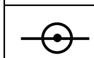
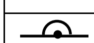
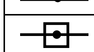
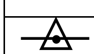
Appendices A through L

November 20, 2004

Appendix A
Symbols & Abbreviations

B	**Bearing or the direction from an observer to an object; usually expressed in PSC or PC but can be in T or M.**
C	**Course that a boat was steered through the water based on the steering compass, and may be expressed as T, M or PSC.**
COG	**Course Over Ground, the course actually achieved over the ground but not necessarily through the water; expressed as T or M.**
CTS	**The necessary Course To Steer the boat, based on the steering compass, to arrive at a desired point in consideration of current and wind effects. CTS refers to the boat heading through the water as does C; the difference between them is that CTS is the course to steer in the future, and C is what was actually steered in the past. CTS may be expressed as T, M or PSC.**
D	**Distance through the water, usually in NM.**
DF	**Distance correction factor for use in calibrating distance log instrument**
DOG	**Distance Over Ground, usually in NM.**
DR	**Dead Reckoning**
Drift	**Water current speed relative to the ground expressed in knots.**
E	**East**
Ebb	**Ebb current; water is flowing out to sea**
EP	**Estimated Position based on DR plus one additional line of position, or DR plus current set, or wind leeway.**
Flood	**Flood current; water is flowing in from the sea**
GMT	**Greenwich Mean Time**
GPS	**Ground position satellite instrument for position**
H	**Heading, the momentary direction that the boat bow is pointing as read on the ship's compass. Heading may or may not be the same as course, C.**
High Tide	**High water in a tide cycle**
Knot	**Nautical miles per hour**
L	**Latitude**
Lat	**Latitude**
LD	**Log distance for use in calibrating distance log instrument**
Long	**Longitude**
LOP	**Line of position**
Loran	**Ground position instrument based on signals from shore based towers**
Low Tide	**Low water in a tide cycle**
LS	**Log speed through the water for use in calibrating speed log instrument**
LTD	**Longitude Time Difference is the number of hours between any longitude and the Greenwich meridian based on the rotational speed of the earth**
M	**Magnetic direction referenced to north magnetic pole of earth**
MTD	**Meridian Time Difference is the number of hours from a zone meridian to the Greenwich meridian based on the rotational speed of the earth.**

N	North
NE	Northeast
NM	Nautical Mile; 1 minute of latitude or 6076 feet.
NW	Northwest
PC	Direction per compass other than ship's steering compass.
PSC	Direction per ship's compass, referring to the steering compass.
RB	Relative Bearing (±180°) referenced to the bow of the boat; expressed in degrees without any other designator such as T or M. Starboard angles are plus (+) and port angles are negative (-).
RF	Running Fix
RL	Rhumb Line, a line representing a planned route
S	Boat speed through the water as indicated by a speed log which measures the speed of the boat relative to the water
S	South
SBE	Slack current before ebb current begins
SBF	Slack current before flood current begins
SE	Southeast
SET	Direction to which a current is flowing expressed in True degrees.
SF	Speed correction factor for use in calibrating speed log instrument
SOG	Speed Over Ground can be calculated by dividing the distance traveled over ground by elapsed time, or it can be measured by GPS or Loran instruments relative to the ground beneath the sea.
SW	Southwest
T	True direction referenced to earth's polar axis
Track	The desired course from one known geographic point to another known geographic point usually expressed as T or M.
VMG	Velocity Made Good is a term used by racers to indicate the speed they are making toward a waypoint even when not sailing directly toward it.
W	West
Zn	Azimuth or direction from an observer to a celestial body expressed in True degree
ZTD	Zone Time Difference is the number of hours between any longitude and the zone meridian based on the rotational speed of the earth
λ	Longitude
°	Degrees
'	Minutes
"	Seconds
	FIX, which is an accurately known location on the chart. Also used for a running fix.
	Dead Reckoning point.
	Estimated Position (EP) based on a DR position plus estimates of water current flow, wind effects and other factors.
	An electronic fix based on GPS or LORAN

Appendix B
Time Zones

Time Zones are based on the rotational speed of the earth. Since the earth rotates at 360° per 24-hour day each one-hour time zone is, by definition, 15° of longitude wide. The central meridian of each time zone is called the Zone Meridian and successive Zone Meridians are 15° apart at longitudes of 0°, 15°, 30° etc up to 180°.

- **Zone 0 extends from 7-1/2°E longitude to 7-1/2°W longitude and is centered at Greenwich, England, which is 0° longitude, thus half of this zone is in the western hemisphere and half in the eastern. The center longitude of each time zone is called the zone meridian, and in Zone 0 this is referred to as the Prime Meridian.**
- **Zone 1W is the next time zone west of Greenwich, its Zone Meridian is at 15°W and it extends from 7-1/2°W to 22-1/2°W.**
- **Each succeeding time zone is numbered in a similar fashion up to Zone 11W with a Zone Meridian at 165°. This zone extends from 157-1/2°W to 172-1/2°W. Similar numbering extends to the east of Greenwich and these zones are designated as 1E through 11E.**
- **Zone 12 is split similar to Zone 0 with half in the eastern and half in the western hemispheres. Zone 12W extends from 172-1/2°W to 180° and Zone 12E from 172-1/2°E to 180°.**

Western zone descriptions carry a positive math sign (+) and eastern zones carry a negative sign (-), for example: zone 4W may be designated zone +4 and zone 7E may be designated zone -7.

Meridian Time Difference (MTD) is the number of hours from a zone meridian to Greenwich based on the rotational speed of the earth. For example, the MTD of the Zone Meridian at 45°W is:

MTD = Longitude of Zone Meridian ÷ 15°
MTD = 45°W ÷ 15° per hour
= 3 hours west = + 3 hours

Longitude Time Difference (LTD) is the number of hours between any longitude and Greenwich based on the rotational speed of the earth. For example, if you were at longitude 47°18.2W, your LTD would be:

LTD = Longitude ÷ 15° per hour
= 47°18.2W ÷ 15°
= 47.30°W ÷ 15°
= 3.15 hours west
= + 3.15 hours

<u>Zone Time Difference</u> (ZTD) is the number of hours between any longitude and the zone meridian based on the rotational speed of the earth, and is calculated as:

ZTD = LTD - MTD
= 3.15 - 3.00
= 0.15 hours

<u>Greenwich Mean Time</u>: (GMT or UT1) is the reference time for all celestial data and is based on the daily rotation of the earth relative to the Sun. It is within 1 second of Coordinated Universal Time, UTC which is broadcast over SSB radio.

<u>Zone Time</u> (ZT): There are twenty-four 15º segments or Zones of Longitude around the earth and each is one hour different from the adjacent zones.

<u>Standard Time</u> (ST): May be different than ZT depending on the preferences of the various localities around the earth; most are the same as ZT, but some vary from 1/4 hour to a full hour away from ZT. Whatever the difference from ZT, it must be accounted for in calculating GMT.

<u>Local Time</u> (LT): Is a further local preference such as Daylight Time or Ship's Time, which must also be accounted for.

Zone Time and Greenwich Mean Time are related as follows:

GMT = ZT + MTD

The proper math sign must be applied to MTD as follows: West longitudes and time zones are designated positive (+) and East are designated negative (-). If you properly account for the math signs, this equation will enable you to reliably convert from any time zone to GMT or to any other time zone and to properly account for changes in date.

In most of the US,

Zone Time = Standard Time

Daylight Time = Standard Time + 1 hour

Accuracy

If you're doing Celestial Navigation, you need time accuracy to the second and therefore need a radio time standard. If you're sailing coastal, you'll be able to use an AM/FM radio time cube or a WWV radio controlled clock; if offshore, you can use an SSB radio to receive the WWV time check from Ft Collins, Colorado over 2500, 5000, 10000 or 15000 Khz or an INMARSAT time signal. Beware of using GPS clock time which may be in error by as much as 13 seconds depending on the equipment manufacturer.

HF radio refers to the High Frequency spectrum from 3 to 30 MHZ, and this is where marine band SSB and the HAM bands operate. Of the two, SSB (Single Side band) is the most prevalent on recreational boats. HF radio permits long range communications easily up to 1,000 miles and, sometimes, halfway around the world. This is achieved because HF radio waves do not penetrate the ionosphere as do higher frequencies, but are bounced back to earth a long distance away. With the right antenna and atmospheric conditions, these waves can repeatedly skip back and forth between ionosphere and earth several times and fully reach around the earth.

These radios require Ship Station licenses and Operators Licenses, which can be obtained with a simple application to the FCC plus fee with no testing required. The HAM requires considerable study, practice and testing before licensing. For further information or download of forms check the FCC website by linking to it through the American Sailing Association's website at http://www.american-sailing.com/ Sailing Resources.

Practice Exercises

1. **Using the procedures discussed above determine what time zones the following longitudes located in:**

   a. **Longitude 146°16.2'W**

   b. **Longitude 97°29.9'E**

   c. **Longitude 97°30.1'E**

2. **Determine the zone meridian longitudes for the following longitudes:**

   a. **Longitude 8°27.3'W**

   b. **Longitude 167°45.9'E**

   c. **Longitude 52°31.6'W**

3. **Determine the distance in nautical miles from:**

a. The equator to 12°N latitude

b. The equator to 36°14.3'S latitude

c. 63°32.8'N latitude to 16°52.6'S latitude

4. If the time is 1425ZT on June 16 at Longitude 128°27.3'W, what is the time and date at:

a. Greenwich, England.

b. Longitude 100°00.0'E

c. Longitude 170°13.0'W

d. And, in which time zone is it noon time?

Appendix C
USCG Light List for US Waters

Light lists are discussed in Chapters 2 and 8. Following is an example of four of the Nav Aides on training chart 1210Tr which were downloaded from the NGA website which can be reached through http://www.american-sailing.com/ Sailing Resources link.

(1) No.	(2) Name	(3) Position	(4) Characteristic	(5) Height	(6) Range	(7) Structure	(8) Remarks
SEACOAST (Massachusetts) - First District							
	APPROACHES TO NEW YORK - NANTUCKET SHOALS TO FIVE FATHOM BANK (Chart 12300)						
620 15610	**Gay Head Light**	41 20 54N 70 50 06W	**Al W R** 15s 0.2s W fl 7.3s ec 0.2s R fl 7.3s ec	170	W 24 R 20	Red brick tower. 51	Obscured from 342° to 359° by Nomans Land; light occasionally visible through notches in hilltop. Emergency light (Fl W 6s) of reduced intensity when main light is extinguished. Lighted throughout 24 hours.
SEACOAST (Massachusetts) - First District							
630 15985	**Buzzards Bay Entrance Light**	41 23 48N 71 02 01W	**Fl W** 2.5s	67	17	Tower on red square on 3 red piles with large tube in center, worded BUZZARDS on sides.	Emergency light of reduced intensity when main light is extinguished. RACON: B(- • • •). HORN: 2 blasts ev 30s (2s bl-2s si-2s bl-24s si).

(1) No	(2) Name	(3) Position	(4) Characteristic	(5) Height	(6) Range	(7) Structure	(8) Remarks
SEACOAST (Rhode Island) - First District							
640	**Block Island Southeast Light**	41 09 10N 71 33 04W	**Fl G** 5s	261	20	Red-brick octagon-pyramid tower attached to dwelling. 67	Lighted throughout 24 hours. Emergency light of reduced intensity when main light is extinguished. Emergency light is offset from main light. HORN: 1 blast ev 30s (3s bl).
RHODE ISLAND - First District							
19450	**Point Judith Light**	41 21 42N 71 28 54W	**Oc (3) W** 15s 5s fl 2s ec 2s fl 2s ec 2s fl 2s ec	65	16	Octagon tower, lower half white, upper half brown. 51	HORN: 1 blast ev 15s (2s bl

The following 39 pages are the descriptive material of the USCG Light List downloaded from the NGA website, which can be linked through http://www.american-sailing.com/ Sailing Resources link.

DEPARTMENT OF TRANSPORTATION, U.S. COAST GUARD

LIGHT LIST

Volume I

ATLANTIC COAST

St. Croix River, Maine to
Shrewsbury River, New Jersey

2001 Edition

This publication contains a list of lights, sound signals, buoys, daybeacons, and other aids to navigation.

Includes corrections through:
First Coast Guard District Local Notice to
Mariners No. 13/01, March 28, 2001
and
National Imagery and Mapping Agency Notice to
Mariners No. 16/01, April 21, 2001

IMPORTANT

THIS PUBLICATION SHOULD BE CORRECTED EACH WEEK FROM THE LOCAL NOTICES TO MARINERS OR NOTICES TO MARINERS AS APPROPRIATE.

COMDTPUB P16502.1

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CONTENTS

Geographic Sections

PREFACE

Lights and other marine aids to navigation, maintained by or under authority of the U.S. Coast Guard and located on waters used by general navigation, are described in the Light List. This volume includes aids to navigation located between St. Croix River, Maine to Shrewsbury River, New Jersey.

Included are all Coast Guard aids to navigation used for general navigation. Not included are Coast Guard mooring buoys and some buoys having no lateral significance, such as special purpose, anchorage, fish net, and dredging.

PRIVATE AIDS TO NAVIGATION

Included: Class I aids to navigation on marine structures or other works which the owners are legally obligated to establish, maintain, and operate as prescribed by the Coast Guard.

Included: Class II aids to navigation exclusive of Class I, located in waters used by general navigation.

Not included: Class III aids to navigation exclusive of Class I and Class II, located in waters not ordinarily used by general navigation.

This Light List is published annually and is intended to furnish more complete information concerning aids to navigation than can be conveniently shown on charts. It is not intended to be used during navigation in place of charts or Coast Pilots. Charts should be consulted for the location of all aids to navigation. It may be dangerous to use aids to navigation without reference to charts.

This list is corrected to the date of the notices to mariners shown on the title page. Changes made to aids to navigation during the year are published in U.S. Coast Guard Local Notices to Mariners and National Imagery and Mapping Agency (NIMA) Notices to Mariners. Important changes to aids to navigation are also broadcast through Coast Guard or Naval radio stations. Mariners should keep their Light Lists, charts and other nautical publications corrected from these notices and should consult all notices issued after the date of publication of this Light List.

IMPORTANT: A summary of corrections for this publication, which includes corrections from the dates shown on the title page to the date of availability, is published in the Local Notice to Mariners and the Notice to Mariners. These corrections must be applied, in order to bring the Light List up-to-date. Additionally, this publication should be corrected weekly from the Local Notices to Mariners or the Notices to Mariners, as appropriate.

Mariners and others are requested to bring to the attention of the District Commander (see pg. v) or Commandant (G-OPN-2), U.S. Coast Guard, 2100 Second St., S.W., Washington, DC 20593-0001, any apparent errors or omissions in these lists.

The 2001 edition supersedes the 2000 edition.

RECORD OF CORRECTIONS PUBLISHED IN LOCAL/NOTICES TO MARINERS

YEAR 20___

1	12	23	33	43 ....
2	13	24	34	44 ....
3	14	25	35	45 ....
4	15	26	36	46 ....
5	16	27	37	47 ....
6	17	28	38	48 ....
7	18	29	39	49 ....
8	19	30	40	50 ....
9	20	31	41	51 ....
10	21	32	42	52 ....
11	22			

YEAR 20___

1	12	23	33	43 ....
2	13	24	34	44 ....
3	14	25	35	45 ....
4	15	26	36	46 ....
5	16	27	37	47 ....
6	17	28	38	48 ....
7	18	29	39	49 ....
8	19	30	40	50 ....
9	20	31	41	51 ....
10	21	32	42	52 ....
11	22			

COAST GUARD DISTRICT COMMANDERS

DISTRICT	ADDRESS	WATERS OF JURISDICTION
FIRST	408 Atlantic Avenue Boston, MA 02110-3350 PHONE: DAY 617-223-8338 PHONE: NIGHT 617-223-8558	Maine, New Hampshire, Massachusetts, Vermont (Lake Champlain), Rhode Island, Connecticut, New York, to Shrewsbury River, New Jersey.
FIFTH	Federal Building; 431Crawford Street; Portsmouth, VA 23704-5004 PHONE: DAY 757-398-6486 PHONE: NIGHT 757-398-6231	Shrewsbury River, New Jersey to Delaware, Maryland, Virginia, District of Columbia and North Carolina.
SEVENTH	Brickell Plaza Federal Building 909 SE 1st Avenue; Rm: 406 Miami, FL 33131-3050 PHONE: DAY 305-415-6730 PHONE: NIGHT 305-415-6800	South Carolina, Georgia, Florida to 83° 50'W, and Puerto Rico and adjacent islands of the United States.
EIGHTH	Hale Boggs Federal Building 501 Magazine Street New Orleans LA 70130-3396 PHONE: DAY 504-589-6277 PHONE: NIGHT 504-589-6225	Florida westward from 83°50'W, Alabama, Mississippi, Louisiana, Texas, the Mississippi River System except that portion of the Illinois River north of Joliet, Illinois.
NINTH	1240 East 9th Street Cleveland, OH 44199-2060 PHONE: DAY 216-902-6060 PHONE: NIGHT 216-902-6117	Great Lakes and St. Lawrence River above St. Regis River.
ELEVENTH	Coast Guard Island Building 50-6 Alameda, CA 94501-5100 PHONE: DAY 510-437-2976	California.
THIRTEENTH	Federal Building 915 Second Avenue Seattle, WA 98174-1067 PHONE: DAY 206-220-7270 PHONE: NIGHT 206-220-7004	Oregon, Washington, Idaho, and Montana.
FOURTEENTH	Prince Kalanianaole Federal Bldg. 300 Ala Moana Blvd 9th Floor, Room 9139 Honolulu, HI 96850-4982 PHONE: DAY 808-541-2315 PHONE: NIGHT 808-541-2500	Hawaiian, American Samoa, Marshall, Marianas, and Caroline Islands.
SEVENTEENTH	P.O. Box 25517 Juneau, AK 99802-5517 PHONE: DAY 907-463-2262 PHONE: NIGHT 907-463-2004	Alaska.

INTRODUCTION

Arrangement. Aids to navigation on the Atlantic coast from St. Croix River, Maine to Shrewsbury River, New Jersey are listed in this volume.

Aids to navigation are arranged in geographic order from north to south along the Atlantic coast. Seacoast aids to navigation are listed first, followed by entrance and harbor aids to navigation, listed from seaward to the head of navigation

Names of aids to navigation are printed as follows to help distinguish at a glance the type of aid to navigation listed:

Seacoast Lights and Secondary Lights
Radiobeacons
RACONS
Sound Signals
RIVER, HARBOR, AND OTHER LIGHTS
Lighted Buoys
Daybeacons and Unlighted Buoys

Light List numbers are assigned to all aids to navigation in order to facilitate reference in the Light List and to resolve ambiguity when referencing aids to navigation. Aids to navigation are numbered by fives in accordance with their order of appearance in each volume of the Light List. Other numbers and decimal fractions are assigned where newly established aids to navigation are listed between previously numbered aids to navigation. The Light Lists are renumbered periodically to assign whole numbers to all aids to navigation.

International numbers are assigned to certain aids to navigation in cooperation with the International Hydrographic Organization. They consist of an alphabetic character followed by three or four numeric characters. A cross reference listing appears after the index.

DESCRIPTION OF COLUMNS

Column (1): Light List number.

Column (2): Name of the aid to navigation.

A dash (–) is used to indicate the bold heading is part of the name of the aid to navigation. When reporting defects or making reference to such aids to navigation in correspondence, the full name of the aid, including the geographic heading, should be given.

Bearings are in degrees true, read clockwise from 000° through 359°.

Bearings on rangelines are given in degrees and tenths of minutes.

Column (3): Geographic position of the aid to navigation in latitude and longitude. *NOTE:* Latitude and longitude is approximate, to the nearest second, and is intended only to facilitate locating the aid on the chart.

Column (4): Light characteristic for a lighted aid to navigation. Morse code characteristic for a radiobeacon.

Column (5): Height above water from the focal plane of the fixed light to mean high water, listed in feet. For metric conversion, see table inside rear cover.

Column (6): Nominal range of lighted aids to navigation, in nautical miles, listed by color for alternating sector and passing lights. Not listed for ranges, directional lights or private aids to navigation.

Column (7): Structural characteristic of the aid to navigation, including; dayboard (if any), description of fixed structure, color and type of buoy, height of structure above ground.

Column (8): General remarks, including; fog signal characteristic, RACON characteristic, light sector's arc of visibility, radar reflector if installed on fixed structure, emergency lights, seasonal remarks, and private aid to navigation identification.

Abbreviations used in the Light Lists.

Al – Alternating
bl - blast
C - Canadian
ec - Eclipse
ev - Every
F – Fixed
fl - flash
Fl - Flashing
FS - Fog Signal
Fl(2) - Group flashing
G - Green
I - Interrupted
Iso - Isophase (Equal interval)
kHz - Kilohertz
LFl - Long Flash
lt - Lighted
MHz - Megahertz
Mo - Morse Code
Oc - Occulting
ODAS - Anchored Oceanographic Data Buoy
Q - Quick (Flashing)
Ra ref - Radar reflector
RBN - Radiobeacon
R - Red
s - seconds
si - silent
SPM - Single Point Mooring Buoy
W - White
Y – Yellow

RELATED PUBLICATIONS

OTHER LIGHT LISTS PUBLISHED BY THE U.S. COAST GUARD

VOLUME II, ATLANTIC COAST, describes aids to navigation from Shrewsbury River, New Jersey to Little River, South Carolina.

VOLUME III, ATLANTIC and GULF COASTS, describes aids to navigation from Little River, South Carolina to Econfina River, Florida (includes Puerto Rico and U.S. Virgin Islands).

VOLUME IV, GULF OF MEXICO, describes aids to navigation from Econfina River, Florida to the Rio Grande, Texas.

VOLUME V, MISSISSIPPI RIVER SYSTEM, describes aids to navigation on the Mississippi River and its navigable tributaries.

VOLUME VI, PACIFIC COAST AND PACIFIC ISLANDS, describes aids to navigation on the Pacific coast and outlying Pacific islands.

VOLUME VII, GREAT LAKES, describes aids to navigation on the Great Lakes and the St. Lawrence River above the St. Regis River.

Coast Guard Light Lists are sold by the Superintendent of Documents, U.S. Government Printing Office (GPO) and can be ordered by phone: (202) 512-1800; FAX: (202) 512-2250; or mail: Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954. Light Lists are also available at GPO Bookstores and from GPO Sales Agents.

NOTICES TO MARINERS

Broadcast Notices to Mariners are made by the Coast Guard through Coast Guard and Navy radio stations. These broadcast notices, which are broadcast on VHF-FM, NAVTEX, and other maritime frequencies, are navigational warnings that contain information of importance to the safety of navigation. Included are reports of deficiencies and changes to aids to navigation, the positions of ice and derelicts, and other important hydrographic information.

Radio stations broadcasting Notices to Mariners are listed in the National Ocean Service Coast Pilots and in the National Imagery and Mapping Agency publication Radio Navigational Aids (RAPUB 117).

Local Notices to Mariners (U.S. regional coverage) are another means by which the Coast Guard disseminates navigation information for the United States, its territories, and possessions. A Local Notice to Mariners is issued by each Coast Guard district and is used to report changes to, and deficiencies in, aids to navigation maintained by and under the authority of the Coast Guard. Local Notices to Mariners contain other marine information such as channel depths, naval operations, regattas, etc., which may affect vessels and waterways within the jurisdiction of each Coast Guard district. Reports of channel conditions, obstructions, menaces to navigation, danger areas, new chart editions, etc., are also included in the Local Notice to Mariners.

These notices are essential to all navigators for the purposes of keeping their charts, Lights Lists, Coast Pilots and other nautical publications up-to-date. These notices are published as often as required, but usually weekly. They may be obtained, free of charge, by making application to the appropriate Coast Guard district commander (see pg. v). Vessels operating in ports and waterways in several districts will have to obtain the Local Notice to Mariners from each district in order to be fully informed.

Weekly Notices to Mariners (worldwide coverage) are prepared jointly by the National Imagery and Mapping Agency, the U.S. Coast Guard, and the National Ocean Service, and are published weekly by National Imagery and Mapping Agency.

The Weekly Notices to Mariners advise mariners of important matters affecting navigational safety including new hydrographic discoveries, changes in channels and aids to navigation. Also included are corrections to Light Lists, Coast Pilots, and Sailing Directions. Foreign marine information is also included. This notice is intended for mariners and others who have a need for information related to oceangoing operations. Because it is intended for use by oceangoing vessels, many corrections that affect small craft navigation and waters are not included. Information concerning small craft is contained in the Coast Guard Local Notices to Mariners only. The Weekly Notices to Mariners may be obtained free of charge from commercial maritime sources and upon request to Defense Logistics Agency, Defense Supply Center Richmond, ATTN: JNB, 8000 Jefferson Davis Highway, Richmond, VA 23297-5100 or FAX (804) 279-6510, ATTN: Accounts Manager, RMF.

Change of Address. Persons receiving the Local Notices to Mariners or the Weekly Notices to Mariners are requested to notify the appropriate agency of a change of address, or when the Notices to Mariners are no longer needed. Both the old and new address should be given in the case of an address change.

NAUTICAL CHARTS AND PUBLICATIONS

Charts and Coast Pilots covering the United States and its territories are published by the National Ocean Service (NOS), Silver Spring, MD 20910, and are for sale by NOS and authorized NOS Sales Agents. A free catalog of available NOS/NOAA products can be obtained from NOS by phone: (301) 436-6990/(800) 638-8972; FAX: (301) 436-6829; or mail: National Ocean Service/NOAA, Distribution Division N/ACC3, Riverdale, MD 20737-1199.

Sailing Directions covering the waters outside of the U.S. and its territories are published by the National Imagery and Mapping Agency and is available from the Superintendent of Documents, U.S. Government Printing Office (GPO). They can be ordered by phone: (202) 512-1800; FAX: (202) 512-2250; or mail: Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954.

Radio Navigational Aids (RAPUB 117) is published by the National Imagery and Mapping Agency. This publication lists selected radio stations (worldwide) that provide services to mariners. Included are stations transmitting radio navigation warnings, radio time signals, medical advice; chapters on distress, emergency and safety traffic; AMVER, and miscellaneous navigational instructions and procedures. Also included are descriptions of long range aids to navigation such as Loran. Discussions and instructions for use of radio navigational aids are also provided. RAPUB 117 is available from the Superintendent of Documents, U.S. Government Printing Office (GPO).

Maps for the Mississippi River System are published by the various District Engineers, U.S. Army Corps of Engineers.

Tide Tables and Tidal Current Tables are no longer printed or distributed by NOS. Private publishing companies are printing the tables using data provided by NOS. These products may be obtained from local stores that carry marine publications.

DEFECTS IN AIDS TO NAVIGATION

Mariners should realize the Coast Guard cannot keep the thousands of aids to navigation comprising the U.S. Aids to Navigation System under simultaneous and continuous observation and that it is impossible to maintain every aid to navigation operating properly and on its assigned position at all times. Therefore, for the safety of all mariners, any person who discovers an aid to navigation that is either off station or exhibiting characteristics other than those listed in the Light Lists should promptly notify the nearest Coast Guard unit. Radio messages should be prefixed "COAST GUARD" and transmitted directly to one of the U.S. Government radio stations listed in *Chapter 3, Section 300L, Radio Navigational Aids (RAPUB 117).*

Recommendations and requests for aids to navigation and to report aids to navigation that are no longer needed should be mailed to the Coast Guard district concerned (see pg. v).

U.S. AIDS TO NAVIGATION SYSTEM

The waters of the United States and its territories are marked to assist navigation by the U.S. Aids to Navigation System. This system encompasses buoys and beacons, conforming to the International Association of Lighthouse Authorities (IALA) buoyage guidelines, and other short range aids to navigation.

The U.S. Aids to Navigation System is intended for use with nautical charts. The exact meaning of a particular aid to navigation may not be clear to the mariner unless the appropriate nautical chart is consulted. Information supplementing that shown on charts is contained in the Light List, Coast Pilots, and Sailing Directions.

TYPES OF MARKS

Lateral marks are buoys or beacons indicating the port and starboard sides of a route to be followed, and are used in conjunction with a *conventional direction of buoyage.*

Generally, lateral aids to navigation indicate which side of an aid to navigation a vessel should pass when channels are entered from seaward and a vessel proceeds in the conventional direction of buoyage. Since all channels do not lead from seaward, certain assumptions must be made so the system can be consistently applied. In the absence of a route leading from seaward, the conventional direction of buoyage generally follows a clockwise direction around land masses.

Virtually all U.S. lateral marks are located in IALA Region B and follow the traditional 3R rule of **red, right, returning.** In U.S. waters, returning from seaward and proceeding toward the head of navigation is generally considered as moving southerly along the Atlantic coast, westerly along the Gulf coast and northerly along the Pacific coast. In the Great Lakes, the conventional direction of buoyage is generally considered westerly and northerly, except on Lake Michigan, where southerly movement is considered as returning from sea. A summary of the port and starboard hand lateral mark characteristics is contained in the following table.

Characteristic	**Port Hand Marks**	**Starboard Hand Marks**
Color	Green	Red
Shape (buoys)	Cylindrical (can) or pillar	Conical (nun) or pillar
Dayboard	Green square	Red triangle
Topmark (if fitted)	Cylinder	Cone, point upward
Light Color (if lighted)	Green	Red
Reflector Color	Green	Red
Number	Odd	Even

Preferred channel marks are aids to navigation which mark channel **junctions** or **bifurcations** and often mark wrecks or obstructions. Preferred channel marks may normally be passed on either side by a vessel, but indicate to the mariner the preferred channel. Preferred channel marks are colored with red and green bands.

At a point where a channel divides, when proceeding in the "conventional direction of buoyage", a preferred channel in IALA Region B may be indicated by a modified port or starboard lateral mark as follows:

Characteristic	**Preferred channel to starboard**	**Preferred channel to port**
Color	Green with one broad red band	Red with one broad green band
Shape (buoys)	Cylindrical (can) or pillar	Conical (nun) or pillar
Dayboard	Green square, lower half red	Red triangle, lower half green
Topmark (when fitted)	Green square or cylinder	Red triangular cone, point upward
Light Color (if lighted)	Green	Red
Rhythm	Composite group flashing (2+1)	Composite group flashing (2+1)
Reflector color	Green	Red

NOTE: U.S. lateral aids to navigation at certain Pacific islands are located within IALA Region A and thus exhibit opposite color significance. Port hand marks are red with square or cylindrical shapes while starboard hand marks are green with triangular or conical shapes.

CAUTION: It may not always be possible to pass on either side of preferred channel aids to navigation. The appropriate nautical chart should always be consulted.

Non-lateral marks have no lateral significance, but may be used to supplement the lateral aids to navigation specified above. Occasionally, daybeacons or minor lights outside of the normal channel will not have lateral significance since they do not define limits to navigable waters. These aids to navigation will utilize diamond-shaped dayboards and are divided into four diamond-shaped sectors. The side sectors of these dayboards are colored white, and the top and bottom sectors are colored black, red, or green as the situation dictates.

Safe water marks are used to mark fairways, mid-channels, and offshore approach points, and have unobstructed water on all sides. They can also be used by the mariner transiting offshore waters to identify the proximity of intended landfall. Safe water marks are red and white striped and have a red spherical topmark to further aid in identification. If lighted, they display a white light with the characteristic Morse code "A".

Isolated danger marks are erected on, or moored above or near, an isolated danger, which has navigable water all around it. These marks should not be approached closely without special caution.

Isolated danger marks are colored with black and red bands, and if lighted, display a group flashing (2) white light. A topmark consisting of two black spheres, one above the other, is fitted for both lighted and unlighted marks.

Special marks are not intended to assist in navigation, but rather to alert the mariner to a special feature or area. The feature should be described in a nautical document such as a chart, Light List, Coast Pilot or Notice to Mariner. Some areas which may be marked by these aids to navigation are spoil areas, pipelines, traffic separation schemes, jetties, or military exercise areas. Special marks are yellow in color and, if lighted, display a yellow light.

Information and regulatory marks are used to alert the mariner to various warnings or regulatory matters. These marks have orange geometric shapes against a white background. The meanings associated with the orange shapes are as follows:

1) An open-faced diamond signifies danger.

2) A diamond shape having a cross centered within indicates that vessels are excluded from the marked area.

3) A circular shape indicates that certain operating restrictions are in effect within the marked area.

BUOYS AND BEACONS

The IALA maritime buoyage guidelines apply to buoys and beacons that indicate the lateral limits of navigable channels, obstructions, other dangers such as wrecks, and other areas or features of importance to the mariner. This system provides five types of marks: lateral marks, safe water marks, special marks, isolated danger marks and cardinal marks. (Cardinal marks are not presently used in the United States.) Each type of mark is differentiated from other types by distinctive colors, shapes and light rhythms. Examples are provided on the enclosed color illustrations.

Buoys are floating aids to navigation used extensively throughout U.S. waters. They are moored to the seabed by concrete sinkers with chain or synthetic rope moorings of various lengths connected to the buoy body. *Buoy positions represented on nautical charts are approximate positions only*, due to the practical limitations of positioning and maintaining buoys and their sinkers in precise geographical locations. Buoy positions are normally verified during periodic maintenance visits. Between visits, atmospheric and sea conditions, seabed slope and composition, and collisions or other accidents may cause buoys to shift from their charted locations, or cause buoys to be sunk or capsized.

Buoy moorings vary in length. The mooring lengths define a *watch circle*, and buoys can be expected to move within this circle. Actual watch circles do not coincide with the symbols representing them on charts.

CAUTION: Mariners attempting to pass a buoy close aboard risk collision with a yawing buoy or with the obstruction which the buoy marks. Mariners must not rely on buoys alone for determining their positions due to factors limiting buoy reliability. Prudent mariners will use bearings or angles from fixed aids to navigation and shore objects, soundings and various methods of electronic navigation to positively fix their position.

Beacons are aids to navigation which are permanently fixed to the earth's surface. These structures range from lighthouses to small unlighted daybeacons, and exhibit a daymark to make these aids to navigation readily visible and easily identifiable against background conditions. The daymark conveys to the mariner, during daylight hours, the same significance as does the aid to navigation's light at night.

CAUTION: Vessels should not pass fixed aids to navigation close aboard due to the danger of collision with rip-rap or structure foundations, or with the obstruction or danger being marked.

LIGHTED AIDS TO NAVIGATION

Most lighted aids to navigation are equipped with controls which automatically cause the light to operate during darkness and to be extinguished during daylight. These devices are not of equal sensitivity, therefore all lights do not come on or go off at the same time. (Mariners should ensure correct identification of aids to navigation during twilight periods when some lighted aids to navigation are lit while others are not.)

The lighting apparatus is serviced at periodic intervals to assure reliable operation, but there is always the possibility of a light being extinguished or operating improperly. The condition of the atmosphere has a considerable effect upon the distance at which lights can be seen. Sometimes lights are obscured by fog, haze, dust, smoke, or precipitation which may be present at the light, or between the light and the observer, and which is possibly unknown by the observer. Atmospheric refraction may cause a light to be seen farther than under ordinary circumstances.

A light of low intensity will be easily obscured by unfavorable conditions of the atmosphere and little dependence can be placed on it being seen. For this reason, the intensity of a light should always be considered when expecting to sight it in thick weather. Haze and distance may reduce the apparent duration of the flash of a light. In some atmospheric conditions, white lights may have a reddish hue. Lights placed at high elevations are more frequently obscured by clouds, mist, and fog than those lights located at or near sea level.

In regions where ice conditions prevail in the winter, the lantern panes of unattended lights may become covered with ice or snow, which will greatly reduce the visibility of the lights and may also cause colored lights to appear white.

The increasing use of brilliant shore lights for advertising, illuminating bridges, and other purposes, may cause marine navigational lights, particularly those in densely inhabited areas, to be outshone and difficult to distinguish from the background lighting. Mariners are requested to report such cases in order that steps may be taken to improve the conditions.

The "loom" (glow) of a powerful light is often seen beyond the limit of visibility of the actual rays of the light. The loom may sometimes appear sufficiently sharp enough to obtain a bearing. At short distances, some flashing lights may show a faint continuous light between flashes.

The distance of an observer from a light cannot be estimated by its apparent intensity. Always check the characteristics of lights so powerful lights, visible in the distance, are not mistaken for nearby lights (such as those on lighted buoys) showing similar characteristics of low intensity. If lights are not sighted within a reasonable time after prediction, a dangerous situation may exist requiring prompt resolution or action in order to ensure the safety of the vessel.

The apparent characteristic of a complex light may change with the distance of the observer. For example, a light which actually displays a characteristic of fixed white varied by flashes of alternating white and red (the rhythms having a decreasing range of visibility in the order: flashing white, flashing red, fixed white) may, when first sighted in clear weather, show as a simple flashing white light. As the vessel draws nearer, the red flash will become visible and the characteristics will apparently be alternating flashing white and red. Later, the fixed white light will be seen between the flashes and the true characteristic of the light will finally be recognized as fixed white, alternating flashing white and red (F W Al WR).

If a vessel has considerable vertical motion due to pitching in heavy seas, a light sighted on the horizon may alternately appear and disappear. This may lead the unwary to assign a false characteristic and hence, to err in its identification. The true characteristic will be evident after the distance has been sufficiently decreased or by increasing the height of eye of the observer.

Similarly, the effects of wave motion on lighted buoys may produce the appearance of incorrect light phase characteristics when certain flashes occur, but are not viewed by the mariner. In addition, buoy motion can reduce the distance at which buoy lights are detected.

Sectors of colored glass are placed in the lanterns of some lights in order to produce a system of light sectors of different colors. In general, red sectors are used to mark shoals or to warn the mariner of other obstructions to navigation or of nearby land. Such lights provide approximate bearing information, since observers may note the change of color as they cross the boundary between sectors. These boundaries are indicated in the Light List (Col. 8) and by dotted lines on charts. These bearings, as all bearings referring to lights, are given in true degrees from 000° to 359°, as observed from a vessel toward the light.

Altering course on the changing sectors of a light or using the boundaries between light sectors to determine the bearing for any purpose is not recommended. Be guided instead by the correct compass bearing to the light and do not rely on being able to accurately observe the point at which the color changes. This is difficult to determine because the edges of a colored sector cannot be cut off sharply. On either side of the line of demarcation between white, red, or green sectors, there is always a small arc of uncertain color. Moreover, when haze or smoke are present in the intervening atmosphere, a white sector might have a reddish hue.

The area in which a light can be observed is normally an arc with the light as the center and the range of visibility as the radius. However, on some bearings the range may be reduced by obstructions. In such cases, the obstructed arc might differ with height of eye and distance. When a light is cut off by adjoining land and the arc of visibility is given, the bearing on which the light disappears may vary with the distance of the vessel from which observed and with the height of eye. When the light is cut off by a sloping hill or point of land, the light may be seen over a wider arc by a vessel farther away than by one closer to the light.

The arc drawn on charts around a light is not intended to give information as to the distance at which it can be seen, but solely to indicate, in the case of lights which do not show equally in all directions, the bearings between which the variation of visibility or obstruction of the light occurs.

OIL WELL STRUCTURES

Oil well structures in navigable waters are not listed in the Light List. The structures are shown on the appropriate nautical charts. Information concerning the location and characteristics of those structures which display lights and sound signals not located in obstruction areas are published in Local and/or Weekly Notices to Mariners.

In general, during the nighttime, a series of white lights are displayed extending from the platform to the top of the derrick when drilling operations are in progress. At other times, structures are usually marked with one or more fixed or quick flashing white or red lights, visible for at least one nautical mile during clear weather. Obstructions which are a part of the appurtenances to the main structure, such as mooring piles, anchor and mooring buoys, etc., normally are not lighted. In addition, some of the structures are equipped with sound signals (bell, siren, whistle, or horn). When operating, bells sound one stroke every 15 seconds, while sirens, whistles, or horns sound a single two-second blast every 20 seconds.

CHARACTERISTICS OF AIDS TO NAVIGATION

LIGHT COLORS

Only aids to navigation with green or red lights have lateral significance. When proceeding in the conventional direction of buoyage, the mariner in IALA Region B, may see the following lighted aids to navigation:

Green lights on aids to navigation mark port sides of channels and locations of wrecks or obstructions which must be passed by keeping these lighted aids to navigation on the port hand of a vessel. Green lights are also used on preferred channel marks where the preferred channel is to starboard (i.e., aid to navigation left to port when proceeding in the conventional direction of buoyage).

Red lights on aids to navigation mark starboard sides of channels and locations of wrecks or obstructions which must be passed by keeping these lighted aids to navigation on the starboard hand of a vessel. Red lights are also used on preferred channel marks where the preferred channel is to port (i.e., aid to navigation left to starboard when proceeding in the conventional direction of buoyage).

White and yellow lights have no lateral significance. The purpose of aids to navigation exhibiting white or yellow lights may be determined by the shapes, colors, letters, and light rhythms.

Most aids to navigation are fitted with retroreflective material to increase their visibility in darkness. Red or green retroreflective material is used on lateral aids to navigation which, if lighted, will display lights of the same color.

LIGHT RHYTHMS

Light rhythms have no lateral significance. Aids to navigation with lateral significance exhibit flashing, quick, occulting or isophase light rhythms. Ordinarily, flashing lights (frequency not exceeding 30 flashes per minute) will be used.

Preferred channel marks exhibit a composite group-flashing light rhythm of two flashes followed by a single flash.

Safe water marks show a white Morse code "A" rhythm (a short flash followed by a long flash).

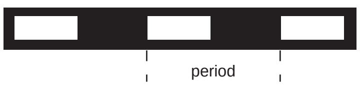
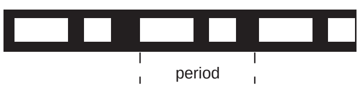
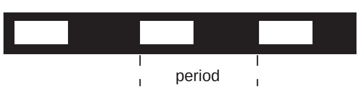
Isolated danger marks show a white flashing (2) rhythm (two flashes repeated regularly).

Special marks show yellow lights and exhibit a flashing or fixed rhythm; however, a flashing rhythm is preferred.

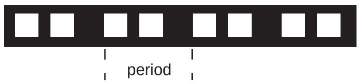
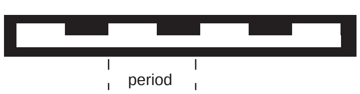
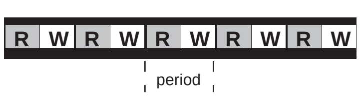
Information and regulatory marks, when lighted, display a white light with any light rhythm except quick flashing, flashing (2) and Morse code "A".

For situations where lights require a distinct cautionary significance, as at sharp turns, sudden channel constrictions, wrecks or obstructions, a quick flashing light rhythm will be used.

CHARACTERISTICS OF LIGHTS

Illustration	Type Description	Abbreviation
	**1. Fixed.** A light showing continuously and steadily.	F
	2. Occulting. A light in which the total duration of light in a period is longer than the total duration of darkness and the intervals of darkness (eclipses) are usually of equal duration.	
	**2.1 Single-occulting.** An occulting light in which an eclipse is regularly repeated.	Oc
	**2.2 Group-occulting.** An occulting light in which a group of eclipses, specified in numbers, is regularly repeated.	Oc (2)
	**2.3 Composite group-occulting.** A light, similar to a group-occulting light, except that successive groups in a period have different numbers of eclipses.	Oc (2+1)
	**3. Isophase.** A light in which all durations of light and darkness are equal.	Iso
	4. Flashing. A light in which the total duration of light in a period is shorter than the total duration of darkness and the appearances of light (flashes) are usually of equal duration.	
	**4.1 Single-flashing.** A flashing light in which a flash is regularly repeated (frequency not exceeding 30 flashes per minute).	Fl

CHARACTERISTICS OF LIGHTS (continued)

Illustration	Type Description	Abbreviation
	**4.2 Group-flashing.** A flashing light in which a group of flashes, specified in number, is regularly repeated.	**Fl (2)**
	**4.3 Composite group-flashing.** A light similar to a group flashing light except that successive groups in the period have different numbers of flashes.	**Fl (2+1)**
	5. Quick. A light in which flashes are produced at a rate of 60 flashes per minute.	
	**5.1 Continuous quick.** A quick light in which a flash is regularly repeated.	**Q**
	**5.2 Interrupted quick.** A quick light in which the sequence of flashes is interrupted by regularly repeated eclipses of constant and long duration.	**IQ**
	**6. MORSE CODE.** A light in which appearances of light of two clearly different durations (dots and dashes) are grouped to represent a character or characters in the Morse code.	**Mo (A)**
	**7. Fixed and flashing.** A light in which a fixed light is combined with a flashing light of higher luminous intensity.	**FFl**
	**8. ALTERNATING.** A light showing different colors alternately	**Al RW**

SHAPES

In order to provide easy identification, certain unlighted buoys and dayboards on beacons are differentiated by shape. These shapes are laterally significant only when associated with laterally significant colors.

Cylindrical buoys (referred to as "can buoys") and square dayboards mark the left side of a channel when proceeding from seaward. These aids to navigation are associated with solid green or green and red banded marks where the topmost band is green.

Conical buoys (referred to as "nun buoys") and triangular dayboards mark the right side of the channel when proceeding from seaward. These aids to navigation are associated with solid red or red and green banded marks where the topmost band is red.

Unless fitted with topmarks; lighted, sound, pillar, and spar buoys have no shape significance. Their meanings are conveyed by their numbers, colors, and light characteristics.

NUMBERS

All solid red and solid green aids to navigation are numbered, with red aids to navigation bearing even numbers and green aids to navigation bearing odd numbers. The numbers for each increase from seaward, proceeding in the conventional direction of buoyage. Numbers are kept in approximate sequence on both sides of the channel by omitting numbers where necessary.

Letters may be used to augment numbers when lateral aids to navigation are added to channels with previously completed numerical sequences. Letters will increase in alphabetical order from seaward, proceeding in the conventional direction of buoyage and are added to numbers as suffixes.

No other aids to navigation are numbered. Preferred channel, safe water, isolated danger, special marks, and information and regulatory aids to navigation may be lettered, but not numbered.

