Naval Oceanographic and
Atmospheric Research Laboratory

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SEVERE WEATHER GUIDE MEDITERRANEAN PORTS

33. TANGIER

CONTENTS

FOREWORD

This handbook on Mediterranean Ports was developed as part of an ongoing effort at the Atmospheric Directorate, Naval Oceanographic and Atmospheric Laboratory (NOARL), Monterey, to create products for direct application to Fleet Operations. The research was conducted in response to Commander Naval Oceanography Command (COMNAVOCEANCOM) 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, deletions and/or additions to Naval Oceanography Command Center (NAVOCEANCOMCEN), Rota with a copy to the oceanographer, COMSIXTHFLT. They will then be passed on to NOARL, Monterey for review and incorporation as appropriate. This document will be a dynamic one, changing and improving as more and better information is obtained.

ACKNOWLEDGMENTS

The support of the sponsors -- Naval Oceanography Command, Stennis Space Center, MS: and Fleet Numerical Oceanography Center, Monterey, CA (Program Element O&M,N) -- is gratefully acknowledged.

PORT INDEX

The following is a tentative prioritized list of Mediterranean Ports to be evaluated during the five-year period 1988-92, with ports grouped by expected year of the port study's publication. This list is subject to change as dictated by circumstances and periodic review. Computerized versions of these port guides are available for those ports with an asterisk (*). Contact the Atmospheric Directorate, NOARL, Monterey or NOCC Rota for IBM compatable floppy disk copies.

NO.	PORT
1	GAETA, ITALY
*2	NAPLES, ITALY
*3	CATANIA, ITALY
*4	AUGUSTA BAY, ITALY
*5	CAGLIARI, ITALY
*6	LA MADDALENA, ITALY
7	MARSEILLE, FRANCE
8	TOULON, FRANCE
9	VILLEFRANCHE, FRANCE
10	MALAGA, SPAIN
11	NICE, FRANCE
12	CANNES, FRANCE
13	MONACO
14	ASHDOD, ISRAEL
15	HAIFA, ISRAEL
16	BARCELONA, SPAIN
17	PALMA, SPAIN
18	IBIZA, SPAIN
19	POLLENSA BAY, SPAIN
20	LIVORNO, ITALY
21	LA SPEZIA, ITALY
22	VENICE, ITALY
23	TRIESTE, ITALY
*24	CARTAGENA, SPAIN
*25	VALENCIA, SPAIN
*26	SAN REMO, ITALY
*27	GENOA, ITALY
*28	PORTO TORRES, ITALY
*29	PALERMO, ITALY
*30	MESSINA, ITALY
*31	TAORMINA, ITALY

1991	PORT
*32	TARANTO, ITALY
*33	TANGIER, MOROCCO
*34	BENIDORM, SPAIN
35	ROTA, SPAIN
36	LIMASSOL, CYPRUS
37	LARNACA, CYPRUS
38	ALEXANDRIA, EGYPT
39	PORT SAID, EGYPT
	SOUSSE, TUNISIA
	SFAX, TUNISIA
	TUNIS, TUNISIA
	BIZERTE, TUNISIA
	SOUDA BAY, CRETE
	VALETTA, MALTA
	PIRAEUS, GREECE

1992	PORT
	KALAMATA, GREECE
	CORFU, GREECE
	KITHIRA, GREECE
	THESSALONIKI, GREECE

DELAYED INDEFINITELY

	ALGIERS, ALGERIA
	ISKENDERUN, TURKEY
	IZMIR, TURKEY
	ISTANBUL, TURKEY
	ANTALYA, TURKEY
	GOLCUK, TURKEY

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 will be covered in the handbook. A priority list, established by the Sixth Fleet, exists for the port studies conducted and this list will be followed as closely as possible in terms of scheduling publications.

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 NOARLW 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 previsit 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 become 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 were forecast.

2. CAPTAIN'S SUMMARY

Although Tangier is technically an Atlantic port, its weather patterns are heavily influenced by the same metecrological conditions that effect the Mediterranean Sea. For this reason and because Tangier falls within COMSIXTHFLT's area of responsibility, it has been included in this series of guides.

Tangier is situated on the southern side of the western approaches to the Strait of Gibraltar near 35°47'N, 5°49'W (Figure 2-1).

