

## **The Bosphorus : Factors Contributing to Marine Casualties**

### **İstanbul Boğazı : Deniz Kazalarına Yolaçan Faktörler**

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#### **Abstract**

Ships trade in a complex and high-risk operating environment; hence very many shipping casualties still occur at sea as well as waters connected therewith.

Any accident, whatever in nature, is every seafarer's nightmare and comes under the fierce scrutiny of the public. It may take different shapes – i.e 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 .

Several causes may give rise to a shipping casualty. In broad terms these are: inter alia, natural conditions, technical failures, route conditions, ship-related factors and human errors.

The Strait of Istanbul , the Bosphorus, is roughly a "S-shaped" narrow channel and links the Black Sea to the Sea of Marmara. It is thus the integral part of the Turkish Straits, namely the Dardanelles,the Sea of Marmara and the Bosphorus, the whole area being known as the Turkish Straits Region (TSR), which constitute one of the major and busiest seaways.

Geographical conditions and navigational constraints of the Strait, i.e. narrowness, deep and steep structure which grants poor visibility at nights for ships passing through, and day-to-day changing currents together with bad weather conditions, are the main parameters contributing to marine casualties in the Bosphorus.

The Strait has faced 454 marine casualties of different types in 1953-2002 period, accounting 24 percent for the “left-side up scheme”, 60 percent for the “right-side up scheme and the remaining 16 percent for the “traffic separation schemes” respectively.

The Turkish Government adopted the by-law, so-called “Maritime Traffic Schemes in the Turkish Straits Region”, currently in use in 1994 and revised further in 1998, to enhance safety of navigation in the Strait as a life saving measure. Hence, with full implementation of the By-law, shipping casualties in the Bosphorus have been drastically reduced.

Key words : marine casualty, Strait of Istanbul, current, orkoz, traffic separation schemes, collision, grounding, stranding, the Collision Regulations.

## I. Introduction

### *1. The Strait of Istanbul :*

The Strait of Istanbul , the Bosphorus, is roughly a “S-shaped” narrow channel and links the Black Sea to the Sea of Marmara. It is thus the integral part of the Turkish Straits, namely the Dardanelles, the Sea of Marmara and the Bosphorus, the whole area being known as the Turkish Straits Region (TSR), which constitute one of the major and busiest seaways.

The Bosphorus which is within the administrative port limits of Istanbul, lies between the parallels of latitude of 41° 01' N and 41° 13' N and its length is about 17 nautical miles. 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 with houses and many historical buildings throughout its length, whereas the Asian or east side the buildings are scattered and almost everywhere are backed by hills covered with vegetation.

There are sixteen headlands which affect the navigation in the Strait – nine of which are on the European side and the remaining seven are on the Asian. The trends and width of the Strait permit a significant range of visibility at many parts of the navigable channel. (Akten, 1968). Several sharp turns within the Strait exist in areas such as Umuryeri,

Yeniköy, Kanlıca, Kandilli and Kızkulesi (45° at Kandilli, 80° at Yeniköy, 70° at Umur Bankı). Shape of the Strait however limits to have an extended sight for a proper look-out particularly beyond several headlands, except a few, as those close the view behind, while proceeding through the current traffic lane allocated for the vessels.

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 narrowest part of the Strait is İstinye-Kandilli area, almost lying at midway along the Strait, where the width is merely 0.4 nautical mile and a strong current usually known as “Şeytan akıntısı – devil’s current”, the average rate being 4 knots but can reach about 8 knots, sets. The Strait of Istanbul resembles a river with abrupt and angular windings and is surrounded by the spreading city on both sides.

The Strait is bordered on both sides partly by steep and mountainous coasts.

## *2. Navigational constraints :*

### *a. Currents.*

Mainly two types of current are dominant in the Region – the main surface (or kanal) current and the undercurrent. The main surface current is a slope current – the primary cause being the difference of level between the adjacent seas ; whereas the undercurrent is of density type. Furthermore, a bottom current which maintains mostly the same direction as the surface current also exists.

The currents through the Bosphorus can well be compared to two rivers flowing reciprocally one above the other in the same river bed which has a depth of 40 to 90 metres.

*“The surface current in the Bosphorus is similar in character to that which would be produced by a great jet of water, under high pressure, directed from the narrow and irregular channel and does not everywhere fill the whole width of this strait, and takes the shortest route from point to point.”*

*“ The character of the current alters when its strength changes due to any cause, and if it is stronger than usual it becomes a faster and narrower band, which sets into and across the wider parts of the Strait as a thinner jet.” (The Admiralty, 1948,1955,1985)*

Very strong current and counter currents exist within the Strait and its rate may reach upto 8 knots when Northerly wind(s) are severe and the rate of precipitation is excessive. In proceeding northward through the Strait, vessels will usually have to contend with the main or surface current which invariably sets souhtward and the prevailing NE'ly wind.

