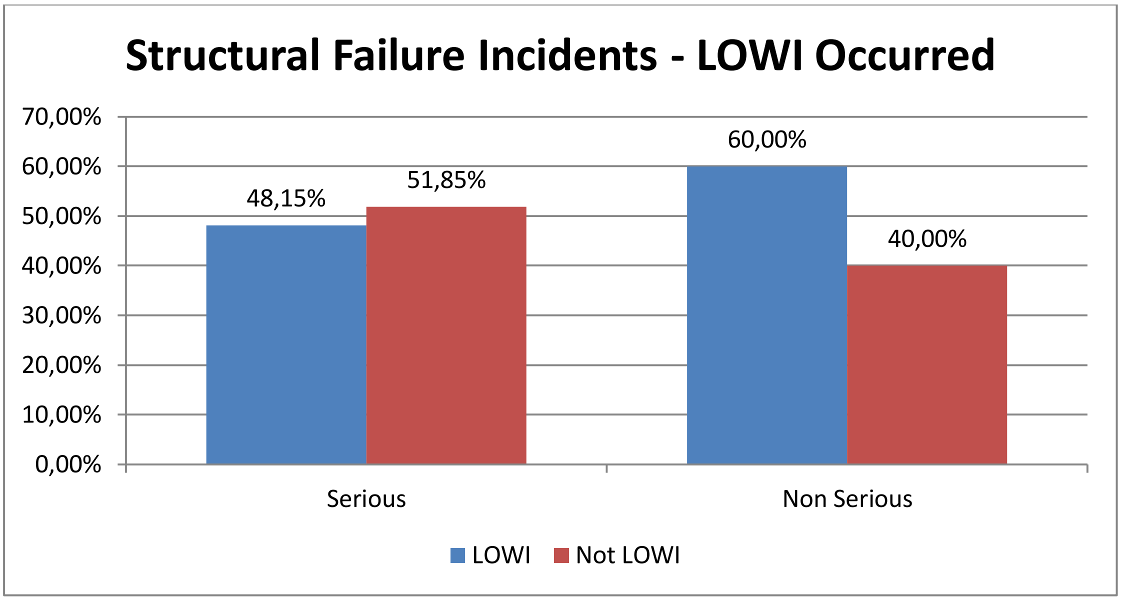


If the number of the active fleet is taken in mind, the overall frequency per year seems to considerably decrease.

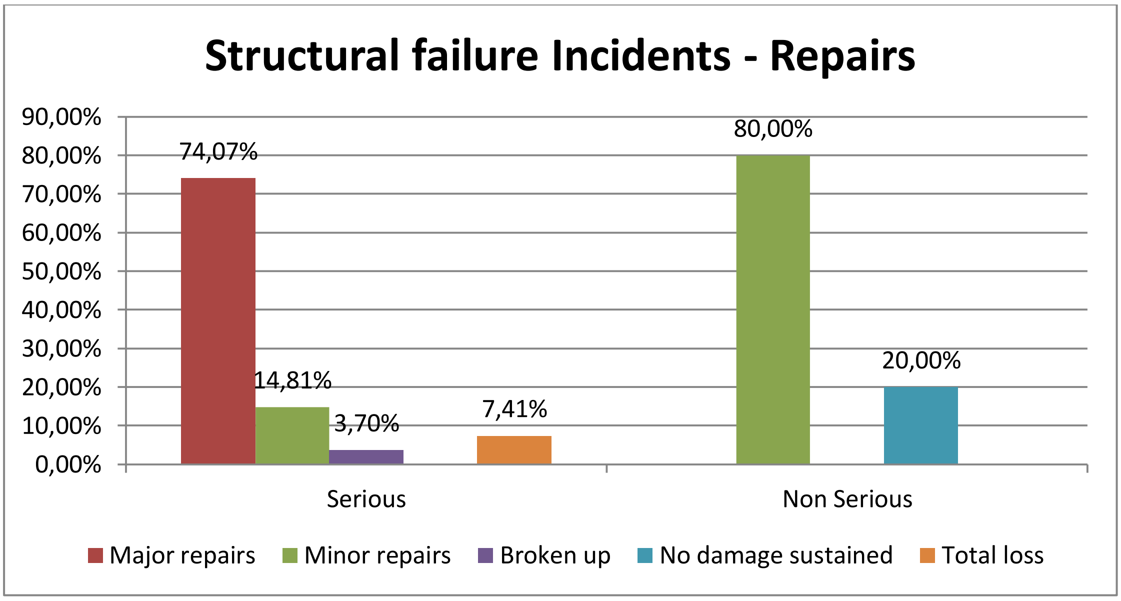
4.8.4 COMPARISON OF SERIOUS AND NON-SERIOUS ACCIDENTS



Serious accidents occur five times more frequently than non- serious. The fact that in some occasions accidents involve release of oil or polluting cargo contributes to this result.

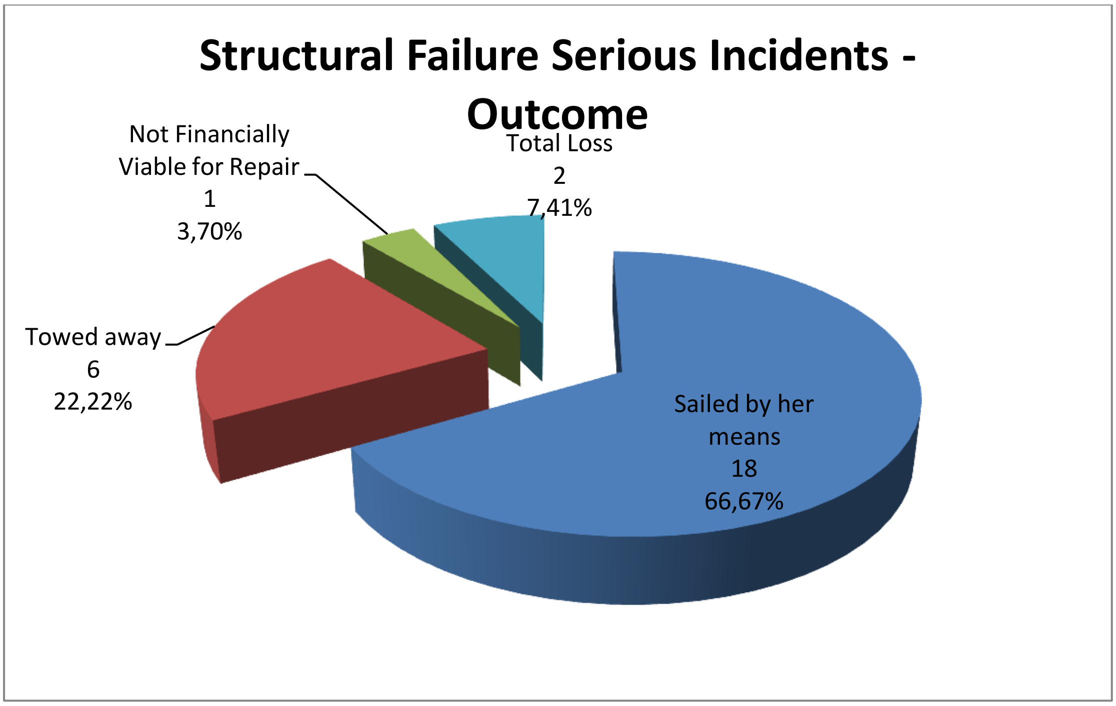


Both cases involve a large amount of LOWI occurred. In fact, it is strangely observed that in non-serious accidents the percentage of LOWI is greater than in serious accidents. However, if we take in mind that 60% on non-serious represents 3 accidents, when 48.15% on serious represents 13 accidents, it is obvious that in absolute numbers serious accidents involve LOWI more often.



This fact is reinforced by the above chart, where non-serious accidents require only minor repairs or no damage has been sustained, when on the other hand 74% of serious accidents required major repairs.

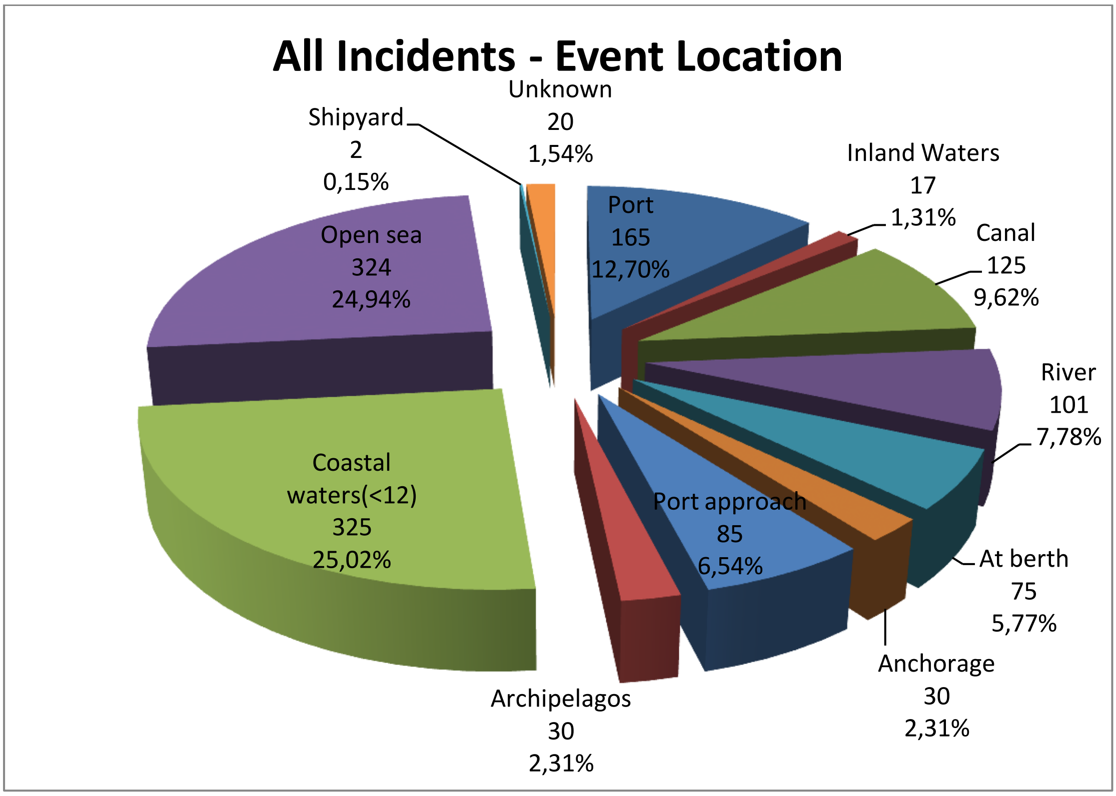
The following chart shows the outcome for serious accidents, because all ships involved in non-serious accidents sailed by their means. Overall, it is safe to come to a conclusion that most ships sailed by their means after a structural failure.



4.9 ALL INCIDENTS

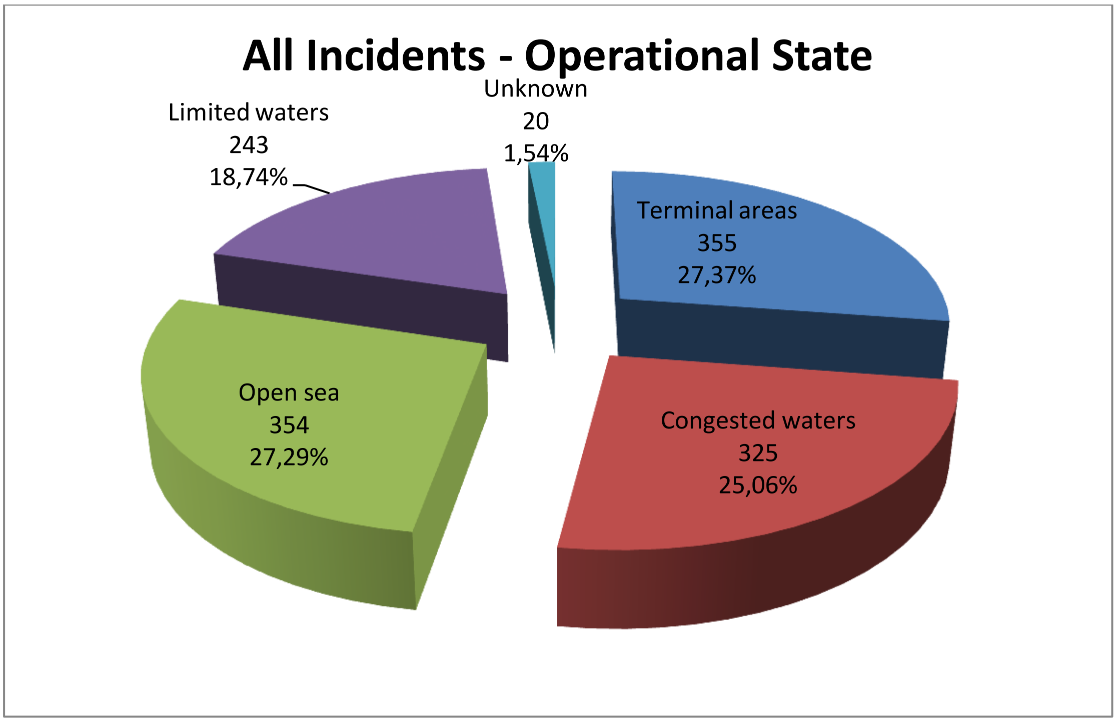
4.9.1 CONDITIONS OF ACCIDENTS

Event Location



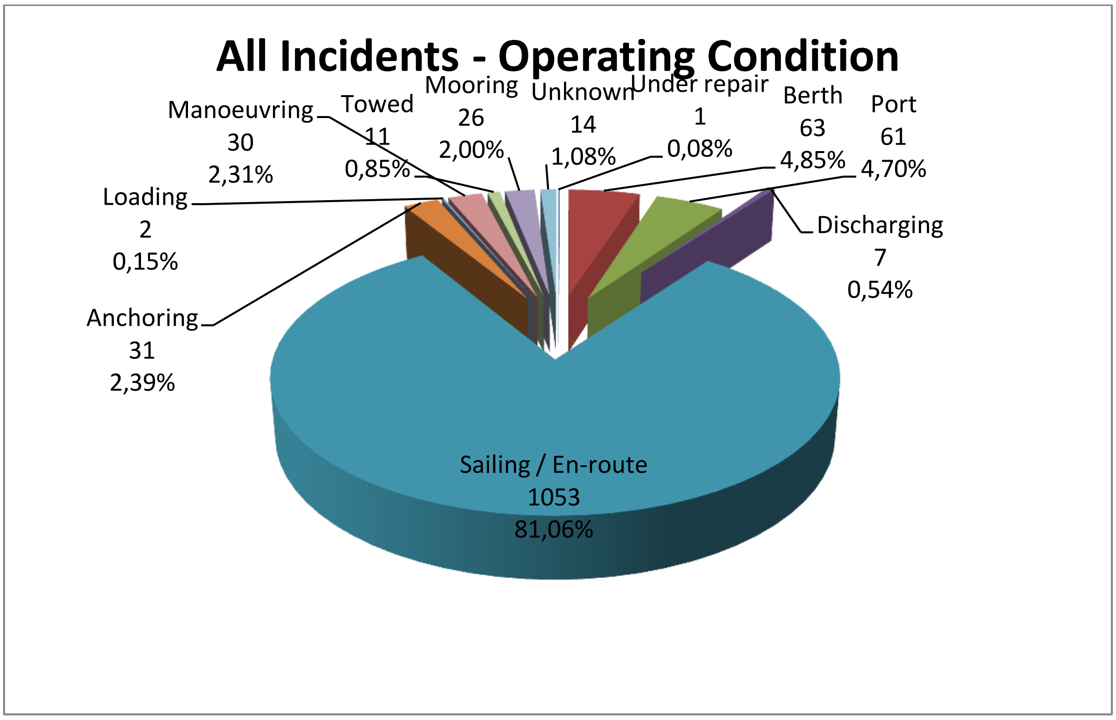
The majority of accidents occur at open sea or coastal waters, 24.94% and 25.02% respectively.

Operational State



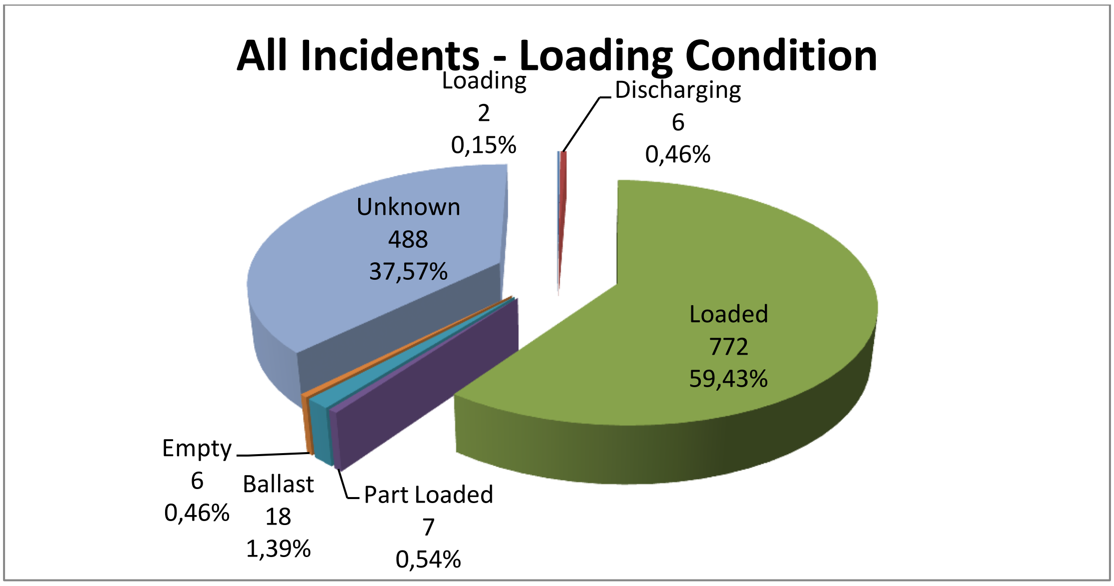
All incidents are almost equally divided in 4 operational states. No safe conclusion can be drawn from this chart.

