THE JOURNAL OF NAVIGATION (2004), **57**, 345–356. © The Royal Institute of Navigation
DOI: 10.1017/S0373463304002826 Printed in the United Kingdom

# Analysis of Shipping Casualties in the Bosphorus

Necmettin Akten

(*Institute of Marine Sciences and Management*, *Istanbul University*, *Turkey*)
(Email: necmettinakten@hotmail.com)

The Strait of Istanbul which constitutes one of the major and busiest seaways in the world links the Black Sea to the Sea of Marmara, it is a narrow ''S-shaped'' channel, open day and night for international shipping. Currents and darkness are the two dominant factors causing marine casualties in the Bosphorus. In this regard, Yenikoy and Umuryeri (or Umur Banki) are the two critical areas where most of the stranding and grounding casualties occur as vessels negotiate sharp turns (80° at Yenikoy, 70° at Umuryeri). The casualty case investigations reveal that in most of the incidents, vessels lose their manoeuvrability in the course of taking a sharp turn with the current. The number of casualties occurring in darkness was found to be nearly twice the number of occurring in daylight. A total of 461 marine casualties of different types occurred in this tricky strip of water during the period 1953–2002, the majority being collisions. Since 1994 when the TSS was introduced there have been 82 marine casualties the majority of which have been groundings/strandings.

This paper examines marine casualties in-depth in relation to casualty types, numbers of ships, the localities where most incidents occur, and external factors such as currents and darkness that contribute to marine casualties in the Strait. The major factors are deduced in order to suggest possible solutions.

KEY WORDS

1. Bosphorus. 2. Shipping casualties.

1. INTRODUCTION. Ships trade in a complex and high-risk operating environment and many shipping casualties still occur at sea as well as in restricted waters. Shipping casualty is a term usually used for any accident involving ships which results in financial loss either to a ship or to property. Casualties can be caused by a variety of means, by collision or contact, capsize, foundering, sinking, breaking-up, grounding, stranding, fire or explosion, breakdown of the ship underway, or bad weather conditions.[1] The contributory factors to the seriousness of shipping casualties are many and complex. The increase in the size of ships to achieve economies in transport cost has major effects. A bigger size brings a corresponding

[1] *Maritime casualty* means a collision of ships, stranding or other incident of navigation, or other occurrence on board a ship or external to it resulting in material damage or imminent threat of material damage to a ship or cargo. (International Convention relating to intervention on the high seas in cases of oil pollution casualties, Brussels, November 29, 1969, Article II(1).)

increase in cargo and passenger capacity; hence when a casualty occurs, the risk to life and property immediately becomes higher. A larger ship will have a reduced manoeuvrability, which ultimately is an increased risk, especially in restricted water (Chapman and Akten, 1998).

An accident, whatever its nature, is every seafarer's nightmare and is likely to be subjected to fierce public scrutiny. An accident may take different shapes, from a single operational mishap to a possible major regional catastrophe. Should it occur in a channel or a strait, where the shipping traffic is dense, the sea-room is relatively insufficient and depth of water is rather restricted, serious risks are likely to be faced (Akten, 2002).

The safe operation and handling of ships relies mainly on the standards of seafarers' knowledge rather than the sophistication of the ship's equipment and condition. Statistical analyses of the main causal trends explicitly reveal that human errors, though declining marginally, continue to be the major cause for all shipping accidents and are cited in almost 80 percent of accidents. Consequently, the acts or omissions of seafarers play a significant part in almost every accident.

The density of vessel traffic is second to human errors as a contributing factor for shipping casualties, particularly in those narrow areas such as straits, channels and port approaches where sea-room is insufficient. In such areas close-quarter situations frequently exist and more ships are concentrated. This paper examines the shipping casualties in a very restricted waterway, the Strait of Istanbul. Section 2 of the paper is a general description of the Strait followed by an examination in Section 3 of the key factors the Strait contributes to accidents. The historic and current measures taken to provide safe passage through the Strait are outlined in Section 4 and an analysis of the traffic density is contained in Section 5. Section 6 identifies the types of casualties and the conclusion, with suggestions for methods to reduce the number of occurrences is found in Section 7.