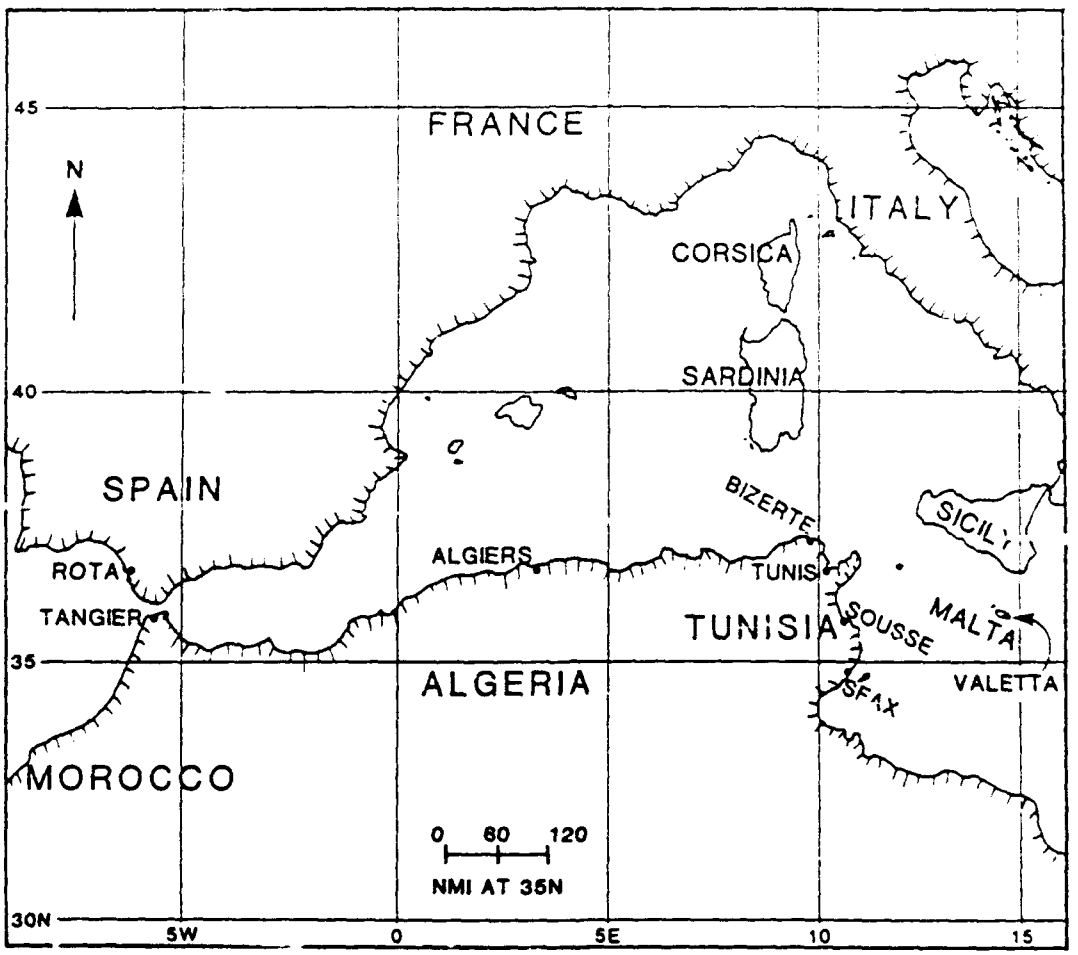

Figure 2-1. Ports of Northwestern Africa

Tangier is located in Tangier Bay about 7 n mi (13 km) east of Cape Spartel on the northern coast of Morocco (Figure 2-2). With the exception of the area directly south of the northern breakwater, the port is exposed to waves and swell generated by north and northwesterly winds normally associated with cold frontal passage. Northeasterly or easterly winds, associated with Levante conditions in the Alboran Sea, are funneled through the Strait of Gibraltar and effect primarily the northern anchorage area.

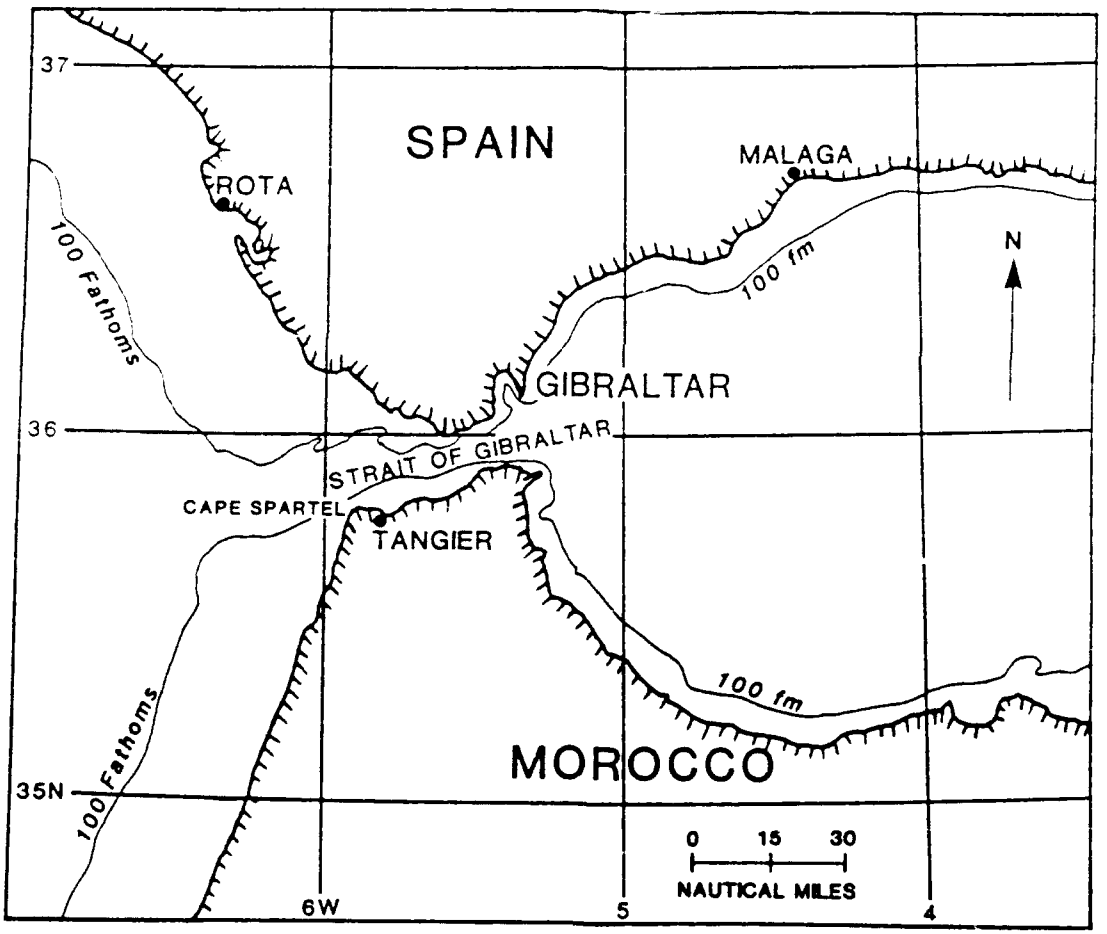

Figure 2-2. Tangier and approaches to the Strait of Gibraltar.

The port is protected by the surrounding topography from south, southwest, east, and west winds (Figure 2-3). A breakwater/quay protects the port from the majority of the effects of north-north-westerly winds. However, swell generated by these winds can reach 20 feet (6 m) and has previously breached the breakwater destroying

