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Shipping accidents: a serious threat for marine environment

Gemi kazaları: deniz çevresi için ciddi bir tehdit

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Abstract

Shipping accident is a term generally used for any accident results in financial loss, either in life or property or both. The reasons for shipping accidents are many and complex. Bigger size brings corresponding increases in cargo and passenger capacity; hence when an accident occurs, the risk of life and property immediately becomes higher. Reduced ship maneuverability in connection with larger scale is another contributing factor in shipping accidents.

Several crucial causes play a role in shipping accidents. Natural conditions, technical failures, route conditions, ship-related factors, human errors, cargo-related factors are the striking ones.

Shipping accidents by types are quite many and their impacts on marine environment differ from one another. Collision or contact, capsize, foundering,

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breaking up, grounding, stranding, breakdown of the ship underway, and fire or explosion are examples of common shipping accidents.

Groundings and shipboard fires are the dominant types of shipping accidents worldwide.

Torrey Canyon disaster has been the cornerstone for the protection of marine environment. The first 20 major oil spills of all time reveal that nearly 2.4 million tonnes of oil entered the sea due to accidental and operational oil pollutions.

Shipping is and always will be full of risks despite high and ever increasing safety standards. Nevertheless, improved standards for ships, seafarers and shipping management by way of internationally adopted measures have all made and will make a major impact on shipping safety for safer shipping and cleaner oceans.

Keywords: *shipping* accident, collision, stranding, grounding, shipboard fires, human errors, darkness, clear weather, collision risks, SOLAS, marine environment, oil spill, MARPOL, Bosphorus.

Introduction

1. Shipping accidents

Shipping is the fundamental as well as dominant means of transport for the world trade [1] as the Earth is almost covered by sea. Nearly 90.000 vessels of various size and more than 250 different types, specialized on cargo or passenger trade or both, serve for humanity. (O'Neil, 2003)

[1] In rounded figure, 4/5th of the world trade.

Yet shipping is the bulk delivery mechanism of international trade, and it plays a massive part in humanity's collective well being; billions of tons of raw materials and finished goods are carried onboard ships between ports / port terminals economically, cleanly and without mishap everyday.

Ships trade in a high-risk operating environment. In the age of precision navigation and the satellite era, very many casualties still occur at sea. Even the available advanced and sophisticated navigation instruments and the enhanced communication technologies have been unable to halt shipping accidents.[2]

Any shipping accident, whatever in nature, is every seafarer's nightmare. Should it occur in a confined area, like a channel or a strait where the traffic is heavy, several as well as serious risks are likely to be faced. On the other hand, a major shipping accident becomes even more critical by way of, say, water ingress thus possibly worsening the ship's damage stability if exacerbated by heavy weather or strong current. In some other accidents however the issue becomes more "environmental" due to oil spillage. (Akten and Gonencgil, 2002)

The Oxford English Dictionary defines an accident as, "anything that happens without foresight and expectation: an unusual event, which proceeds from unknown cause, or is an unusual effect of a known cause."

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[2] According to Lloyd's Register's Casualty Statistics, the number of ships lost as a proportion of the number of ships in the world fleet continues
to decline:

- * In 1995, 3 ships were lost for every thousand in the world fleet.
- * In 2000, the equivalent figure was 1.9 for every thousand.

Major studies into marine oil spills show a similar decline in the annual percentage of oil carried by ships that is subsequently spilled.

Webster's Third New International Dictionary gives the similar essence - but with slightly more explanation, as "a usually sudden event or change, occurring without intent or volition through carelessness, unawareness, ignorance, or combination of causes and producing an unfortunate result."

Shipping accident is a term generally used for any accident results in financial loss, either in life and/or property or both. (Akten, 1982)

The reasons for shipping accidents are many and complex. Increased sizes of ships to achieve economies in transport costs are one of the primary reasons. Bigger size brings corresponding increases in cargo and passenger capacity; hence when an accident or a casualty occurs, the risk of life and property immediately becomes higher. Reduced ship maneuverability in connection with larger scale, which ultimately is a function of increased risk, is another contributing factor in marine accidents. (Chapman and Akten, 1998)

There may be several causes for shipping accidents. In broad terms these are: natural conditions, technical failures, route conditions, ship-related factors, human or personal errors and cargo related factors.

- *Natural conditions* could be natural phenomena such as current, tide and tidal stream, severe wind, reduced visibility (fog, heavy snow and rain), storm seas, darkness etc. affecting the ship or those controlling her.
- *Technical failures* are shortcomings within the ship, such as corrosion[3], steering failure, engine failure, or hull failure arising

[3] Corrosion has been a major factor in bulk carrier losses.

from defective materials or construction, or by the shore-based installations, such as aids to navigation.[4]