Operating Condition



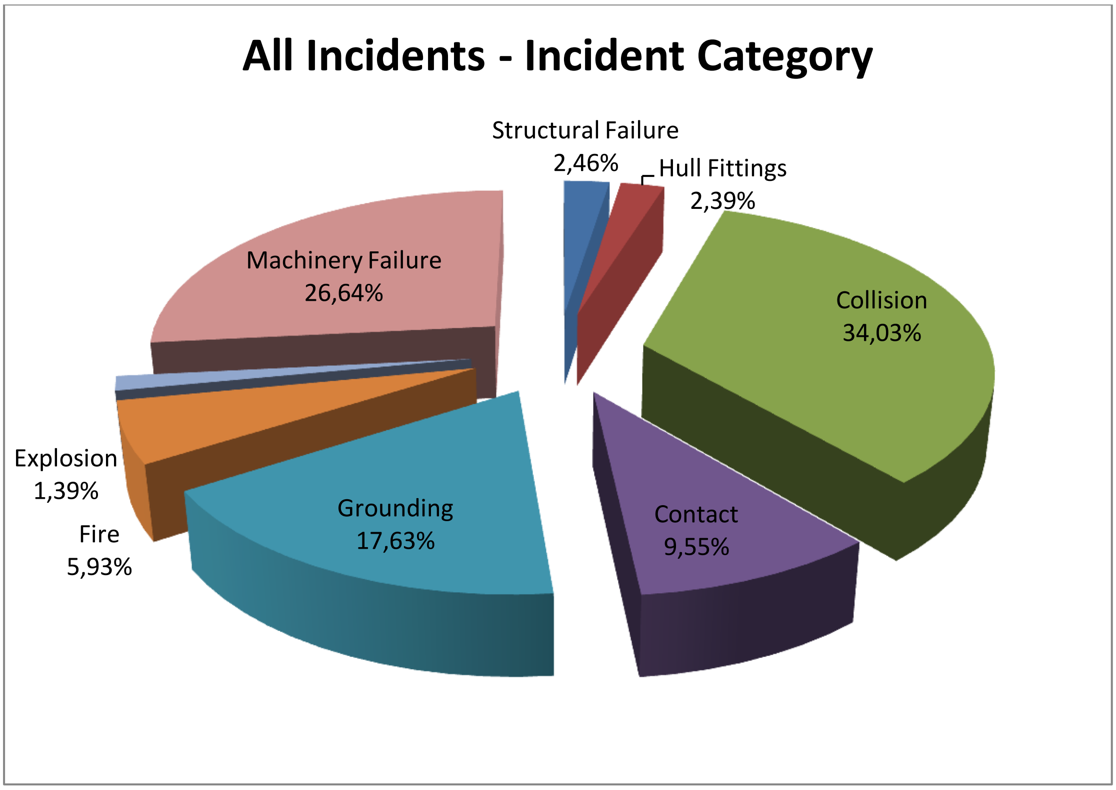
Proportion of incidents that occur during voyages is significantly greater than all other operating conditions.

Loading Conditions

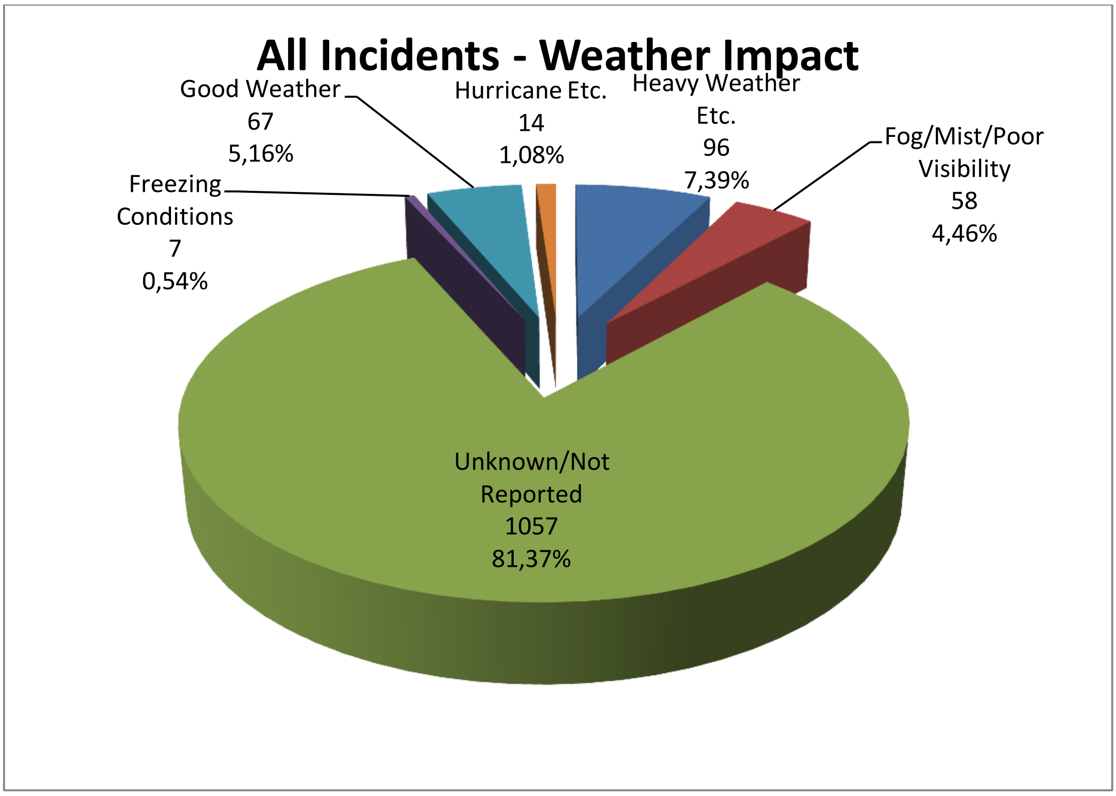


More than half the vessels investigated were loaded at the time of the incident.

Incident Category



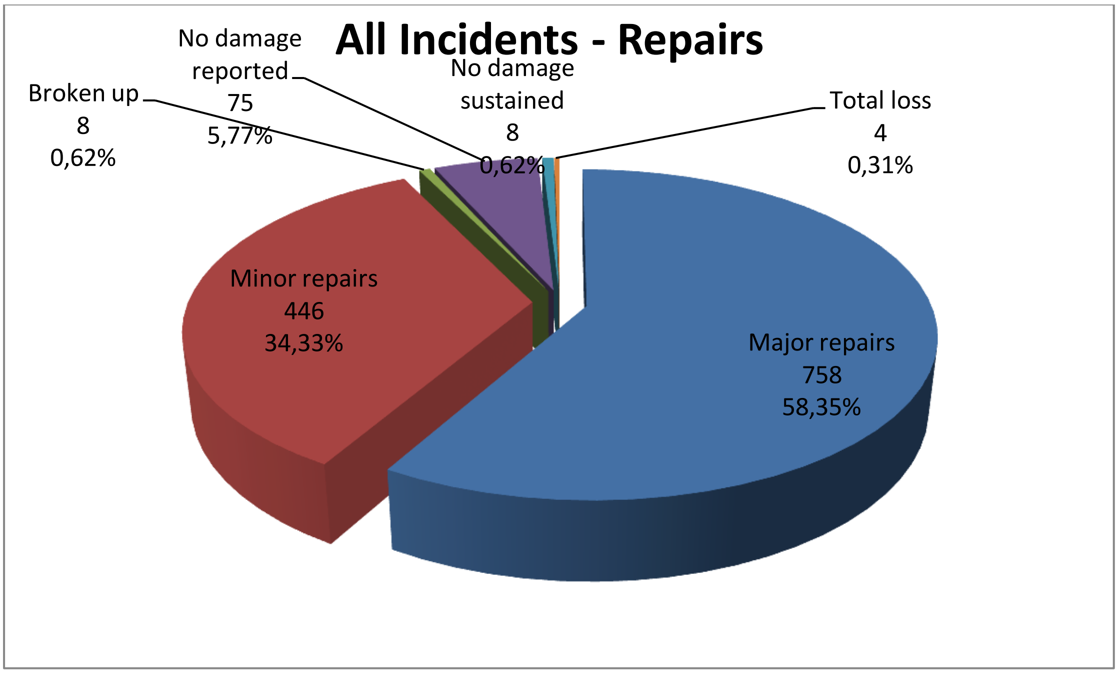
Weather Impact



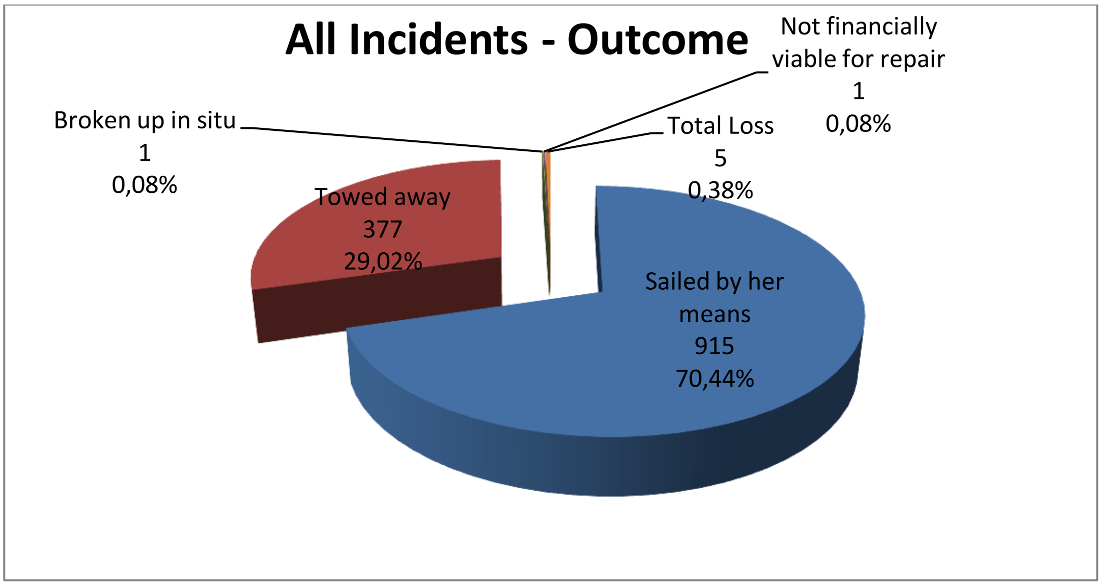
There is a significant absence of weather condition's information.

4.9.2 CONSEQUENCES OF ACCIDENTS

Repairs

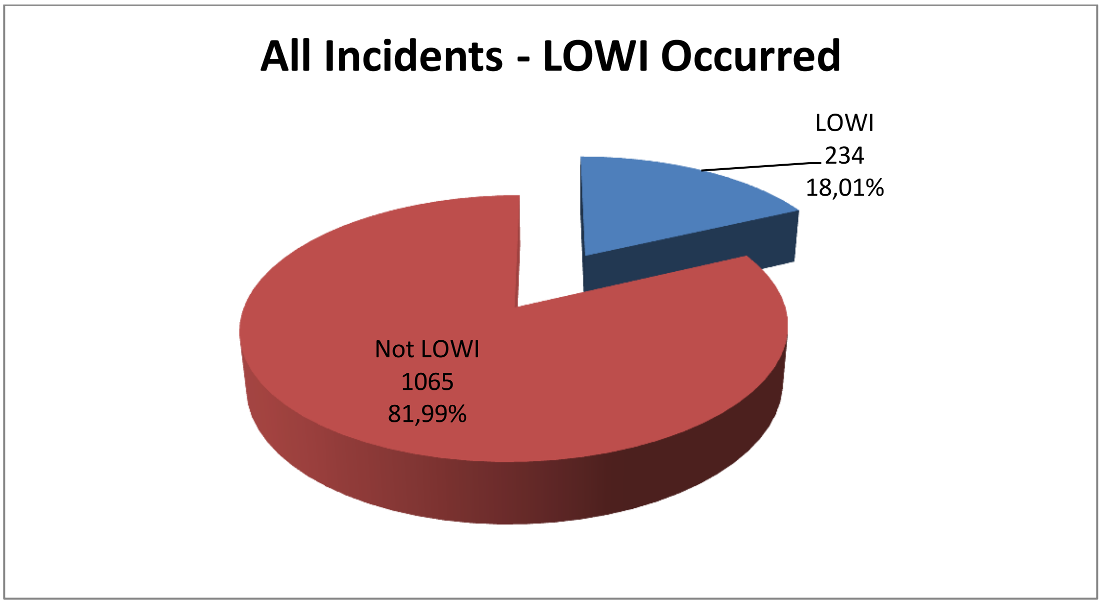


Outcome



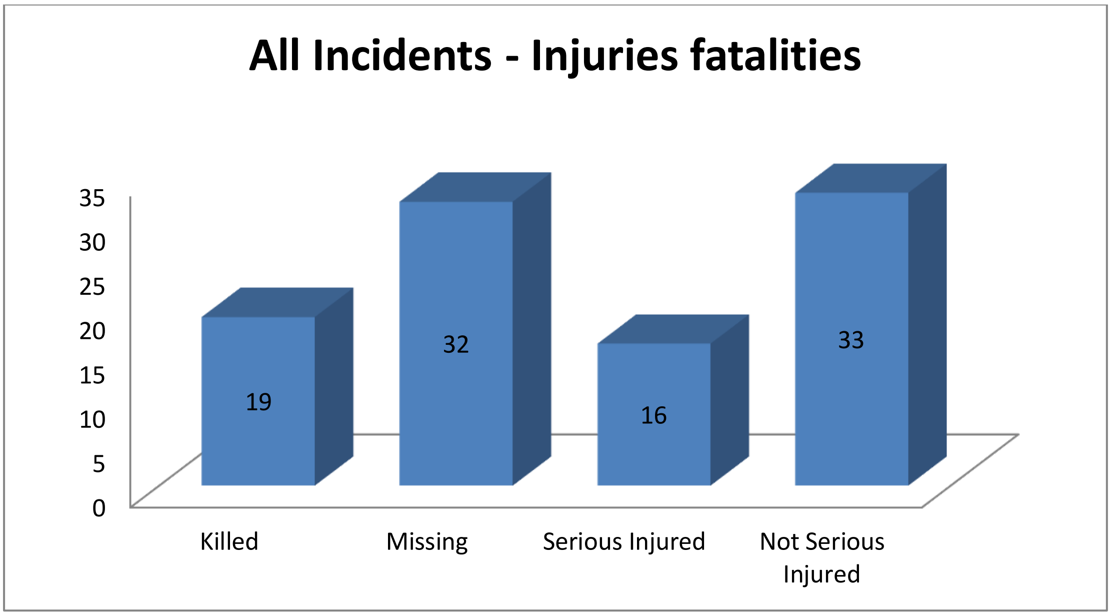
Although more ships required major than minor repairs, most of them were able to sail by their means for the necessary repairs.

LOss of Water Integrity (LOWI)



The rate of vessels with an intact water integrity after the accident is much greater than those with a LOWI occurred.

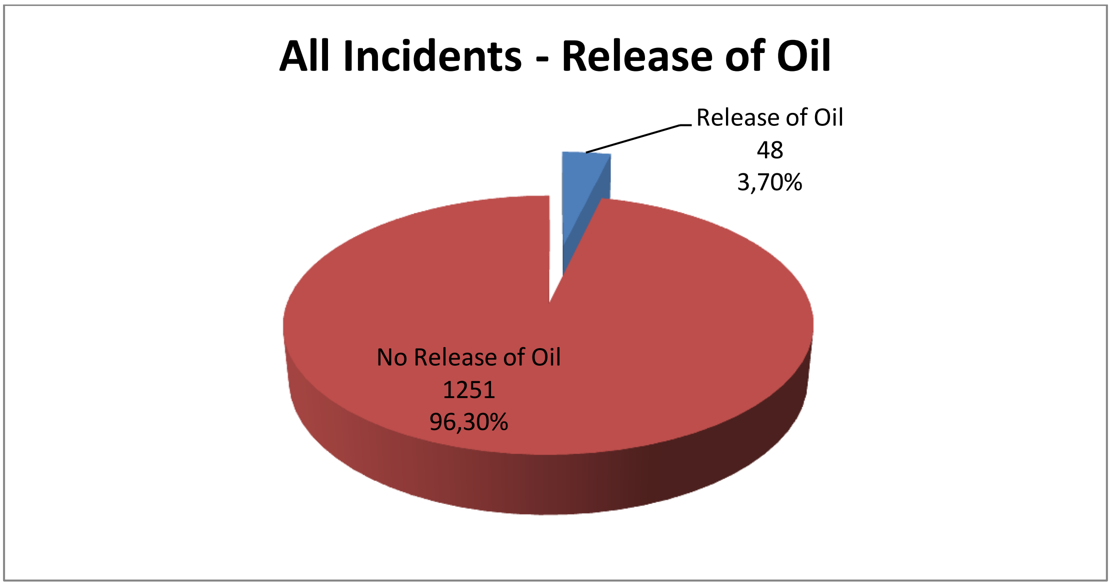
Injuries/ Fatalities



Loss of Payload

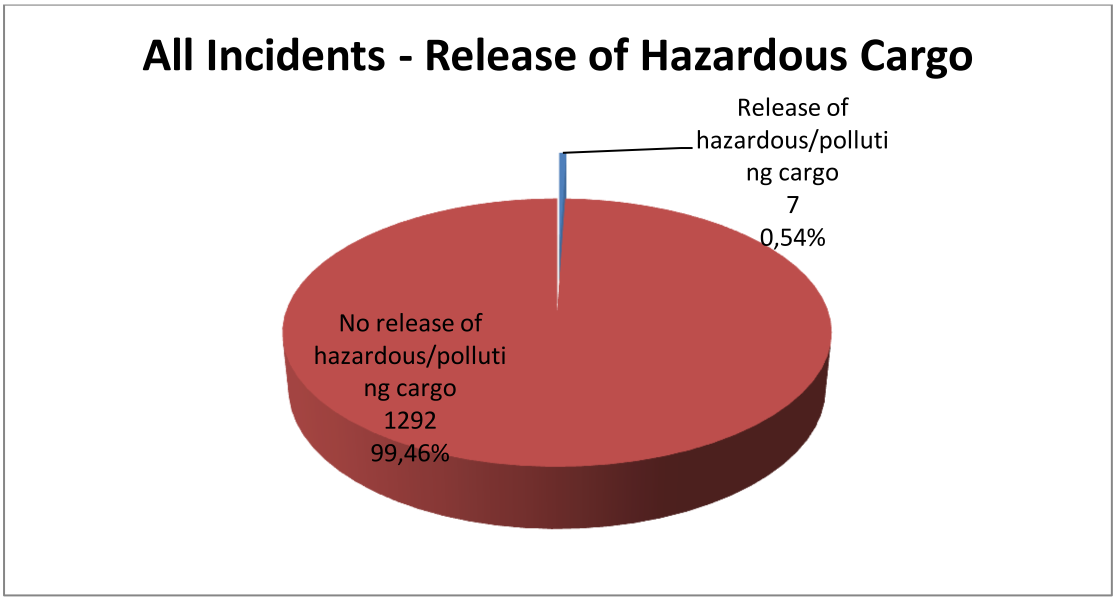
1914 TEUs were lost in 34 accidents.

Release of Oil

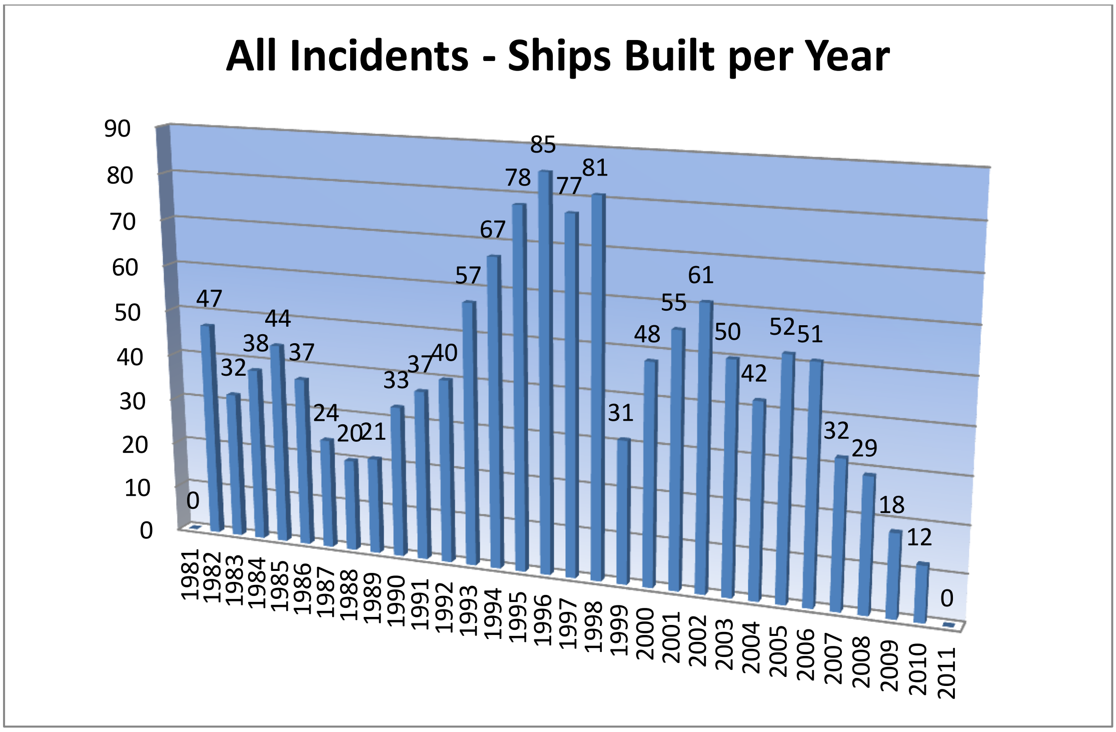


An amount of 3598 tonnes of oil has been verified to be released during the investigated accidents.

