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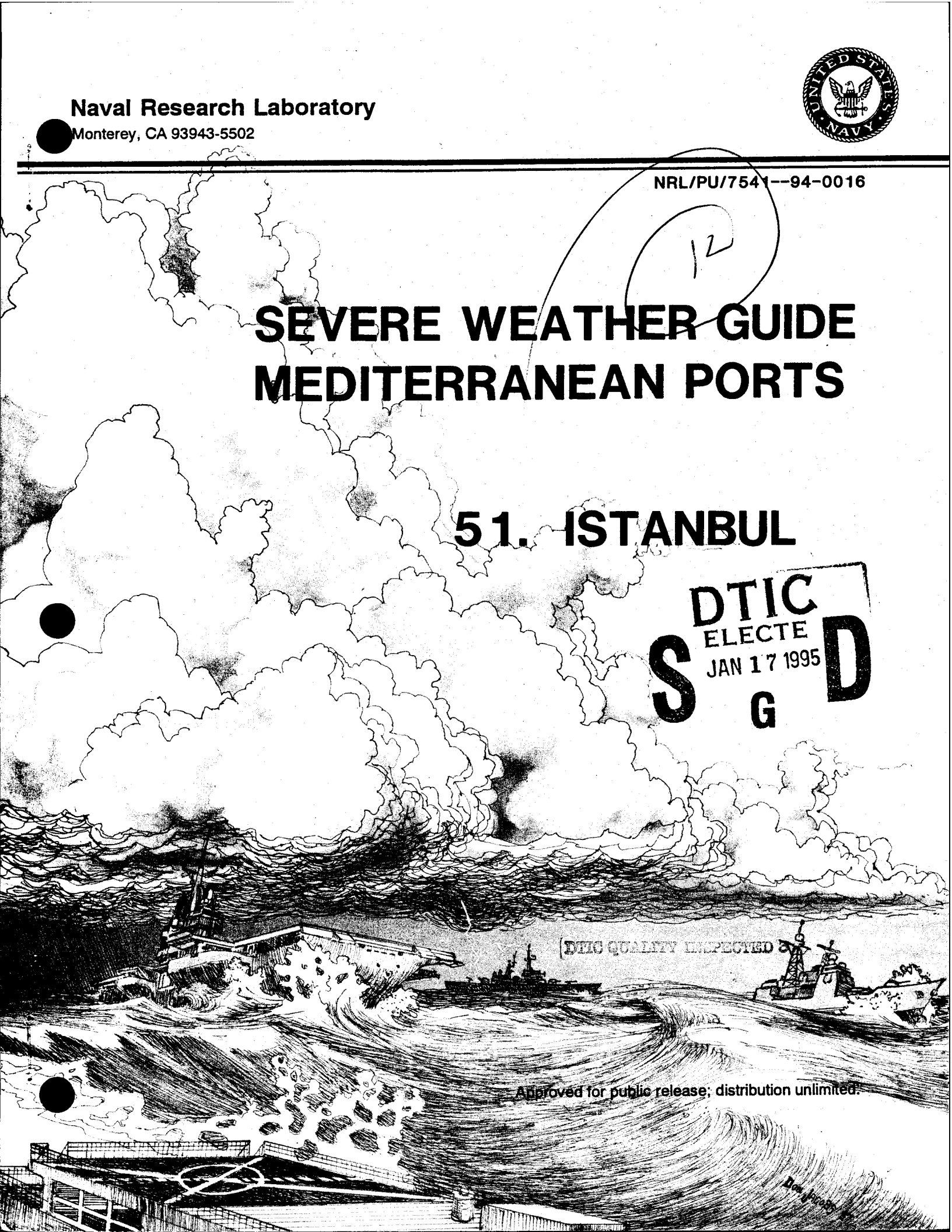
SEVERE WEATHER GUIDE MEDITERRANEAN PORTS

51. ISTANBUL



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This handbook for the port of Istanbul, one in a series of severe weather guides for Mediterranean ports, provides decision-making guidance for ship captains whose vessels are threatened by actual or forecast strong winds, high seas, restricted visibility or thunderstorms in the port vicinity. Causes and effects of such hazardous conditions are discussed. Precautionary or evasive actions are suggested for various vessel situations. The handbook is organized in four sections for ready reference: general guidance on handbook content and use; a quick-look captain's summary; a more detailed review of general information on environmental conditions; and an appendix that provides oceanographic information.

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CONTENTS

FOREWORD

This handbook on Mediterranean Ports was developed as part of an ongoing effort at the Meteorology Division, Naval Research Laboratory, Monterey, to create products for direct application to Fleet operations. The research was conducted in response to Commander Naval Meteorology and Oceanography Command (COMNAVMETOCCOM) requirements validated by the Chief of Naval Operations (OP-096).

As mentioned in the preface, the Mediterranean region is unique in that several areas exist where local winds can cause dangerous operating conditions. This handbook will provide the ship's captain with assistance in making decisions regarding the disposition of his ship when heavy winds and seas are encountered or forecast at various port locations.

Readers are urged to submit comments, suggestions for changes, and recommended additions/deletions to the Naval Meteorology and Oceanography Command Center, Rota, with a copy to oceanographer COMSIXTHFLT. They will be passed on to the Naval Research Laboratory, Monterey, for review and incorporation as appropriate. This document will be a dynamic one, changing and improving as more and better information is obtained.

PORT INDEX

The following is a list of Mediterranean Ports that have been evaluated. Computerized versions of these port guides are currently available. Contact the Naval Research Laboratory (NRL), Monterey or NMOCC Rota for IBM compatible floppy disk copies.

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PREFACE

Environmental phenomena such as strong winds, high waves, restrictions to visibility and thunderstorms can be hazardous to critical Fleet operations. The cause and effect of several of these phenomena are unique to the Mediterranean region and some prior knowledge of their characteristics would be helpful to ship's captains. The intent of this publication is to provide guidance to the captains for assistance in decision making.

The Mediterranean Sea region is an area where complicated topographical features influence weather patterns. Katabatic winds will flow through restricted mountain gaps or valleys and, as a result of the venturi effect, strengthen to storm intensity in a short period of time. As these winds exit and flow over port regions and coastal areas, anchored ships with large 'sail areas' may be blown aground. Also, hazardous sea state conditions are created, posing a danger for small boats ferrying personnel to and from port. At the same time, adjacent areas may be relatively calm. A glance at current weather charts may not always reveal the causes for these local effects which vary drastically from point to point.

Because of the irregular coast line and numerous islands in the Mediterranean, swell can be refracted around such barriers and come from directions which vary greatly with the wind. Anchored ships may experience winds and seas from one direction and swell from a different direction. These conditions can be extremely hazardous for tendered vessels. Moderate to heavy swell may also propagate outward in advance of a storm resulting in uncomfortable and sometimes dangerous conditions, especially during tending, refueling and boating operations.

This handbook addresses the various weather conditions, their local cause and effect and suggests some evasive action to be taken if necessary. Most of the major ports in the Mediterranean are covered in this series of handbooks. A priority list, established by the Sixth Fleet, exists for the port studies conducted and this list was followed as closely as possible in terms of scheduling publications.

ACKNOWLEDGMENT

The support of the sponsor, the Naval Meteorology and Oceanography Command, under program element O&M,N, is gratefully acknowledged.

RECORD OF CHANGES

CHANGE NUMBER	DATE OF CHANGE	DATE ENTERED	PAGE NUMBER	ENTERED BY

1. GENERAL GUIDANCE

1.1 DESIGN

This handbook is designed to provide ship captains with a ready reference on hazardous weather and wave conditions in selected Mediterranean harbors. Section 2, the captain's summary, is an abbreviated version of section 3, the general information section intended for staff planners and meteorologists. Once section 3 has been read, it is not necessary to read section 2.

1.1.1 Objectives

The basic objective is to provide ship captains with a concise reference of hazards to ship activities that are caused by environmental conditions in various Mediterranean harbors, and to offer suggestions for precautionary and/or evasive actions. A secondary objective is to provide adequate background information on such hazards so that operational forecasters, or other interested parties, can quickly gain the local knowledge that is necessary to ensure high quality forecasts.

1.1.2 Approach

Information on harbor conditions and hazards was accumulated in the following manner:

A. A literature search for reference material was performed.
B. Cruise reports were reviewed.
C. Navy personnel with current or previous area experience were interviewed.
D. A preliminary report was developed which included questions on various local conditions in specific harbors.
E. Port/harbor visits were made by NOARL personnel; considerable information was obtained through interviews with local pilots, tug masters, etc; and local reference material was obtained.
F. The cumulative information was reviewed,combined, and condensed for harbor studies.

1.1.3 Organization

The handbook contains two sections for each harbor. The first section summarizes harbor conditions and is intended for use as a quick reference by ship captains, navigators, inport/at sea OOD's, and other interested personnel. This section contains:

A. a brief narrative summary of environmental hazards,
B. a table display of vessel location/situation, potential environmental hazard, effect-precautionary/evasion actions, and advance indicators of potential environmental hazards,
C. local wind wave conditions, and
D. tables depicting the wave conditions resulting from propagation of deep water swell into the harbor.

The swell propagation information includes percent occurrence, average duration, and the period of maximum wave energy within height ranges of greater than 3.3 feet and greater than 6.6 feet. The details on the generation of sea and swell information are provided in Appendix A.

The second section contains additional details and background information on seasonal hazardous conditions. This section is directed to personnel who have a need for additional insights on environmental hazards and related weather events.

1.2 CONTENTS OF SPECIFIC HARBOR STUDIES

This handbook specifically addresses potential wind and wave related hazards to ships operating in various Mediterranean ports utilized by the U.S. Navy. It does not contain general purpose climatology and/or comprehensive forecast rules for weather conditions of a more benign nature.

The contents are intended for use in both pre-visit planning and in situ problem solving by either mariners or environmentalists. Potential hazards related to both weather and waves are addressed. The oceanographic information includes some rather unique information relating to deep water swell propagating into harbor shallow water areas.

Emphasis is placed on the hazards related to wind, wind waves, and the propagation of deep water swell into the harbor areas. Various vessel locations/situations are considered, including moored, nesting, anchored, arriving/departing, and small boat operations. The potential problems and suggested precautionary/evasive actions for various combinations of environmental threats and vessel location/situation are provided. Local indicators of environmental hazards and possible evasion techniques are summarized for various scenarios.

CAUTIONARY NOTE: In September 1985 Hurricane Gloria raked the Norfolk, VA area while several US Navy ships were anchored on the muddy bottom of Chesapeake Bay. One important fact was revealed during this incident: Most all ships frigate size and larger dragged anchor, some more than others, in winds of over 50 knots. As winds and waves increased, ships 'fell into' the wave troughs, BROADSIDE TO THE WIND and became difficult or impossible to control.

This was a rare instance in which several ships of recent design were exposed to the same storm and much effort was put into the documentation of lessons learned. Chief among these was the suggestion to evade at sea rather than remain anchored at port whenever winds of such intensity are forecast.

2. CAPTAIN'S SUMMARY

Istanbul is located in northwestern Turkey near 41°01'N 029°00'E on the north shore of the Sea of Marmara (Figure 2-1).