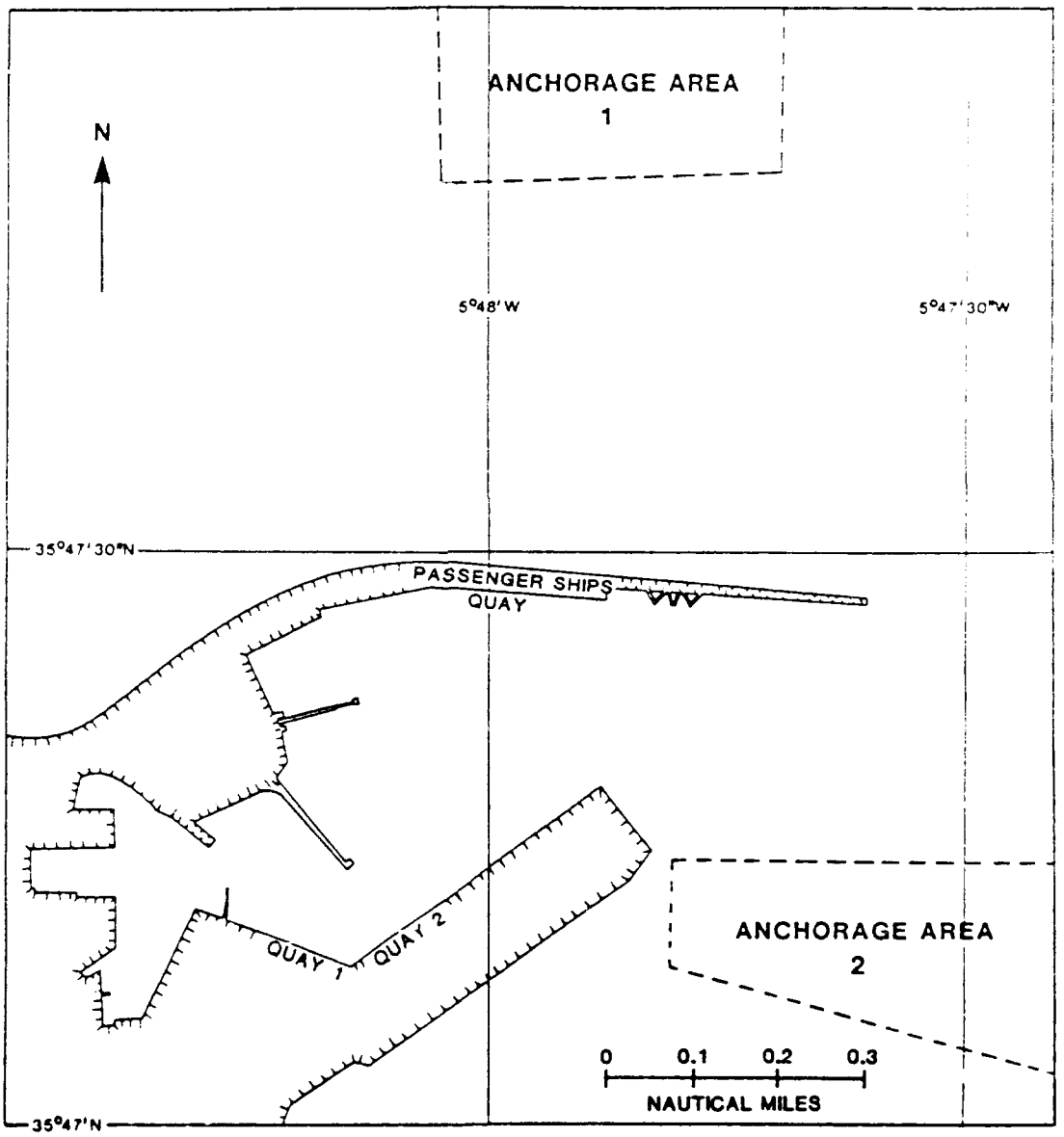

Figure 2-3. Port of Tangier

storage containers on the pier. Ferry service across the straits is suspended during these episodes. In addition, northwest swell reflects off of the eastern shore of the Tangier Bay and causes an east-west back and forth motion in the anchorage area east of the port and inside the port. This movement has, on at least one occasion, broken the anchor chain of a submarine.

There are two primary anchorage areas in Tangier. One is located approximately one nautical mile north of the breakwater and is used by vessels with drafts greater than 25 ft. The other is just east of Quay #2 and is used by small ships and submarines. The clay and sand bottom provides good holding. Tidal range is 7 ft (2 m) and there are no strong currents in the harbor. Fleet Landing is located at the passenger ship quay.

Visibility is generally good. Occasional early morning zero visibility can occur in spring and summer but improves by mid-to-late morning.

Specific hazardous environmental conditions, vessel situations, and suggested precautionary/evasive action scenarios for the Port of Tangier are summarized in Table 2-1.

Table 2-1. Summary of hazardous environmental conditions for the Port of Te

HAZARDOUS CONDITION	INDICATORS OF POTENTIAL HAZARD	VESSEL LOCATION/ SITUATION AFFECTED	EFFECT
1. Levante winds/waves - Strong winds from NE to E - Locally known as "Levante". • A weak to moderate Levante is nearly constant during the warm season. Strong episodes are most likely to occur in the May to September period but can occur anytime during the year. • Typical strong event has daytime winds of 20-40 kt with higher gusts. Nighttime winds decrease to 12-25 kt. Stronger events 35-45 kt with gusts to 60 kt. • Strong events may last 3-7 days. • Typical strong event is accompanied by high swell in open waters. Heights of 5-7 ft max 10 ft have been experienced in the strait with 7-10 ft being experienced in the northern anchorage area. • Little or no swell enters the harbor.	Advance warning • Clouds building to the east is a local indicator of the onset of Levante. • Onset of Levante will occur as the barometric pressure at Gibraltar becomes higher than at Tangier.	(1) Moored - harbor (2) Anchorage 1 (3) Anchorage 2 (4) Arriving/Departing (5) Small boats	(a) M + H a (a) M + (a) M + (a) M + (a) M + +
2. Strong N to NW winds - Caused by cold frontal passage. • Most likely to occur October to April. • Typical event has 30 kt winds with 45 kt maximum. Lasts from a few hours up to a day. • Typical event is accompanied by high (20 ft (6 m)) waves. • Swell effects northern anchorage area and also reflects off eastern shore of bay and enters harbor. • Waves and swell have breached northern seawall.	Advance Warning • Clouds building to the west is a good local indicator of the onset of north-northwest winds. • Deep pressure falls often accompany these active systems.	(1) Moored - harbor (2) Anchorage 1 (3) Anchorage 2 (4) Arriving/Departing (5) Small boats	(a) M + + (a) Mi + (a) Ex + (a) Mi ar (b) Mi (a) Sm

ous environmental conditions for the Port of Tangier, Morocco.

L HAZARD	VESSEL LOCATION/ SITUATION AFFECTED	*EFFECT - PRECAUTIONARY/EVASIVE ACTIONS*
a local rate. as the ter becomes	(1) Moored - harbor	(a) Minimal effect * Harbor well protected from east winds. Additional mooring lines may be required to reduce vessel movement in strong winds.
	(2) Anchorage 1	(a) Wind/waves impact the anchorage with full open ocean force. * Lee shelter for shallow draft ships is available on the east side of Tangier Bay. No shelter is available for deep draft vessels.
	(3 Anchorage 2	(a) Minimal effect. * Relatively well protected from east winds by mountains to the east.
	(4) Arriving/Departing	(a) Minimal effect. * Normal approaches can be made with easterly winds.
	(5 Small boats	(a) Small boat operation curtailed under high wind/wave conditions. * Boats should not be operated in waves exceeding 3 ft (1 m). * Winds of 12 kt or greater rapidly raise waves exceeding small craft limits. * Boats should stay in harbor in winds above 22 kt.
is a good t of north- mpany	(1 Moored - harbor	(a) Minimal effect * Harbor is protected from north-northwest winds. Additional mooring lines may be required to reduce vessel movement during strong winds. Containers on pier should be moved prior to strong episodes. * Swell reflects off east side of Tangier Bay and may enter harbor causing back and forth movement of ships at fleet landing.
	(2) Anchorage 1	(a) Wind/waves impact the anchorage with full open ocean force. * There is no lee shelter available for large ships in Tangier Bay. Ships unable to remain at anchor must sortie until conditions abate.
	(3) Anchorage 2	(a) Effects of wind/waves vary with wind direction. * Anchorage area 2 is relatively well protected from northwesterly winds. As the winds become northerly the area becomes vulnerable to the full impact of the wind/waves.
	(4) Arriving/Departing	(a) Wind/waves may make approaches to the harbor and anchorage areas hazardous. (b) Winds may make vessel handing difficult at slow SOA.
	(5) Small boats	(a) Small boat operation curtailed under high wind/wave conditions. * Boats should not be operated in waves exceeding 3 ft (1 m). * Winds of 12 kt or greater rapidly raise waves exceeding small craft limits. * Boats should not leave harbor in winds above 22 kt.

SEASONAL SUMMARY OF HAZARDOUS WEATHER CONDITIONS

(Much of this information has been adapted from Brody and Nestor, 1980).