## 2. THE STRAIT OF ISTANBUL.

2.1. *General description*. The Strait of Istanbul, the Bosphorus, is roughly a "S-shaped" channel and links the Black Sea to the Sea of Marmara. It is thus an integral part of the Turkish Straits, which comprises the Dardanelles, the Sea of Marmara and the Bosphorus, the whole area being known as the Turkish Straits Region (TSR), which constitutes one of the major and busiest seaways. Figure 1 shows a sketch of the Strait and includes an indication of the location of marine accidents between 1982 and 2003. The Strait of Istanbul lies between latitudes 41° 01′ N and 41° 13′ N and is about 17 nautical miles long, with an average width of just 8 cables. The shores on both sides are densely populated and closely-packed buildings are interspersed with parks, gardens and restaurants. The European or west side is built-up with houses and many historical buildings throughout its length, whereas on the Asian or east side the buildings are scattered and backed by vegetation covered hills. There are sixteen headlands that affect navigation in the Strait – nine of which are on the European side and the remaining seven on the Asian. The trends and width of the Strait restrict a significant range of visibility in many parts of the navigable channel (Akten, 1968). Several sharp turns within the Strait exist in areas such as Umuryeri, Yenikoy, Kanlica, Kandilli and Kizkulesi (45° at Kandilli, 80° at Yenikoy, 70° at Umur Banki or Umuryeri).