Northwestern Turkey is divided by a complex waterway that connects the Black Sea to the Sea of Marmara and the Aegean Sea. The channel passing between the Black Sea and the Sea of Marmara is named the Istanbul Bogazi, more commonly called the Bosporus. Istanbul is positioned at the south end of the Bosporus (Figure 2-2). The Sea of Marmara is connected to the Aegean Sea by a channel called the Canakkale Bogazi, also known as the Dardanelles.

Greater Istanbul is situated on both sides of the Bosporus and both sides of the Golden Horn, a waterway extending westward near the south end of the Bosporus (Figure 2-2). The western side of the Bosporus is commonly referred to as the European side, and the eastern side is alternatively called the Asian or Anatolian side. The Port of Istanbul technically encompasses the entire length of the Bosporus.

The old, walled city of Istanbul is located on the south side of the Golden Horn and stands on the site of the old Greek settlement of Byzantium. The relatively new cities of Beyoglu and Galata on the north side of the Golden Horn are the commercial and modern shopping centers of Istanbul (Figure 2-3). A third section of the city, called Uskudar-Kadikoy (Scutari), is located on the Asian side of the Bosporus (FICEURLANT, 1989).

The topography of Turkey varies from the lowlands of coastal regions to mountains exceeding 16,000 ft (4,877 m). East of Istanbul the Pontic Mountain Range is oriented east-west along the north coast of Turkey, and in some areas extends to the shore of the Black Sea (Figure 2-4). Much of central Turkey south of the Pontic Mountain Range is a relatively high area known as the

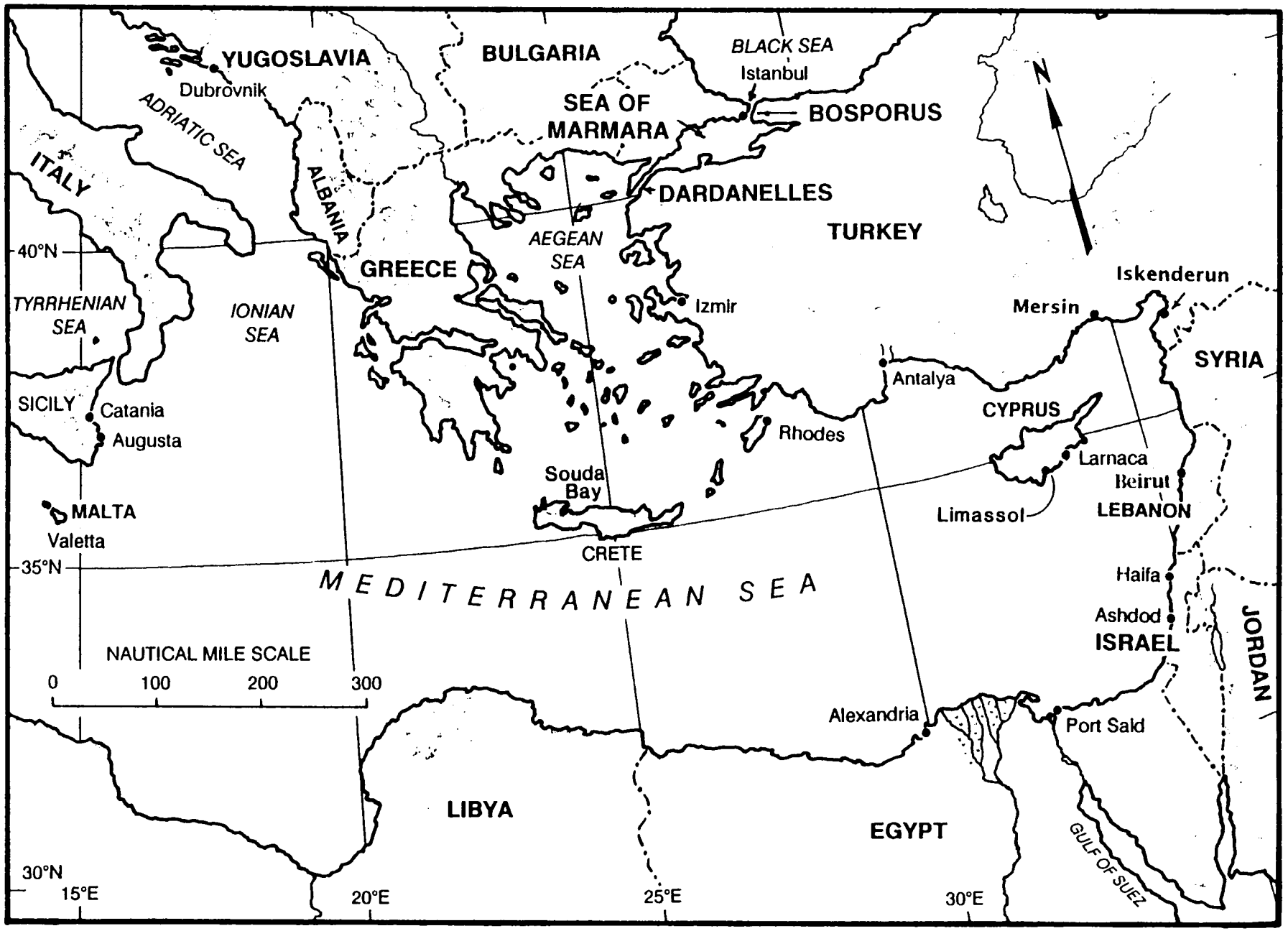

Figure 2-1. Turkey and Eastern Mediterranean Basin.

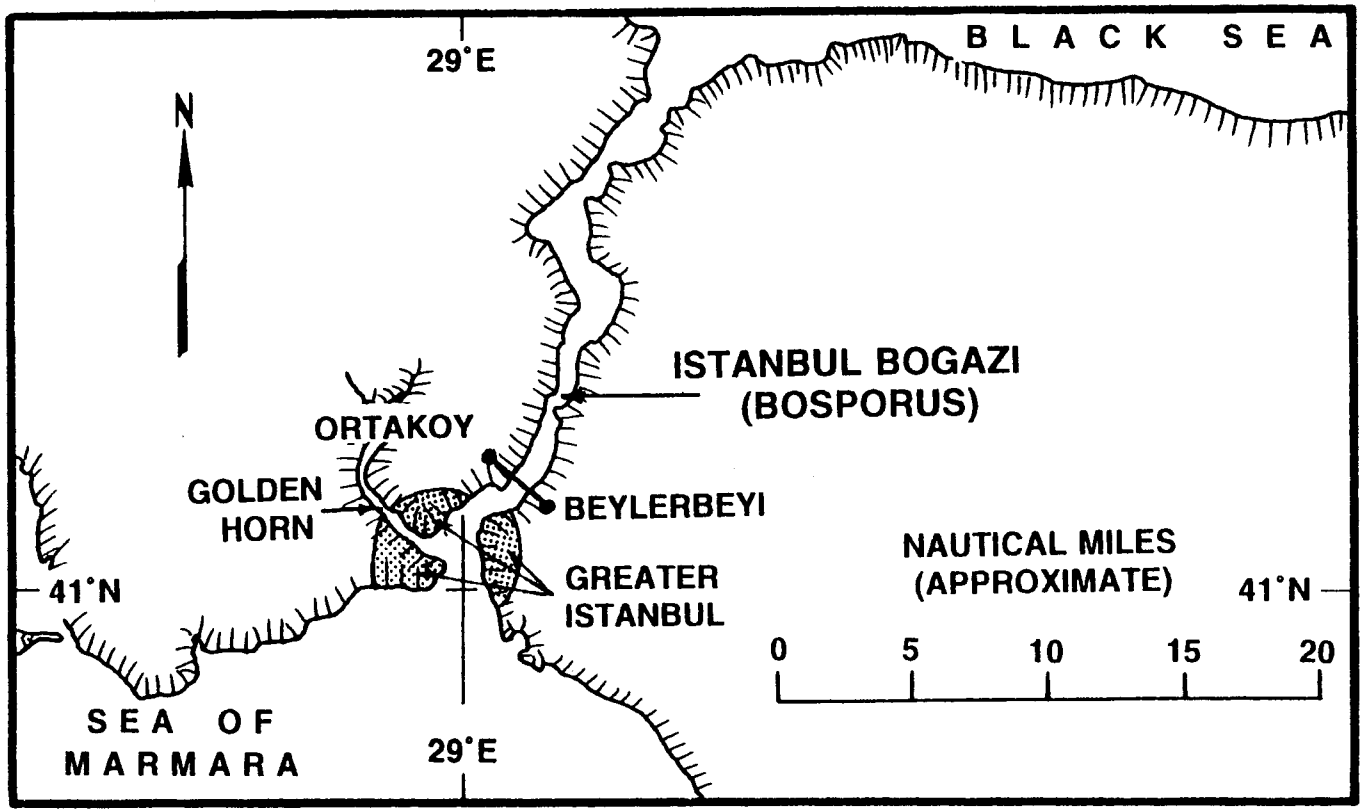

Figure 2-2. Greater Istanbul, Bosporus and surrounding area.