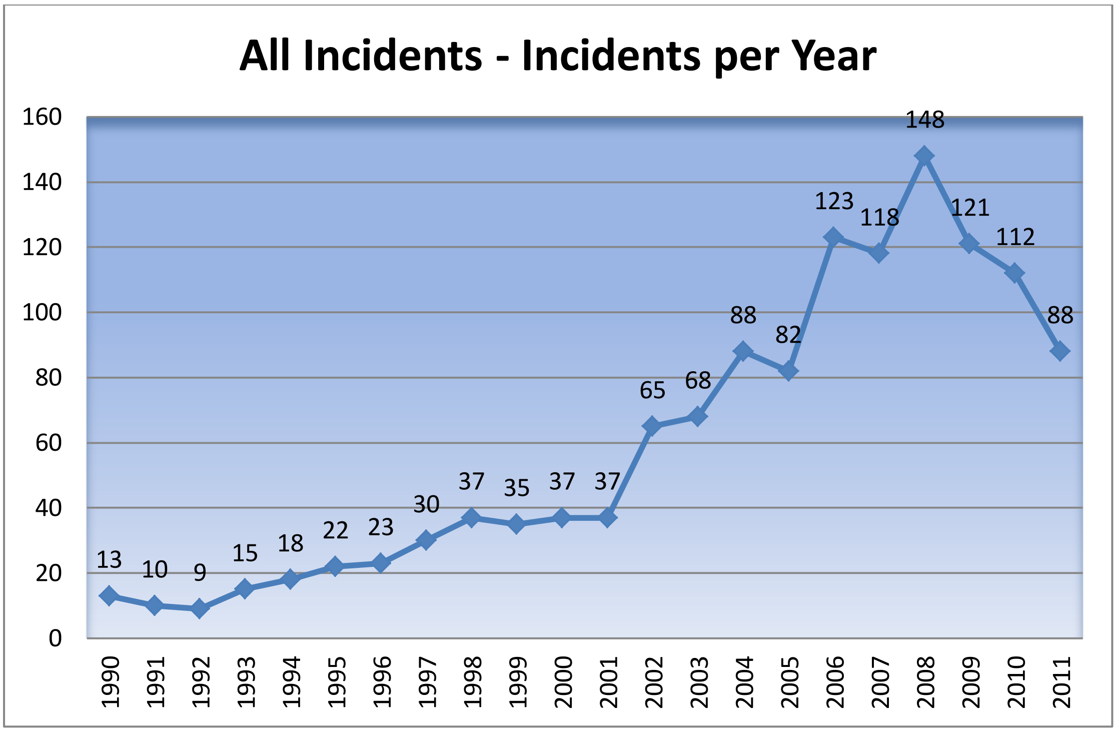
Release of hazardous Cargo



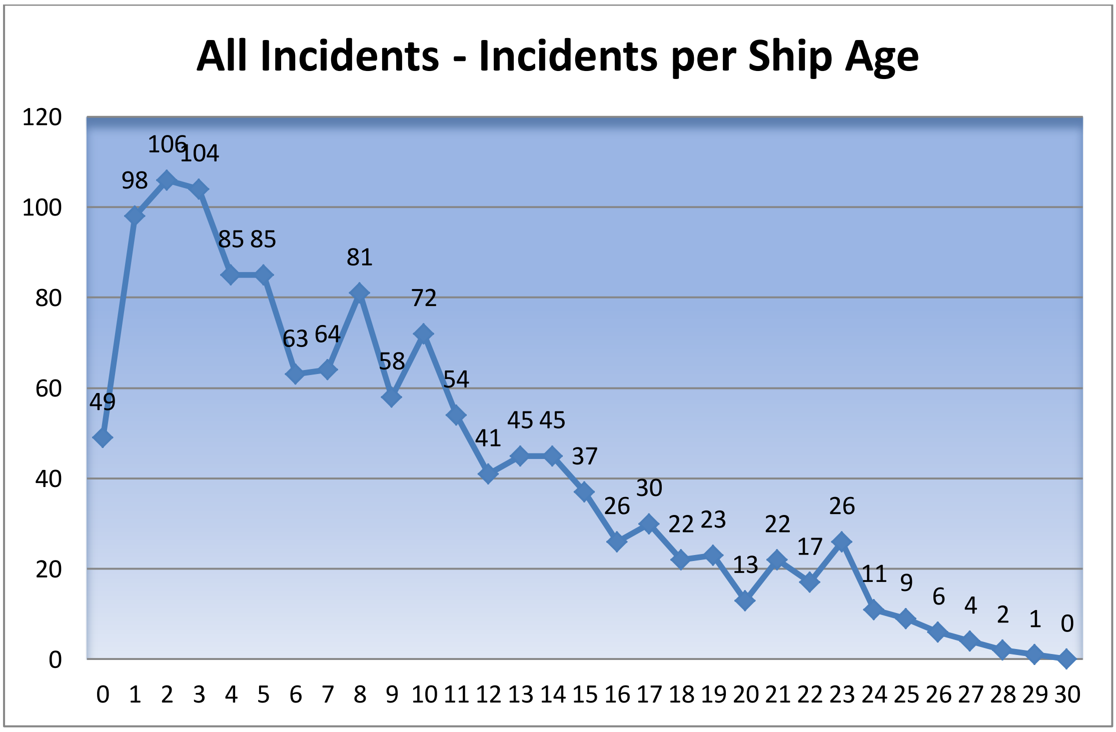
4.9.3 FREQUENCIES OF ACCIDENTS

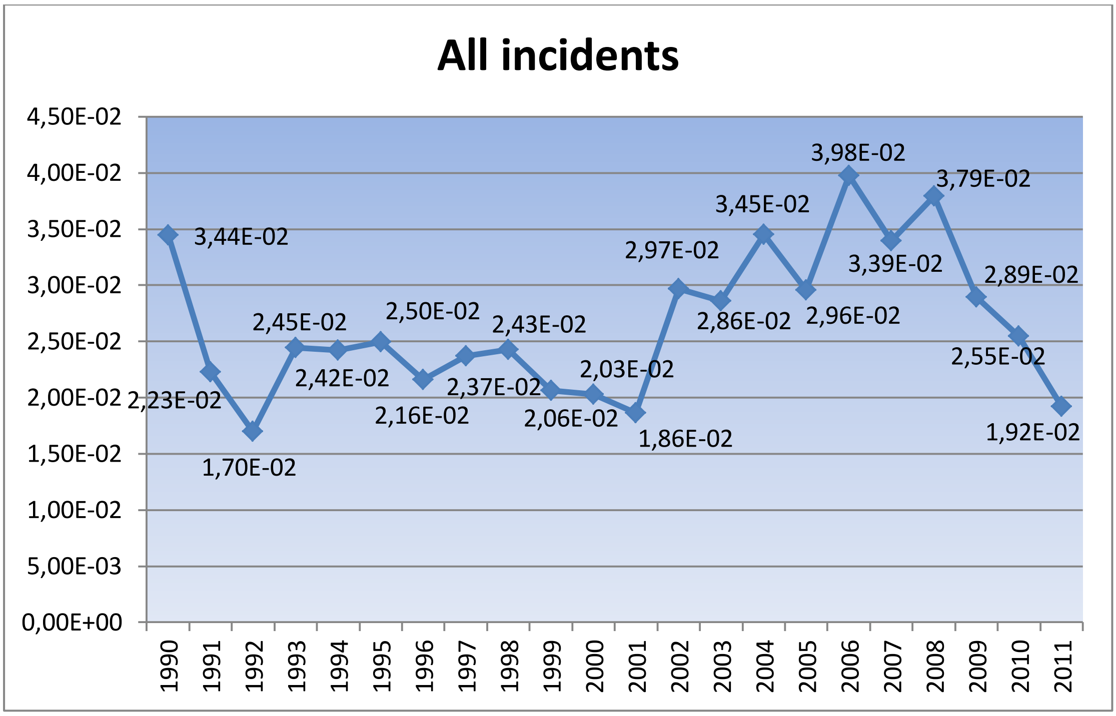


The majority of ships were built in period 1993- 1998.



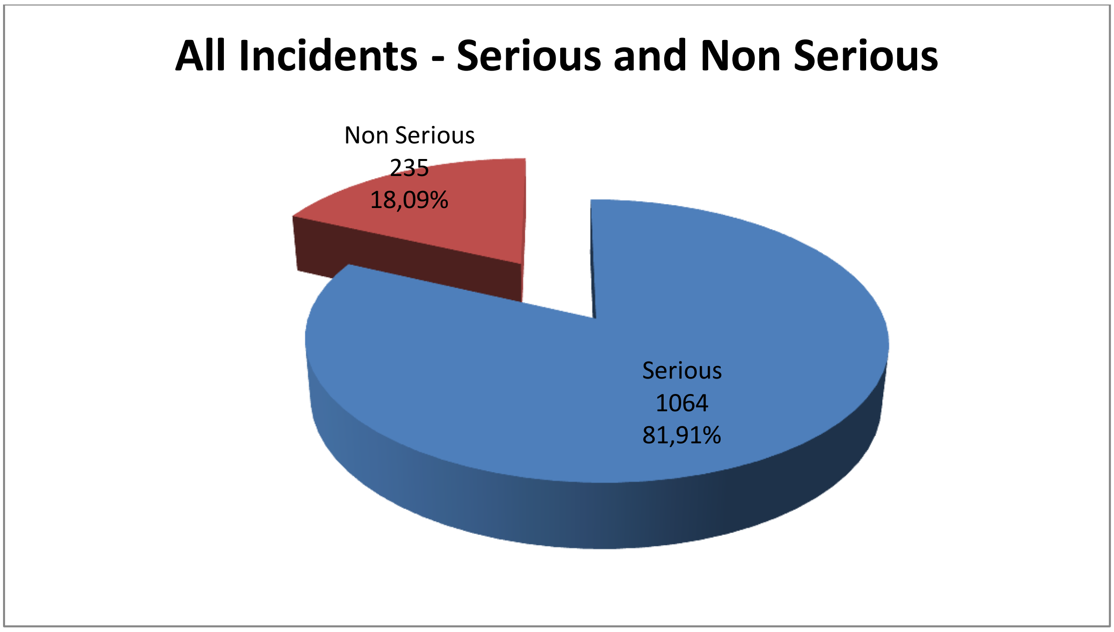
As years go by, more accidents occur during each year until 2008. From 2009 there is a rapid decrease of accidents' number.

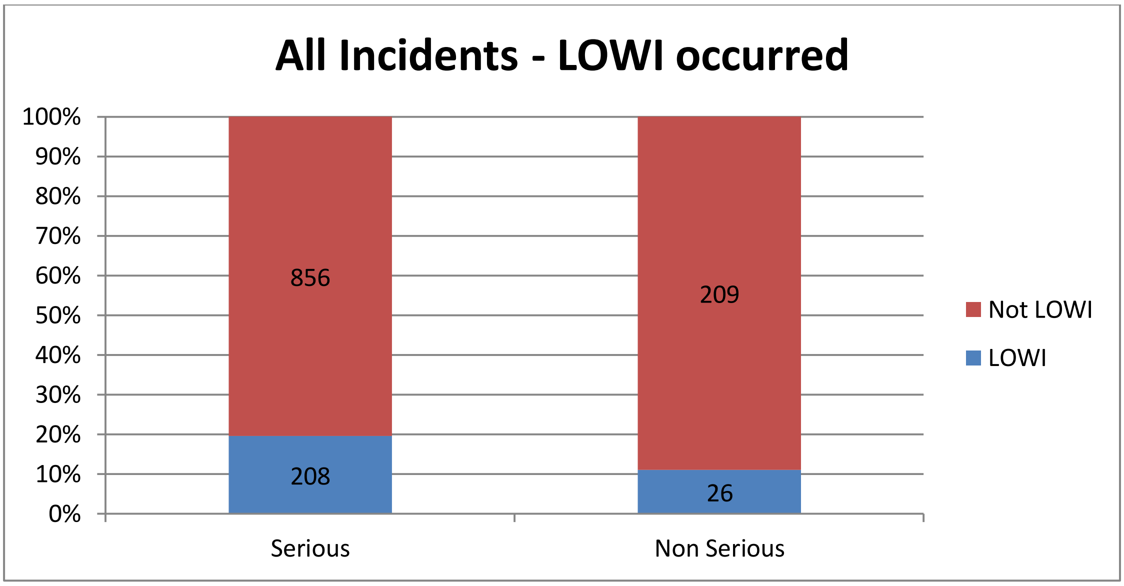




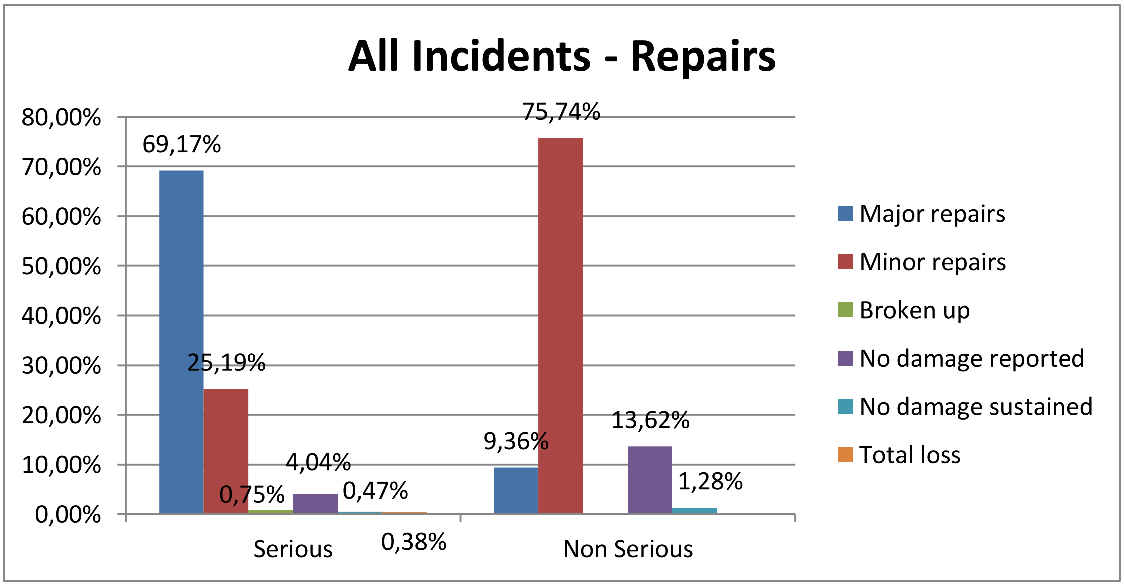
Overall, accidents' average rate for the period of 1991- 2001 is much smaller than the one for the period of 2002- 2011 (2,20E-02 and 3,07E-02 respectively). Nevertheless it is important to be noted that 2001's rate is at the levels of 2001 and almost at all times' lowest.

4.9.4 COMPARISON OF SERIOUS AND NON-SERIOUS ACCIDENTS

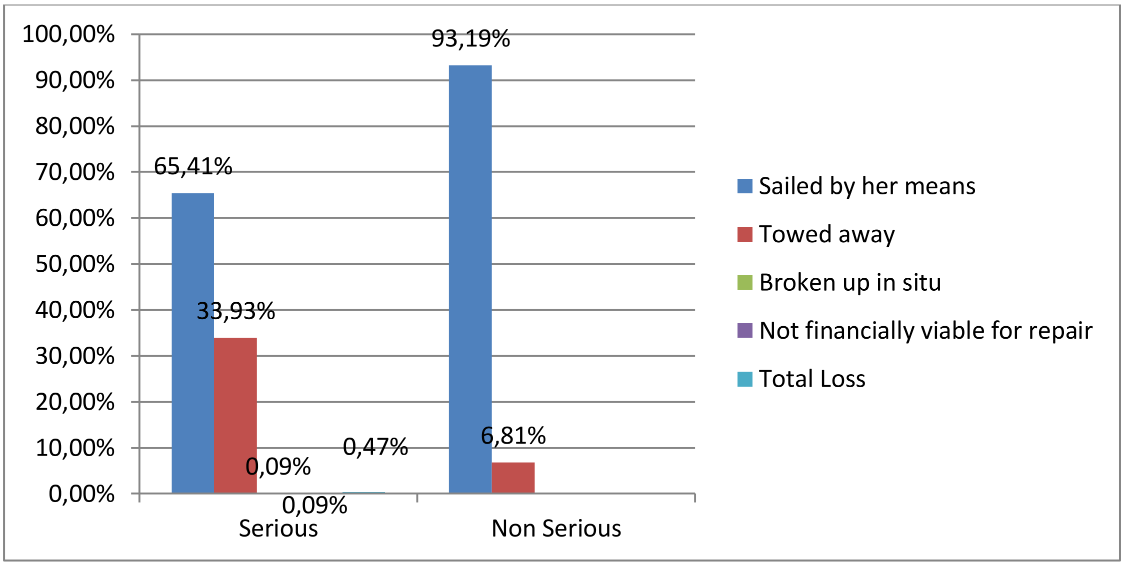




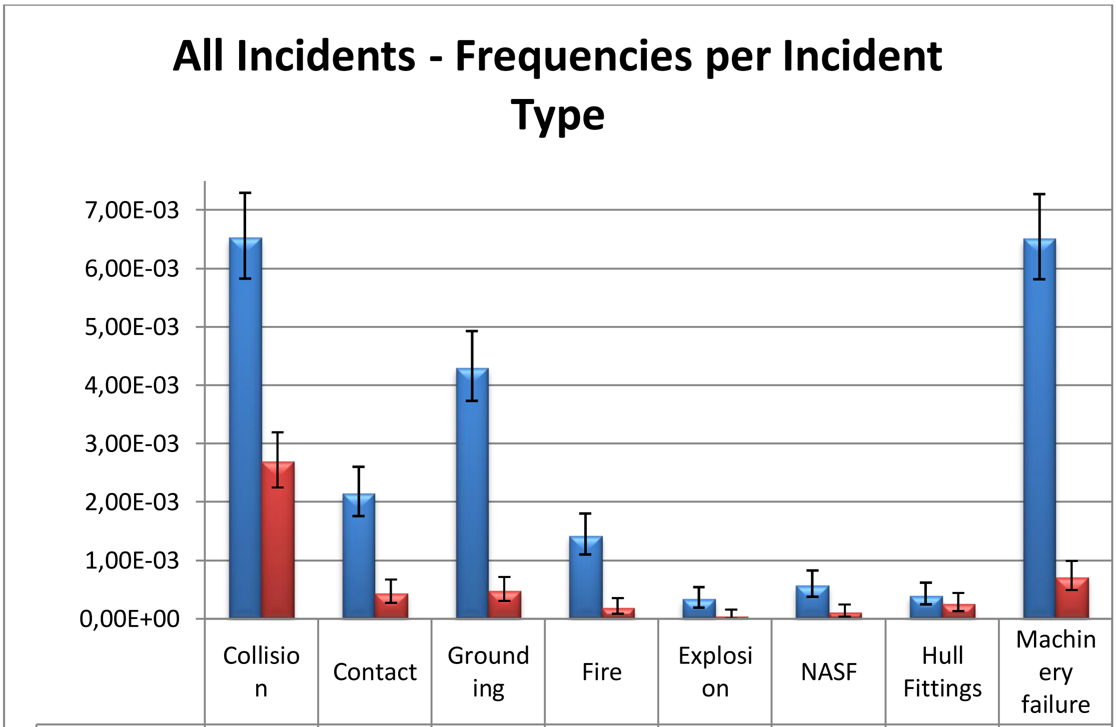
There is small difference in the relationship between LOWI and No LOWI incidents for the two categories.