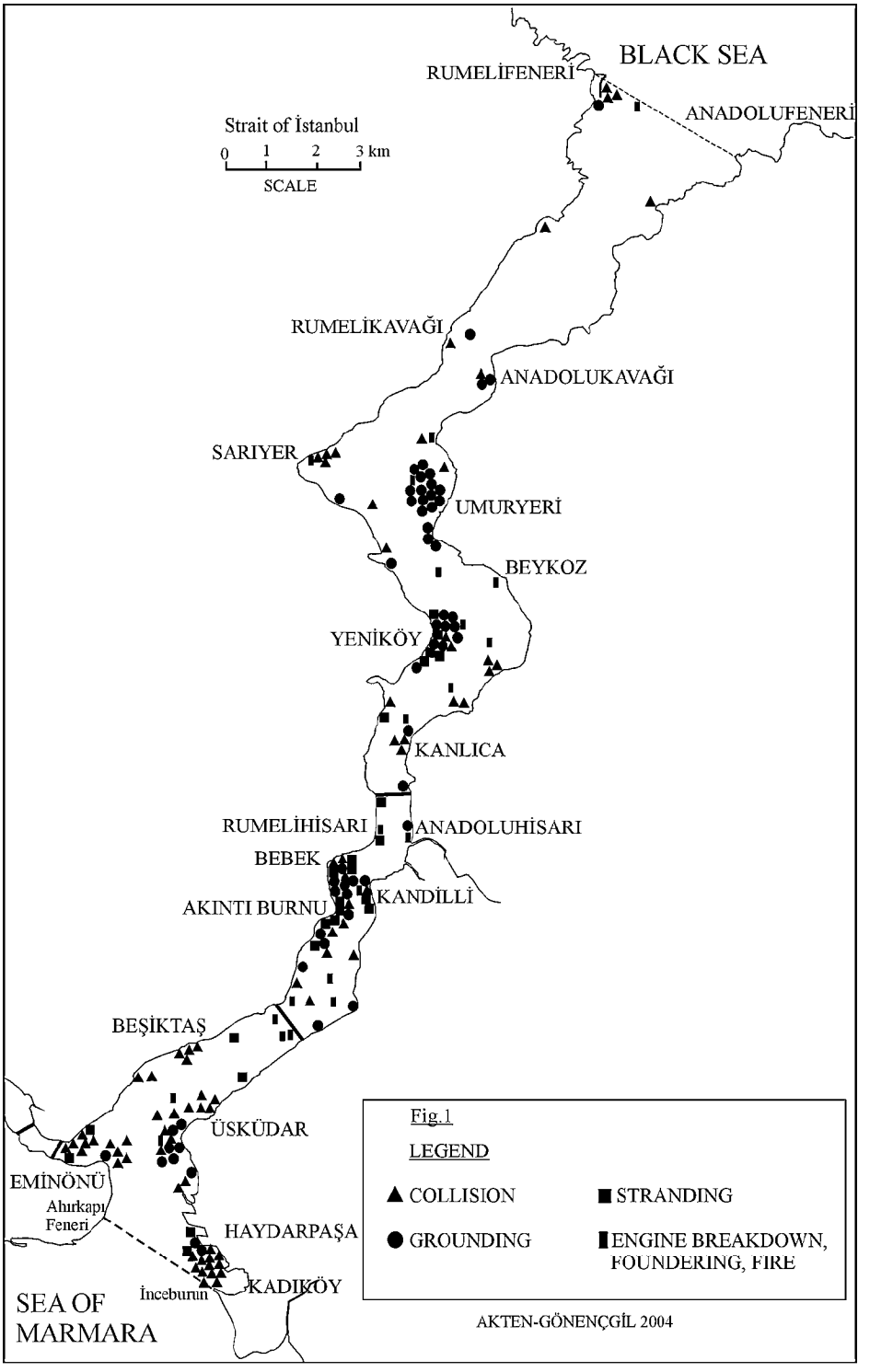


Figure 1. Marine accidents in the Strait of Istanbul (1982–2003).

https://doi.org/10.1017/S0373463304002826 Published online by Cambridge University Press

The narrowest part of the Strait is the Istinye-Kandilli area, laying almost midway along the Strait, where the width is merely 0·4 nautical mile and where a strong current, usually known as ''Sheytan akintisi – devil's current'', sets. The average rate is 4 knots but it can reach about 8 knots. The Strait of Istanbul resembles a river with abrupt and angular windings and is partly bordered on both sides by steep and mountainous coasts.

2.2. *Navigational marks.* Coastal lights are used on both sides to clearly indicate the lateral ends of the navigable channel. The Anatolian coast is considered the portside and accordingly the lights exhibit red lights; the European coast is considered the starboard side and the lights thus exhibit green lights. (Admiralty, 1955, 1990) Therefore, the lateral system as such is used in the Bosphorus in conjunction with a conventional direction for marking the channel. The conventional direction in the Bosphorus as far as the deployed lights/marks are taken into consideration may be defined as ''the direction taken by the seafarer when approaching the Channel from seaward''. Thus, the term ''from seaward'' accordingly indicates the direction of marking taken from the Black Sea towards the Sea of Marmara.

The lateral system is used to define the starboard and port sides of a channel and lateral marks/lights are usually deployed to indicate the starboard and port sides of the route to be followed. Marking the channel aims to help a seafarer of any nationality to navigate safely and to fix the ship's position in the channel, as well as to avoid a possible danger without fear of ambiguity and thus to contribute affirmatively to safety of life and property in the region. There are 24 coastal lights in total, twelve on each side, and 8 navigation buoys to mark the safe passage in the Strait.

The Strait is a singularly tricky strip of water. Due to angular windings, transits, up or down, require at least 12 major alterations of course as much as 80°, with severely limited vision around these bends. The shape of the Strait limits the extended sight line needed for a proper lookout particularly beyond several headlands, which conceal the view of the oncoming traffic.

## 3. KEY FACTORS CAUSING MARINE CASUALTIES.

Currents and darkness are the two dominant factors causing marine casualties in the Bosphorus. There are two main crucial areas in the Bosphorus, Yenikoy and Umuryeri, where most of the stranding and grounding casualties take place. The complex and day-to-day changing character of the prevalent 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 casualties occur when vessels travelling with the current take sharp turns and lose their manoeuvrability. More than half of the grounding and stranding casualties in the Bosphorus since 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.

3.1. *Currents.* Two types of current are dominant in the Bosphorus, the main surface (or kanal) current and the undercurrent. The main surface current is a slope current – the primary cause being that the level of the Black Sea is about 0·4 metres higher than that of the Sea of Marmara because of the excessive flow of water into the Black Sea discharged by the rivers. The undercurrent however is of a density type.