- *Route conditions* may include navigational error like over reliance on inaccurate nautical charts, charts of suspect reliability or based upon old surveys, narrow channels with abrupt and angular windings, allowing for very limited maneuverability and exposed to dense marine traffic, such as the Turkish Straits, anchorage contiguous to traffic separation lanes, confined marine areas with insufficient sea-room as well as navigational hazards such as shoals, reefs, wrecks etc.
- *Ship-related factors* could be the weakness of a ship, associated with her larger size, hence less maneuvering capability and stability or draught constraints.
- *Human errors* may include, inter alia, a lack of adequate knowledge and experience, technical inability, bad look-out, not paying proper attention to procedures and rules, carelessness in commanding a ship, misinterpretations of radar information, fatigue and lack of alertness, overworking, tiredness, insufficient rest periods, etc.
- *Cargo-related factors* mostly include dangerous goods and heavy cargoes; i.e. their hazardous characteristics (oils, chemicals, nuclear substances), the place / compartment they are stowed

[4] Some of the navigation and collision avoidance aids such as ARPA, GPS and VHF may also contribute to the cause of a collision accident if not treated properly or the correct precautions are not taken.

onboard ships (on deck or under deck), and degree of diligence that such cargoes need (grain, timber), all of which are related to ships' seaworthiness.

Any accident may have more than one cause. Nevertheless, statistical analyses on the basis of the main causal trends explicitly reveal that human errors, though declining marginally, continue to be the major cause for all shipping accidents - being almost 80 percent. In other words, *"the acts or omissions of human beings play some part in virtually every accident, including failures, like structural or equipment ones, which may be the immediate cause."* (ISF and ICS, 1996)

Most of the accidents are attributed to human error; quite a lot to bad weather conditions and some also to force majeure reasons.

The density of vessel traffic, particularly in those narrow areas such as straits, channels, port approaches where there is likely insufficient sea-room, close-quarter situations frequently exist, and more ships are concentrated, remains second to human errors as contributing factor of marine casualties.

Accidents may take place anywhere, anytime and under any conditions – day or night, in clear weather or restricted visibility, in narrow straits, canals, inland waterways, coastal waters or on the high seas; and even due to defective or off-station navigational marks.

In daytime and in a visual situation, it is easier to judge distances. Likewise, course alterations are rather obvious and the other vessels around will notice any change of aspect. To judge distances and to estimate the visibility at night is at times quite difficult. Therefore, navigation, even on a dark clear night, requires special care for certain reasons such as:

- areas where there exist bright and scattered background lighting from the shore can cause confusion, and,
- reduction of the nominal range of visibility of the lights thereby, and,
- sailing lights being hardly visible,
- Unlit navigational hazards affect also the navigational safety.

The reasons above are contributing factors in shipping accidents. It has been computed, for instance, that the lights exhibited on both sides of the Strait of Istanbul are visible only to 1.9 nautical miles at night though their nominal range is mostly eight nautical miles, due to the presence of bright background lights from restaurants, city and residential illuminations, moving cars, etc. Nevertheless, the background lighting in the Strait usually masks the navigation lights of not only small crafts but also large vessels and the presence of such floating objects are sometimes first noticed by the moving silhouette they cast against the shore lights. (Akten, 2004)

"*The effect of darkness on the accidents in clear weather was found to be three times the number taking place in daylight*". *"During restricted visibility there was found to be no appreciable difference."* (Cockroft, 1982) For the Bosphorus however the number of accidents occurring in darkness was found to be nearly twice the number of occurring in daylight. (Akten, 2004) Darkness is thus one of the most significant impacts on clear weather accidents.

2. Types of shipping accidents

Shipping accidents by types are quite many and their impacts on marine environment differ from one another. Collision or contact, capsize, foundering, breaking up, grounding, breakdown of the ship underway, stranding, and fire or explosion are examples of common shipping accidents.

Very many vessels differ from one another in size and types navigate round-the-clock on the seven seas. On their way to destinations they normally follow customary routes and courses; the primary objective along the way being, inter alia:

- to keep the shortest distance,
- to avoid navigational hazards, and defective navigational marks, and,
- to prevent collision(s).

In areas where shipping traffic exists, encounters of vessels, be it seldom or frequent, single or multi, take place if and when their courses coincide and ultimately maneuvering may become, sooner or later, inevitable.

Should vessels underway approach one another so as to involve risk of collision either of the following encounter situations may occur:

a. meetings,
    - end-on or nearly end-on as to the other,
    - crossing on either side, or

b. overtaking the other.

Areas of heavy traffic, vicinity of large ports or port terminals, headlands where traffic vice-versa are concentrated are the critical places that likely collision, stranding or grounding accidents to occur.

Collision is one of the major types of shipping accidents. It is the impact of ship against ship by way of striking or contact. Ships or other floating bodies are the main constituents of the collision cases. Such accidents have still been the bane of modern navigation - despite the sustained improvements in navigation techniques.

Where one of the ships involved in a collision accident is a tanker, or a vessel carrying dangerous goods, the outcome will be damage to the environment. Incidents have occurred in the Turkish Straits, such as with the Peter Zoranic, World Harmony, Norborn, Nordic Faith, Blue Star, Lutsk, Independenta, Nassia, Jambur and Datton Shang to mention a few, are examples of this. Around 200.000 tonnes of oil has been spilt into the Strait of Istanbul and its approaches from these collisions alone. (Chapman and Akten, 1998)

There are even certain collision accidents and claims which taken in the past to the International Court of Justice for final resolution. The first such marine collision dispute in the World is the Bozkurt v. Lotus case.