The primary cause of the main (or south-going) surface current is that the level of the Black Sea is higher, almost invariably, than that of the Sea of Marmara by about 0.4 metre, due to excessive flow of water into the Black Sea, discharged by the rivers Danube, Dnyestr,Dnyepr, Don, Sakarya, Kızılırmak, and others.

The rate of the south-going current flowing out of the Black Sea is the highest during the season when the rivers discharge the greatest volume of water, due to thawing of the snow,and also winds from a northerly quarter blow strongest.

Experience gained so far by the local seafarers reveals that the current in the Strait is stronger in the afternoon than in the forenoon and is the weakest at the northern entrance,where its rate is less than a knot. The average maximum rate of the current under normal conditions is from 4 to 5 knots in the narrower part of the waterway. The mean rate however can be taken as from 2 to 3 knots. (Akten, 1968)

The average rates of flow for the south-going surface current for different localities are as follows: 0.5 to 1 knot at Rumeli Burnu, 1.5 to 2 knots at Köybaşı Burnu (Yeniköy), 2 to 3 knots at Kanlıca, 3 to 4 knots at Rumelihisarı, 4 to 5 knots at Akıntı Burnu, 3 to 4 knots at Sarayburnu.

Below the surface / main current, there exists a slower but saltier undercurrent in the reverse, north-going direction, flowing into the Black Sea. It is not surprising to see in the Channel (Kanal suyu) that some fishing boats (or kayıks) making headway towards the Black Sea against strong opposing surface currents by dint of lowering heavily weighed nets / baskets down to near-bottom in order to gain from favourable traction by the undercurrent.

The existence of the northwards-flowing undercurrent in the Bosphorus (or Karadeniz Bogazı) out of the saline Aegean Sea goes as far back as 1681. In that year, Count Marsili announced the existence of an undercurrent beneath the oppositely running surface waters in a letter addressed to Queen Cristina of Sweden. It was in 1881 and 1882 that the Russian Admiral Makaroff made current measurements by around 1000 in the Strait to clear up the undercurrent question. (Carruthers, 1963).

Beneath the north-flowing undercurrent, under 50 metre or more in depth, near bottom, there exists yet another current running in the same sense as the surface waters, i.e towards the Sea of Marmara (Wharton, 1872; Gueydon, 1886; Möller, 1928; Carruthers, 1963).

Under the influence of strong Southerly winds of prolonged duration, the water level in the Bosphorus rises as much as almost 0.6 metre and thus gives rise to the rate of surface current be reduced, or reversed in direction, i.e flowing towards the Black Sea. Such current is locally named as Orkoz. *“With strong southerly winds the usual surface current can be totally arrested and reversed without any accentuation – even with a diminution – of the north-going undercurrent”* (Carruthers, 1963).

Orkoz is a typical drift current - though it is quite infrequent - which can be seen between November and January, and sometimes as late as February in the Straits. When strong southerly or especially southwesterly winds blow over the area, the Sea of Marmara inclusive, in winter, in connection with depressions travelling over or near the region tend to raise the water level and thus weaken and widen the current.

Orkoz is triggered by depressions which settle near or travel over the region and strong southerly winds so formed push the surface waters towards the Black Sea to the coasts of the Strait to pile up and thus the slope of the sea level being upwards to the coasts. As the surface waters are higher at the southern end of the Strait than that of the northern mouth the surface waters are driven up and the reverse surface current, i.e. Orkoz, is formed.

The stronger is the wind the greater is the rise in sea level, ultimately Orkoz being stronger. The farthest distance that Orkoz may reach at in the Strait is the vicinity of Kavaklar Points, almost entrance to the Black Sea. In the region at which Orkoz and the south-flowing main current encounter one another, a zone of ripples and froth is observed.

The Orkoz or northerly current may flow several hours, or even a day, after the southerly winds have ceased, unless a northerly wind quickly follows. It has been noticed that Orkoz slackens within 24 hours as far as it reaches the Kavaklar region, as the northernmost limit, and the main current sets in its usual direction.

When Orkoz affects the Strait, vessels passing through should exercise extreme caution. The most critical part with regard to safety of navigation is the narrowest reach of the Strait, i.e. the area between İstinye and Arnavutkoy. It is prudent not to navigate southbound with low-powered vessels, especially large ones, when Orkoz is noticed to reach at Yenikoy.