The main surface current, almost invariably setting southward, may reach up to 8 knots when northerly winds are severe and the rivers discharge the greatest volume of water into the Black Sea. However, under the influence of strong southerly winds of prolonged duration, the water level in the Bosphorus rises by as much as 0·6 metres and this reduces the rate of surface current, or even reverses the direction, i.e. flowing towards the Black Sea. Such a current is locally named the Orkoz.

The Orkoz, although it is quite infrequent, is a typical drift current that can be seen in the Straits between November and January, sometimes as late as February. It is triggered by depressions which settle near or travel over the region. The strong southerly winds push the surface waters towards the Black Sea and they pile up along the coasts of the Strait so that the slope of the sea level is upwards to the coasts. The stronger the wind the greater is the rise in the sea level, ultimately the Orkoz is stronger. The farthest distance that Orkoz may reach in the Strait is in the vicinity of Kavaklar Points, almost at the entrance to the Black Sea. It has been noticed that Orkoz slackens within 24 hours however far it reaches towards the northernmost limit of the Kavaklar region, and the main current sets in its usual direction.

3.2. *Darkness.* Night at sea is the period between sunset and sunrise. Navigating at night is in many ways easier than in daylight. Though the general features of land disappear in the few hours after dusk and it is difficult to see much, the unambiguous pinpoint lights of the salient navigation marks are easily identified. Nevertheless, darkness is one of the major impacts on marine casualties not only in confined waters but also upon the high seas. In daytime and in a visual situation it is easier to judge speed and distance, and to notice any change of aspect of other vessels around. To judge distance and to estimate the visibility is rather difficult at night (and similarly in restricted visibility) and can even lead to confusion as the visibility naturally deteriorates. Therefore navigating in darkness, even on a clear night, may require special care for reasons such as:

- Areas where there are bright and scattered background lighting from the shore can cause confusion, and,
- The lights thereby reduce the range of visibility, and,
- Sailing lights are hardly visible because of background lighting from the shore, and,
- Unlit navigational hazards affect navigational safety.

In the Strait visibility can be restricted by several meteorological factors such as heavy rain, snow and fog; strong winds and gales, although not very common, can adversely affect navigation. However, these contributing factors are quite limited, and on average account for 5–8% of days in any year (Akten, 1996). Darkness or restricted visibility requires extra care and a slower speed for safe navigation in the Turkish Straits and the Bosphorus in particular.

The Strait is a risk generator from the point of view of maintaining a safe passage at night. The presence of bright background shore lights and the proximity of navigational hazards, like abrupt and angular windings, reduce the safety of navigation. For example, because of the presence of background lights from restaurants, city and residential illuminations and moving cars, sailing lights are barely visible. It has been computed that the lights exhibited on both sides of the Strait with a typical nominal range of 8 nautical miles are visible only to 1·9 nautical miles at night (Chapman and Akten, 1998).

Deep and steep like a narrow canyon through most of its length, the Strait restricts visibility and thus there is a need for a good and alert lookout at night on ships in transit. In the channel there are few shallows or sandbars where errant ships might ground before smashing into the many villas and apartments that line the shore (Chelminsky, 1998). The advice in the Black Sea Pilot which states, "*no stranger should attempt to navigate the Strait by night*" (Admiralty, 1955) is a sincere warning for all those interested in safer navigation in the Bosphorus, as darkness is one of the dominant factors on marine casualties in the Strait. The number of casualties occurring in darkness was found to be nearly twice the number occurring in daylight for the period 1994–2002.[2] The IMO recommendations on navigation through the Strait of Istanbul encourages daylight transit to prevent possible large-scale casualties and states "*Vessels having a maximum draught of 15 m or more and vessels over 200 m in length are advised to navigate the Strait in daylight*" (IMO, 1995).