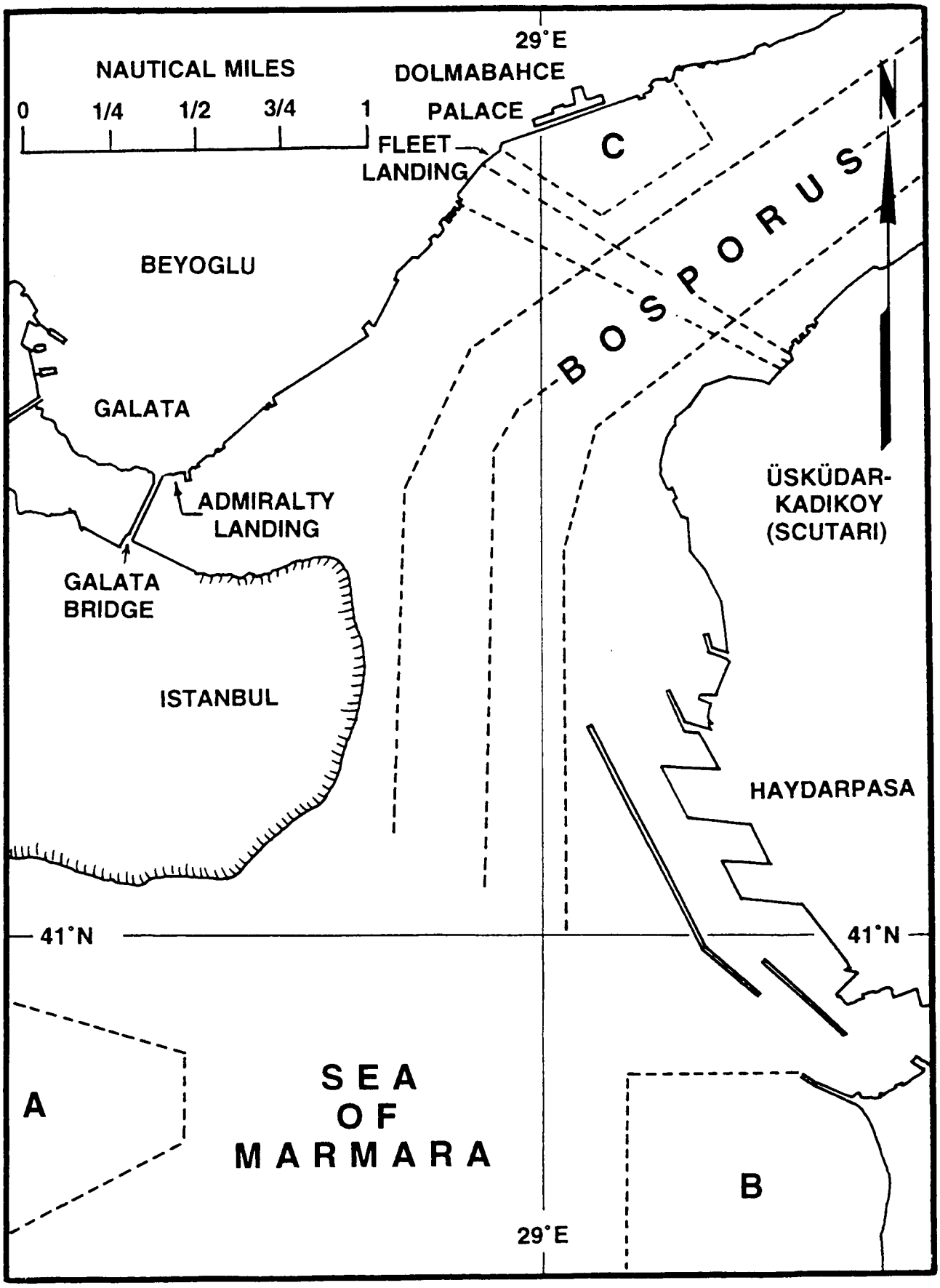

Figure 2-3. Greater Istanbul and adjacent port facilities.

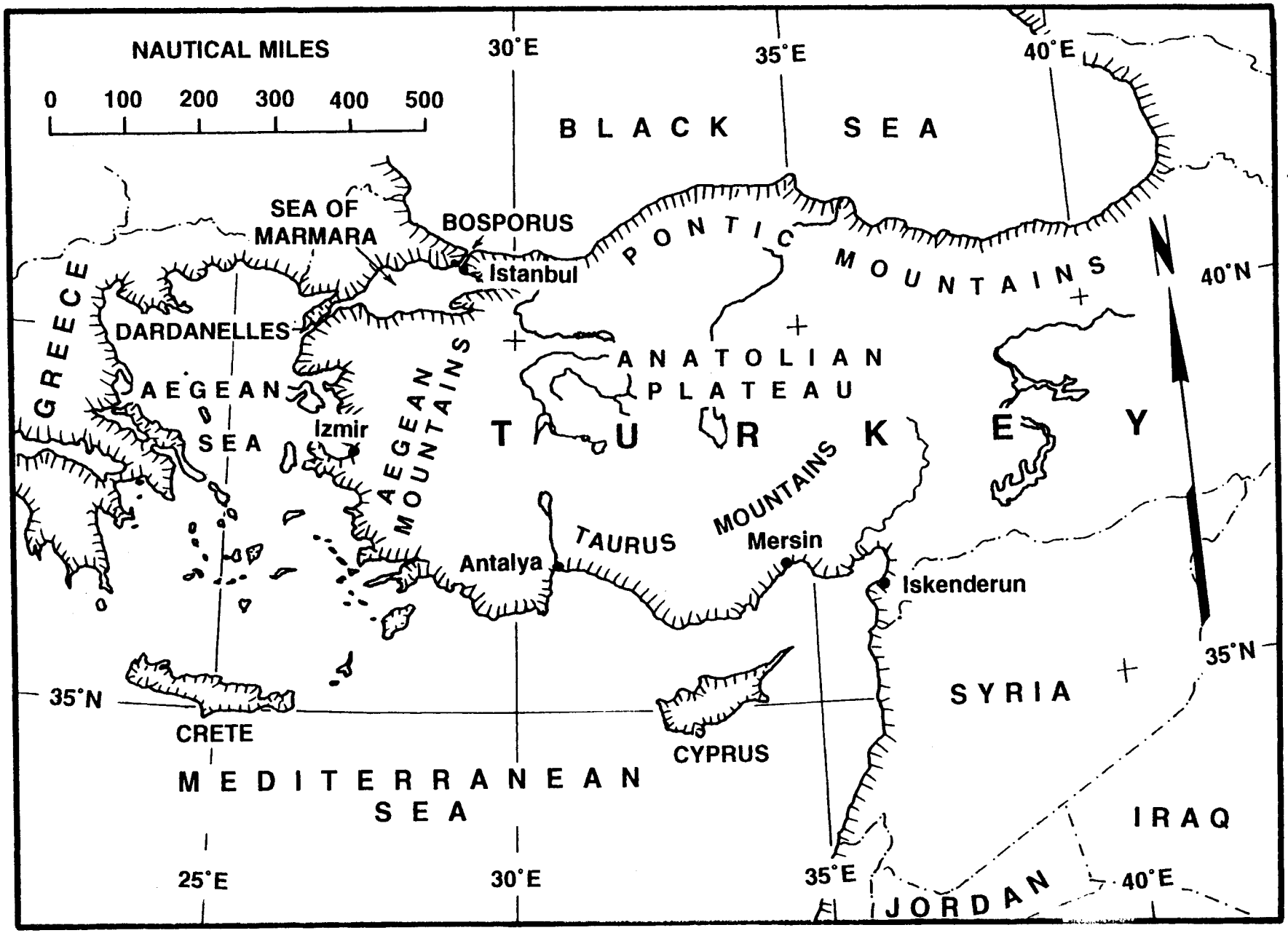

Figure 2-4. Geographical configuration and topography of Turkey.

Central or Anatolian Plateau (Department of the Air Force, 1977). The Taurus Mountain Range extends east-west south of the Anatolian Plateau. The Aegean Mountains, with some elevations exceeding 8,000 ft (2,438 m), lie roughly north-south on the western side of Asian Turkey.

The southern approach to the Bosporus is approximately 990 yd (905 m) wide (Figure 2-3). All maritime traffic must stay to the starboard side of the channel. Charted depths in the channel vary between 11 to over 27 fathoms (20 to over 49 m) between the pilot pick-up point and the anchorage adjacent to Dolmabahce Palace. Pilotage is compulsory for all U. S. Navy vessels entering the Bosporus. They can be picked up either at the Black Sea entrance for southbound entry, or south of the entrance to Istanbul for northbound entry (FICEURLANT, 1989).

A bridge crosses the Bosporus approximately 3.5 nmi north of the southern entrance to the channel between Beylerbeyi on the Asian side and Ortakoy on the European side (Figure 2-2). The bridge has a vertical clearance of 210 ft (64 m) over the central 1,312 ft (400 m) of its total span of 3,524 ft (1,074 m).

Although other facilities are located on both sides of the Bosporus and in the Golden Horn (Inner Harbor), a large part of the Port of Istanbul is located on the Asian side of the Bosporus at Haydarpasa. According to FICEURLANT (1989), Haydarpasa's quays total 6,522 ft (1,988 m) in length. As shown in Figure 2-3, the port is protected by two breakwaters with an overall length of 5,607 ft (1,709 m). Up to 6 medium-sized vessels may be accommodated simultaneously, and cargo operations may be made direct to and from wharves or railway trucks. Depth alongside quays varies from 19.7 to 32.8 ft (6 to 10 m). Other berthing facilities at Istanbul, located on the European side of the Bosporus, include passenger vessel piers which are about 1/2 nmi northeast of the Galata Bridge, a coal handling facility, and a cargo terminal.

Since U. S. Navy ships do not use any of the previously described berthing facilities, the areas of primary interest to the U. S. Navy are the anchorages at the port. Three anchorage locations for U.S. Navy ships are identified.

(1) The preferred anchorage for aircraft carriers is located on the Sea of Marmara just south of Istanbul near 40°59'24"N 28°57'42"E, as indicated by the letter "A" on Figure 2-3. Holding is good on a mud bottom in depths of 82 to 95 ft (25 to 29 m).

(2) According to FICEURLANT (1989), good anchorage for large vessels is also available off Haydarpasa. The position is indicated by the letter "B" on Figure 2-3.

(3) There are nine anchorage positions and 4 mooring buoys located on the west side of the channel adjacent to Dolmabahce Palace, approximately 2-1/2 nmi north of the southern entrance to the Bosporus. The general location is indicated by the letter "C" on Figure 2-3. Good holding on a mud bottom is reported in depths of 82 to 115 ft (25 to 35 m). Specific anchorage and approximate buoy positions as provided on a chart by port officials are shown on Figure 2-5.

Local authorities state that the Fleet Landing is located just south of Dolmabahce Palace on the west side of the Bosporus (Figure 2-4). It is common practice for U. S. Navy ships to rent water taxis to use for personnel and supply runs to/from ships in the anchorages. Run time from the aircraft carrier anchorage to the Fleet Landing is about 45 minutes, but the return trip takes only about 25 minutes due to the strong southwesterly setting current. According to FICEURLANT (1989), during difficult boating weather, ships may use the President's boat harbor, about 1,500 ft (457 m) south of Dolmabahce Palace, near a mosque, a location essentially coincident with the Fleet Landing described by local authorities.

Another location, called Admiralty Landing, is located just east of the Galata Bridge on the north side of the Golden Horn (Figure 2-3). It is not a designated Fleet Landing, and is