On the night of August 02, 1926 the Turkish cargo ship, Bozkurt, with 1000 tons of coal onboard was involved in a collision in the Aegean Sea, off Sigri Lighthouse, west of Lesvos (Mitylene) Island, with the French passenger ship, Lotus. The Bozkurt sank just after the incident and only 10 seafarers out of the full complement were rescued and eight of the crew was lost.

The case was brought to the attention of the Turkish Criminal Court and on appeal the Court found that both parties contributed to the collision and accordingly both vessels were held liable. The decision that each vessel should have proportionate share in the blame plus criminal penalties was upheld.

The French side raised objections against the Court decision that the Turkish jurisdiction on the case was inconsistent. The Court decision was jointly appealed through the International Court of Justice, in Hague, and the International Court finally upheld the Turkish Court decision.

The main question before the Court whether Turkey had acted in conflict with the principles of international law by instituting proceedings against the master of m.v Lotus.

The Court decided in its judgment of September 7, 1927 that Turkey had not acted in conflict with the principles of international law.

Collision accidents have decreased significantly, particularly in narrow waters such as straits, channels, port approaches after implementation of traffic separation schemes (TSSs). The International Regulations for Preventing Collisions at Sea (ColRegs), which were adopted by IMO in 1972 and entered into force in 1977, first introduced and made mandatory a traffic separation scheme.[5] Since then TSSs have been implemented in many parts of the world and have notably reduced the number of shipping accidents, especially groundings/strandings and collisions.

A total of 461 shipping accidents occurred in the Bosphorus during the1953–2002 period,[6] the majority being collisions. Since 1994, i.e. with the implementation of TSS, however there has been 82 accidents the majority of which have been groundings / strandings. Groundings and strandings having occurred in the Bosphorus constitute 55 percent of all casualties with the major risk factors being currents, sharp turns and darkness.

Fire aboard ship at sea which may lead to serious financial losses or large-scale environmental damages is one of a seafarer's worst fears. It is also another potential threat that all seafarers and passengers are faced with. It sometimes results in total loss of the ship and / or her cargo. In spite of high safety standards it is an immediate danger for life, cargo and the environment.

In the earlier days of merchant shipping a shipboard fire had been the major threat for ships and seafarers. Today it ranks second to stranding accidents in shipping casualties. [7]

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[5] The designated "traffic lanes" are shown on nautical charts and their primary implementation is to avoid collisions and/or groundings of large ships or tankers. A large vessel sailing at full speed can take many miles to stop. Even at slower speeds, large vessels take a long time to turn or stop.

[6] 24 percent during the "left-side up scheme"(1934–1982), 58 percent during the "right-side up scheme"(1982–1994), and the remaining 18 percent since the introduction of the "traffic separation schemes (TSS)" (1994–2002).

[7] Mendiola S. et al, 1999: Fire ranks second in maritime casualties, IFE Journal, 1.

Shipboard fires which may either be a cargo fire, accommodation fire or engine room fire, may occur suddenly and on some of the occasions their effects are not localised. The hazard ranges from such incidents are upto several cables, or even miles, and there may be some potential for them to impact on shipping routes, particularly in narrow waters.

The nature of oil and refined products carried onboard tankers means that such ships are vulnerable to fires and / or explosions, and the danger of fire onboard such ships is much greater. For that reason, fire safety provisions specified by international regulations are much more stringent for tankers than for ordinary dry cargo ships. The SOLAS Convention therefore contains a special section devoted to fire safety measures for tankers.(SOLAS, Chapter II–2)

Cargo loading and discharging operations pose a threat for tankers and their crew as there is a danger of explosive gas building up inside cargo tanks, and in the late 1960s such happenings led to a number of ships exploding. To avoid this, IMO requires tankers to be fitted with an inert gas system which pumps gas taken from the ship's boiler flue gas system into the cargo tanks during cargo handling operations, thus preventing explosive gases from accumulating.[8]

"Fire leads to serious consequences not only in the carriage of dangerous goods specified by the IMDG Code or timber cargoes on deck*, but also poses a risk to other goods which otherwise would not be dangerous and create a hazard during sea passage – such as sugar, walnuts, cotton, and the like*

[8] IMO,1998: Cutting oil pollution, IMO News,2-1998,17-18.

which can readily be stowed with no apparent fire risk. This kind of cargo burns easily and can become a risk if neighbouring hot work or a faulty mains line causes fire to break out in the cargo hold." (Mendiola *et al.*, 1999)

The most disastrous ship fire / explosion took place in December 30,1917 in Port of Halifax, Canada. The French freighter "Mont Blanc" loaded with high explosives destined for Europe was rammed by the Belgian freighter "Imo" while entering the harbour to meet other ships for a joint Atlantic crossing, including the cruiser HMS "High Flyer". Approximately 15 minutes after the collision the cargo exploded destroying about 50% of the City of Halifax; estimated 3,000 people died and more than 7,500 were injured. Similarly, in December 20th 1987, the ferry "Dona Paz" (designed to carry 1,400 passengers and a crew of 50) crowded with approximately 3,000 passengers collided head-on with the tanker "Victor" loaded with 8,300 barrels of oil; in the subsequent explosion and fire at least 3,000 people died; only 24 passengers survived in Tablas Strait, off Mindoro Island, Philippines.