4. MEASURES – PAST AND PRESENT. A "left-side up" navigation scheme was applicable in the Bosphorus within the period 1934–1982. According to Article 25 of the Collision Regulations in force at that time, vessels proceeding from the Sea of Marmara had to keep the port (European) side of the channel and as close inshore as possible to avoid collisions. From 1 May 1982 however, the Collisions Regulations 1972 became fully applicable, and hence a "right-side up" scheme now applies in the Strait (Chapman and Akten, 1998). Turkey introduced Traffic Separation Schemes, in full compliance with Rule 10 of the ColRegs 72, in the Turkish Straits Region, the Strait of Istanbul inclusive, to enhance safety of navigation. TSS are implemented to ease and regulate traffic flow, and to prevent ships approaching head on to each other in the busy seaways where shipping traffic is dense and sea-room is restricted or insufficient. The new TSS was approved by IMO and formally adopted on 25th November 1994. According to the scheme a transit route, divided into north- and south-bound traffic lanes, has been established all the way through the Strait and vessels, during transit of the Strait, shall not overtake, nor attempt to overtake, other vessels unless forced to do so and not to cross the median line of the transit route. The new schemes have been in use since 1 July 1994. Prior the current status, groundings and collisions were increasingly regular occurrences in the area. Implementation allows two-way traffic to ensure the "innocent passage" of any vessel. However, when a large vessel is enjoying the freedom of passage afforded by the Strait, an authoritative intervention of some sort is needed to avoid a potential collision.

As an international seaway, the Turkish Straits, and accordingly the Bosphorus, is kept open for two-way traffic and all merchant ships enjoy freedom of navigation through it. For large vessels, which cannot comply with the requirements of the schemes, the temporary suspension of two-way traffic, when needed, is envisaged by the Rules to ensure a "no-collision" situation. This protects the interests of vessels passing through, as well as the safety of local inhabitants and the environment. Such a suspension of two-way traffic is necessary because it is impossible for

[2] In an earlier study, covering worldwide collisions occurring in coastal waters or the open sea but narrow straits such as the Sound, the Bosphorus and the Strait of Messina excluded, number of casualties occurring in darkness under clear weather conditions was found to be three times than that of in daylight. (Cockroft, 1982)

Table 1. Development of shipping traffic in the Bosphorus.

| Year | Number of vessels passed | Yearly increase (1936 = 100) |
|---|---|---|
| 1841 | 4125 | 88 |
| 1856 | 14 170 | 301 |
| 1910 | 35 256 | 750 |
| 1936 | 4700 | 100 |
| 1982 | 12 983 | 276 |
| 1994 | 18 720 | 398 |
| 2000 | 48 079 | 1023 |
| 2002 | 47 253 | 1005 |

N.B. From 1994 onwards the totals include local shipping traffic using the Strait.

large vessels when rounding a narrow bend with a following current to keep to the lane without crossing over the centre of the channel. This is particularly relevant in the Rumelihisari-Anadoluhisari area, which is the narrowest part of the Bosphorus (Chapman and Akten, 1998).

In order to prevent damage to the coasts, coastal structures and small craft, vessels must proceed at moderate speed within the Strait. On no account is a speed of 10 knots to be exceeded by ships throughout their passage in the Bosphorus.

5. MARITIME TRAFFIC. The Strait of Istanbul, or the Bosphorus, is one of the busiest seaways in the world. 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 would not be incorrect to note that at any time of day nearly 100 "floating bodies" use the Strait – either crossing or proceeding up or down.

In the year 1841 the number of transits was 4125 and this almost tripled in 1856 during the Crimean War to 14 170. Today there are around 24 000 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 47 253 vessels with an aggregate tonnage of 389·4 million tonnes and an average vessel size of 8300 grt.[3] Table 1 shows the development of shipping traffic in the Bosphorus, taking the traffic figure for the year 1936 as the basis (1936 = 100). (Stewig, 1965; Turkish Maritime Undersecretariat 1994 to 2002.)

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

[3] Corresponding aggregate tonnage figures for previous years was: 318·1 million tonnes in 2001, 309·4 million tonnes in the year 2000.