WINTER (November through February):

* Strong north to northwest winds, usually following a cold front, accompanied by high swell. Winds typically 30 kt with higher gusts.
* Strong southwesterlies may precede cold front. These winds may be as strong as the following northwesterlies. These events are often preceded by short, strong Levante.
* West to northwest waves, generated out in the Atlantic, appear as swell (period 6-10 sec) at the outer anchorage and can last for days.

SPRING (March through May):

* Early spring similar to winter
* Late spring, strong northeast to east winds (Levante) occur. Typical strong event, with gusts to 40-60 kt, can cause 7-10 ft (3m) swell at northern anchorage area.

SUMMER (June through September):

* Weak to moderate Levante is nearly constant throughout summer (producing fully arisen seas) interrupted by occasional strong events.
* Infrequent thunderstorms, normally not severe, occur.

AUTUMN (October):

* Short transition season as winter weather returns by end of month.
* Strong north to northwest winds will accompany vigorous cold fronts, usually late in the month.

NOTE: For more detailed information on hazardous weather conditions, see previous Summary table in this section and Hazardous Weather Summary in Section 3.

3. GENERAL INFORMATION

This section is intended for Fleet meteorologists/oceanographers and staff planners. Paragraph 3.5 provides a general discussion of hazards and Table 3-1 provides a summary of vessel location/situation, potential hazards, effects-precautionary/evasive actions, and advance indicators and other information about the potential hazards by season. (NOTE: check page iv to see if a computerized version of this port study is available).

3.1 Geographic Location

Tangier is located at 35°47'N, 5°49'W on the southern side of the western approaches to the Strait of Gibraltar (Figure 3-1).

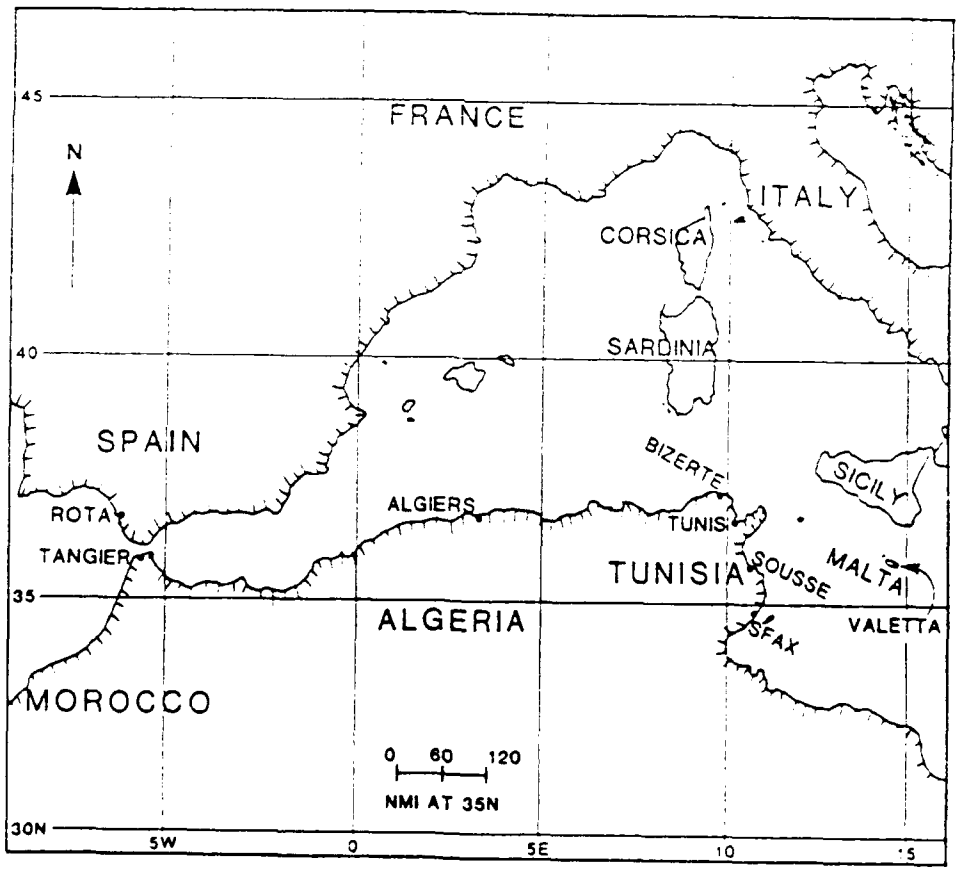

Figure 3-1. Ports of Northwestern Africa.

The Port of Tangier is situated in the Bay of Tangier about seven n mi (13 km) east of Cape Spartel on the northern coast of Morocco (Figure 3-2).

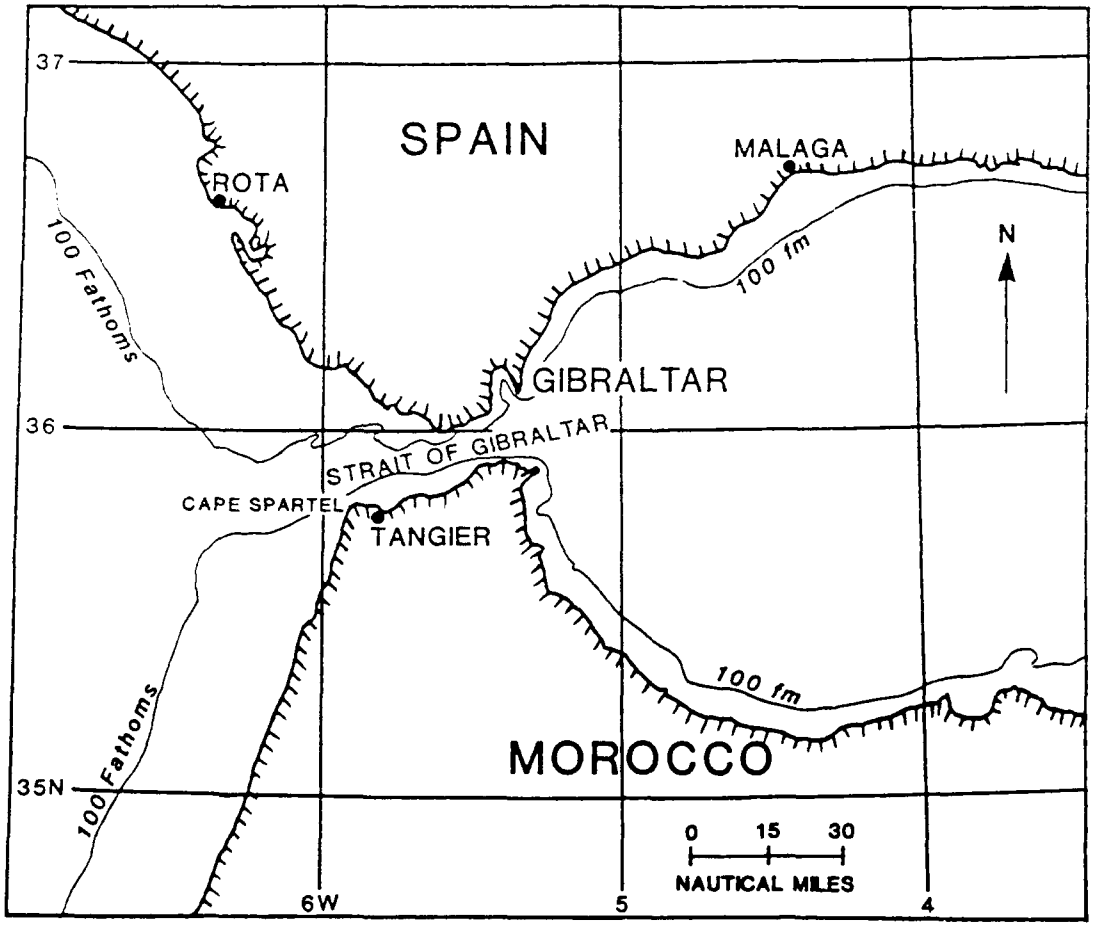

Figure 3-2. Tangier and approaches to the Strait of Gibraltar.