The repairs needed after an accident indicate the contrast of serious and non-serious accidents.

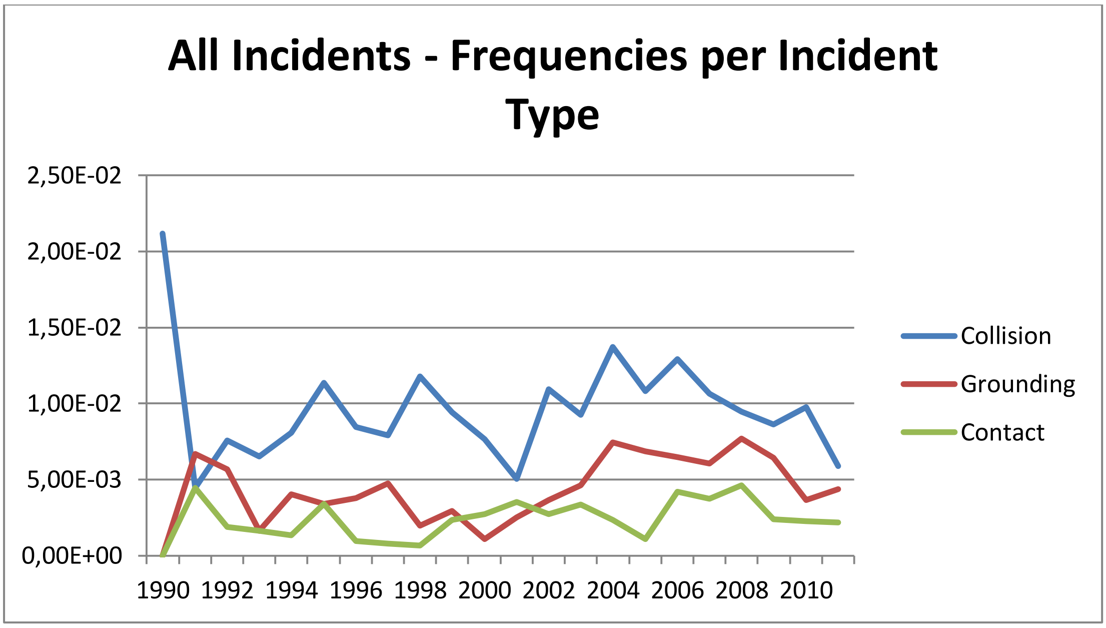


Almost all ships involved on any type of accident sailed by their means, whether it was a serious accident or not.

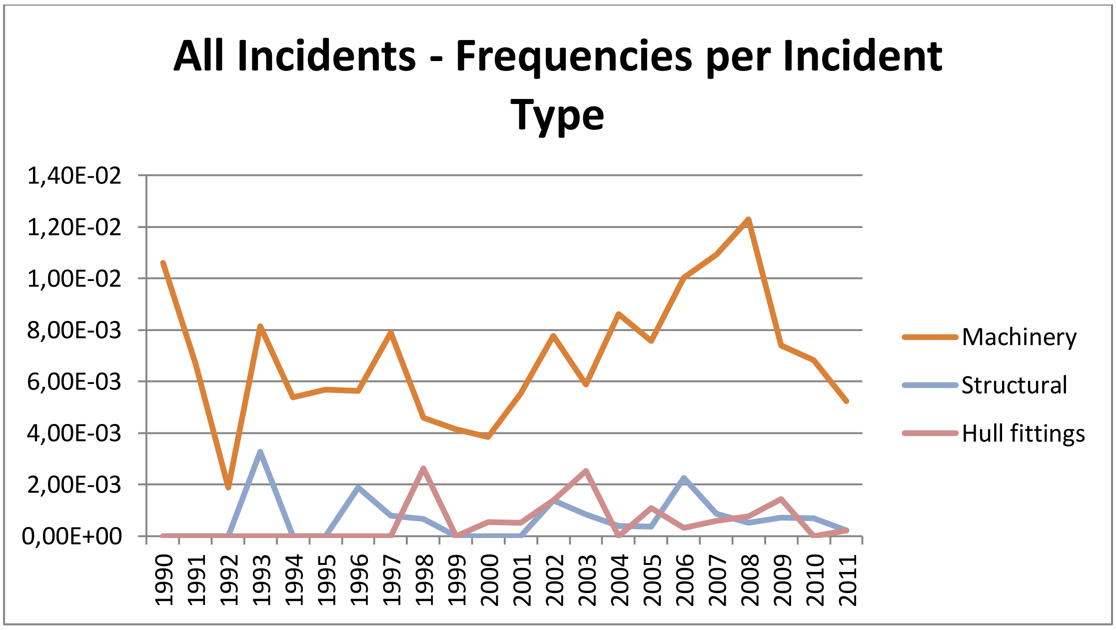


	Collision	Contact	Grounding	Fire	Explosion	NASF	Hull Fittings	Machinery failure
Serious	6,53E-03	2,15E-03	4,30E-03	1,42E-03	3,34E-04	5,63E-04	3,96E-04	6,51E-03
Non-serious	2,69E-03	4,38E-04	4,80E-04	1,88E-04	4,17E-05	1,04E-04	2,50E-04	7,09E-04

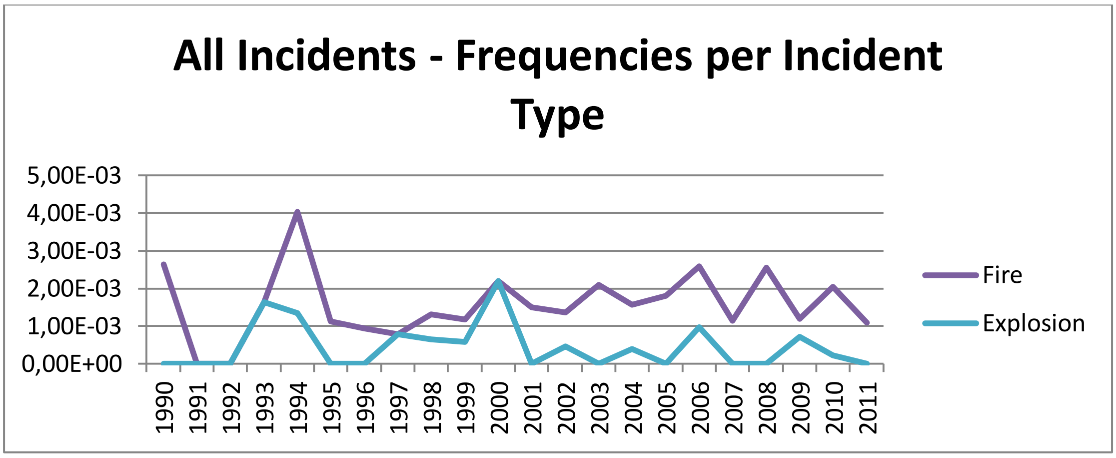
Confidence intervals are presented on the basis of binomial confidence analysis and are calculated as 95% confidence intervals, corresponding to the 95% probability that certain values will be met.



Collision incidents tend to occur more often than any other type of incident every year. This may be, because collision incidents involve at least two vessels and the factor of human error is doubled compared to grounding and contact incidents.



Machinery failure is expected to take place more frequently, since it involves a lot of equipment that are in use almost anytime, if not always. Structural and hull fittings failure incidents' frequency all over the years are similar and extremely lower than previous mentioned categories.



Explosion incidents are rarer than fire incidents. The frequency for both types is low, however- as it can be seen in relevant chapter- the injuries and fatalities from these incidents are considerably common.

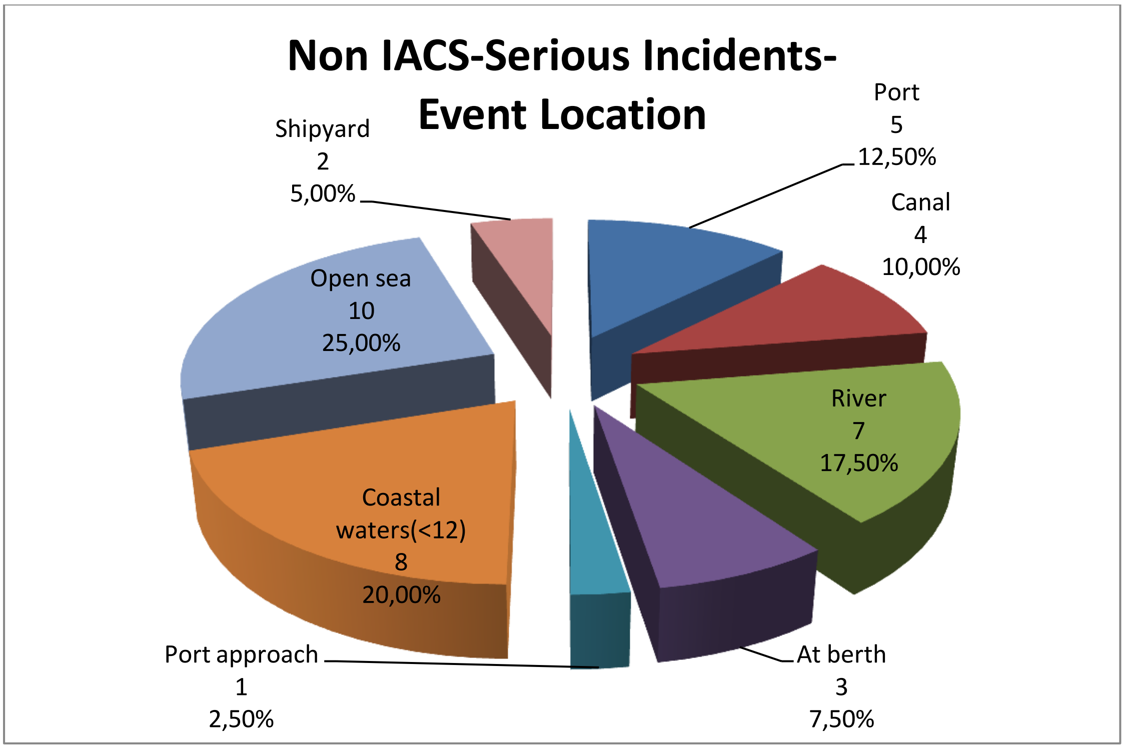
Frequencies	Collision	Grounding	Contact	Fire	Explosion	Machinery	Structural	Hull fittings
1990	2,12E-02	0,00E+00	0,00E+00	2,65E-03	0,00E+00	1,06E-02	0,00E+00	0,00E+00
1991	4,45E-03	6,68E-03	4,45E-03	0,00E+00	0,00E+00	6,68E-03	0,00E+00	0,00E+00
1992	7,55E-03	5,66E-03	1,89E-03	0,00E+00	0,00E+00	1,89E-03	0,00E+00	0,00E+00
1993	6,52E-03	1,63E-03	1,63E-03	1,63E-03	1,63E-03	8,15E-03	3,26E-03	0,00E+00
1994	8,08E-03	4,04E-03	1,35E-03	4,04E-03	1,35E-03	5,38E-03	0,00E+00	0,00E+00
1995	1,13E-02	3,40E-03	3,40E-03	1,13E-03	0,00E+00	5,67E-03	0,00E+00	0,00E+00
1996	8,46E-03	3,76E-03	9,40E-04	9,40E-04	0,00E+00	5,64E-03	1,88E-03	0,00E+00
1997	7,89E-03	4,74E-03	7,89E-04	7,89E-04	7,89E-04	7,89E-03	7,89E-04	0,00E+00
1998	1,18E-02	1,97E-03	6,56E-04	1,31E-03	6,56E-04	4,59E-03	6,56E-04	2,62E-03
1999	9,44E-03	2,95E-03	2,36E-03	1,18E-03	5,90E-04	4,13E-03	0,00E+00	0,00E+00
2000	7,67E-03	1,10E-03	2,74E-03	2,19E-03	2,19E-03	3,84E-03	0,00E+00	5,48E-04
2001	5,03E-03	2,51E-03	3,52E-03	1,51E-03	0,00E+00	5,53E-03	0,00E+00	5,03E-04
2002	1,10E-02	3,65E-03	2,74E-03	1,37E-03	4,57E-04	7,76E-03	1,37E-03	1,37E-03
2003	9,25E-03	4,63E-03	3,36E-03	2,10E-03	0,00E+00	5,89E-03	8,41E-04	2,52E-03
2004	1,37E-02	7,45E-03	2,35E-03	1,57E-03	3,92E-04	8,62E-03	3,92E-04	0,00E+00
2005	1,08E-02	6,85E-03	1,08E-03	1,80E-03	0,00E+00	7,57E-03	3,60E-04	1,08E-03
2006	1,29E-02	6,47E-03	4,20E-03	2,59E-03	9,70E-04	1,00E-02	2,26E-03	3,23E-04
2007	1,06E-02	6,04E-03	3,74E-03	1,15E-03	0,00E+00	1,09E-02	8,63E-04	5,75E-04
2008	9,49E-03	7,69E-03	4,61E-03	2,56E-03	0,00E+00	1,23E-02	5,13E-04	7,69E-04
2009	8,60E-03	6,45E-03	2,39E-03	1,20E-03	7,17E-04	7,41E-03	7,17E-04	1,43E-03
2010	9,77E-03	3,64E-03	2,27E-03	2,05E-03	2,27E-04	6,82E-03	6,82E-04	0,00E+00
2011	5,89E-03	4,36E-03	2,18E-03	1,09E-03	0,00E+00	5,23E-03	2,18E-04	2,18E-04

5. ANALYSIS OF NON IACS SHIPS' SERIOUS INCIDENTS

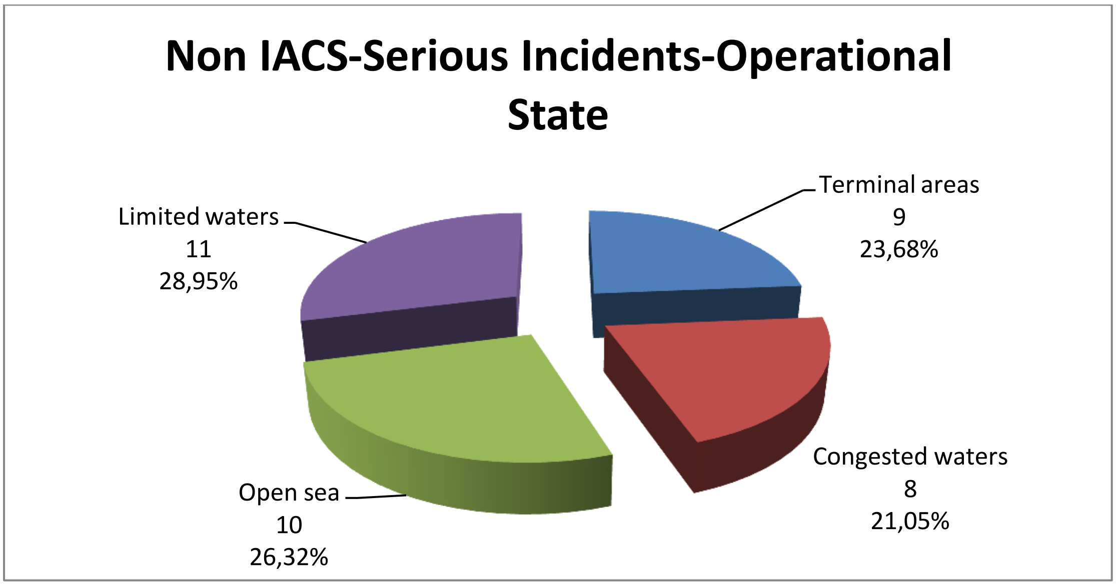
5.1 ALL INCIDENTS

5.1.1 CONDITIONS OF ACCIDENTS

Event Location

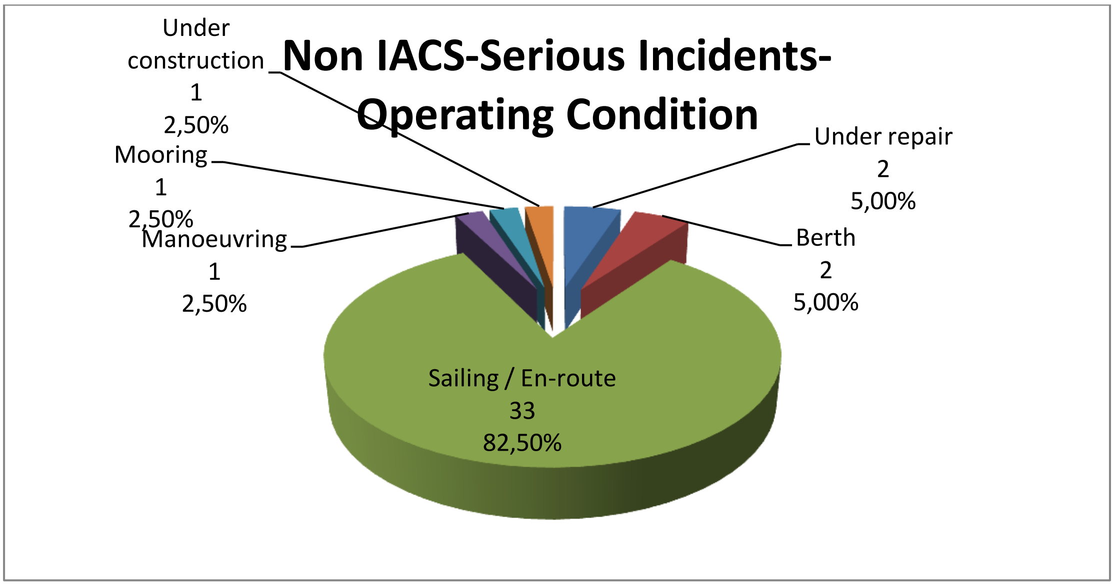


Operational State



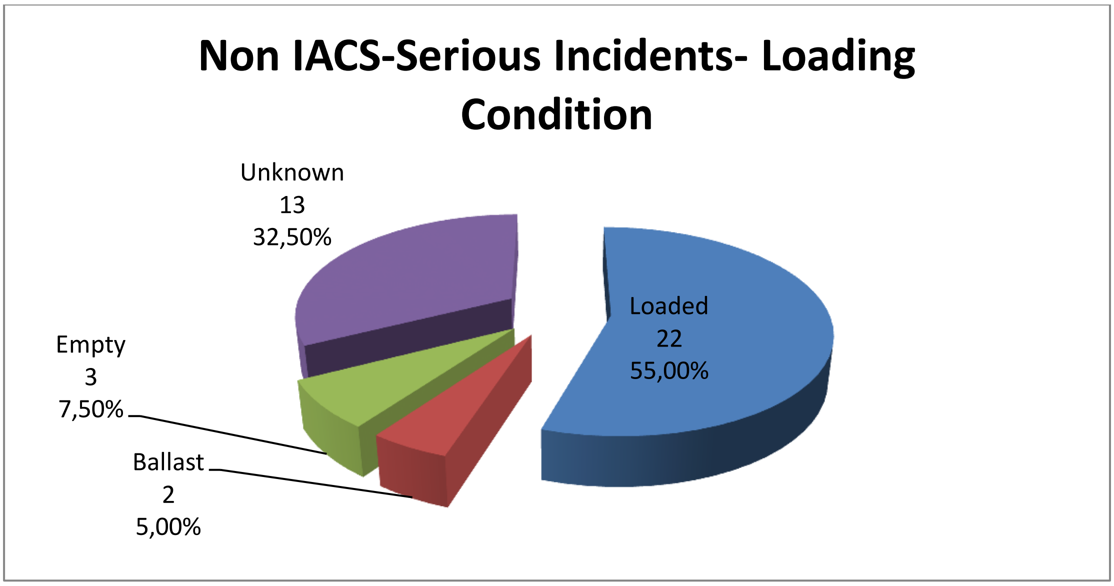
All incidents are almost equally divided in 4 operational states.