DAYBOARDS

In order to describe the appearance and purpose of each dayboard used in the U.S. System, standard designations have been formulated. A brief explanation of the designations and of the purpose of each type of dayboard in the system is given below, followed by a verbal description of the appearance of each dayboard type.

Designations:

1. First Letter - Shape or Purpose

   S: Square used to mark the port (left) side of channels when proceeding from seaward.

   T: Triangle used to mark the starboard (right) side of channels when proceeding from seaward.

   J: Junction (square or triangle) used to mark (preferred channel) junctions or bifurcations in the channel, or wrecks or obstructions which may be passed on either side; color of top band has lateral significance for the preferred channel.

   M: Safe water (octagonal) used to mark the fairway or middle of the channel.

   C: Crossing (western rivers only) diamond-shaped, used to indicate the points at which the channel crosses the river.

   K: Range (rectangular) when both the front and rear range dayboards are aligned on the same bearing, the observer is on the azimuth of the range, usually used to mark the center of the channel.

   N: No lateral significance (diamond or rectangular-shaped) used for special purpose, warning, distance, or location markers.

2. Second letter - Key color

   G - Green R - Red
   B - Black W - White
   Y - Yellow

3. Third letter (color of center stripe; range dayboards only)

4. Additional information after a (-)

   -I: Intracoastal Waterway; a yellow reflective horizontal strip on a dayboard; indicates the aid to navigation marks the Intracoastal Waterway.

   -SY: Intracoastal Waterway; a yellow reflective square on a dayboard; indicates the aid to navigation is a port hand mark for vessels traversing the Intracoastal Waterway. May appear on a triangular daymark where the Intracoastal Waterway coincides with a waterway having opposite conventional direction of buoyage.

   -TY: Intracoastal Waterway; a yellow reflective triangle on a dayboard; indicates the aid to navigation is a starboard hand mark for vessels traversing the Intracoastal Waterway. May appear on a square daymark where the Intracoastal Waterway coincides with a waterway having opposite conventional direction of buoyage.

Example: The designation KRW-I indicates a range dayboard (K); key color red (R); with a white stripe (W); in the Intracoastal Waterway (-I).

Descriptions:

SG: Square green dayboard with a green reflective border.

SG-I: Square green dayboard with a green reflective border and a yellow reflective horizontal strip.

SG-SY: Square green dayboard with a green reflective border and a yellow reflective square.

SG-TY: Square green dayboard with a green reflective border and a yellow reflective triangle.

SR: Square red dayboard with a red reflective border. (IALA Region "A")

TG: Triangular green dayboard with a green reflective border. (IALA Region "A")

TR: Triangular red dayboard with a red reflective border.

TR-I: Triangular red dayboard with a red reflective border and a yellow reflective horizontal strip.

TR-SY: Triangular red dayboard with a red reflective border and a yellow reflective square.

TR-TY: Triangular red dayboard with a red reflective border and a yellow reflective triangle.

JG: Dayboard bearing horizontal bands of green and red, green band topmost, with a green reflective border.

JG-I: Square dayboard bearing horizontal bands of green and red, green band topmost, with a green reflective border and a yellow reflective horizontal strip.

JG-SY: Square dayboard bearing horizontal bands of green and red, green band topmost, with a green reflective border and a yellow reflective square.

JG-TY: Square dayboard bearing horizontal bands of green and red, green band topmost, with a green reflective border and a yellow reflective triangle.

JR: Dayboard bearing horizontal bands of red and green, red band topmost, with a red reflective border.

JR-I: Triangular dayboard bearing horizontal bands of red and green, red band topmost, with a red reflective border and a yellow horizontal strip.

JR-SY: Triangular dayboard bearing horizontal bands of red and green, red band topmost, with a red reflective border and a yellow reflective square.

JR-TY: Triangular dayboard bearing horizontal bands of red and green, red band topmost, with a red reflective border and a yellow reflective triangle.

MR: Octagonal dayboard bearing stripes of white and red, with a white reflective border.

MR-I: Octagonal dayboard bearing stripes of white and red, with a white reflective border and a yellow reflective horizontal strip.

CG: Diamond-shaped dayboard divided into four diamond-shaped colored sectors with the sectors at the side corners white and the sectors at the top and bottom corners green, with a white reflective border.

CR: Diamond-shaped dayboard divided into four diamond-shaped colored sectors with the sectors at the side corners white and the sectors at the top and bottom corners red, with a white reflective border.

KBG: Rectangular black dayboard bearing a central green stripe.

KBG-I: Rectangular black dayboard bearing a central green stripe and a yellow reflective horizontal strip.

KBR: Rectangular black dayboard bearing a central red stripe.

KBR-I: Rectangular black dayboard bearing a central red stripe and a yellow reflective horizontal strip.

KBW: Rectangular black dayboard bearing a central white stripe.

KBW-I: Rectangular black dayboard bearing a central white stripe and a yellow reflective horizontal strip.

KGB: Rectangular green dayboard bearing a central black stripe.

KGB-I: Rectangular green dayboard bearing a central black stripe and a yellow reflective horizontal strip.

KGR: Rectangular green dayboard bearing a central red stripe.

KGR-I: Rectangular green dayboard bearing a central red stripe and a yellow reflective horizontal strip.

KGW: Rectangular green dayboard bearing a central white stripe.

KGW-I: Rectangular green dayboard bearing a central white stripe and a yellow reflective horizontal strip.

KRB: Rectangular red dayboard bearing a central black stripe.

KRB-I: Rectangular red dayboard bearing a central black stripe and a yellow reflective horizontal strip.

KRG: Rectangular red dayboard bearing a central green stripe.

KRG-I: Rectangular red dayboard bearing a central green stripe and a yellow reflective horizontal strip.

KRW: Rectangular red dayboard bearing a central white stripe.

KRW-I: Rectangular red dayboard bearing a central white stripe and a yellow reflective horizontal strip.

KWB: Rectangular white dayboard bearing a central black stripe.

KWB-I: Rectangular white dayboard bearing a central black stripe and a yellow reflective horizontal strip.

KWG: Rectangular white dayboard bearing a central green stripe.

KWG-I: Rectangular white dayboard bearing a central green stripe and a yellow reflective horizontal strip.

KWR: Rectangular white dayboard bearing a central red stripe.

KWR-I: Rectangular white dayboard bearing a central red stripe and a yellow reflective horizontal strip.

NB: Diamond-shaped dayboard divided into four diamond-shaped colored sectors with the sectors at the side corners white and the sectors at the top and bottom corners black, with a white reflective border.

NG: Diamond-shaped dayboard divided into four diamond-shaped colored sectors with the sectors at the side corners white and the sectors at the top and bottom corners green, with a white reflective border.

NR: Diamond-shaped dayboard divided into four diamond-shaped colored sectors with the sectors at the side corners white and the sectors at the top and bottom corners red, with a white reflective border.

NW: Diamond-shaped white dayboard with an orange reflective border and black letters describing the information or regulatory nature of the mark.

ND: Rectangular white mileage marker with black numerals indicating the mile number (western rivers only).

NL: Rectangular white location marker with an orange reflective border and black letters indicating the location.

NY: Diamond-shaped yellow dayboard with yellow reflective border.

These abbreviated descriptions are used in column (7) and may also be found on the illustration of U.S. Aids to Navigation System.

OTHER SHORT RANGE AIDS TO NAVIGATION

Lighthouses are placed on shore or on marine sites and most often do not show lateral markings. They assist the mariner in determining his position or safe course, or warn of obstructions or dangers to navigation. Lighthouses with no lateral significance usually exhibit a white light.

Occasionally, lighthouses use sectored lights to mark shoals or warn mariners of other dangers. Lights so equipped show one color from most directions and a different color or colors over definite arcs of the horizon as indicated on the appropriate nautical chart. These sectors provide approximate bearing information and the observer should note a change of color as the boundary between the sectors is crossed. Since sector bearings are not precise, they should be considered as a warning only, and used in conjunction with a nautical chart.

Seasonal aids to navigation are placed into service or changed at specified times of the year. The dates shown in the Light List (Col. 8) are approximate and may vary due to adverse weather or other conditions.

Ranges are non-lateral aids to navigation systems employing dual beacons which when the structures appear to be in line, assist the mariner in maintaining a safe course. The appropriate nautical chart must be consulted when using ranges to determine whether the range marks the centerline of the navigable channel and also what section of the range may be safely traversed. Ranges display rectangular dayboards of various colors and are generally, but not always lighted. When lighted, ranges may display lights of any color.

Sound signal is a generic term used to describe aids to navigation that produce an audible signal designed to assist the mariner in fog or other periods of reduced visibility. These aids to navigation can be activated by several means (e.g., manually, remotely, or fog detector). In cases where a fog detector is in use, there may be a delay in the automatic activation of the signal. Additionally, fog detectors may not be capable of detecting patchy fog conditions. Sound signals are distinguished by their tone and phase characteristics.

Tones are determined by the devices producing the sound, e.g., diaphones, diaphragm horns, sirens, whistles, bells, and gongs.

Phase characteristics are defined by the signal's sound pattern, i.e., the number of blasts and silent periods per minute and their durations. Sound signals sounded from fixed structures generally produce a specific number of blasts and silent periods each minute when operating. Buoy sound signals are generally activated by the motion of the sea and therefore do not emit a regular signal characteristic. It is common, in fact, for a buoy to produce no sound signal when seas are calm. Mariners are reminded that buoy positions are not always reliable.

The characteristic of a sound signal can be located in column (8) of the Light List. Unless it is specifically stated that a sound signal "Operates continuously", or the signal is a bell, gong, or whistle on a buoy, it can be assumed that the sound signal only operates during times of fog, reduced visibility, or adverse weather.

An emergency sound signal is sounded at some locations when the main and standby signals are inoperative. If the emergency signal is of a different type or characteristic than the main signal, its characteristic is listed in column (8) of this publication.

CAUTION: Mariners should not rely on sound signals to determine their position. Distance cannot be accurately determined by sound intensity. Occasionally, sound signals may not be heard in areas close to their location. Signals may not sound in cases where fog exists close to, but not at, the location of the sound signal.

VARIATIONS TO THE U.S. SYSTEM

Intracoastal Waterway aids to navigation: The Intracoastal Waterway runs parallel to the Atlantic and Gulf coasts from Manasquan Inlet, New Jersey to the Mexican border. Aids to navigation marking these waters have some portion of them marked with yellow. Otherwise, the coloring and numbering of the aids to navigation follow the same system as that in other U.S. waterways.

In order that vessels may readily follow the Intracoastal Waterway route, special markings are employed. These marks consist of a yellow square and yellow triangle and indicate which side the aid to navigation should be passed when following the conventional direction of buoyage. The yellow square indicates that the aid to navigation should be kept on the left side and the yellow triangle indicates that the aid to navigation should be kept on the right side.

NOTE: The conventional direction of buoyage in the Intracoastal Waterway is generally southerly along the Atlantic coast and generally westerly along the Gulf coast.

The **Western Rivers System,** a variation of the standard U.S. Aids to Navigation System described in the preceding sections, is employed on the Mississippi River and its tributaries above Baton Rouge, LA and on certain other rivers which flow toward the Gulf of Mexico.

The Western Rivers System varies from the standard U.S. system as follows:

1) Aids to navigation are not numbered.

2) Numbers on aids to navigation do not have lateral significance, but rather indicate mileage from a fixed point (normally the river mouth).

3) Diamond shaped crossing dayboards, red and white or green and white as appropriate, and are used to indicate where the river channel crosses from one bank to the other.

4) Lights on green aids to navigation show a single-flash characteristic which may be green or white.

5) Lights on red aids to navigation show a group-flash characteristic which may be red or white.

6) Isolated danger marks are not used.

Uniform State Waterway Marking System (USWMS): This system was developed in 1966 to provide an easily understood system for operators of small boats. While designed for use on lakes and other inland waterways that are not portrayed on nautical charts, the USWMS was authorized for use on other waters as well. It supplements the existing Federal marking system and is generally compatible with it.

The conventional direction of buoyage is considered upstream or towards the head of navigation.

The USWMS varies from the standard U.S. system as follows:

1) The color black is used instead of green.

2) There are three aids to navigation which reflect cardinal significance:

a. A white buoy with a red top indicates an obstruction and the buoy should be passed to the south or west.

b. A white buoy with a black top indicates an obstruction and the buoy should be passed to the north or east.

c. A red and white vertically striped buoy indicates that an obstruction exists between that buoy and the nearest shore.

3) Mooring buoys are white buoys with a horizontal blue band midway between the water line and the top of the buoy. This buoy may be lighted and will generally show a slow flashing light.

BRIDGE MARKINGS

Bridges across navigable waters are generally marked with red, green and/or white lights for nighttime navigation. Red lights mark piers and other parts of the bridge. Red lights are also used on drawbridges to show when they are in the closed position.

Green lights are used on drawbridges to show when they are in the open position. The location of these lights will vary according to the bridge structure. Green lights are also used to mark the centerline of navigable channels through fixed bridges. If there are two or more channels through the bridge, the preferred channel is also marked by three white lights in a vertical line above the green light.

Red and green retroreflective panels may be used to mark bridge piers and may also be used on bridges not required to display lights.

Main channels through bridges may be marked by lateral red and green lights and dayboards. Adjacent piers should be marked with fixed yellow lights when the main channel is marked with lateral aids to navigation.

Centerlines of channels through fixed bridges may be marked with a safe water mark and an occulting white light when lateral marks are used to mark main channels. The centerline of the navigable channel through the draw span of floating bridges may be marked with a special mark. The mark will be a yellow diamond with yellow retroreflective panels and may exhibit a yellow light that displays a Morse code "B"(**-...**).

Clearance gauges may be installed to enhance navigation safety. The gauges are located on the right channel pier or pier protective structure facing approaching vessels. They indicate the vertical clearance available under the span.

Drawbridges equipped with radiotelephones display a blue and white sign which indicates what VHF radiotelephone channels should be used to request bridge openings.

ELECTRONIC AIDS TO NAVIGATION

RACONS

Aids to navigation may be enhanced by the use of **RA**dar bea**CONS** (RACONS). RACONS, when triggered by pulses from a vessel's radar, will transmit a coded reply to the vessel's radar. This reply serves to identify the RACON station by exhibiting a series of dots and dashes which appear on the radar display emanating radially from the RACON. This display will represent the approximate range and bearing to the RACON. Although RACONS may be used on both laterally significant and non-laterally significant aids to navigation, the RACON signal itself is for identification purposes only, and therefore carries no lateral significance. RACONS are also used as bridge marks to mark the point of best passage.

All RACONS operate in the marine radar X-band from 9,300 to 9,500 MHz. Some frequency-agile RACONS also operate in the 2,900 to 3,000 MHz marine radar S-band.

RACONS have a typical output of 100 to 300 milliwatts and are considered a short range aid to navigation. Reception varies from a nominal range of 6 to 8 nautical miles when mounted on a buoy to as much as 17 nautical miles for a RACON with a directional antenna mounted at a height of 50 feet on a fixed structure. It must be understood that these are nominal ranges and are dependent upon many factors.

The beginning of the RACON presentation occurs about 50 yards beyond the RACON position and will persist for a number of revolutions of the radar antenna (depending on its rotation rate). Distance to the RACON can be measured to the point at which the RACON flash begins, but the figure obtained will be greater than the ship's distance from the RACON. This is due to the slight response delay in the RACON apparatus.

Radar operators may notice some broadening or spoking of the RACON presentation when their vessel approaches closely to the source of the RACON. This effect can be minimized by adjustment of the IF gain or sweep gain control of the radar. If desired, the RACON presentation can be virtually eliminated by operation of the FTC (fast time constant) controls of the radar.

Radar Reflectors

Many aids to navigation incorporate special fixtures designed to enhance the reflection of radar energy. These fixtures, called radar reflectors, help radar equipped vessels to detect buoys and beacons which are so equipped. They do not however, positively identify a radar target as an aid to navigation.

Radiobeacons

As the first electronic system of navigation, radiobeacons provided offshore coverage and also became the first all-weather electronic aid to navigation. As of January 2001, only 1 Coast Guard operated traditional marine radiobeacon remains, located at Ediz Hook, WA. To use this system, the mariner needs a radio direction finder, which is a specifically designed radio receiver with a directional antenna. This antenna is used to determine the direction of the signal being emitted by the shore station, relative to the vessel.

The basic value of the radiobeacon system lies in its simplicity of operation and its relatively low user costs, even though the results obtained may be somewhat limited. The general problems and practices of navigation when using radiobeacons are very similar to those encountered when using visual bearings of lighthouses or other charted objects.

A radiobeacon is basically a short-range navigational aid, with ranges from 5 to 65 nautical miles. Although bearings can be obtained at greater ranges, they will be of doubtful accuracy and should be used with caution. When the distance to a radiobeacon is greater than 50 miles, a correction is usually applied to the bearing before plotting on a Mercator chart. These corrections, as well as information on accuracy of bearings, plotting, and other matters are contained in the National Imagery and Mapping Agency publication, Radio Navigational Aids (RAPUB 117).

All radiobeacons operated and maintained by the U.S. Coast Guard are classified as continuous radiobeacons. Continuous radiobeacons operate continuously through every minute of the hour.

All Coast Guard-operated radiobeacons are assigned Morse code characteristics for ease in station identification.

The accuracy to be expected from radiobeacons depends to a large extent on the skill of the operator, the condition and type of equipment being used, the range from the stations, and the accuracy of the ship's calibration curve.

The range at which a particular marine radiobeacon signal will be received depends on atmospheric conditions and on the receiver sensitivity. The advertised service range of marine radiobeacons is expressed in nautical miles.

In general, the better the sensitivity of a receiver (i.e., the lower the signal strength required to obtain satisfactory bearings) the better the receiver is for direction-finding purposes. Unless the receiver and antenna combination is capable of obtaining a radio bearing on a signal as low as 50 microvolts per meter, full benefit will not be obtained from the system.

The selectivity of a receiver is important because it allows the direction finder to receive a desired signal on a particular frequency, while rejecting any undesired signals which may be present on adjacent frequencies.

Since the bandwidth of the transmitted radiobeacon signal is relatively narrow, being only 2.1 kilohertz, a narrow-band receiver, having good selectivity is well suited for direction finding purposes. The narrow-band receiver should extract all of the useful information from the transmitted marine radiobeacon signal.

Although a wider-band receiver may also extract all of the useful information from the transmitted signal, it will also admit more noise and more undesired signals, if these signals are present on adjacent frequencies. The additional noise and undesired signal interference may reduce the usefulness of the desired signal and effectively reduce the service range of the radiobeacon below its advertised value. This is a receiver defect, not a system error.

LORAN-C

LORAN, an acronym for LOng RAnge Navigation, is an electronic aid to navigation consisting of shore-based radio transmitters. The LORAN system enables users equipped with a LORAN receiver to determine their position quickly and accurately, day or night, in practically any weather.

A LORAN-C chain consists of three to six transmitting stations separated by several hundred miles. Within a chain, one station is designated as master (M) while the other stations are designated as secondary. Each secondary station is identified as either Victor (V), Whiskey (W), X-ray (X), Yankee (Y), or Zulu (Z).

The master station is always the first station to transmit. It transmits a series of nine pulses. The secondary stations then follow in turn, transmit eight pulses each, at precisely timed intervals. This cycle continuously repeats itself. The length of the cycle is measured in microseconds and is called a Group Repetition Interval (GRI).

LORAN-C chains are designated by the four most significant digits of their GRI. For example, a chain with a GRI of 89,700 microseconds is referred to as 8970. A different GRI is used for each chain because all LORAN-C stations broadcast in the same 90 to 110 kilohertz frequency band and would otherwise interfere with one another.

The LORAN-C system can be used in either a hyperbolic or range mode. In the widely used hyperbolic mode, a LORAN-C line of position is determined by measuring the time difference between synchronized pulses received from two separate transmitting stations. In the range mode, a line of position is determined by measuring the time required for LORAN-C pulses to travel from a transmitting station to the user's receiver.

A user's position is determined by locating the crossing point of two lines of position on a LORAN-C chart. Many receivers have built-in coordinate converters that automatically display the receiver's latitude and longitude. With a coordinate converter, a position can be determined using a chart that is not overprinted with LORAN-C lines of position.

CAUTION: The latitude/longitude computation in some receivers is based upon an all seawater propagation path. This may lead to error if the LORAN-C signals from the various stations involve appreciable overland propagation paths. These errors may put the mariner at risk in areas requiring precise positioning, if the proper correctors (ASF) are not applied. *Therefore, it is recommended that mariners using Coordinate Converters check the manufacturer's operating manual to determine if and how corrections are to be applied to compensate for timing variations caused by the overland paths.*

There are two types of LORAN-C accuracy; absolute and repeatable. Absolute accuracy is a measure of the navigator's ability to determine latitude and longitude position from the LORAN-C time differences measured. Repeatable accuracy is a measure of the LORAN-C navigator's ability to return to a position where readings have been taken before.

The absolute accuracy of LORAN-C is 0.25 nautical miles, with 95% confidence within the published coverage area using standard LORAN-C charts and tables. Repeatable accuracy depends on many factors, so measurements must be taken to determine the repeatable accuracy in any given area. Coast Guard surveys have found repeatable accuracy to be between 30 and 170 meters in most ground wave coverage areas.

If the timing or pulse shape of a master-secondary pair deviates from specified tolerances, the first two pulses of secondary station's pulse train will blink on and off. The LORAN-C receiver sees this blinking signal and indicates a warning to the user. This warning will continue until the signals are once again in tolerance. A blinking signal is not exhibited during off-air periods, so a separate receiver alarm indicates any loss of signal. Never use a blinking secondary signal for navigation.

Although LORAN-C signal availability normally exceeds 99.9% and scheduled off-air periods are broadcast to the mariners, LORAN-C should not be relied upon as the only aid to navigation. A prudent navigator will use radar, a radio direction finder, a fathometer and any other aid to navigation, in addition to the LORAN-C receiver.

LORAN-C interference

Interference to LORAN-C may result from radio transmissions by public or private sources operating near the LORAN-C band of 90-110kHz. Anyone observing interference to LORAN-C, should promptly report it to the Coast Guard command listed below. Include, in such reports, information regarding the date, time, identifying characteristics, strength of the interfering signals and your vessel's position. These interference reports are very important and cooperation from users of LORAN-C will assist the Coast Guard in improving LORAN-C service.

Commanding Officer
U.S. Coast Guard
NAVCEN
7323 Telegraph Road
Alexandria, VA 22310-3998

Phone: (703) 313-5900
FAX: (703) 313-5920
Internet: http://www.navcen.uscg.mil

LORAN-C Charts and Publications

Navigational charts overprinted with LORAN-C lines of position are published by the National Ocean Service and the National Imagery and Mapping Agency and are sold through National Ocean Service/NOAA. A free catalog of available products can be obtained from NOS by phone: (301) 436-6990/(800) 638-8972; FAX: (301) 436-6829; or mail: National Ocean Service/NOAA, Distribution Division N/ACC3, Riverdale, MD 20737-1199.

GLOBAL POSITIONING SYSTEM (GPS)

The Global Positioning System (GPS) is a satellite-based Radionavigation System providing continuous worldwide coverage. GPS provides navigation, position, and timing information to air, marine, and land users. The GPS System has reached Full Operating Capability (FOC). FOC status signifies that the system meets specific requirements of performance. The GPS is operated and controlled by the Department of Defense (DOD) under U.S. Air Force management.

GPS consists of a constellation of 24 satellites, orbiting Earth in six planes of 4 satellites each, at an altitude of 10,900 nautical miles. The orbit period of each satellite is 12 hours. Mariners can expect 7-9 satellites available for use with unrestricted view of the sky. Fewer satellites will be available in areas where portions of the sky are blocked by mountains, buildings, or vegetation. At least three satellites are required for a two-dimensional solution. On May 1st, 2000, the United States stopped the intentional degradation of GPS Signals known as "Selective Availability" and users can now expect accuracy to within 20 meters. The GPS system does not provide integrity information and mariners should exercise extreme caution when using GPS in restricted waterways.

Although originally intended for military use only, Federal radionavigation policy has established that GPS will be available for civil use. Whenever possible, advance notice of when the GPS satellites should not be used will be provided by the DOD and made available by the U.S. Coast Guard. GPS status messages are available at http://www.navcen.uscg.mil.

DIFFERENTIAL GPS (DGPS)

The Coast Guard has implemented a system for marine navigation called Differential GPS (DGPS). As the newest electronic system of navigation, DGPS transmitters provide offshore coverage and an all-weather electronic aid to navigation capability. The Coast Guard DGPS transmitting sites provide coverage to the Great Lakes, and coastal areas of the continental United States as well as selected portions of Alaska, Hawaii, Puerto Rico and the inland river system.

The Coast Guard's DGPS system achieved Full Operational Capability (FOC) on March 15, 1999. The network now meets the high standards of accuracy, integrity, reliability, availability and coverage required for the Harbor Entrance and Approach phase of navigation. As of November 2000, 56 sites were providing differential correction.

The Department of Transportation (DOT) has recognized the benefit of an augmented GPS signal for other public safety applications. In DOT's effort to expand the maritime DGPS signals into a Nationwide DGPS (NDGPS) network, an additional 10 sites are currently transmitting DGPS corrections. Some of these sites provide wide coverage to navigable waters with the same performance criteria as the Maritime DGPS signal. Where available, these signals are also useable for maritime navigation. The NDGPS network will not be completed for several years.

DGPS is an augmentation to the GPS signals. Each site corrects for small variations in the signals from each satellite that is in view at that time. Satellite signals can vary due to small changes in the satellite's circuitry and orbit and from changes caused by local weather conditions. Satellite corrections are transmitted to users via radio signals in the medium frequency band (285-325 kHz) previously used for marine radiobeacons. DGPS corrections and integrity information are transmitted using Minimum Shift Keying (MSK) modulation; the modulation data rate is usually 100 or 200 bits per second (bps) but can also be 50 bps. The range of DGPS transmissions is from 40 to 300 nautical miles.

DGPS is the first federal radionavigation system capable of providing the 10-meter navigation service required for the harbor entrance and approach phase of maritime navigation. DGPS provides integrity messages for signals from the GPS satellites as well as DGPS position corrections and provides absolute position accuracy of 1-5 meters.

Each DGPS site has two reference stations (which calculate the differential corrections), two integrity monitors (which ensure the differential corrections are accurate), a transmitter and communications equipment to communicate status information to and receive control commands from the control station. Each transmitter and reference station has a unique ID number that permits users to determine which site/equipment is providing their differential corrections. As distance from the transmitting site increases, the small error in the differential corrections increases; best accuracy is achieved when using the DGPS site closest to the user.

Information regarding the location of DGPS transmitters is given on pages xxiv and xxv. Users can access additional information and DGPS system status, submit questions, and provide comments via the Navigation Information Service website or by calling the Coast Guard Navigation Center watchstander (see below).

NAVIGATION INFORMATION SERVICE (NIS)

The Coast Guard is the government interface for civil users of GPS and has established a Navigation Information Service (NIS) to meet the information needs of the civil user. The NIS is a Coast Guard facility that is manned 24 hours a day, 7 days a week, and is located at the Navigation Center (NAVCEN) in Alexandria, VA. It provides voice broadcasts, data broadcasts, facsimile, and on-line computer-based information services, which are all available 24 hours a day. The information provided includes present or future satellite outages and constellation changes, user instructions and tutorials, lists of service and receiver provider/users, and other GPS, DGPS, and LORAN related information.

NIS Internet Service (www)

Users with access to the World Wide Web (www) can access real time or archived GPS, NDGPS, DGPS and Loran-C information at www.navcen.uscg.mil as well as subscribe to a list server which enables users to receive GPS status messages and Notice to NAVSTAR User (NANU) messages via direct internet e-mail.

The NIS 24 hour voice recording is a 3-line telephone answering machine. Up to 3 callers can listen to the 90 second recording at the same time.

The NIS also disseminates GPS and DGPS safety advisory broadcast messages through USCG broadcast stations utilizing VHF-FM voice, HF-SSB voice, and NAVTEX broadcasts. The broadcasts provide the GPS and DGPS user in the marine environment with the current status of the navigation systems, as well as any planned/unplanned system outages that could affect GPS, DGPS, and LORAN navigational accuracy.

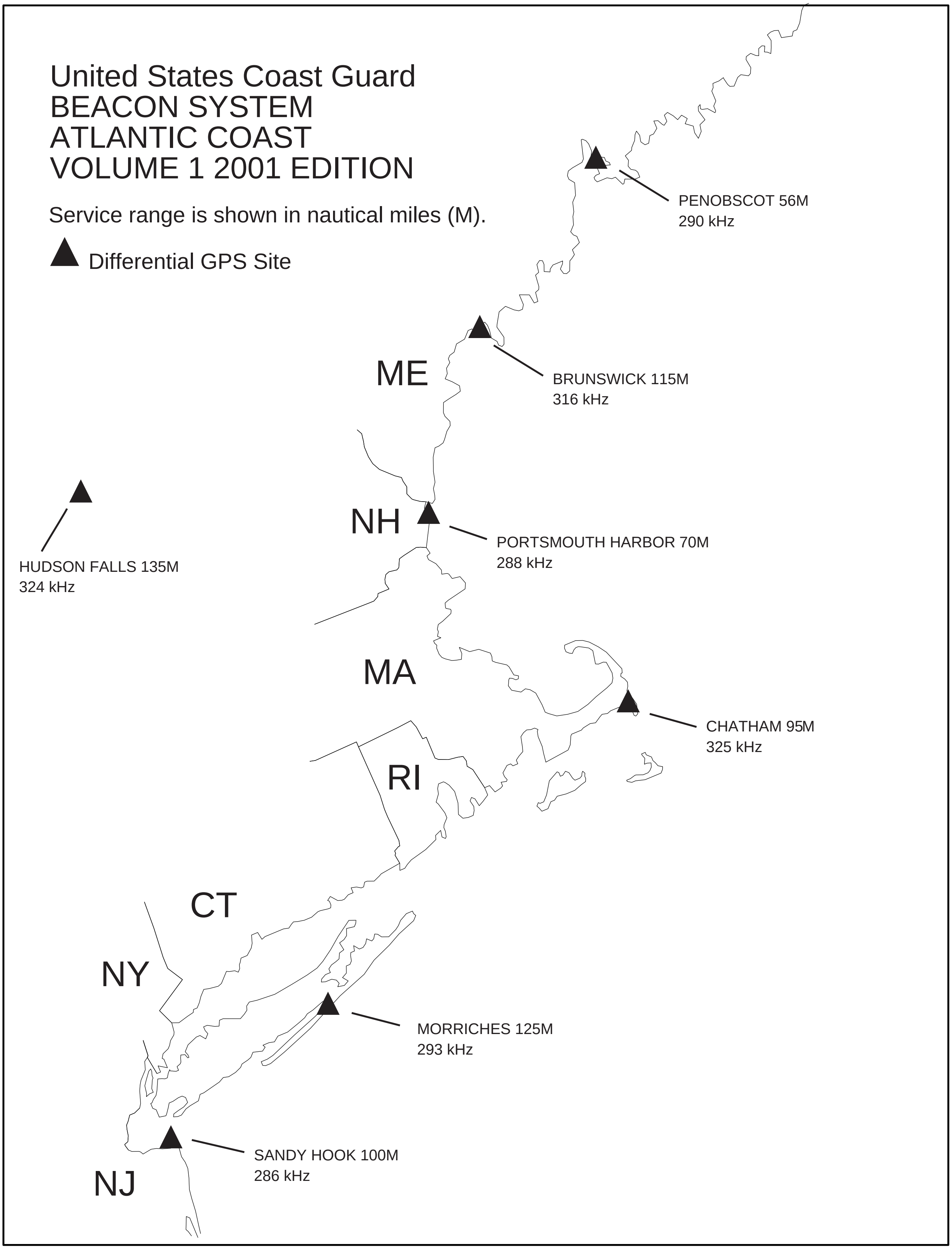
To comment on any of these services or ask questions about the service offered by NIS, contact the NIS at:

Commanding Officer
U.S. Coast Guard
NAVCEN (NIS)
7323 Telegraph Road
Alexandria, VA 22310-3998

Phone: (703) 313-5900
FAX: (703) 313-5920
Internet: http://www.navcen.uscg.mil

DIFFERENTIAL GPS SITES – ATLANTIC COAST

Broadcast Site	*Freq kHz*	*Trans Rate (BPS)*	*Lat. (N)* ° ' "	*Long. (W)* ° ' "	*Range (n.m.)*	*Radiobeacon ID #*
PENOBSCOT	290	200	44 27 06	68 46 18	56	779
BRUNSWICK	316	100	43 53 42	69 56 17	115	800
HUDSON FALLS	324	200	43 16 13	73 32 19	135	844
PORTSMOUTH	288	100	43 04 15	70 42 36	70	801
CHATHAM	325	200	41 40 17	69 57 02	95	802
MORICHES	293	100	40 47 04	72 44 07	125	803
SANDY HOOK	286	200	40 28 18	74 00 42	100	804


United States Coast Guard
BEACON SYSTEM
ATLANTIC COAST
VOLUME 1 2001 EDITION
Service range is shown in nautical miles (M).
Differential GPS Site
PENOBSCOT 56M
290 kHz
BRUNSWICK 115M
316 kHz
ME
NH
PORTSMOUTH HARBOR 70M
288 kHz
HUDSON FALLS 135M
324 kHz
MA
CHATHAM 95M
325 kHz
RI
CT
NY
MORRICHES 125M
293 kHz
SANDY HOOK 100M
286 kHz
NJ

GLOSSARY OF AIDS TO NAVIGATION TERMS

Adrift: Afloat and unattached in any way to the shore or seabed.

Aid to navigation: Any device external to a vessel or aircraft specifically intended to assist navigators in determining their position or safe course, or to warn them of dangers or obstructions to navigation.

Alternating light: A rhythmic light showing light of alternating colors.

Arc of visibility: The portion of the horizon over which a lighted aid to navigation is visible from seaward.

Articulated beacon: A beacon-like buoyant structure, tethered directly to the seabed and having no watch circle. Called articulated light or articulated daybeacon, as appropriate.

Assigned position: The latitude and longitude position for an aid to navigation.

Beacon: A lighted or unlighted fixed aid to navigation attached directly to the earth's surface. (Lights and daybeacons both constitute beacons.)

Bearing: The horizontal direction of a line of sight between two objects on the surface of the earth.

Bell: A sound signal producing bell tones by means of a hammer actuated by electricity on fixed aids and by sea motion on buoys.

Bifurcation: The point where a channel divides when proceeding from seaward. The place where two tributaries meet.

Broadcast Notice to Mariners: A radio broadcast designed to provide important marine information.

Buoy: A floating object of defined shape and color, which is anchored at a given position and serves as an aid to navigation.

Characteristic: The audible, visual, or electronic signal displayed by an aid to navigation to assist in the identification of an aid to navigation. Characteristic refers to lights, sound signals, RACONS, radiobeacons, and daybeacons.

Commissioned: The action of placing a previously discontinued aid to navigation back in operation.

Composite group-flashing light: A group-flashing light in which the flashes are combined in successive groups of different numbers of flashes.

Composite group-occulting light: A light similar to a group-occulting light except that the successive groups in a period have different numbers of eclipses.

Conventional direction of buoyage: The general direction taken by the mariner when approaching a harbor, river, estuary, or other waterway from seaward, or proceeding upstream or in the direction of the main stream of flood tide, or in the direction indicated in appropriate nautical documents (normally, following a clockwise direction around land masses).

Daybeacon: An unlighted fixed structure which is equipped with a dayboard for daytime identification.

Dayboard: The daytime identifier of an aid to navigation presenting one of several standard shapes (square, triangle, rectangle) and colors (red, green, white, orange, yellow, or black.)

Daymark: The daytime identifier of an aid to navigation. (See column 7 of the Light List.)

Diaphone: A sound signal which produces sound by means of a slotted piston moved back and forth by compressed air. A "two-tone" diaphone produces two sequential tones with the second tone of lower pitch.

Directional light: A light illuminating a sector or very narrow angle and intended to mark a direction to be followed.

Discontinued: To remove from operation (permanently or temporarily) a previously authorized aid to navigation.

Discrepancy: Failure of an aid to navigation to maintain its position or function as prescribed in the Light List.

Discrepancy buoy: An easily transportable buoy used to temporarily replace an aid to navigation not watching properly.

Dolphin: A minor aid to navigation structure consisting of a number of piles driven into the seabed or riverbed in a circular pattern and drawn together with wire rope.

Eclipse: An interval of darkness between appearances of a light.

Emergency light: A light of reduced intensity displayed by certain aids to navigation when the main light is extinguished.

Establish: To place an authorized aid to navigation in operation for the first time.

Extinguished: A lighted aid to navigation which fails to show a light characteristic.

Fixed light: A light showing continuously and steadily, as opposed to a rhythmic light. (Do not confuse with "fixed" as used to differentiate from "floating.")

Flash: A relatively brief appearance of a light, in comparison with the longest interval of darkness in the same character.

Flash tube: An electronically controlled high-intensity discharge lamp with a very brief flash duration.

Flashing light: A light in which the total duration of light in each period is clearly shorter than the total duration of darkness and in which the flashes of light are all of equal duration. (Commonly used for a single-flashing light which exhibits only single flashes which are repeated at regular intervals.)

Floating aid to navigation: A buoy, secured in its assigned position by a mooring.

Fog detector: An electronic device used to automatically determine conditions of visibility which warrant the activation of a sound signal or additional light signals.

Fog signal: See sound signal.

Geographic range: The greatest distance the curvature of the earth permits an object of a given height to be seen from a particular height of eye without regard to luminous intensity or visibility conditions.

Global Positioning System (GPS): A satellite-based radionavigation system providing continuous worldwide coverage. It provides navigation, position, and timing information to air, marine, and land users.

Gong: A wave actuated sound signal on buoys which uses a group of saucer-shaped bells to produce different tones.

Group-flashing light: A flashing light in which a group of flashes, specified in number, is regularly repeated.

Group-occulting light: An occulting light in which a group of eclipses, specified in number, is regularly repeated.

Horn: A sound signal which uses electricity or compressed air to vibrate a disc diaphragm.

Inoperative: Sound signal or electronic aid to navigation out of service due to a malfunction.

Interrupted quick light: A quick flashing light in which the rapid alternations are interrupted at regular intervals by eclipses of long duration.

Isolated danger mark: A mark erected on, or moored above or very near, an isolated danger which has navigable water all around it.

Isophase light: A rhythmic light in which all durations of light and darkness are equal. (Formerly called equal interval light.)

Junction: The point where a channel d-vides when proceeding seaward. The place where a distributary departs from the main stream.

Lateral system: A system of aids to navigation in which characteristics of buoys and beacons indicate the sides of the channel or route relative to a conventional direction of buoyage (usually upstream).

Light: The signal emitted by a lighted aid to navigation. The illuminating apparatus used to emit the light signal. A lighted aid to navigation on a fixed structure.

Light sector: The arc over which a light is visible, described in degrees true, as observed from seaward towards the light. May be used to define distinctive color difference of two adjoining sectors, or an obscured sector.

Lighted ice buoy (LIB): A lighted buoy without a sound signal, and designed to withstand the forces of shifting and flowing ice. Used to replace a conventional buoy when that aid to navigation is endangered by ice.

Lighthouse: A lighted beacon of major importance.

Local Notice to Mariners: A written document issued by each U.S. Coast Guard district to disseminate important information affecting aids to navigation, dredging, marine construction, special marine activities, and bridge construction on the waterways within that district.

LORAN: An acronym for LOng RAnge Navigation, is an electronic aid to navigation consisting of shore-based radio transmitters. The LORAN system enables users equipped with a LORAN receiver to determine their position quickly and accurately, day or night, in practically any weather.

Luminous range: The greatest distance a light can be expected to be seen given its nominal range and the prevailing meteorological visibility (see page xxxvii).

Mark: A visual aid to navigation. Often called navigation mark, includes floating marks (buoys) and fixed marks (beacons).

GLOSSARY OF AIDS TO NAVIGATION TERMS

Meteorological visibility: The greatest distance at which a black object of suitable dimension could be seen and recognized against the horizon sky by day, or, in the case of night observations, could be seen and recognized if the general illumination were raised to the normal daylight level.

Mileage number: A number assigned to aids to navigation which gives the distance in sailing miles along the river from a reference point to the aid to navigation. The number is used principally in the Mississippi River System.

Nominal range: The maximum distance a light can be seen in clear weather (meteorological visibility of 10 nautical miles). Listed for all lighted aids to navigation except range lights, directional lights, and private aids to navigation.

Occulting light: A light in which the total duration of light in each period is clearly longer than the total duration of darkness and in which the intervals of darkness (occultations) are all of equal duration. (Commonly used for single-occulting light which exhibits only single occultations which are repeated at regular intervals.)

Ocean Data Acquisition System (ODAS): Certain very large buoys in deep water for the collection of oceanographic and meteorological information. All ODAS buoys are yellow in color and display a yellow light.

Off shore tower: Monitored light stations built on exposed marine sites to replace lightships.

Off station: A floating aid to navigation not on its assigned position.

Passing light: A low intensity light which may be mounted on the structure of another light to enable the mariner to keep the latter light in sight when passing out of its beam during transit.

Period: The interval of time between the commencement of two identical successive cycles of the characteristic of the light or sound signal.

Pile: A long, heavy timber driven into the seabed or riverbed to serve as a support for an aid to navigation.

Port hand mark: A buoy or beacon which is left to the port hand when proceeding in the "conventional direction of buoyage".

Preferred channel mark: A lateral mark indicating a channel junction or bifurcation, or a wreck or other obstruction which, after consulting a chart, may be passed on either side.

Primary aid to navigation: An aid to navigation established for the purpose of making landfalls and coastwise passages from headland to headland.

Quick light: A light exhibiting very rapid regular alternations of light and darkness, normally 60 flashes per minute. (Formerly called quick flashing light).

RACON: A radar beacon which produces a coded response, or radar paint, when triggered by a radar signal.

Radar: An electronic system designed to transmit radio signals and receive reflected images of those signals from a "target" in order to determine the bearing and distance to the "target".

Radar reflector: A special fixture fitted to or incorporated into the design of certain aids to navigation to enhance their ability to reflect radar energy. In general, these fixtures will materially improve the aid to navigation for use by vessels with radar.

Radiobeacon: Electronic apparatus which transmits a radio signal for use in providing a mariner a line of position.

Range: A line formed by the extension of a line connecting two charted points.

Range lights: Two lights associated to form a range which often, but not necessarily, indicates a channel centerline. The front range light is the lower of the two, and nearer to the mariner using the range. The rear range light is higher and further from the mariner.

Rebuilt: A fixed aid to navigation, previously destroyed, which has been restored as an aid to navigation.

Regulatory marks: A white and orange aid to navigation with no lateral significance. Used to indicate a special meaning to the mariner, such as danger, restricted operations, or exclusion area.

Relighted: An extinguished aid to navigation returned to its advertised light characteristics.

Replaced: An aid to navigation previously off station, adrift, or missing, restored by another aid to navigation of the same type and characteristics.

Replaced (temporarily): An aid to navigation previously off station, adrift, or missing, restored by another aid to navigation of different type and/or characteristic.

Reset: A floating aid to navigation previously off station, adrift, or missing, returned to its assigned position (station).

Rhythmic light: A light showing intermittently with a regular periodicity.

Sector: See light sector.

Setting a buoy: The act of placing a buoy on assigned position in the water.

Siren: A sound signal which uses electricity or compressed air to actuate either a disc or a cup-shaped rotor.

Skeleton tower: A tower, usually of steel, constructed of heavy corner members and various horizontal and diagonal bracing members.

Sound signal: A device which transmits sound, intended to provide information to mariners during periods of restricted visibility and foul weather.

Starboard hand mark: A buoy or beacon which is left to the starboard hand when proceeding in the conventional direction of buoyage.

Topmark: One or more relatively small objects of characteristic shape and color placed on an aid to identify its purpose.

Traffic Separation Scheme: Shipping corridors marked by buoys which separate incoming from outgoing vessels. Improperly called SEA LANES.

Watching properly: An aid to navigation on its assigned position exhibiting the advertised characteristics in all respects.

Whistle: A wave actuated sound signal on buoys which produces sound by emitting compressed air through a circumferential slot into a cylindrical bell chamber.

Winter marker: An unlighted buoy without sound signal, used to replace a conventional buoy when that aid to navigation is endangered by ice.

Winter light: A light which is maintained during those winter months when the regular light is extinguished. It is of lower candlepower than the regular light but usually of the same characteristic.

Withdrawn: The discontinuance of a floating aid to navigation during severe ice conditions or for the winter season.

ABBREVIATIONS USED IN BROADCAST NOTICES TO MARINERS

Light characteristics

Fixed	F
Occulting	OC
Group-Occulting	OC(2)
Composite Group-Occulting	OC(2+1)
Isophase	ISO
Single-Flashing	FL
Group-Flashing	FL(3)
Composite Group-Flashing	FL(2+1)
Continuous Quick-Flashing	Q
Interrupted Quick-Flashing	IQ
Morse Code	MO(A)
Fixed and Flashing	FFL
Alternating	AL
Characteristic	CHAR

Colors

Black	B
Blue	BU
Green	G
Orange	OR
Red	R
White	W
Yellow	Y

Aids to Navigation

Aeronautical Radiobeacon	AERO RBN
Articulated Daybeacon	ART DBN
Articulated Light	ART LT
Destroyed	DESTR
Discontinued	DISCONTD
Established	ESTAB
Exposed Location Buoy	ELB
Fog signal station	FOG SIG
Large Navigation Buoy	LNB
Light	LT
Light List Number	LLNR
Lighted Bell Buoy	LBB
Lighted Buoy	LB
Lighted Gong Buoy	LGB
Lighted Horn Buoy	LHB
Lighted Whistle Buoy	LWB
Ocean Data Acquisition System	ODAS
Privately Maintained	PRIV MAINTD
Radar responder beacon	RACON
Radar Reflector	RA REF
Radiobeacon	RBN
Temporarily replaced by unlighted buoy	TRUB
Temporarily replaced by lighted buoy	TRLB
Whistle	WHIS

Organizations

Coast Guard	CG
Commander, Coast Guard District (#)	CCGD(#)
U S Army Corps of Engineers	COE
National Imagery and Mapping Agency	NIMA
National Ocean Service	NOS
National Weather Service	NWS

Vessels

Aircraft	A/C
Fishing Vessel	F/V
Liquefied Natural Gas Carrier	LNG
Motor Vessel	M/V[1]
Pleasure Craft	P/C
Research Vessel	R/V
Sailing Vessel	S/V

Compass Directions

East	E
North	N
Northeast	NE
Northwest	NW
South	S
Southeast	SE
Southwest	SW
West	W

Months

January	JAN
February	FEB
March	MAR
April	APR
May	MAY
June	JUN
July	JUL

[1] M/V includes: Steam Ship, Container Vessel, Cargo Vessel, etc.