The port is protected by the surrounding topography from south, southwest, east, and west winds while a breakwater/quay (3,970 ft (1,210 m long) shelters the port from the major effects of northwesterly winds; however, northerly swell does enter the port area and can cause interruption of some operations (Figure 3-3).

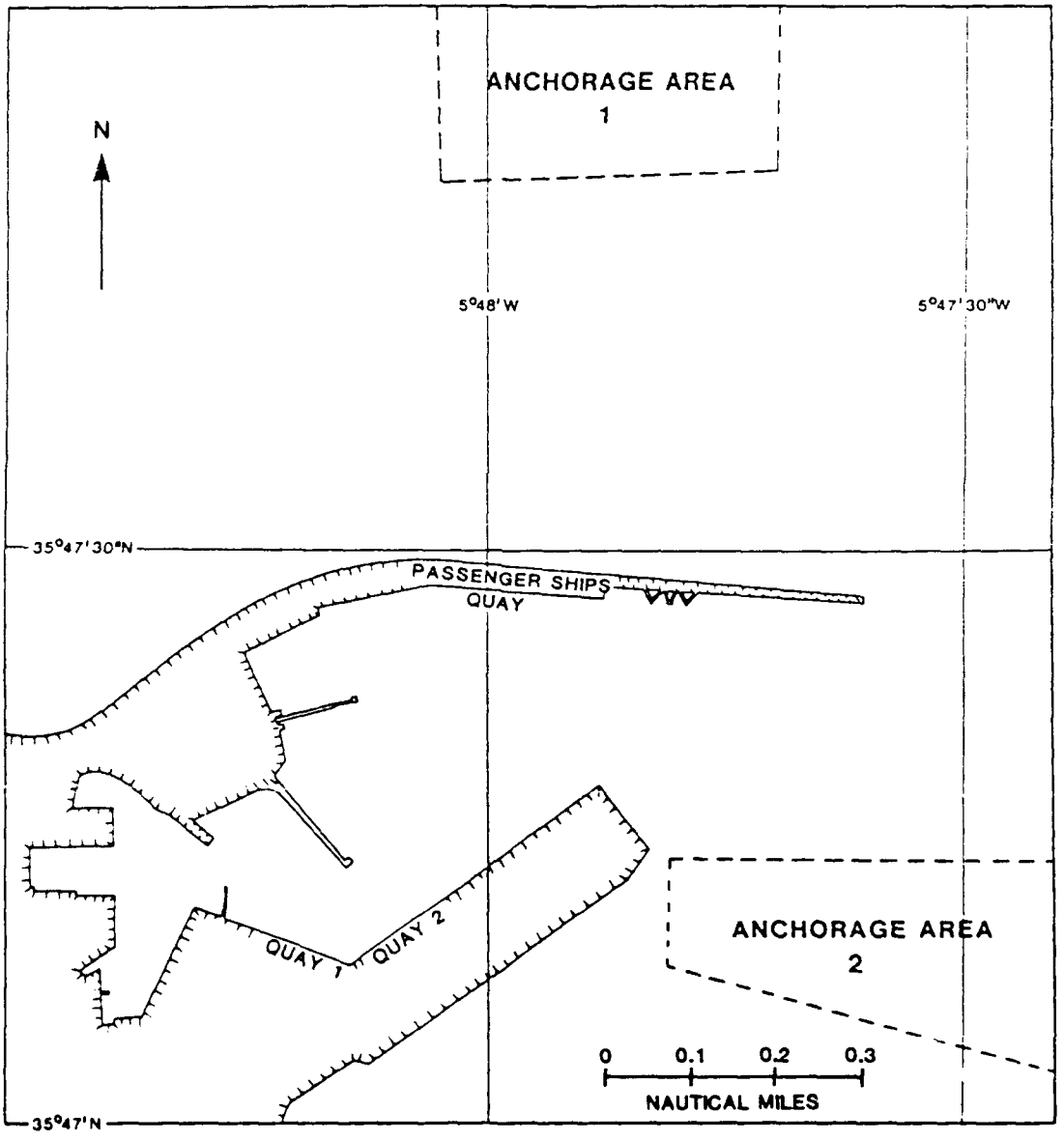

Figure 3-3 Port of Tangier

3.2 Qualitative Evaluation of the Port of Tangier

The Port of Tangier is open on the northern semi-circle but, because of the breakwater/quay, north or northwest winds do not normally disturb operations in the harbor. Swell generated by these winds will, however, enter the harbor and affect ships at anchorage. Ships at the quay and fleet landing, located near the passenger ship quay, are usually protected from this swell. Occasionally, however, an exceptional event of strong northwesterlies, normally associated with a cold frontal passage, will generate 20 ft (6 m) waves breaching the breakwater. During a recent episode, high waves destroyed storage containers on the breakwater quay. Additionally, northwest swell can reflect off the eastern shore of Tangier Bay causing an east-west wave motion in the anchorage area east of the port and inside the port itself. During one such event, a submarine experienced a broken anchor chain. Ships at the passenger quay/fleet landing may have to sortie to avoid parting lines.

There are two primary anchorage areas in Tangier. One is located approximately one nautical mile north of the breakwater/quay and is used by vessels with drafts greater than 25 ft (7.5 m). This anchorage is exposed to the aforementioned northwesterlies and also to the strong easterlies (Levante) that frequently occur in this area. The other anchorage is just east of Quay #2 and is used by small ships and submarines. This anchorage is protected from the Levante and the clay and sand bottom provides good holding. During strong Levante episodes, ships at the passenger quay/fleet landing berth can move to the east side of the bay where the topography provides a lee shelter.

3.3 Currents and Tides

There are no strong currents in the harbor area of Tangier. The tidal range is 7 ft (2 m).

3.4 Visibility

Visibility is normally good. Occasionally, early morning visibility can lower to zero then lift by early or late morning. This would most likely occur in the spring or summer months. For the

ocean area around Tangier, visibilities less than 1/2 n mi occur three percent of the time in August and only one-tenth of a percent in February. Annually, visibilities greater than 2 n mi occur about 97 percent of the time (Naval Oceanography Command, 1987).