Table 2. Shipping traffic and marine casualties in the Bosphorus.

| Year | Number of transits | Casualties | |
|---|---|---|---|
| | | Number | Per ten thousand |
| 1994 | 18 720 | 3* | 2·7 |
| 1995 | 46 954 | 5 | 1·1 |
| 1996 | 49 952 | 8 | 1·6 |
| 1997 | 50 942 | 9 | 1·8 |
| 1998 | 49 304 | 20 | 4·1 |
| 1999 | 47 906 | 6 | 1·3 |
| 2000 | 48 079 | 7 | 1·5 |
| 2001 | 42 637 | 13 | 3·0 |
| 2002 | 47 253 | 11 | 2·1 |
| **Yearly average** | **47 264** | **9** | **2·1** |

* Annual casualty figure is 12.

through the Turkish Straits to their customers in the Far East. Nearly 123 million tons of oil passed through the Turkish Straits last year, representing 5 per cent of the oil traded by sea.[4] The number of tankers passing through the Strait of Istanbul last year was 5188.[5] 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.

The Turkish Maritime Undersecretariat has produced casualty records for the Istanbul area from 1994 to 2002 and they provide the source for the statistics in Tables 2 to 9. Table 2 reveals that within the current Traffic Separation Schemes period around 47 000 vessels annually transit the Strait and 82 marine casualties occurred.

The figure for 1995 indicates a sharp increase by 150 per cent compared with 1994. This is mainly because all vessels of 500 grt and upward, including local shipping traffic, are included in the maritime traffic schemes and are required by the Bye-law in force for international shipping traffic to submit sailing plan I and II. A large vessel is specified in the Turkish Bye-law as "*a vessel 200 metres or more in length*". Such large vessels use the Strait despite the navigational constraints for such vessels and constitute nearly 5 per cent of the total traffic. The development of large vessel traffic in the Bosphorus is shown in Table 3.

The largest vessels to have used the Strait so far were two tankers and a bulker of very large size (TUMPA, 2003):

- Kanchen Junga, Indian tanker, 139 820 grt, 283 878 dwt, length 333 m, breadth 52 m (01.01.1990),
- Agip Lazio, Italian tanker, 127 070 grt, 254 659 dwt, length 349 m, breadth 52 m (25.05.1990),
- S. G. Enterprise, Bahamanian bulker, 108 083 grt, 211 201 dwt, length 312 m, breadth 50 m (05.08.2000).

[4] 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.

[5] 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.

Table 3. Large vessel traffic in the Bosphorus.

| Year | Bosphorus traffic total | Large vessel total | Daily average |
|---|---|---|---|
| 1994 | 18 720 | — | — |
| 1995 | 46 954 | — | — |
| 1996 | 49 952 | 3720 | 10 |
| 1997 | 50 942 | 6487 | 18 |
| 1998 | 49 304 | 1943 | 5 |
| 1999 | 47 906 | 2168 | 6 |
| 2000 | 48 079 | 2203 | 6 |
| 2001 | 42 637 | 2453 | 7 |
| 2002 | 47 253 | 3013 | 8 |

Table 4. Marine casualties in the Bosphorus (1953–2002).

| Navigation scheme | Period | Collision | Grounding | Stranding | Fire/explosion | Others* | **Total** |
|---|---|---|---|---|---|---|---|
| "left-side up" | 1953–1982 | 79 | 17 | 14 | none | — | **110** |
| "right–side up" | 1982–1994 | 105 | 89 | 50 | 25 | — | **269** |
| Traffic Separation Schemes | 1994–2002 | 25 | 32 | 130 | 3 | 9 | **82** |
| **Total** | **1953–2002** | **209** | **138** | **77** | **28** | **9** | **461** |

* Others include rudder blockage, vessel list and engine breakdown.

Table 5. Marine casualties in the Bosphorus in TSSs period.

| Year | Collision | Grounding | Stranding | Fire/explosion | Others | **Total** |
|---|---|---|---|---|---|---|
| 1994 (from 1 Jul) | 2 | 1 | — | — | — | **3** |
| 1995 | 2 | 2 | 1 | — | — | **5** |
| 1996 | 1 | 4 | 3 | — | — | **8** |
| 1997 | 4 | 4 | 1 | — | — | **9** |
| 1998 | 6 | 7 | 4 | 1 | 2 | **20** |
| 1999 | 1 | 1 | — | 1 | 3 | **6** |
| 2000 | 1 | 2 | 2 | 1 | 1 | **7** |
| 2001 | 4 | 6 | 1 | — | 2 | **13** |
| 2002 | 4 | 5 | 1 | — | 1 | **11** |
| **Total** | **25** | **32** | **13** | **3** | **9** | **82** |