Vessels bound for the Black Sea however would have no difficulty to make headway while Orkoz is prevalent as they head the stream.

Under conditions of Orkoz vessels passing through the Strait should keep as close to the centre / median line as possible in order to have a better manoeuvrability in case of necessity. In December 1960, under Orkoz condition, World Harmony, a Greek tanker, bound for the Black Sea and no pilot onboard, collided with Peter Zoranic, a Yugoslav tanker, southbound with pilot onboard, off the Kanlica Point. World Harmony drifted towards the other lane allocated for vessels of southbound due to Orkoz condition when rounded the Point prior to the collision accident.

Similarly, in September 1963, Arkhangelsk, a Russian vessel, ran ashore more or less in the same locality, Baltalimanı area on the European side, having lost her manoeuvrability because of Orkoz.

*b. Weather conditions.*

Most disturbed weather in the Strait occurs in winter and is usually associated with depressions moving eastward across the area.

Winds from the northeast are most frequent, almost 75 percent of the year, but are occasionally interrupted by winds from southerly quadrant. Violent winds or gales are however most frequently from northeast or northerly directions but occasionally from south to southwest in winter season. Gales are also recorded in around 3 to 4 days a month, in winter.

Visibility affecting the navigation adversely is restricted by several meteorological factors such as showers, heavy snow and fog. Their share is expected to be quite limited and may be taken as 5 to 8 percent in any year as an average. (Akten, 1996).

Fog at sea as well as coastal areas may occasionally be encountered in winter and spring but is quite rare in summer.

Breakdown of climatic elements are given in Table 1.

**Table.1**  
**Climatic Table for Istanbul**

Month mean wind speed number of days with :  
(knots) winds fog thunder- snowfall  
0700 1400 (34 knot storm  
or more)

Month	0700	1400	(34 knot or more)	fog	thunder- storm	snowfall
January	6	8	1	1	rare	3
February	6	8	1	1	rare	3
March	5	8	1	1	rare	3
April	4	8	rare	1	1	0
May	4	7	rare	1	1	0
June	4	8	rare	rare	2	0
July	5	10	rare	rare	2	0
august	4	10	rare	rare	1	0
september	3	9	rare	1	1	0
october	4	7	rare	1	1	0
november	5	7	rare	1	1	rare
december	6	7	1	1	rare	rare
means	5	8				
<b>totals</b>			<b>5</b>	<b>9</b>	<b>12</b>	<b>8</b>

(Compiled from 15 to 52 years' observations, 1929 to 1980)

Source :Admiralty,(1990) : Black Sea pilot,NP 24,Table 1.187, WMO No 17062, London, pp,37

### 3. Navigational marks :

Coastal lights are used on both sides to indicate clearly the lateral ends of the navigable channel. The Anatolian coast is considered the port-side and the lights accordingly exhibit red lights; the European coast similarly is considered the starboard side and the lights thus exhibit green lights. (The Admiralty, 1985). Therefore, lateral system as such is used in the Strait in

conjunction with a conventional direction for marking the channel.

Conventional direction of marking the channel in the Bosphorus may be defined as “the direction taken by the seafarer when approaching the Channel from seaward”, as far as the deployed lights / marks are taken into consideration. Thus, the term “from seaward” accordingly indicates the direction of marking taken from the Black Sea towards the Sea of Marmara.

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 of the channel aims to help the 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 at sea or in the region.

There exists 24 coastal lights in total, equally twelve on each side, and 8 navigation buoys to mark the Strait for a safe passage. The presence of bright background shore lights and the proximity of navigational hazards, such as 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 are visible only to 1.9 nautical miles at night, although their nominal range is mostly eight nautical miles. (Chapman, Akten, 1998) Deep and steep like a canyon through most of its length, the Strait grants rather poor visibility / look-out at night for ships passing through. *In the channel there exists few shallows or sandbars where errant ships might ground before smashing into the many villas and apartments that line the shore. (Chelminsky, 1998).*

## II. The Strait and Marine Casualties

### 1. Maritime traffic :

Merchant vessels enjoy the right of innocent passage through the Straits in accordance with the Montreux Convention in force. Innocent passage is effected by passing through the Straits region en-route to or from, ports of the Region inclusive. While effecting innocent passage, vessels to follow the customary navigational course recommended through sea corridors / traffic separation schemes. In the case that the rules of innocent passage is violated the master of the vessel is accountable under Turkish legislation.