ABBREVIATIONS USED IN BROADCAST NOTICES TO MARINERS

August	AUG
September	SEP
October	OCT
November	NOV
December	DEC

Days of the Week

Monday	MON
Tuesday	TUE
Wednesday	WED
Thursday	THU
Friday	FRI
Saturday	SAT
Sunday	SUN

Various

Anchorage	ANCH
Anchorage prohibited	ANCH PROHIB
Approximate	APPROX
Atlantic	ATLC
Authorized	AUTH
Average	AVG
Bearing	BRG
Breakwater	BKW
Broadcast Notice to Mariners	BNM
Channel	CHAN
Code of Federal Regulations	CFR
Continue	CONT
Degrees (temperature; geo pos)	DEG
Diameter	DIA
Edition	ED
Effect/Effective	EFF
Entrance	ENTR
Explosive Anchorage	EXPLOS ANCH
Fathom(s)	FM(S)
Foot/Feet	FT
Harbor	HBR
Height	HT
Hertz	HZ
Horizontal clearance	HOR CL
Hour	HR
International Regulations for Preventing Collisions at Sea, 1972	COLREGS
Kilohertz	KHZ
Kilometer	KM
Knot(s)	KT(S)
Latitude	LAT
Local Notice to Mariners	LNM
Longitude	LONG
Maintained	MAINTD
Maximum	MAX
Megahertz	MHZ
Millibar	MB
Millimeter	MM
Minute (time; geo pos)	MIN
Moderate	MDT
Mountain, Mount	MT
Nautical Mile(s)	NM
Notice to Mariners	NTM
Obstruction	OBSTR
Occasion/Occasionally	OCCASION
Operating Area	OPAREA
Pacific	PAC
Point(s)	PT(S)
Position	PSN
Position Approximate	PA
Pressure	PRES
Private, Privately	PRIV
Prohibited	PROHIB
Publication	PUB
Range	RGE
Reported	REP
Restricted	RESTR
Rock	RK
Saint	ST
Second (time; geo pos)	SEC
Signal station	SIG STA
Station	STA
Statute Mile(s)	SM
Storm signal station	S SIG STA
Temporary	TEMP
Through	THRU
Thunderstorm	TSTM
True	T
Uncovers; Dries	UNCOV
Universal Coordinate Time	UTC
Urgent Marine Information Broadcast	UMIB
Velocity	VLCTY
Vertical clearance	VERT CL
Visibility	VSBY
Warning	WRNG
Weather	WEA

ABBREVIATIONS USED IN BROADCAST NOTICES TO MARINERS

Wreck	WK
Yard(s)	YD

Countries and States

Alabama	AL
Alaska	AK
American Samoa	AS
Arizona	AZ
Arkansas	AR
California	CA
Canada	CN
Colorado	CO
Connecticut	CT
Delaware	DE
District of Columbia	DC
Federated States of Micronesia	FSM
Florida	FL
Georgia	GA
Guam	GU
Hawaii	HI
Idaho	ID
Illinois	IL
Indiana	IN
Iowa	IA
Kansas	KS
Kentucky	KY
Louisiana	LA
Maine	ME
Maryland	MD
Massachusetts	MA
Mexico	MX
Michigan	MI
Minnesota	MN
Mississippi	MS
Missouri	MO
Montana	MT
Nebraska	NE
New Hampshire	NH
Nevada	NV
New Jersey	NJ
New Mexico	NM
New York	NY
North Carolina	NC
North Dakota	ND
Northern Marianas	CM
Ohio	OH
Oklahoma	OK
Oregon	OR
Pennsylvania	PA
Puerto Rico	PR
Rhode Island	RI
South Carolina	SC
South Dakota	SD
Tennessee	TN
Texas	TX
United States	US
Utah	UT
Vermont	VT
Virgin Islands	VI
Virginia	VA
Washington	WA
West Virginia	WV
Wisconsin	WI
Wyoming	WY

GEOGRAPHIC RANGE TABLE

The following table gives the approximate geographic range of visibility for an object which may be seen by an observer at sea level. It is necessary to add to the distance for the height of any object the distance corresponding to the height of the observer's eye above sea level.

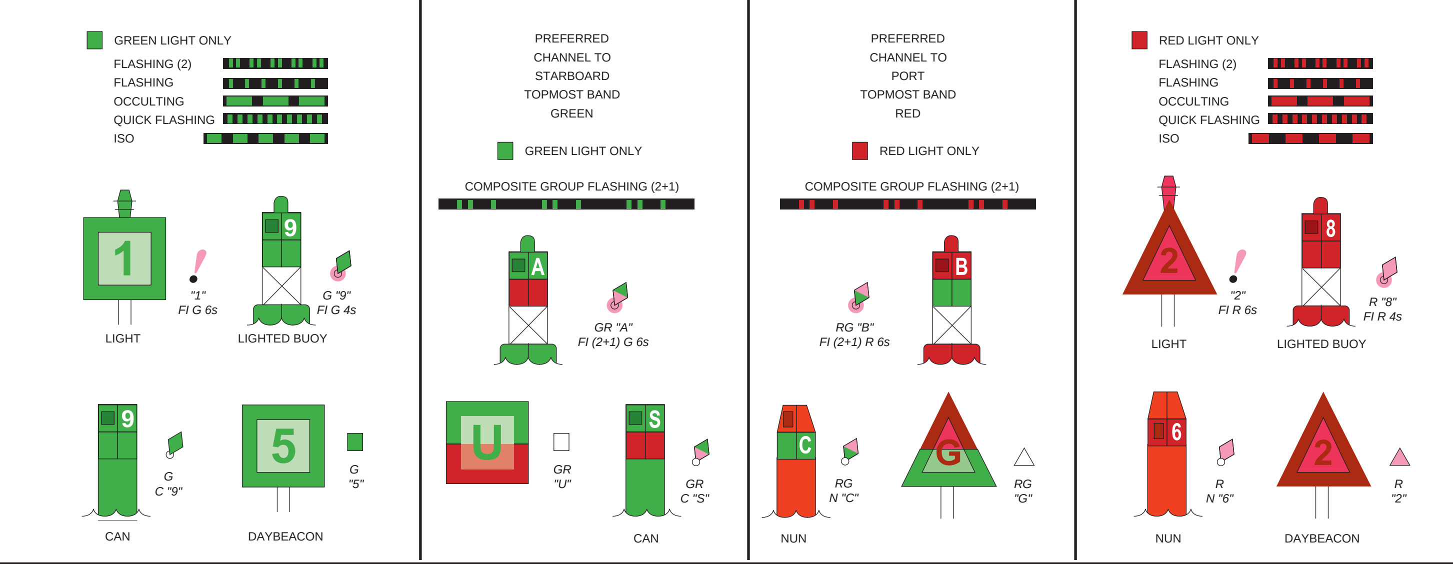
Height Feet/Meters	Distance Nautical Miles (NM)	Height Feet/Meters	Distance Nautical Miles (NM)	Height Feet/Meters	Distance Nautical Miles (NM)
5/1.5	2.6	70/21.3	9.8	250/76.2	18.5
10/3.1	3.7	75/22.9	10.1	300/91.4	20.3
15/4.6	4.5	80/24.4	10.5	350/106.7	21.9
20/6.1	5.2	85/25.9	10.8	400/121.9	23.4
25/7.6	5.9	90/27.4	11.1	450/137.2	24.8
30/9.1	6.4	95/29.0	11.4	500/152.4	26.2
35/10.7	6.9	100/30.5	11.7	550/167.6	27.4
40/12.2	7.4	110/33.5	12.3	600/182.9	28.7
45/13.7	7.8	120/36.6	12.8	650/198.1	29.8
50/15.2	8.3	130/39.6	13.3	700/213.4	31.0
55/16.8	8.7	140/42.7	13.8	800/243.8	33.1
60/18.3	9.1	150/45.7	14.3	900/274.3	35.1
65/19.8	9.4	200/61.0	16.5	1000/304.8	37.0

Example: Determine the geographic visibility of an object, with a height above water of 65 feet, for an observer with a height of eye of 35 feet. Enter above table;

Height of object ....65 feet = 9.4 NM
Height of observer......................................35 feet = 6.9 NM
Computed geographic visibility 16.3 NM

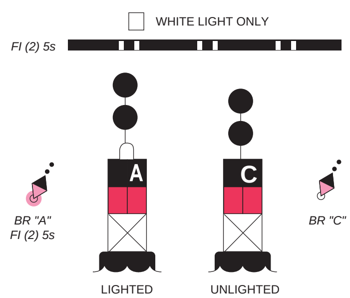
U.S. AIDS TO NAVIGATION SYSTEM
on navigable waters except Western Rivers

LATERAL SYSTEM AS SEEN ENTERING FROM SEAWARD

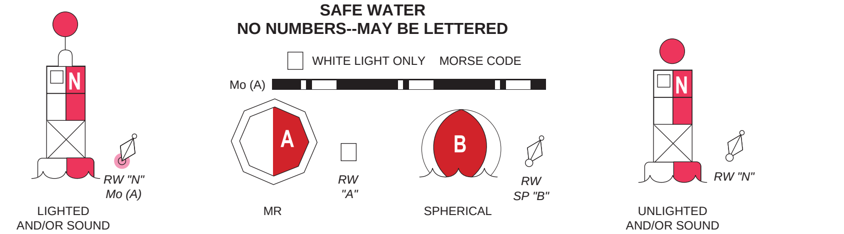


AIDS TO NAVIGATION HAVING NO LATERAL SIGNIFICANCE

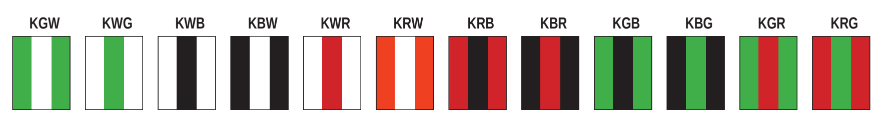
ISOLATED DANGER
NO NUMBERS--MAY BE LETTERED



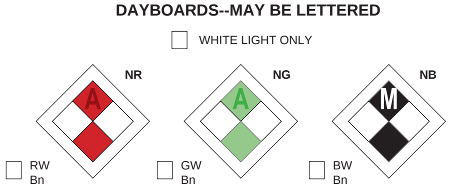
SAFE WATER
NO NUMBERS--MAY BE LETTERED



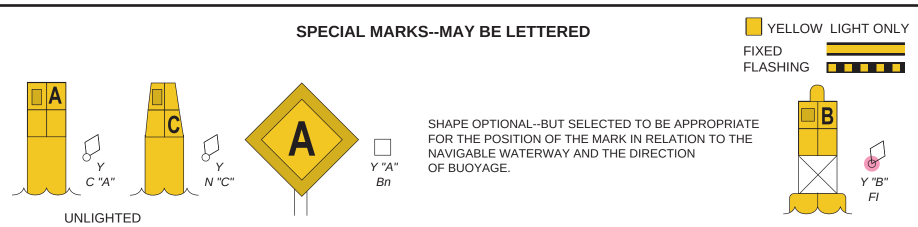
RANGE DAYBOARDS--MAY BE LETTERED



DAYBOARDS--MAY BE LETTERED



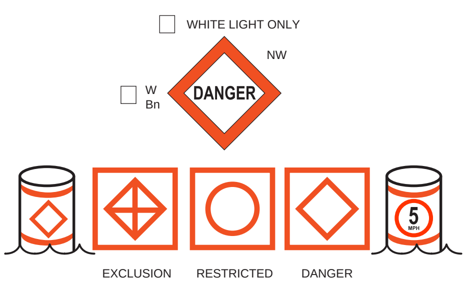
SPECIAL MARKS--MAY BE LETTERED



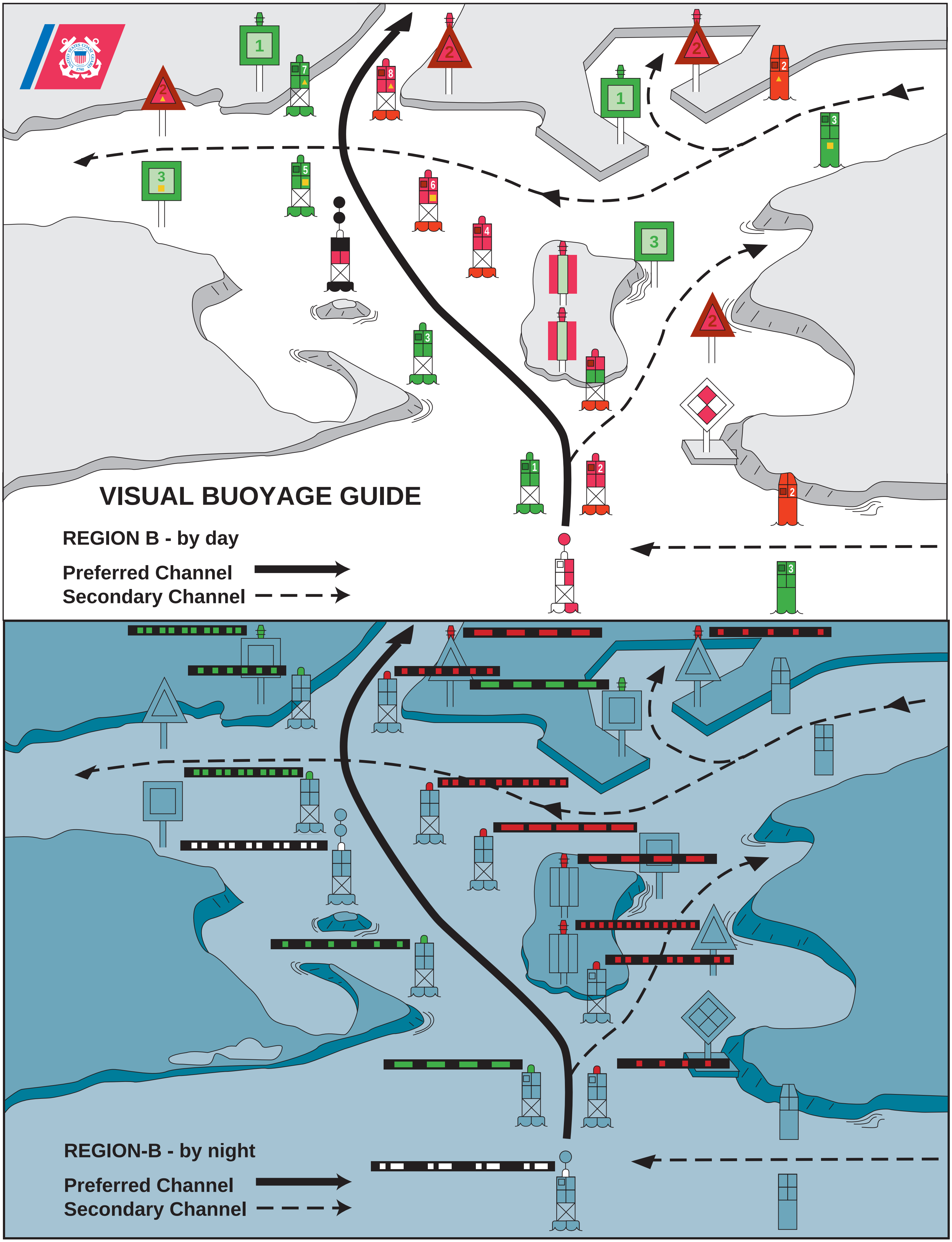
TYPICAL INFORMATION AND REGULATORY MARKS

INFORMATION AND REGULATORY MARKERS

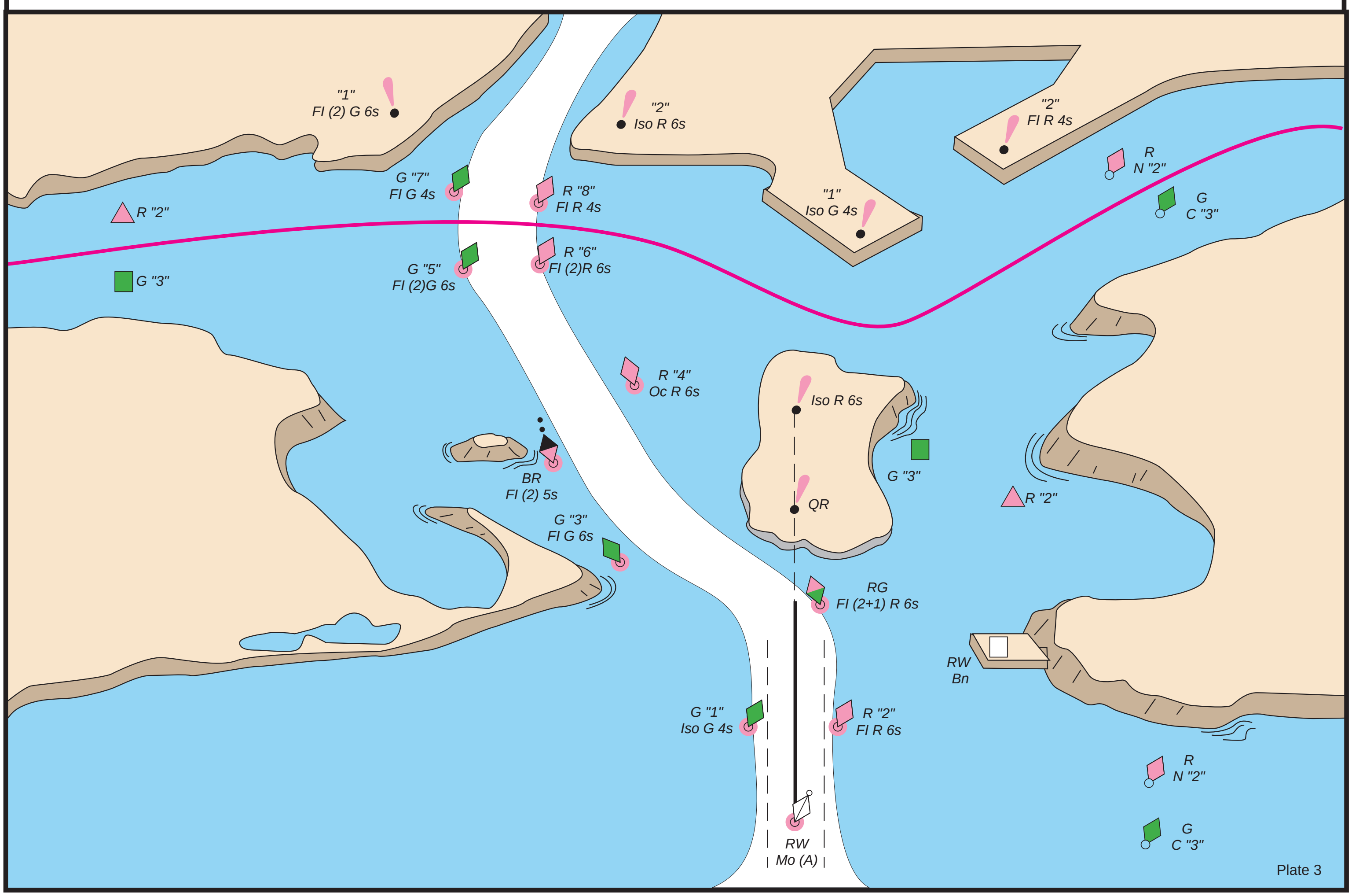
WHEN LIGHTED, INFORMATION AND REGULATORY MARKS MAY DISPLAY ANY LIGHT RHYTHM EXCEPT QUICK FLASHING AND FLASHING (2)

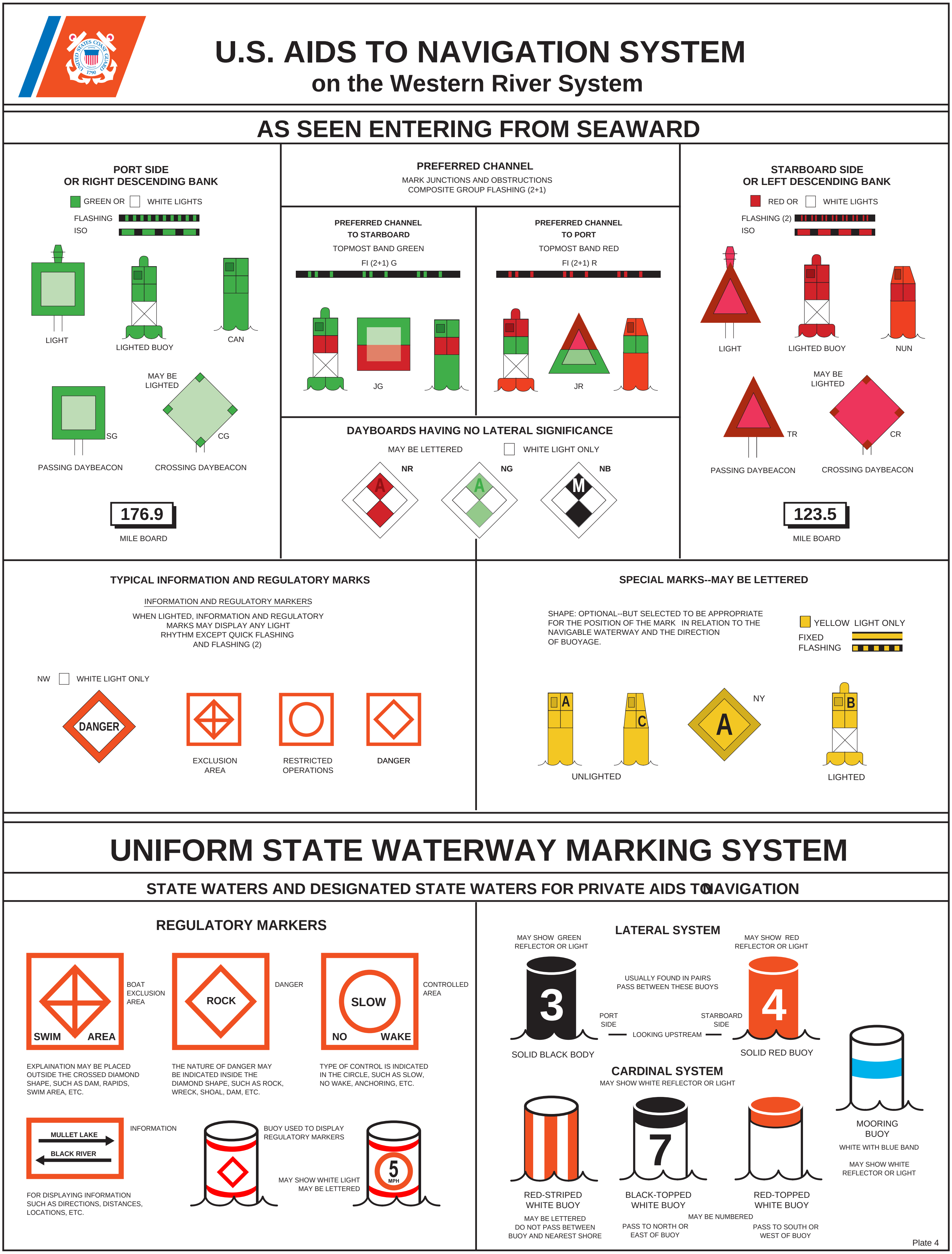


Aids to navigation marking the Intercoastal Waterway (ICW) display unique yellow symbols to distinguish them from aids marking other waters. Yellow triangles indicate aids should be passed by keeping them on the starboard (right) hand of the vessel. Yellow squares indicate aids should be passed by keeping them on the port (left) hand of the vessel. A yellow horizontal band provides no lateral information, but simply identifies aids as marking the ICW.


VISUAL BUOYAGE GUIDE
REGION B - by day
Preferred Channel
Secondary Channel
REGION-B - by night
Preferred Channel
Secondary Channel

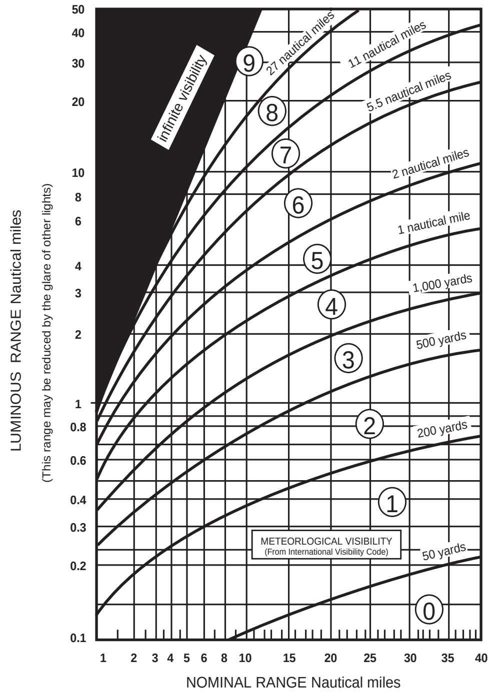
FICTITIOUS NAUTICAL CHART




U.S. AIDS TO NAVIGATION SYSTEM
on the Western River System
AS SEEN ENTERING FROM SEAWARD
PORT SIDE
OR RIGHT DESCENDING BANK
GREEN OR WHITE LIGHTS
FLASHING
ISO
LIGHT
LIGHTED BUOY
CAN
MAY BE LIGHTED
SG
CG
PASSING DAYBEACON
CROSSING DAYBEACON
176.9
MILE BOARD
PREFERRED CHANNEL
MARK JUNCTIONS AND OBSTRUCTIONS
COMPOSITE GROUP FLASHING (2+1)
PREFERRED CHANNEL
TO STARBOARD
TOPMOST BAND GREEN
Fl (2+1) G
JG
PREFERRED CHANNEL
TO PORT
TOPMOST BAND RED
Fl (2+1) R
JR
DAYBOARDS HAVING NO LATERAL SIGNIFICANCE
MAY BE LETTERED
WHITE LIGHT ONLY
NR
NG
NB
A
A
M
STARBOARD SIDE
OR LEFT DESCENDING BANK
RED OR WHITE LIGHTS
FLASHING (2)
ISO
LIGHT
LIGHTED BUOY
NUN
MAY BE LIGHTED
TR
CR
PASSING DAYBEACON
CROSSING DAYBEACON
123.5
MILE BOARD
TYPICAL INFORMATION AND REGULATORY MARKS
INFORMATION AND REGULATORY MARKERS
WHEN LIGHTED, INFORMATION AND REGULATORY
MARKS MAY DISPLAY ANY LIGHT
RHYTHM EXCEPT QUICK FLASHING
AND FLASHING (2)
NW
WHITE LIGHT ONLY
DANGER
EXCLUSION AREA
RESTRICTED OPERATIONS
DANGER
SPECIAL MARKS--MAY BE LETTERED
SHAPE: OPTIONAL--BUT SELECTED TO BE APPROPRIATE
FOR THE POSITION OF THE MARK IN RELATION TO THE
NAVIGABLE WATERWAY AND THE DIRECTION
OF BUOYAGE.
YELLOW LIGHT ONLY
FIXED
FLASHING
A
C
A
NY
B
UNLIGHTED
LIGHTED
UNIFORM STATE WATERWAY MARKING SYSTEM
STATE WATERS AND DESIGNATED STATE WATERS FOR PRIVATE AIDS TO NAVIGATION
REGULATORY MARKERS
SWIM AREA
BOAT EXCLUSION AREA
ROCK
DANGER
SLOW
NO WAKE
CONTROLLED AREA
EXPLAINATION MAY BE PLACED
OUTSIDE THE CROSSED DIAMOND
SHAPE, SUCH AS DAM, RAPIDS,
SWIM AREA, ETC.
THE NATURE OF DANGER MAY
BE INDICATED INSIDE THE
DIAMOND SHAPE, SUCH AS ROCK,
WRECK, SHOAL, DAM, ETC.
TYPE OF CONTROL IS INDICATED
IN THE CIRCLE, SUCH AS SLOW,
NO WAKE, ANCHORING, ETC.
MULLET LAKE
BLACK RIVER
INFORMATION
FOR DISPLAYING INFORMATION
SUCH AS DIRECTIONS, DISTANCES,
LOCATIONS, ETC.
BUOY USED TO DISPLAY
REGULATORY MARKERS
MAY SHOW WHITE LIGHT
MAY BE LETTERED
5
MPH
LATERAL SYSTEM
MAY SHOW GREEN
REFLECTOR OR LIGHT
MAY SHOW RED
REFLECTOR OR LIGHT
USUALLY FOUND IN PAIRS
PASS BETWEEN THESE BUOYS
3
4
PORT SIDE
STARBOARD SIDE
LOOKING UPSTREAM
SOLID BLACK BODY
SOLID RED BUOY
CARDINAL SYSTEM
MAY SHOW WHITE REFLECTOR OR LIGHT
7
RED-STRIPED
WHITE BUOY
MAY BE LETTERED
DO NOT PASS BETWEEN
BUOY AND NEAREST SHORE
BLACK-TOPPED
WHITE BUOY
PASS TO NORTH OR
EAST OF BUOY
MAY BE NUMBERED
RED-TOPPED
WHITE BUOY
PASS TO SOUTH OR
WEST OF BUOY
MOORING
BUOY
WHITE WITH BLUE BAND
MAY SHOW WHITE
REFLECTOR OR LIGHT
Plate 4

Luminous Range Diagram

The nominal range given in this Light List is the maximum distance a given light can be seen when the meteorological visibility is 10 nautical miles. If the existing visibility is less than 10 NM, the range at which the light can be seen will be reduced below its nominal range. And, if the visibility is greater than 10 NM, the light can be seen at greater distances. The distance at which a light may be expected to be seen in the prevailing visibility is called its luminous range.



METEOROLOGICAL VISIBILITY (From International Visibility Code)		
Code	Metric	Nautical (approximate)
0	less than 50 meters	less than 50 yards
1	50-200 meters	50-200 yards
2	200-500 meters	200-500 yards
3	500-1,000 meters	500-1,000 yards
4	1-2 kilometers	1,000-2,000 yards
5	2-4 kilometers	1-2 nautical miles
6	4-10 kilometers	2-5.5 nautical miles
7	10-20 kilometers	5.5-11 nautical miles
8	20-50 kilometers	11-27 nautical miles
9	greater than 50 km	greater than 27 nm

This diagram enables the mariner to determine the approximate luminous range of a light when the nominal range and the prevailing meteorological visibility are known. The diagram is entered from the bottom border using the nominal range listed in column 6 of this book. The intersection of the nominal range with the appropriate visibility curve (or, more often, a point between two curves) yields, by moving horizontally to the left border, the luminous range.

CAUTION
When using this diagram it must be remembered that:

1. The ranges obtained are approximate.
2. The transparency of the atmosphere may vary between the observer and the light.
3. Glare from background lighting will considerably reduce the range at which lights are sighted.
4. The rolling motion of the mariner and/or of a lighted aid to navigation may reduce the distance at which lights can be detected and identified.

CONVERSION TABLES

FEET TO METERS

(1 foot = 0.3048 meters) – (1 meter = 3.2808 feet)

Feet	Meters	Feet	Meters	Feet	Meters	Feet	Meters	Feet	Meters	Feet	Meters
0	0	35	10.7	70	21.3	105	32.0	140	42.7	175	53.3
1	0.3	36	11.0	71	21.6	106	32.3	141	43.0	176	53.6
2	0.6	37	11.3	72	22.0	107	32.6	142	43.3	177	54.0
3	0.9	38	11.6	73	22.3	108	32.9	143	43.6	178	54.3
4	1.2	39	11.9	74	22.6	109	33.2	144	43.9	179	54.6
5	1.5	40	12.2	75	22.9	110	33.5	145	44.2	180	54.9
6	1.8	41	12.5	76	23.2	111	33.8	146	44.5	181	55.2
7	2.1	42	12.8	77	23.5	112	34.1	147	44.8	182	55.5
8	2.4	43	13.1	78	23.8	113	34.4	148	45.1	183	55.8
9	2.7	44	13.4	79	24.1	114	34.8	149	45.4	184	56.1
10	3.1	45	13.7	80	24.4	115	35.1	150	45.7	185	56.4
11	3.4	46	14.0	81	24.7	116	35.4	151	46.0	186	56.7
12	3.7	47	14.3	82	25.0	117	35.7	152	46.3	187	57.0
13	4.0	48	14.6	83	25.3	118	36.0	153	46.6	188	57.3
14	4.3	49	14.9	84	25.6	119	36.3	154	46.9	189	57.6
15	4.6	50	15.2	85	25.9	120	36.6	155	47.2	190	57.9
16	4.9	51	15.5	86	26.2	121	36.9	156	47.6	191	58.2
17	5.2	52	15.9	87	26.5	122	37.2	157	47.9	192	58.5
18	5.5	53	16.2	88	26.8	123	37.5	158	48.2	193	58.8
19	5.8	54	16.5	89	27.1	124	37.8	159	48.5	194	59.1
20	6.1	55	16.8	90	27.4	125	38.1	160	48.8	195	59.4
21	6.4	56	17.1	91	27.7	126	38.4	161	49.1	196	59.7
22	6.7	57	17.4	92	28.0	127	38.7	162	49.4	197	60.1
23	7.0	58	17.7	93	28.4	128	39.0	163	49.7	198	60.4
24	7.3	59	18.0	94	28.7	129	39.3	164	50.0	199	60.7
25	7.6	60	18.3	95	29.0	130	39.6	165	50.3	200	61.0
26	7.9	61	18.6	96	29.3	131	39.9	166	50.6	300	91.4
27	8.2	62	18.9	97	29.6	132	40.2	167	50.9	400	121.9
28	8.5	63	19.2	98	29.9	133	40.5	168	51.2	500	152.4
29	8.8	64	19.5	99	30.2	134	40.8	169	51.5	600	182.9
30	9.1	65	19.8	100	30.5	135	41.2	170	51.8	700	213.4
31	9.5	66	20.1	101	30.8	136	41.5	171	52.1	800	243.8
32	9.8	67	20.4	102	31.1	137	41.8	172	52.4	900	274.3
33	10.1	68	20.7	103	31.4	138	42.1	173	52.7	1000	304.8
34	10.4	69	21.0	104	31.7	139	42.4	174	53.0	2000	609.6

STATUTE MILES (St M) TO NAUTICAL MILES (NM)

(1 St M = 5,280 feet) – (1 NM = 6,076.1 feet)

St M	NM	St M	NM	St M	NM	St M	NM	St M	NM	St M	NM
1	0.9	21	18.3	41	35.6	61	53.0	81	70.4	101	87.8
2	1.7	22	19.1	42	36.5	62	53.9	82	71.3	102	88.6
3	2.6	23	20.0	43	37.4	63	54.8	83	72.1	103	89.5
4	3.5	24	20.9	44	38.2	64	55.6	84	73.0	104	90.3
5	4.4	25	21.7	45	39.1	65	56.5	85	73.9	105	91.2
6	5.2	26	22.6	46	40.0	66	57.4	86	74.7	106	92.1
7	6.1	27	23.5	47	40.8	67	58.2	87	75.6	107	93.0
8	7.0	28	24.3	48	41.7	68	59.1	88	76.4	108	93.8
9	7.8	29	25.2	49	42.6	69	60.0	89	77.3	109	94.7
10	8.7	30	26.1	50	43.5	70	60.8	90	78.2	110	95.6
11	9.6	31	26.9	51	44.3	71	61.7	91	79.1	111	96.5
12	10.4	32	27.8	52	45.2	72	62.6	92	80.0	112	97.3
13	11.3	33	28.7	53	46.1	73	63.4	93	80.9	113	98.2
14	12.2	34	29.6	54	46.9	74	64.3	94	81.7	114	99.1
15	13.0	35	30.4	55	47.8	75	65.2	95	82.6	115	99.9
16	13.9	36	31.3	56	48.7	76	66.0	96	83.4	116	100.8
17	14.8	37	32.2	57	49.5	77	66.9	97	84.3	117	101.7
18	15.6	38	33.0	58	50.4	78	67.8	98	85.2	118	102.5
19	16.5	39	33.9	59	51.3	79	68.7	99	86.0	119	103.4
20	17.4	40	34.8	60	52.1	80	69.5	100	86.9	120	104.3

Appendix D
List of Lights for Non-US Waters

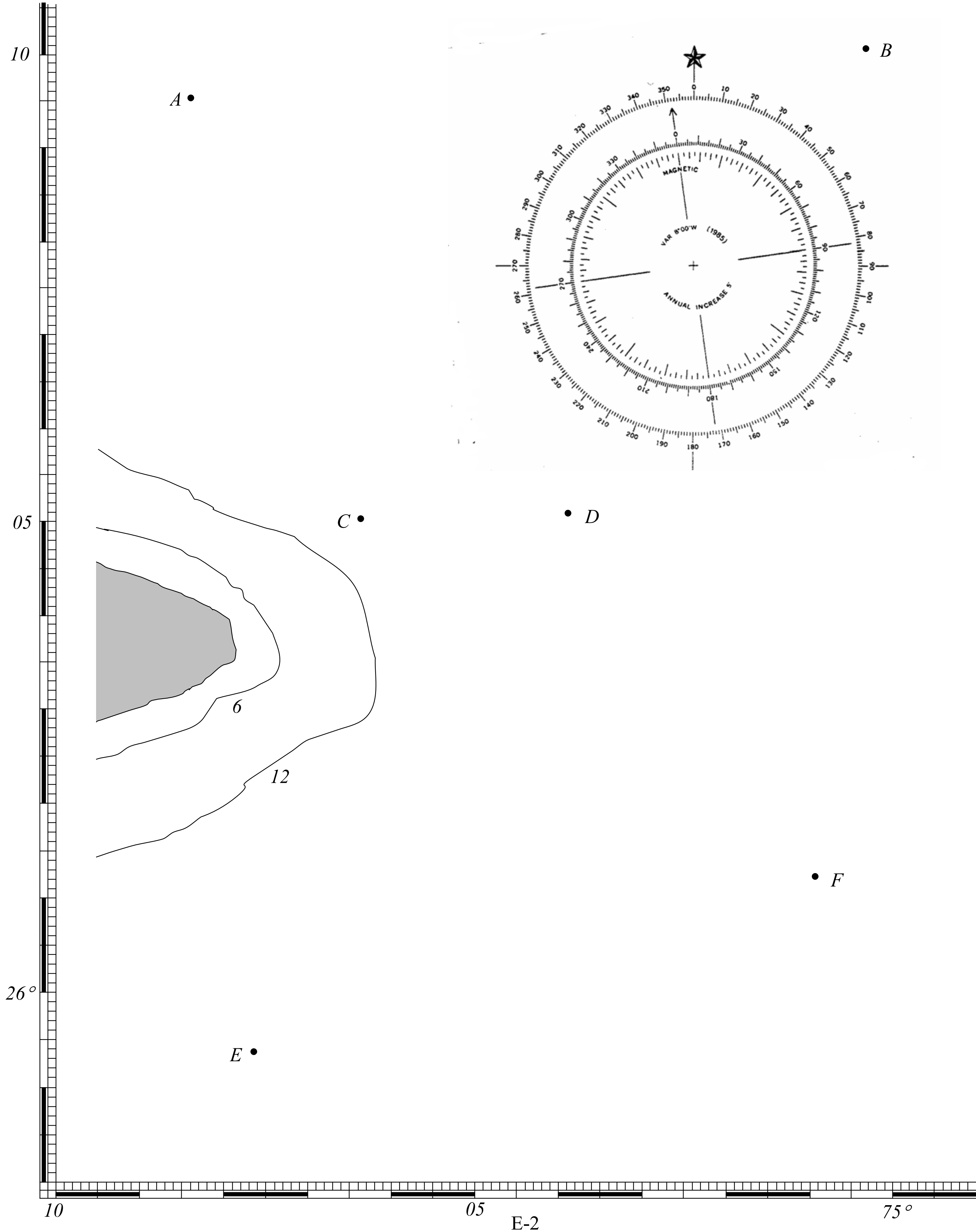
The List of Lights for Non-US Waters can be downloaded from the NGA website which can be reached through the http://www.american-sailing.com/ Sailing Resources link. Following is an example of the Nav Aides for Bermuda downloaded from this internet site.

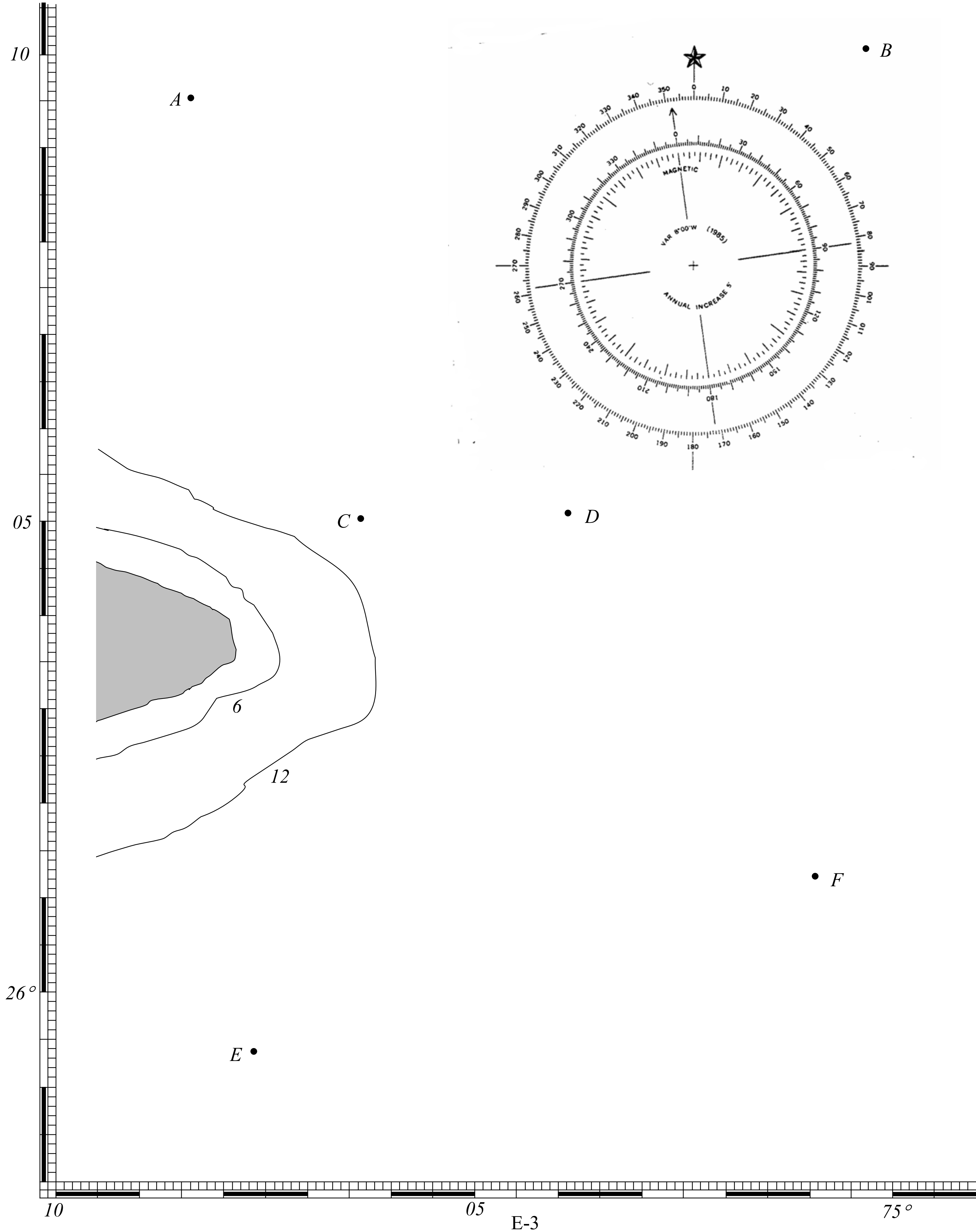
(1) No.	(2) Name	(3) Position	(4) Characteristic	(5) Height	(6) Range	(7) Structure	(8) Remarks
			Bermuda				
11616 *J 4472*	**St. Davids Island.**	32 21.8 N 64 39.0 W	**Fl.(2)W.** period 20s fl. 0.4s, ec. 2.9s fl. 0.4s, ec. 16.3s	213 **65**	**15**	White octagonal tower, red band; 72.	Partially obscured 044°-135°. **Radiobeacon** 031° 380 meters.
			F.R.G.	207 **63**	**20**		R. 135°-221°, G.-276°, R.-044°, R. (partially obscured)-135°. F.R. lights 0.95 mile SSW., 0.63 mile SW., 0.75 mile and 1.12 miles WNW.
11620 *J 4471.3*	NE. breaker.	32 28.7 N 64 40.9 W	**Fl.W.** period 2.5s	45 **14**	12	Red fiberglass tower, on concrete tripod; 46.	**Radar reflector.**
	RACON		**N(- •)**				
11624 *J 4471.5*	Kitchen Shoal.	32 26.0 N 64 37.6 W	**Fl.(3)W.** period 15s	45 **14**	12	White fiberglass tower, red bands, on concrete tripod; 45.	**Radar reflector.**
	ST. GEORGES ISLAND:						

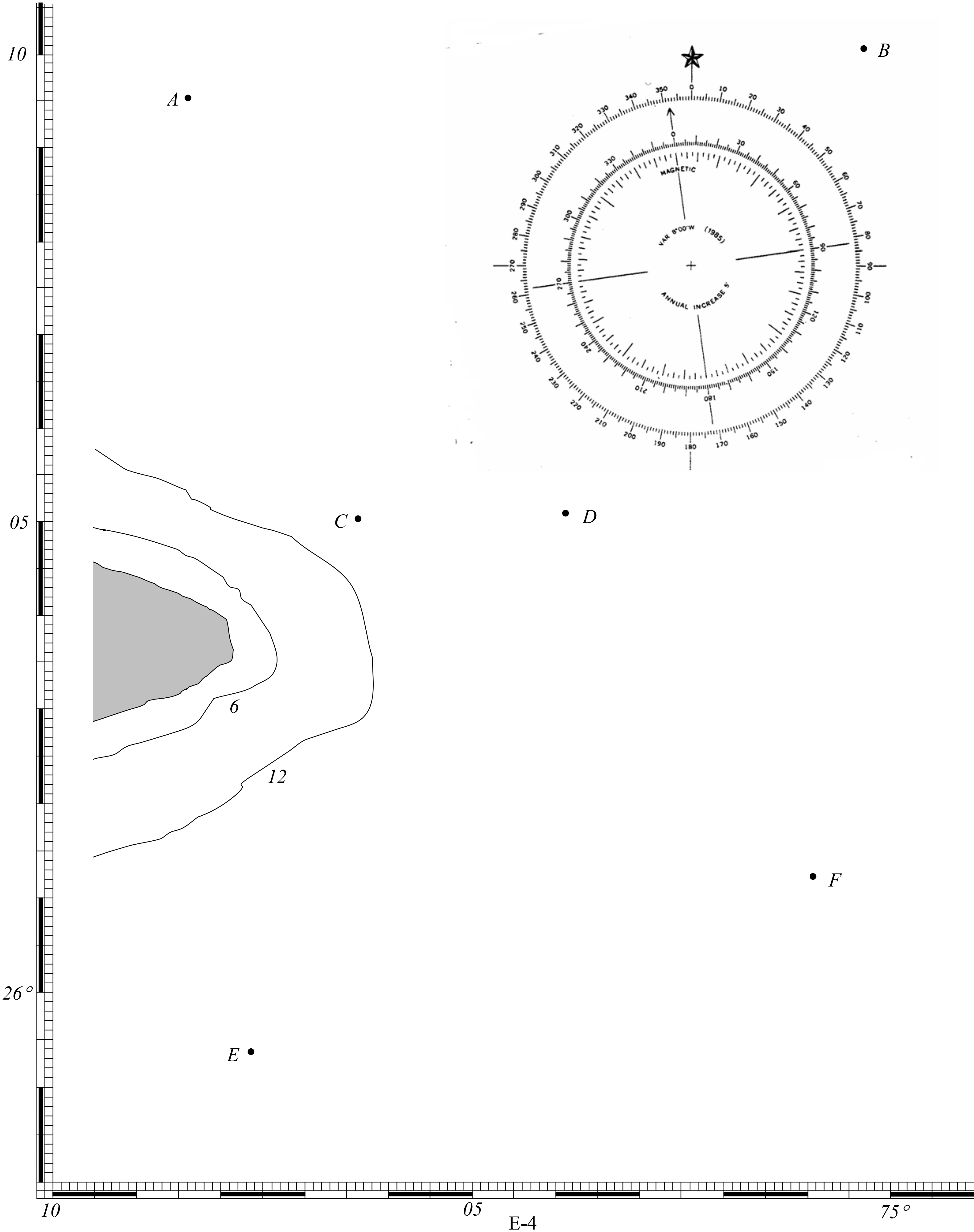
11632 *J 4477*	-Town Cut Channel, N. side, outer.	32 22.7 N 64 39.7 W	**F.R.**	46 **14**	8	White metal framework tower, black and white checkered daymark.	Visible 250°-080°.
11636 *J 4478*	- -N. side, inner, Chalk wharf.	32 22.7 N 64 39.9 W	**F.R.**	52 **16**	8	White metal framework tower, black and white checkered daymark.	Visible 250°-095°.
11640 *J 4476*	-Town Cut Channel, Higgs Island, NE. corner.	32 22.6 N 64 39.7 W	**F.G.**	48 **15**	8	Red and white checkered square on red metal framework tower, white bands.	F.R. lights shown from Fort George flagstaff 1 mile W.
11644 *J 4476.5*	-Horseshoe Island.	32 22.6 N 64 39.8 W	**F.G.**		8		
11664 *J 4482*	**Kindley Field** AVIATION LIGHT, St. Davids.	32 21.9 N 64 40.5 W	**Al.Fl.W.W.G.** period 10s	141 **43**	**15**	Control tower.	F.R. on tank 0.5 mile WNW. 2 F.R. at Swing Bridge Ferry Reach 0.8 mile WNW.
	BERMUDA ISLAND:						
11668 *J 4550*	**-Gibbs Hill.**	32 15.1 N 64 50.0 W	**Fl.W.** period 10s	354 **108**	**26**	White round iron tower; 133.	Obscured 223°-228°, 229°-237° F.R. obstruction light shown on top of lantern.
11684 *J 4471*	-North Rock.	32 28.5 N 64 46.0 W	**Fl.(4)W.** period 20s	69 **21**	12	Yellow fiberglass tower, black band, concrete base; 49.	