6. CASUALTIES. During the period 1953–2002, the Strait has had 461 marine casualties of different types, 24 per cent during the "left-side up scheme", 58 per cent during the "right-side up scheme" and the remaining 18 per cent since the introduction of the "traffic separation schemes". Table 4 provides the breakdown of casualty groups under the different navigation schemes during this period.

Table 5 classifies the 82 shipping casualties in the Strait between 1994–2002 under the TSS scheme, all of which occurred within the TSS zone. The *others* column

https://doi.org/10.1017/S0373463304002826 Published online by Cambridge University Press

Table 6. The Bosphorus. Marine casualties in darkness and daylight.

| Type of casualty | Darkness | Daylight | Darkness/daylight ratio |
|---|---|---|---|
| Collision | 17 | 8 | 2·1 |
| Grounding | 24 | 8 | 3·0 |
| Stranding | 8 | 5 | 1·6 |
| Fire/explosion | — | 3 | 0·0 |
| Others | 4 | 5 | 0·8 |
| **Total** | **53** | **29** | **1·8** |

Table 7. The Bosphorus. Marine casualties by group in darkness (a) and daylight (b).

| | Collision | | Grounding | | Stranding | | Fire/explosion | | Others | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | (a) | (b) | (a) | (b) | (a) | (b) | (a) | (b) | (a) | (b) | **Total** |
| 1994 | 2 | — | 1 | — | — | — | — | — | — | — | **3** |
| 1995 | 1 | 1 | 2 | — | 1 | — | — | — | — | — | **5** |
| 1996 | 1 | — | 1 | 3 | 2 | 1 | — | — | — | — | **8** |
| 1997 | 3 | 1 | 3 | 1 | — | 1 | — | — | — | — | **9** |
| 1998 | 2 | 4 | 6 | 1 | 3 | 1 | — | 1 | 1 | 1 | **20** |
| 1999 | 1 | — | 1 | — | — | — | — | 1 | 2 | 1 | **6** |
| 2000 | 1 | — | 2 | — | 1 | 1 | — | 1 | — | 1 | **7** |
| 2001 | 3 | 1 | 5 | 1 | — | 1 | — | — | 1 | 1 | **13** |
| 2002 | — | — | 3 | — | — | — | — | — | — | 1 | **11** |
| **Total** | **17** | **8** | **24** | **8** | **8** | **5** | **—** | **3** | **4** | **5** | **82** |

includes engine breakdown, rudder blockage and listing; and two of the four collisions listed for 2002 were touching incidents.

Ships spend quite a long time in transit between ports and necessarily travel in different visibility conditions, including darkness, which can contribute to marine casualties. A breakdown of the numbers of casualties known to have occurred during darkness and daylight, are shown in Table 6, classified by main casualty group in Table 7 and in 2 hourly periods throughout the day in Table 8.

## 7. CONCLUSION.

The Bosphorus is 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. 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 marine casualty is potentially catastrophic. The city, with its 15 million inhabitants, has so far been fortunate to have escaped relatively undamaged (Chapman and Akten, 1998).

Groundings and strandings are the major casualty types that occur in the Bosphorus constituting 55 per cent of all casualties with the major risk factors being currents, sharp turns and darkness. Their share compared with other casualty types, are shown in Table 9. The localities with a high risk of grounding or stranding

Table 8. The Bosphorus. Hourly breakdown by casualty groups.