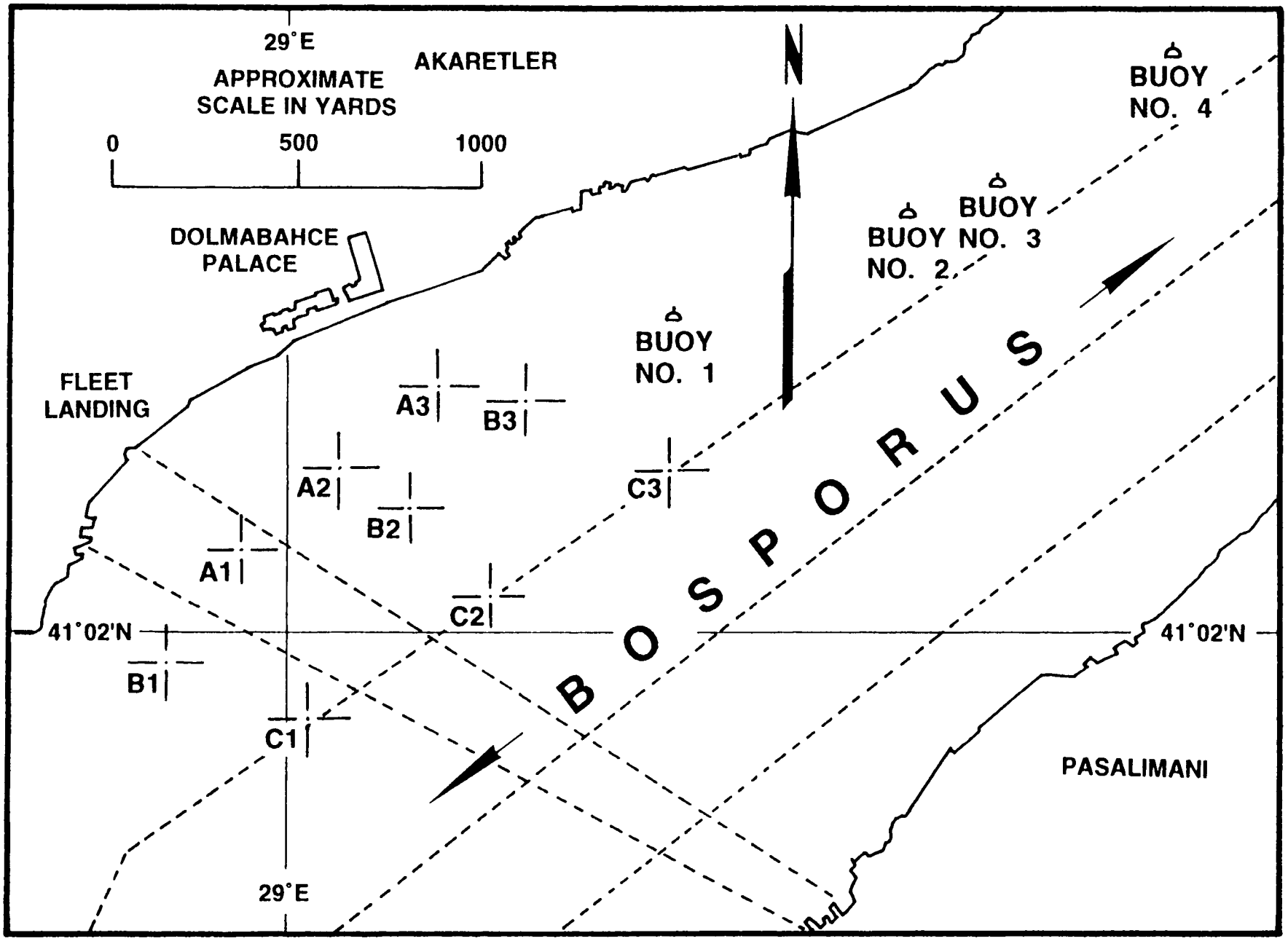

Figure 2-5. Anchorage and buoy positions near Dolmabahce Palace.

available for use only in weather conditions that would make landing at the designated Fleet Landing unsafe.

Local authorities state that the major boating hazard in the region is considered to be the density of traffic through and across the channel. More than 500 accidents, including collisions, groundings, and other incidents have been recorded over a 30-year period.

A strong southwesterly-setting current of 3 to 4 kt is typical in the center of the channel adjacent to Dolmabahce Palace. Its strength is due to the 47.6 ft (14.5 m) average difference in water levels between the Black and Aegean Seas. The current may increase to a maximum of 6 to 7 kt during winter due to river run-off into the Black Sea and the presence of strong north or northeasterly winds. A counter-current with a normal velocity of 0.5 to 1 kt flows northward along the west shore of the Bosporus near the Fleet Landing. The maximum speed of the counter-current is 2 kt. FICEURLANT (1989) reports that a counter-current may also be encountered on the east side of the channel.

Tidal range at Istanbul is small, with a normal change of only about ±14 inches (35 cm) from mean sea level.

Specific hazardous conditions, vessel situations, and suggested precautionary/evasive action scenarios are summarized in Table 2-1.

SEASONAL SUMMARY OF HAZARDOUS WEATHER CONDITIONS

WINTER (November through February)

* Strong south to southwesterly winds to 60 kt possible in advance of migrating low pressure systems
  - Wind affects all anchorages
  - Accompanied by waves to 8.2 ft (2.5 m) in the aircraft carrier anchorage and anchorage off Haydarpasa
  - Most frequent in January, but may occur any time from late November through January.

SPRING (March through May)

* Strong wind events in advance of the migrating low pressure systems continue with decreasing frequency as the season progresses.

SUMMER (June through September)

* Northerly winds are the rule.
* Dry warm weather prevails. Strong southerly winds are rare.
* Thunderstorms are at their annual maximum frequency of occurrence during June, with 2 observed during an average month. July averages 1.1, August 1.4 and September 1.9 thunderstorms.

AUTUMN (October)

* Rapid transition from summer to winter conditions, threat of passage of migratory lows by end of month with strong southerly winds.

Table 2.2 Summary of Hazardous Environmental Conditions for the Port of Istanbul, Turkey

HAZARDOUS CONDITION	INDICATORS OF POTENTIAL HAZARDS	VESSEL LOCATION/ SITUATION AFFECTED	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS
1. **S to SW winds and waves** - The most hazardous weather condition at the port. * Most likely to occur in November, December and January. * Rare in summer. * Wind velocity may reach 60 kt. * Waves at S end and W of mouth of Bosporus may reach 8.2 ft (2.5 m). * Waves in Bosporus channel are limited to 3.3 ft (1 m).	**Advance Warning**. * Developing low pressure system in Gulf of Genoa (Genoa Low) or Adriatic Sea with storm track across Aegean Sea to Black Sea.	(1) **Anchored - aircraft carrier anchorage**.	a. **Worst conditions for ships in the anchorage**. * Wind force is sufficient to dictate a sortie to the Sea of Marmara or, if time permits, into the Aegean Sea or Black Sea. * If vessels must remain in the anchorage, steaming to the anchor may be required to prevent anchor dragging.
		(2) **Anchored - off Haydarpasa**.	a. **Worst conditions for ships in the anchorage**. * Wind force is sufficient to dictate a sortie to the Sea of Marmara or, if time permits, into the Aegean Sea or Black Sea. * If vessels must remain in the anchorage, steaming to the anchor may be required to prevent anchor dragging.
		(3) **Anchored/moored to buoy in Bosporus off Dolmabahce Palace**.	a. **Worst conditions for ships in the anchorage**. * Ships may swing widely on their anchor chain/buoy mooring due to the combination of wind force and south-setting, sometimes swirling currents in the Bosporus. Vessels should sortie into the Sea of Marmara or, if time permits, into the Aegean Sea or Black Sea prior to wind onset. * If vessels must remain in the anchorage, adequate room must be maintained between vessels to permit full radius swings without interference. Steaming to the anchor/moor may be required.
		(4) **Small boat/water taxi operations**.	a. **Worst conditions for running small boats/water taxis to/from ships in the anchorages**. * Choppy seas created by opposing forces of wind and current may make boat operation uncomfortable, if not hazardous east of the aircraft carrier anchorage, in the anchorage off Haydarpasa, and exposed waters between the anchorages and the Fleet Landing. * Runs to/from ships in the anchorage off Dolmabahce Palace are only minimally affected. Chop to 3.3 ft (1 m) may minimally impact runs.
2. **Restricted visibility due to fog** - * Most commonly observed in autumn, winter and spring. * Possible in summer. * Usually an early morning condition.	**Advance Warning**. * Stable weather pattern with little wind.	(1) **Arriving/ departing**.	a. **Restricted visibility may stop ship movement in the Bosporus**. * Pilots will not move ships in the harbor when both sides of the Bosporus cannot be seen simultaneously. * Arriving and departing ships should schedule movements within harbor in afternoon hours during periods of stable, calm conditions.

REFERENCES

Department of the Air Force, 1977: European Theater Weather Orientation, 2nd Weather Wing Pamphlet 2WWP 105-12. Published by the Department of the Air Force.

FICEURLANT, 1989: Port Directory for Istanbul, Turkey. Fleet Intelligence Center Europe and Atlantic, Norfolk, Virginia.

Reiter, Elmar R., 1975: Weather Phenomena of the Mediterranean Basin, Part 1: General Description of the Meteorological Processes. Published by Environmental Prediction Research Facility, Naval Postgraduate School, Monterey, CA 93940.

Port Visit

April 1993: NRL Meteorologist Mr. Samson Brand and SAIC Meteorologist Mr. R. W. Fett met with Istanbul Pilot Captain Saim Oguzulgen and Husbandry Agent Mr. Ziya Goksel to obtain much of the information contained in this port evaluation.

3. GENERAL INFORMATION

This section is intended for Fleet meteorologists, oceanographers and staff planners. Sub-section 3.7 provides a general discussion of hazards and Table 3-3 provides a summary of vessel locations and situations, potential hazards, effects, precautionary and evasive actions, as well as advance indicators and other information about the potential hazards by season.

3.1 Geographic Location and Topography

Istanbul is located in northwestern Turkey near 41°01'N 029°00'E on the north shore of the Sea of Marmara (Figure 3-1).

Northwestern Turkey is divided by a complex waterway that connects the Black Sea to the Sea of Marmara and the Aegean Sea. The channel passing between the Black Sea and the Sea of Marmara is named the Istanbul Bogazi, more commonly called the Bosporus. Istanbul is positioned at the south end of the Bosporus (Figure 3-2). The Sea of Marmara is connected to the Aegean Sea by a channel called the Canakkale Bogazi, also known as the Dardanelles.

Greater Istanbul is situated on both sides of the Bosporus and both sides of the Golden Horn, a waterway extending westward near the south end of the Bosporus (Figure 3-2). The western side of the Bosporus is commonly referred to as the European side, and the eastern side is alternatively called the Asian or Anatolian side. The Port of Istanbul technically encompasses the entire length of the Bosporus.