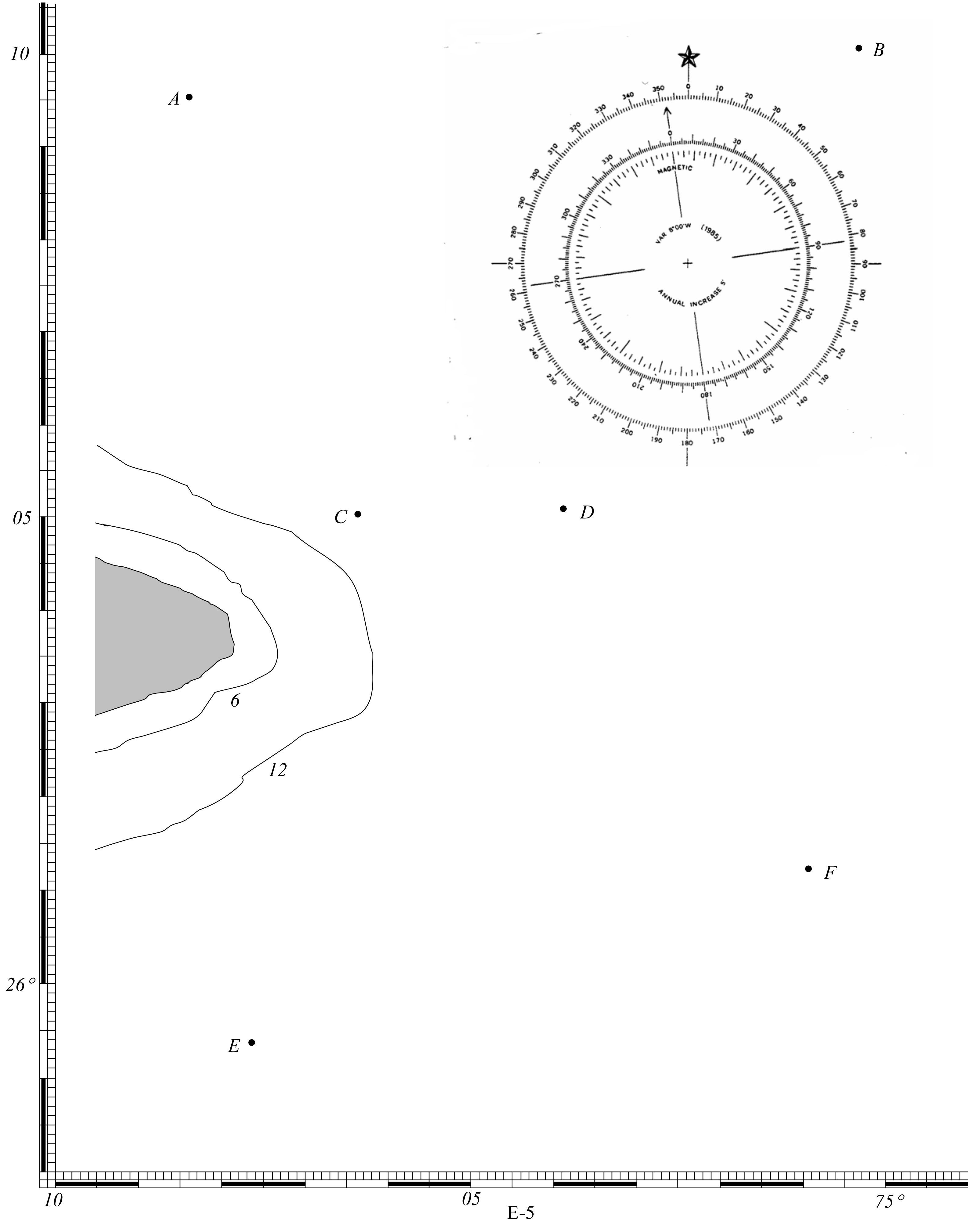
11686 *J 4547*	-Eastern Blue Cut, NW. reef.	32 24.0 N 64 52.6 W	**Mo.(U)W.** period 10s	60 **18**	12	White fiberglass tower, black bands, black concrete base marked ‘‘Eastern Blue Cut"; 59.	**Radar reflector.**
11742 *J 4546*	-Chub Heads.	32 17.2 N 64 58.7 W	**Q.(9)W.** period 15s	60 **18**	12	W. CARDINAL YBY, beacon, name on side.	**Radar reflector.**
	-RACON		**C(- • - •)**				

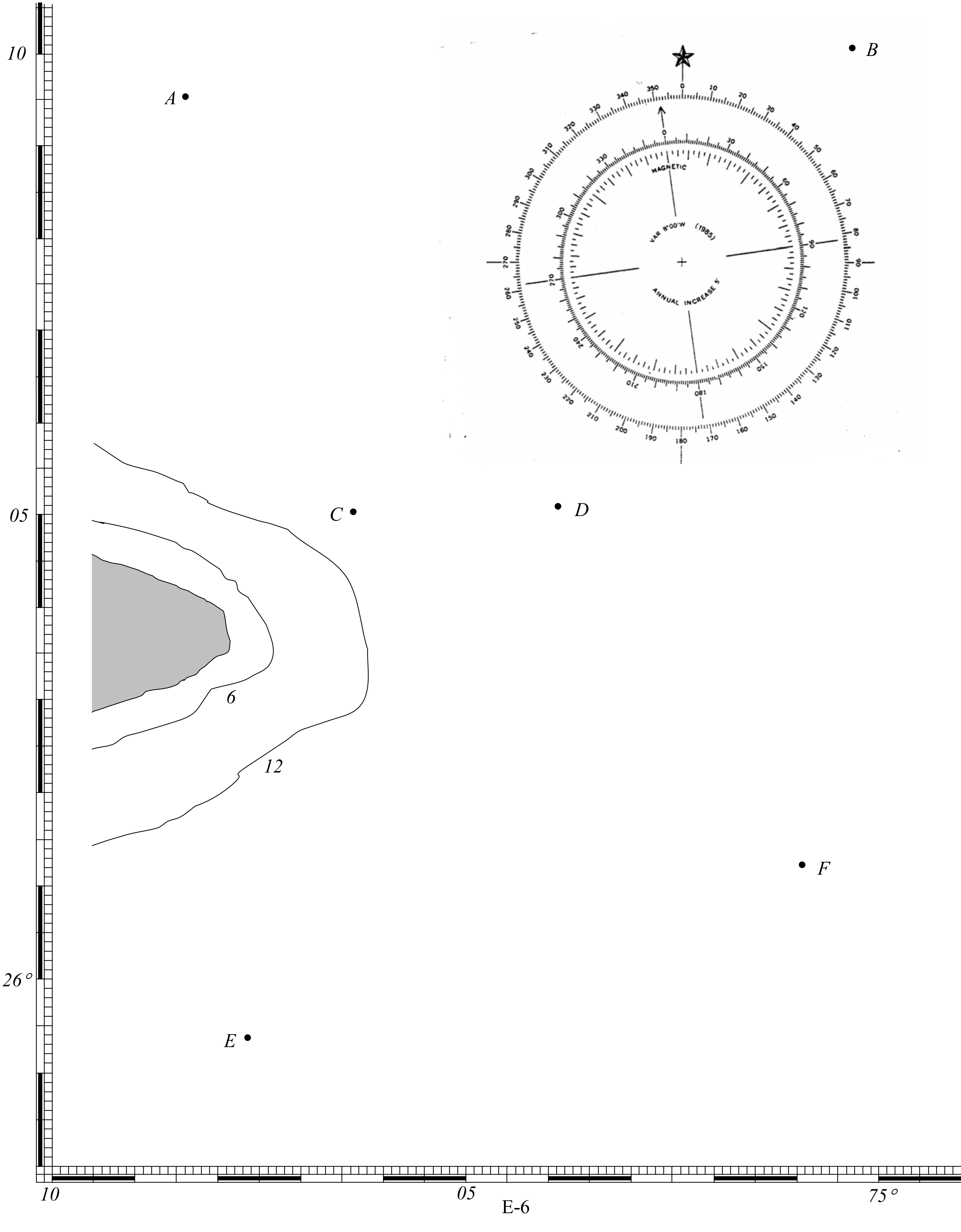
Appendix E
Plotting Sheets


10
05
26°
A
B
C
D
E
F
6
12
MAGNETIC
VAR 8°00'W (1985)
ANNUAL INCREASE 5'
10
05
75°


10
05
26°
A
B
C
D
E
F
6
12
10
05
75°
MAGNETIC
VAR 8°00'W (1985)
ANNUAL INCREASE 5'


10
05
26°
A
B
C
D
E
F
6
12
MAGNETIC
VAR 8°00'W (1985)
ANNUAL INCREASE 5'
10
05
75°


10
05
26°
10
05
75°
A
B
C
D
E
F
6
12
MAGNETIC
VAR 8°00'W (1985)
ANNUAL INCREASE 5'


10
05
26°
A
B
C
D
E
F
6
12
MAGNETIC
VAR 8°00'W (1985)
ANNUAL INCREASE 5'
10
05
75°

E-6

Preprinted Plotting Sheets

The following plotting sheets are available from NGA:

- **<u>Ocean Position Plotting Sheets</u> contain reference grids used for detailed navigational plots but contain no land features. These are about 30" by 40" in size and can be folded in quarters for use on a navigation table or lap board. *Figure B-1* shows the basic arrangement of these sheets, and Figure B-2 shows details of the compass rose used on these charts, which includes only True degrees. Different sheets are used for different bands of latitude as follows:**

    - **920- Latitude 4°S to 4°N**
    - **921- Latitude 3° to 11° N or S**
    - **922- Latitude 10° to 18° N or S**
    - **923- Latitude 17° to 24° N or S**
    - **924- Latitude 23° to 30° N or S**
    - **925- Latitude 29° to 36° N or S**
    - **926- Latitude 35° to 41° N or S**
    - **927- Latitude 40° to 46° N or S**
    - **928- Latitude 45° to 50° N or S**
    - **929- Latitude 49° to 54° N or S**
    - **930- Latitude 53° to 57° N or S**
    - **931- Latitude 56° to 60° N or S**
    - **932- Latitude 59° to 63° N or S**
    - **933- Latitude 62° to 65° N or S**

- **<u>Universal Plotting Sheets</u> approximately 13" by 14" in size; they come in pads of 50 each; stock number Pub VP-OS. Setting up of these sheets for different locations on earth is discussed below.**

- **<u>Maneuvering Board Radar Plotting Sheets</u> approximately 13" by 14" in size; they come in pads of 50 each; stock number Pub 5090. Refer to Pub 1310 or Dutton's Navigation & Piloting, for a detailed description of the procedures for using these sheets.**

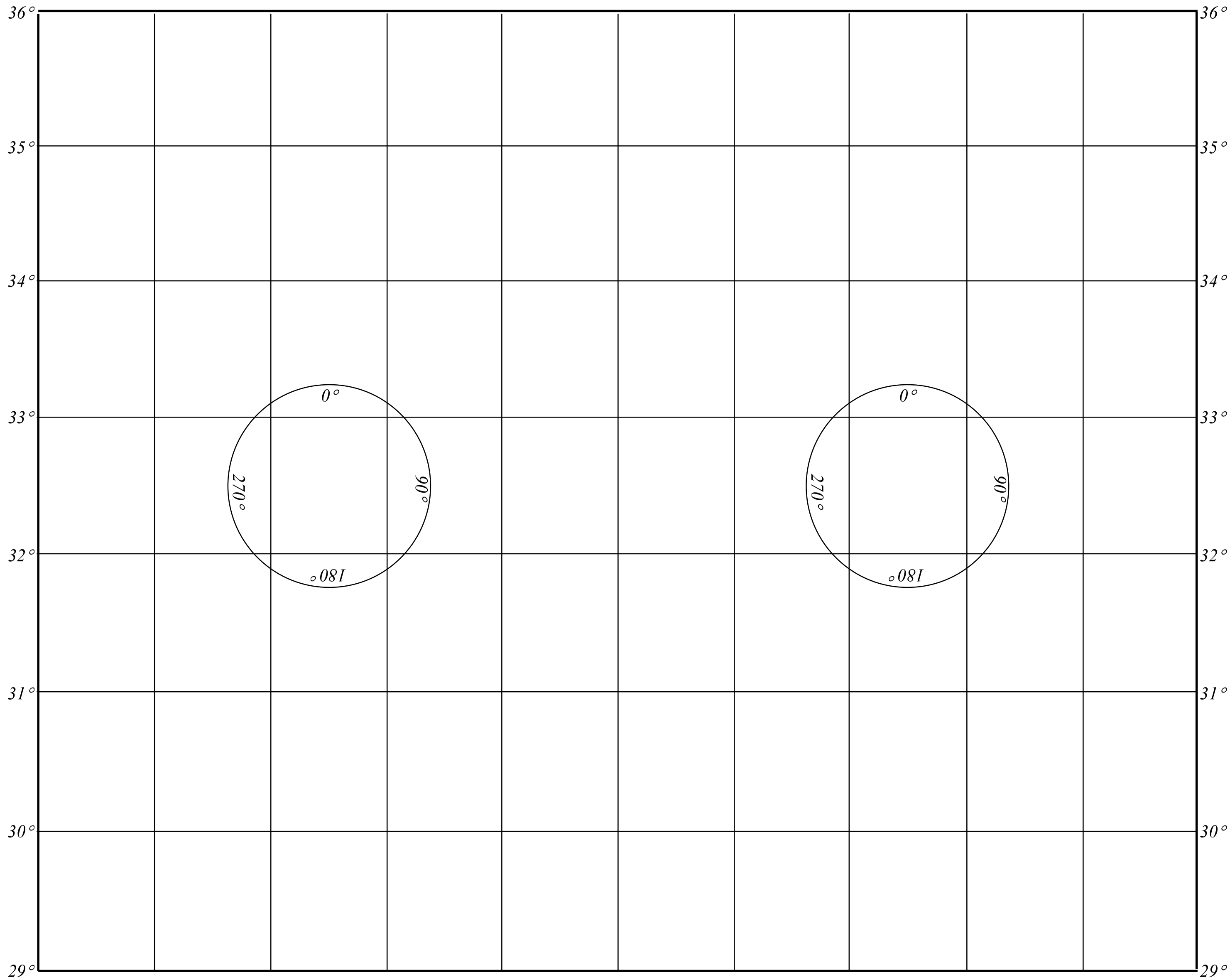


Figure E-1: Position Plotting Sheet; NIMA Pub 925 for latitudes 29° to 36°, North or South. This sheet measures 33 x 40 inches and is used for offshore and coastal plotting of position and related information. This is one in a series of sheets, each proportioned for a particular band of latitudes; numbers for the remaining sheets in the series are given in Appendix L. The user writes in the desired longitude degrees. Not shown in this sketch: Each degree is divided into 60 minutes.

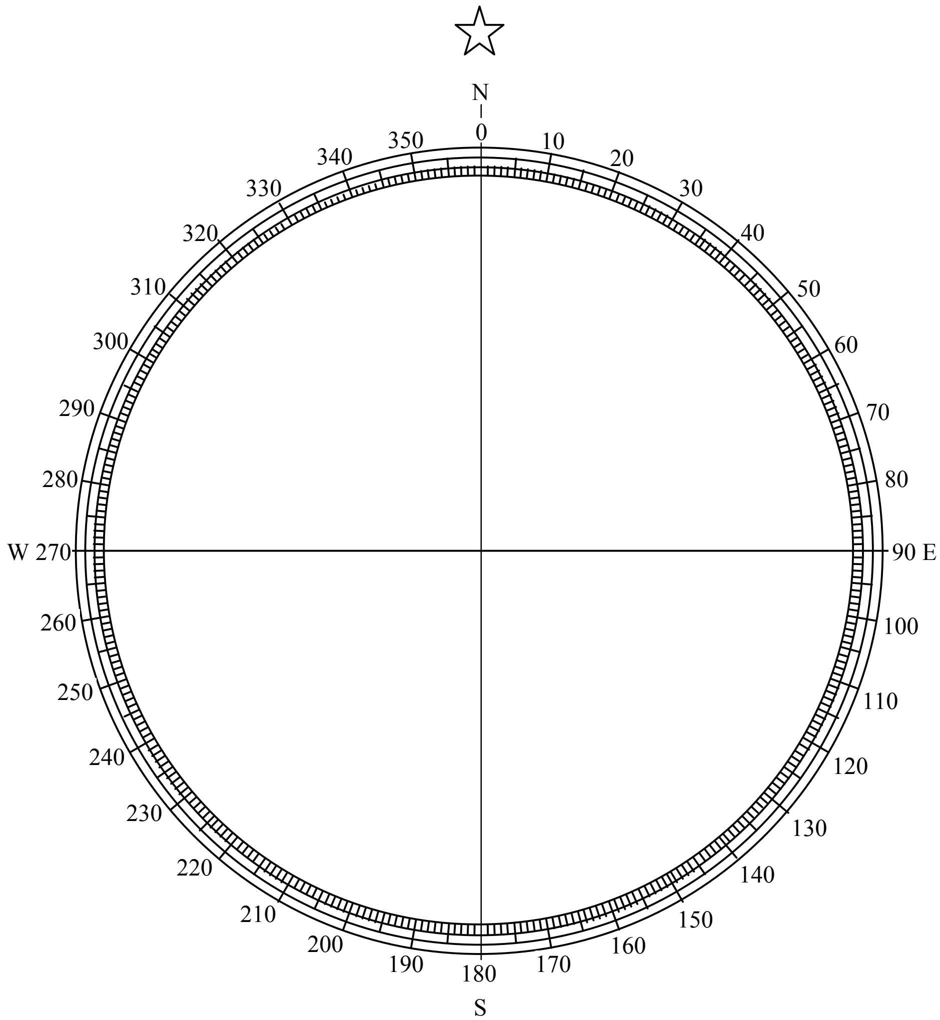


Figure E-2: This is a True North Compass Rose as used on ocean charts where plotting is normally done in True degrees. It is a 360° compass rose with 1° graduations. The Star at 0° signifies the North Pole and this compass therefore signifies "TRUE" directions, ie directions referenced to the North-South polar axis of the earth. The Equator of earth lies in the direction from 270° W to 90°E.

The Universal plotting sheet shown in *Figure E-3* can be setup for any location on earth between 70ºN and 70ºS with proper proportions of the latitude-longitude grid. The procedure for this is as follows and as shown in *Figure E-4* for 40°N latitude:

- **Write in 39°N, 40°N and 41°N latitudes.**
- **Draw in the vertical longitude lines at the 40° points of the compass.**
- **Mark these lines with the desired longitude values; in this case 70°W, 71°W and 72°W.**
- **Draw a horizontal line at the 40° latitude point of the grid scale at the lower right, and use this to measure minutes of longitude.**
- **Minutes of latitude can be read directly from the scale at the middle of the compass rose.**

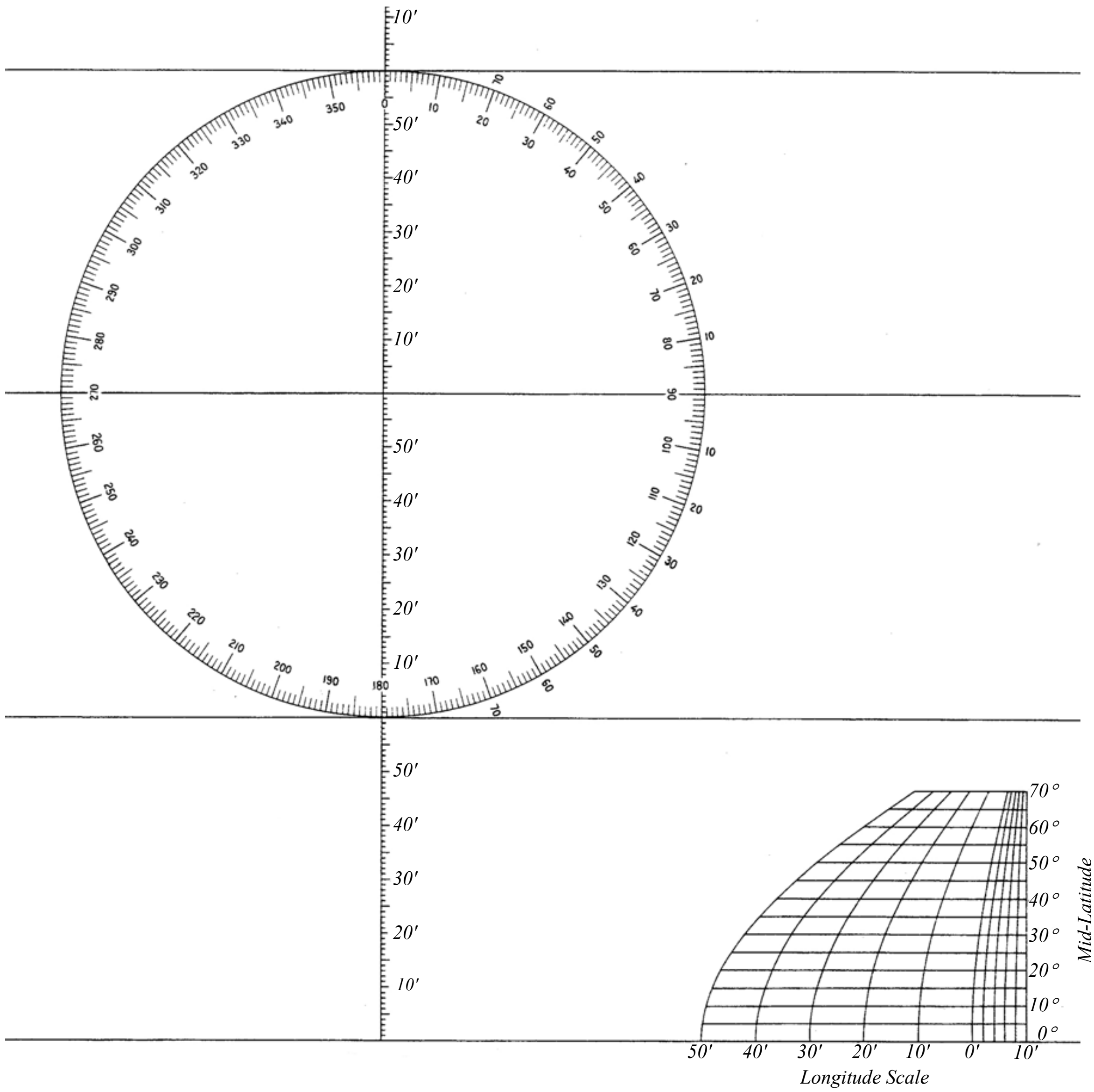


Figure E-3: Universal Plotting Sheet, which can be setup for use at any location on earth between 80°N and 80°S with the proper proportions of the latitude-longitude grid.

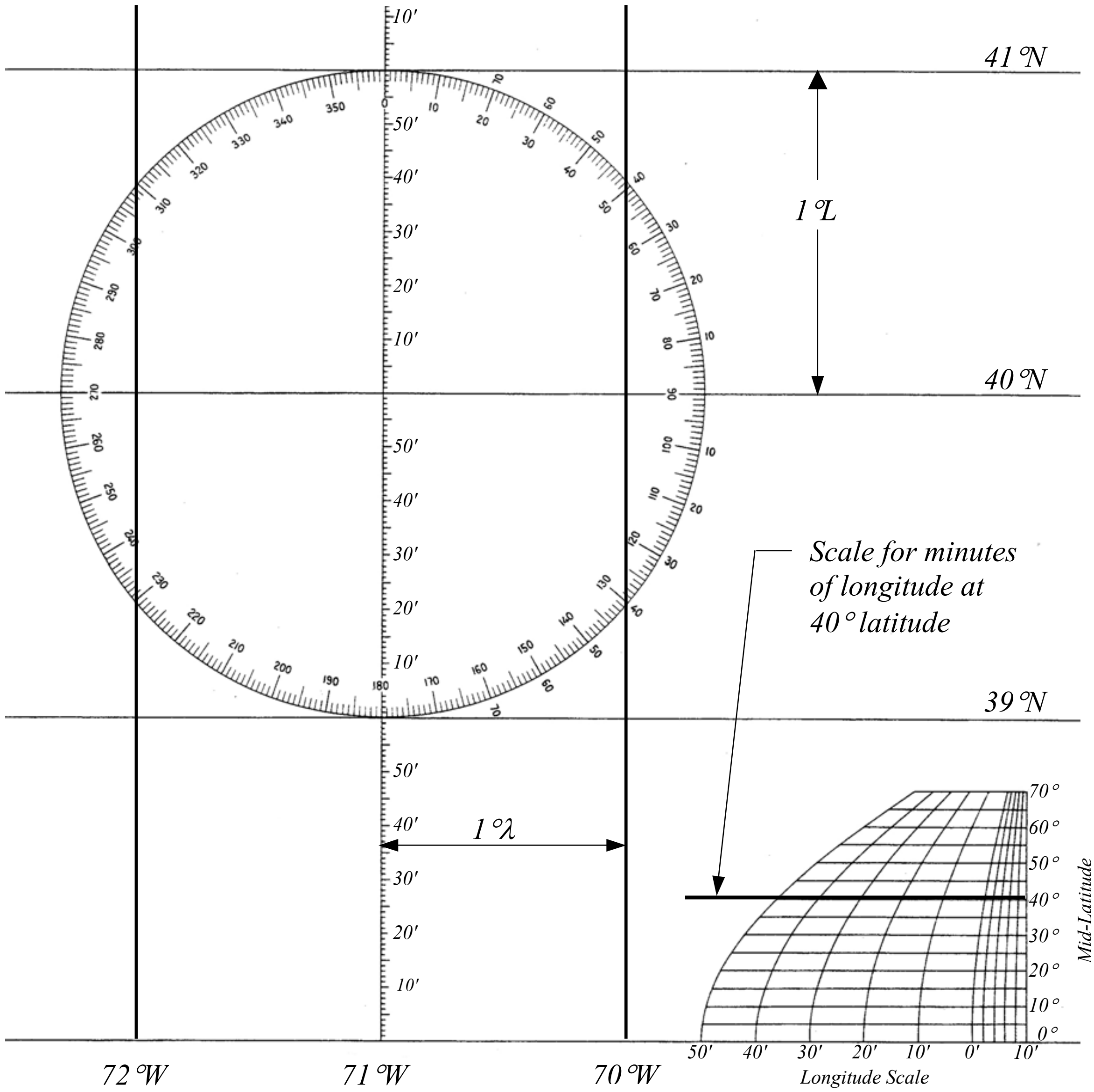


Figure E-4: Universal Plotting Sheet setup for proper latitude-longitude proportions at 40°N latitude. Note that a 1° rectangle is narrowed E-W to maintain similar proportions as on a Mercator chart. Also note that at higher latitudes, for example 70°N, that the E-W narrowing would be even greater. The grid scale at the lower right corner is used to measure the longitude minutes for the chosen latitude of the chart.

<u>Practice Exercise</u>: Setup the plotting sheet in *Figure E-3* for a center latitude of 50° North and a center longitude of 30° West following the example shown in *Figure 1-10b.* Then plot a point at 50°40' North and 30°45' West. Determine the bearing to this point from the center of the compass rose. __________________

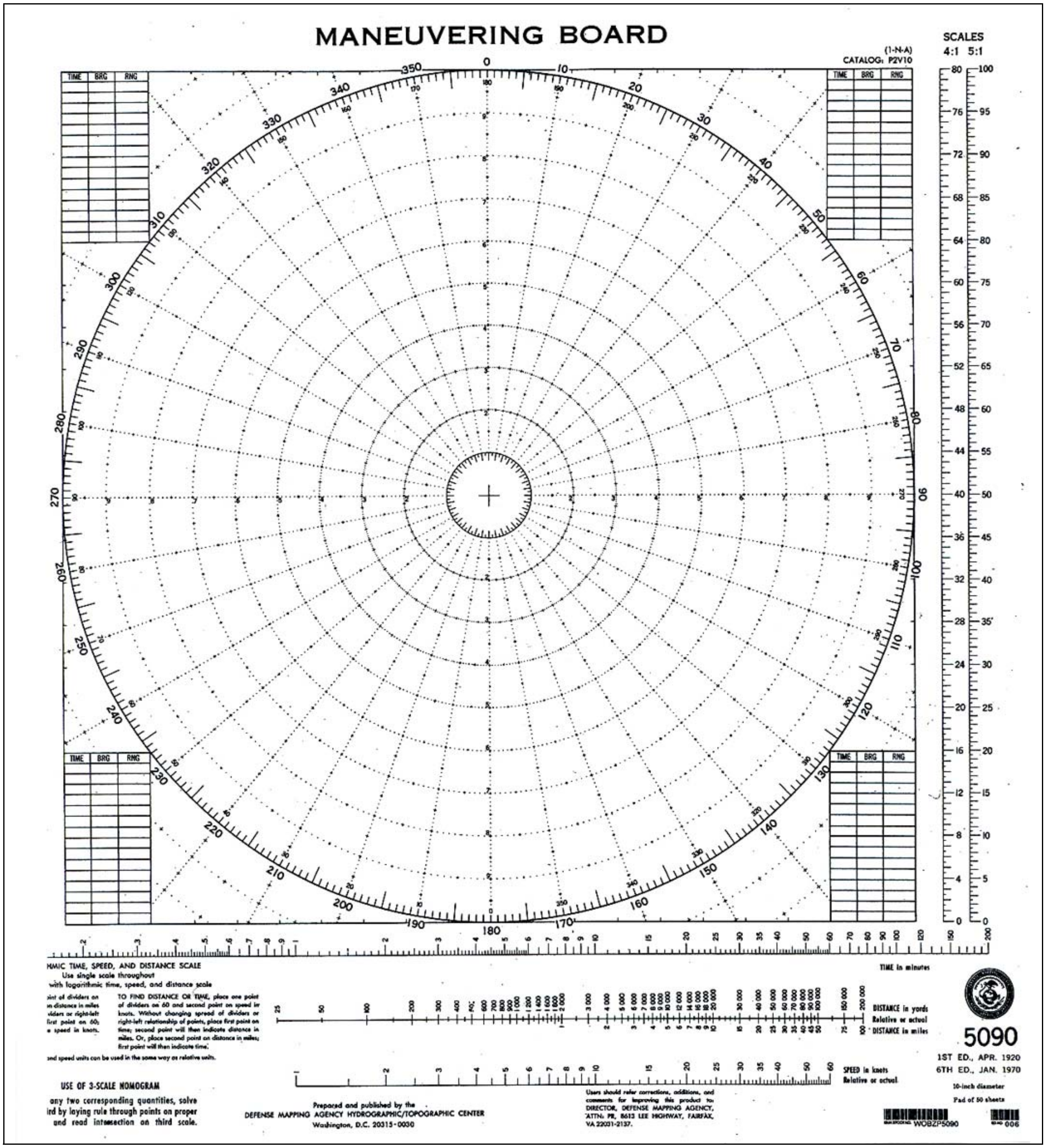


Figure E-5: Radar Plotting Sheet

Appendix F
<u>Equations</u>

Speed = $\dfrac{\textbf{Distance}}{\textbf{Time}}$

Distance = Speed x Time

Time = $\dfrac{\textbf{Distance}}{\textbf{Speed}}$

Greenwich Mean Time = Zone Time + Meridian Time Difference

Daylight Time = Standard Time + 1 hour

Meridian Time Difference = $\dfrac{\textbf{Longitude of Zone Meridian}}{\mathbf{15^\circ}}$

Longitude Time Difference = $\dfrac{\textbf{Longitude}}{\mathbf{15^\circ}}$

ZTD = LTD - MTD

Speed Over Ground = $\dfrac{\textbf{Distance Over Ground}}{\textbf{Elapsed Time}}$

Speed Correction Factor = SF = $\dfrac{\textbf{Speed Over Ground}}{\textbf{Log Speed}}$

Corrected Speed through the water = S = SF x Log Speed.

Distance Correction Factor = DF = $\dfrac{\textbf{Distance Over Ground}}{\textbf{Log Distance}}$

Corrected Distance through the water = D = DF x Log Distance

Bearing = Course + Relative Bearing

Appendix G
Tide Table Extracts

Tide Tables 1997

HIGH AND LOW WATER PREDICTIONS

EAST COAST OF NORTH AND SOUTH AMERICA

INCLUDING GREENLAND

This publication contains tide and/or tidal current predictions and associated information produced by and obtained from the Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service. This is not a National Ocean Service publication. The National Ocean Service is not responsible for any reproduction errors. These predictions satisfy all U.S. Coast Guard requirements including: 33 CFR Ch. I (7-1-91 Edition), 164.33 Charts and Publications.

GLOSSARY OF TERMS

ANNUAL INEQUALITY—Seasonal variation in the water level or current, more or less periodic, due chiefly to meteorological causes.

APOGEAN TIDES OR TIDAL CURRENTS—Tides of decreased range or currents of decreased speed occurring monthly as the result of the Moon being in apogee (farthest from the Earth).

AUTOMATIC TIDE GAGE—An instrument that automatically registers the rise and fall of the tide. In some instruments, the registration is accomplished by recording the heights at regular intervals in digital format, in others by a continuous graph in which the height versus corresponding time of the tide is recorded.

BENCH MARK (BM)—A fixed physical object or marks used as reference for a vertical datum. A *tidal bench mark is* one near a tide station to which the tide staff and tidal datums are referred. A *Geodetic bench mark* identifies a surveyed point in the National Geodetic Vertical Network.

CHART DATUM—The tidal datum to which soundings on a chart are referred. It is usually taken to correspond to low water elevation of the tide, and its depression below mean sea level is represented by the symbol Zo.

CURRENT—Generally, a horizontal movement of water. Currents may be classified as *tidal* and *nontidal.* Tidal currents are caused by gravitational interactions between the Sun, Moon, and Earth and are a part of the same general movement of the sea that is manifested in the vertical rise and fall, called *tide*. Nontidal currents include the permanent currents in the general circulatory systems of the sea as well as temporary currents arising from more pronounced meteorological variability.

CURRENT DIFFERENCE—Difference between the time of slack water (or minimum current) or strength of current in any locality and the time of the corresponding phase of the tidal current at a reference station, for which predictions are given in the *Tidal Current Tables.*

CURRENT ELLIPSE—A graphic representation of a rotary current in which the velocity of the current at different hours of the tidal cycle is represented by radius vectors and vectorial angles. A line joining the extremities of the radius vectors will form a curve roughly approximating an ellipse. The cycle is completed in one-half tidal day or in a whole tidal day according to whether the tidal current is of the semidiurnal or the diurnal type. A current of the mixed type will give a curve of two unequal loops each tidal day.

CURRENT METER—An instrument for measuring the speed and direction or just the speed of a current. The measurements are usually Eulerian since the meter is most often fixed or moored at a specific location.

DATUM (vertical)—For marine applications, a base elevation used as a reference from which to reckon heights or depths. It is called a *tidal datum* when defined by a certain phase of the tide. Tidal datums are local datums and should not be extended into areas which have differing topographic features without substantiating measurements. In order that they may be recovered when needed, such datums are referenced to fixed points known as *bench marks.*

DAYLIGHT SAVING TIME—A time used during the summer in some localities in which clocks are advanced 1 hour from the usual standard time.

DIURNAL—Having a period or cycle of approximately 1 tidal day. Thus, the tide is said to be diurnal when only one high water and one low water occur during a tidal day, and the tidal current is said to be diurnal when there is a single flood and single ebb period in the tidal day. A rotary current is diurnal if it changes its direction through all points of the compass once each tidal day.

DIURNAL INEQUALITY—The difference in height of the two high waters or of the two low waters of each day; also the difference in speed between the two flood tidal currents or the two ebb tidal currents of each day. The difference changes with the declination of the Moon and to a lesser extent with the declination of the Sun. In general, the inequality tends to increase with an increasing declination, either north or south, and to diminish as the Moon approaches the Equator. *Mean diurnal high water inequality* (DHQ) is one-half the average difference between the two high waters of each day observed over a specific 19-year Metonic cycle (the National Tidal Datum Epoch). It is obtained by subtracting the mean of all high waters from the mean of the higher high waters. *Mean diurnal low water inequality* (DLQ) is one-half the average difference between the two low waters of each day observed over a specific 19-year Metonic cycle (the National Tidal Datum Epoch). It is obtained by subtracting the mean of the lower low waters from the mean of all low waters. *Tropic high water inequality* (HWQ) is the average difference between the two high waters of the day at the times of the tropic tides. *Tropic low water inequality* (LWQ) is the average difference between the two low waters of the day at the times of the tropic tides. Mean and tropic inequalities as defined above are applicable only when the type of tide is either semidiurnal or mixed. Diurnal inequality is sometimes called *declinational inequality*.

DOUBLE EBB—An ebb tidal current where, after ebb begins, the speed increases to a maximum called *first ebb;* it then decreases, reaching a *minimum ebb* near the middle of the ebb period (and at some places it may actually run in a flood direction for a short period); it then again ebbs to a maximum speed called *second ebb* after which it decreases to slack water.

DOUBLE FLOOD—A flood tidal current where, after flood begins, the speed increases to a maximum called first flood; it then decreases, reaching a minimum flood near the middle of the flood period (and at some places it may actually run in an ebb direction for a short period); it then again floods to a maximum speed called second flood after which it decreases to slack water.

DOUBLE TIDE—A double-headed tide, that is, a high water consisting of two maxima of nearly the same height separated by a relatively small depression, or a low water consisting of two minima separated by a relatively small elevation. Sometimes, it is called an *agger*.

DURATION OF FLOOD AND DURATION OF EBB—*Duration of flood* is the interval of time in which a tidal current is flooding, and the *duration of ebb* is the interval in which it is ebbing. Together they cover, on an average, a period of 12.42 hours for a semidiurnal tidal current or a period of 24.84 hours for a diurnal current. In a normal semidiurnal tidal current, the duration of flood and duration of ebb will each be approximately equal to 6.21 hours, but the times may be modified greatly by the presence of a nontidal flow. In a river the duration of ebb is usually longer than the duration of flood because of the freshwater discharge, especially during the spring when snow and ice melt are the predominant influences.

DURATION OF RISE AND DURATION OF FALL—*Duration of rise* is the interval from low water to high water, and *duration of fall* is the interval from high water to low water. Together they cover, on an average, a period of 12.42 hours for a semidiurnal tide or a period of 24.84 hours for a diurnal tide. In a normal semidiurnal tide, the duration of rise and duration of fall will each be approximately equal to 6.21 hours, but in shallow waters and in rivers there is a tendency for a decrease in the duration of rise and a corresponding increase in the duration of fall.

EBB CURRENT—The movement of a tidal current away from shore or down a tidal river or estuary. In the mixed type of reversing tidal current, the terms *greater ebb* and *lesser ebb* are applied respectively to the ebb tidal currents of greater and lesser speed of each day. The terms *maximum ebb* and *minimum ebb* are applied to the maximum and minimum speeds of a current running continuously ebb, the speed alternately increasing and decreasing without coming to a slack or reversing. The expression *maximum ebb is* also applicable to any ebb current at the time of greatest speed.

EQUATORIAL TIDAL CURRENTS—Tidal currents occurring semimonthly as a result of the Moon being over the Equator. At these times the tendency of the Moon to produce a diurnal inequality in the tidal current is at a minimum.

EQUATORIAL TIDES—Tides occurring semi monthly as the result of the Moon being over the Equator. At these times the tendency of the Moon to produce a diurnal inequality in the tide is at a minimum.

FLOOD CURRENT—The movement of a tidal current toward the shore or up a tidal river or estuary. In the mixed type of reversing current, the terms *greater flood* and *lesser flood* are applied respectively to the flood currents of greater and lesser speed of each day. The terms *maximum flood* and *minimum flood* are applied to the maximum and minimum speeds of a flood current, the speed of which alternately increases and decreases without coming to a slack or reversing. The expression *maximum flood is* also applicable to any flood current at the time of greatest speed.

GREAT DIURNAL RANGE (Gt)—The difference in height between mean higher high water and mean lower low water. The expression may also be used in its contracted form, *diurnal range*.

GREENWICH INTERVAL—An interval referred to the transit of the Moon over the meridian of Greenwich as distinguished from the local interval which is referred to the Moon's transit over the local meridian. The relation in hours between Greenwich and local intervals may be expressed by the formula:

$$\text{Greenwich interval} = \text{local interval} + 0.069\,L$$

where L is the west longitude of the local meridian in degrees. For east longitude, L is to be considered negative.

GULF COAST LOW WATER DATUM—A chart datum. Specifically, the tidal datum formerly designated for the coastal waters of the Gulf Coast of the United States. It was defined as *mean lower low water* when the type of tide was mixed and *mean low water* when the type of tide was diurnal.

HALF-TIDE LEVEL—See *mean tide level.*

HARMONIC ANALYSIS—The mathematical process by which the observed tide or tidal current at any place is separated into basic harmonic constituents.

HARMONIC CONSTANTS—The amplitudes and epochs of the harmonic constituents of the tide or tidal current at any place.