Operating Condition



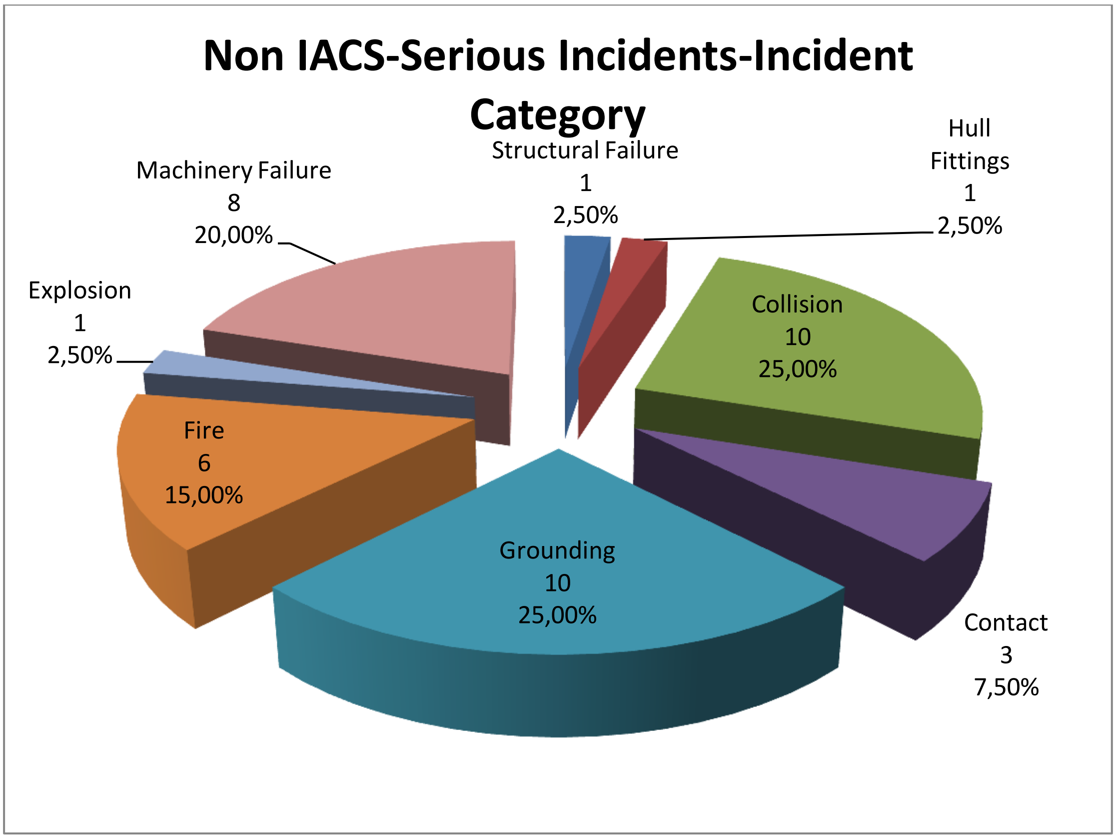
The majority of incidents that occur during voyages is significantly greater than all other operating conditions.

Loading Conditions

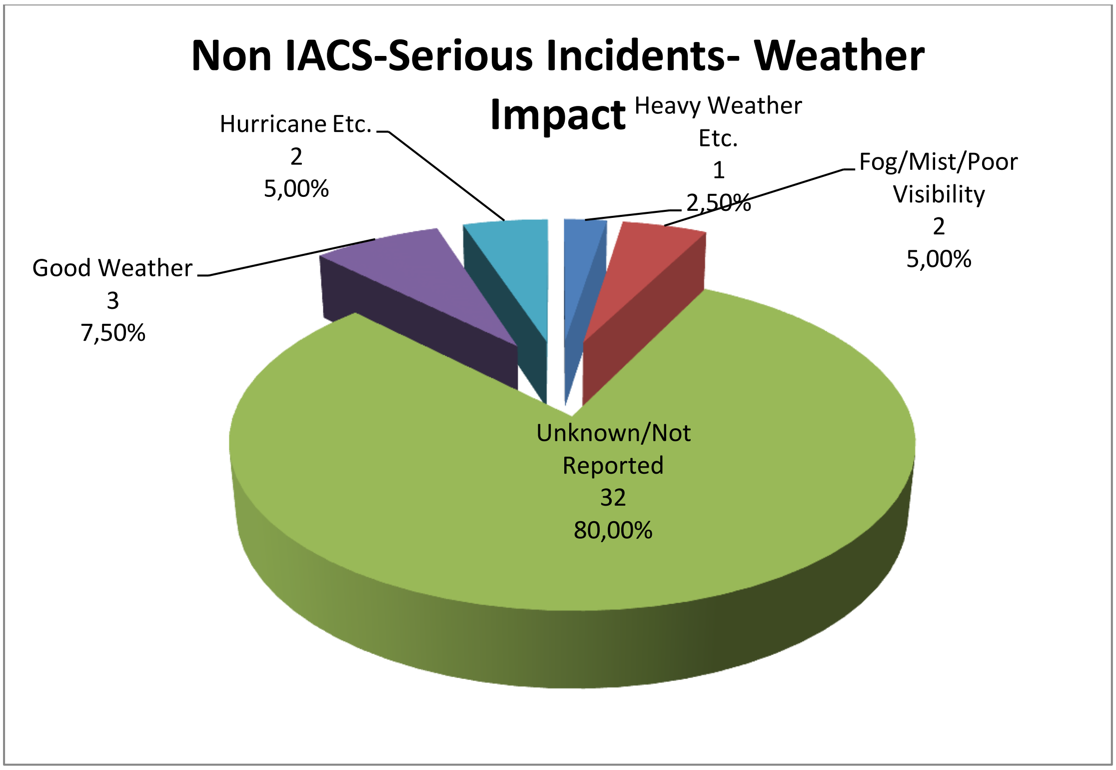


More than half the vessels investigated were loaded at the time of the incident.

Incident Category



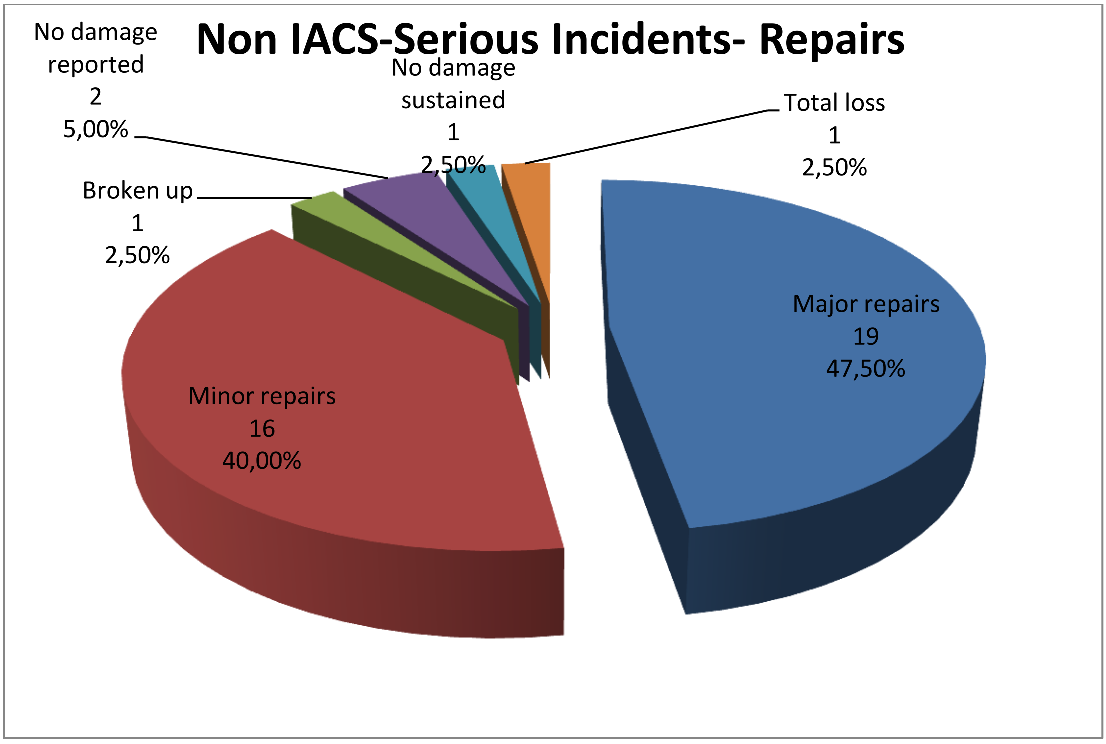
Weather Impact



There is a significant absence of weather condition's information.

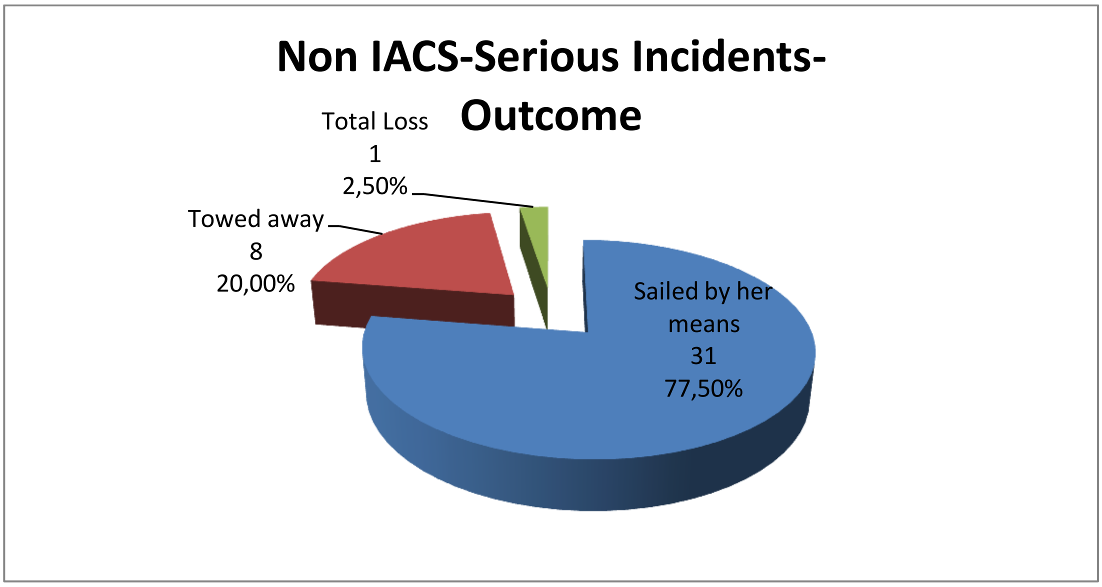
5.1.2 CONSEQUENCES OF ACCIDENTS

Repairs



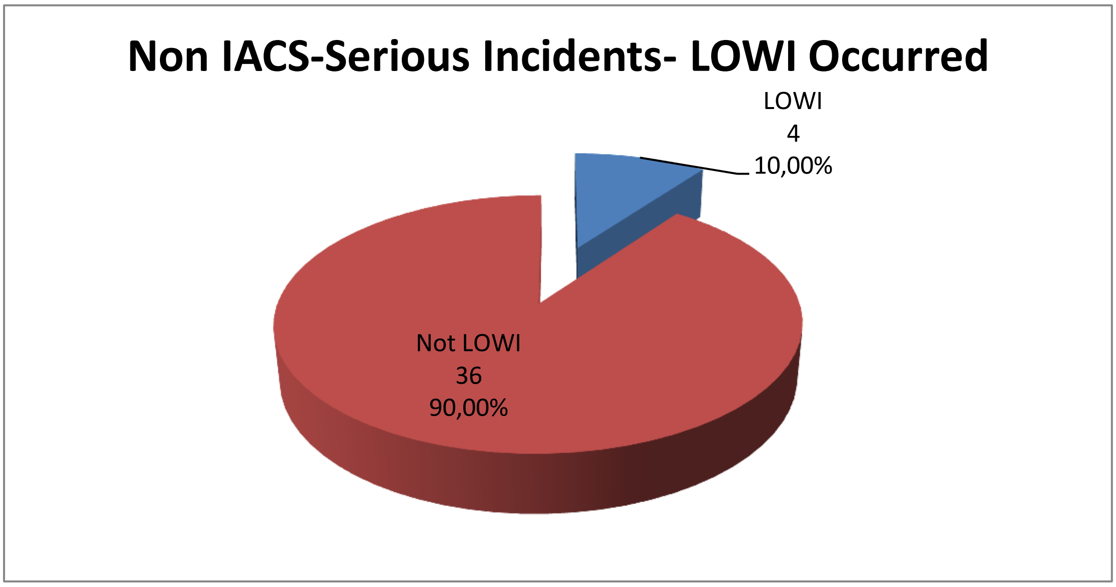
Major repairs were effected on almost half of the incidents.

Outcome



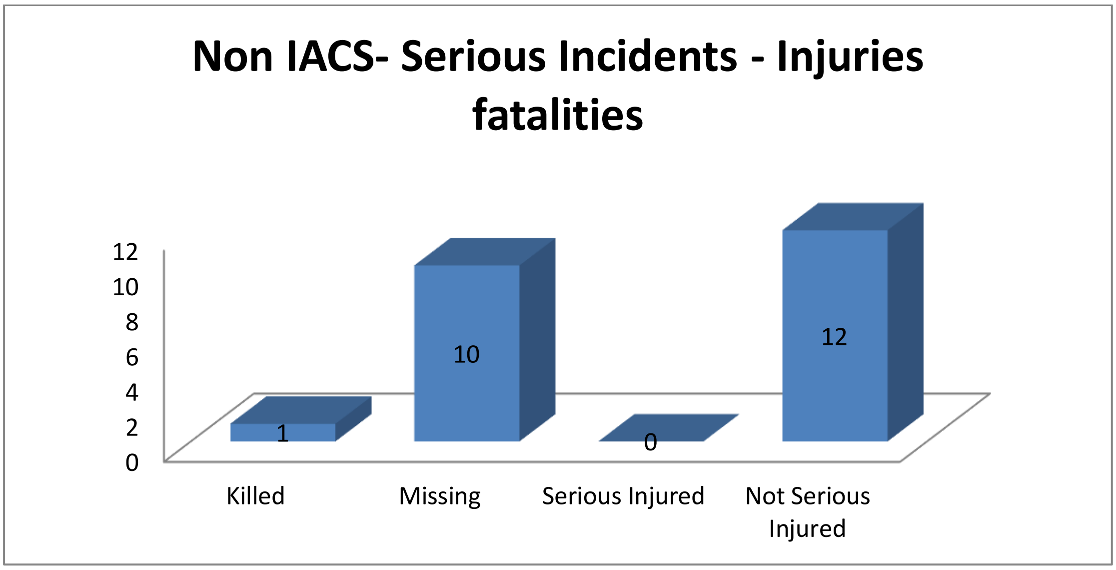
Although more ships required major than minor repairs, most of them were able to sail by their means for the necessary repairs.

LOss of Water Integrity (LOWI)



No LOWI occurred for the majority of accidents.

Injuries/ Fatalities

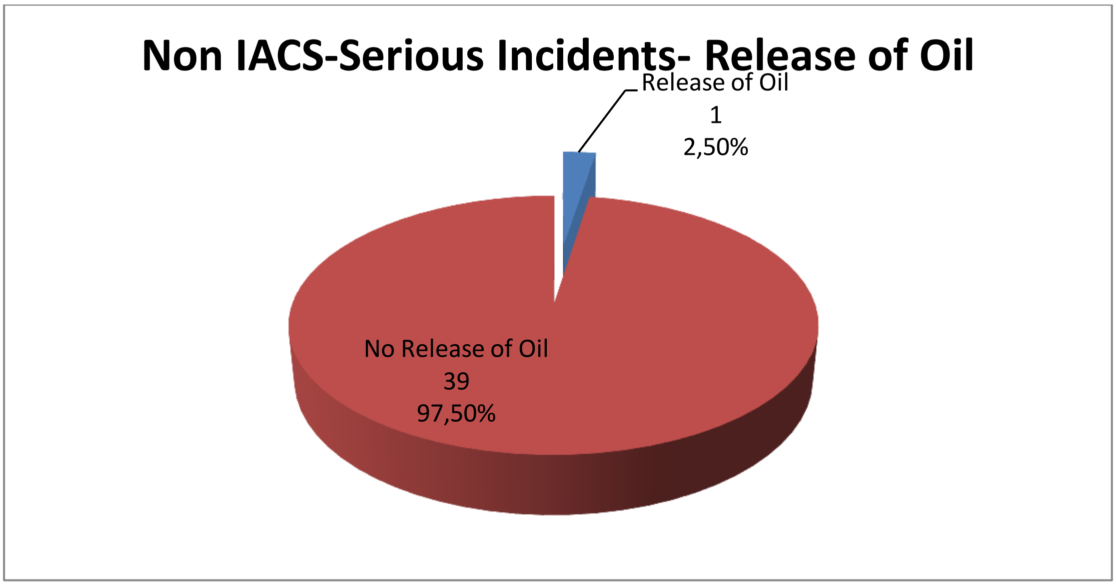


There is only one fatality on non-IACS ships. Nevertheless, it can't be disregarded the fact that injuries and missing persons on 40 incidents of non-IACS vessels are almost 30% of the ones for IACS vessels.