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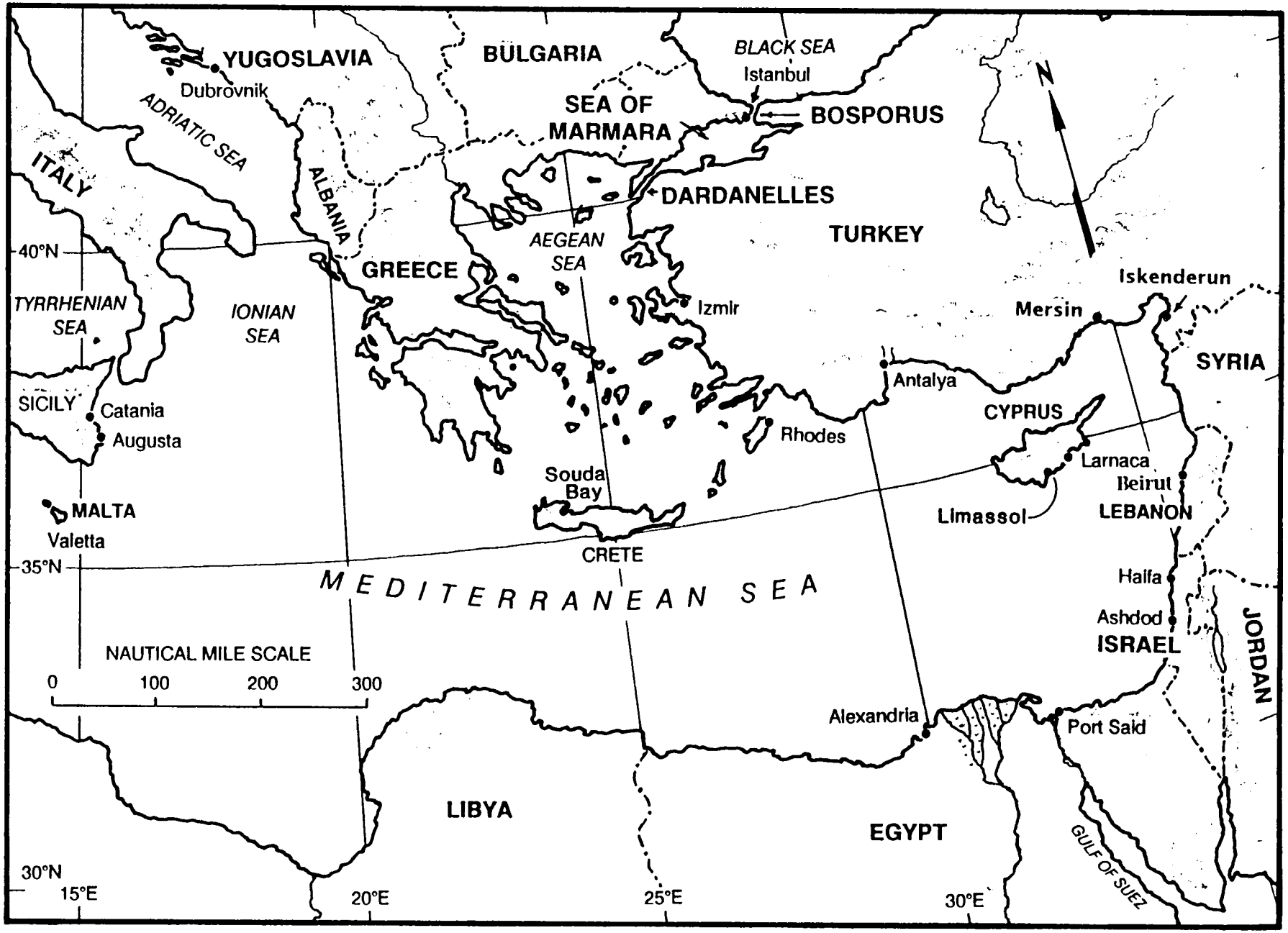

Figure 3-1. Turkey and Eastern Mediterranean Basin.

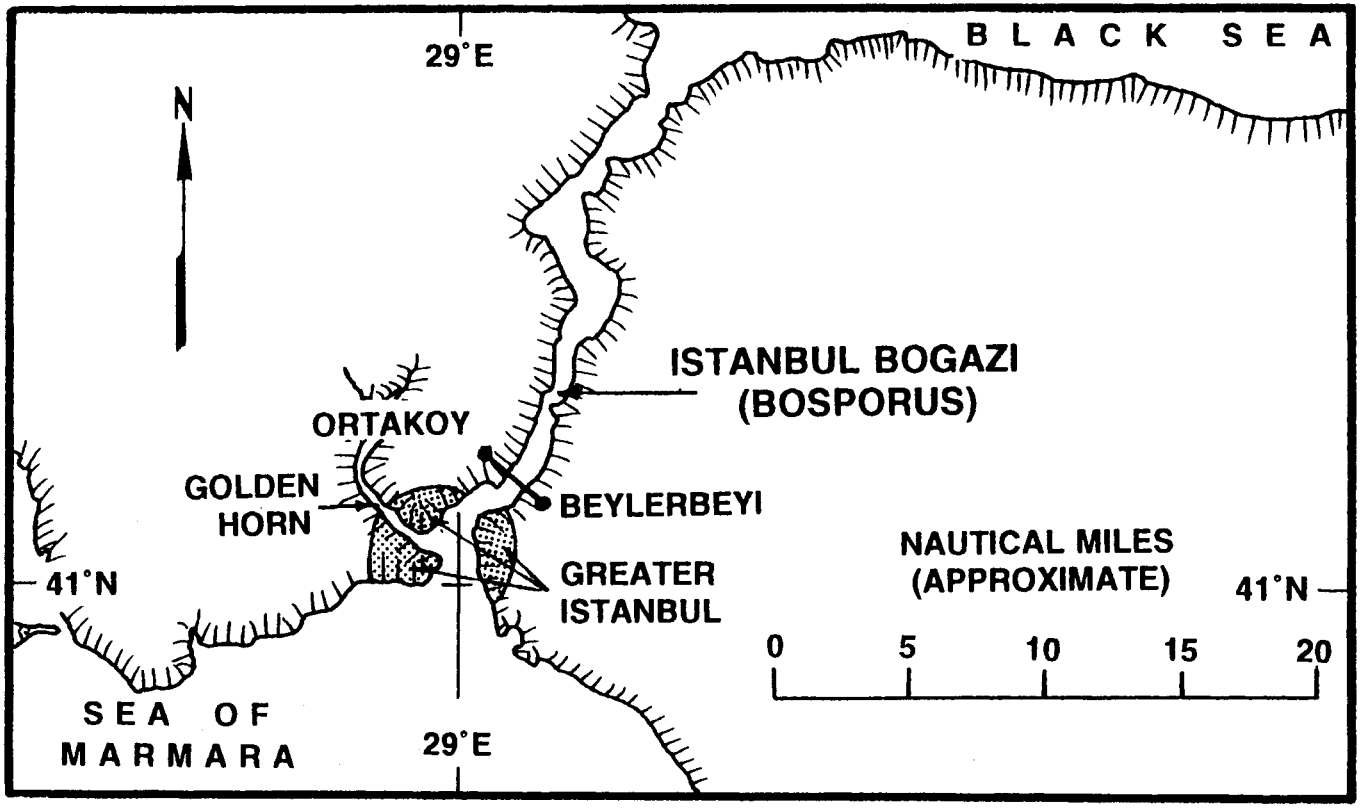

Figure 3-2. Greater Istanbul, Bosporus and surrounding area.

commercial and modern shopping centers of Istanbul (Figure 3-3). A third section of Greater Istanbul, called Uskudar-Kadikoy (Scutari), is located on the Asian side of the Bosporus (FICEURLANT, 1989).

The topography of Turkey varies from the lowlands of coastal regions to mountains exceeding 16,000 ft (4,877 m). The country is interspersed with lakes and is divided in the west by the Dardanelles, Sea of Marmara and the Bosporus (Figure 3-4). East of Istanbul the Pontic Mountain Range is oriented east-west along the north coast of Turkey and extends in some areas to the shore of the Black Sea. Much of central Turkey south of the Pontic Mountain Range is a relatively high area known as the Central or Anatolian Plateau (Department of the Air Force, 1977). The Taurus Mountain Range extends east-west south of the Anatolian Plateau. The Aegean Mountains, with some elevations exceeding 8,000 ft (2,438 m), lie roughly north-south on the western side of Asian Turkey.

3.2 Entrance and Channel

The southern approach to the Bosporus is approximately 990 yd (905 m) wide (Figure 3-3). All maritime traffic must stay to the starboard side of the channel. Charted depths in the channel vary between 11 to over 27 fathoms (20 to over 49 m) between the pilot pick-up point and the anchorage adjacent to Dolmabahce Palace. Pilotage is compulsory for all U. S. Navy vessels entering the Bosporus. They can be picked up either at the Black Sea entrance for southbound entry, or south of the entrance to Istanbul for northbound entry (FICEURLANT, 1989).

A bridge crosses the Bosporus approximately 3.5 nmi north of the southern entrance to the channel between Beylerbeyi on the Asian side and Ortakoy on the European side (Figure 3-2). The bridge has a vertical clearance of 210 ft (64 m) over the central 1,312 ft (400 m) of its total span of 3,524 ft (1,074 m).

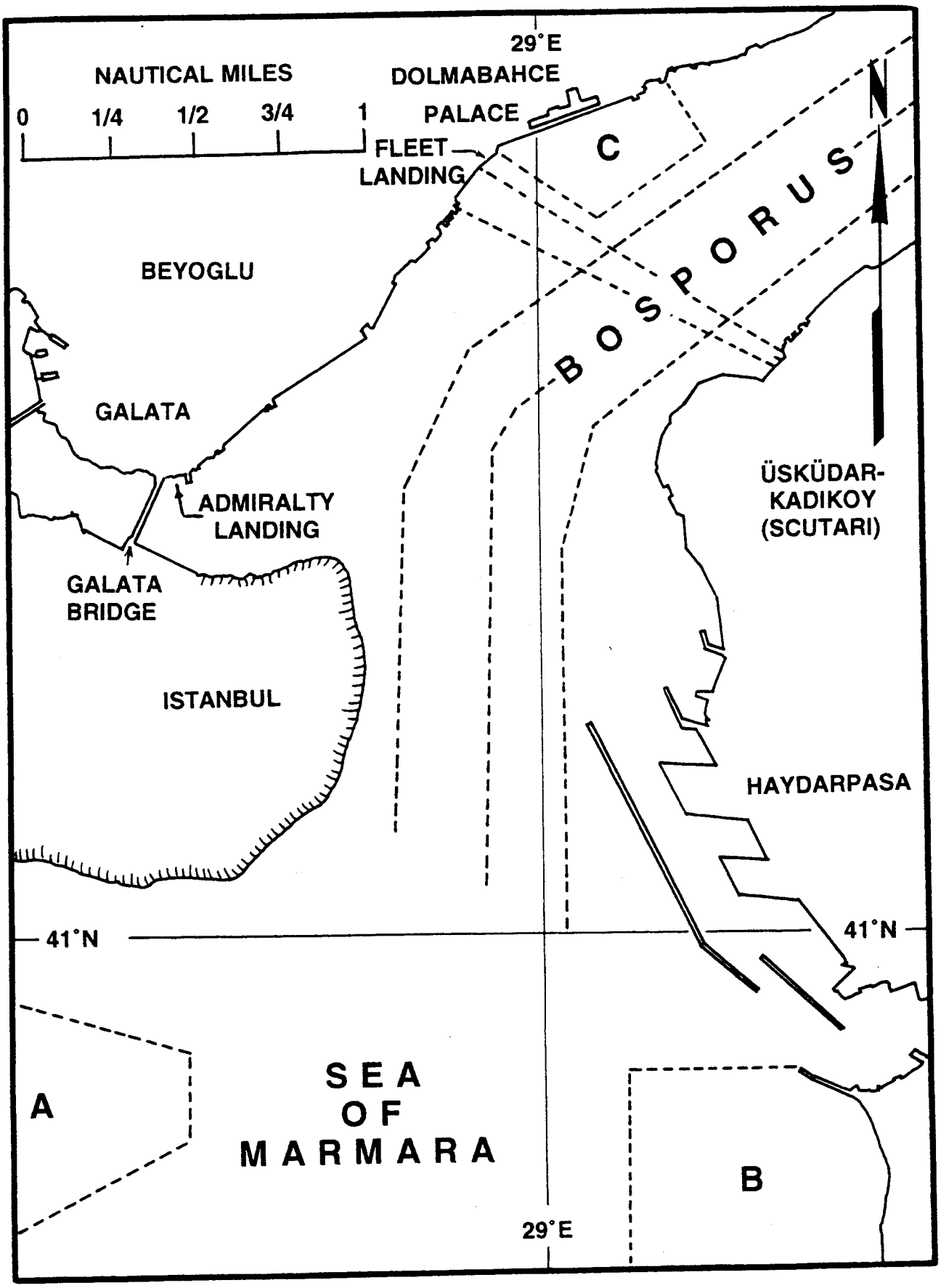

Figure 3-3. Greater Istanbul and adjacent port facilities.