HARMONIC CONSTITUENT—One of the harmonic elements in a mathematical expression for the tide-producing force and in corresponding formulas for the tide or tidal current. Each constituent represents a periodic change or variation in the relative positions of the Earth, Moon, and Sun. A single constituent is usually written in the form $y=A\cos(at+\alpha)$, in which y is a function of time as expressed by the symbol t and is reckoned from a specific origin. The coefficient A is called the amplitude of the constituent and is a measure of its relative importance. The angle $(at+\alpha)$ changes uniformly and its value at any time is called the phase of the constituent. The speed of the constituent is the rate of change in its phase and is represented by the symbol a in the formula. The quantity α is the phase of the constituent at the initial instant from which the time is reckoned. The period of the constituent is the time required for the phase to change through 360° and is the cycle of the astronomical condition represented by the constituent.

HIGH WATER (HW)—The maximum height reached by a rising tide. The height may be due solely to the periodic tidal forces or it may have superimposed upon it the effects of prevailing meteorological conditions. Use of the synonymous term, *high tide,* is discouraged.

HIGHER HIGH WATER (HHW)—The higher of the two high waters of any tidal day.

HIGHER LOW WATER (HLW)—The higher of the two low waters of any tidal day.

HYDRAULIC CURRENT—A current in a channel caused by a difference in the surface level at the two ends. Such a current may be expected in a strait connecting two bodies of water in which the tides differ in time or range. The current in the East River, N.Y., connecting Long Island Sound and New York Harbor, is an example.

KNOT—A unit of speed, one international nautical mile (1,852.0 meters or 6,076.11549 international feet) per hour.

LOW WATER (LW)—The minimum height reached by a falling tide. The height may be due solely to the periodic tidal forces or it may have superimposed upon it the effects of meteorological conditions. Use of the synonymous term, *low tide,* is discouraged.

LOWER HIGH WATER (LHW)—The lower of the two high waters of any tidal day.

LOWER LOW WATER (LLW)—The lower of the two low waters of any tidal day.

LUNAR DAY—The time of the rotation of the Earth with respect to the Moon, or the interval between two successive upper transits of the Moon over the meridian of a place. The mean lunar day is approximately 24.84 solar hours long, or 1.035 times as long as the mean solar day.

LUNAR INTERVAL—The difference in time between the transit of the Moon over the meridian of Greenwich and over a local meridian. The average value of this interval expressed in hours is 0.069 L, in which L is the local longitude in degrees, positive for west longitude and negative for east longitude. The lunar interval equals the difference between the local and Greenwich interval of a tide or current phase.

LUNICURRENT INTERVAL—The interval between the Moon's transit (upper or lower) over the local or Greenwich meridian and a specified phase of the tidal current following the transit. Examples: *strength of flood interval* and *strength of ebb interval,* which may be abbreviated to *flood interval* and *ebb interval,* respectively. The interval is described as local or Greenwich according to whether the reference is to the Moon's transit over the local or Greenwich meridian. When not otherwise specified, the reference is assumed to be local.

LUNITIDAL INTERVAL—The interval between the Moon's transit (upper or lower) over the local or Greenwich meridian and the following high or low water. The average of all high water intervals for all phases of the Moon is known as *mean high water lunitidal interval* and is abbreviated to high water interval (HWI). Similarly the mean *low water lunitidal interval* is abbreviated to *low water interval* (LWI). The interval is described as local or Greenwich according to whether the reference is to the transit over the local or Greenwich meridian. When not otherwise specified, the reference is assumed to be local.

MEAN HIGH WATER (MHW)—A tidal datum. The arithmetic mean of the high water heights observed over a specific 19-year Metonic cycle (the National Tidal Datum Epoch). For stations with shorter series, simultaneous observational comparisons are made with a primary control tide station in order to derive the equivalent of a I9-year value.

MEAN HIGHER HIGH WATER (MHHW)—A tidal datum. The arithmetic mean of the higher high water heights of a mixed tide observed over a specific I9-year Metonic cycle (the National Tidal Datum Epoch). Only the higher high water of each pair of high waters, or the only high water of a tidal day is included in the mean.

MEAN HIGHER HIGH WATER LINE (MHHWL)—The intersection of the land with the water surface at the elevation of mean higher high water.

MEAN LOW WATER (MLW)—A tidal datum. The arithmetic mean of the low water heights observed over a specific I9-year Metonic cycle (the National Tidal Datum Epoch). For stations with shorter series, simultaneous observational comparisons are made with a primary control tide station in order to derive the equivalent of a I9-year value.

MEAN LOW WATER SPRINGS (MLWS)—A tidal datum. Frequently abbreviated *spring low water.* The arithmetic mean of the low water heights occurring at the time of the spring tides observed over a specific I9-year Metonic cycle (the National Tidal Datum Epoch).

MEAN LOWER LOW WATER (MLLW)—A tidal datum. The arithmetic mean of the lower low water heights of a mixed tide observed over a specific I9-year Metonic cycle (the National Tidal Datum Epoch). Only the lower low water of each pair of low waters, or the only low water of a tidal day is included in the mean.

MEAN RANGE OF TIDE (Mn)—The difference in height between mean high water and mean low water.

MEAN RIVER LEVEL—A tidal datum. The average height of the surface of a tidal river at any point for all stages of the tide observed over a I9-year Metonic cycle (the National Tidal Datum Epoch), usually determined from hourly height readings. In rivers subject to occasional freshets the river level may undergo wide variations, and for practical purposes certain months of the year may be excluded in the determination of tidal datums. For charting purposes, tidal datums for rivers are usually based on observations during selected periods when the river is at or near low water stage.

MEAN SEA LEVEL (MSL)—A tidal datum. The arithmetic mean of hourly water elevations observed over a specific I9-year Metonic cycle (the National Tidal Datum Epoch). Shorter series are specified in the name; e.g., monthly mean sea level and yearly mean sea level.

MEAN TIDE LEVEL (MTL)—Also called half-tide level. A tidal datum midway between mean high water and mean low water.

MIXED TIDE—Type of tide with a large inequality in the high and/or low water heights, with two high waters and two low waters usually occurring each tidal day. In strictness, all tides are mixed but the name is usually applied to the tides intermediate to those predominantly semidiurnal and those predominantly diurnal.

NATIONAL TIDAL DATUM EPOCH—The specific 19-year period adopted by the National Ocean Service as the official time segment over which tide observations are taken and reduced to obtain mean values (e.g., mean lower low water, etc.) for tidal datums. It is necessary for standardization because of periodic and apparent secular trends in sea level. The present National Tidal Datum Epoch is 1960 through 1978. It is reviewed annually for possible revision and must be actively considered for revision every 25 years.

NEAP TIDES OR TIDAL CURRENTS—Tides of decreased range or tidal currents of decreased speed occurring semimonthly as the result of the Moon being in quadrature. The *neap range* (Np) of the tide is the average semidiurnal range occurring at the time of neap tides and is most conveniently computed from the harmonic constants. It is smaller than the mean range where the type of tide is either semidiurnal or mixed and is of no practical significance where the type of tide is diurnal. The average height of the high waters of the neap tides is called *neap high water* or *high water neaps* (MHWN) and the average height of the corresponding low waters is called *neap low water* or *low water neaps* (MLWN).

PERIGEAN TIDES OR TIDAL CURRENTS—Tides of increased range or tidal currents of increased speed occurring monthly as the result of the Moon being in perigee or nearest the Earth. The *perigean range* (Pn) of tide is the average semidiurnal range occurring at the time of perigean tides and is most conveniently computed from the harmonic constants. It is larger than the mean range where the type of tide is either semidiurnal or mixed, and is of no practical significance where the type of tide is diurnal.

RANGE OF TIDE—The difference in height between consecutive high and low waters, the *mean range* is the difference in height between mean high water and mean low water. Where the type of tide is diurnal the mean range is the same as the diurnal range. For other ranges, see great diurnal, spring, neap, perigean, apogean, and tropic tides.

REFERENCE STATION—A tide or current station for which independent daily predictions are given in the *Tide Tables* and *Tidal Current Tables*, and from which corresponding predictions are obtained for subordinate stations by means of differences and ratios.

REVERSING CURRENT—A tidal current which flows alternately in approximately opposite directions with a slack water at each reversal of direction. Currents of this type usually occur in rivers and straits where the direction of flow is more or less restricted to certain channels. When the movement is towards the shore or up a stream, the current is said to be flooding, and when in the opposite direction it is said to be ebbing. The combined flood and ebb movement including the slack water covers, on an average, 12.42 hours for the semidiurnal current. If unaffected by a nontidal flow, the flood and ebb movements will each last about 6 hours, but when combined with such a flow, the durations of flood and ebb may be quite unequal. During the flow in each direction the speed of the current will vary from zero at the time of slack water to a maximum about midway between the slacks.

ROTARY CURRENT—A tidal current that flows continually with the direction of flow changing through all points of the compass during the tidal period. Rotary currents are usually found offshore where the direction of flow is not restricted by any barriers. The tendency for the rotation in direction has its origin in the Coriolis force and, unless modified by local conditions, the change is clockwise in the Northern Hemisphere and counterclockwise in the Southern. The speed of the current usually varies throughout the tidal cycle, passing through the two maxima in approximately opposite directions and the two minima with the direction of the current at approximately 90° from the direction at time of maximum speed.

SEMIDIURNAL—Having a period or cycle of approximately one-half of a tidal day. The predominating type of tide throughout the world is semidiurnal, with two high waters and two low waters each tidal day. The tidal current is said to be semidiurnai when there are two flood and two ebb periods each day.

SET (OF CURRENT)—The direction *towards* which the current flows.

SLACK WATER—The state of a tidal current when its speed is near zero, especially the moment when a reversing current changes direction and its speed is zero. The term is also applied to the entire period of low speed near the time of turning of the current when it is too weak to be of any practical importance in navigation. The relation of the time of slack water to the tidal phases varies in different localities. For standing tidal waves, slack water occurs near the times of high and low water, while for progressive tidal waves, slack water occurs midway between high and low water.

SPRING TIDES OR TIDAL CURRENTS—Tides of increased range or tidal currents of increased speed occurring semimonthly as the result of the Moon being new or full. The *spring range* (Sg) of tide is the average semidiurnal range occurring at the time of spring tides and is most conveniently computed from the harmonic constants. It is larger than the mean range where the type of tide is either semidiurnal or mixed, and is of no practical significance where the type of tide is diurnal. The mean of the high waters of the spring tide is called *spring high water* or *mean high water springs* (MHWS), and the average height of the corresponding low waters is called *spring low water* or *mean low water springs* (MLWS).

STAND OF TIDE—Sometimes called a platform tide. An interval at high or low water when there is no sensible change in the height of the tide. The water level is stationary at high and low water for only an instant, but the change in level near these times is so slow that it is not usually perceptible. In general, the duration of the apparent stand will depend upon the range of tide, being longer for a small range than for a large range, but where there is a tendency for a double tide the stand may last for several hours even with a large range of tide.

STANDARD TIME—A kind of time based upon the transit of the Sun over a certain specified meridian, called the *time meridian*, and adopted for use over a considerable area. With a few exceptions, standard time is based upon some meridian which differs by a multiple of 15° from the meridian of Greenwich.

STRENGTH OF CURRENT—Phase of tidal current in which the speed is a maximum; also the speed at this time. Beginning with slack before flood in the period of a reversing tidal current (or minimum before flood in a rotary current), the speed gradually increases to flood strength and then diminishes to slack before ebb (or minimum before ebb in a rotary current), after which the current turns in direction, the speed increases to ebb strength and then diminishes to slack before flood completing the cycle. If it is assumed that the speed throughout the cycle varies as the ordinates of a cosine curve, it can be shown that the average speed for an entire flood or ebb period is equal to $2/\pi$ or 0.6366 of the speed of the corresponding strength of current.

SUBORDINATE CURRENT STATION—(1) A current station from which a relatively short series of observations is reduced by comparison with simultaneous observations from a control current station. (2) A station listed in the *Tidal Current Tables* for which predictions are to be obtained by means of differences and ratios applied to the full predictions at a reference station .

SUBORDINATE TIDE STATION—(1) A tide station from which a relatively short series of observations is reduced by comparison with simultaneous observations from a tide station with a relatively long series of observations. (2) A station listed in the *Tide Tables* for which predictions are to be obtained by means of differences and ratios applied to the full predictions at a reference station.

TIDAL CURRENT TABLES—Tables which give daily predictions of the times and speeds of the tidal currents. These predictions are usually supplemented by current differences and constants through which additional predictions can be obtained for numerous other places.

TIDAL DIFFERENCE—Difference in time or height of a high or low water at a subordinate station and at a reference station for which predictions are given in the *Tide Tables.* The difference, when applied according to sign to the prediction at the reference station, gives the corresponding time or height for the subordinate station .

TIDE—The periodic rise and fall of the water resulting from gravitational interactions between the Sun, Moon, and Earth. The vertical component of the particulate motion of a tidal wave. Although the accompanying horizontal movement of the water is part of the same phenomenon, it is preferable to designate the motion as tidal current.

TIDE TABLES—Tables which give daily predictions of the times and heights of high and low waters. These predictions are usually supplemented by tidal differences and constants through which additional predictions can be obtained for numerous other places.

TIME MERIDIAN—A meridian used as a reference for time.

TROPIC CURRENTS—Tidal currents occurring semimonthly when the effect of the Moon's maximum declination is greatest. At these times the tendency of the Moon to produce a diurnal inequality in the current is at a maximum.

TROPIC RANGES—The *great tropic range* (Gc), or *tropic range,* is the difference in height between tropic higher high water and tropic lower low water. The *small tropic range* (Sc) is the difference in height between tropic lower high water and tropic higher low water. The *mean tropic range* (Mc) is the mean between the great tropic range and the small tropic range. The small tropic range and the mean tropic range are applicable only when the type of tide is semidiurnal or mixed. Tropic ranges are most conveniently computed from the harmonic constants.

TROPIC TIDES—Tides occurring semimonthly when the effect of the Moon's maximum declination is greatest. At these times there is a tendency for an increase in the diurnal range. The tidal datums pertaining to the tropic tides are designated as *tropic higher high water* (TcHHW), *tropic lower high water* (TcLHW), *tropic higher low water* (TcHLW), and *tropic lower low water* (TcLLW).

TYPE OF TIDE—A classification based on characteristic forms of a tide curve. Qualitatively, when the two high waters and two low waters of each tidal day are approximately equal in height, the tide is said to be *semidiurnal;* when there is a relatively large diurnal inequality in the high or low waters or both, it is said to be *mixed;* and when there is only one high water and one low water in each tidal day, it is said to be *diurnal.*

VANISHING TIDE—In a mixed tide with very large diurnal inequality, the lower high water (or higher low water) frequently becomes indistinct (or vanishes) at time of extreme declinations. During these periods the diurnal tide has such overriding dominance that the semidiurnal tide, although still present, cannot be readily seen on the tide curve.

INDEX TO STATIONS
(Numbers refer to table 2)

[Stations marked with an asterisk (*) are reference stations for which daily predictions are given in table 1. Page numbers of reference stations are given in parentheses.]

TABLE 2 – TIDAL DIFFERENCES AND OTHER CONSTANTS

No.	PLACE	POSITION Latitude	Longitude	DIFFERENCES Time High Water	Time Low Water	Height High Water	Height Low Water	RANGES Mean	Spring	Mean Tide Level
		North	West	h m	h m	ft	ft	ft	ft	ft
	MAINE, Casco Bay–cont. Time meridian, 75° W			on Portland, p.32						
833	Little Flying Point, Maquoit Bay	43° 50'	70° 03'	–0 01	–0 01	*0.99	*0.99	9.0	10.3	4.8
835	South Freeport	43° 49'	70° 06'	+0 12	+0 10	*0.99	*0.99	9.0	10.3	4.8
837	Chebeague Point, Great Chebeague Island	43° 46'	70° 06'	–0 04	–0 09	*0.99	*0.99	9.0	10.4	4.8
839	Prince Point	43° 46'	70° 10'	0 00	0 00	*1.01	*1.00	9.2	10.6	4.9
841	Doyle Point	43° 45'	70° 08'	–0 02	–0 03	*1.00	*0.88	9.2	10.5	4.9
843	Falmouth Foreside	43° 44'	70° 12'	+0 01	0 00	*1.00	*1.03	9.1	10.5	4.9
845	Great Chebeague Island	43° 43'	70° 08'	+0 03	+0 03	*1.00	*1.00	9.1	10.5	4.9
847	Cliff Island, Luckse Sound	43° 42'	70° 07'	–0 02	–0 02	*1.00	*1.00	9.1	10.4	4.9
849	Vaill Island	43° 41'	70° 09'	+0 05	+0 01	*0.98	*1.03	9.0	10.3	4.8
851	Long Island	43° 41'	70° 10'	–0 01	0 00	*1.00	*1.00	9.1	10.4	4.9
853	Cow Island	43° 41'	70° 11'	–0 01	0 00	*1.00	*1.00	9.1	10.5	4.9
855	Presumpscot River Bridge	43° 41'	70° 15'	+0 01	+0 04	*1.01	*1.06	9.2	10.6	5.0
857	Back Cove	43° 41'	70° 15'	+0 02	+0 06	*0.97	*0.97	9.1	10.5	4.9
859	Great Diamond Island	43° 40'	70° 12'	–0 01	0 00	*0.99	*1.00	9.0	10.4	4.9
861	Peaks Island	43° 39'	70° 12'	–0 04	–0 08	*0.99	*0.99	9.0	10.4	4.8
863	Cushing Island	43° 39'	70° 12'	+0 01	0 00	*0.99	*1.00	9.0	10.4	4.9
865	PORTLAND	43° 40'	70° 15'	*Daily predictions*				9.1	10.4	4.9
867	Fore River	43° 38'	70° 17'	+0 02	+0 02	*1.00	*1.00	9.1	10.5	4.9
869	Portland Head Light	43° 37'	70° 12'	–0 02	–0 02	*0.97	*0.97	8.9	10.2	4.8
	MAINE, outer coast–cont.									
871	Richmond Island	43° 33'	70° 14'	–0 03	–0 03	*0.98	*0.98	8.9	10.1	4.8
873	Old Orchard Beach	43° 31'	70° 22'	0 00	–0 06	*0.97	*0.97	8.8	10.1	4.7
875	Wood Island Harbor	43° 27'	70° 21'	+0 02	–0 04	*0.96	*0.96	8.7	9.9	4.7
877	Cape Porpoise	43° 22'	70° 26'	+0 12	+0 14	*0.95	*0.95	8.7	9.9	4.7
879	Kennebunkport	43° 21'	70° 28'	+0 16	+0 16	*0.94	*0.94	8.6	9.9	4.6
881	York Harbor	43° 08'	70° 38'	+0 03	+0 13	*0.95	*0.95	8.6	9.9	4.6
883	Seapoint, Cutts Island	43° 05'	70° 40'	+0 01	–0 04	*0.96	*0.96	8.8	10.1	4.7
	MAINE and NEW HAMPSHIRE									
	Portsmouth Harbor									
885	Jaffrey Point	43° 03'	70° 43'	–0 03	–0 05	*0.95	*0.95	8.7	10.0	4.7
887	Gerrish Island	43° 04'	70° 42'	–0 02	–0 03	*0.95	*0.95	8.7	10.0	4.7
889	Fort Point	43° 04'	70° 43'	+0 03	+0 07	*0.94	*0.94	8.6	9.9	4.6
891	Kittery Point	43° 05'	70° 42'	–0 07	+0 01	*0.96	*0.96	8.7	10.0	4.7
893	Seavey Island	43° 05'	70° 45'	+0 20	+0 18	*0.89	*0.89	8.1	9.4	4.4
895	Portsmouth	43° 05'	70° 45'	+0 22	+0 17	*0.86	*0.86	7.8	9.0	4.2
	Piscataqua River									
897	Atlantic Heights	43° 05'	70° 46'	+0 37	+0 28	*0.82	*0.82	7.5	8.6	4.0
899	Dover Point	43° 07'	70° 50'	+1 33	+1 27	*0.70	*0.70	6.4	7.4	3.4
901	Salmon Falls River entrance	43° 11'	70° 50'	+1 35	+1 52	*0.75	*0.75	6.8	7.8	3.6
903	Squamscott River RR. Bridge	43° 03'	70° 55'	+2 19	+2 41	*0.75	*0.75	6.8	7.8	3.6
905	Gosport Harbor, Isles of Shoals	42° 59'	70° 37'	+0 02	–0 02	*0.93	*0.93	8.5	9.8	4.5
907	Hampton Harbor	42° 54'	70° 49'	+0 14	+0 32	*0.91	*0.91	8.3	9.5	4.5
	MASSACHUSETTS, outer coast									
909	Merrimack River entrance	42° 49'	70° 49'	+0 20	+0 24	*0.91	*0.91	8.3	9.5	4.4
911	Newburyport, Merrimack River	42° 49'	70° 52'	+0 31	+1 11	*0.86	*0.86	7.8	9.0	4.2
913	Plum Island Sound (south end)	42° 43'	70° 47'	+0 12	+0 37	*0.94	*0.94	8.6	9.9	4.6
915	Annisquam	42° 39'	70° 41'	0 00	–0 07	*0.96	*0.96	8.7	10.1	4.7
917	Rockport	42° 40'	70° 37'	+0 04	+0 02	*0.94	*0.94	8.6	10.0	4.6
				on Boston, p.36						
919	Gloucester Harbor	42° 36'	70° 40'	–0 01	–0 04	*0.91	*0.91	8.7	10.1	4.6
921	Manchester Harbor	42° 34'	70° 47'	0 00	–0 04	*0.92	*0.92	8.8	10.2	4.7
923	Beverly	42° 32'	70° 53'	+0 02	–0 03	*0.94	*0.94	9.0	10.4	4.8
925	Salem	42° 31'	70° 53'	+0 04	+0 03	*0.92	*0.92	8.8	10.2	4.7
927	Marblehead	42° 30'	70° 51'	0 00	–0 04	*0.95	*0.95	9.1	10.6	4.8
	Broad Sound									
929	Nahant	42° 25'	70° 55'	+0 01	0 00	*0.94	*0.94	9.0	10.4	4.8
931	Lynn Harbor	42° 27'	70° 58'	+0 10	+0 06	*0.96	*0.96	9.2	10.7	4.9
	Boston Harbor									
933	Boston Light	42° 20'	70° 53'	+0 02	+0 03	*0.94	*0.94	9.0	10.4	4.8
935	Lovell Island, The Narrows	42° 20'	70° 56'	+0 04	+0 03	*0.95	*0.95	9.1	10.6	4.8
937	Deer Island (south end)	42° 21'	70° 58'	+0 01	0 00	*0.97	*0.97	9.3	10.8	4.9
939	Belle Isle Inlet entrance	42° 23'	71° 00'	+0 20	+0 17	*1.00	*1.00	9.5	11.0	5.0
941	Castle Island	42° 20'	71° 01'	0 00	+0 02	*0.99	*0.99	9.4	10.9	5.0
943	BOSTON	42° 21'	71° 03'	*Daily predictions*				9.5	11.0	5.1
945	Dover St. Bridge, Fort Point Channel	42° 21'	71° 04'	+0 06	+0 08	*1.01	*1.01	9.6	11.0	5.1
	Charles River									
947	Charlestown Bridge	42° 22'	71° 04'	+0 04	+0 04	*1.00	*1.00	9.5	11.0	5.0
949	Charles River Dam	42° 22'	71° 04'	+0 07	+0 06	*1.00	*1.00	9.5	11.0	5.0
951	Charlestown	42° 22'	71° 03'	0 00	+0 01	*1.00	*1.00	9.5	11.0	5.0
953	Chelsea St. Bridge, Chelsea River	42° 23'	71° 01'	+0 01	+0 06	*1.01	*1.01	9.6	11.1	5.1
955	Neponset, Neponset River	42° 17'	71° 02'	–0 02	+0 03	*1.00	*1.00	9.5	11.0	5.0
957	Moon Head	42° 19'	70° 59'	+0 01	+0 04	*0.99	*0.99	9.4	10.9	5.0
959	Rainsford Island, Nantasket Roads	42° 19'	70° 57'	0 00	+0 02	*0.95	*0.95	9.1	10.6	4.8

TABLE 2 – TIDAL DIFFERENCES AND OTHER CONSTANTS

No.	PLACE	POSITION		DIFFERENCES				RANGES		Mean Tide Level
		Latitude	Longitude	Time		Height		Mean	Spring	
				High Water	Low Water	High Water	Low Water			
		North	West	h m	h m	ft	ft	ft	ft	ft
	MASSACHUSETTS–cont. Vineyard Sound Time meridian, 75° W			**on Newport, p.40**						
1085	Nobska Point	41° 31'	70° 39'	+0 41	+2 05	*0.43	*0.43	1.5	1.9	0.8
	Woods Hole									
1087	Little Harbor	41° 31'	70° 40'	+0 32	+2 21	*0.40	*0.40	1.4	1.8	0.8
1089	Oceanographic Institution	41° 32'	70° 40'	+0 22	+1 59	*0.52	*0.50	1.8	2.3	1.0
1091	Uncatena Island (south side)	41° 31'	70° 42'	+0 12	+0 22	*1.02	*1.02	3.6	4.5	1.9
1093	Tarpaulin Cove	41° 28'	70° 46'	+0 11	+1 23	*0.54	*0.54	1.9	2.4	1.0
	Quicks Hole									
1095	South side	41° 26'	70° 51'	–0 10	+0 09	*0.71	*0.71	2.5	3.1	1.3
1097	Middle	41° 27'	70° 51'	0 00	+0 10	*0.85	*0.85	3.0	3.7	1.6
1099	North side	41° 27'	70° 51'	–0 08	–0 08	*0.99	*0.99	3.5	4.4	1.8
	Buzzards Bay									
1101	Cuttyhunk Pond entrance	41° 25'	70° 55'	+0 01	+0 01	*0.97	*0.97	3.4	4.2	1.8
1103	Penikese Island	41° 27'	70° 55'	–0 17	–0 16	*0.97	*0.97	3.4	4.2	1.8
1105	Kettle Cove	41° 29'	70° 47'	+0 09	+0 02	*1.08	*1.08	3.8	4.7	2.1
1107	Chappaquoit Point, West Falmouth Harbor	41° 36'	70° 39'	+0 10	+0 20	*1.10	*1.07	3.9	4.9	2.1
1109	West Falmouth Harbor	41° 36'	70° 39'	+0 21	+0 18	*1.14	*1.14	4.0	5.0	2.2
1111	Barlows Landing, Pocasset Harbor	41° 41'	70° 38'	+0 24	+0 18	*1.14	*1.14	4.0	5.0	2.2
1113	Abiels Ledge	41° 42'	70° 40'	+0 11	+0 16	*1.11	*1.11	3.9	4.9	2.2
1115	Monument Beach	41° 43'	70° 37'	+0 23	+0 18	*1.14	*1.14	4.0	5.0	2.2
1117	Cape Cod Canal, RR. bridge <6>	41° 44'	70° 37'	+1 15	– – –	*0.99	*0.99	3.5	4.1	1.9
1119	Great Hill	41° 43'	70° 43'	+0 12	+0 11	*1.15	*1.21	4.0	5.0	2.2
1121	Wareham, Wareham River	41° 45'	70° 43'	+0 22	+0 16	*1.16	*1.16	4.1	5.1	2.2
1123	Bird Island	41° 40'	70° 43'	+0 05	–0 02	*1.19	*1.19	4.2	5.2	2.3
1125	Marion, Sippican Harbor	41° 42'	70° 46'	+0 10	+0 12	*1.13	*1.29	4.0	4.9	2.2
1127	Mattapoisett, Mattapoisett Harbor	41° 39'	70° 49'	+0 11	+0 20	*1.09	*1.00	3.9	4.8	2.1
1129	West Island (west side)	41° 36'	70° 50'	+0 09	+0 08	*1.05	*1.05	3.7	4.6	1.9
1131	Clarks Point	41° 36'	70° 54'	+0 14	+0 24	*1.06	*1.00	3.6	4.5	2.0
1133	New Bedford	41° 38'	70° 55'	+0 07	+0 07	*1.05	*1.05	3.7	4.6	1.9
1135	Belleville, Acushnet River	41° 40'	70° 55'	+0 07	+0 09	*1.08	*1.08	3.8	4.7	2.1
1137	South Dartmouth, Apponagansett Bay	41° 35'	70° 57'	+0 25	+0 33	*1.05	*1.05	3.7	4.6	1.9
1139	Dumpling Rocks	41° 32'	70° 55'	+0 01	–0 02	*1.05	*1.05	3.7	4.6	1.9
	Westport River									
1141	Westport Harbor	41° 30'	71° 06'	+0 09	+0 33	*0.85	*0.85	3.0	3.7	1.6
1143	Hix Bridge, East Branch	41° 34'	71° 04'	+1 40	+2 30	*0.77	*0.77	2.7	3.4	1.4
	RHODE ISLAND, Narragansett Bay									
1145	Sakonnet	41° 28'	71° 12'	–0 13	–0 01	*0.88	*0.86	3.1	3.9	1.7
1147	Anthony Point, Sakonnet River	41° 38'	71° 13'	–0 02	–0 02	*1.09	*1.07	3.8	4.8	2.1
1149	Beavertail Point	41° 27'	71° 24'	–0 05	+0 04	*0.99	*1.00	3.5	4.3	1.9
1151	Castle Hill	41° 28'	71° 22'	–0 05	+0 12	*0.94	*0.93	3.3	4.1	1.8
1153	NEWPORT	41° 30'	71° 20'	*Daily predictions*				3.5	4.4	1.9
1155	Conanicut Point	41° 34'	71° 22'	+0 07	–0 06	*1.07	*1.07	3.8	4.7	2.0
1157	Prudence Island, (south end)	41° 35'	71° 19'	+0 08	–0 04	*1.08	*1.07	3.8	4.8	2.0
1159	Bristol Point	41° 39'	71° 16'	+0 18	+0 07	*1.14	*1.14	4.0	5.0	2.1
1161	Bristol Highlands	41° 42'	71° 18'	+0 08	–0 07	*1.18	*1.21	4.2	5.2	2.2
1163	Bristol Ferry	41° 38'	71° 15'	+0 16	+0 01	*1.16	*1.14	4.1	5.1	2.2
1165	Fall River, State Pier	41° 42'	71° 10'	+0 19	–0 01	*1.25	*1.25	4.4	5.5	2.4
	RHODE ISLAND and MASSACHUSETTS Narragansett Bay–cont.									
1167	Fall River, Massachusetts	41° 44'	71° 08'	+0 28	+0 29	*1.26	*1.26	4.4	5.5	2.4
1169	Taunton, Taunton River, Massachusetts	41° 53'	71° 06'	+1 06	+2 21	*0.79	*0.79	2.8	3.5	1.5
1171	Bristol, Bristol Harbor	41° 40'	71° 17'	+0 13	0 00	*1.16	*1.14	4.1	5.1	2.2
1173	Warren	41° 44'	71° 17'	+0 18	–0 01	*1.31	*1.29	4.6	5.7	2.5
1175	Nayatt Point	41° 43'	71° 20'	+0 09	–0 02	*1.31	*1.29	4.6	5.7	2.5
1177	Providence, State Pier #1	41° 48'	71° 24'	+0 11	–0 01	*1.28	*1.29	4.5	5.6	2.4
1179	Pawtucket, Seekonk River	41° 52'	71° 23'	+0 18	+0 09	*1.31	*1.29	4.6	5.8	2.5
1181	East Greenwich	41° 40'	71° 27'	+0 13	+0 03	*1.14	*1.14	4.0	5.0	2.1
1183	Wickford	41° 34'	71° 27'	+0 09	+0 02	*1.08	*1.07	3.8	4.7	2.0
1185	Narragansett Pier	41° 25'	71° 27'	–0 11	+0 11	*0.91	*0.93	3.2	4.0	1.7
	RHODE ISLAND, Outer Coast									
1187	Point Judith Harbor of Refuge	41° 22'	71° 29'	–0 10	+0 17	*0.88	*0.86	3.1	3.9	1.6
1189	Block Island (Great Salt Pond)	41° 11'	71° 35'	+0 02	+0 07	*0.74	*0.71	2.6	3.2	1.4
1191	Block Island (Old Harbor)	41° 10'	71° 33'	–0 17	+0 12	*0.83	*0.86	2.9	3.6	1.5
1193	Watch Hill Point	41° 18'	71° 52'	+0 41	+1 16	*0.74	*0.71	2.6	3.2	1.4
				on New London, p.48						
1195	Westerly, Pawcatuck River	41° 23'	71° 50'	–0 21	+0 03	*1.02	*1.00	2.6	3.1	1.5
	CONNECTICUT, Long Island Sound									
1197	Stonington, Fishers Island Sound	41° 20'	71° 54'	–0 32	–0 41	*1.05	*1.05	2.7	3.2	1.5
1199	Noank, Mystic River entrance	41° 19'	71° 59'	–0 22	–0 08	*0.89	*0.90	2.3	2.7	1.4
1201	West Harbor, Fishers Island, N.Y.	41° 16'	72° 00'	0 00	–0 06	*0.97	*0.97	2.5	3.0	1.4
1203	Silver Eel Pond, Fishers Island, N.Y.	41° 15'	72° 02'	–0 16	–0 04	*0.89	*0.89	2.3	2.7	1.3

Portland, Maine, 1997

Times and Heights of High and Low Waters

January

Day	Time (h m)	Height (ft)	Height (cm)
1 W	0349	8.4	256
	0954	1.5	46
	1604	8.3	253
◑	2215	1.1	34
2 Th	0437	8.5	259
	1048	1.4	43
	1657	8.1	247
	2305	1.2	37
3 F	0527	8.7	265
	1144	1.3	40
	1754	8.0	244
	2358	1.1	34
4 Sa	0619	8.9	271
	1241	0.9	27
	1851	8.2	250
5 Su	0052	1.0	30
	0712	9.4	287
	1337	0.4	12
	1948	8.4	256
6 M	0145	0.7	21
	0804	9.9	302
	1430	−0.2	−6
	2042	8.8	268
7 Tu	0238	0.3	9
	0855	10.5	320
	1521	−0.8	−24
	2134	9.3	283
8 W	0329	−0.2	−6
	0945	11.0	335
	1611	−1.3	−40
●	2224	9.7	296
9 Th	0420	−0.6	−18
	1035	11.4	347
	1700	−1.7	−52
	2314	10.1	308
10 F	0512	−0.9	−27
	1127	11.6	354
	1750	−2.0	−61
11 Sa	0005	10.3	314
	0604	−1.0	−30
	1219	11.5	351
	1841	−1.9	−58
12 Su	0058	10.5	320
	0659	−1.0	−30
	1313	11.2	341
	1934	−1.7	−52
13 M	0152	10.4	317
	0756	−0.8	−24
	1410	10.8	329
	2028	−1.3	−40
14 Tu	0248	10.3	314
	0856	−0.5	−15
	1510	10.2	311
	2125	−0.8	−24
15 W	0348	10.1	308
	1000	−0.2	−6
	1614	9.6	293
◐	2226	−0.3	−9
16 Th	0449	9.9	302
	1107	0.0	0
	1721	9.1	277
	2328	0.1	3
17 F	0552	9.8	299
	1215	0.1	3
	1828	8.8	268
18 Sa	0032	0.5	15
	0655	9.7	296
	1319	0.1	3
	1933	8.6	262
19 Su	0132	0.6	18
	0753	9.7	296
	1418	0.0	0
	2031	8.6	262
20 M	0228	0.6	18
	0846	9.8	299
	1511	−0.1	−3
	2123	8.7	265
21 Tu	0318	0.6	18
	0934	9.9	302
	1557	−0.2	−6
	2209	8.8	268
22 W	0402	0.6	18
	1016	9.9	302
	1639	−0.3	−9
	2250	8.8	268
23 Th	0442	0.5	15
	1055	9.9	302
	1716	−0.3	−9
○	2327	8.9	271
24 F	0520	0.5	15
	1131	9.8	299
	1751	−0.2	−6
25 Sa	0002	8.9	271
	0555	0.6	18
	1206	9.7	296
	1824	−0.1	−3
26 Su	0036	8.9	271
	0631	0.6	18
	1241	9.5	290
	1857	0.1	3
27 M	0110	8.8	268
	0707	0.7	21
	1317	9.3	283
	1931	0.2	6
28 Tu	0145	8.8	268
	0745	0.8	24
	1356	9.0	274
	2007	0.4	12
29 W	0222	8.8	268
	0826	0.9	27
	1437	8.7	265
	2046	0.7	21
30 Th	0303	8.8	268
	0912	1.0	30
	1522	8.4	256
	2130	0.9	27
31 F	0348	8.8	268
	1002	1.0	30
	1613	8.2	250
◑	2218	1.0	30

February

Day	Time (h m)	Height (ft)	Height (cm)
1 Sa	0438	8.9	271
	1058	1.0	30
	1709	8.1	247
	2313	1.1	34
2 Su	0533	9.0	274
	1158	0.7	21
	1811	8.1	247
3 M	0012	0.9	27
	0632	9.4	287
	1300	0.3	9
	1914	8.4	256
4 Tu	0113	0.6	18
	0732	9.9	302
	1401	−0.2	−6
	2014	8.8	268
5 W	0212	0.2	6
	0830	10.5	320
	1457	−0.9	−27
	2111	9.4	287
6 Th	0309	−0.4	−12
	0926	11.0	335
	1550	−1.5	−46
	2204	10.0	305
7 F	0403	−0.9	−27
	1020	11.5	351
	1641	−1.9	−58
●	2256	10.5	320
8 Sa	0457	−1.4	−43
	1112	11.7	357
	1732	−2.1	−64
	2347	10.8	329
9 Su	0550	−1.6	−49
	1205	11.6	354
	1822	−2.1	−64
10 M	0038	11.0	335
	0644	−1.6	−49
	1259	11.3	344
	1913	−1.8	−55
11 Tu	0130	10.9	332
	0739	−1.3	−40
	1354	10.8	329
	2005	−1.3	−40
12 W	0224	10.7	326
	0836	−0.9	−27
	1451	10.1	308
	2100	−0.7	−21
13 Th	0320	10.3	314
	0937	−0.5	−15
	1552	9.4	287
	2159	−0.1	−3
14 F	0420	9.9	302
	1042	0.0	0
	1657	8.9	271
◐	2301	0.5	15
15 Sa	0523	9.5	290
	1149	0.3	9
	1804	8.5	259
16 Su	0005	0.9	27
	0627	9.3	283
	1255	0.4	12
	1910	8.3	253
17 M	0109	1.1	34
	0729	9.2	280
	1355	0.4	12
	2009	8.3	253
18 Tu	0207	1.0	30
	0824	9.3	283
	1448	0.3	9
	2101	8.5	259
19 W	0258	0.9	27
	0913	9.4	287
	1535	0.2	6
	2146	8.6	262
20 Th	0342	0.7	21
	0956	9.6	293
	1615	0.1	3
	2226	8.8	268
21 F	0422	0.6	18
	1035	9.6	293
	1651	0.0	0
	2302	9.0	274
22 Sa	0458	0.4	12
	1110	9.7	296
	1724	0.0	0
○	2334	9.1	277
23 Su	0533	0.3	9
	1144	9.6	293
	1755	0.0	0
24 M	0006	9.1	277
	0606	0.3	9
	1217	9.5	290
	1826	0.1	3
25 Tu	0037	9.2	280
	0640	0.3	9
	1251	9.3	283
	1858	0.2	6
26 W	0109	9.2	280
	0716	0.4	12
	1327	9.1	277
	1932	0.4	12
27 Th	0145	9.2	280
	0755	0.4	12
	1406	8.9	271
	2011	0.6	18
28 F	0224	9.2	280
	0838	0.5	15
	1450	8.6	262
	2054	0.8	24

March

Day	Time (h m)	Height (ft)	Height (cm)
1 Sa	0308	9.2	280
	0927	0.6	18
	1540	8.4	256
	2143	0.9	27
2 Su	0359	9.2	280
	1022	0.6	18
	1636	8.3	253
◑	2239	1.0	30
3 M	0457	9.3	283
	1125	0.5	15
	1740	8.3	253
	2342	0.9	27
4 Tu	0601	9.5	290
	1230	0.2	6
	1847	8.5	259
5 W	0048	0.6	18
	0707	9.9	302
	1335	−0.2	−6
	1951	9.1	277
6 Th	0152	0.1	3
	0810	10.4	317
	1435	−0.8	−24
	2050	9.7	296
7 F	0252	−0.5	−15
	0909	10.9	332
	1530	−1.3	−40
	2144	10.4	317
8 Sa	0349	−1.2	−37
	1005	11.3	344
	1622	−1.7	−52
●	2236	10.9	332
9 Su	0443	−1.6	−49
	1058	11.5	351
	1712	−1.9	−58
	2326	11.3	344
10 M	0535	−1.9	−58
	1150	11.5	351
	1801	−1.8	−55
11 Tu	0016	11.4	347
	0627	−1.8	−55
	1242	11.2	341
	1850	−1.5	−46
12 W	0106	11.2	341
	0720	−1.6	−49
	1335	10.6	323
	1941	−1.0	−30
13 Th	0157	10.8	329
	0814	−1.1	−34
	1430	10.0	305
	2034	−0.3	−9
14 F	0251	10.3	314
	0911	−0.5	−15
	1528	9.3	283
	2130	0.3	9
15 Sa	0348	9.8	299
	1012	0.1	3
	1629	8.7	265
◐	2230	0.9	27
16 Su	0449	9.3	283
	1117	0.5	15
	1734	8.3	253
	2335	1.3	40
17 M	0553	9.0	274
	1222	0.8	24
	1838	8.2	250
18 Tu	0039	1.5	46
	0656	8.8	268
	1323	0.8	24
	1938	8.2	250
19 W	0138	1.4	43
	0754	8.9	271
	1417	0.8	24
	2030	8.4	256
20 Th	0231	1.2	37
	0845	9.1	277
	1503	0.6	18
	2115	8.7	265
21 F	0316	0.9	27
	0929	9.2	280
	1544	0.5	15
	2155	8.9	271
22 Sa	0357	0.6	18
	1009	9.4	287
	1620	0.4	12
	2230	9.2	280
23 Su	0433	0.4	12
	1045	9.5	290
	1652	0.3	9
○	2302	9.4	287
24 M	0507	0.2	6
	1119	9.5	290
	1723	0.3	9
	2333	9.5	290
25 Tu	0540	0.1	3
	1152	9.5	290
	1754	0.3	9
26 W	0004	9.6	293
	0614	0.0	0
	1226	9.4	287
	1827	0.4	12
27 Th	0037	9.7	296
	0650	0.0	0
	1302	9.2	280
	1902	0.5	15
28 F	0113	9.7	296
	0729	0.0	0
	1342	9.1	277
	1942	0.6	18
29 Sa	0154	9.7	296
	0813	0.1	3
	1427	8.9	271
	2027	0.7	21
30 Su	0240	9.6	293
	0902	0.2	6
	1517	8.7	265
	2118	0.9	27
31 M	0333	9.6	293
	0958	0.3	9
	1615	8.6	262
◑	2217	1.0	30

Newport, R.I., 1997

Times and Heights of High and Low Waters

January

Day	Time (h m)	Height (ft)	Height (cm)
1 W ◑	0037	2.9	88
	0537	0.5	15
	1255	2.8	85
	1802	0.3	9
2 Th	0130	3.0	91
	0634	0.6	18
	1350	2.8	85
	1855	0.3	9
3 F	0225	3.1	94
	0738	0.6	18
	1446	2.8	85
	1954	0.2	6
4 Sa	0320	3.3	101
	0846	0.4	12
	1542	2.9	88
	2056	0.1	3
5 Su	0412	3.6	110
	0951	0.2	6
	1635	3.2	98
	2157	−0.2	−6
6 M	0503	4.0	122
	1051	−0.1	−3
	1727	3.4	104
	2254	−0.4	−12
7 Tu	0553	4.3	131
	1146	−0.4	−12
	1817	3.7	113
	2349	−0.7	−21
8 W ●	0642	4.6	140
	1237	−0.7	−21
	1907	3.9	119
9 Th	0042	−0.9	−27
	0731	4.7	143
	1326	−0.9	−27
	1956	4.1	125
10 F	0134	−1.0	−30
	0821	4.7	143
	1414	−0.9	−27
	2047	4.2	128
11 Sa	0226	−1.0	−30
	0911	4.6	140
	1503	−0.9	−27
	2138	4.2	128
12 Su	0319	−0.8	−24
	1003	4.4	134
	1552	−0.8	−24
	2232	4.1	125
13 M	0413	−0.6	−18
	1057	4.1	125
	1643	−0.6	−18
	2327	4.0	122
14 Tu	0511	−0.3	−9
	1153	3.8	116
	1737	−0.3	−9
15 W ◐	0026	3.8	116
	0616	0.0	0
	1252	3.5	107
	1836	−0.1	−3
16 Th	0126	3.7	113
	0733	0.2	6
	1352	3.2	98
	1943	0.1	3
17 F	0227	3.7	113
	0859	0.3	9
	1453	3.1	94
	2055	0.2	6
18 Sa	0326	3.7	113
	1015	0.3	9
	1550	3.1	94
	2203	0.1	3
19 Su	0421	3.7	113
	1112	0.2	6
	1644	3.1	94
	2257	0.1	3
20 M	0512	3.8	116
	1158	0.1	3
	1733	3.2	98
	2342	0.0	0
21 Tu	0558	3.9	119
	1234	0.0	0
	1818	3.3	101
22 W	0019	−0.1	−3
	0642	3.9	119
	1303	0.0	0
	1901	3.4	104
23 Th ○	0052	−0.1	−3
	0723	3.9	119
	1329	−0.1	−3
	1942	3.5	107
24 F	0124	−0.2	−6
	0803	3.9	119
	1355	−0.1	−3
	2023	3.5	107
25 Sa	0155	−0.2	−6
	0843	3.8	116
	1422	−0.1	−3
	2103	3.4	104
26 Su	0228	−0.1	−3
	0922	3.6	110
	1452	−0.1	−3
	2143	3.4	104
27 M	0302	0.0	0
	1001	3.4	104
	1524	−0.1	−3
	2224	3.2	98
28 Tu	0338	0.1	3
	1041	3.2	98
	1558	0.0	0
	2307	3.1	94
29 W	0418	0.2	6
	1124	3.0	91
	1637	0.1	3
	2353	3.1	94
30 Th	0503	0.3	9
	1212	2.8	85
	1721	0.1	3
31 F ◑	0045	3.0	91
	0556	0.4	12
	1307	2.7	82
	1813	0.2	6