In the last decade, ships fires have also seriously affected several cruise ships en route and / or in port. Fires broke out in the control room, main switchboard, engine rooms, laundry rooms; auxiliary generator system eventually forced the evacuation of passengers and crew - thanksfully with less injury only.

Marine accidents include groundings and strandings, too. Accident investigations and related studies based on ships 500 GT and over, reveal that stranding / grounding is the leading accident type worldwide. (Mendiola *et al.,* 1999) Similarly, grounding/stranding accidents occurred in the Bosphorus since 1994, after the TSS was implemented, also constitute singly more than half of all shipping accidents in the area.

The tanker *Torrey Canyon* which grounded off the Scilly Isles just 37 years ago was the first major incident of this kind resulting in extensive oil pollution. The Norwegian tanker *Orange Star* went aground in the Bosphorus in December 1997 in the same spot as the bulk carrier *Friendly* a year previously. (Chapman and Akten, 1998) Similarly, the Greek tanker *Sea Salvia* with 81000 tons of Russian crude onboard and en route for the Aegean Sea, ran aground in July 1998 in the same point as the other Greek tanker *Crude Gulf*, loaded with 140800 tons of crude of the same origin, almost a month after, on August 25, when both in the wrong shipping lane at the southern exit of the Bosporus, even blocking the shipping movement for quite some time to and fro the Haydarpasha container terminal.

The grounding of merchant ships may well result in fire and / or explosion particularly should a large tanker involve in such an accident.

Shipping accidents and marine environment

1. **A crucial problem of shipping activities: oil pollution**

Often, a shipping incident or a series of incidents provides a spark for a new regulatory framework of international character. For example, the *Titanic* disaster prompted the first SOLAS Convention; the disastrous grounding of *Torrey Canyon* made its mark and was instrumental in providing the impetus for the MARPOL Convention; the *Estonia* case accelerated the thorough review of the safety of ro/ro ferries; the *Prestige* incident led to increases in the amount of compensation available to the victims of oil spills; both the *Prestige* and *Erika* incidents however caused the regulations surrounding single and double-hull tankers to be reviewed.[9] Hence, the ever growing technical, operational and administrative profiles of shipping are shaped to a great extent by the outcome of such or similar incidents.

Oil pollution from ships was first recognized as a problem during the First World War, but there was no attempt to introduce effective measures concerning accidental and operational oil pollutions, nor to deal with pollution by other substances until the Torrey Canyon disaster occurred in 1967.

The grounding and sinking of the Torrey Canyon off the SW coast of England, which ended up with spilling 120.000 tonnes of oil into the sea, was the worst and biggest oil pollution ever at the time, and for the first time the general public were made aware of the dangers and profound consequences that the carriage of oil posed to the marine environment. Therefore, the Torrey Canyon incident has been the cornerstone for the protection of marine environment. Before this shipping accident however pollution was regarded as a relatively minor problem.

Marine pollution, particularly by oil, is of great importance because the major pollutant in terms of tonnage is oil. Oil is a general expression to designate a viscous liquid having a density less than that of water. It can

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[9] IMO,2003: World maritime day 2003, IMO News–3,18.

include crude oils varying in proportion, and refined oils (such as diesel oil, heavy fuel oil, lubricating oil, kerosene and gasoline). Some oils are toxic to marine life, others are harmful partly due to their smothering effect when deposited. (Smith, 1971)

Oil pollution incidents are caused mostly by shipping activities; either by *ship operations* such as loading or discharging of oil, bunkering, oil transfer etc.(operational pollution) or *ship accidents*, mostly by tankers, such as collision, grounding, hull failures, fire and explosion (accidental pollution). The consequences of an accident can have negative impacts on the affected area, particularly if the accident occurs close to the coastal area.

A large oil spill resulting from a shipping activity, or a series of activities, does not hurt only the people directly involved. Neighbouring economies may also be badly affected as a result of a pollution incident occurred in other state's territorial water. A seaside vacation, swimming, water sports, fishing and fish farming could be ruined by oil pollution. Seafood could be more difficult to find; even harm to fish and wildlife could be immeasurable; the freight of goods carried onboard large ships can increase due to applicable liability compensation(s) after a costly ship accident.

Increasing the dimensions of ships to an incredibly larger size for the good sake of economies of scale has brought in higher risks and ultimately more costly actions in case of emergency. An example to this effect is the m.t. *Atlantic Empress* disaster, off Tobago, West Indies, in 1979 when 287.000 tons of oil polluted the sea.

The first 20 largest oil spills of all time reveal that nearly 2.4 million tonnes of oil entered the sea directly due to accidental as well as operational oil pollutions. The TABLE–1 gives a brief summary of such major spills:

ITOPF has effected a study based on shipping incidents worldwide to shed a light on the causes of oil spills. The study which covers total 9186 incidents occurred within 1974-end 2001 period, has revealed that more than three-fourths of the incidents have been the result of routine ship operations and less than a quarter because of accidents, as shown in Table 2.