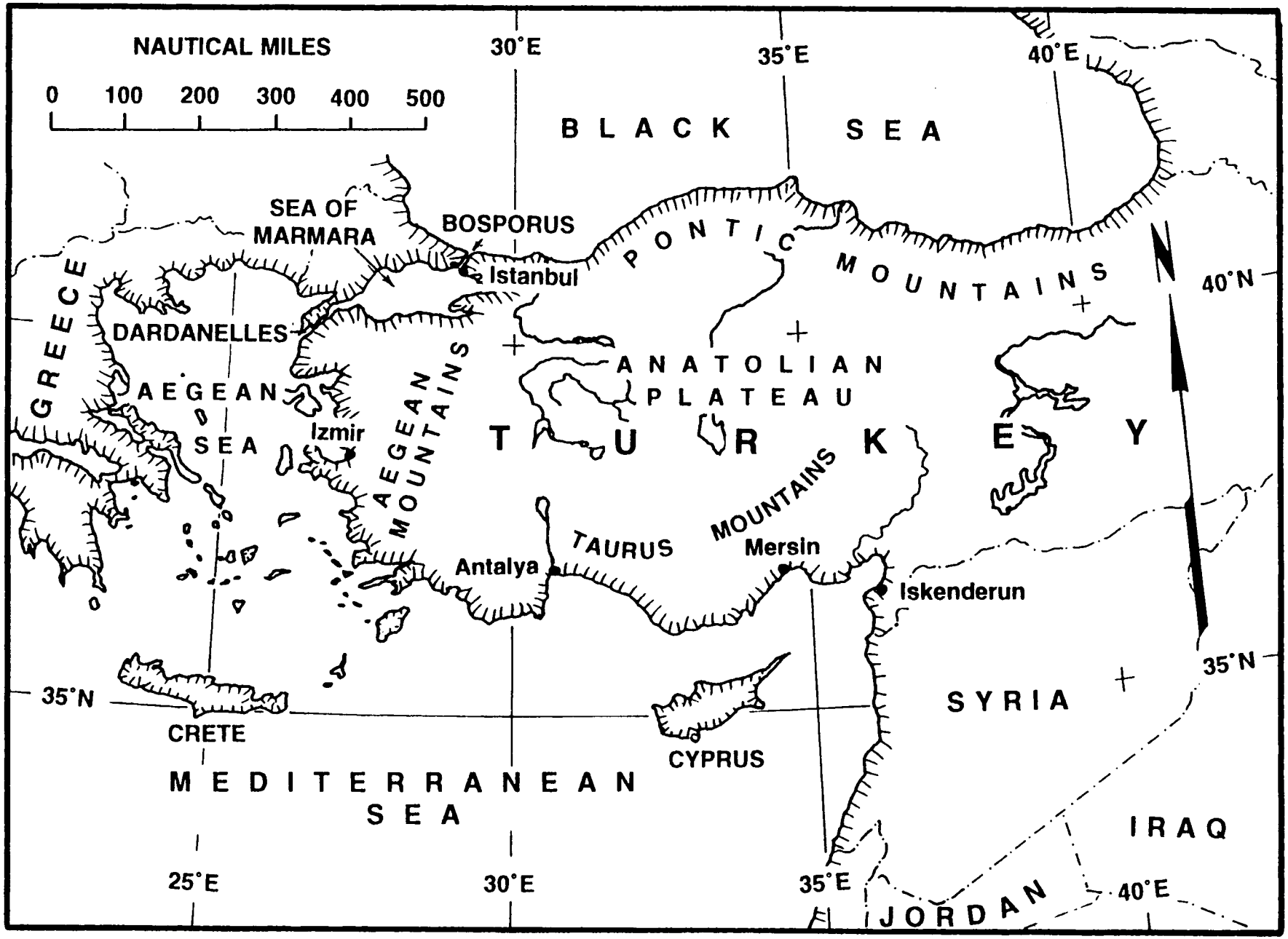

Figure 3-4. Geographical configuration and topography of Turkey.

3.3 Harbor Facilities

Although other facilities are located on both sides of the Bosporus and in the Golden Horn (Inner Harbor), a large part of the Port of Istanbul is located on the Asian side of the Bosporus at Haydarpasa. According to FICEURLANT (1989), Haydarpasa's quays total 6,522 ft (1,988 m) in length. As shown in Figure 3-3, the port is protected by two breakwaters with an overall length of 5,607 ft (1,709 m). Up to 6 medium-sized vessels may be accommodated simultaneously, and cargo operations may be made direct to and from wharves or railway trucks. Depth alongside quays varies from 19.7 to 32.8 ft (6 to 10 m). Other berthing facilities at Istanbul, located on the European side of the Bosporus, include passenger vessel piers about 1/2 nmi northeast of the Galata Bridge, a coal handling facility, and a cargo terminal.

Since U. S. Navy ships do not use any of the previously described berthing facilities, the areas of primary interest to the U. S. Navy are the anchorages at the port. Three anchorage locations are identified for U.S. Navy ships.

(1) The preferred anchorage for aircraft carriers is located on the Sea of Marmara just south of Istanbul near 40°59'24"N 28°57'42"E, as indicated by the letter "A" on Figure 3-3. Holding is good on a mud bottom in depths of 82 to 95 ft (25 to 29 m).

(2) According to FICEURLANT (1989), good anchorage for large vessels is also available off Haydarpasa. The position is indicated by the letter "B" on Figure 3-3.

(3) There are nine anchorage positions and 4 mooring buoys located on the west side of the Bosporus channel adjacent to Dolmabahce Palace, approximately 2-1/2 nmi north of the southern entrance to the Bosporus. The general location is indicated by the letter "C" on Figure 3-3. Good holding on a mud bottom is reported in depths of 82 to 115 ft (25 to 35 m).

Specific anchorage and approximate buoy positions as provided on a chart by port officials are shown on Figure 3-5.

Local authorities state that the Fleet Landing is located just south of Dolmabahce Palace on the west side of the Bosporus (Figure 3-3). It is common practice for U. S. Navy ships to rent water taxis to use for personnel and supply runs to/from ships in the anchorages. Run time from the aircraft carrier anchorage to the Fleet Landing is about 45 minutes, but the return trip takes only about 25 minutes. The difference is due to the strong southwesterly setting current. According to FICEURLANT (1989), during difficult boating weather, ships may use the President's boat harbor, about 1,500 ft (457 m) south of Dolmabahce Palace near a mosque, a location essentially coincident with the Fleet Landing described by local authorities.

Another location, called Admiralty Landing, is located just east of the Galata Bridge on the north side of the Golden Horn (Figure 3-3). It is not a designated Fleet Landing, and is available for use only in severe weather conditions that would make landing at the designated Fleet Landing unsafe.

There are five dry docks at the port. Specifications are listed in Table 3-1.

Table 3-1. Port of Istanbul dry dock specifications. (After FICEURLANT, 1989.)

DRY DOCK TYPE	LENGTH FEET/METERS	WIDTH FEET/METERS	DEPTH FEET/METERS
FIXED/FLOODABLE	369.1/112.5	66.0/20.13	37.6/11.45
FIXED/FLOODABLE	503.3/153.4	53.6/16.33	32.0/9.75
FIXED/FLOODABLE	248.9/75.85	52.5/16.0	32.4/9.86
FLOATING	449.9/137.13	69.7/21.25	22.0/6.7
FLOATING	634.7/193.44	91.5/27.9	26.0/7.92

Mechanical handling facilities at the cargo terminal include six floating cranes with 10 to 60 ton capacities, two

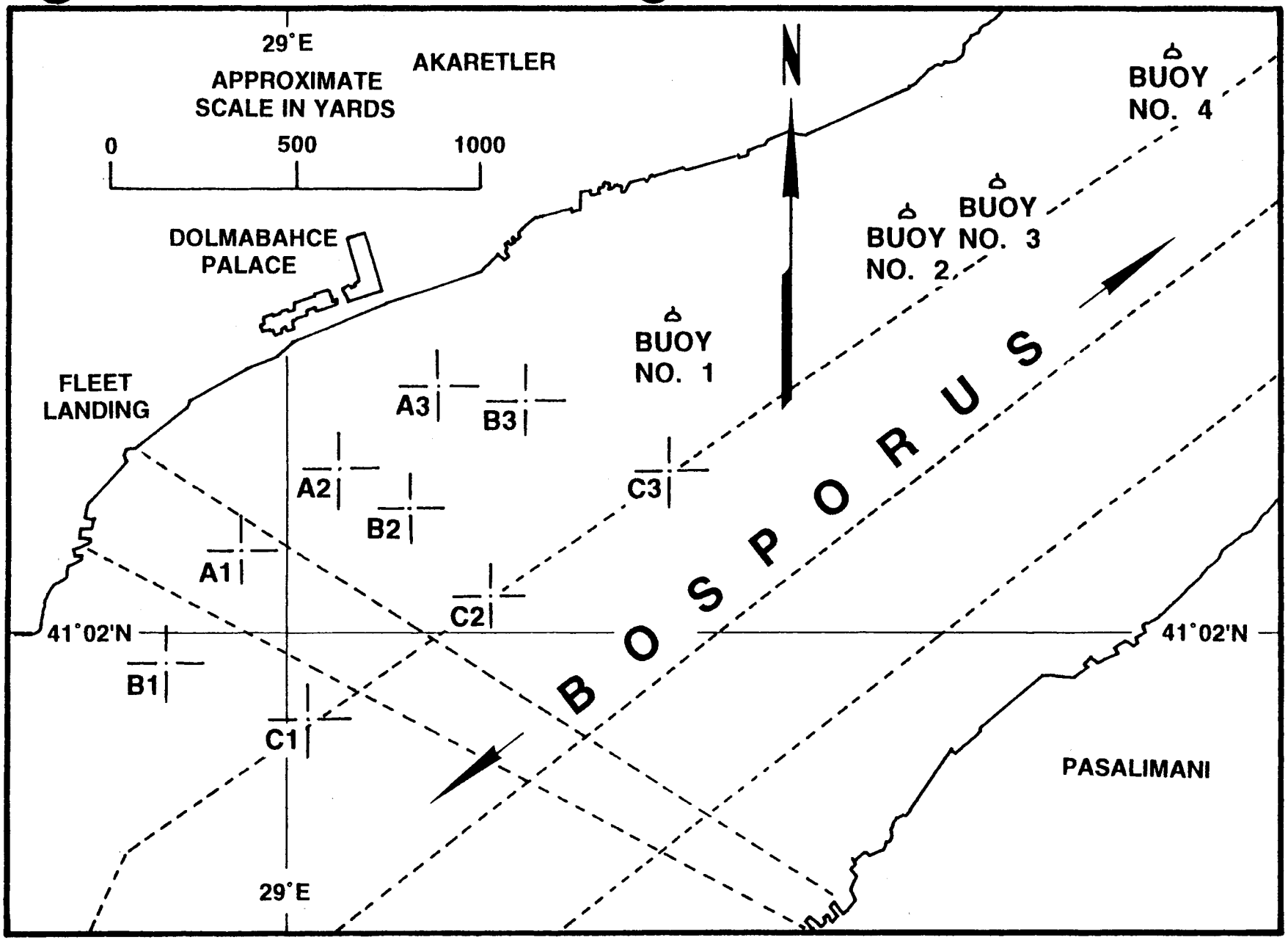

Figure 3-5. Anchorage and buoy positions near Dolmabahce Palace.