February

Day	Time (h m)	Height (ft)	Height (cm)
1 Sa	0142	3.1	94
	0656	0.4	12
	1407	2.7	82
	1913	0.1	3
2 Su	0242	3.3	101
	0806	0.3	9
	1508	2.8	85
	2020	0.0	0
3 M	0341	3.6	110
	0918	0.1	3
	1607	3.1	94
	2128	−0.2	−6
4 Tu	0437	3.9	119
	1025	−0.1	−3
	1703	3.4	104
	2234	−0.4	−12
5 W	0531	4.2	128
	1125	−0.5	−15
	1756	3.8	116
	2335	−0.7	−21
6 Th	0622	4.5	137
	1218	−0.8	−24
	1847	4.1	125
7 F ●	0031	−1.0	−30
	0713	4.7	143
	1309	−1.0	−30
	1937	4.4	134
8 Sa	0124	−1.1	−34
	0803	4.7	143
	1357	−1.1	−34
	2027	4.5	137
9 Su	0216	−1.1	−34
	0852	4.6	140
	1444	−1.0	−30
	2117	4.5	137
10 M	0307	−1.0	−30
	0943	4.4	134
	1531	−0.9	−27
	2209	4.4	134
11 Tu	0359	−0.7	−21
	1034	4.1	125
	1618	−0.6	−18
	2302	4.1	125
12 W	0452	−0.4	−12
	1128	3.7	113
	1708	−0.3	−9
	2358	3.9	119
13 Th	0551	−0.1	−3
	1224	3.3	101
	1802	0.0	0
14 F ◐	0057	3.6	110
	0701	0.3	9
	1324	3.1	94
	1904	0.2	6
15 Sa	0158	3.5	107
	0830	0.4	12
	1425	2.9	88
	2023	0.4	12
16 Su	0258	3.4	104
	0955	0.5	15
	1525	2.9	88
	2145	0.4	12
17 M	0356	3.4	104
	1055	0.4	12
	1620	3.0	91
	2247	0.3	9
18 Tu	0448	3.5	107
	1139	0.3	9
	1709	3.1	94
	2331	0.2	6
19 W	0535	3.6	110
	1212	0.2	6
	1755	3.3	101
20 Th	0006	0.0	0
	0618	3.7	113
	1238	0.1	3
	1837	3.5	107
21 F	0036	−0.1	−3
	0659	3.7	113
	1301	0.0	0
	1917	3.6	110
22 Sa ○	0105	−0.2	−6
	0738	3.8	116
	1326	−0.1	−3
	1956	3.6	110
23 Su	0135	−0.2	−6
	0817	3.7	113
	1353	−0.2	−6
	2035	3.6	110
24 M	0207	−0.2	−6
	0855	3.6	110
	1422	−0.2	−6
	2113	3.6	110
25 Tu	0240	−0.2	−6
	0932	3.4	104
	1453	−0.2	−6
	2152	3.5	107
26 W	0315	−0.1	−3
	1011	3.2	98
	1528	−0.1	−3
	2232	3.4	104
27 Th	0353	0.0	0
	1052	3.0	91
	1606	−0.1	−3
	2316	3.3	101
28 F	0437	0.1	3
	1139	2.9	88
	1650	0.0	0

March

Day	Time (h m)	Height (ft)	Height (cm)
1 Sa	0007	3.2	98
	0527	0.2	6
	1234	2.8	85
	1742	0.1	3
2 Su ◑	0106	3.2	98
	0626	0.3	9
	1336	2.8	85
	1843	0.1	3
3 M	0210	3.3	101
	0735	0.2	6
	1441	2.9	88
	1953	0.1	3
4 Tu	0313	3.5	107
	0850	0.1	3
	1543	3.2	98
	2109	−0.1	−3
5 W	0413	3.8	116
	1002	−0.2	−6
	1641	3.6	110
	2220	−0.4	−12
6 Th	0509	4.1	125
	1104	−0.5	−15
	1735	4.0	122
	2324	−0.7	−21
7 F	0602	4.4	134
	1158	−0.8	−24
	1827	4.3	131
8 Sa ●	0020	−1.0	−30
	0653	4.6	140
	1248	−1.0	−30
	1917	4.6	140
9 Su	0113	−1.1	−34
	0743	4.6	140
	1335	−1.1	−34
	2006	4.7	143
10 M	0203	−1.2	−37
	0832	4.5	137
	1421	−1.0	−30
	2055	4.7	143
11 Tu	0252	−1.0	−30
	0921	4.3	131
	1506	−0.8	−24
	2144	4.5	137
12 W	0341	−0.7	−21
	1011	4.0	122
	1551	−0.6	−18
	2235	4.2	128
13 Th	0430	−0.4	−12
	1102	3.6	110
	1637	−0.2	−6
	2329	3.9	119
14 F	0522	0.0	0
	1157	3.3	101
	1726	0.1	3
15 Sa ◐	0025	3.6	110
	0622	0.3	9
	1255	3.0	91
	1823	0.4	12
16 Su	0125	3.3	101
	0741	0.6	18
	1355	2.8	85
	1938	0.6	18
17 M	0226	3.2	98
	0917	0.6	18
	1455	2.8	85
	2118	0.6	18
18 Tu	0325	3.1	94
	1022	0.6	18
	1551	2.9	88
	2227	0.5	15
19 W	0418	3.2	98
	1104	0.5	15
	1641	3.1	94
	2311	0.4	12
20 Th	0506	3.3	101
	1134	0.3	9
	1727	3.3	101
	2344	0.2	6
21 F	0549	3.5	107
	1159	0.2	6
	1809	3.6	110
22 Sa	0013	0.0	0
	0631	3.6	110
	1223	0.0	0
	1849	3.7	113
23 Su ○	0042	−0.1	−3
	0710	3.7	113
	1250	−0.1	−3
	1928	3.8	116
24 M	0112	−0.2	−6
	0749	3.7	113
	1320	−0.2	−6
	2006	3.9	119
25 Tu	0144	−0.3	−9
	0827	3.6	110
	1351	−0.2	−6
	2044	3.9	119
26 W	0218	−0.3	−9
	0906	3.5	107
	1424	−0.2	−6
	2123	3.8	116
27 Th	0254	−0.3	−9
	0946	3.3	101
	1501	−0.2	−6
	2203	3.7	113
28 F	0333	−0.2	−6
	1028	3.1	94
	1541	−0.1	−3
	2248	3.6	110
29 Sa	0417	−0.1	−3
	1116	3.0	91
	1627	0.0	0
	2340	3.5	107
30 Su	0508	0.0	0
	1212	2.9	88
	1720	0.1	3
31 M ◑	0039	3.4	104
	0606	0.1	3
	1315	2.9	88
	1823	0.2	6

TABLE 3. —HEIGHT OF TIDE AT ANY TIME

EXPLANATION OF TABLE

Although the footnote of table 3 may contain sufficient explanation for finding the height of tide at any time, two examples are given here to illustrated its use.

Example 1.—Find the height of the tide at 0755 at New York (The Battery), N.Y., on a day when the predicted tides from table 1 are given as:

Low Water			*High Water*	
Time h.m.	*Height* ft		*Time* h.m.	*Height* ft
0522	0.1		1114	4.2
1741	0.6		2310	4.1

An inspection of the above example shows that the desired time falls between the two morning tides

The duration of rise is $11^h\ 14^m - 5^h\ 22^m = 5^h\ 52^m$.

The time after low water for which the height is required is $7^h\ 55^m - 5^h\ 22^m = 2^h\ 33^m$.

The range of tide is 4.2 – 0.1 = 4.1 feet.

The duration of rise or fall in table 3 is given in heavy-faced type for each 20 minutes from $4^h\ 10^m$ to $10^h\ 40^m$. The nearest tabular value to $5^h\ 52^m$, the above duration of rise, is $6^h\ 00^m$; and on the horizontal line of $6^h\ 00^m$, the nearest tabular time to $2^h\ 33^m$ after low water for which the height is required is $2^h\ 36^m$ Following down the column in which this $2^h\ 36^m$ is found to its intersection with the line of the range 4.0 feet (the nearest tabular value to the above range of 4.1 feet), the correction is found to be 1.6 feet, which being reckoned from low water, must be added, making 0.1 + 1.6 = 1.7 feet or 52 centimeters which is the required height above mean lower low water, the datum for New York.

Example 2. —Find the height of the tide at 0300 at Somewhere, U.S.A. on a day when the predicted tides are given as:

High Water			*Low Water*	
Time h.m.	*Height* ft		*Time* h.m.	*Height* ft
0012	11.3		0638	–2.0
1251	11.0		1853	–0.8

The duration of fall is $6^h\ 38^m - 00^h\ 12^m = 6^h\ 26^m$.

The time after high water for which the height is required is $3^h\ 00^m - 00^h\ 12^m = 2^h\ 48^m$.

The range of tide is 11.3 – (–2.0) = 13.3 feet.

Entering table 3 at the duration of fall of $6^h\ 20^m$, which is the nearest value to $6^h\ 26^m$, the nearest value on the horizontal line to $2^h\ 48^m$ is $2^h\ 45^m$ after high water. Follow down this column to its intersection with a range of 13.5 feet which is the nearest tabular value to 13.3 feet, one obtains 5.3 which, being calculated from high water, must be subtracted from it. The approximate height at $03^h\ 00^m$ is, therefore, 11.3 – 5.3 = 6.0 feet or 183 centimeters.

When the duration of rise or fall is greater than $10^h\ 40^m$, enter the table with one-half the given duration and with one-half the time from the nearest high or low water; but if the duration of rise or fall is less than 4 hours, enter the table with double the given duration and with double the time from the nearest high or low water.

TABLE 3. —HEIGHT OF TIDE AT ANY TIME.

Similarly, when the range of tide is greater than 20 feet, enter the table with one-half the given range. The tabular correction should then be doubled before applying it to the given high or low water height. If the range of tide is greater than 40 feet, take one-third of the range and multiply the tabular correction by 3.

If the height at any time is desired for a place listed in table 2 predictions of the high and low waters for the day in question should be obtained by the use of the difference given for the place in that table. Having obtained these predictions, the height for any intermediate time is obtained in the same manner as illustrated in the foregoing example.

GRAPHIC METHOD

If the height of the tide is required for a number of times on a certain day the full tide curve for the day may be obtained by the *one-quarter, one-tenth rule*. The procedure is as follows:

1. On cross-section paper plot the high and low water points in the order of their occurrence for the day, measuring time horizontally and height vertically. These are the basic points for the curve.
2. Draw light straight lines connecting the points representing successive high and low waters.
3. Divide each of these straight lines into four equal parts. The halfway point of each line gives another point for the curve.
4. At the quarter point adjacent to high water draw a vertical line above the point and at the quarter point adjacent to low water draw a vertical line below the point, making the length of these lines equal to one-tenth of the range between the high and low waters used. The points marking the ends of these vertical lines give two additional intermediate points for the curve.
5. Draw a smooth curve through the points of high and low waters and the intermediate points, making the curve well rounded near high and low waters. This curve will approximate the actual tide curve and heights for any time of the day may be readily scaled from it.

Caution.—Both methods presented are based on the assumption that the rise and fall conform to simple cosine curves. Therefore the heights obtained will be approximate. The roughness of approximation will vary as the tide curve differs from a cosine curve.

An example of the use of the graphical method is illustrated below. Using the same predicted tides as in example 2, the approximate height at $3^h 00^m$ could be determined as shown below.

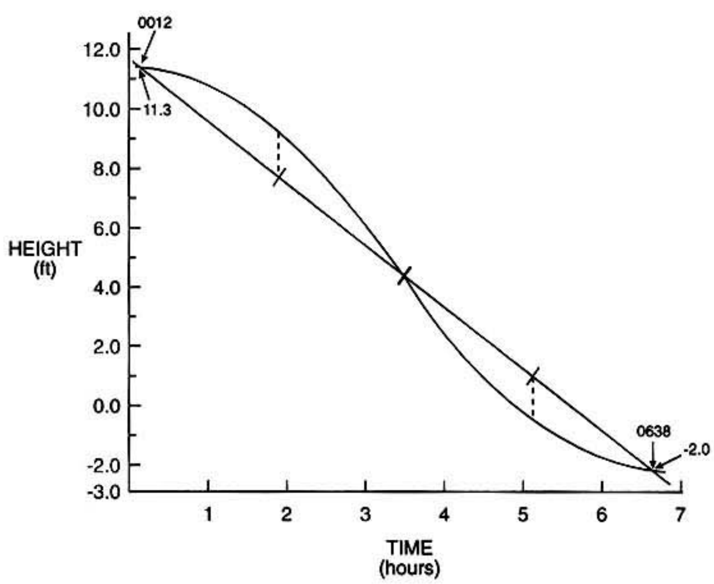


TABLE 3. —HEIGHT OF TIDE AT ANYTIME

Duration of rise or fall, see footnote	Time from the nearest high water or low water														
h. m.	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*	*h. m.*
4 10	0 08	0 16	0 24	0 32	0 40	0 48	0 56	1 04	1 12	1 20	1 28	1 36	1 44	1 52	2 00
4 20	0 09	0 17	0 26	0 35	0 43	0 52	1 01	1 09	1 18	1 27	1 35	1 44	1 53	2 01	2 10
4 40	0 09	0 19	0 28	0 37	0 47	0 56	1 05	1 15	1 24	1 33	1 43	1 52	2 01	2 11	2 20
5 00	0 10	0 20	0 30	0 40	0 50	1 00	1 10	1 20	1 30	1 40	1 50	2 00	2 10	2 20	2 30
5 20	0 11	0 21	0 32	0 43	0 53	1 04	1 15	1 25	1 36	1 47	1 57	2 08	2 19	2 29	2 40
5 40	0 11	0 23	0 34	0 45	0 57	1 08	1 19	1 31	1 42	1 53	2 05	2 16	2 27	2 39	2 50
6 00	0 12	0 24	0 36	0 48	1 00	1 12	1 24	1 36	1 48	2 00	2 12	2 24	2 36	2 48	3 00
6 20	0 13	0 25	0 38	0 51	1 03	1 16	1 29	1 41	1 54	2 07	2 19	2 32	2 45	2 57	3 10
6 40	0 13	0 27	0 40	0 53	1 07	1 20	1 33	1 47	2 00	2 13	2 27	2 40	2 53	3 07	3 20
7 00	0 14	0 28	0 42	0 56	1 10	1 24	1 38	1 52	2 06	2 20	2 34	2 48	3 02	3 16	3 30
7 20	0 15	0 29	0 44	0 59	1 13	1 28	1 43	1 57	2 12	2 27	2 41	2 56	3 11	3 25	3 40
7 40	0 15	0 31	0 46	1 01	1 17	1 32	1 47	2 03	2 18	2 33	2 49	3 04	3 19	3 35	3 50
8 00	0 16	0 32	0 48	1 04	1 20	1 36	1 52	2 08	2 24	2 40	2 56	3 12	3 28	3 44	4 00
8 20	0 17	0 33	0 50	1 07	1 23	1 40	1 57	2 13	2 30	2 47	3 03	3 20	3 37	3 53	4 10
8 40	0 17	0 35	0 52	1 09	1 27	1 44	2 01	2 19	2 36	2 53	3 11	3 28	3 45	4 03	4 20
9 00	0 18	0 36	0 54	1 12	1 30	1 48	2 06	2 24	2 42	3 00	3 18	3 36	3 54	4 12	4 30
9 20	0 19	0 37	0 56	1 15	1 33	1 52	2 11	2 29	2 48	3 07	3 25	3 44	4 03	4 21	4 40
9 40	0 19	0 39	0 58	1 17	1 37	1 56	2 15	2 35	2 54	3 13	3 33	3 52	4 11	4 31	4 50
10 00	0 20	0 40	1 00	1 20	1 40	2 00	2 20	2 40	3 00	3 20	3 40	4 00	4 20	4 40	5 00
10 20	0 21	0 41	1 02	1 23	1 43	2 04	2 25	2 45	3 06	3 27	3 47	4 08	4 29	4 49	5 10
10 40	0 21	0 43	1 04	1 25	1 47	2 08	2 29	2 51	3 12	3 33	3 55	4 16	4 37	4 59	5 20

Range of tide, see footnote	Correction to height														
Ft.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*
0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
1.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.5
1.5	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.6	0.7	0.8
2.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
2.5	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.1	1.2
3.0	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.8	0.9	1.0	1.2	1.3	1.5
3.5	0.0	0.0	0.1	0.2	0.2	0.3	0.4	0.6	0.7	0.9	1.0	1.2	1.4	1.6	1.8
4.0	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.7	0.8	1.0	1.2	1.4	1.6	1.8	2.0
4.5	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.1	1.3	1.6	1.8	2.0	2.2
5.0	0.0	0.1	0.1	0.2	0.3	0.5	0.6	0.8	1.0	1.2	1.5	1.7	2.0	2.2	2.5
5.5	0.0	0.1	0.1	0.2	0.4	0.5	0.7	0.9	1.1	1.4	1.6	1.9	2.2	2.5	2.8
6.0	0.0	0.1	0.1	0.3	0.4	0.6	0.8	1.0	1.2	1.5	1.8	2.1	2.4	2.7	3.0
6.5	0.0	0.1	0.2	0.3	0.4	0.6	0.8	1.1	1.3	1.6	1.9	2.2	2.6	2.9	3.2
7.0	0.0	0.1	0.2	0.3	0.5	0.7	0.9	1.2	1.4	1.8	2.1	2.4	2.8	3.1	3.5
7.5	0.0	0.1	0.2	0.3	0.5	0.7	1.0	1.2	1.5	1.9	2.2	2.6	3.0	3.4	3.8
8.0	0.0	0.1	0.2	0.3	0.5	0.8	1.0	1.3	1.6	2.0	2.4	2.8	3.2	3.6	4.0
8.5	0.0	0.1	0.2	0.4	0.6	0.8	1.1	1.4	1.8	2.1	2.5	2.9	3.4	3.8	4.2
9.0	0.0	0.1	0.2	0.4	0.6	0.9	1.2	1.5	1.9	2.2	2.7	3.1	3.6	4.0	4.5
9.5	0.0	0.1	0.2	0.4	0.6	0.9	1.2	1.6	2.0	2.4	2.8	3.3	3.8	4.3	4.8
10.0	0.0	0.1	0.2	0.4	0.7	1.0	1.3	1.7	2.1	2.5	3.0	3.5	4.0	4.5	5.0
10.5	0.0	0.1	0.3	0.5	0.7	1.0	1.3	1.7	2.2	2.6	3.1	3.6	4.2	4.7	5.2
11.0	0.0	0.1	0.3	0.5	0.7	1.1	1.4	1.7	2.3	2.8	3.3	3.8	4.4	4.9	5.5
11.5	0.0	0.1	0.3	0.5	0.8	1.1	1.5	1.8	2.3	2.9	3.4	4.0	4.6	5.1	5.8
12.0	0.0	0.1	0.3	0.5	0.8	1.1	1.5	1.9	2.5	3.0	3.6	4.1	4.8	5.4	6.0
12.5	0.0	0.1	0.3	0.5	0.8	1.2	2.6	1.9	2.6	3.1	3.7	4.3	5.0	5.6	6.2
13.0	0.0	0.1	0.3	0.6	0.9	1.2	1.7	2.2	2.7	3.2	3.9	4.5	5.1	5.8	6.5
13.5	0.0	0.1	0.3	0.6	0.9	1.3	1.7	2.2	2.8	3.4	4.0	4.7	5.3	6.0	6.8
14.0	0.0	0.2	0.3	0.6	0.9	1.3	1.8	2.3	2.9	3.5	4.2	4.8	5.5	6.3	7.0
14.5	0.0	0.2	0.4	0.6	1.0	1.4	1.9	2.4	3.0	3.6	4.3	5.0	5.7	6.5	7.2
15.0	0.0	0.2	0.4	0.6	1.0	1.4	1.9	2.5	3.1	3.8	4.4	5.2	5.9	6.7	7.5
15.5	0.0	0.2	0.4	0.7	1.0	1.5	2.0	2.6	3.2	3.9	4.6	5.4	6.1	6.9	7.8
16.0	0.0	0.2	0.4	0.7	1.1	1.5	2.1	2.6	3.3	4.0	4.7	5.5	6.3	7.2	8.0
16.5	0.0	0.2	0.4	0.7	1.1	1.6	2.1	2.7	3.4	4.1	4.9	5.7	6.5	7.4	8.2
17.0	0.0	0.2	0.4	0.7	1.1	1.6	2.2	2.8	3.5	4.2	5.0	5.9	6.7	7.6	8.5
17.5	0.0	0.2	0.4	0.8	1.2	1.7	2.2	2.9	3.6	4.4	5.2	6.0	6.9	7.8	8.8
18.0	0.0	0.2	0.4	0.8	1.2	1.7	2.3	3.0	3.7	4.5	5.3	6.2	7.1	8.1	9.0
18.5	0.1	0.2	0.5	0.8	1.2	1.8	2.4	3.1	3.8	4.6	5.5	6.4	7.3	8.3	9.2
19.0	0.1	0.2	0.5	0.8	1.3	1.8	2.4	3.1	3.9	4.8	5.6	6.6	7.5	8.5	9.5
19.5	0.1	0.2	0.5	0.8	1.3	1.9	2.5	3.2	4.0	4.9	5.8	6.7	7.7	8.7	9.8
20.0	0.1	0.2	0.5	0.9	1.3	1.9	2.6	3.3	4.1	5.0	5.9	6.9	7.9	9.0	10.0

Obtain from the predictions the high water and low water, one of which is before and the other after the time for which the height is required. The difference between the times of occurrence of these tides is the duration of rise or fall, and the difference between their heights is the range of tide for the above table. Find the difference between the nearest high or low water and the time for which the height is required.

Enter the table with the duration of rise or fall, printed in heavy-faced type, which most nearly agrees with the actual value, and on that horizontal line find the time from the nearest high or low water which agrees most nearly with the corresponding actual difference. The correction sought is in the column directly below, on the line with the range of tide.

When the nearest tide is high water, subtract the correction.

When the nearest tide is low, add the correction.

Appendix H
Current Diagrams

These are two examples of current diagrams published by the US Government, and similar diagrams are available for many different estuaries.

Puget Sound is a set of 12 diagrams showing current direction and strength for each hour of the tide cycle. To use these, you need to lookup the times of maximum flood and ebb current at the reference station for the date and time in question.

The Vineyard-Nantucket diagram allows you to estimate transit time of the estuary for different vessel speeds.

TIDAL CURRENT CHARTS

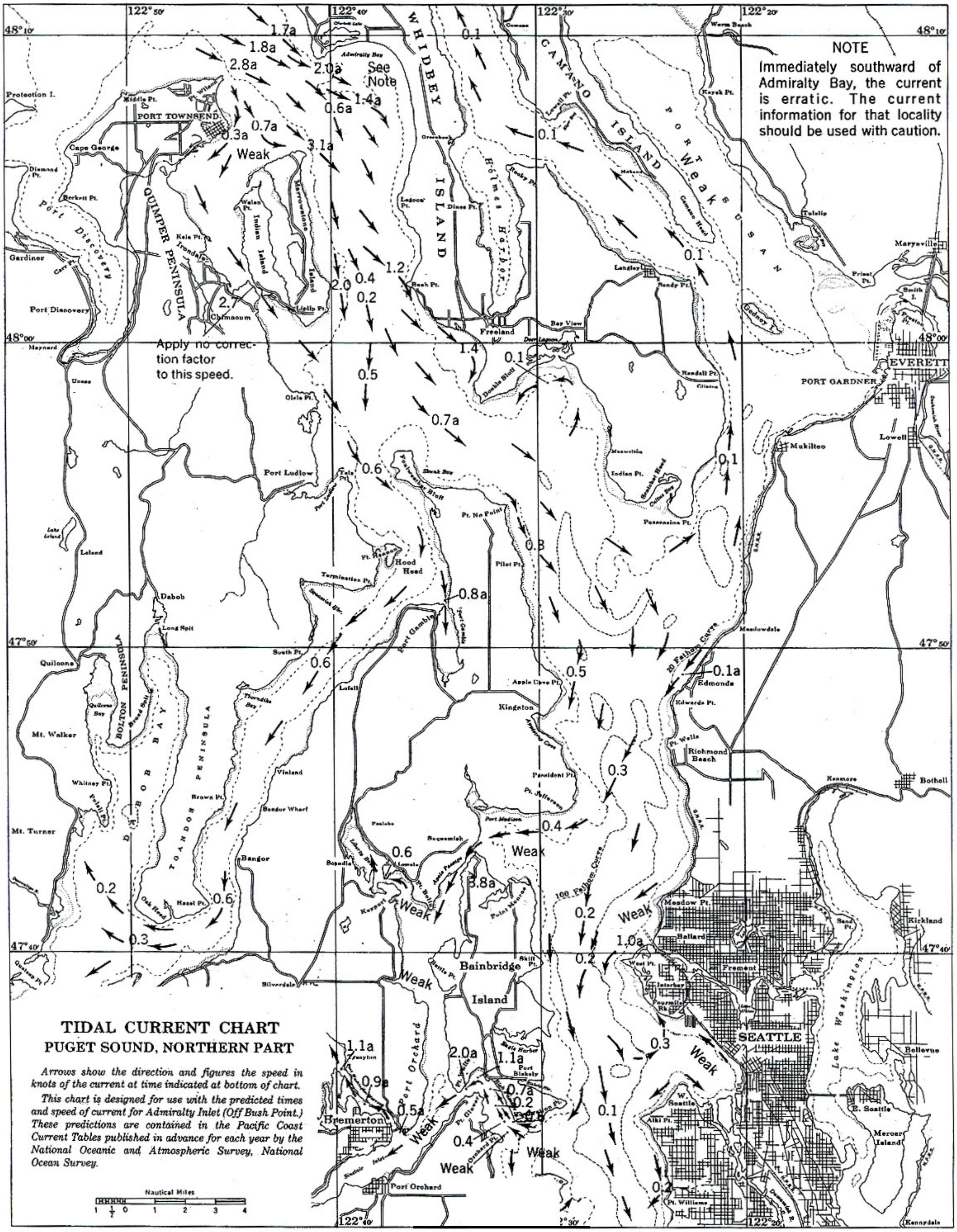
PUGET SOUND NORTHERN PART

Third Edition, 1973

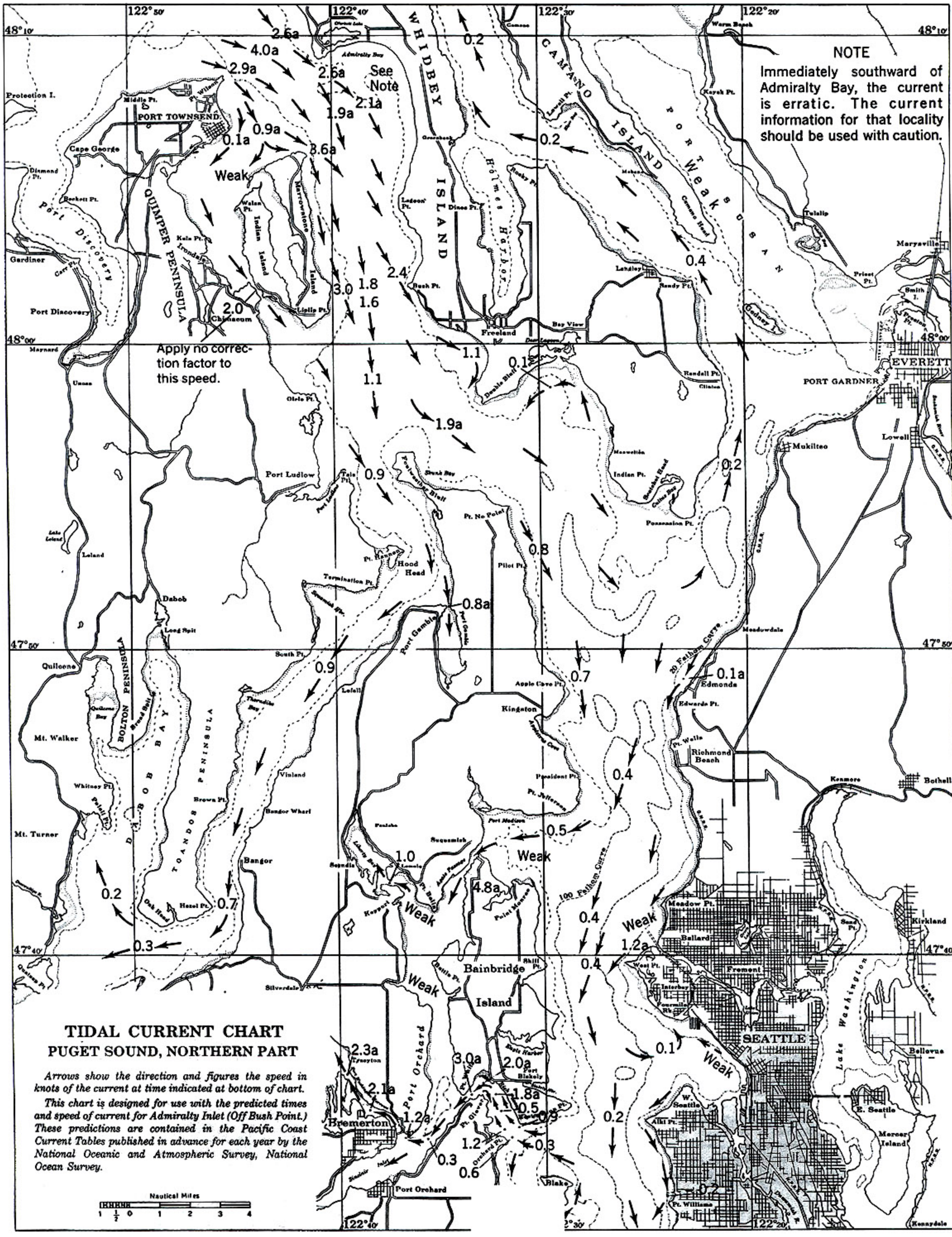
U.S. DEPARTMENT
OF COMMERCE

NATIONAL OCEANIC
AND ATMOSPHERIC
ADMINISTRATION

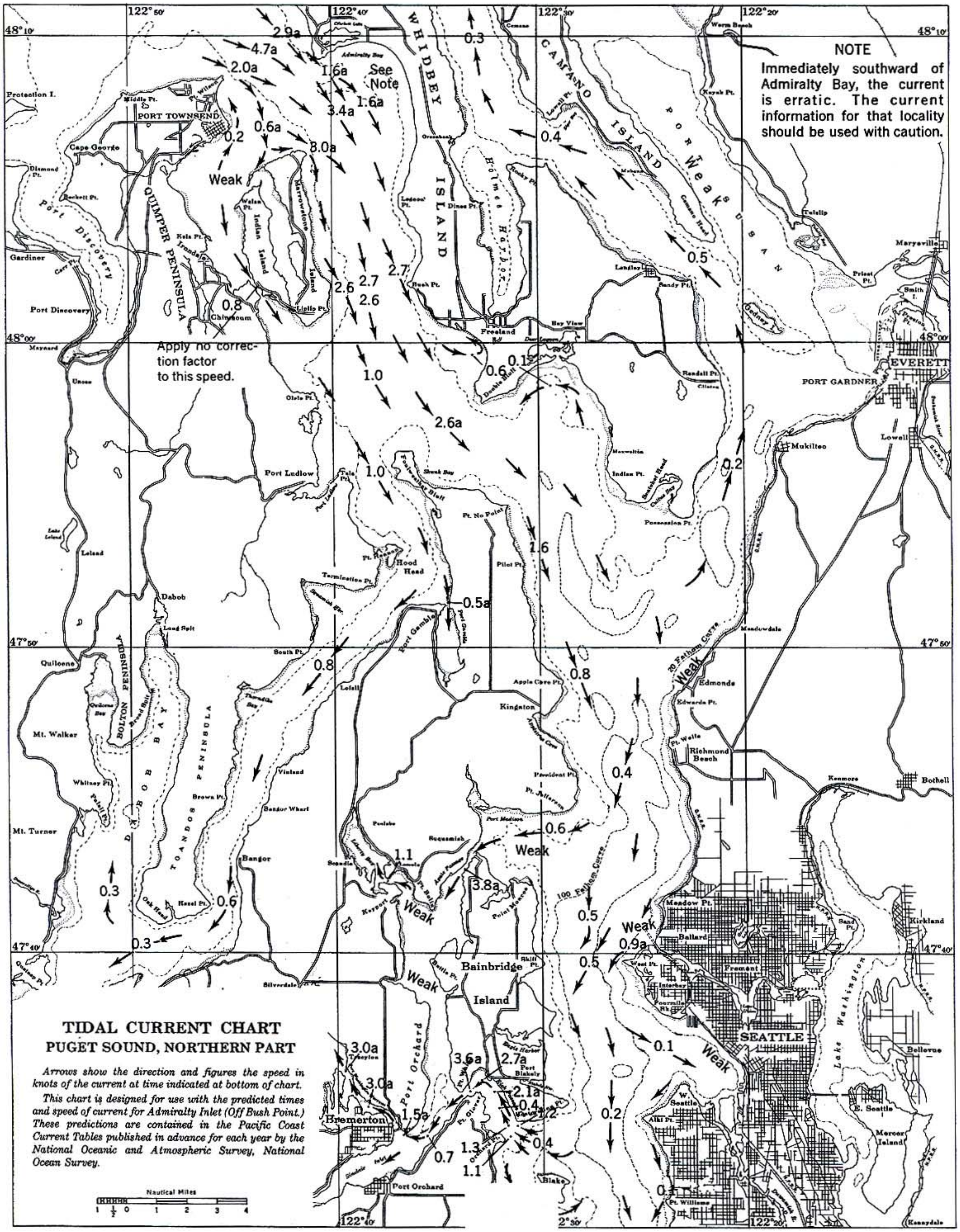
NATIONAL OCEAN SURVEY



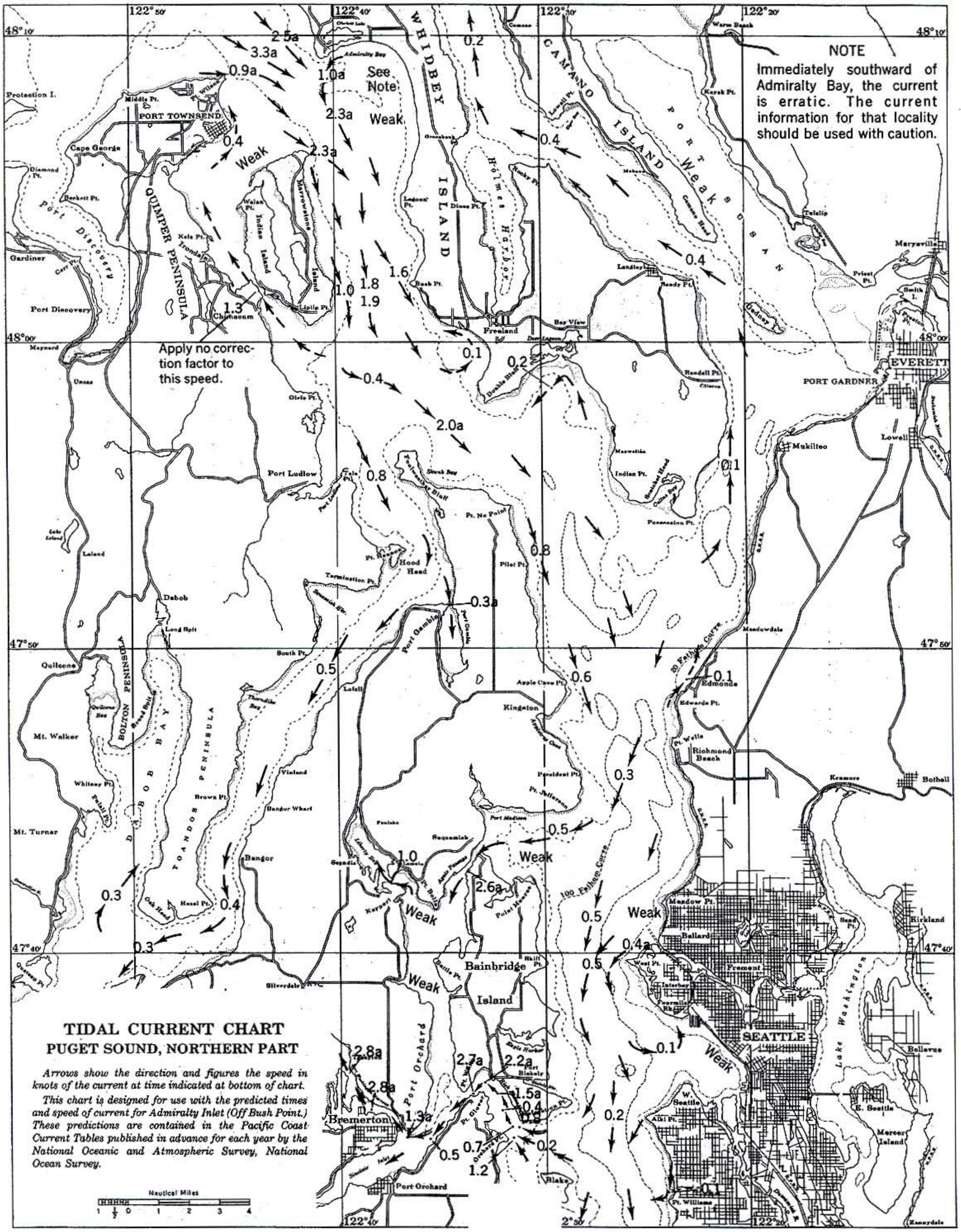
TWO HOURS BEFORE MAXIMUM FLOOD OFF BUSH POINT. (F–2)



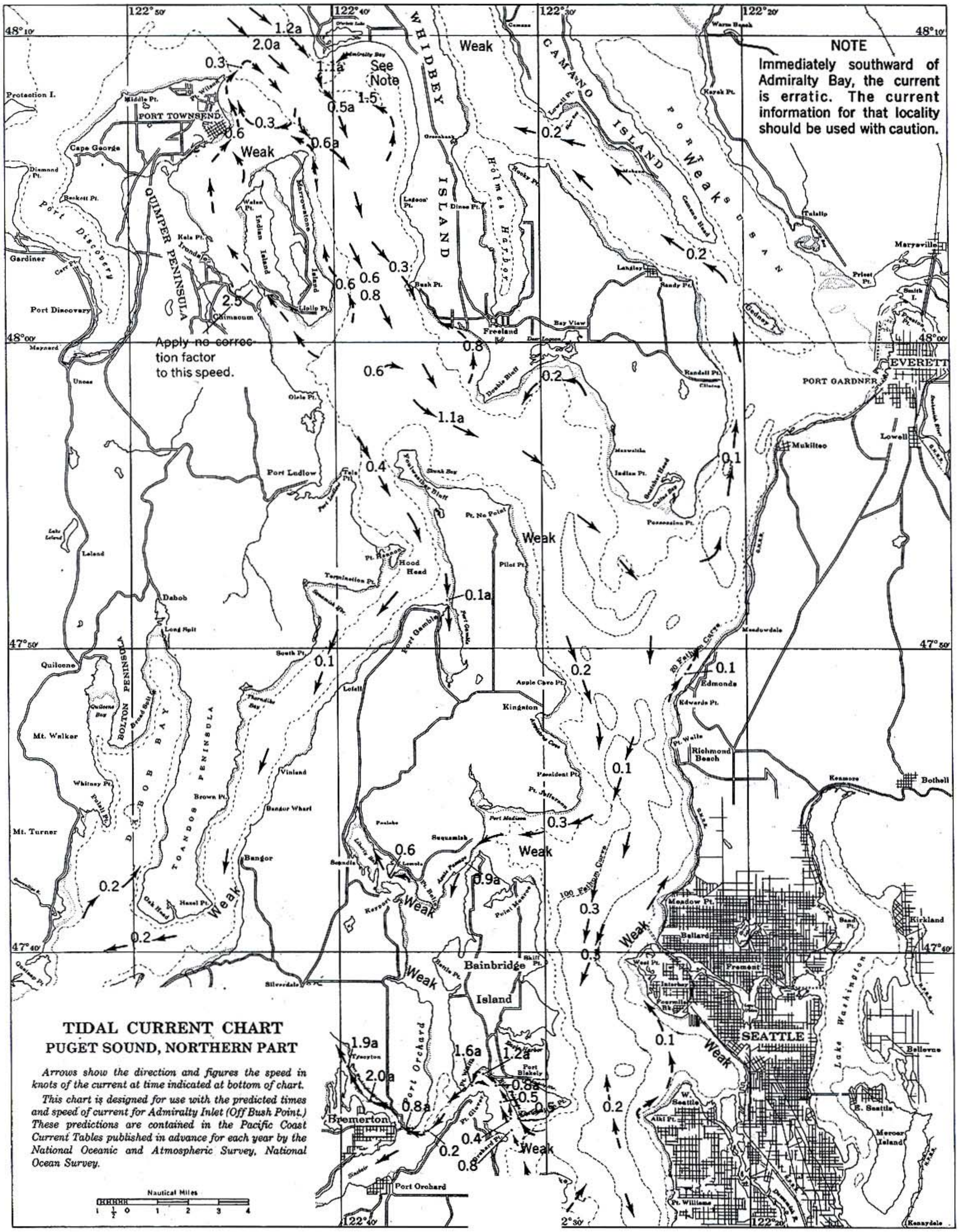
ONE HOUR BEFORE MAXIMUM FLOOD OFF BUSH POINT. (F−1)



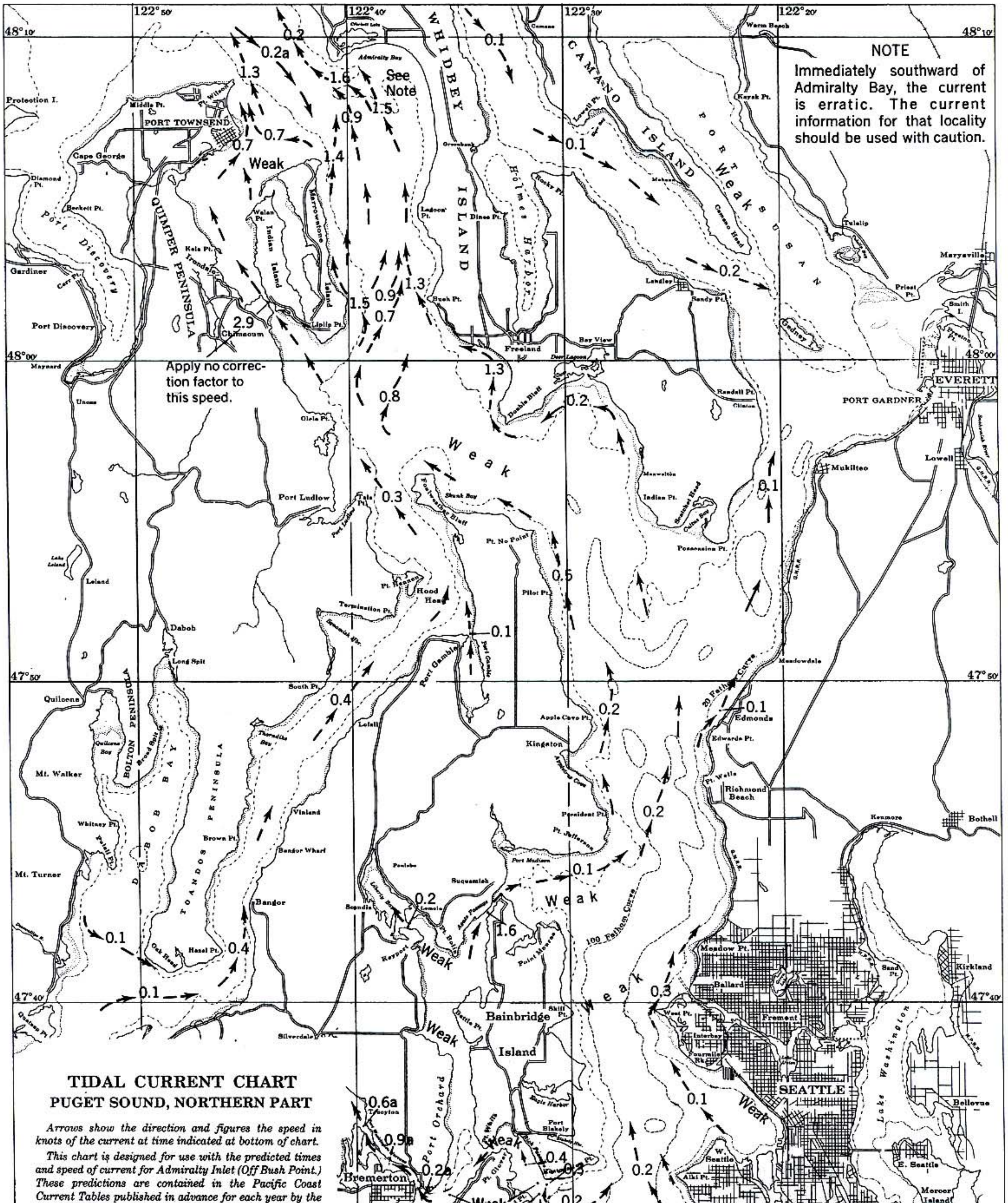
MAXIMUM FLOOD OFF BUSH POINT. (F)