Loss of Payload

103 TEUs were lost in 2 accidents.

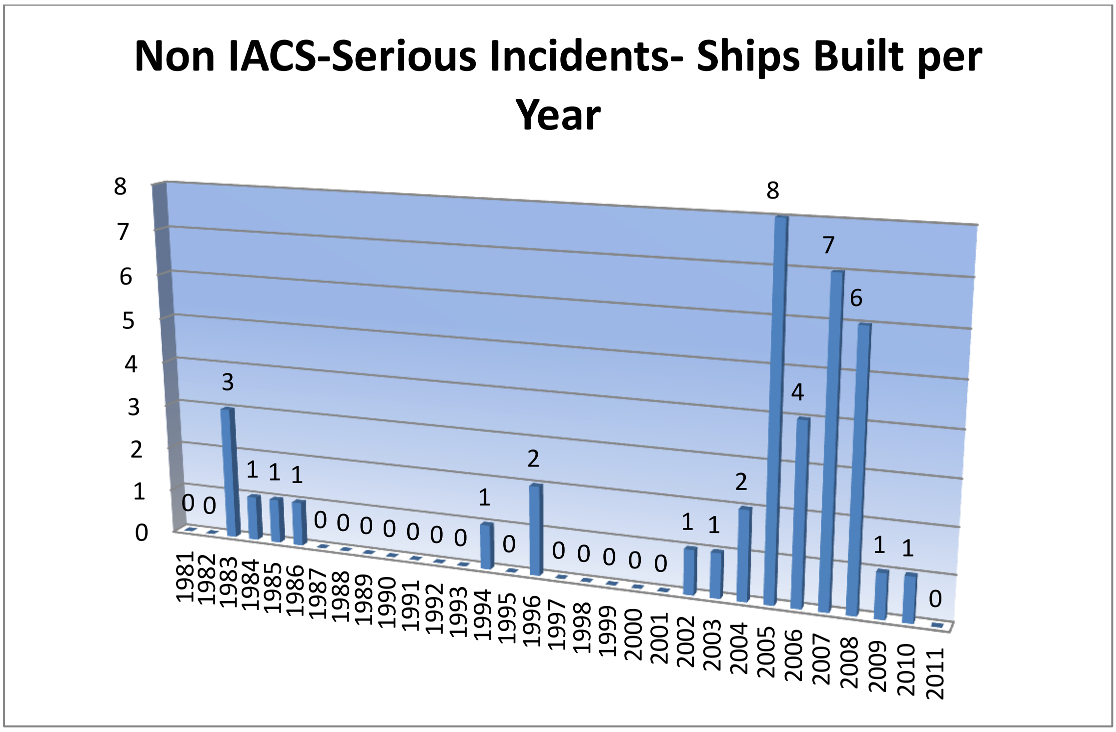
Release of Oil

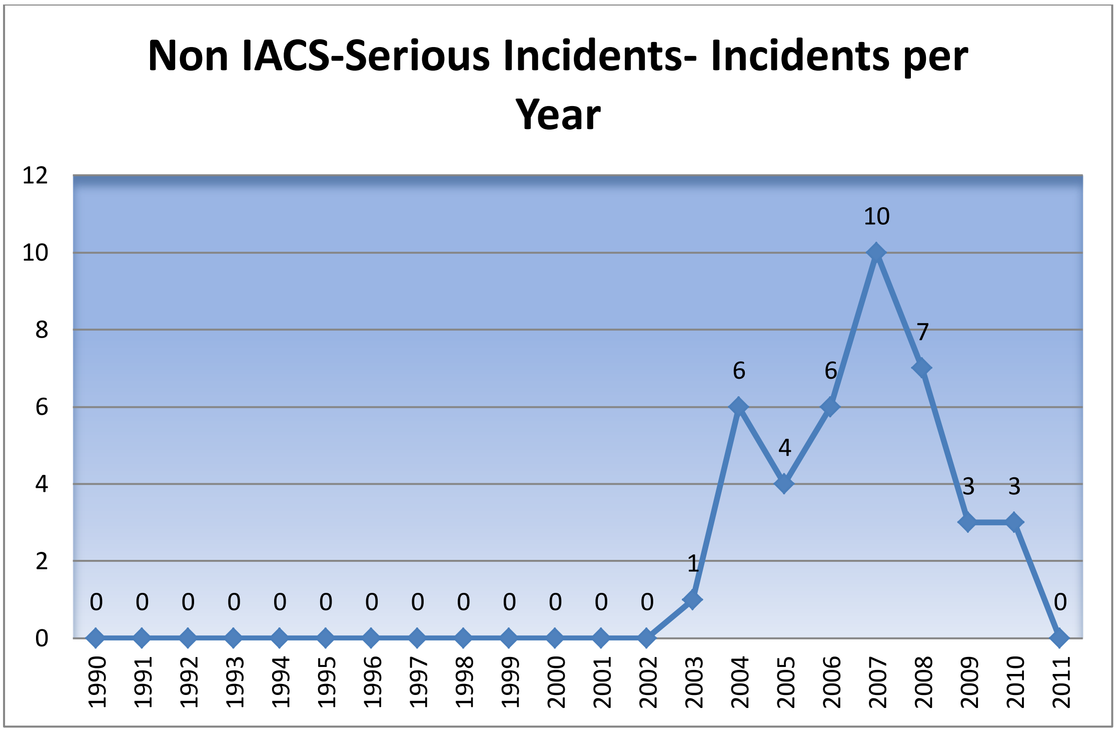


Release of hazardous Cargo

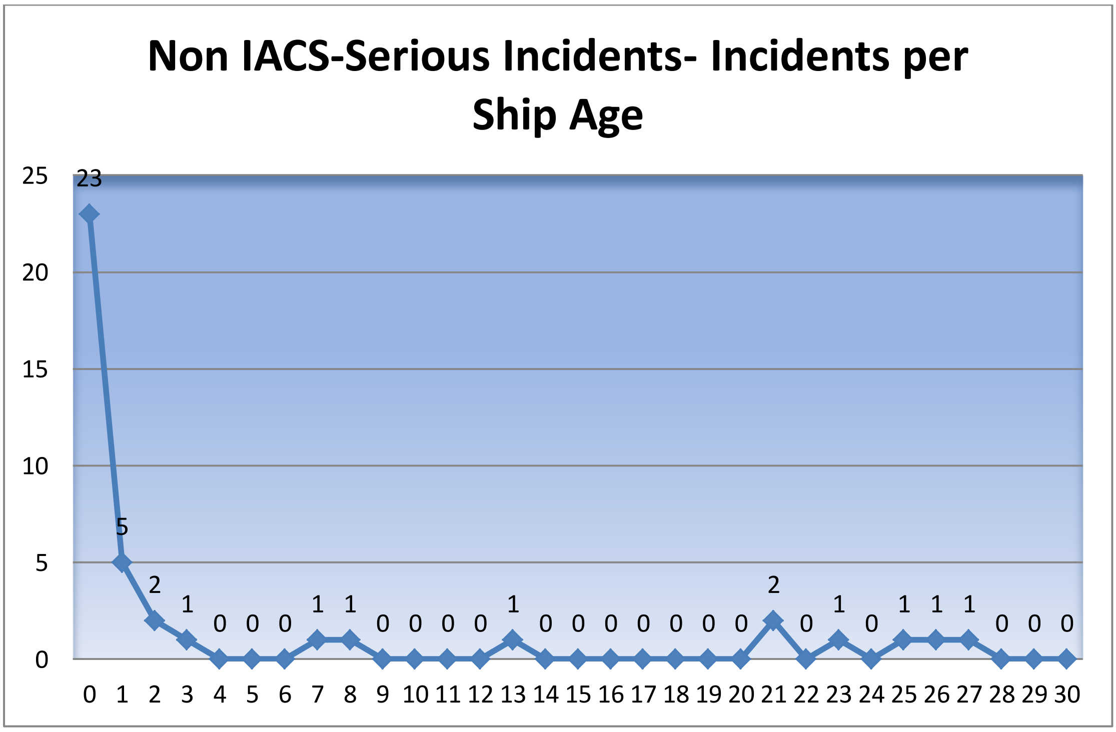
No release of hazardous cargo.

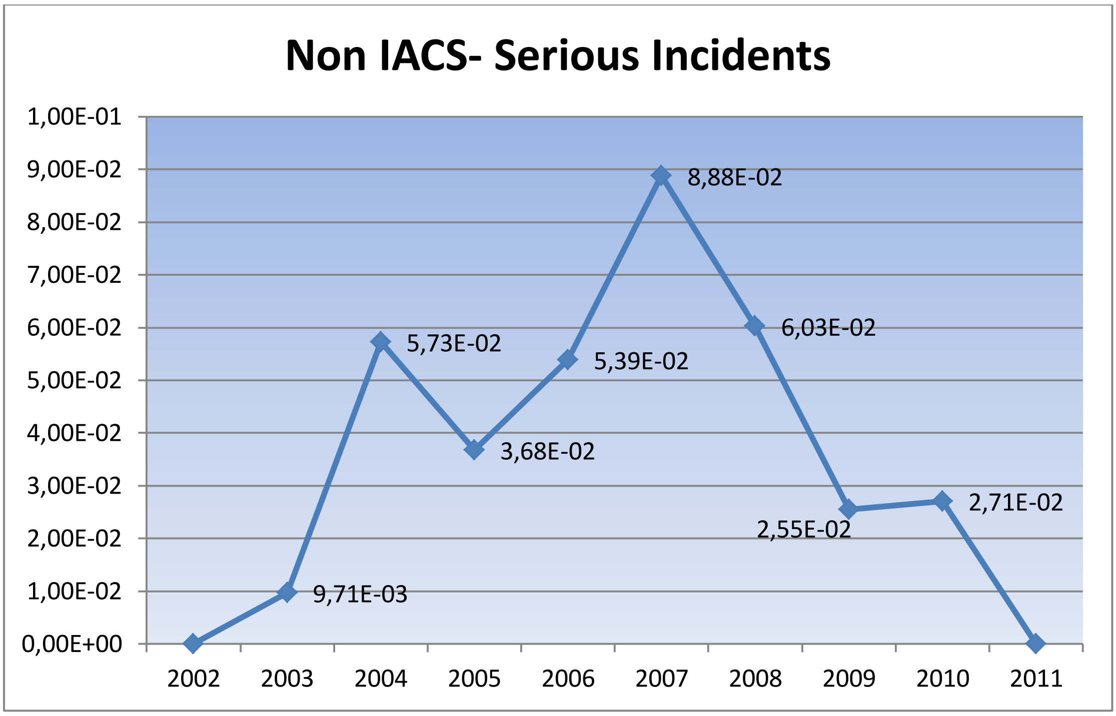
5.1.3 FREQUENCIES OF ACCIDENTS





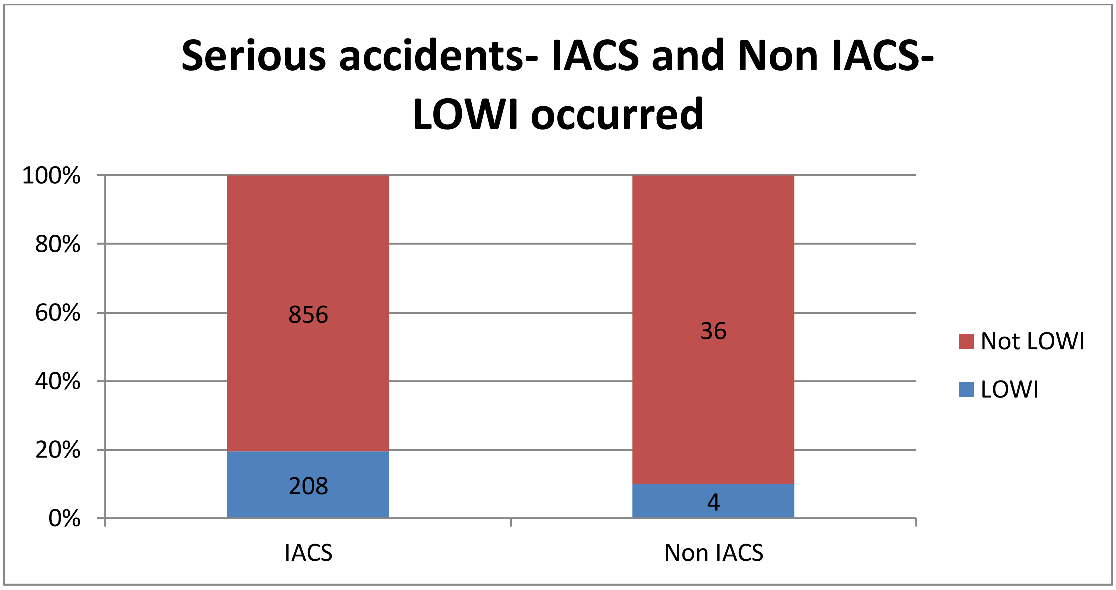
It is a disadvantage of this study that there is no information of non-IACS ships' accidents before 2002.

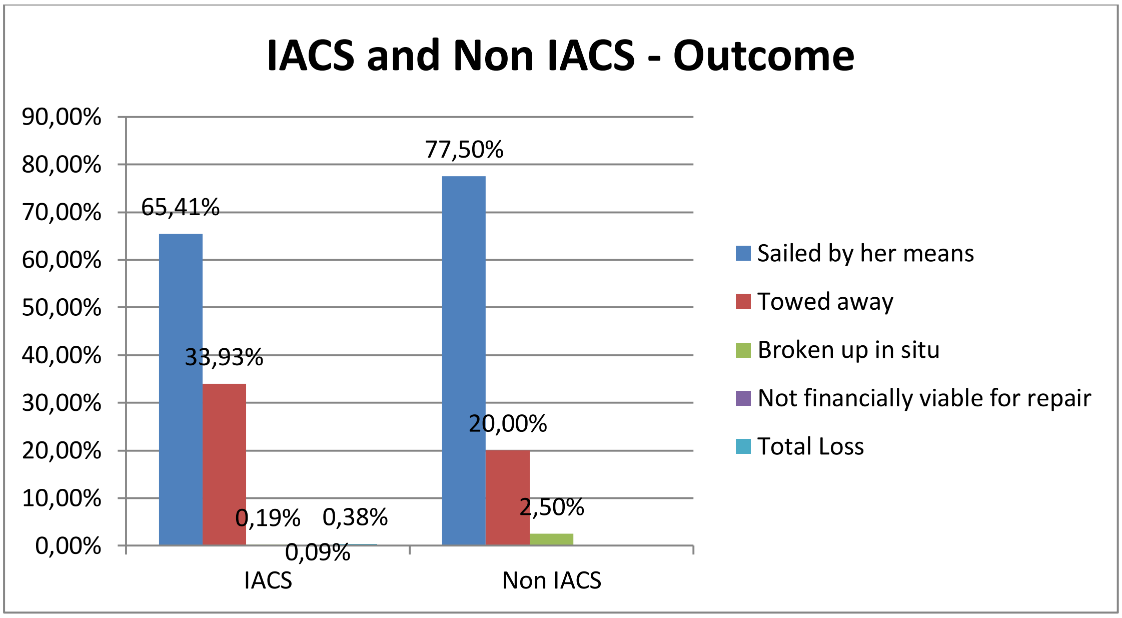




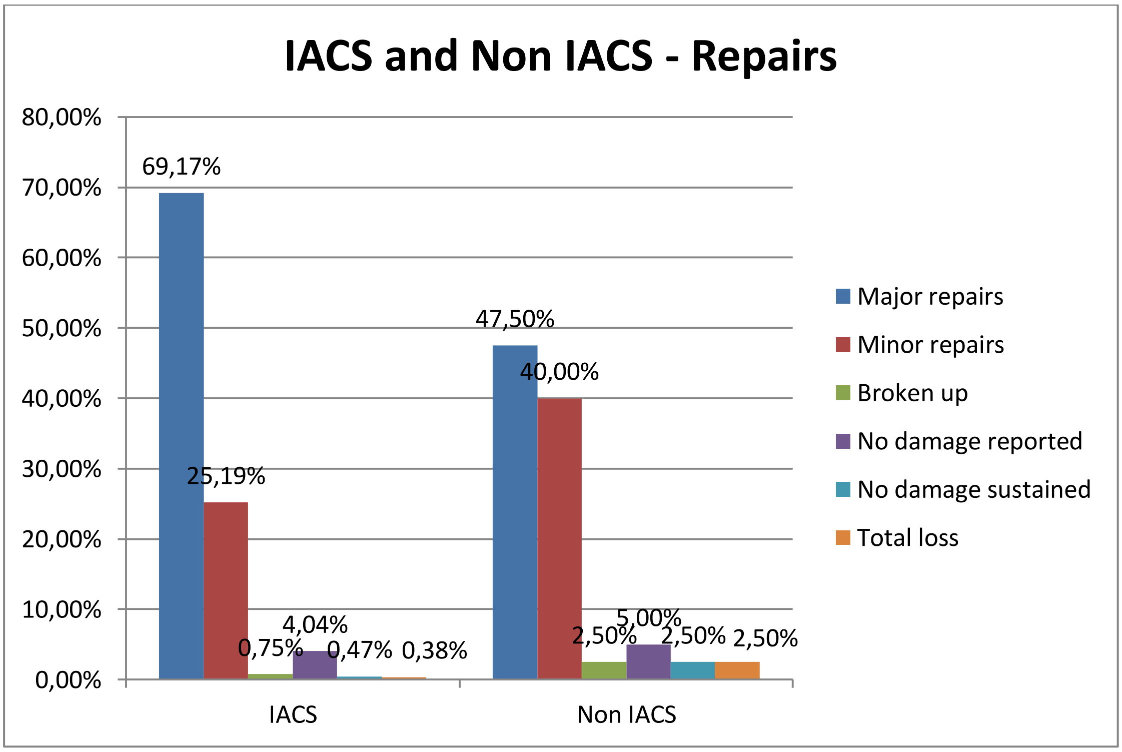
Frequencies of non-IACS ships are extremely high, twice as IACS ships'. This is because Fleet at risk of Non IACS vessels is small in comparison with the one for IACS vessels.

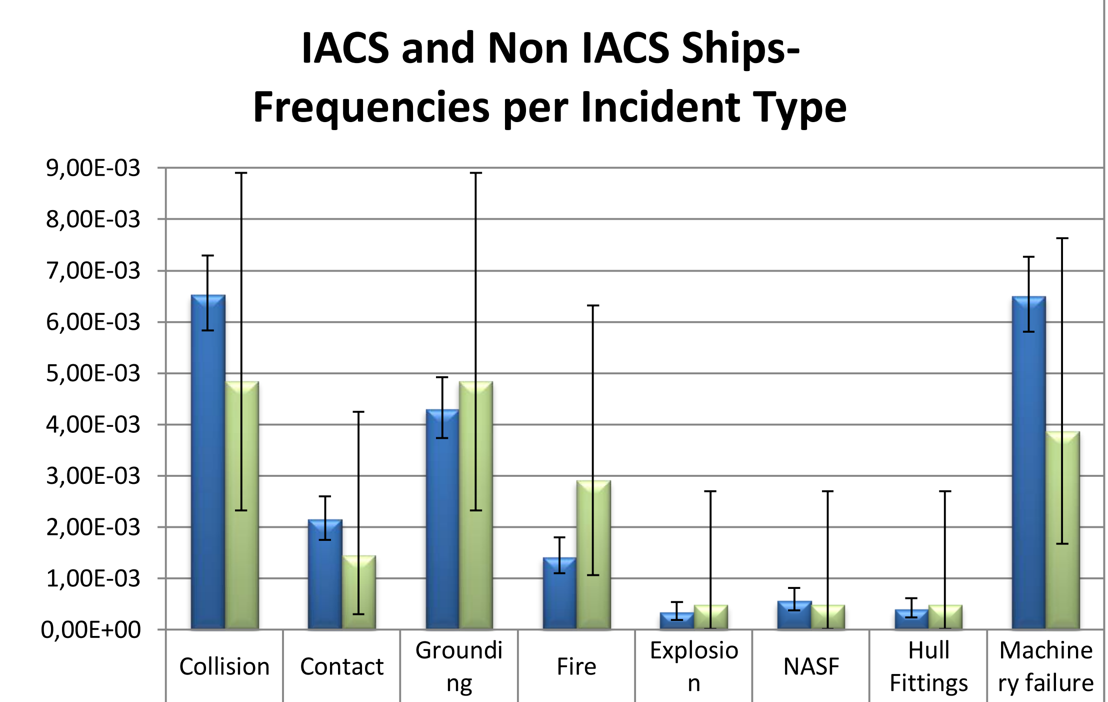
5.1.4 COMPARISON OF IACS AND NON-IACS SHIPS' ACCIDENTS





Similar outcome for both IACS and non-IACS ships, as well as loss of water integrity.