Oil spills are generally categorised by size, as < 7 tonnes (small spill),7–700 tonnes (medium spill) and > 700 tonnes (large spill). Large spills mostly resulting from collisions, groundings, strandings, structural damage like hull failure form serious threat for marine environment. However, occurrence of large scale oil pollution from shipping activities have declined over the years. Table 3 shows this achievements.

The amount of oil entering the sea from shipping activities has to agreat extent lessened and was estimated to have fallen from almost 1.57 million tonnes in 1981 to just over 500.000 tonnes in 1990. The figure for 1973 however was 2.1 million tonnes. (IMO, 1998) According to International Tanker Owners Pollution Federation (ITOPF) only 71.000 tonnes of oil was spilt into the sea as a result of tanker accidents.

Table 1. Major oil spills worldwide

Shipname	Year	Location	Oil lost (tonnes)
Atlantic Empress	1979	off Tobago, West Indies	287,000
ABT Summer	1991	700 nautical. Miles off Angola	260,000
Castillo de Bellver	1983	off Saldanha Bay, South Africa	252,000
Amoco Cadiz	1978	off Brittany, France	223,000
Haven	1991	Genoa, Italy	144,000
Odyssey	1988	700 nautical. Miles off Nova Scotia, Canada	132,000
Torrey Canyon	1967	Scilly Isles, UK	119,000
Urquiola	1976	La Coruna, Spain	100,000
Hawaiian Patriot	1977	300 nautical. miles off Honolulu	95,000
Independenta	1979	Bosphorus, Turkey	95,000
Jakob Maersk	1975	Oporto, Portugal	88,000
Braer	1993	Shetland Islands, UK	85,000
Khark 5	1989	120 nautical. miles off Atlantic coast of Morocco	80,000
Aegean Sea	1992	La Coruna, Spain	74,000
Sea Empress	1996	Milford Haven, UK	72,000
Katina P.	1992	off Maputo, Mozambique	72,000
Assimi	1983	55 nautical. Miles off Muscat, Oman	53,000
Metula	1974	Magellan Straits, Chile	50,000
Wafra	1971	off Cape Agulhas, South Africa	40,000
Exxon Valdez	1989	Prince William Sound, Alaska, USA	37,000

N.B:The Exxon Valdez is included because it is so well known although it is not the twentieth largest spill of all time but rather about number 34. Source : Historical data,ITOPF, Table 3. http://www.itopf.com/pastspil.html

The implementations of such internationally accepted rules and regulations reduced operational and accidental pollutions considerably.

2. How about if a LPG casualty occurs?

Dangers and environmental threats did not exist long ago; but it does today. A LPG tanker of 30.000 tonnes dwcc may, in the case that cargo explosion occurs, have an effect of 11 times more than that of the atomic bombs dropped onto Hiroshima and Nagasaki.

Nothing is impossible; it may be argued that a LPG tanker whatever the size is secure enough and petroleum gases carried in cargo tanks in liquefied form do not explode easily; but it can not be measured beforehand how physical or environmental changes can give rise to a violent collision ending up with a very serious threat or how a large fire affects the gas leaking or escaping from a cargo tank...

Without jumping into chemical equations, the energy emitted due to successive explosions in an LPG tanker of 30.000 tonnes dwcc can be calculated as is explained below:

Lower heating value of the LPG carried in tanks:

QLPG (total) = 30.000.000 kg x 40.000 KJ/kg = 1.200.000.000.000 KJ

As 1 kg of dynamite generates energy of 5434 KJ;

Table 2. Incidence of oil spills by causes

Shipping activity	< 7 tonnes	7-700 tonnes	> 700 tonnes	TOTAL Number	Percent
OPERATIONS	**4475**	**371**	**17**	**4863**	**58**
Loading/discharging	2767	299	17	3083	36
Bunkering	541	25	0	566	7
Other operations	1167	47	0	1214	15
ACCIDENTS	**1097**	**547**	**255**	**1899**	**14**
Collisions	163	254	87	504	2
Groundings	222	200	106	528	3
Hull failures	562	77	43	682	7
Fires and explosions	150	16	19	185	2
OTHER/ Unknown	**2221**	**165**	**37**	**2423**	**28**
TOTAL	**7793**	**1083**	**309**	**9185**	**100**

Source: ITOPF (2004), Historical data, Table 4.

Table3. Improvements of oil spills incidence **(1970-2001)**

PERIOD	SPILLS 1	INDEX 1	SPILLS 2	INDEX 2	TOTAL SPILLS	INDEX 3
1970–1979	531	100	242	100	773	100
1980–1989	345	65	89	36	434	56
1990–1999	273	51	73	30	346	44
2000–2001	34		6		40	
TOTAL	1183		410		1593	

Spills 1 : Spill size, 7-700 Tonnes
Spills 2 : Spil size, >700 Tonnes
Source : ITOPF (2004), Historical data,derived from Table 1.

1.200.000.000.0 KJ: 5434 = abt. 220.000.000 kg of dynamite = 220.000 tons of dynamite.

The atomic bombs dropped onto Hirosima on Aug. 5, 1945 was equal to 20.000 tons of dynamite. (Dogru, 1989) Therefore an LPG tanker of 30.000 tons dwcc can generate energy equivalent to approximtely 11 atomic bombs of Hiroshima size.