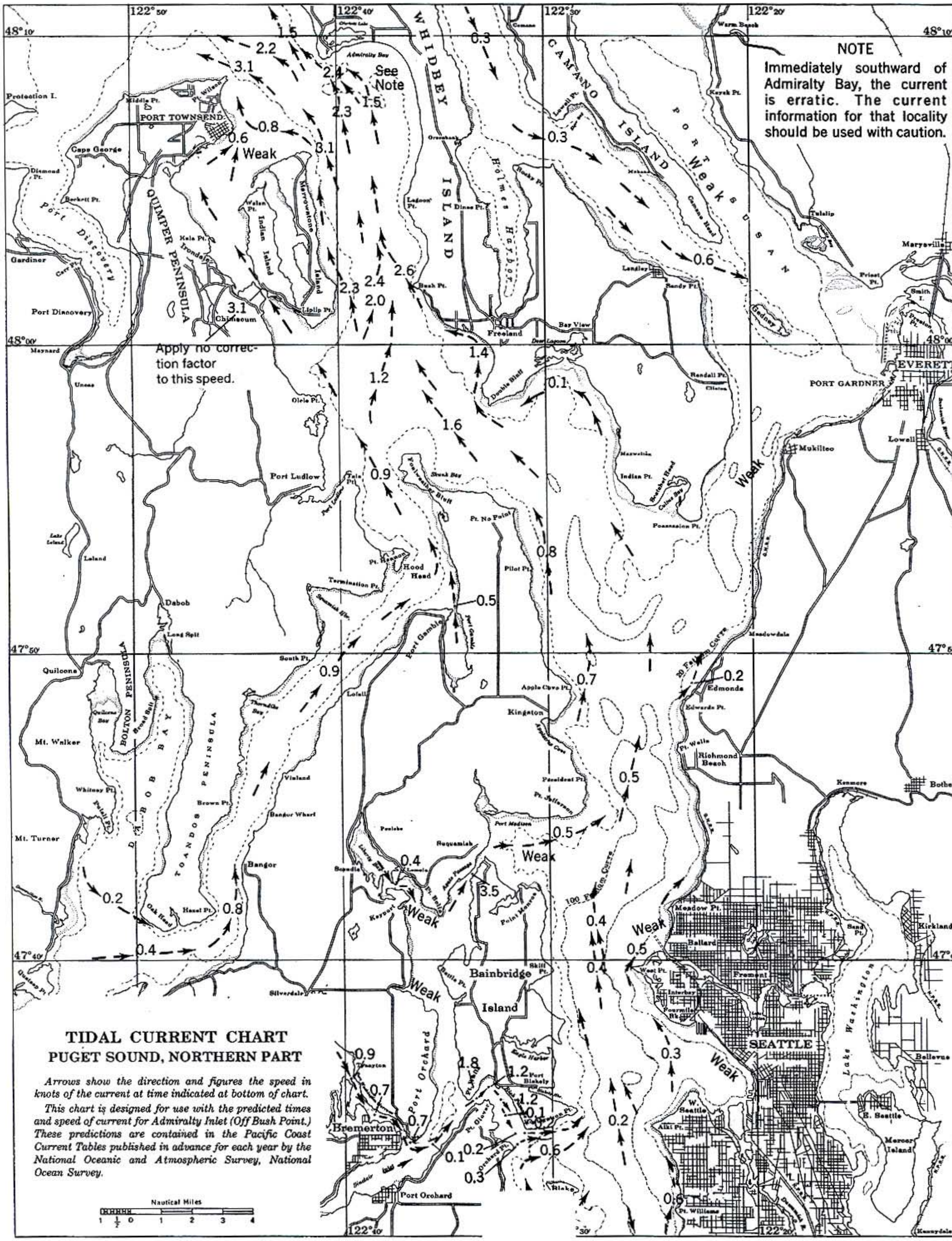
ONE HOUR AFTER MAXIMUM FLOOD OFF BUSH POINT. (F+1)



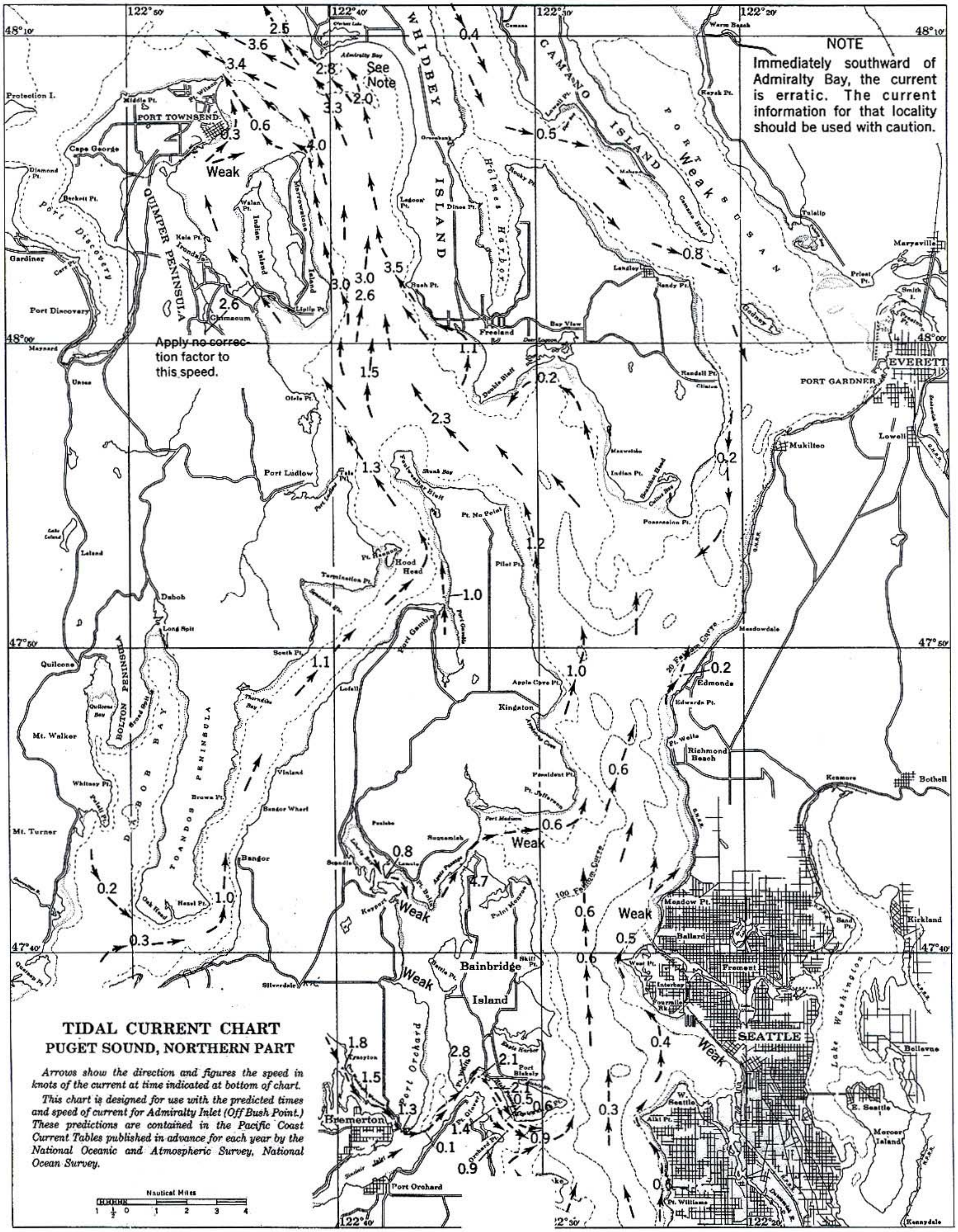
TWO HOURS AFTER MAXIMUM FLOOD OFF BUSH POINT. (F+2)



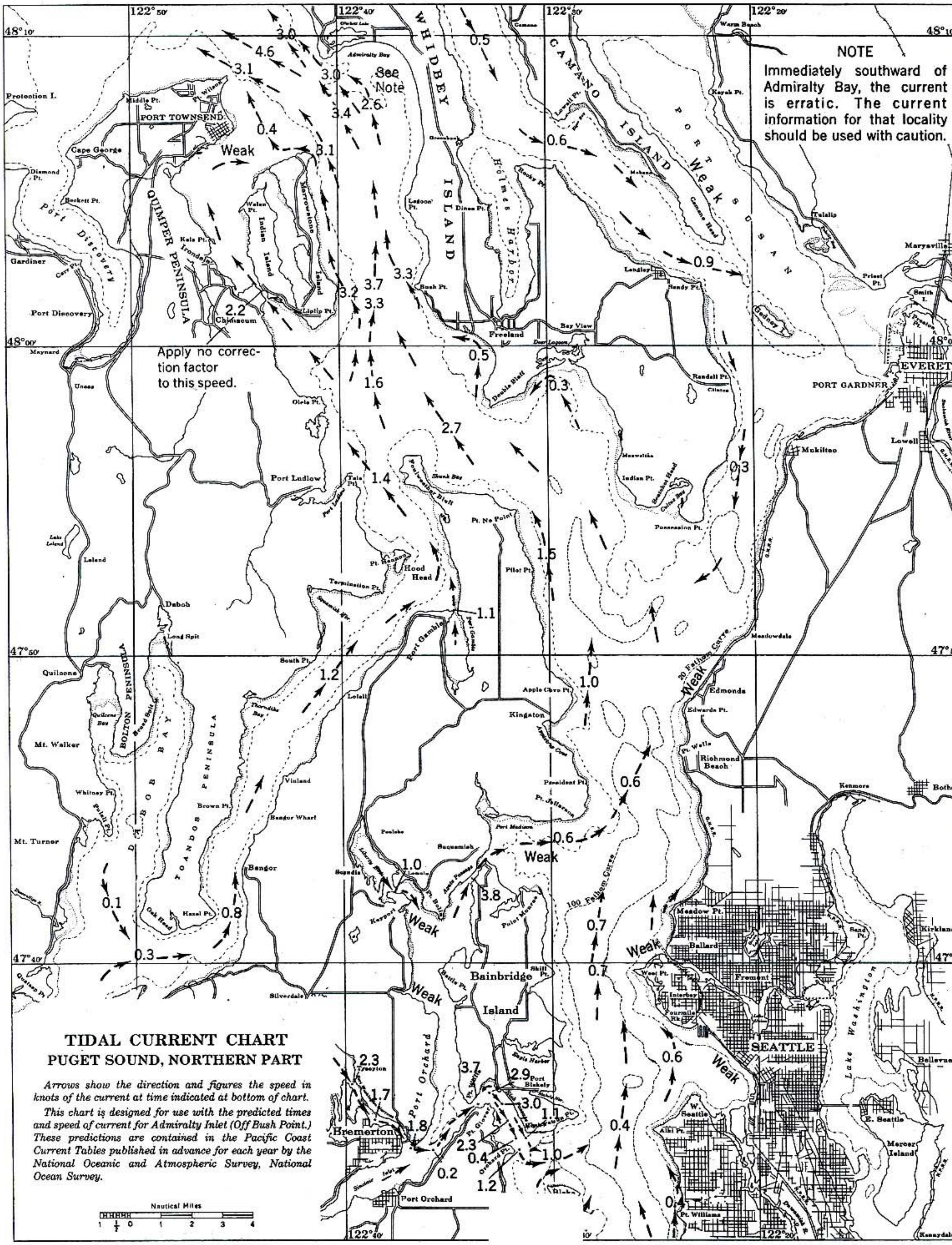
THREE HOURS AFTER MAXIMUM FLOOD OFF BUSH POINT. (F+3)



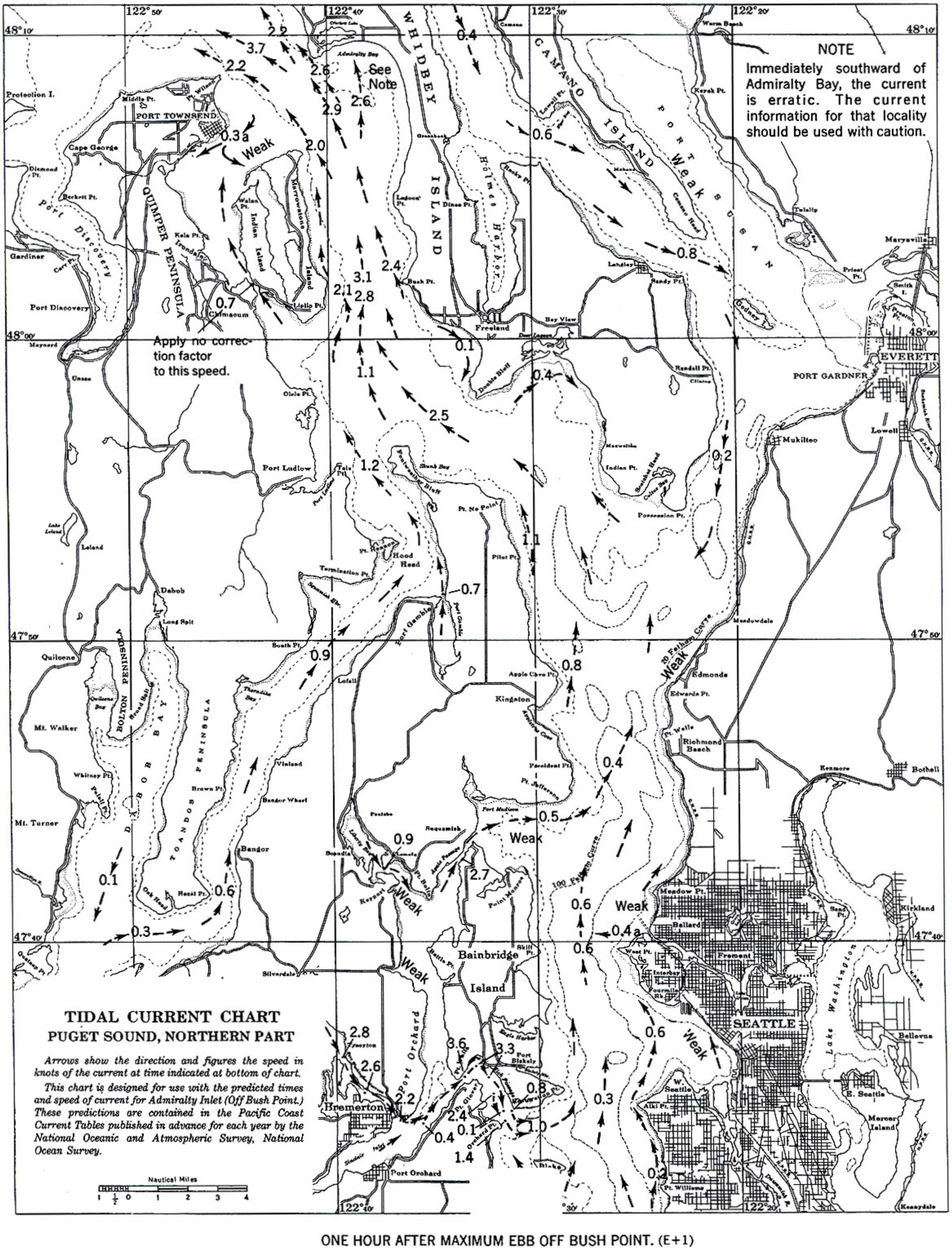
TWO HOURS BEFORE MAXIMUM EBB OFF BUSH POINT. (E−2)



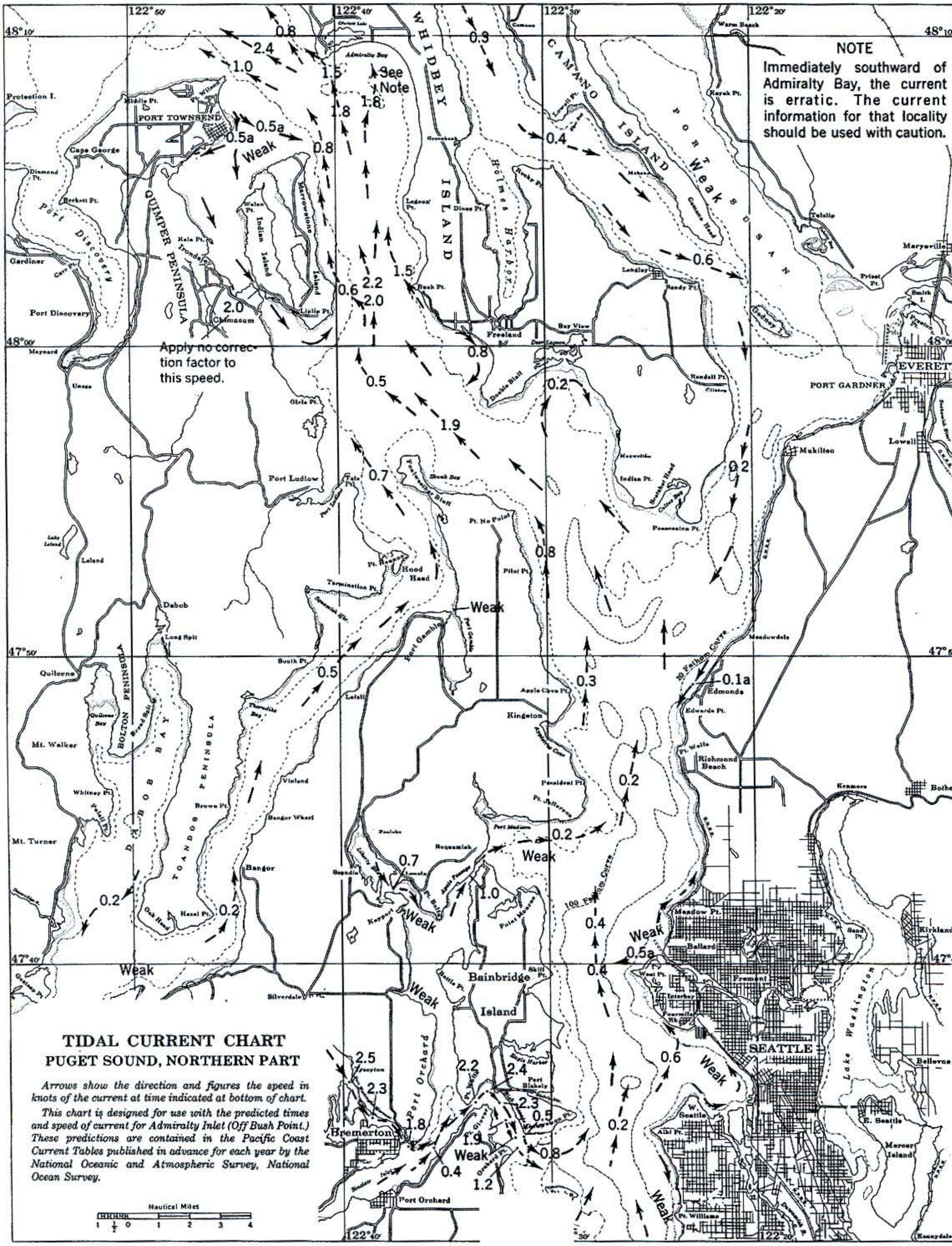
ONE HOUR BEFORE MAXIMUM EBB OFF BUSH POINT. (E–1)



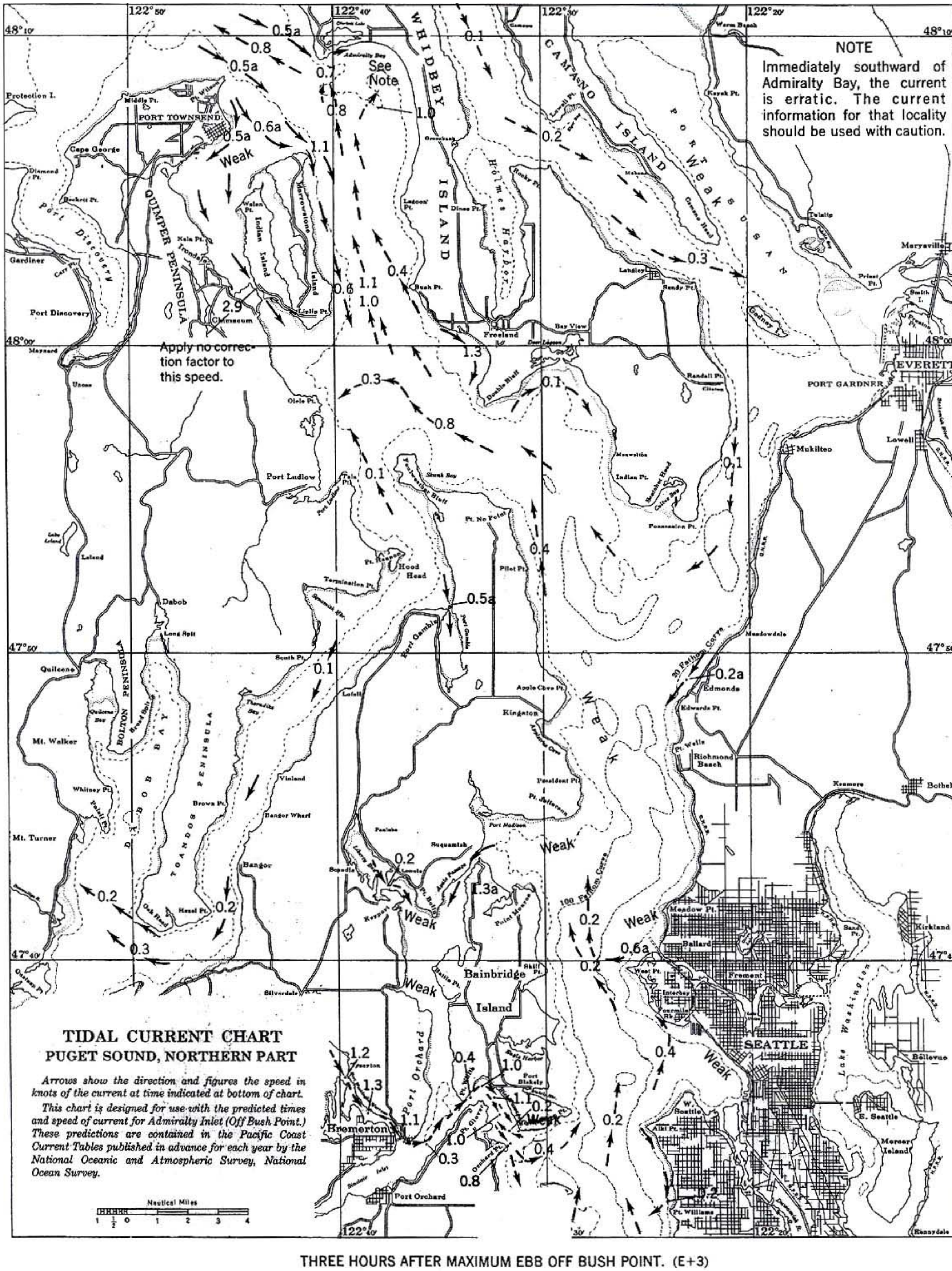
MAXIMUM EBB OFF BUSH POINT. (E)



ONE HOUR AFTER MAXIMUM EBB OFF BUSH POINT. (E+1)



TWO HOURS AFTER MAXIMUM EBB OFF BUSH POINT. (E+2)



THREE HOURS AFTER MAXIMUM EBB OFF BUSH POINT. (E+3)

CURRENT DIAGRAMS

EXPLANATION

"Current diagram" is a graphic table that shows the velocities of the flood and ebb currents and the times of slack and strength over a considerable stretch of the channel of a tidal waterway. At definite intervals along the channel the velocities of the current are shown with reference to the times of turning of the current at some reference station. This make it a simple matter to determine the approximate velocity of the current along the channel for any desired time.

In using the diagrams, the desired time should be converted to hours before or after the time of the nearest predicted slack water at the reference station.

Besides showing in compact form the velocities of the current and their changes through the flood and ebb cycles, the current diagram serves two other useful purposes. By its use the mariner can determine the most advantageous time to pass through the waterway to carry the most favorable current and also the speed and direction of the current that will be encountered in the channel at any time.

Each diagram represents average durations and average velocities of flood and ebb. The durations and velocities of flood and ebb vary from day to day. Therefore predictions for the reference station at times will differ from average conditions and when precise results are desired the diagrams should be modified to represent conditions at such particular times. This can be done by changing the width of the shaded and unshaded portions of the diagram to agree in hours with the durations of flood and ebb, respectively, as given by the predictions for that time. The speeds in the shaded area should then be multiplied by the ratio of the predicted flood speed to the average flood speed (maximum flood speed given opposite the name of the reference station on the diagram) and the speeds in the unshaded area by the ratio of the predicted ebb speed to the average ebb speed.

In a number of cases approximate results can be obtained by using the diagram as drawn and modifying the final result by the ratio of speeds as mentioned above. Thus, if the diagram in a particular case gives a favorable flood speed averaging about 1.0 knot and the ratio of the predicted flood speed to the average flood speed is 0.5 the approximate favorable current for the particular time would be $1.0 \times 0.5 = 0.5$ knot.

VINEYARD AND NANTUCKET SOUNDS
EXPLANATION OF CURRENT DIAGRAM

The current diagram on the opposite page represents average conditions of the surface currents along the middle of the channel from Gay Head to the east end of Pollock Rip Channel, the scale being too small to show details.

Easterly streams are designated "Flood" and westerly streams "Ebb". The small figures in the diagram denote the speed of the current in knots and tenths. The times are referred to slack waters at Pollock Rip Channel (Butler Hole), daily predictions for which are given in Table 1 of these current tables.

The speed lines are directly related to the diagram. By transferring to the diagram the direction of the speed line which corresponds to the ship's speed, the diagram will show the general direction and speed of the current encountered by the vessel in passing through the sounds or the most favorable time, with respect to currents, for leaving any place shown on the left margin.

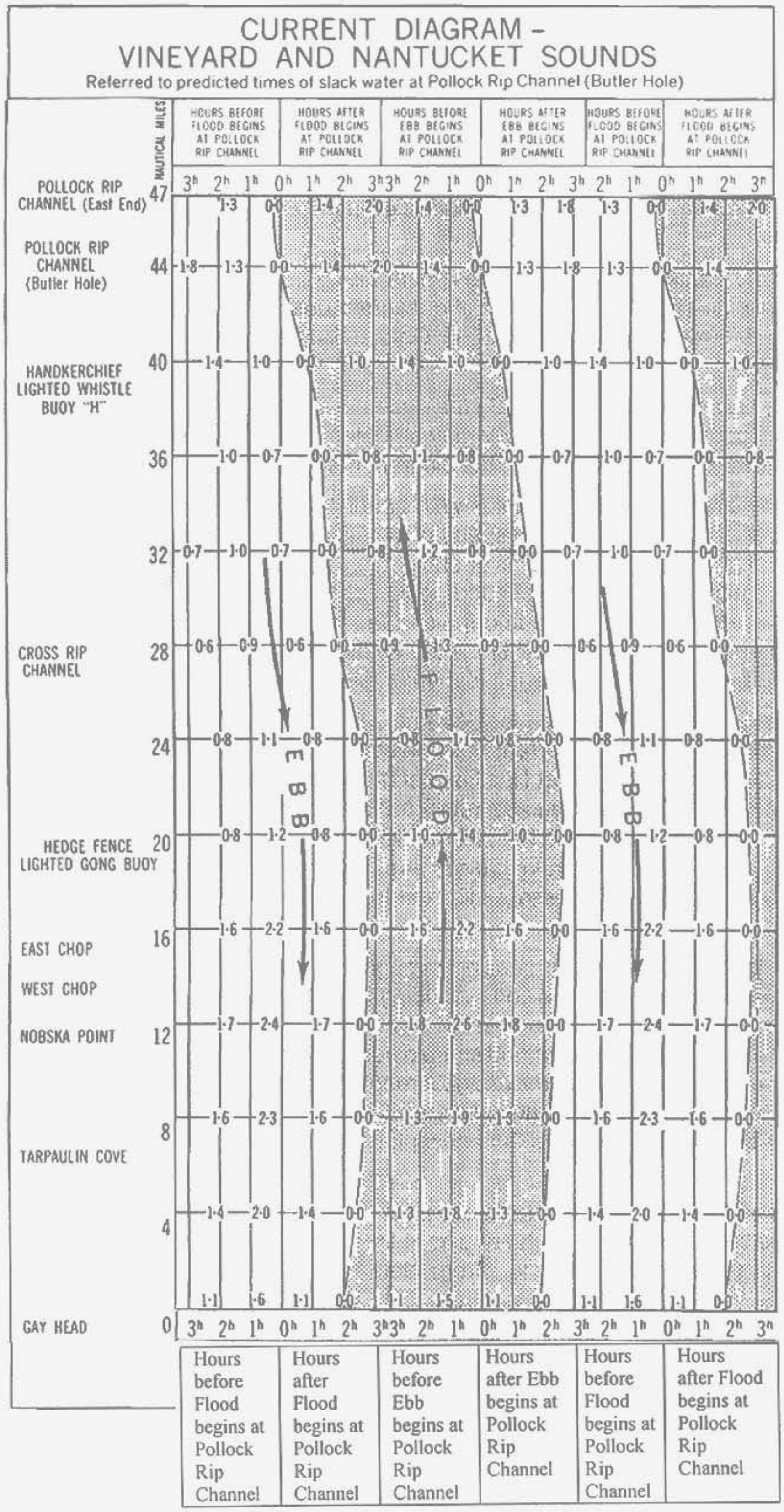
To determine speed and direction of current.—With parallel rulers transfer to the diagram the direction of the speed line corresponding to normal speed of vessel, moving edge of ruler to the point where the horizontal line representing place of departure intersects the vertical line representing the time of day in question. If the ruler's edge lies within the shaded portion of the diagram, a flood current will be encountered; if within the unshaded, an ebb current; and if along the boundary of both, slack water. The figures on the diagram along the edge of the rule will show the speed of the current encountered at any place indicated on the left margin of the diagram.

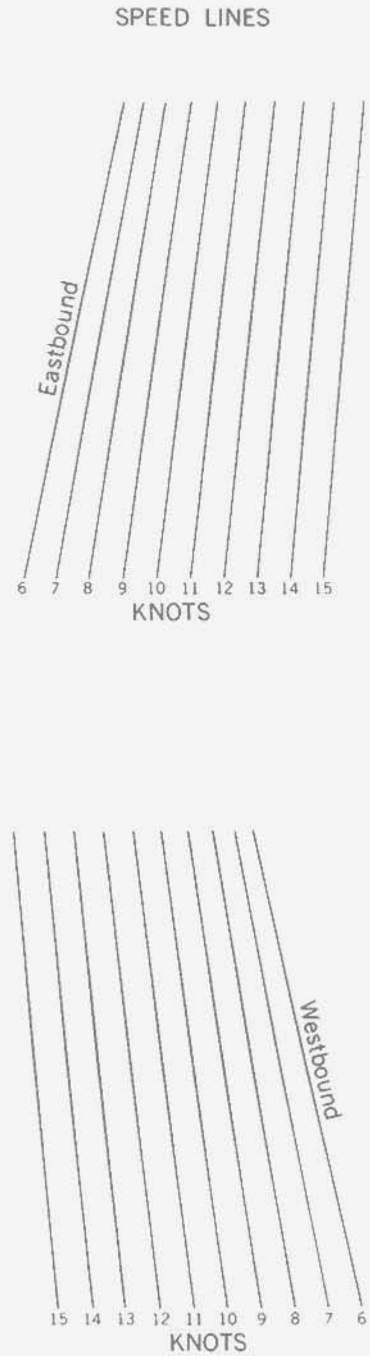
Example.—A 12-knot vessel bound westward enters Pollock Rip Channel at 0700 of a given day, and it is desired to ascertain the speed and direction of the current which will be encountered on its passage through the sounds. Assuming that on the given day ebb begins at Pollock Rip Channel at 0508 and flood begins at 1120, the time 0700 will be about 2 hours after ebb begins. With parallel rulers transfer to the diagram the 12-knot speed line "Westbound", placing edge of rule on the point where the vertical line "2 hours after ebb begins at Pollock Rip Channel" intersects the horizontal 47-mile line which is the starting point. It will be found that the edge of the ruler passes through the unshaded portion of the diagram, the speeds along the edge averaging about 1.4 knots. The vessel will, therefore, have a favorable ebb current averaging about 1.4 knots all the way to Gay Head. It will also be seen that the edge of the ruler crosses the horizontal 16-mile line (at East Chop) about halfway between the figures 1.6 and 2.2. Therefore, when passing the vicinity of East Chop she will have a favorable current of almost 2 knots.

To determine the time of a favorable current for passing through the sounds.—With parallel rulers transfer to the diagram the direction of the speed line corresponding to normal speed of vessel, moving the ruler over the diagram until its edge runs as nearly as possible through the general line of largest speeds of shaded portion if eastbound and unshaded portion if westbound, giving consideration only to that part of the diagram which lies between place of departure and destination. An average of the figures along the edge of the ruler will give the average strength of current. The time (before or after flood begins or ebb begins at Pollock Rip Channel) for leaving any place shown on the left margin will be indicated vertically above the point where the ruler cuts a line drawn horizontally through the name of the place in question.

Example.—A 12-knot vessel will leave Gay Head for Pollock Rip Channel on a day when flood begins at Pollock Rip Channel at 0454 and ebb begins at 1104. At what time should she get under way so as to carry the most favorable current all the way through the sounds?

Place parallel rulers along the 12-knot speed line "Eastbound". Transfer the direction to the shaded portion of the diagram and as near as possible to the axis so as to include the greatest possible number of larger current speeds. It will be found that the edge of the ruler cuts the horizontal line at Gay Head at the point representing "3 hours after flood begins at Pollock Rip Channel", and that the average of the currents along the edge of rulers is about 0.8 knot in a favorable direction. For the given day flood begins at Pollock Rip Channel at 0454; hence, if the vessel leaves Gay Head 3 hours later, or about 0754, she will average a favorable current of almost 1 knot all the way.


CURRENT DIAGRAM -
VINEYARD AND NANTUCKET SOUNDS
Referred to predicted times of slack water at Pollock Rip Channel (Butler Hole)
NAUTICAL MILES
HOURS BEFORE FLOOD BEGINS AT POLLOCK RIP CHANNEL
HOURS AFTER FLOOD BEGINS AT POLLOCK RIP CHANNEL
HOURS BEFORE EBB BEGINS AT POLLOCK RIP CHANNEL
HOURS AFTER EBB BEGINS AT POLLOCK RIP CHANNEL
POLLOCK RIP CHANNEL (East End)
POLLOCK RIP CHANNEL (Butler Hole)
HANDKERCHIEF LIGHTED WHISTLE BUOY "H"
CROSS RIP CHANNEL
HEDGE FENCE LIGHTED GONG BUOY
EAST CHOP
WEST CHOP
NOBSKA POINT
TARPAULIN COVE
GAY HEAD
EBB
FLOOD
Hours before Flood begins at Pollock Rip Channel
Hours after Flood begins at Pollock Rip Channel
Hours before Ebb begins at Pollock Rip Channel
Hours after Ebb begins at Pollock Rip Channel


SPEED LINES
Eastbound
KNOTS
Westbound
KNOTS

Appendix I
Current Table Extracts

Tidal Current Tables 1997

ATLANTIC COAST OF NORTH AMERICA

This publication contains tide and/or tidal current predictions and associated information produced by and obtained from the Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service. This is not a National Ocean Service publication. The National Ocean Service is not responsible for any reproduction errors. These predictions satisfy all U.S. Coast Guard requirements including: 33 CFR Ch. I (7-1-91 Edition), 164.33 Charts and Publications.

INDEX TO STATIONS
(Numbers refer to table 2)

[Stations marked with an asterisk (*) are reference stations for which daily predictions are given in table 1. Page numbers of reference stations are given in parentheses.]

TABLE 2 – CURRENT DIFFERENCES AND OTHER CONSTANTS

No.	PLACE	Meter Depth	POSITION Latitude	POSITION Longitude	TIME DIFFERENCES Min. before Flood	TIME DIFFERENCES Flood	TIME DIFFERENCES Min. before Ebb	TIME DIFFERENCES Ebb	SPEED RATIOS Flood	SPEED RATIOS Ebb	Minimum before Flood knots	Minimum before Flood Dir.	Maximum Flood knots	Maximum Flood Dir.	Minimum before Ebb knots	Minimum before Ebb Dir.	Maximum Ebb knots	Maximum Ebb Dir.
		ft	North	West	h m	h m	h m	h m			knots	Dir.	knots	Dir.	knots	Dir.	knots	Dir.
	MASSACHUSETTS COAST–cont. Time meridian, 75° W				on Boston Harbor, p.12													
971	Annisquam Harbor Light		42° 40.1'	70° 41.1'	+0 42	+0 49	+0 58	+0 03	0.9	1.1	0.0	--	1.0	200°	0.0	--	1.3	013°
976	Gloucester Harbor entrance		42° 34.9'	70° 40.5'	−0 28	+0 01	−0 29	−0 36	0.3	0.2	0.0	--	0.3	340°	0.0	--	0.3	195°
981	Blynman Canal ent., Gloucester Harbor		42° 36.6'	70° 40.4'	−0 06	+0 05	−0 15	−0 39	2.7	2.8	0.0	--	3.0	310°	0.0	--	3.3	130°
986	Marblehead Channel		42° 30'	70° 49'	+1 09	+1 09	+1 09	+1 09	0.4	0.3	0.0	--	0.4	285°	0.0	--	0.4	105°
991	Ram Island, 0.2 n.mi. NNE of	10	42° 28.75'	70° 51.68'	See Rotary tidal currents, table 2.													
996	Ram Island, 0.2 n.mi. southeast of	10	42° 28.45'	70° 51.55'	See Rotary tidal currents, table 2.													
1001	Great Pig Rocks, southeast of	10	42° 27.53'	70° 50.70'	See Rotary tidal currents, table 2.													
1006	Galloupes Point, 0.4 n.mi. south of	10	42° 27.24'	70° 53.70'	See Rotary tidal currents, table 2.													
1011	Little Nahant, 0.9 n.mi. northeast of	10	42° 26.85'	70° 54.84'	See Rotary tidal currents, table 2.													
1016	Egg Rock, 0.2 n.mi. north of	10	42° 26.25'	70° 53.93'	See Rotary tidal currents, table 2.													
1021	Egg Rock, southwest of	10	42° 25.85'	70° 54.20'	See Rotary tidal currents, table 2.													
1026	Nahant, 1.8 n.mi. NE of East Point	10	42° 26.00'	70° 52.02'	+0 32	+0 49	+0 15	+1 00	0.6	0.6	0.0	--	0.7	252°	0.1	291°	0.7	144°
	... do.	45	42° 26.00'	70° 52.02'	−0 21	+1 04	+1 14	−0 31	0.3	0.2	0.0	--	0.3	250°	0.0	--	0.2	070°
	... do.	80	42° 26.00'	70° 52.02'	−0 25	+1 04	+1 15	−0 31	0.2	0.1	0.1	329°	0.2	238°	0.0	--	0.2	077°
1031	Nahant, 0.4 n.mi. east of East Point	15	42° 25.23'	70° 53.63'	+0 04	−0 41	+0 15	+0 22	0.4	0.5	0.2	118°	0.5	205°	0.0	--	0.6	045°
	... do.	25	42° 25.23'	70° 53.63'	+0 03	−0 26	+0 08	+0 29	0.4	0.4	0.1	102°	0.4	198°	0.1	282°	0.5	027°
1036	Nahant, 1 n.mi. SE of East Point	45	42° 23.83'	70° 51.17'	+0 04	+1 04	+1 13	+0 14	0.3	0.2	0.0	--	0.3	253°	0.0	--	0.3	074°
	... do.	70	42° 23.83'	70° 51.17'	−0 22	−0 04	+0 19	−1 01	0.2	0.2	0.0	--	0.2	261°	0.0	--	0.2	090°
1041	Pea Island, 0.4 n.mi. southeast of	15	42° 24.63'	70° 54.13'	+0 53	+0 55	+0 42	−0 01	0.5	0.4	0.0	--	0.5	239°	0.1	161°	0.5	063°
	... do.	25	42° 24.63'	70° 54.13'	+0 34	+0 34	+0 57	+0 29	0.4	0.3	0.0	--	0.5	224°	0.0	--	0.4	048°
	... do.	65	42° 24.63'	70° 54.13'	−0 37	−0 59	+0 14	−0 31	0.3	0.3	0.1	332°	0.4	271°	0.0	--	0.3	035°
1046	Bass Point, 1.2 n.mi. southeast of	10	42° 24.12'	70° 55.07'	−0 22	+1 20	+0 58	−0 14	0.7	0.6	0.1	351°	0.7	259°	0.0	--	0.7	066°
	... do.	45	42° 24.12'	70° 55.07'	−0 29	−0 10	+0 52	−0 29	0.3	0.2	0.0	--	0.4	251°	0.0	--	0.3	086°
	... do.	60	42° 24.12'	70° 55.07'	−0 29	−0 10	+0 31	−0 59	0.2	0.2	0.0	--	0.3	250°	0.0	--	0.2	091°
1051	Bass Point, 0.5 n.mi. SSW of	15	42° 24.57'	70° 56.53'	See Rotary tidal currents, table 2.													
1056	Bass Point, 0.7 n.mi. west of	10	42° 25.13'	70° 57.25'	See Rotary tidal currents, table 2.													
1061	Little Nahant Cupola, 0.6 n.mi. west of	10	42° 25.87'	70° 56.83'	−0 02	−0 26	+1 32	+0 46	0.4	0.4	0.0	--	0.4	033°	0.1	137°	0.5	219°
1066	Sand Point, Black Marsh Channel	10	42° 26.58'	70° 56.52'	+0 04	−0 17	+1 00	+0 27	0.5	0.4	0.0	--	0.5	013°	0.0	--	0.5	203°
1071	Lynn Harbor	10	42° 27.27'	70° 56.78'	+0 29	−0 26	+2 35	+1 25	0.2	0.2	0.0	--	0.3	274°	0.0	--	0.2	090°
1076	Point of Pines, 0.5 n.mi. south of	6	42° 25.97'	70° 57.53'	+0 05	+0 19	+1 08	+0 41	0.4	0.5	0.0	--	0.5	009°	0.0	--	0.6	198°
1081	Point of Pines, 0.1 n.mi. northeast of	6	42° 26.52'	70° 57.62'	+0 43	+0 29	+1 00	+0 34	0.8	1.0	0.0	--	0.9	296°	0.0	--	1.2	131°
1086	Finn's Ledge Bell, 0.2 n.mi. west of	10	42° 22.17'	70° 55.42'	−0 01	+1 05	+0 26	−0 02	0.5	0.6	0.0	--	0.6	226°	0.2	295°	0.8	035°
	... do.	25	42° 22.17'	70° 55.42'	−0 11	+0 50	+0 36	+0 28	0.3	0.4	0.0	--	0.3	229°	0.0	--	0.5	033°
1091	Winthrop Head, 1.1 n.mi. east of	10	42° 21.93'	70° 56.52'	−1 12	+0 19	+0 31	−1 46	0.4	0.3	0.3	103°	0.5	205°	0.2	297°	0.4	019°
1096	Lovell Island, 1.3 n.mi. north of	10	42° 21.30'	70° 55.90'	−0 52	−0 57	−0 14	−0 25	0.8	1.0	0.2	112°	0.9	196°	0.2	300°	1.2	033°
	... do.	25	42° 21.30'	70° 55.90'	−1 19	−0 59	−0 12	−0 13	0.7	0.6	0.2	102°	0.7	197°	0.1	135°	0.7	033°
	BOSTON HARBOR APPROACHES																	
1101	The Graves, 0.3 n.mi. SSE of	10	42° 21.60'	70° 52.00'	+0 16	+1 08	+1 21	+0 19	0.5	0.5	0.3	171°	0.6	227°	0.1	135°	0.6	103°
	... do.	45	42° 21.60'	70° 52.00'	−0 37	−0 52	−0 10	−0 58	0.3	0.4	0.1	186°	0.4	262°	0.0	--	0.5	085°
	... do.	60	42° 21.60'	70° 52.00'	−0 49	−0 52	−0 16	−1 23	0.2	0.3	0.0	--	0.3	252°	0.0	--	0.4	070°
1106	Thieves Ledge	45	42° 19.28'	70° 50.28'	−0 15	−0 06	−0 40	−1 37	0.2	0.2	0.1	030°	0.2	304°	0.0	--	0.3	128°
1111	Little Brewster Island, 1.5 n.mi. E of	10	42° 19.68'	70° 51.43'	+2 19	+0 41	−0 40	+0 55	0.5	1.0	0.4	028°	0.6	285°	0.6	337°	1.2	080°
	... do.	35	42° 19.68'	70° 51.43'	+0 53	−0 49	+0 03	+1 30	0.3	0.4	0.0	--	0.3	236°	0.2	212°	0.5	076°
	... do.	60	42° 19.68'	70° 51.43'	−1 14	−1 23	+1 31	−0 45	0.3	0.2	0.2	265°	0.3	225°	0.0	--	0.2	047°
1116	Hypocrite Channel	10	42° 20.95'	70° 53.63'	+0 13	+0 19	+0 49	−0 31	0.8	0.8	0.1	345°	0.9	262°	0.1	351°	1.0	070°
1121	Little Calf Island, 0.4 n.mi. NW of	10	42° 21.05'	70° 54.00'	+0 23	+0 04	−0 15	−0 18	0.5	0.6	0.0	--	0.5	220°	0.1	290°	0.7	048°
1126	Boston Light, 0.2 n.mi. south of	10	42° 19.52'	70° 53.40'	+0 14	+0 19	+0 41	+0 40	0.9	1.1	0.1	203°	1.0	267°	0.0	--	1.4	100°
1131	Point Allerton, 0.8 n.mi. NNW of	10	42° 19.28'	70° 53.25'	+0 25	+0 03	+0 46	−0 05	1.0	1.1	0.0	--	1.1	270°	0.1	005°	1.4	086°
	... do.	25	42° 19.28'	70° 53.25'	+0 17	+0 13	+0 55	+0 29	0.9	0.9	0.0	--	1.0	257°	0.0	--	1.0	090°
1136	Point Allerton, 0.5 n.mi. NNW of	10	42° 19.05'	70° 53.10'	+0 14	+0 26	+0 41	+0 11	0.9	1.0	0.0	--	1.0	280°	0.0	--	1.3	079°
	... do.	25	42° 19.05'	70° 53.10'	+0 08	+0 29	+0 53	+0 25	0.8	0.8	0.0	--	0.9	262°	0.0	--	0.9	080°
1141	Point Allerton, 0.4 n.mi. northwest of	10	42° 18.88'	70° 53.23'	−0 09	+0 53	+0 17	−1 11	0.6	0.7	0.0	--	0.7	265°	0.2	353°	0.8	080°