5-ton and eight 3-ton electric cranes, 12 5-ton and three 3-ton mobile cranes, as well as several forklifts, and other, smaller freight handling equipments. Tug boats of 110 to 2,500 hp are available at the port (FICEURLANT, 1989).

3.4 Qualitative Evaluation of the Port of Istanbul

The Port of Istanbul is open and exposed to wind extremes. But, due to the lack of extreme winds and relatively short fetch exposure, it experiences only minimal problems. The aircraft carrier anchorage, located west of the south end of the Bosporus and identified by the letter "A" on Figure 3-3, occasionally experiences south to southwesterly winds to 60 kt and seas to 8.2 ft (2.5 m). These conditions occur in advance of low migratory pressure systems approaching the area from the southwest. The same winds are felt at the anchorage in the Bosporus adjacent to Dolmabahce Palace (identified by the letter "C" on Figure 3-3). However, according to local authorities, waves at that location are limited to only 1.5 ft (0.5 m). A sortie from the port is recommended when winds are forecast to reach 50 kt regardless of vessel location.

Although the southerly winds and south-setting currents generate a choppy sea, especially at the south end of the Bosporus, boat runs by rented water taxis are seldom canceled. To facilitate small boats coming alongside, local authorities state that "camel barges" are used at all times at the Fleet Landing and at anchored ships when water taxis are operating. Sizeable wakes produced by ferries passing close aboard at high rates of speed pose an additional hazard to small boat operation (FICEURLANT, 1989).

Another factor to be considered at Istanbul is the existence of strong currents in the Bosporus. According to FICEURLANT (1989), two ships occupying positions closest to the channel in the anchorage area adjacent to Dolmabahce Palace (see Figure 3-4) experienced swirling currents and moderate winds that

required one ship to pay out additional anchor chain, and the other ship to relocate her position. The currents shifted direction frequently, resulting in one ship's heading being as much as 180° different from the other. The need for adequate swinging room was stressed.

Local authorities state that the major boating hazard in the region is considered to be the density of traffic through and across the channel. More than 500 accidents, including collisions, groundings, and other incidents, have been recorded over a 30-year period.

3.5 Currents and Tides

A strong southwesterly-setting current of 3 to 4 kt is typical in the center of the channel adjacent to Dolmabahce Palace. Its strength is due to the 47.6 ft (14.5 m) average difference in water levels between the Black and Aegean Seas. The current may increase to a maximum of 6 to 7 kt during winter due to river run-off into the Black Sea and the presence of strong north or northeasterly winds.

A counter-current with a normal velocity of 0.5 to 1 kt flows northward along the west shore of the Bosporus near the Fleet Landing. The maximum speed of the counter-current is 2 kt. FICEURLANT (1989) reports that a counter-current may also be encountered on the east side of the channel.

Tidal range at Istanbul is small, with a normal change of only about ±14 inches (35 cm) from mean sea level.

3.6 Visibility

The port occasionally experiences fog that causes the port to be closed to traffic. Pilots will not move ships at any time that both sides of the Bosporus are not visible, a distance of approximately 1/2 nautical mile when viewed from the middle of the waterway. Severely restricted visibility is usually an early

morning condition, occurring on an average of 6 days during winter, 5.1 days during spring, 1.1 days during summer, and 4.5 days during autumn.

3.7 Hazardous Conditions

Conversations with local port officials reveal that the port experiences remarkably few weather phenomena that create hazardous conditions for ships in the harbor. The Taurus and Aegean mountain ranges (Figure 3-4) limit the typical Mediterranean climate to the southern and western coasts of Turkey. These mountains block the eastward and northward progression of storms moving across the Mediterranean. Consequently, the location of Istanbul on the north side of the country and away from the Mediterranean Sea separates it from much of the typical Mediterranean weather phenomena. Instead, the port's location at the south end of the relatively short Bosporus waterway between the Black Sea and the Sea of Marmara exposes Istanbul primarily to weather regimes that affect southeastern Europe and the Black Sea.

Although bordered on three sides by water (Black Sea, Sea of Marmara, Aegean Sea, and Mediterranean Sea), the maritime influence on Turkey is limited. The mountain ranges bordering these bodies of water limit the influence, for the most part, to the narrow coastal regions. The influence at Istanbul is primarily the moderation of both summer and winter temperature extremes. The climate of Istanbul has been observed as being similar to that of southern California, with low humidity and temperature extremes ranging from lows near 30°F (-1°C) to over 100°F (38°C).

A seasonal summary of environmental conditions that affect Istanbul follows. Unless otherwise specified, the climatological statistics presented herein have been extracted from Biel (1946).

A. Winter (November through February)

Most European cyclones move in a generally zonal direction along one of three preferred paths: the primary tracks along the northern and southern borders of the continent and a third track of lesser frequency across the North and Baltic seas. Although a few storms enter the southern tracks from the English Channel, the overwhelming majority form south of the Alps near the relatively warm waters of the Gulf of Genoa or Adriatic Sea (Department of the Air Force, 1977). Most of the Mediterranean cyclones travel along a well defined path east-southeastward into a center of maximum frequency near Cyprus. Some of the Mediterranean lows migrate northeastward across the Aegean and Black seas, while a few go farther east, into the Caspian Sea or Aral Sea.

It is the transient Mediterranean lows which migrate northeastward across the Aegean and Black seas that bring the most hazardous winter-time weather to Istanbul--strong southerly winds in the pressure gradient ahead of migrating low pressure systems. South to southwesterly winds to 60 kt and associated seas to 8.2 ft (2.5 m) have been experienced in the aircraft carrier anchorage during the approach of such low pressure systems. Istanbul (observation site not specified) experiences an average of 4 days per year with winds ≥28 kt. January is the month of most frequent occurrence of winds ≥28 kt, with an average incidence of 1.0 days during the month. Local authorities state that strong winds may occur any time from late November through January.

Temperatures in the Istanbul area are moderate. Visual interpolation of isotherms contained in Reiter (1975), indicates that the February mean maximum temperature at Istanbul is approximately 45°F (7.2°C), while the February mean minimum temperature is approximately 35°F (1.7°C). Freezing temperatures are experienced at Istanbul during winter and, when combined with wind, can result in equivalent chill temperatures that would be uncomfortable, if not hazardous, to personnel working on exposed

weather decks. Table 3-2 is provided as a guide to determine approximate equivalent chill temperatures.

Table 3-2. Wind Chill. The cooling power of the wind expressed as "Equivalent Chill Temperature" (adapted from Kotsch, 1983).

Wind Speed		Cooling Power of Wind expressed as "Equivalent Chill Temperature"								
Knots	MPH	Temperature (°F)								
Calm		40	35	30	25	20	15	10	5	0
		Equivalent Chill Temperature								
3-6	5	35	30	25	20	15	10	5	0	-5
7-10	10	30	20	15	10	5	0	-10	-15	-20
11-15	15	25	15	10	0	-5	-10	-20	-25	-30
16-19	20	20	10	5	0	-10	-15	-25	-30	-35
20-23	25	15	10	0	-5	-15	-20	-30	-35	-45
24-28	30	10	5	0	-10	-20	-25	-30	-40	-50
29-32	35	10	5	-5	-10	-20	-30	-35	-40	-50
33-36	40	10	0	-5	-15	-20	-30	-35	-45	-55

The annual "rainy season" starts in mid-November and lasts through the winter months. Precipitation can be expected on about 38% of the days during the season, with a maximum frequency of occurrence during December when the average percentage is 45%. Average annual accumulation is 20 to 25 inches. Snowfall can be expected on about 10 to 15 days per year. Thunderstorms are not unknown during winter, but are primarily an early- to mid-summer occurrence.

B. Spring (March through May)

The spring season brings gradually moderating temperatures to the Istanbul area. A storm track develops that starts near the Atlas Mountains in North Africa and extends east-northeast across the Mediterranean with a secondary track extending northeastward across southern Greece, the Aegean Sea, Istanbul

and the Black Sea. Strong wind events in advance of the migrating low pressure systems continue with decreasing frequency as the season progresses. Winds of ≥28 kt can be expected on an average of only 0.3 days during March and April and 0.2 days in May.

Visual interpolation of isotherms contained in Reiter (1975), indicates that the mean maximum temperature during May is about 70°F (21°C) and the mean minimum for the same month is near 55°F (13°C) (Reiter, 1975).

Precipitation can be expected on an average of 10 days in March, 8 days in April (the last month of the annual "rainy season") and 6 days in May. Thunderstorms can be expected on an average of 0.1 days in March, 0.4 days in April and 0.9 days in May.

C. Summer (June through September)

The summer storm track is across northern Europe well north of Istanbul. Consequently, the threat of strong south to southwesterly winds in advance of approaching low pressure systems is greatly diminished, and relatively dry and warm summer weather prevails. Northerly winds are the rule, due to the counter-clockwise circulation of the winds around the Siberian low pressure center that extends westward over southwestern Asia. Winds of ≥28 kt can be expected on an average of only 0.2 days during June and July, and 0.3 days in August and September.

Summer temperatures at Istanbul are relatively cool when compared with the interior of Turkey. Interpolation of isotherms contained in Reiter (1975) indicates that the mean maximum temperature for August is approximately 82°F (28°C), while the mean minimum for the same month is about 62°F (17°C).

Precipitation can be expected on an average of 5 days in June, 3 days in July (the driest month of the year), 4 days in August, and 6 days in September. Thunderstorms are at their annual maximum frequency of occurrence during June, with 2

observed during an average month. July averages 1.1, August 1.4 and September 1.9 thunderstorms.

D. Autumn (October)

The short transitional autumn season sees a rapid return to the winter pattern of transient low pressure systems as the storm track returns from northern Europe to southern Europe and the Mediterranean Basin. The month of October is not a windy one, however. The average occurrence of winds ≥28 kt is only 0.1 days for the month, the lowest of the year.

The probability of precipitation increases from that of summer, with precipitation being recorded on an average of 7 days during October. Thunderstorm activity occurs on an average of 1 day during the month.

3.8 Harbor Protection

The port facilities at Haydarpasa are protected by a series of breakwaters. Facilities situated on the Golden Horn have limited protection as a result of the orientation of the waterway (Figure 3-3). However, other locations at Istanbul, including the anchorages that are used by visiting U. S. Navy ships, are exposed to the effects of wind and waves.