Another aspect of LPG in case of gas escaping or leakage is the toxicity. As specified in the relevant safety guide, petroleum gas produces narcosis on human being. “The symptoms include headache and eye irritation with dizzines similar to drunkenness. At high concentration these lead to paralysis, insensibility and death”. (ICS, OCIMF and IAPH, 1984)

The human body can tolerate gas concentrations up to 0.2 p.c and irritation of eyes occurs. When the concentration reaches to a level of 0.7 p.c however, drunkenness within 15 minutes takes place and immediate death happens when the concentration is of 2 p.c or 20.000 ppm. (ICS, OCIMF and IAPH, 1984)

3. A study area: The Bosphorus with high accident rate

The Strait of İstanbul, or the Bosphorus, is one of the major and busiest seaways in the world linking the Black Sea to the Sea of Marmara. It is a narrow “S-shaped” channel, open for international shipping. It is also one of the most critical passages in the world for vessels particularly because of its narrowness, its shape with several sharp turns and headlands which limit the opportunity to maintain to a proper look-out and the complex nature and changes of its currents.

Geographical and oceanographic conditions as well as navigational constraints are the main parametres making the navigation through difficult and risky. Additionally, since passage through the Strait entails a run by about 17 nautical miles all the way and takes almost two hours, utmost vigilance is necessary in order to maintain safe standards of navigation and to conduct vessels.

The Montreux Convention relating to the regime of the Turkish Straits establishes freedom of passage and navigation with certain formalities for merchant vessels of any flag and with any kind of cargo,by day and by night,and the Strait is kept open for shipping traffic. Hence the Bosphorus serves as an international seaway of economic and strategic importance.

For the period 1994 – 2002, since the introduction of the TSS the mean of the yearly figures indicates that 132 vessels a day (or nearly 6 vessels an hour) navigate the Strait. When local traffic is taken into account, almost another 2000 crossings a day (or roughly 85 crossings an hour) must be added to this figure. Therefore, it wouldn’t be wrong to say that any time of day nearly 100 “floating bodies” use the Strait – either crossing or proceeding up or down.

The Strait with its dense shipping traffic is second to the Malacca Straits. The Straits of Malacca are the busiest seaway in the World with approximately 300 vessels passage a day (100.000 per year).The Bosphorus follows with an average of 132 vessels transit (passage) a day, local traffic exclusive, and the Dover Strait with approximately 125 vessels passing north-south and 100 crossings a day is the very close third. (Oral, 2001)

Similarly, shipping traffic compared with the main canals of the world shows clearly the high density of the traffic through the Strait:

Table 4. Shipping traffic in the Bosphorus and the main canals
(1999-2000)

canal	*shipping traffic*
Panama Canal	12755
Suez Canal	13552
Kiel Canal	23945
Bosphorus	48000

*Source: Institute of Shipping Economics and Llogistics*Bremen, *yearly statistics*.

In the year 1841 the number of transits was 4125 and this almost tripled in 1856 during the Crimean War to 14170. Today there are around 28000 transits in each direction including *inter alia*, large tankers, chemical product tankers, LNG and LPG carriers as well as local transits. In 1936 when the Montreux Convention was signed and brought into effect, the number of vessels passing through the Bosphorus was 4700; the aggregate tonnage was 9.71 million tonnes and the average vessel size was 2066 nrt. Similar figures for 2002 were 47253 vessels with an aggregate tonnage of 389.4 million tonnes and an average vessel size of 8300 grt. [10]

[10] Corresponding aggregate tonnage figures for previous years was: 318.1 million tonnes in 2001, 309.4 million tonnes in the year 2000.

Over the last 10 years the Turkish Straits have turned into one of the key shipping foci of the world seaborne oil trade, comparable with the Suez Canal, the Straits of Malacca and the Straits of Dover. It was previously the same in 1892 when oil cargoes loaded in the Black Sea port of Batumi were delivered by tankers which passed through the Turkish Straits to their customers in the Far East. Nearly 123 millon tons of oil passed through the Turkish Straits in 2002, representing 5 per cent of the oil traded by sea.[11] The number of tankers passing through the Strait of Istanbul in the year 2002 was 5188.[12] In other words, 15 tankers per day, large or small, laden or in ballast, sailed through the Bosphorus. Similarly, a further 1330 tankers carrying LPG and chemicals used the Bosphorus, an additional 4 tankers a day - but smaller in size.

Currents and darkness are the two dominant factors causing marine accidents in the Bosphorus. The complex and day-to-day changing character of the prevalent surface current, as well as the large course alterations that vessels have to make with or against the main current, cause the difficulties. Most of the incidents occur when vessels travelling with the current taking sharp turns lose their manoeuvrability. There are critical areas in the Strait, such as Yenikoy and Umuryeri (or Umur Banki) where most of the stranding and grounding accidents occur as vessels negotiate sharp turns (80º at Yenikoy, 70º at Umuryeri). More than half of the grounding and stranding incidents in

[11] Corresponding figures for previous years in terms of million tons was as follows: 61 in 1997, 67 in 1998, 85 in 1999, 91 in 2000, 101 in 2001, 123 in the year 2002 respectively.