| Hours | Collision | Grounding | Stranding | Fire/explosion | Others | **Total** |
|---|---|---|---|---|---|---|
| 0600–0800 | 2 | 2 | | | 1 | **5** |
| 0800–1000 | 2 | 2 | 1 | | | **5** |
| 1000–1200 | | 1 | 2 | | 2 | **5** |
| 1200–1400 | 1 | 2 | 1 | 2 | | **6** |
| 1400–1600 | 2 | | 1 | 1 | 1 | **5** |
| 1600–1800 | 1 | 1 | | | 1 | **3** |
| 1800–2000 | 3 | 7 | 3 | | | **13** |
| 2000–2200 | 2 | 5 | 2 | | | **9** |
| 2200–2400 | 4 | 3 | | | 2 | **9** |
| 0000–0200 | 4 | 5 | 1 | | 2 | **12** |
| 0200–0400 | 4 | 4 | 2 | | | **10** |
| 0400–0600 | | | | | | |
| **Total** | **25** | **32** | **13** | **3** | **9** | **82** |

Table 9. Types of casualties and their respective indices.

| Type of casualty | Number of incidents | Indices (collision = 100) |
|---|---|---|
| Collision | 25 | 100 |
| Grounding/Stranding | 45 | 180 |
| Fire/explosion | 3 | 12 |
| Others | 9 | 36 |
| **Total** | **82** | |

in the Bosphorus are Umur Banki, Yenikoy, Bebek and Kandilli; for collisions the evidence suggests that the critical areas are Besiktas, Bebek, Kandilli, Kanlica, Yenikoy, Beykoz and Sariyer.

Marine casualties occurring in the Strait of Istanbul involve local factors but are of international interest. The casualty case investigations reveal the main causal factors that contribute to shipping accidents. The primary factors are: dense shipping traffic, ships proceeding without a pilot, the strong, complex and day-to-day changing nature of currents, the existence of areas with sharp turns, the improper conduct of vessels within the TSS and finally, darkness. The causal factors of secondary importance include: shore background lighting, loss of alertness and caution which impede safe passage, and lack of adequate knowledge about the region.

In an attempt to improve the navigational safety measures using traffic management, the current TSS regime in the Strait is supported by the VTMIS, which became fully operational on 1 July 2003. The system, which cost around US$40 million, is based on 7 radar stations which fully cover the Strait. With this contemporary system, the system operators are able to monitor the whole Strait and know the whereabouts and conduct of each ship. The system can provide the essential information for ships to avoid unwanted encounters and collision risks in critical localities in the Strait such as Kandilli, Yenikoy and Umuryeri where two ships should not proceed in opposite directions at the same time.

Pilotage is one of the proper means of minimising shipping accidents in confined waters. Article – 4 (2) of the Montreux Convention clearly states that pilotage and towage remains optional; accordingly compulsory pilotage has not been a binding instrument for ships passing through the Strait and last year slightly more than 40 per cent of the ships using the Strait took pilots. The IMO Rules and Recommendations adopted in association with the TSS zone strongly recommend that all ships should use the pilotage services in order to comply with the requirements of safe navigation. The approach is an affirmative step forward in minimizing the danger to marine life, facilities, common human heritage in the area and to ships.

## REFERENCES

Akten, N (2002). The Bosphorus: Factors contributing to marine casualties, Turkish *Journal of Marine Sciences*, Istanbul University, **8**, 179–195.

Akten, N (1996). *How to use the sea utmost in Metropolitan transportation*. The Istanbul Chamber of Commerce, Istanbul, 41–44.

Akten, N (1968). General description of the Bosphorus, UWIST, Cardiff, 1–2.

Admiralty (1955). Black Sea Pilot, 150.

Admiralty (1990, 2000). Black Sea Pilot, 22–29.

Chapman, S.E, Akten, N (1998). Marine casualties in the Turkish Straits – A way ahead. *Seaways*, November 6–8.

Chelminsky, R (1998). The Bosporus – A disaster waiting to happen. *Smithsonian*, November, 116.

IMO (1995). MSC.63, Rules and recommendations on navigation through the Strait of Istanbul, the Strait of Canakkale and Marmara Denizi, para 4.

Stewig, R (1965). Konstantinopolis ISTANBUL, Istanbul Ticaret Odası, 34.

TUMPA (Turkish Marine Pilots' Association) (2003). www.turkishpilots.org

TURKISH MARITIME UNDERSECRETARIAT (1994–2003). Yearly casualty records, Istanbul Area, Ankara.