3.5 Wind and Weather

Tangier is geographically situated in an area characterized by generally good weather. However, there are some exceptions as described in the following paragraphs.

3.5.1 Northwest Winds

Northwest winds will usually accompany cold frontal passages in the Tangier area. Many wintertime cold fronts are vigorous enough to bring strong winds to the southern Mediterranean area. Note that northwest winds arriving at Tangier have not had a long over-water trajectory and are partially diminished by the landmass of Spain. Often, early autumn and late spring cold fronts will not be very strong when passing Tangier. As expected, the strongest cold frontal passages occur during the winter months.

Waves generated by the northwest winds can affect certain areas of the port. The outer, deep water anchorage is affected directly because it is outside the breakwater and exposed to the wind and waves. On occasion, waves will be high enough (20 ft (6 m)) to breach the breakwater/quay causing damage.

Southwest winds will generally precede cold frontal passages and can be as strong as the northwesterlies following the front. But, because of the topography, the port area is well protected from southwest winds and waves.

Forecasters tracking cold fronts in the eastern Atlantic should be alert for those cold fronts which have strong cold air advection from north to south behind the front. These are the fronts that penetrate into the southern reaches of the Mediterranean and cause strong winds and waves at Tangier. According to mariners in the Tangier area, clouds building to the west is a good local indicator of the onset of northwest winds.

3.5.2 Levante

The Levante is an easterly or northeasterly wind that occurs in an area from the coast of southern France to west of the Strait of Gibraltar. It can occur as a result of several different weather patterns. The most typical situation is when the Azores High extends northeastward over Spain and southern France into the Western Mediterranean Sea with relatively lower pressure over the Gulf of Cadiz. With a large anticyclone over western Europe and a low pressure center over the southern Western Mediterranean Sea, the Levante will be widespread and destructive. It can be accompanied by rain and extend through the strait and into the Tangier area. The topography of the strait will cause a channeling of the wind and wind speeds are higher in the strait than on either side of it. Levante winds are usually northeast in the western Mediterranean but will be easterly in the strait and spread both north and south after passing through the strait. The Levante at Tangier is usually easterly.

The Levante wind brings the most troublesome conditions to the port of Tangier. Although the Levante can occur year-round, local mariners indicate that between May and September is the period of most frequent occurrence. However, gale force (33+ kt) Levante winds can occur in any month with storm force winds occurring during strong events. Waves of 7-10 ft (3 m) can be experienced at the outer anchorage while little or no swell will enter the harbor. Ferry service across the strait will be curtailed during strong Levante episodes.

If the gradient level winds at Tangier are north of 090°, there will be no low-level turbulence. Winds from north of 090° are generally over water (through the strait) and therefore relatively non-turbulent. Gradient level winds south of 090° (about 130-140°) are over terrain and cause strong low-level turbulence in the Tangier area. In Tangier Bay, surface winds of 25 to 30 knots can be accompanied by gusts up to 60 kt. Local mariners watch for clouds building to the east as a clue to the onset of the Levante.

3.5.3 Swell

Waves other than those generated by the northwest winds and/or the Levante occur at the outer anchorage. These waves are in the form of swell generated out in the Atlantic and can last for days at a time.

3.6 Seasonal Summary of Hazardous Weather Conditions

The seasonal patterns in the western Mediterranean/eastern Atlantic area will vary in response to the movement of the Azores High. This high moves southward during winter, allowing low pressure systems to move in over Europe. The high builds northward as summer approaches and storms affecting the Tangier area become less frequent; in the middle of summer, migratory storms are nearly non-existent. Much of the information in this section is adapted from Brody and Nestor, 1980.

A. Winter (November through February)

The winter season is characterized by cold frontal passages which bring strong southwesterlies preceding the front and strong north to northwest winds following the front. A vigorous front with a strong low pressure center south of 50°N will generate winds of 30-45 kt with higher gusts. High waves will accompany the northwest winds following the front. Significant thunderstorm activity may also follow passage of these fronts.

The Levante wind can also occur in winter, but not as frequent as in summertime. Levante episodes in the winter however, can be as strong or even stronger than those in summer.

Precipitation at Tangier is representative of an Atlantic, rather than Mediterranean, coastal port. Yearly totals average about 35 inches, occurring mainly between October and April. Winter temperatures are rarely near or below freezing and will last for only a few hours.

B. Spring (March through May)

Springtime in the Tangier area is noted for periods of stormy winter-like weather alternating with false starts of summer. Temperatures are warming, and storm events are decreasing in both strength

and frequency. By late spring, Levante winds are more frequent. Because late spring Levante winds are nearly uninterrupted, fully arisen seas are common. Typical strong events, with gusts up to 40-60 kt, can cause high waves outside the protected harbor area. Precipitation amounts fall off considerably in May.

Although visibility is generally good at Tangier, occasionally it can lower to zero in the early mornings and lift before noon. These episodes of restricted visibility are due to fog and generally occur in the spring or summer months.

C. Summer (June through September)

The Levante wind is most frequent in summer and easterly winds occur uninterrupted for days at a time at Tangier. Strong Levante episodes can occur throughout the summer, similar to those described above (Spring).

Of course, temperatures are at a maximum in summer. Midday readings of 100°F (38°C) are not uncommon. Precipitation is at a minimum in summer, especially in July and August. Thunderstorms, although uncommon and not relatively severe, occur at this time of the year and can often be accompanied by hail.

D. Autumn (October)

Autumn is a short season in this area of the world and usually lasts for only the month of October. It is a transitional period and by month's end, winter like weather is occurring. Infrequent thunderstorms can occur and precipitation increases to winter-like amounts.

3.7 Local Indicators of Hazardous Weather Conditions

Local port personnel have indicated that very few helpful hints exist in the area to help mariners forecast the onset of bad weather. The best local indicator is cloudiness associated with the northwesterlies (clouds to the west) and with the Levante (clouds to the east).

Forecasting cold frontal passages can be accomplished using common meteorological practices in concert with available synoptic charts and satellite imagery. For Levante forecasts, the shipboard forecaster should become familiar with the following Levante onset and cessation rules adapted from Nestor and Brody, (1980):

A. Forecasting sudden onset of Levante conditions in the Gibraltar area during the summer requires the tracking of old cold fronts as they move southwestward along the coast of Spain. Movement of the cold fronts can be followed by observing changes in humidity and wind direction from the normal sea breeze at coastal stations. Two very useful stations are Alicante (08359) and Malaga (08482).

B. A gale force Levante in the Strait will commence when northwesterly winds at 300-mb over central and south Spain veer to 040°.

C. Strong Levante winds in the Strait of Gibraltar occur when a large pressure difference exists between Gibraltar and Tangier with the highest pressure at Gibraltar. Use the following values as a guide noting that the strongest winds may not be evenly distributed across the Strait from north to south:

2 mb gradient = east 30-38 kt
3 mb gradient = east 36-45 kt
4 mb gradient = east 43-53 kt
5 mb gradient = east 48-58 kt

D. During Levante conditions in the Strait of Gibraltar, easterly winds at Tarifa (08458) gives a close approximation of the winds in the Strait. Note that Tarifa does not transmit a 0000Z weather observation.