*“When the Montreux Convention was signed in 1936 allowing free access through the Bosphorus into the Black Sea, the largest vessel in the Turkish merchant fleet was just 13 t. In the meantime both the volume of traffic and the sizes of ships using the waterway have increased beyond all recognition.”* (Lloyd’s Ship Manager, 1992). There are now an average of 25.000 transits per year in each direction including inter alia, tankers, chemicals, product tankers, LNG and LPG carriers - the largest size passing through being 150 to 160.000 tonners fully laden or vessels of around 300 metres in length partly laden. Almost one-third of the total transits is the local ships passing through the Strait. <sup>1</sup>

The Strait of Istanbul is the most congested sea lanes in the World. On a daily basis ,an average of 142 vessels (or almost 6 vessels an hour) navigate the Strait. When local traffic is taken into account, almost another 2,000 crossings a day must be added to the figure above.

Turkey applied a “left-side up” (European - side up) navigation scheme in the period 1934-82, i.e vessels proceeding from the Sea of Marmara had to keep to the port side of the channel and

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<sup>1</sup> All vessels 500 GT and upwards are included in the maritime traffic schemes and are required to submit sailing plans – local shipping inclusive.

as close inshore as possible, according to Article 25 of the Collision Regulations in force at that time. From May 1982 however, the Collision Regulations 1972 became fully applicable in the Turkish Straits, and hence a "right-side up" scheme now applies. (Chapman, Akten, 1998).

Turkey introduced the new traffic separation schemes in the Turkish Straits Region, the Strait of Istanbul inclusive, on 01 July 1994, and the relevant by-law was fully brought into effect, amended further on 06 November 1998. Groundings and collisions were increasingly regular occurrences before 1994, i.e. before the traffic separation schemes were introduced.

According to the new traffic separation schemes, a transit route,<sup>2</sup> divided into north and south bound traffic lanes, has been established all the way through the Strait and vessels, during transit of the Strait, not to overtake, nor attempt to overtake, other vessels unless forced to do so and not to cross the median line of the transit route.

In order to prevent damage the coasts, or coastal structures and to small crafts, vessels to proceed at moderate speed within the Strait. On no account is a speed of 10 knots to be exceeded by ships in the Bosphorus throughout the passage.<sup>3</sup>

## 2. *Marine casualties* :

Marine casualty is a term usually used for any accident by ship(s) result in financial loss, either in property or both. Collision or contact, capsizing, foundering, sinking, breaking-up, grounding, stranding, fire / explosion, breakdown of the ship underway, bad weather conditions are typical examples of shipping casualties (Akten, Gonencgil, 2002).

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<sup>2</sup> By-law related to maritime traffic schemes in the Turkish Straits Region,

<sup>3</sup> Article 13, By-law related to maritime traffic scheme in the Turkish Straits, Turkish official gazette, dd. July 01, 1994; Revised November 06, 1998.

The Strait has faced 454 marine casualties in 1953-2002 period. The localities with high risk for grounding / stranding in the Bosphorus are : Umur Bankı, Yeniköy, Bebek, Kandilli; for collisions however the evidence suggests that critical areas are Bebek, Kandilli, Kanlıca, Yeniköy, Beykoz and Sarıyer.

Having studied the casualty cases in-depth one may deduce either one or some of the following reasons are major factors contributing a casualty, like :

- Vessels proceeding without a pilot,
- Dense marine traffic,
- Bad weather conditions,
- Technical inadequacy of ship,
- Complex and sometimes day-to-day changing nature of currents,
- Lack of adequate knowledge about the region,
- Loss of alertness and caution impeding the safe passage,
- Existence of areas with sharp turns (45° for Kandilli, 80° for Yeniköy, 70° for Umur Bankı),
- Lack of a proper vessel-escorting system.

Table.2 indicates the breakdown of the casualties occurred in the area in terms of main casualty groups: i.e collision, stranding, grounding, foundering and fire and explosion.

Table.2. 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 Scheme	1994-2002 a	19	29	12	3	12 b	75
<b>Total</b>	<b>1953-2002</b> a	<b>203</b>	<b>135</b>	<b>76</b>	<b>28</b>	<b>12</b>	<b>454</b>

a first quarter

b includes rudder blockade, vessel's list and engine breakdown

Source : Turkish Maritime Undersecretariat, casualty records,İstanbul area, 1994 to 2002 (first quarter),Ankara.

### III. Conclusion

Maritime traffic was 4125 transits in the year 1841 and almost tripled in 1856, during the Crimenian War, and is around 25000 transits in each direction as of 2002, local transits inclusive.