	Collision	Contact	Grounding	Fire	Explosion	NASF	Hull Fittings	Machinery failure
IACS	6,53E-03	2,15E-03	4,30E-03	1,42E-03	3,34E-04	5,63E-04	3,96E-04	6,51E-03
Non IACS	4,85E-03	1,45E-03	4,85E-03	2,91E-03	4,85E-04	4,85E-04	4,85E-04	3,88E-03

Based on the comparison of IACS and Non IACS ships, it is important also to state the fact that for IACS vessels a number of 4 total losses occurred with a frequency of 8.35E-05, when for Non IACS vessels there was only 1 total loss with a respective frequency of 4.85E-04. Although, confidence intervals were calculated the same way for both occasions of IACS and Non IACS vessels, there is a great difference in results because of the small number of Non IACS incidents

6. CONCLUSIONS

In the previous paragraphs, there has been a statistical analysis of accidents on fully cellular containerships built after 1980 and with a gross tonnage (GT) greater than 999 that occurred during the period 1990- 2011.

First of all, it must be clarified that in the current study only the IHS database was used. Therefore it is expected to have several discrepancies with previous studies that included other databases- such as LMIU or GISIS- subject to different criteria. There are some incidents in both LMIU and IHS, which in one database are counted as serious and in the other as non- serious. In the NTUA-SDL database, all incidents can be characterized as serious or non- serious on a separate field (User opinion on incident severity) in order all incidents to be sorted with the same standards.

It is obvious that in IHS database most accidents are considered to be serious, 1064 (81,91%), rather than non- serious, 235 (18,09%) for ships registered to an IACS member. This is because criteria of IHS are more stringent than those of LMIU or GISIS and take also in mind human life or environment pollution as indication of a serious incident.

In inverse proportion is the existence of loss of water integrity of the vessel after any type of incident. Overall, 18,01% of the incidents led to a state of LOWI which represents 234 incidents. Highest rates appear in structural failure accidents (50% - 16 incidents), contact accidents (31,45% - 39 incidents) and grounding accidents (20,09% - 46 incidents). More restricted regulations of SOLAS as well as more frequently inspections onboard have a positive impact.

Most of the incidents recorded are machinery failure (26,69% and 20,00%), collision (34,03% and 25,00%) or grounding incidents (17,63% and 25,00%) for IACS and non IACS members' ships respectively. It is important to notice that in both machinery failure incidents and grounding incidents the frequency of accidents peaked on 2008, which- combined with previous statement- led to an increased frequency of all incidents for ships of IACS members.

Additionally, the majority of incidents occurred during voyage (1053 incidents or 81,06% for IACS ships and 33 incidents or 82,50% for non IACS ships). It is completely logical that machinery failure and grounding incidents show the greatest rates in this category (94,22% and 94,32% respectively) considered the fact that both imply propulsion and steering systems operating. Besides this, on 74,49% of grounding incidents vessel was on a fully loaded condition which enforced the grounding accident. Moreover, only in machinery failure incidents the rate of ship taken in tow was greater than "sailed by her mean" condition (63,29% and 36,42%).

Hull fittings and especially lashing arrangement have a direct impact on TEUs' condition during voyage and loading- discharging procedures. Therefore, it was expected to have big losses of TEUs caused by lashing failure. In total, there was a loss of 1914 TEUs in 34 accidents for IACS ships- with an average of 56,3 lost TEUs per accident- and 103 TEUs in 2 accidents for non IACS ships- average is 51.5 TEUs. Because of the small amount of information on non IACS ships' accidents, it is not wise to draw conclusions out of these facts. On the other hand, it is clear that hull fittings failure contains the greatest risk on TEUs' safety with a total loss of 1074 TEUs in 11 accidents and a risk of 2.24E-02.

Incident type	No of Incidents	No of incidents with Loss of Cargo	Frequency of Loss of Cargo	Fleet	TEU lost	TEU lost per Incident	Risk
Collision	442	15	3,13E-04	47927,18	230	15,33	4,80E-03
Contact	124	1	2,09E-05	47927,18	14	14,00	2,92E-04
Explosion	18	0	0,00E+00	47927,18	0	0,00	0,00E+00
Fire	77	4	8,35E-05	47927,18	372	93,00	7,76E-03
Grounding	229	1	2,09E-05	47927,18	4	4,00	8,35E-05
Hull fittings failure	31	11	2,30E-04	47927,18	1074	97,64	2,24E-02
Machinery failure	346	1	2,09E-05	47927,18	110	110,00	2,30E-03
Structural failure	32	1	2,09E-05	47927,18	110	110,00	2,30E-03
TOTAL	1299						

An important objective of this study is also the environmental protection against the consequences of oil spill after ships' accidents. For all types of incidents there has been a total of 3598 tonnes oil spill. The greatest rate for such an occasion appears on structural failure incidents with a percentage of 21,88% (7 out of 32 incidents) and 265 tonnes of oil spilled. Rates for collision and contact incidents are 3,39%(15 out of 442 incidents) and 9,68%(12 out of 124 incidents) respectively. The amount of oil spilled is 620 and 1833 tonnes in order designated. If the definition of risk is taken in mind: (Risk) = (Frequency) x (Consequences)

we have the following table:

Type of incident	Frequency (See below Table)	Oil spill per incident (tonnes)	Risk
Collision	3.13E-04	620/15 = 41.33	1.29E-02
Contact	2.50E-04	1833/12 = 152.75	3.82E-02

Type of incident	Frequency (See below Table)	Oil spill per incident (tonnes)	Risk
Explosion	0.00E+00	0.00	0.00E+00
Fire	0.00E+00	0.00	0.00E+00
Grounding	2.71E-04	60/13 = 4.62	1.25E-03
Hull fittings	0.00E+00	100/1 = 100	0.00E+00
Machinery failure	0,00E+00	0.00	0.00E+00
NASF	1.46E-04	265/7 = 37.86	5.53E-03

and it is clear that contact incidents involve greatest risk.

Incident type	No of incidents	Frequency of incident	No of incidents with oil spill	Frequency of oil spill	Fleet
Collision	442	9,22E-03	15	3,13E-04	47927,18
Contact	124	2,59E-03	12	2,50E-04	47927,18
Explosion	18	3,76E-04	0	0,00E+00	47927,18
Fire	77	1,61E-03	0	0,00E+00	47927,18
Grounding	229	4,78E-03	13	2,71E-04	47927,18
Hull fittings failure	31	6,47E-04	1	2,09E-05	47927,18
Machinery failure	346	7,22E-03	0	0,00E+00	47927,18
Structural failure	32	6,68E-04	7	1,46E-04	47927,18
TOTAL	1299	2,71E-02			

As far as the human life in danger is concerned, the most dangerous types of incidents are:

- Explosion incidents with 11 persons killed, 12 serious injured, 2 persons non-serious injured and 1 person missing
- Collision incidents with 4 persons killed and 3 non- serious injuries
- Fire incidents with 3 persons killed, 4 persons serious injured, 18 non-serious injured and 1 person missing
- Grounding incidents with 1 person killed
- Structural failure incidents with 2 non- serious injuries and 30 missing crew members in a total loss of the vessel under heavy sea.

Although non IACS members' ships' accidents (40) are much lesser than IACS members' (1299), it is noticeable that these incidents led to a comparable amount (approximately 1/3) of persons missing or with a non- serious injury.

It must also be noted that there was no information of weather conditions during the accidents for the majority of records. This information would be extremely helpful and descriptive for the purposes that led to an incident. For example, many of collision and grounding incidents occurred during heavy weather, but for 76,47% and 79,04% respectively there was no information about the weather.

Finally, a comparison with previous results of Safedor FSA is necessary. It should be reminded that some accidents of LMIU may be included in IHS database and indicated by the LMIU-info and LMIU-severity on the "Enhanced info" section of the NTUA- SDL database.

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 accident's severity.

Updated results-Sampling Plan

- Input databases: IHS
- Fully cellular containerships
- Calculated period: 1990-2011
- Excluded ships <999 GT
- Excluded ships built before 1980
- Included only IACS ships
- All incidents regardless the degree of accident's severity

SAFEDOR FSA-Investigated hazards

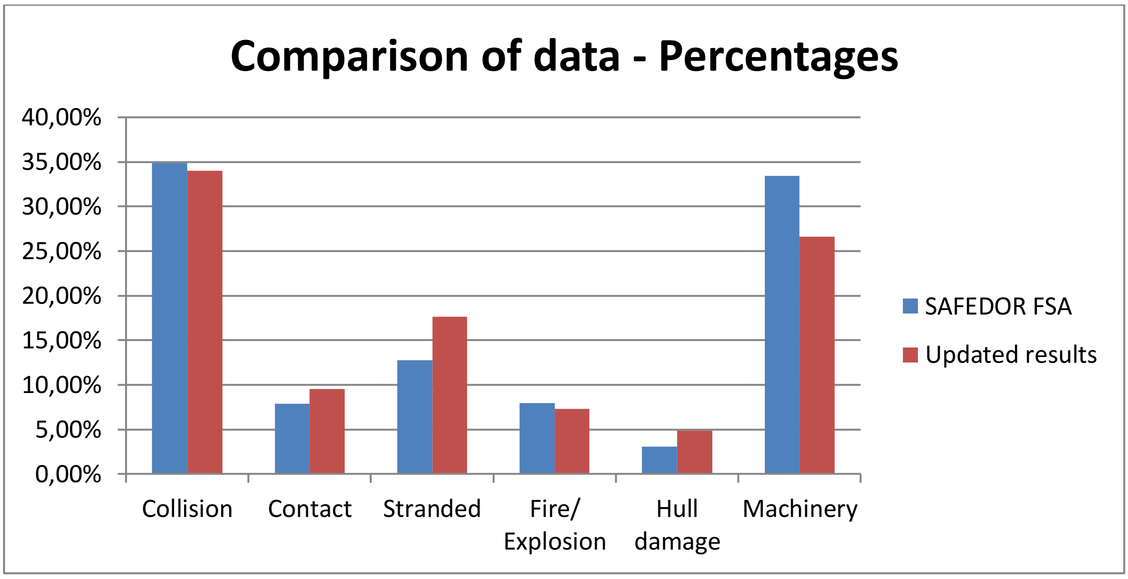
- Collision
- Contact
- Grounding
- Fire/Explosion
- Water ingress in container hold

Updated results-Investigated hazards

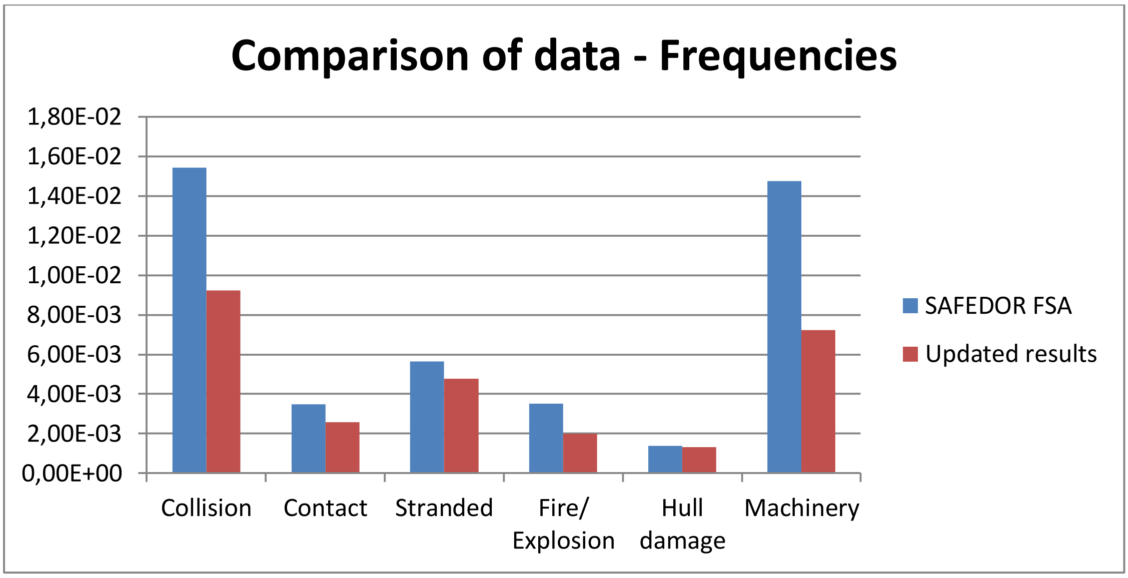
- Collision
- Contact
- Grounding
- Fire
- Explosion
- Non-accidental structural failure
- Hull Fittings failure
- Machinery failure

SAFEDOR FSA				
Incident type	**No of incidents**	**Percentage**	**Fleet at risk**	**Frequency**
Collision	473	34,88%	30682	1,54E-02
Contact	107	7,89%	30682	3,49E-03
Stranded	173	12,76%	30682	5,64E-03
Fire/ Explosion	108	7,96%	30682	3,52E-03
Hull damage	42	3,10%	30682	1,37E-03
Machinery	453	33,41%	30682	1,48E-02

Updated results				
Incident type	**No of incidents**	**Percentage**	**Fleet at risk**	**Frequency**
Collision	442	34,03%	47927	9,22E-03
Contact	124	9,55%	47927	2,59E-03
Grounding	229	17,63%	47927	4,78E-03
Fire	77	5,93%	47927	1,61E-03
Explosion	18	1,39%	47927	3,76E-04
NASF	32	2,46%	47927	6,68E-04
Hull fittings failure	31	2,39%	47927	6,47E-04
Machinery failure	346	26,64%	47927	7,22E-03



The percentage of contact and stranded (grounding) incidents has been increased compared to other categories.



The above diagram outlines the decrease of frequencies for all type of incidents. Especially on collision and machinery incidents there is a drop to almost half the FSA frequency. This fact is encouraging, considering that the main difference between Safedor FSA and the updated results is the period 2004 until 2011.

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8. ANNEX 1: MANUAL OF NTUA- SDL DATABASE

CONTAINERSHIPS INCIDENT DATABASE

SHIP DESIGN LABORATORY
NATIONAL TECHNICAL UNIVERSITY OF ATHENS

MANUAL

Classification and Approval

Classification: Restricted

Definition

PU = Public

PP = Restricted to other programme participants

RE = Restricted to a group specified by the consortium

CO = Confidential, only for members of the consortium

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DOCUMENT HISTORY:

Issue:	Date:	Initials:	Revised pages:	Short description of changes: File name:

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CONTENTS

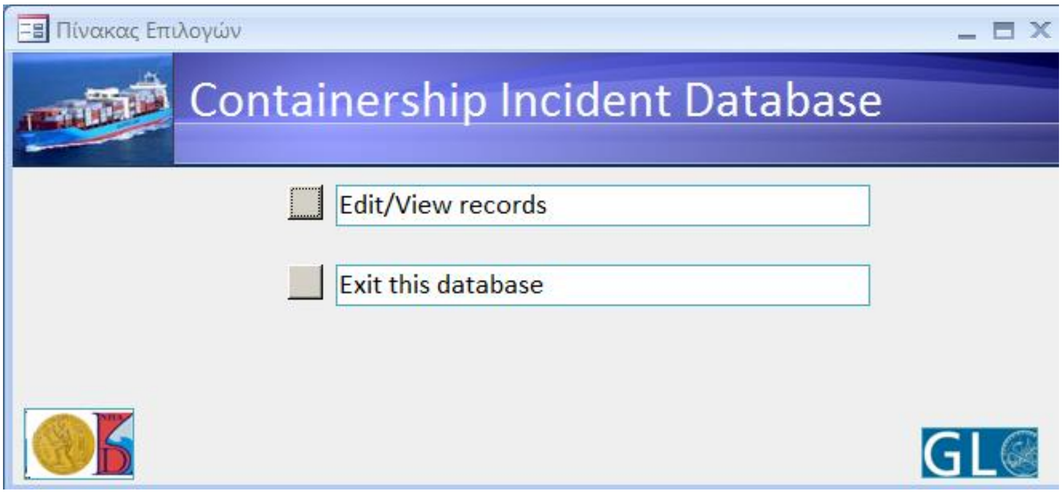
Preamble

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.

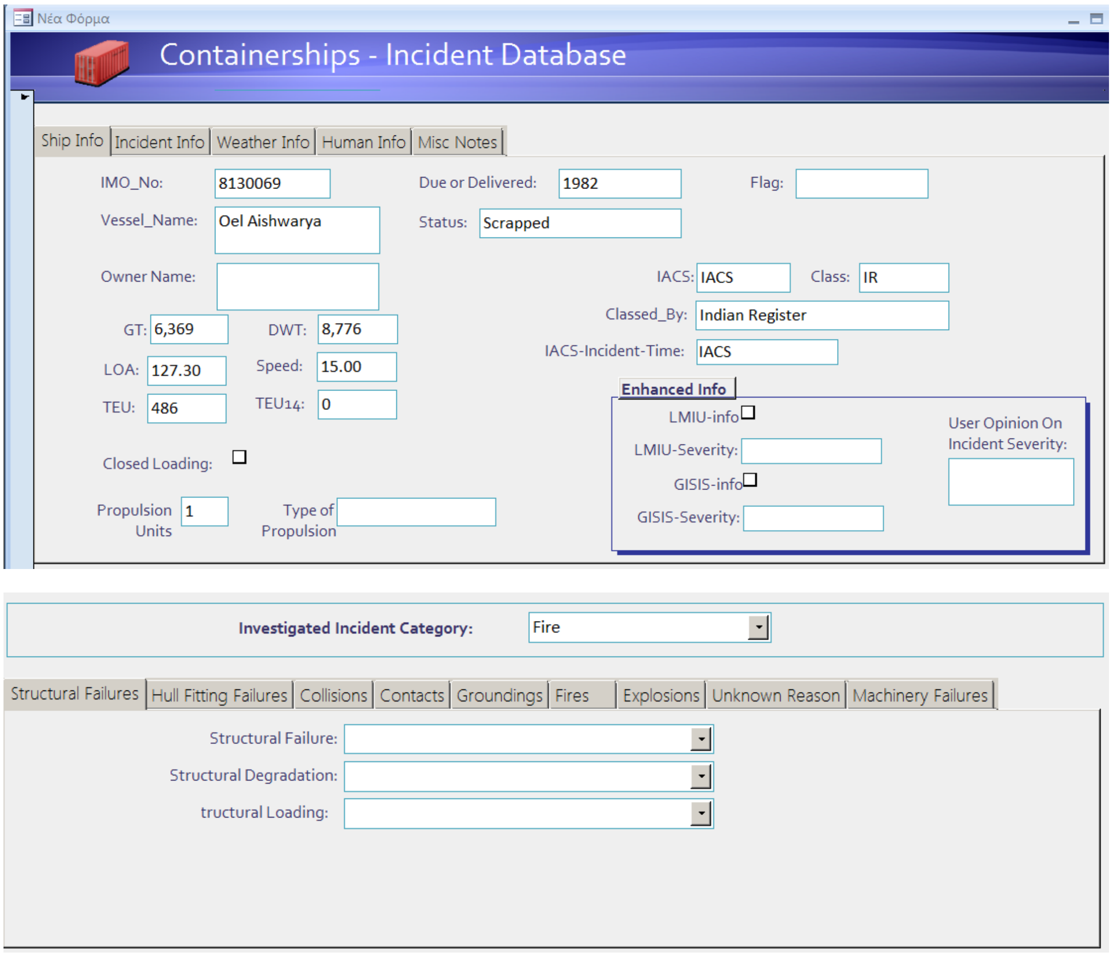
General Instructions

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.