E. During Levante conditions in the Strait of Gibraltar, the area of maximum easterly winds is normally quite narrow, only about 2 n mi wide and can extend 60 n mi westward of the Strait north of 36° N. A general easterly wind flow of 15 to 20 kt will produce a maximum band of 35 kt winds.

F. Strong Levante conditions occasionally cause an eddy in the low-level flow southwest of Tangier and can be seen in satellite imagery. A cold ocean eddy is sometimes found in the same area.

G. Forecast a Levante to end, especially in the Strait of Gibraltar, when a depression passes across either the British Isles or France and its cold front begins to cross the Iberian Peninsula. Since westerlies replace easterlies while the front is some distance to the north, the front need not progress as far south as Gibraltar for the Levante to cease.

3.8 Protective and Mitigating Measures

Local maritime personnel have indicated that protective measures are needed only infrequently. The harbor area (including the inner anchorage) is generally well protected while the outer anchorage is subject to high waves from either the northwesterlies or the Levante.

In the event of strong northwesterlies, ships anchored in the outer anchorage may need to sortie. In an extreme case, waves can break over the breakwater/quay exposing the passenger quay berth/fleet landing area to hazardous waves and/or debris swept from the quay. Occasionally, northwest swell will reflect off the east side of Tangier Bay and cause an east-west motion in the harbor. Ships anchored at the inner anchorage must sortie during these occurrences to avoid breaking anchor chains and/or dragging anchor.

During strong Levante episodes, ships anchored at the outer anchorage may want to sortie to avoid high waves. Ships at the passenger quay/fleet landing berths may move to the east of Tangier Bay for lee shelter, avoiding high winds. Normally, waves from Levante winds do not enter the harbor area.

Obviously, small boats will be in danger in either the northwest wind occurrences or the Levante episodes. Note than ferry service across Gibraltar Strait is curtailed during strong wind events.

3.9 Summary of Problems and Actions

Table 3-1 is intended to provide easy-to-use seasonal references for meteorologists on ships using the port of Tangier. Table 2-1 (Section 2) summarizes Table 3-1 and is intended primarily for use by ship captains.

Table 3-1. Potential problem situations at the Port of Tangier, Moro

VESSEL LOCATION/SITUATION	POTENTIAL HAZARD	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS	ADV
1. Moored-harbor. Occurs year-round; more frequent in summer months.	a. Levante winds/waves - Strong winds from northeast or east. Can be accompanied by rain in cool season.	a. Levante has minimal effect at berthing areas. Additional mooring lines may be required to reduce vessel movement during strong episodes.	
Occurs October to April.	b. North to Northwest winds - Strong winds usually accompanying cold fronts. Can be gusty and generally lasts a day or less, with swell lasting another 2-3 days.	b. Harbor is protected from north-northwest winds. During strong episodes, additional mooring lines may be needed. Exceptionally strong episodes can generate waves large enough to breach breakwater/pier. Containers and other equipment should be taken off pier in such cases. Swell can reflect off east side of the bay and enter harbor, causing back and forth motion of ships at fleet landing. Additional lines may be required.	
2. Outer Anchorage. Occurs year-round; more frequent in summer months.	a. Levante winds/waves - Strong winds from northeast or east. Can be accompanied by rain in cool season.	a. Outer anchorage exposed to Levante winds/waves. Lee shelter for shallow draft ships is available on the east side of Tangier Bay. Deep draft ships may need to protect at sea when strong Levante event is occurring.	
Occurs October to April.	b. North to Northwest winds - Strong winds usually accompanying cold fronts. Can be gusty and generally lasts a day or less, with swell lasting another 2-3 days.	b. Full force of north or northwest winds is felt at the outer anchorage. There is no shelter available in Tangier harbor for large ships. Protect at sea if necessary.	

blem situations at the Port of Tangier, Morocco - ALL SEASONS

PRECAUTIONARY/EVASIVE ACTIONS	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARD
...s minimal effect at berthing areas. ... mooring lines may be required to reduce ...ovement during strong episodes.	a. The Levante typically occurs when the Azores High extends northeastward over Spain and southern France. Consequently, Levante events are frequent in summer months. However, winter episodes may be stronger than summer episodes. Gale force Levantes occur in any month. Waves of 7-10 ft (3m) can occur at the outer anchorage while little or no swell enters the harbor. If Tangier's gradient level winds are north of 090° expect little low level turbulence; expect low level turbulence if gradient winds are south of 090° (130-140°). On the bay, gusts of 60 kt can accompany 30 kt sustained winds. Local indicator of oncoming Levante is clouds building to the east.
...is protected from north-northwest winds. During ...episodes, additional mooring lines may be needed. ...ionally strong episodes can generate waves large ...t breach breakwater/pier. Containers and other ...ment should be taken off pier in such cases. Swell ...enter off east side of the bay and enter harbor, ...back and forth motion of ships at fleet landing. ...mooring lines may be required.	b. North to northwest winds usually accompany cold frontal passages. Strongest fronts occur late fall to early spring and are rare in the summer months. High waves (20 ft (6 m)) can occur at the outer anchorage and, on rare occasions, breach the breakwater pier. A strong north/south cold air advection pattern should alert the forecaster to the likelihood of strong winds following frontal passage. Local mariners watch for clouds building to west or northwest as a precursor to north/northwest wind onset.
...anchorage exposed to Levante winds/waves. Lee shelter ...shallow draft ships is available on the east side of ...er Bay. Deep draft ships may need to protect at sea ...strong Levante event is occurring.	a. The Levante typically occurs when the Azores High extends northeastward over Spain and southern France. Consequently, Levante events are frequent in summer months. However, winter episodes may be stronger than summer episodes. Gale force Levantes occur in any month. Waves of 7-10 ft (3m) can occur at the outer anchorage while little or no swell enters the harbor. If Tangier's gradient level winds are north of 090° expect little low level turbulence; expect low level turbulence if gradient winds are south of 090° (130-140°). On the bay, gusts of 60 kt can accompany 30 kt sustained winds. Local indicator of oncoming Levante is clouds building to the east.
...force of north or northwest winds is felt at the outer ...rage. There is no shelter available in Tangier harbor ...rge ships. Protect at sea if necessary.	b. North to northwest winds usually accompany cold frontal passages. Strongest fronts occur late fall to early spring and are rare in the summer months. High waves (20 ft (6 m)) can occur at the outer anchorage and, on rare occasions, breach the breakwater pier. A strong north/south cold air advection pattern should alert the forecaster to the likelihood of strong winds following frontal passage. Local mariners watch for clouds building to west or northwest as a precursor to north/northwest wind onset.