The Bosphorus is the most critical passage in the World, due to its shape,narrowness, complex as well as day-to-day changing nature of currents. Furthermore, due to over-crowded character of the area surrounding the Straits,consequence of any casualty which may easily lead to a possible catastrophe is very likely. It is simply divine luck the city with its almost 15 millions inhabitants has so far encamped relatively undamagedly.

The Strait is something like a risk generator from the point of view of maintaining a safe passage. Not only the state of currents, eddies, fog and strong winds (even sometimes gales) within the Strait, but also its shape which limits, or closes rather, the view behind headlands, to a great extent reduce the safety of navigation and hence build up potential risks and perils for vessels to pass through. Ships of increased size and thus with reduced manoeuvrability bring further implications on the safety issue.

*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 Turkey to take immediate action and to reinforce existing regulations of maritime traffic in the Strait.*<sup>4</sup>

The Turkish Government adopted the By-law, so-named "Maritime Traffic Schemes in the Turkish Straits Region", currently in use in 1994, revised in 1998 to enhance safety of navigation in the Strait as a life saving measure. With full Turkish implementation of the By-law, shipping casualties in the Bosphorus have been drastically reduced.

Furthermore, there was a need to establish some form of vessel traffic control system, which has been under construction at the time, to avoid unwanted encounters of vessels in critical points in the Strait.

The Montreux Convention with regard to the regime of the Turkish Straits establishes the principle of freedom of navigation for all merchant vessels, regardless their sizes, flags and cargoes, in peace time, with Turkey the sole authority with legal power to interpret the Convention. This freedom for vessels does not however give free reign to uncontrolled or undisciplined passage in accordance with the provisions of of

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<sup>4</sup> The Montreux Convention and maritime traffic regulations in the Turkish Straits, [http:// www.byegm.gov.tr/YAYINLARIMIZ/newspot/2002/july-aug/n7.htm](http://www.byegm.gov.tr/YAYINLARIMIZ/newspot/2002/july-aug/n7.htm)

the relevant internationally accepted rules and regulations currently in use.

## Özet

Gemiler karmaşık ve kaza rizikosunu yüksek ortamda seyrederek. Bu yüzden denizlerde ve bağlantılı içsularda hala deniz kazaları meydana gelmektedir.

Niteliği ve boyutu ne olursa olsun, her deniz kazası gemiadamlarının korkulu rüyasıdır ve tüm kamuoyunun da sıkı gözetimi altındadır. Bir deniz kazası değişik şekillerde meydana gelebilir – basit bir uygulama / kullanım hatasından, olası bölgesel kapsamlı bir katastrofiye kadar tırmanabilen. Kaza, deniz trafiğinin yoğun, manevra alanının yetersiz ve su derinliğinin oldukça sığ olduğu dar bir kanalda ya da boğazda meydana geldiğinde ciddi rizikolarla karşılaşılması olasıdır.

Deniz kazalarına değişik nedenler yol açar. Bunlar, diğerleri meyanında, doğal koşullar, teknik kusurlar, seyir koşulları, insane hataları ve gemiden kaynaklanan aksaklıklardır.

İstanbul Boğazı, Karadenizi Marmaraya bağlayan dar bir geçittir. Aynı zamanda, Türk Boğazlar Bölgesi zincirinin en kritik halkasıdır. Seyir alanının darlığı - dolayısıyla da manevra zorluğu, değişken karakterli akıntıların varlığı, kıvrımlı ve vadi görünümü coğrafi yapısı gibi seyri zorlaştıran unsurlar, bu yöredeki deniz kazalarının temel nedenlerini oluşturmaktadır.

İstanbul Boğazı, 1953-2002 (ilk çeyrek) döneminde 454 deniz kazasına tanık olmuştur. Bu kazaların %24'ü "sol-seyir düzeni", %60'ı "sağ-seyir düzeni", geri kalan %16'sı da "trafik ayırım düzeni" dönemlerinde meydana gelmiştir.

Türkiye Cumhuriyeti 1994'de yürürlüğe giren, 1998 yılında da uygulamadan edinilen deneyime bağlı olarak yeniden gözden geçirilen "Türk Boğazlar Bölgesinde Deniz Trafik Düzeni Tüzüğü" ile bu bölgede seyir güvenliğini ve kent insanının can güvenliğini artırıcı önlemler almıştır. Tüzüğün işlerlik kazanmasıyla birlikte İstanbul Boğazı'ndaki kazalarda ciddi bir düşüş olmuştur.

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