[12] Figures for number of tankers passed through for previous years was as follows: 4248 in 1996, 4303 in 1997, 5142 in 1998, 5504 in 1999, 6093 in 2000, and 6516 in the year 2001.

the Bosphorus since 1994 in which the Traffic Separation Scheme (TSS) was introduced have occurred at these two critical points. Specifically, 26 such casualties took place in Yenikoy and Umuryeri areas (13 in Yenikoy, 13 in Umuryeri) out of the total 45. (Akten, 2004)

A total of 461 marine accidents of different types (i.e 209 collisions, 138 groundings, 77 strandings, 28 fires / explosions and 9 others, such as rudder blockage, vessel's list, or engine breakdown) occurred in this tricky strip of water during the period 1953–2002,[13] the majority being collisions. Since 1994 after the TSS was implemented there have been 82 shipping accidents the majority of which have been groundings / strandings. Groundings and strandings having occurred in the Bosphorus constitute 55 percent of all incidents with the major risk factors being currents, sharp turns and darkness. (Akten, 2004)

Shipping accidents ended up with mostly oil pollution, large or medium scale, have also occurred in the Bosphorus Region and around 200.000 tons of oil spilled into the sea. Such accidents with oil spill are listed in Table 5.

The Independenta disaster, one of the majors in the world, besides its fire and explosion threats to the Istanbul area and Istanbuller also added a new but serious dimension to the environmental performance, namely the air pollution. The emission of SO_2 NO_x and particles given to the atmosphere were equal to the daily emission of the whole city in winter. In the six days period almost 480 tons of SO_2 and 104 tons of NO_x were emitted to the

[13] 24 percent during the "left-side up scheme"(1934–1982), 58 percent during the "right-side up scheme"(1982–1994), and the remaining 18 percent since the introduction of the "traffic separation schemes".

atmosphere in that area. It is clear that emissions had an impact on the acidic rains measured regionally, as a consequence of emissions and particles being carried to quite remote distances. (Erturk, 1994) Safe navigation in the Bosphorus is a matter of vital importance to Turkey as well as to all nations using the Strait. Therefore, the dangers posed by ever increasing shipping traffic to the surrounding inhabited areas and to the environment have compelled.

Table 5. Oil spills in the Bosphorus

Date	Vessel name and flag	Accident area	Accident type and oil spilt
14.12.1960	World Harmony (Greek) v. Peter Zoranic (Yugoslav)	Kanlıca	Collision and fire: 18.000 tons oil spilled
15.09.1964	Norborn (Norwegian) v. wreck of Peter Zoranic	Kanlıca	Contact: fire and oil spilled
01.03.1966	Lutsk(USSR) v.Kransky Oktiabr (USSR)	Kızkulesi	Collision and fire: 1.850 tons oil spilled
15.11.1979	Independentia (Romania) v.Evriali (Greek)	Haydarpaşa	Collision and fire:94.600 tons oil spilled
09.11.1980	Nordic Faith(British) v.Stavanda (Greek)	-	Collision and fire
29.10.1988	Bluestar (Malta) Gaziantep (Turkish)	Ahırkapı	Contacted m.t. Gaziantep; 1000 tons ammonia spill
25.03.1990	Jambur(Iraqi) v. Da Tung Shan(Chinese)	Sarıyer	Collision : 2.600 tons oil spilled
14.11.1991	Madonna Lily (Philippines) Rabunion 18 (Lebanese)	Kanlıca	Collision: 20.000 live animals drowned
13.03.1994	Nassia (Philippines)v.		Collision and fire : 9.000 tons oil spilled; 20.000 tons oil fired
07.10.2002	Gotia (Greek)	Bebek	Collision and stranding : 22 tons oil spilled

Turkey to take immediate action and to reinforce existing regulations of maritime traffic in the Strait

Marine casualties occurring in the Bosphorus involve local factors and are mostly of international interest. Therefore, having studied the casualty cases in-depth one may deduce either one or some of the following reasons are major factors and suggest possible solutions:

Factor	*possible solution(s)*
Ships proceeding without a pilot	compulsory pilotage / VTS or VTMIS
Bad weather conditions	delay passage
Dense marine traffic	VTS
Technical inadequacy of ship	-
Complex and day-to-day changing nature of current	navigation advisory; take pilot
Lack of adequate knowledge about region	take pilot; VTS
Loss of alertness and caution impeding the safe passage	delay passage
Existence of areas with sharp turns	take pilot; VTS
Darkness and background shore lightings	exercise extreme caution
Improper conduct of vessels within the TSS	VTS; take pilot

The Strait separates the metropolitan area of Istanbul into two almost equal parts and due to the over-crowded character of the area the consequence of any shipping accident is potentially catastrophic. The city, with its 15 million inhabitants, has so far been fortunate to have escaped relatively undamaged. (Chapman and Akten, 1998)

Conclusion

1. Safer shipping ahead

Shipping accidents of today have become more “environmental” and the issue has been though than ever for all parties concerned, as those may end up with huge financial losses. Shipping accidents are also a threat to smooth flow of shipping trade and damage to the environment.