Table 3-1 (continued)

VESSEL LOCATION/SITUATION	POTENTIAL HAZARD	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS
3. Inner Anchorage. Occurs year-round; more frequent in summer months.	a. Levante winds/waves - Strong winds from northeast or east. Can be accompanied by rain in cool season.	a. Minimal effect - Inner anchorage protected from east or northeast winds/waves due to topography around the harbor of Tangier. Moving to east side of Tangier Bay will provide lee shelter if needed.
Occurs October to April.	b. North to Northwest winds - Strong winds usually accompanying cold fronts. Can be gusty and generally lasts a day or less, with swell lasting another 2-3 days.	b. Generally, the inner anchorage is protected from northwest winds/waves. However, during extremely strong events, northwest swell will reflect off the eastern shore of the bay and cause an east to west motion in the harbor. Additional anchors may be required during such episodes.
4. Arriving/Departing. Occurs year-round; more frequent in summer months.	a. Levante winds/waves - Strong winds from northeast or east. Can be accompanied by rain in cool season.	a. Inner approaches to harbor are normally not affected during Levante. Outer approaches are not protected and experience high winds/waves. Strait of Gibraltar usually has higher winds/waves due to funneling effect of topography.
Occurs October to April.	b. North to Northwest winds - Strong winds usually accompanying cold fronts. Can be gusty and generally lasts a day or less, with swell lasting another 2-3 days.	b. Both outer and inner approaches to harbor are exposed to north or northwest winds/waves. Ships arriving from Strait of Gibraltar will experience sudden increase in northwest winds once clear of sheltering topography.

Table 3-1 (continued)

FECT - PRECAUTIONARY/EVASIVE ACTIONS	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARD
a. Minimal effect - Inner anchorage protected from east or northeast winds/waves due to topography around the harbor of Tangier. Moving to east side of Tangier Bay will provide lee shelter if needed.	a. The Levante typically occurs when the Azores High extends northeastward over Spain and southern France. Consequently, Levante events are frequent in summer months. However, winter episodes may be stronger than summer episodes. Gale force Levantes occur in any month. Waves of 7-10 ft (3m) can occur at the outer anchorage while little or no swell enters the harbor. If Tangier's gradient level winds are north of 090° expect little low level turbulence; expect low level turbulence if gradient winds are south of 090° (130-140°). On the bay, gusts of 60 kt can accompany 30 kt sustained winds. Local indicator of oncoming Levante is clouds building to the east.
b. Generally, the inner anchorage is protected from northwest winds/waves. However, during extremely strong events, northwest swell will reflect off the eastern shore of the bay and cause an east to west motion in the harbor. Additional anchors may be required during such episodes.	b. North to northwest winds usually accompany cold frontal passages. Strongest fronts occur late fall to early spring and are rare in the summer months. High waves (20 ft (6 m)) can occur at the outer anchorage and, on rare occasions, breach the breakwater pier. A strong north/south cold air advection pattern should alert the forecaster to the likelihood of strong winds following frontal passage. Local mariners watch for clouds building to west or northwest as a precursor to north/northwest wind onset.
c. Inner approaches to harbor are normally not affected during Levante. Outer approaches are not protected and experience high winds/waves. Strait of Gibraltar usually has higher winds/waves due to funneling effect of topography.	a. The Levante typically occurs when the Azores High extends northeastward over Spain and southern France. Consequently, Levante events are frequent in summer months. However, winter episodes may be stronger than summer episodes. Gale force Levantes occur in any month. Waves of 7-10 ft (3m) can occur at the outer anchorage while little or no swell enters the harbor. If Tangier's gradient level winds are north of 090° expect little low level turbulence; expect low level turbulence if gradient winds are south of 090° (130-140°). On the bay, gusts of 60 kt can accompany 30 kt sustained winds. Local indicator of oncoming Levante is clouds building to the east.
d. Both outer and inner approaches to harbor are exposed to north or northwest winds/waves. Ships arriving from Strait of Gibraltar will experience sudden increase in northwest winds once clear of sheltering topography.	b. North to northwest winds usually accompany cold frontal passages. Strongest fronts occur late fall to early spring and are rare in the summer months. High waves (20 ft (6 m)) can occur at the outer anchorage and, on rare occasions, breach the breakwater pier. A strong north/south cold air advection pattern should alert the forecaster to the likelihood of strong winds following frontal passage. Local mariners watch for clouds building to west or northwest as a precursor to north/northwest wind onset.

Table 3-1 (continued)

VESSEL LOCATION/SITUATION	POTENTIAL HAZARD	EFFECT - PRECAUTIONARY/EVASIVE ACTIONS
5. Small Boats. Occurs year-round; more frequent in summer months.	a. Levante winds/waves - Strong winds from northeast or east. Can be accompanied by rain in cool season.	a. Small boat operations curtailed in high winds waves. Over open water winds of 12 kt or greater can raise seas to small craft limits (3 ft, 1 m) in a short time. Small boats usually will not leave harbor with winds of 22 kt or more.
Occurs October to April.	b. North to Northwest winds - Strong winds usually accompanying cold fronts. Can be gusty and generally lasts a day or less, with swell lasting another 2-3 days.	b. Small boat operations curtailed in high winds waves. Over open water winds of 12 kt or greater can raise seas to small craft limits (3 ft, 1 m) in a short time. Small boats usually will not leave harbor with winds of 22 kt or more.

Table 3-1 (continued)

PRECAUTIONARY/EVASIVE ACTIONS	ADVANCE INDICATORS AND OTHER INFORMATION ABOUT POTENTIAL HAZARD
[illegible] operations curtailed in high winds/waves. [illegible] winds of 12 kt or greater can raise [illegible] seas limits (3 ft [illegible] 1 m) in a short time. [illegible] will not leave harbor with winds [illegible]	a. The Levante typically occurs when the Azores High extends northeastward over Spain and southern France. Consequently, Levante events are frequent in summer months. However, winter episodes may be stronger than summer episodes. Gale force Levantes occur in any month. Waves of 7-10 ft (3m) can occur at the outer anchorage while little or no swell enters the harbor. If Tangier's gradient level winds are north of 090° expect little low level turbulence; expect low level turbulence if gradient winds are south of 090° (130-140°). On the bay, gusts of 60 kt can accompany 30 kt sustained winds. Local indicator of oncoming Levante is clouds building to the east.
[illegible] operations curtailed in high winds/waves. [illegible] winds of 12 kt or greater can raise [illegible] seas limits (3 ft [illegible] 1 m) in a short time. [illegible] will not leave harbor with winds [illegible]	b. North to northwest winds usually accompany cold frontal passages. Strongest fronts occur late fall to early spring and are rare in the summer months. High waves (20 ft (6 m)) can occur at the outer anchorage and, on rare occasions, breach the breakwater pier. A strong north/south cold air advection pattern should alert the forecaster to the likelihood of strong winds following frontal passage. Local mariners watch for clouds building to west or northwest as a precursor to north/northwest wind onset.

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Port Visit Information

JANUARY 1990: NOARL meteorologists R. Fett and Lt. M. Evans met with Mr. A. Hadrami, Chief of the Marine Division of the Port of Tangier, to obtain much of the information included in this port evaluation.

* Formerly the Naval Environmental Prediction Research Facility.

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

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This handbook for the port of Tangier, 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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