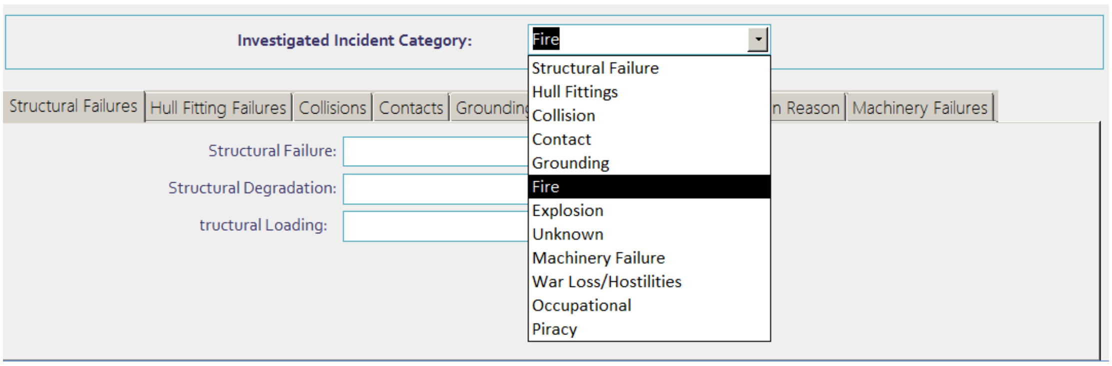
Notes:

- ✓ 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.

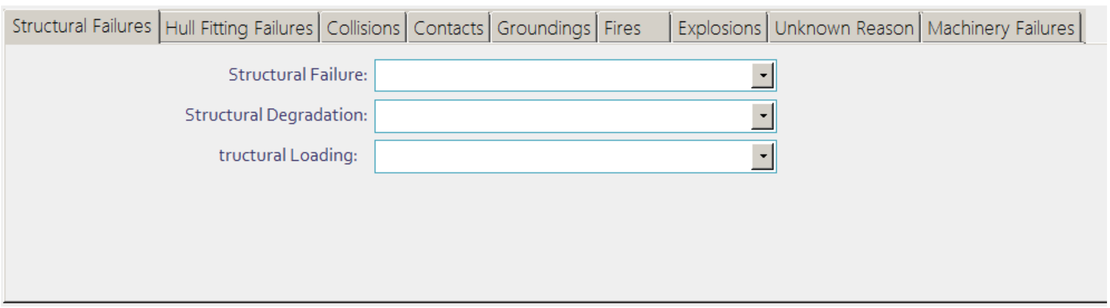
In the following, some guidance is provided for the proper interpretation of the laid-down FT scheme and the correct use of the database.

ACCIDENTAL CAUSAL DATA

8.1 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.

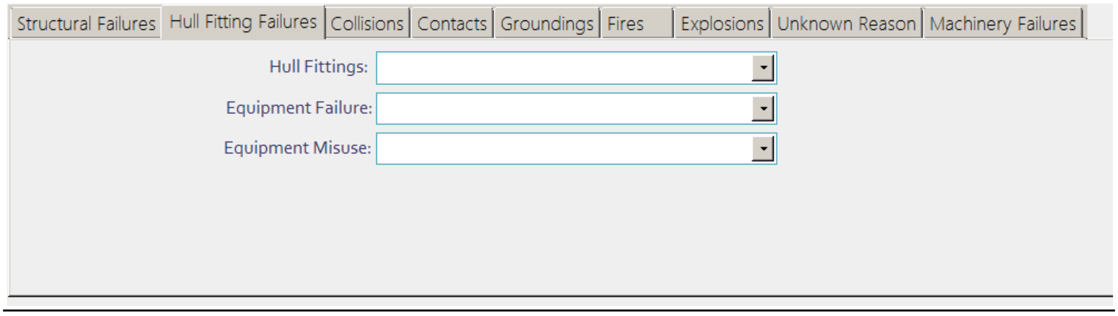
If the user/analyst chooses "Excessive loading", the user/analyst should select one choice of the following drop-down menu:

- Operation in abnormal conditions
- Ballast related
- Cargo related

8.2 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:

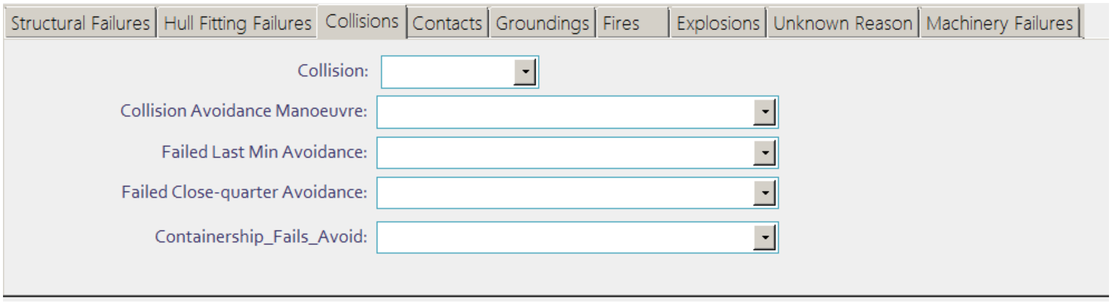
- Misuse of Chainlocker
- Manhole left open
- Ventilation lines incorrectly open
- Misuse of Loading Equipment

8.3 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

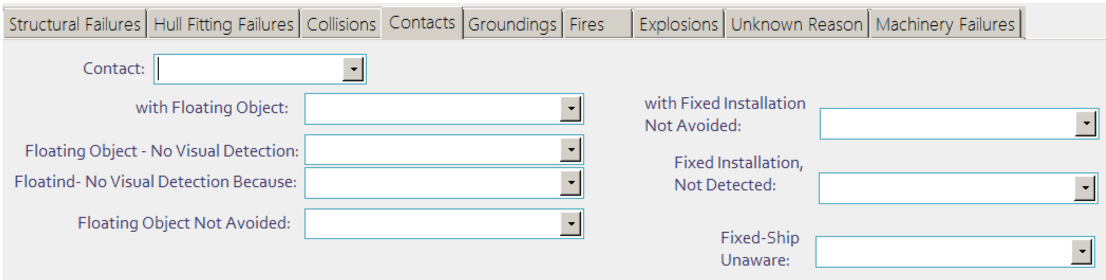
For the "Containership Fails Avoid", the user/analyst can choose one of the following options of the drop-down menu:

- Failure to supervise route
- Failure of collision avoidance manoeuvre

8.4 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.

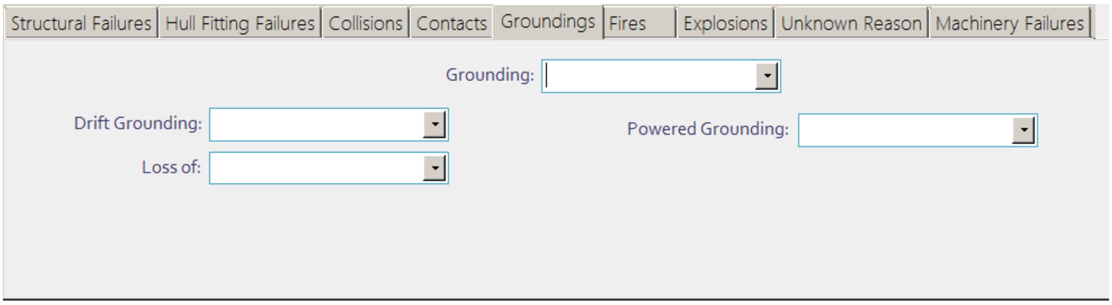
If “Ship unaware of striking hazard” is chosen, then the user/analyst should click on the one and only choice of the following drop-down menu:

- VTS Failure & Uncorrected Navigational Error & External Communication Failure

8.5 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

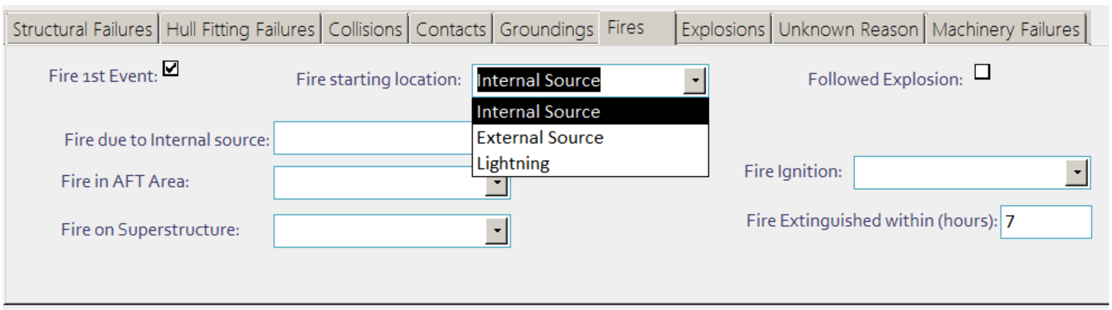
If “Powered Grounding” is selected, the user/analyst should click on one of the choices of the following drop-down menu:

- Detected but not avoided
- Squat Effect
- Not detected

8.6 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:

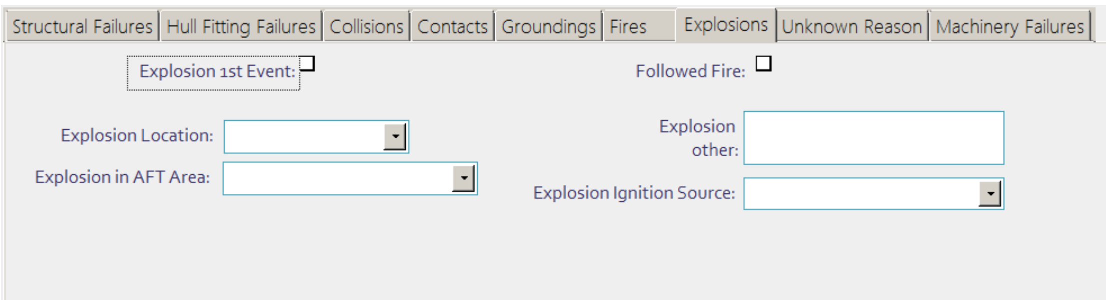
- Electrostatic charges
- Cooking related
- Heating equipment
- Hot works
- Smoking related
- Electrical faults
- Broken Fuel Pipe
- Self-Ignition
- Containers' Content
- Engine's Crankcase
- Unknown

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.

8.7 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.

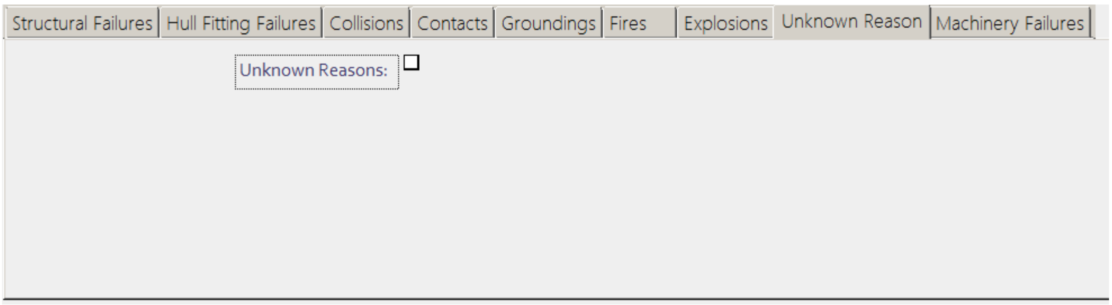
Then, the user/analyst should complete any information on "Ignition Source" box, where there is the following drop-down menu:

- 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.

8.8 FT-8: Unknown reasons

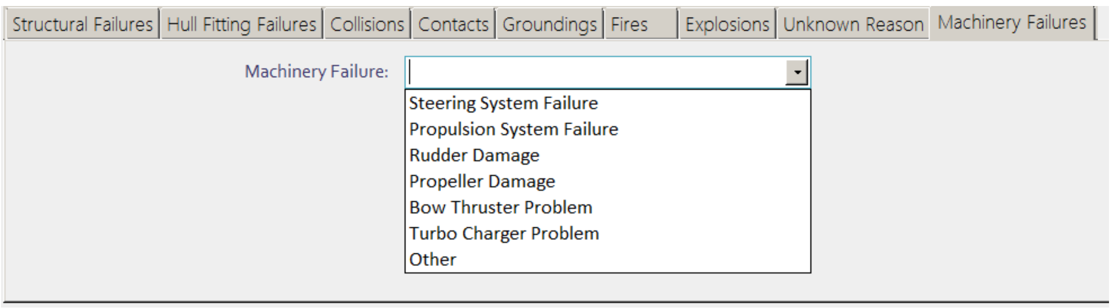
If "**Unknown reasons**" is selected, (due to e.g. lack of information), in the relevant tab the user/analyst should tick *"YES"*.



8.9 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



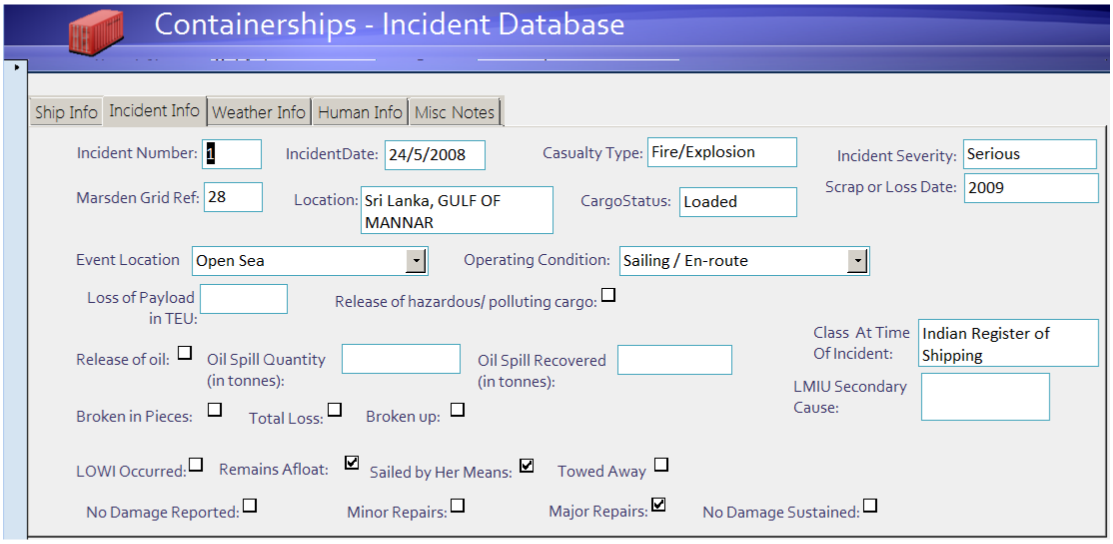
Notes:

- ✓ 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.

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:

8.10 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:

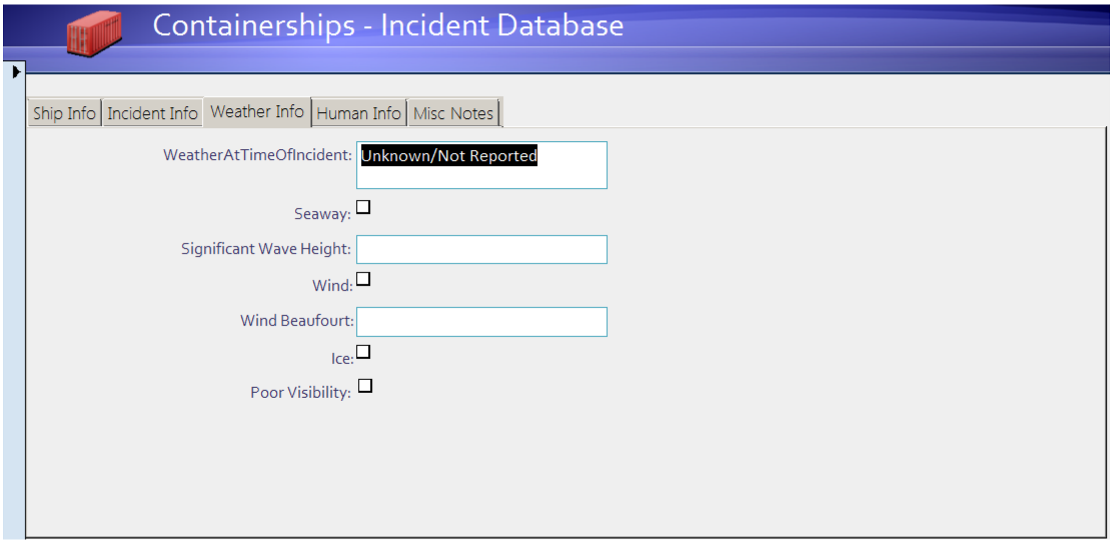
  i. if it requires hull check by Class, it is major

  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).

8.11 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

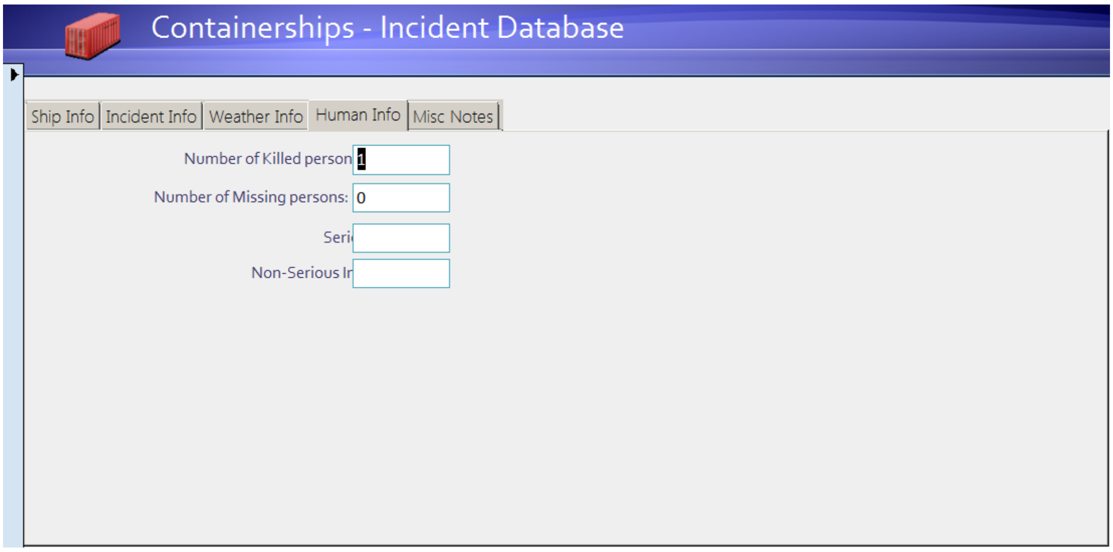
8.12 Human Info tab

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.