Ships are exposed to various external hazards such as darkness, different visibility conditions, bad weather, and currents, which one way or another, may contribute to shipping accidents like collisions, strandings or groundings. Bad look-outs, not taking the proper action until a very late stage, close presence of a third ship which prevents taking early action and a late proper maneuver as against the crossing, overtaking and meeting end-on rules, etc. also constitute the internal threats of such incidents.

Almost every new ship built today and very many others as existing ships are fitted with sophisticated shipboard equipment to reduce navigational risks, sustain and enhance safety of life and property, and preserve the environment.

Merchant ships now rely heavily on instrumentation more than ever for safe navigation and a collision-free voyage. Ships are fitted with a receiver for a global navigation satellite system (GPS / DGPS or GLONASS), or a terrestrial radionavigation system (LORAN-C), or other suitable means, for use at all times throughout the intended voyage to establish and update the ship's position automatically.

A Number of recent collisions and serious accidents have been caused far too frequently by failure to make proper use of collision avoidance aids and over-reliance on navigational equipment; several others too have been attributed to fatigue.

The modern ship's of today is full of equipment – some very sophisticated and some less so. As the equipment gets more sophisticated, watch-keeper or assigned officer has less chance of really understanding the principles of how it works and may tend to forget the errors that might occur and how they should be corrected. (Signal, 2000) All those, one way or other, may ultimately lead to human errors.

Admiral John LANG, MAIB Chief Inspector, in one his statements suggested the following solutions to the problem associated closely with effective interfacing of the "*human-equipment factors*": (GARD, 2002)

- An ability to operate the system or equipment correctly,
- An understanding of any limitations and awareness of the distraction factor,
- Standardization of the equipment layout, thus the proper operation of high-technology equipment

Collisions and accidents keep occurring though the collision avoidance aids is getting more and more advanced. Numerous recent examples have reflected how seafarers made expensive and even tragic mistakes in spite of the sophisticated technology available. Developments in collision avoidance technology have centered on making the equipment robust and more reliable, and the outcome mostly being less time-consuming operation(s) with better reaction time.

Today's sophisticated shipboard equipment and collision avoidance aids in particular, are tailor-made and operate effectively. But there are dangers in the incorrect / improper use of the bridge equipment. Some of the collision avoidance aids that watch keepers rely on heavily may also contribute to the cause of a collision or accident if not treated properly. Therefore it is still imperative that emphases be placed on issues such as:

- improving the "human-equipment" interface,
- awareness of the distraction factor, and,
- clear understanding of any limitations that collision avoidance aids may have,

for better yield of the collision avoidance aids.

Shipping is and always will be full of risks despite high and ever increasing safety standards. Nevertheless, improved standards for ships, seafarers and management, development of navigational aids, and inclusion of traffic separation schemes for collision avoidance by way of internationally adopted measures have all made and will make a major impact on shipping safety and benefit the health of the oceans by reducing oil pollution.

“Even on the most modern ship, the most sophisticated navigational instrument is still the human being, and one of the problems could be that those human beings are starting to rely too much on particular pieces of equipment and not enough on their own common sense, experience and training.” (O’Neill: 1999)

No matter how sophisticated navigational aids and safety devices are onboard ships, and how far mathematically planned, computerized and automated the voyages are, human fallibility will always exist and remain the prime cause of accidents in navigable waters.

Özet

Deniz kazası can, mal ya da her ikisinin kaybı şeklinde ortaya çıkan ve maddi zararla sonuçlanan kazalar için kullanılan bir terimdir. Deniz kazalarının nedenleri çok ve karmaşıktır. Artan gemi tonajları aynı biçimde yük ve yolcu kapasitesinde artış getirmiştir. Dolayısıyla bir deniz kazası meydana geldiğinde can ve mal riskindeki boyut da giderek yükselmektedir. Büyük boy gemilerde tonaj ölçeğine bağlı olarak azalan manevra yeteneği gemi kazalarının oluşumunda katkı sağlayan bir unsurdur.

Gemi kazalarının doğumunda çeşitli kritik unsurlar rol oynar. Doğa koşulları, teknik zafiyetler, rota şartları, gemi ve yük kökenli unsurlar, insan hataları bu bağlamda en çok göze çarpanlarıdır.

Gemi kazaları çeşit olarak sayılamayacak kadar çoktur ve deniz çevresine olan etkileri açısından biri diğerinden farklılık gösterir. Çatışma ya da çatma, alabora olma, batma, kırılma, oturma, kıyıya bindirme, arıza, yangın ve patlama sıradan gemi kazalarının örnekleridir.

Gemi kazaları arasında ön sırayı alanlar oturma ve gemi yangınlarıdır.

Torrey Canyon faciası deniz çevresinin korunması açısından köşe taşı olmuştur. Dünyanın önde gelen gelmiş-geçmiş 20 büyük ölçekli deniz kazası deniz çevresine yaklaşık 2.4 milyon ton yakıtın döküldüğünü ortaya koymaktadır.

Deniz taşımacılığı giderek yükselen emniyet standartlarına karşın hep risklerle doludur ve olmayı da sürdürecektir. Yine de uluslar arası genel kabul görmüş yönetim, eğitim ve emniyet önlemleri deniz taşımacılığının daha güvenle yapılması ve daha temiz deniz çevresi için olumlu adımlar olmuştur, olmaya da devam edecektir.

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