3.8.1 Wind and Weather

Transient Mediterranean lows migrating northeastward across the Aegean and Black Seas bring the most hazardous winter-time weather to Istanbul. The hazards result from strong south to southwesterly winds blowing across the Sea of Marmara in advance of the low pressure systems. The aircraft carrier anchorage located just west of the entrance to the Bosporus (see location "A" on Figure 3-3) is fully exposed to the winds, which can reach 60 kt. Northerly winds are not identified as a problem for the

port. The low-lying terrain to the north provides some protection to the aircraft anchorage. The anchorage on the Bosporus adjacent to Dolmabahce Palace (see location "C" on Figure 3-3) and the buoy positions immediately north of the anchorage are exposed to northerly or southerly winds that blow more-or-less parallel to the orientation of the waterway. The southerly winds ahead of approaching low pressure systems pose the greatest problem to the anchorage because of their strength, which can reach 60 kt, and the fact that they are opposite in direction to the relatively strong current in the Bosporus.

3.8.2 Waves

Local authorities state that wave motion at the port is a problem only at the aircraft carrier anchorage. Even then the waves are a problem only to the water taxis that make personnel and logistic runs to/from ships in the anchorage. When the south to southwesterly 60 kt winds described in section 3.8.1 reach the anchorage, they are accompanied by waves to about 8.2 ft (2.5 m). When the southerly winds and waves encounter the southerly setting currents of the Bosporus, a choppy sea is raised, but it is described as more bothersome than hazardous to small boat operations. Local authorities state that wave heights in the anchorage adjacent to Dolmabahce Palace are limited to about 3.3 ft (1 m) during the strongest wind events.

3.9 Protective and Mitigating Measures

3.9.1 Sortie from the Port

When winds are forecast to reach 50 kt, a sortie from the port into the Sea of Marmara is recommended. Hazards of anchor dragging and swinging due to variable wind and currents in the channel are pertinent factors. If time permits, a sortie out of

the entire Bosporus/Sea of Marmara/Dardanelles waterway into the Aegean Sea or Black Sea should be considered.

3.9.2 Steaming to the Anchor/Buoy

When ships cannot sortie and must remain in the port during strong wind situations, crews should be prepared to steam to the anchor/buoy to prevent anchor dragging.

3.9.3 Scheduling

Pilots will not move ships at the port unless both sides of the Bosporus can be seen. Fog is likely to be an early morning event, and since most fog conditions improve by late morning, arrivals or departures from the port should be scheduled for afternoon hours during periods when fog is likely or has been reported on previous days in a stable weather situation.

3.10 Summary of Problems, Actions, and Indicators

Table 3-3 is intended to provide easy-to-use, seasonal references for meteorologists on ships visiting the Port of Istanbul. Table 2-1 of Section 2 summarizes Table 3-3 and is intended primarily for use by ship captains.

Table 3- 3 Potential Problem Situations at the Port of Istanbul, Turkey – All Seasons

VESSEL LOCATION/ SITUATION AFFECTED	POTENTIAL HAZARD	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARDS
1. **Aircraft Carrier Anchorage south of Istanbul.** Winter event occurring primarily during November through January. Possible spring and autumn. Rare in summer.	a. **S-SW'ly Winds/Waves** - Winds to 60 kt possible, accompanied by waves to 8.2 ft (2.5 m).	a. Wind force is sufficient to dictate a sortie to the Sea of Marmara or, if time permits, into the Aegean Sea or Black Sea. If vessels must remain in the anchorage, steaming to the anchor may be required to prevent anchor dragging.	a. The strongest winds result from the tightening pressure gradient in advance of transient low pressure systems moving NE'ly across the Aegean and Black Seas. Meteorologists should be alert for developing low pressure systems in the Gulf of Genoa (Genoa Lows) or Adriatic Sea, with a forecast track that would take them across the Aegean Sea toward the Black Sea. Numerical guidance should be reliable.
2. **Anchorage off Haydarpasa.** Winter event occurring primarily during November through January. Possible spring and autumn. Rare in summer.	a. **S-SW'ly Winds/Waves** - Winds to 60 kt possible, accompanied by waves to 8.2 ft (2.5 m).	a. Wind force is sufficient to dictate a sortie to the Sea of Marmara or, if time permits, into the Aegean Sea or Black Sea. If vessels must remain in the anchorage, steaming to the anchor may be required to prevent anchor dragging.	a. The strongest winds result from the tightening pressure gradient in advance of transient low pressure systems moving NE'ly across the Aegean and Black Seas. Meteorologists should be alert for developing low pressure systems in the Gulf of Genoa (so-called Genoa Lows) or Adriatic Sea, with a forecast track that would take them across the Aegean Sea toward the Black Sea. Numerical guidance should be reliable.
3. **Anchorage in Bosporus off Dolmabahce Palace.** Winter event occurring primarily during November through January. Possible spring and autumn. Rare in summer.	a. **S-SW'ly Winds/Waves** - Winds to 60 kt possible, with waves limited to 3.3 ft (1 m) at anchorage. Anticipate choppy water due to wind and current moving in opposite directions.	a. Ships may swing widely on their anchor chain/buoy mooring due to the combination of wind force and south-setting, sometimes swirling currents in the Bosporus. Vessels should sortie into the Sea of Marmara or, if time permits, into the Aegean Sea or Black Sea prior to wind onset. If vessels must remain in the anchorage, adequate room must be maintained between vessels to permit full radius swings without interference. Steaming to the anchor/moor may be required.	a. The strongest winds result from the tightening pressure gradient in advance of transient low pressure systems moving NE'ly across the Aegean and Black Seas. Meteorologists should be alert for developing low pressure systems in the Gulf of Genoa (so-called Genoa Lows) or Adriatic Sea, with a forecast track that would take them across the Aegean Sea toward the Black Sea. Numerical guidance should be reliable.
4. **Small Boat/Water Taxi operation.** Winter event occurring primarily during November through January. Possible spring and autumn. Rare in summer.	a. **S-SW'ly Winds/Waves** - Winds to 60 kt possible, with waves to 8.2 ft (2.5 m) in exposed areas S of and in mouth of Bosporus. Limited to 3.3 ft (1 m) in Bosporus N of mouth.	a. Choppy seas created by opposing forces of wind and current may make boat operation uncomfortable, if not hazardous in the aircraft carrier anchorage, anchorage off Haydarpasa, and exposed waters between the anchorages and the Fleet Landing.	a. The strongest winds result from the tightening pressure gradient in advance of transient low pressure systems moving NE'ly across the Aegean and Black Seas. Meteorologists should be alert for developing low pressure systems in the Gulf of Genoa (so-called Genoa Lows) or Adriatic Sea, with a forecast track that would take them across the Aegean Sea toward the Black Sea. Numerical guidance should be reliable.
5. **Arriving/Departing.** Autumn, winter and spring event. Possible, but not common, in summer.	a. **Fog** - May restrict early morning visibility in harbor to less than 1/2 nmi.	a. Restricts visibility so that both sides of the Bosporus cannot be seen simultaneously, and pilots will not move ships in the harbor unless they can see both sides. Ship captains should schedule arrivals and departures for afternoon hours during periods of known restricted visibility episodes or when the weather is otherwise conducive to fog formation.	a. Meteorologists should be alert for cold, moist, and stable weather conditions moving over the Istanbul area. A stable weather pattern with little wind is most likely to produce the fog. Once occurring, the fog is likely to repeat on consecutive days until the air mass over the area changes.

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Port Visit

April 1993: NRL Meteorologist Mr. Samson Brand and and SAIC Meteorologist Mr. R. W. Fett met with Istanbul Pilot Captain Saim Oguzulgen and Husbandry Agent Mr. Ziya Goksel to obtain much of the information contained in this port evaluation.

APPENDIX A

General Purpose Oceanographic Information

This section provides some general definitions regarding waves and is extracted from H.O. Pub. No. 603, Practical Methods for Observing and Forecasting Ocean Waves (Pierson, Neumann, and James, 1955).

Definitions

Waves that are being generated by local winds are called "SEA". WAVES that have traveled out of the generating area are known as "SWELL". Seas are chaotic in period, height and direction while swell approaches a simple sine wave pattern as its distance from the generating area increases. An in-between state exists for a few hundred miles outside the generating area and is a condition that reflects parts of both of the above definitions. In the Mediterranean area, because its fetches and open sea expanses are limited, SEA or IN-BETWEEN conditions will prevail. The "SIGNIFICANT WAVE HEIGHT" is defined as the average value of the heights of the one-third highest waves. PERIOD and WAVE LENGTH refer to the time between passage of, and distances between, two successive crests on the sea surface. The FREQUENCY is the reciprocal of the period ($f = 1/T$); therefore as the period increases the frequency decreases. Waves result from the transfer of energy from the wind to the sea surface. The area over which the wind blows is known as the FETCH, and the length of time that the wind has blown is the DURATION. The characteristics of waves (height, length, and period) depend on the duration, fetch, and velocity of the wind. There is a continuous generation of small short waves from the time the wind starts until it stops. With continual transfer of energy from the wind to the sea surface the waves grow with the older waves leading the growth and spreading the energy over a greater range of frequencies. Throughout the growth cycle a SPECTRUM of ocean waves is being developed.

A Beaufort Scale table with related wave effects is shown on the following page.

BEAUFORT SCALE

Beaufort Number	Wind Speed Knots	Wind Speed MPH	Seaman's term	Effects observed at sea	Term and height of Waves in meters
0	Under 1	Under 1	Calm	Sea like mirror.	Calm, glassy, 0
1	1-3	1-3	Light air	Ripples with appearance of scales; no foam crests.	
2	4-6	4-7	Light breeze	Small wavelets; crests of glassy appearance, not breaking	Rippled, less than 0.5
3	7-10	8-12	Gentle breeze	Large wavelets; crests begin to break; scattered whitecaps.	Smooth, 0.5
4	11-16	13-18	Moderate breeze	Small waves, becoming longer; numerous whitecaps.	Slight, 1.0
5	17-21	19-24	Fresh breeze	Moderate waves, taking longer form; many whitecaps; some spray.	Moderate, 1.0-2.5
6	22-27	25-31	Strong breeze	Larger waves forming; whitecaps everywhere; more spray.	Rough, 2.5-4.0
7	28-33	32-38	Moderate gale	Sea heaps up; white foam from breaking waves begins to be blown up in streaks.	
8	34-40	39-46	Fresh gale	Moderate high waves; edges of crests begin to break; foam is blown in steaks.	Very rough, 4.0-6.0
9	41-47	47-54	Strong gale	High waves; sea begins to roll; dense streaks of foam; spray may reduce visibility.	
10	48-55	55-63	Whole gale	Very high waves with overhanging crests; sea takes white appearance as foam is blown in very dense streaks; rolling is heavy and visibility reduced.	High, 6.0-9.0
11	56-63	64-72	Storm	Exceptionally high waves; sea covered with white foam patches; visibility still more reduced.	Very high, 9.0-13.5
12 13 14 15 16 17	64-71 72-80 81-89 90-99 100-108 109-118	73-82 83-92 93-103 104-114 115-125 126-136	Hurricane	Air filled with foam; sea completely white with driving spray; visibility greatly reduced. Winds of force 12 and above very rarely experienced on land; usually accompanied by widespread damage.	Phenomenal, greater than 13.5