TABLE 2 – CURRENT DIFFERENCES AND OTHER CONSTANTS

No.	PLACE	Meter Depth	POSITION Latitude	POSITION Longitude	TIME DIFFERENCES Min. before Flood	TIME DIFFERENCES Flood	TIME DIFFERENCES Min. before Ebb	TIME DIFFERENCES Ebb	SPEED RATIOS Flood	SPEED RATIOS Ebb	Minimum before Flood knots	Minimum before Flood Dir.	Maximum Flood knots	Maximum Flood Dir.	Minimum before Ebb knots	Minimum before Ebb Dir.	Maximum Ebb knots	Maximum Ebb Dir.
		ft	North	West	h m	h m	h m	h m			knots	Dir.	knots	Dir.	knots	Dir.	knots	Dir.
	BUZZARDS BAY <7>–cont. Time meridian, 75° W				on Pollock Rip Channel, p.20													
2056	Penikese Island, 0.2 mile south of		41° 26.6'	70° 55.5'	−1 43	−0 15	−1 30	−2 39	0.4	0.5	0.0	– –	0.7	093°	0.0	– –	0.9	287°
2061	Gull I. and Nashawena I., between		41° 26.2'	70° 54.2'	−2 15	−0 57	−2 01	−2 41	0.5	0.6	0.0	– –	0.9	091°	0.0	– –	1.1	247°
2066	Weepecket Island, south of		41° 30.4'	70° 44.3'	−3 16	−1 07	−1 28	−2 27	0.4	0.4	0.0	– –	0.8	069°	0.0	– –	0.6	255°
2071	Quamquisset Harbor entrance		41° 32.4'	70° 39.8'	Current weak and variable						0.0	– –	0.4	– –	0.0	– –	0.3	– –
2076	West Falmouth Harbor entrance		41° 36.5'	70° 39.3'	Current weak and variable													
2081	Megansett Harbor		41° 38.8'	70° 39.2'	Current weak and variable													
2086	Abiels Ledge, 0.4 mile south of		41° 41.1'	70° 40.4'	+0 26	−0 36	−0 06	−0 23	0.4	0.6	0.0	– –	0.8	035°	0.0	– –	1.0	216°
2091	Dumpling Rocks, 0.2 mile southeast of		41° 32.0'	70° 55.1'	−1 43	−1 03	−1 32	−2 09	0.4	0.6	0.0	– –	0.8	066°	0.0	– –	1.1	190°
2096	Apponaganset Bay		41° 35'	70° 57'	Current weak and variable													
2101	Clarks Cove		41° 36'	70° 55'	Current weak and variable													
2106	New Bedford Harbor and approaches				Current weak and variable													
2111	West Island and Long Island, between		41° 35.6'	70° 50.4'	Current weak and variable						0.0	– –	0.3	– –	0.0	– –	0.4	– –
2116	West Island, 1 mile southeast of	6	41° 34.0'	70° 48.6'	−0 43	−0 43	−1 28	−1 42	0.4	0.5	0.0	– –	0.7	079°	0.0	– –	0.8	203°
2121	Nasketucket Bay		41° 37.1'	70° 50.2'	Current weak and variable						0.0	– –	0.3	– –	0.0	– –	0.3	– –
2126	Mattapoisett Harbor		41° 38'	70° 47'	Current weak and variable													
2131	Sippican Harbor		41° 41'	70° 44'	Current weak and variable						0.0	– –	0.3	– –	0.0	– –	0.4	– –
2136	Wareham River, off Long Beach Point		41° 44.0'	70° 43.0'	−1 41	−0 31	−1 22	−1 23	0.3	0.4	0.0	– –	0.6	022°	0.0	– –	0.6	202°
2141	Wareham River, off Barneys Point		41° 44.7'	70° 42.4'	−1 49	−0 27	−1 22	−1 31	0.4	0.4	0.0	– –	0.7	010°	0.0	– –	0.6	185°
					on Cape Cod Canal, p.16													
2146	Onset Bay, south of Onset Island		41° 43.9'	70° 38.7'	Current weak and variable													
2151	Onset Bay, south of Wickets Island		41° 44.1'	70° 39.3'	Current weak and variable													
	CAPE COD CANAL																	
2156	CAPE COD CANAL, railroad bridge		41° 44.5'	70° 36.8'	*Daily predictions*						0.0	– –	4.0	070°	0.0	– –	4.5	250°
2161	Bourne Highway bridge		41° 45'	70° 35'	−0 03	−0 01	−0 03	−0 04	0.8	0.9	0.0	– –	3.3	065°	0.0	– –	4.0	245°
2166	Bournedale		41° 46'	70° 34'	−0 07	−0 03	−0 09	−0 10	0.8	0.8	0.0	– –	3.4	030°	0.0	– –	3.6	210°
2171	Sagamore Bridge		41° 46'	70° 33'	−0 09	−0 04	−0 11	−0 13	0.7	0.6	0.0	– –	2.8	095°	0.0	– –	2.5	275°
2176	Cape Cod Canal, east end	15	41° 46.5'	70° 30.0'	−0 13	−0 06	−0 17	−0 19	0.6	0.6	0.0	– –	2.4	065°	0.0	– –	2.6	245°
	NARRAGANSETT BAY <8>				on Pollock Rip Channel, p.20													
2181	Sakonnet River (except Narrows)		– – –	– – –	Current weak and variable													
2186	Black Point, SW of, Sakonnet River	15	41° 30.4'	71° 13.2'	−2 54	−1 55	−2 13	−2 26	0.2	0.2	0.0	– –	0.4	012°	0.0	– –	0.4	194°
2191	Almy Point Bridge, south of, Sakonnet River	15	41° 37.3'	71° 13.2'	−3 00	−2 10	−2 30	−3 13	0.2	0.8	0.0	– –	0.4	034°	0.0	– –	1.5	180°
2196	Tiverton, Stone bridge, Sakonnet R. <9>		41° 37.5'	71° 13.0'	−2 58	−5 02	−2 26	−3 06	1.4	1.6	0.0	– –	2.7	010°	0.0	– –	2.7	190°
						−2 54			0.3				0.6	010°				
						−0 36			1.3				2.5	010°				
2201	Tiverton, RR. bridge, Sakonnet R. <10>		41° 38.3'	71° 12.9'	−3 26	−5 06	−2 48	−3 41	1.2	1.4	0.0	– –	2.3	000°	0.0	– –	2.4	180°
						−3 04			– –				– –					
						−1 15			0.8				1.5	000°				
2206	Common Fence Point, northeast of	10	41° 39.5'	71° 12.5'	−2 38	−4 50	−2 32	−2 41	0.1	0.2	0.0	– –	0.2	026°	0.0	– –	0.3	210°
						−2 25			0.0				0.1	058°				
						−0 58			0.1				0.1	046°				
2211	Brenton Point, 1.4 n.mi. southwest of	7	41° 25.9'	71° 22.6'	−1 03	−0 38	−1 20	−1 04	0.2	0.4	0.0	– –	0.4	347°	0.0	– –	0.6	170°
2216	Castle Hill, west of, East Passage	15	41° 27.4'	71° 22.7'	−0 06	−0 42	−1 07	−0 29	0.4	0.7	0.0	– –	0.7	013°	0.0	– –	1.2	237°
2221	Bull Point, east of	10	41° 28.8'	71° 21.0'	−1 10	−0 47	−1 10	−1 33	0.6	0.8	0.0	– –	1.2	001°	0.0	– –	1.5	206°
2226	Mackerel Cove		41° 28.5'	71° 22.8'	Current weak and variable													
2231	Newport Harbor, S and E of Goat Island		41° 29'	71° 20'	Current weak and variable													
2236	Rose Island, northeast of	15	41° 30.2'	71° 19.9'	−1 57	−0 07	−1 17	−2 08	0.4	0.5	0.0	– –	0.8	310°	0.0	– –	1.0	124°
2241	Rose Island, northwest of	15	41° 30.4'	71° 21.1'	−1 38	−0 26	−1 38	−1 39	0.4	0.5	0.1	105°	0.7	007°	0.1	102°	1.0	190°
2246	Rose Island, west of		41° 29.8'	71° 21.0'	−0 42	−0 34	−1 20	−1 28	0.4	0.6	0.0	– –	0.7	001°	0.0	– –	1.0	172°
2251	Gould Island, southeast of	7	41° 31.5'	71° 20.2'	−1 40	−1 28	−1 14	−1 16	0.3	0.4	0.0	– –	0.5	033°	0.0	– –	0.7	217°
2256	Gould Island, west of	15	41° 31.9'	71° 21.5'	−0 16	−0 32	−1 13	−1 07	0.3	0.4	0.0	– –	0.6	351°	0.1	279°	0.8	193°

Boston Harbor (Deer Island Light), Massachusetts, 1997

F–Flood, Dir. 254° True   E–Ebb, Dir. 111° True

January

Day	Slack h m	Maximum h m	knots
1 W		0009	1.1F
	0342	0824	1.0E
	1029	1233	1.0F
◑	1603	2045	0.9E
	2250		
2 Th		0100	1.1F
	0433	0914	1.0E
	1121	1329	1.0F
	1657	2136	0.9E
	2340		
3 F		0155	1.1F
	0525	1003	1.1E
	1213	1431	1.1F
	1751	2225	1.0E
4 Sa	0031	0254	1.2F
	0618	1050	1.1E
	1306	1605	1.1F
	1846	2311	1.1E
5 Su	0123	0359	1.3F
	0711	1135	1.2E
	1357	1700	1.2F
	1940	2354	1.1E
6 M	0214	0501	1.3F
	0802	1214	1.3E
	1447	1749	1.3F
	2032		
7 Tu		0031	1.2E
	0304	0550	1.4F
	0852	1248	1.4E
	1536	1835	1.4F
	2122		
8 W		0106	1.3E
	0353	0636	1.5F
	0942	1324	1.5E
●	1624	1918	1.5F
	2212		
9 Th		0145	1.4E
	0443	0721	1.5F
	1031	1405	1.5E
	1713	2001	1.5F
	2301		
10 F		0230	1.4E
	0532	0806	1.5F
	1120	1450	1.5E
	1802	2043	1.5F
	2351		
11 Sa		0319	1.4E
	0624	0854	1.5F
	1210	1539	1.4E
	1851	2129	1.5F
12 Su	0041	0417	1.3E
	0717	0943	1.4F
	1301	1639	1.4E
	1943	2221	1.4F
13 M	0132	0540	1.3E
	0810	1040	1.3F
	1354	1809	1.3E
	2038	2336	1.3F
14 Tu	0226	0650	1.2E
	0908	1214	1.2F
	1450	1919	1.2E
	2132		
15 W		0050	1.2F
	0322	0754	1.2E
	1007	1326	1.1F
◐	1549	2023	1.2E
	2231		
16 Th		0156	1.1F
	0421	0855	1.3E
	1107	1430	1.0F
	1651	2123	1.2E
	2330		
17 F		0258	1.1F
	0521	0953	1.3E
	1209	1532	1.0F
	1753	2221	1.2E
18 Sa	0030	0357	1.1F
	0621	1050	1.4E
	1309	1630	1.1F
	1856	2316	1.3E
19 Su	0128	0453	1.1F
	0720	1143	1.5E
	1405	1724	1.1F
	1958		
20 M		0009	1.4E
	0222	0546	1.2F
	0815	1234	1.5E
	1457	1815	1.2F
	2054		
21 Tu		0059	1.4E
	0312	0635	1.2F
	0906	1323	1.5E
	1544	1903	1.3F
	2142		
22 W		0147	1.4E
	0400	0721	1.3F
	0951	1409	1.5E
	1629	1948	1.3F
	2223		
23 Th		0233	1.4E
	0444	0806	1.3F
	1033	1454	1.5E
○	1710	2031	1.3F
	2302		
24 F		0317	1.3E
	0527	0847	1.2F
	1112	1537	1.4E
	1750	2111	1.3F
	2340		
25 Sa		0359	1.3E
	0608	0926	1.2F
	1151	1617	1.3E
	1830	2148	1.2F
26 Su	0017	0440	1.2E
	0649	0958	1.2F
	1229	1656	1.2E
	1910	2213	1.2F
27 M	0054	0518	1.1E
	0731	0948	1.2F
	1309	1632	1.1E
	1951	2206	1.2F
28 Tu	0134	0444	1.0E
	0816	1023	1.2F
	1350	1647	1.0E
	2034	2244	1.2F
29 W	0216	0510	1.0E
	0901	1106	1.2F
	1435	1722	1.0E
	2120	2329	1.2F
30 Th	0301	0551	1.1E
	0950	1153	1.1F
	1523	1807	1.0E
	2209		
31 F		0017	1.2F
	0350	0640	1.1E
	1041	1244	1.1F
◑	1616	1900	1.0E
	2300		

February

Day	Slack h m	Maximum h m	knots
1 Sa		0109	1.2F
	0442	0739	1.1E
	1136	1340	1.1F
	1711	2003	1.0E
	2354		
2 Su		0204	1.2F
	0538	0848	1.1E
	1230	1439	1.1F
	1809	2117	1.0E
3 M	0049	0303	1.2F
	0634	1049	1.2E
	1325	1545	1.2F
	1907	2322	1.1E
4 Tu	0144	0407	1.3F
	0730	1145	1.3E
	1419	1717	1.3F
	2004		
5 W		0014	1.2E
	0239	0522	1.4F
	0825	1233	1.4E
	1510	1817	1.4F
	2059		
6 Th		0102	1.3E
	0331	0629	1.5F
	0919	1319	1.5E
	1601	1908	1.5F
	2151		
7 F		0148	1.4E
	0422	0723	1.5F
	1011	1405	1.6E
●	1651	1957	1.6F
	2242		
8 Sa		0235	1.5E
	0513	0813	1.6F
	1102	1451	1.6E
	1740	2045	1.6F
	2332		
9 Su		0324	1.5E
	0605	0903	1.5F
	1152	1541	1.5E
	1830	2133	1.6F
10 M	0022	0418	1.5E
	0657	0954	1.5F
	1243	1638	1.5E
	1920	2223	1.5F
11 Tu	0112	0519	1.4E
	0749	1051	1.4F
	1335	1746	1.3E
	2012	2320	1.4F
12 W	0204	0624	1.4E
	0843	1154	1.3F
	1429	1853	1.2E
	2107		
13 Th		0023	1.3F
	0258	0727	1.3E
	0941	1259	1.1F
	1526	1957	1.2E
	2203		
14 F		0127	1.1F
	0354	0829	1.3E
	1041	1403	1.0F
◐	1627	2058	1.2E
	2302		
15 Sa		0230	1.1F
	0454	0928	1.3E
	1142	1506	1.0F
	1731	2157	1.2E
16 Su	0003	0331	1.0F
	0554	1026	1.3E
	1243	1605	1.0F
	1834	2253	1.2E
17 M	0103	0429	1.1F
	0655	1121	1.4E
	1342	1701	1.1F
	1941	2347	1.3E
18 Tu	0201	0523	1.1F
	0754	1213	1.5E
	1436	1753	1.1F
	2048		
19 W		0038	1.3E
	0253	0614	1.1F
	0847	1302	1.5E
	1523	1842	1.2F
	2132		
20 Th		0126	1.4E
	0341	0701	1.2F
	0932	1348	1.5E
	1607	1926	1.3F
	2206		
21 F		0211	1.4E
	0424	0745	1.2F
	1013	1432	1.4E
	1647	2008	1.3F
	2241		
22 Sa		0255	1.3E
	0505	0826	1.2F
	1050	1513	1.4E
○	1725	2047	1.3F
	2315		
23 Su		0335	1.3E
	0544	0903	1.2F
	1127	1551	1.3E
	1802	2121	1.3F
	2350		
24 M		0411	1.2E
	0623	0934	1.2F
	1203	1621	1.2E
	1840	2137	1.3F
25 Tu	0026	0435	1.1E
	0703	0923	1.2F
	1241	1548	1.1E
	1919	2136	1.3F
26 W	0103	0404	1.1E
	0745	0954	1.3F
	1320	1610	1.1E
	2000	2213	1.4F
27 Th	0143	0433	1.2E
	0829	1036	1.3F
	1403	1645	1.1E
	2045	2257	1.4F
28 F	0227	0512	1.2E
	0917	1122	1.2F
	1450	1729	1.1E
	2133	2344	1.3F

March

Day	Slack h m	Maximum h m	knots
1 Sa	0314	0600	1.2E
	1008	1211	1.2F
	1541	1821	1.0E
	2226		
2 Su		0034	1.3F
	0406	0656	1.1E
	1101	1304	1.2F
◑	1637	1921	1.0E
	2321		
3 M		0129	1.2F
	0502	0801	1.1E
	1159	1402	1.2F
	1737	2033	1.0E
4 Tu	0019	0228	1.2F
	0601	0923	1.2E
	1256	1507	1.2F
	1838	2300	1.1E
5 W	0118	0333	1.2F
	0701	1123	1.3E
	1351	1652	1.2F
	1938	2356	1.2E
6 Th	0214	0509	1.3F
	0800	1217	1.4E
	1446	1758	1.4F
	2035		
7 F		0047	1.4E
	0309	0619	1.4F
	0857	1307	1.5E
	1538	1852	1.5F
	2129		
8 Sa		0136	1.5E
	0402	0714	1.5F
	0950	1355	1.6E
●	1628	1942	1.6F
	2221		
9 Su		0224	1.6E
	0453	0805	1.6F
	1042	1443	1.6E
	1718	2030	1.7F
	2311		
10 M		0312	1.6E
	0545	0854	1.6F
	1133	1532	1.6E
	1807	2118	1.6F
11 Tu	0001	0403	1.6E
	0636	0944	1.5F
	1223	1625	1.5E
	1857	2206	1.6F
12 W	0050	0457	1.5E
	0727	1036	1.4F
	1314	1724	1.4E
	1948	2258	1.5F
13 Th	0140	0557	1.4E
	0820	1132	1.3F
	1407	1827	1.3E
	2040	2355	1.3F
14 F	0231	0659	1.4E
	0915	1232	1.2F
	1502	1930	1.2E
	2136		
15 Sa		0056	1.2F
	0326	0800	1.3E
	1012	1334	1.1F
◐	1601	2031	1.1E
	2233		
16 Su		0159	1.1F
	0424	0900	1.3E
	1112	1436	1.0F
	1703	2130	1.1E
	2334		
17 M		0301	1.0F
	0524	0959	1.3E
	1213	1536	1.0F
	1806	2227	1.2E
18 Tu	0036	0400	1.0F
	0624	1054	1.3E
	1312	1633	1.0F
	1911	2321	1.2E
19 W	0133	0456	1.0F
	0724	1147	1.4E
	1407	1726	1.1F
	2023		
20 Th		0013	1.3E
	0228	0547	1.1F
	0819	1236	1.4E
	1455	1814	1.2F
	2105		
21 F		0101	1.3E
	0316	0635	1.1F
	0906	1323	1.4E
	1539	1859	1.2F
	2139		
22 Sa		0146	1.4E
	0359	0719	1.2F
	0947	1406	1.4E
	1619	1940	1.3F
	2213		
23 Su		0229	1.3E
	0440	0759	1.2F
	1024	1447	1.3E
○	1657	2019	1.3F
	2247		
24 M		0308	1.3E
	0519	0837	1.2F
	1101	1523	1.2E
	1733	2053	1.3F
	2322		
25 Tu		0342	1.2E
	0557	0908	1.2F
	1137	1546	1.1E
	1811	2102	1.3F
	2357		
26 W		0332	1.2E
	0637	0900	1.3F
	1215	1518	1.1E
	1849	2109	1.4F
27 Th	0035	0335	1.2E
	0718	0929	1.3F
	1254	1543	1.1E
	1930	2146	1.4F
28 F	0115	0405	1.2E
	0800	1010	1.3F
	1337	1618	1.1E
	2016	2229	1.4F
29 Sa	0158	0445	1.2E
	0849	1055	1.3F
	1423	1702	1.1E
	2104	2316	1.4F
30 Su	0245	0532	1.2E
	0939	1144	1.3F
	1514	1753	1.1E
	2158		
31 M		0006	1.3F
	0337	0627	1.2E
	1033	1237	1.2F
◑	1609	1854	1.0E
	2255		

Pollock Rip Channel, Massachusetts, 1997

F–Flood, Dir. 035° True E–Ebb, Dir. 225° True

January

Day	Slack (h m)	Maximum (h m)	knots
1 W	0229	0505	1.7E
	0819	1135	1.7F
	1451	1724	1.6E
	2033	2356	1.8F
2 Th	0319	0555	1.6E
	0910	1229	1.7F
	1545	1817	1.5E
	2126		
3 F		0050	1.8F
	0409	0647	1.6E
	1002	1325	1.7F
	1640	1912	1.5E
	2221		
4 Sa		0144	1.8F
	0500	0739	1.6E
	1054	1420	1.8F
	1734	2007	1.5E
	2315		
5 Su		0238	1.8F
	0551	0831	1.7E
	1145	1512	1.9F
	1827	2101	1.6E
6 M	0009	0330	1.8F
	0640	0921	1.8E
	1234	1601	2.0F
	1917	2152	1.7E
7 Tu	0101	0418	1.8F
	0727	1010	1.9E
	1322	1648	2.1F
	2006	2242	1.8E
8 W	0150	0505	1.9F
	0814	1058	2.0E
	1409	1733	2.3F
	2053	2330	1.9E
9 Th	0239	0551	2.0F
	0901	1145	2.1E
	1456	1819	2.4F
	2140		
10 F		0018	2.0E
	0327	0637	2.1F
	0948	1233	2.2E
	1544	1906	2.5F
	2228		
11 Sa		0107	2.1E
	0416	0725	2.1F
	1038	1323	2.2E
	1633	1954	2.5F
	2318		
12 Su		0156	2.1E
	0507	0816	2.2F
	1130	1414	2.2E
	1725	2046	2.5F
13 M	0009	0248	2.1E
	0559	0911	2.1F
	1224	1508	2.1E
	1819	2141	2.4F
14 Tu	0103	0343	2.0E
	0655	1011	2.1F
	1323	1605	2.0E
	1917	2242	2.2F
15 W	0159	0441	1.9E
	0754	1117	2.0F
	1425	1707	1.8E
	2018	2349	2.1F
16 Th	0259	0543	1.8E
	0857	1228	2.0F
	1530	1814	1.7E
	2124		
17 F		0059	2.0F
	0400	0650	1.7E
	1001	1338	2.0F
	1637	1926	1.6E
	2231		
18 Sa		0208	1.9F
	0501	0759	1.7E
	1105	1444	2.0F
	1741	2037	1.5E
	2336		
19 Su		0311	1.9F
	0601	0903	1.7E
	1206	1544	2.1F
	1842	2141	1.6E
20 M	0037	0408	1.9F
	0656	1001	1.7E
	1301	1638	2.2F
	1937	2237	1.6E
21 Tu	0132	0500	2.0F
	0747	1051	1.8E
	1350	1727	2.3F
	2026	2324	1.7E
22 W	0220	0547	2.0F
	0833	1134	1.8E
	1434	1811	2.3F
	2110		
23 Th		0005	1.7E
	0303	0629	2.0F
	0915	1212	1.8E
	1514	1850	2.3F
	2150		
24 F		0041	1.7E
	0341	0707	1.9F
	0955	1246	1.8E
	1551	1926	2.2F
	2228		
25 Sa		0113	1.7E
	0417	0741	1.9F
	1034	1319	1.8E
	1627	1958	2.2F
	2305		
26 Su		0146	1.8E
	0453	0812	1.9F
	1113	1354	1.8E
	1703	2029	2.1F
	2343		
27 M		0220	1.8E
	0530	0844	1.9F
	1153	1431	1.8E
	1740	2102	2.1F
28 Tu	0022	0258	1.8E
	0608	0920	1.9F
	1235	1512	1.8E
	1820	2138	2.0F
29 W	0103	0339	1.8E
	0650	1000	1.8F
	1321	1557	1.7E
	1904	2219	2.0F
30 Th	0148	0423	1.8E
	0735	1045	1.8F
	1410	1644	1.7E
	1951	2306	1.9F
31 F	0235	0511	1.7E
	0823	1135	1.8F
	1504	1736	1.6E
	2043	2357	1.7F

February

Day	Slack (h m)	Maximum (h m)	knots
1 Sa	0326	0603	1.6E
	0915	1231	1.7F
	1600	1831	1.5E
	2139		
2 Su		0054	1.7F
	0420	0657	1.6E
	1011	1332	1.8F
	1658	1929	1.5E
	2238		
3 M		0155	1.6F
	0515	0753	1.6E
	1107	1433	1.8F
	1755	2027	1.5E
	2337		
4 Tu		0256	1.7F
	0609	0850	1.7E
	1203	1532	2.0F
	1850	2125	1.6E
5 W	0035	0353	1.8F
	0702	0945	1.8E
	1257	1626	2.1F
	1942	2220	1.8E
6 Th	0129	0446	1.9F
	0753	1037	2.0E
	1349	1717	2.3F
	2032	2311	1.9E
7 F	0220	0536	2.1F
	0842	1128	2.1E
	1439	1805	2.4F
	2121		
8 Sa		0001	2.0E
	0310	0625	2.2F
	0932	1218	2.2E
	1529	1852	2.5F
	2209		
9 Su		0050	2.1E
	0359	0713	2.3F
	1022	1308	2.3E
	1619	1940	2.5F
	2257		
10 M		0139	2.2E
	0448	0803	2.3F
	1113	1358	2.2E
	1709	2030	2.5F
	2347		
11 Tu		0228	2.1E
	0539	0855	2.3F
	1206	1450	2.2E
	1802	2123	2.4F
12 W	0039	0320	2.1E
	0632	0951	2.2F
	1303	1545	2.0E
	1857	2221	2.2F
13 Th	0133	0416	1.9E
	0728	1054	2.1F
	1403	1644	1.8E
	1956	2325	2.0F
14 F	0231	0516	1.8E
	0829	1202	2.0F
	1506	1750	1.6E
	2100		
15 Sa		0034	1.9F
	0332	0621	1.6E
	0932	1312	2.0F
	1612	1902	1.5E
	2207		
16 Su		0143	1.8F
	0434	0731	1.6E
	1037	1419	2.0F
	1717	2014	1.5E
	2313		
17 M		0247	1.8F
	0535	0838	1.6E
	1139	1520	2.1F
	1818	2119	1.5E
18 Tu	0014	0345	1.9F
	0632	0938	1.6E
	1236	1614	2.2F
	1913	2214	1.6E
19 W	0109	0437	1.9F
	0724	1028	1.7E
	1326	1703	2.2F
	2001	2301	1.7E
20 Th	0156	0523	2.0F
	0810	1112	1.8E
	1410	1746	2.3F
	2043	2340	1.7E
21 F	0238	0604	2.0F
	0852	1149	1.8E
	1450	1824	2.3F
	2122		
22 Sa		0014	1.8E
	0315	0641	2.0F
	0931	1222	1.8E
	1526	1859	2.2F
	2159		
23 Su		0045	1.8E
	0349	0713	2.0F
	1008	1253	1.9E
	1600	1929	2.2F
	2234		
24 M		0115	1.8E
	0423	0742	2.0F
	1046	1326	1.9E
	1635	1957	2.2F
	2310		
25 Tu		0148	1.9E
	0457	0811	2.0F
	1124	1402	1.9E
	1711	2027	2.1F
	2347		
26 W		0224	1.9E
	0533	0844	2.0F
	1204	1441	1.9E
	1749	2101	2.1F
27 Th	0026	0303	1.9E
	0611	0921	2.0F
	1247	1524	1.8E
	1830	2140	2.0F
28 F	0109	0346	1.8E
	0654	1004	1.9F
	1335	1610	1.7E
	1916	2225	1.8F

March

Day	Slack (h m)	Maximum (h m)	knots
1 Sa	0156	0434	1.7E
	0741	1053	1.9F
	1428	1701	1.6E
	2008	2317	1.7F
2 Su	0248	0525	1.7E
	0834	1149	1.8F
	1525	1757	1.5E
	2105		
3 M		0015	1.6F
	0344	0621	1.6E
	0932	1253	1.8F
	1626	1857	1.5E
	2208		
4 Tu		0121	1.6F
	0443	0721	1.6E
	1034	1401	1.8F
	1726	1959	1.5E
	2311		
5 W		0230	1.7F
	0543	0823	1.7E
	1136	1507	2.0F
	1825	2101	1.6E
6 Th	0012	0334	1.8F
	0640	0923	1.8E
	1235	1607	2.1F
	1920	2200	1.8E
7 F	0109	0431	2.0F
	0734	1019	2.0E
	1330	1700	2.3F
	2011	2253	1.9E
8 Sa	0202	0523	2.1F
	0826	1113	2.1E
	1423	1750	2.4F
	2100	2343	2.1E
9 Su	0252	0612	2.3F
	0916	1203	2.2E
	1513	1838	2.5F
	2148		
10 M		0032	2.2E
	0340	0659	2.4F
	1006	1252	2.2E
	1603	1925	2.5F
	2236		
11 Tu		0119	2.2E
	0428	0748	2.4F
	1057	1342	2.2E
	1653	2013	2.4F
	2324		
12 W		0207	2.1E
	0517	0838	2.3F
	1148	1432	2.1E
	1743	2104	2.3F
13 Th	0014	0257	2.0E
	0608	0931	2.2F
	1243	1525	1.9E
	1837	2159	2.1F
14 F	0107	0350	1.9E
	0702	1030	2.1F
	1340	1622	1.8E
	1934	2300	1.9F
15 Sa	0203	0447	1.7E
	0759	1135	2.0F
	1441	1725	1.6E
	2035		
16 Su		0007	1.8F
	0303	0550	1.6E
	0901	1243	1.9F
	1545	1834	1.5E
	2140		
17 M		0116	1.7F
	0405	0659	1.5E
	1005	1349	1.9F
	1648	1944	1.4E
	2245		
18 Tu		0219	1.7F
	0506	0806	1.5E
	1107	1449	2.0F
	1747	2047	1.5E
	2345		
19 W		0317	1.8F
	0604	0906	1.6E
	1204	1543	2.1F
	1840	2142	1.6E
20 Th	0038	0408	1.9F
	0656	0958	1.6E
	1255	1632	2.2F
	1928	2228	1.7E
21 F	0125	0454	2.0F
	0742	1041	1.7E
	1339	1715	2.2F
	2010	2307	1.7E
22 Sa	0206	0535	2.1F
	0825	1119	1.8E
	1420	1753	2.2F
	2049	2341	1.8E
23 Su	0243	0611	2.1F
	0904	1153	1.8E
	1457	1827	2.2F
	2126		
24 M		0012	1.9E
	0318	0642	2.1F
	0941	1225	1.9E
	1532	1856	2.2F
	2201		
25 Tu		0043	1.9E
	0351	0711	2.1F
	1018	1258	1.9E
	1606	1924	2.1F
	2237		
26 W		0115	1.9E
	0424	0740	2.1F
	1056	1334	1.9E
	1642	1954	2.1F
	2313		
27 Th		0151	1.9E
	0459	0812	2.1F
	1136	1412	1.9E
	1720	2028	2.0F
	2352		
28 F		0231	1.9E
	0537	0849	2.1F
	1219	1455	1.9E
	1802	2108	1.9F
29 Sa	0035	0314	1.9E
	0620	0932	2.0F
	1306	1542	1.8E
	1848	2154	1.8F
30 Su	0122	0402	1.8E
	0708	1022	2.0F
	1359	1633	1.7E
	1941	2246	1.7F
31 M	0216	0455	1.7E
	0802	1119	1.9F
	1457	1730	1.6E
	2040	2348	1.6F

TABLE 3.—SPEED OF CURRENT AT ANY TIME

EXPLANATION

Though the predictions in this publication give only the slacks and maximum currents, the speed of the current at any intermediate time can be obtained approximately by the use of this table. Directions for its use are given below the table.

Before using the table for a place listed in Table 2, the predictions for the day in question should be first obtained by means of the differences and ratios given in Table 2.

The examples below follow the numbered steps in the directions.

Example 1.—Find the speed of the current in The Race at 6:00 on a day when the predictions which immediately precede and follow 6:00 are as follows:

(1)	Slack Water	Maximum (Flood)	
	Time	Time	Speed
	4:18	7:36	3.2 knots

Directions under the table indicate Table A is to be used for this station.

(2) Interval between slack and maximum flood is 7:36 – 4:18 = 3^h18^m. Column heading nearest to 3^h18^m is 3^h20^m.

(3) Interval between slack and time desired is 6:00 – 4:18 = 1^h42^m. Line labeled 1^h40^m is nearest to 1^h42^m.

(4) Factor in column 3^h20^m and on line 1^h40^m is 0.7. The above flood speed of 3.2 knots multiplied by 0.7 gives a flood speed of 2.24 knots (or 2.2 knots, since one decimal is sufficient) for the time desired.

Example 2.—Find the speed of the current in the Harlem River at Broadway Bridge at 16:30 on a day when the predictions (obtained using the difference and ratio in table 2) which immediately precede and follow 16:30 are as follows:

(1)	Maximum (Ebb)		Slack Water
	Time	Speed	Time
	13:49	2.5 knots	17:25

Directions under the table indicate Table B is to be used, since this station in Table 2 is referred to Hell Gate.

(2) Interval between slack and maximum ebb is 17:25 – 13:49 = 3^h36^m. Hence, use column headed 3^h40^m.

(3) Interval between slack and time desired is 17:25 – 16:30 = 0^h55^m. Hence, use line labeled 1^h00^m.

(4) Factor in column 3^h40^m and on line 1^h00^m is 0.5. The above ebb speed of 2.5 knots multiplied by 0.5 gives an ebb speed of 1.2 knots for the desired time.

When the interval between slack and maximum current is greater than 5^h40^m, enter the table with one-half the interval between slack and maximum current and one-half the interval between slack and the desired time and use the factor thus found.

TABLE 3.—SPEED OF CURRENT AT ANY TIME

TABLE A

Interval between slack and desired time	Interval between slack and maximum current													
	h. m. 1 20	*h. m.* 1 40	*h. m.* 2 00	*h. m.* 2 20	*h. m.* 2 40	*h. m.* 3 00	*h.m.* 3 20	*h.m.* 3 40	*h.m.* 4 00	*h.m.* 4 20	*h.m.* 4 40	*h.m.* 5 00	*h.m.* 5 20	*h.m.* 5 40
h. m.	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*
0 20	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
0 40	0.7	0.6	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2
1 00	0.9	0.8	0.7	0.6	0.6	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.3
1 20	1.0	1.0	0.9	0.8	0.7	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4
1 40	----	1.0	1.0	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.5	0.4
2 00	----	----	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.5
2 20	----	----	----	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.7	0.6	0.6
2 40	----	----	----	----	1.0	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.7
3 00	----	----	----	----	----	1.0	1.0	1.0	0.9	0.9	0.8	0.8	0.8	0.7
3 20	----	----	----	----	----	----	1.0	1.0	1.0	0.9	0.9	0.9	0.8	0.8
3 40	----	----	----	----	----	----	----	1.0	1.0	1.0	0.9	0.9	0.9	0.9
4 00	----	----	----	----	----	----	----	----	1.0	1.0	1.0	1.0	0.9	0.9
4 20	----	----	----	----	----	----	----	----	----	1.0	1.0	1.0	1.0	0.9
4 40	----	----	----	----	----	----	----	----	----	----	1.0	1.0	1.0	1.0
5 00	----	----	----	----	----	----	----	----	----	----	----	1.0	1.0	1.0
5 20	----	----	----	----	----	----	----	----	----	----	----	----	1.0	1.0
5 40	----	----	----	----	----	----	----	----	----	----	----	----	----	1.0

TABLE B

Interval between slack and desired time	Interval between slack and maximum current													
	h. m. 1 20	*h. m.* 1 40	*h. m.* 2 00	*h. m.* 2 20	*h. m.* 2 40	*h. m.* 3 00	*h. m.* 3 20	*h. m.* 3 40	*h. m.* 4 00	*h. m.* 4 20	*h. m.* 4 40	*h. m.* 5 00	*h. m.* 5 20	*h. m.* 5 40
h. m.	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*	*ft.*
0 20	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
0 40	0.8	0.7	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.3
1 00	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4
1 20	1.0	1.0	0.9	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.5
1 40	----	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.7	0.6	0.6	0.6	0.6
2 00	----	----	1.0	1.0	0.9	0.9	0.9	0.8	0.8	0.7	0.7	0.7	0.7	0.6
2 20	----	----	----	1.0	1.0	1.0	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.7
2 40	----	----	----	----	1.0	1.0	1.0	0.9	0.9	0.9	0.8	0.8	0.8	0.7
3 00	----	----	----	----	----	1.0	1.0	1.0	0.9	0.9	0.9	0.9	0.8	0.8
3 20	----	----	----	----	----	----	1.0	1.0	1.0	1.0	0.9	0.9	0.9	0.9
3 40	----	----	----	----	----	----	----	1.0	1.0	1.0	1.0	0.9	0.9	0.9
4 00	----	----	----	----	----	----	----	----	1.0	1.0	1.0	1.0	0.9	0.9
4 20	----	----	----	----	----	----	----	----	----	1.0	1.0	1.0	1.0	0.9
4 40	----	----	----	----	----	----	----	----	----	----	1.0	1.0	1.0	1.0
5 00	----	----	----	----	----	----	----	----	----	----	----	1.0	1.0	1.0
5 20	----	----	----	----	----	----	----	----	----	----	----	----	1.0	1.0
5 40	----	----	----	----	----	----	----	----	----	----	----	----	----	1.0

Use table A for all places except those listed below for table B.
Use table B for Cape Code Canal, Hell Gate, Chesapeake and Delaware Canal, and all stations in table 2 which are referred to them.

1. From predictions find the time of slack water and the time and velocity of maximum current (flood or ebb), one of which is immediately before and the other after the time for which the velocity is desired.
2. Find the interval of time between the above slack and maximum current, and enter the top of table A or B with the interval which most nearly agrees with this value.
3. Find the interval of time between the above slack and the time desired, and enter the side of table A or B with the interval which most nearly agrees with this value.
4. Find, in the table, the factor corresponding to the above two intervals, and multiply the maximum velocity by this factor. The result will be the approximate velocity at the time desired.

Appendix J
Additional Compass Calibration Methods

The ship's steering compass should be calibrated periodically and a Deviation Table established using either a land based range as discussed in Chapter 3 or the Sun as discussed below:

Compass Calibration using the Sun: This is a simple procedure that takes two people about ten minutes to complete. The basic steps are as follows:

- **In morning or evening when the Sun is low on the horizon, put the boat on a compass course of North, and hold her steady while the second person sights across the compass at the Sun noting the bearing to the Sun. Write down the time, the boat's heading and the compass bearing to the Sun.**

- **Now put the boat on a compass heading of NE and repeat the above procedure, and repeat for additional headings of E, SE, S, SW, W and NW.**

- **If this is completed within about ten minutes, average the start and finish times together, and, using this time and your DR position, calculate the Sun's azimuth, Zn in degrees True. This value will be the same for all of the headings.**

- **Lookup the Magnetic Variation on a navigational chart for your position. This value will be the same for all headings.**

- **Use this data to complete the TVMDC the table below to determine the Compass Deviation on various headings as follows:**

    - **Enter the Ship's headings in column H.**
    - **Enter the compass bearing to the Sun in column C for each heading.**
    - **Enter the Sun's Azimuth as degrees True in Column T. This will be the same for all rows if the sights were completed in a short time of about ten minutes and will require a calculation using celestial procedures and will be illustrated in the Example problem below.**
    - **Determine the Magnetic Variation from a chart of your location and date; enter in column M. This will be the same for all rows.**
    - **Calculate the Magnetic bearing to the Sun based in columns T and V as follows and enter result in column M:**
        - **Moving from True to Compass in this table, add Westerly and subtract Easterly.**
        - **Moving from Compass to True in this table, add Easterly and subtract Westerly.**
    - **Calculate the Deviation for each heading based on columns M and C as follows and enter result in column D:**

- Take the numerical difference between these two columns and enter this number in column M, and
- If column C is larger than column M, the Deviation is Westerly, so write a "W" after the number, or
- If column C is smaller than column M, the Deviation is Easterly, so write an "E" after the number.

- **Plot a graph of Deviation vs. Heading, which can be used to interpolate between headings as shown in *Figure J-1.***

T	H	V	M	D	C
True Azimuth to Sun °T	Ship's Heading psc	Magnetic Variation for your present position °E or W	Magnetic Bearing to Sun °M	Calculated Compass Deviation °E or W	Compass Bearing to Sun °psc
	N				
	NE				
	E				
	SE				
	S				
	SW				
	W				
	NW				

Example- Compass Calibration using the Sun

On June 23, 1993 you decide to calibrate your ship's compass using the Sun a little before sunset. You take a round of compass bearings starting at 1841 ZT and completing at 1849 ZT. Your DR position is Latitude 35°16.2N, Longitude 61°19.3W. Variation = 18°W.

Procedure:

- **Time Zone = MTD = 61.32°W/15° = +4.09 = +4**
- **Average time of shots = (1841 + 1849)/2 = 1845 ZT**
- **Greenwich Time = GMT = 1845 + 4 = 2245**
- **Lookup GHA and Declination in a Nautical Almanac for the date and average time of the shots.**
- **Calculate LHA based on the GHA and your longitude.**
- **Calculate the whole number Assumed Latitude.**
- **Using the LHA, Assumed Latitude, Declination and the N-S contrariness lookup the Sun's azimuth in HO229 or HO249 as follows:**

	GHA	Dec
22	149°26.0	N 23°25.0//-0.0
4500	+ 11°15.0	+0.0
GHA	160°41.0	N 23°25.0
-ALong	- 61°41.0	
LHA	99°	
ALat	35° N	
Z = 66°	Zn = 360° - 66° = 294°	

Complete the TVMDC table as described above:

Heading	True	Variation	Magnetic	Deviation	Compass
N	294°	18°W	312°	1°W	313°
NE	294°	18°W	312°	4°W	316°
E	294°	18°W	312°	5°W	317°
SE	294°	18°W	312°	4°W	316°
S	294°	18°W	312°	1°W	313°
SW	294°	18°W	312°	2°E	310°
W	294°	18°W	312°	3°E	309°
NW	294°	18°W	312°	2°E	310°

Prepare a deviation table using just the boat Heading and compass Deviation as follows:

Heading °psc	Deviation °
000	1W
045	4W
090	5W
135	4W
180	1W
225	2E
270	3E
315	2E

Plot a graph of the Deviation versus the boat heading to allow interpolation for intermediate headings as follows:

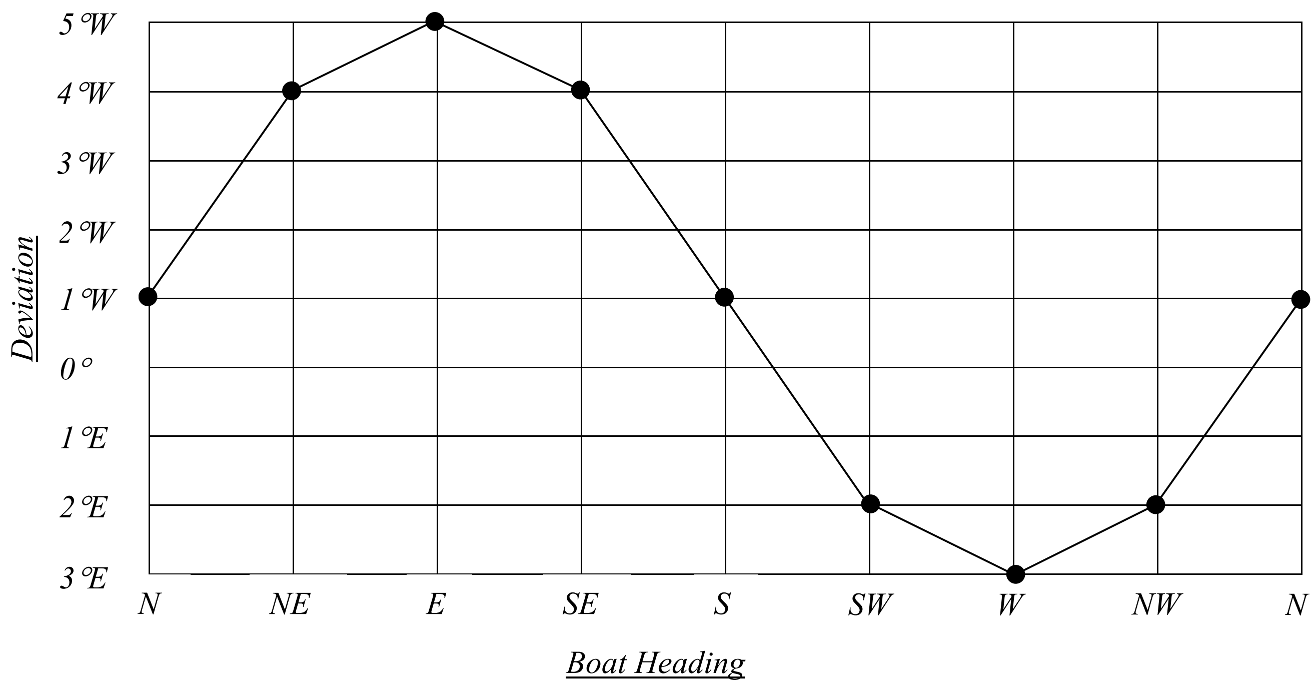


Figure J-1: Graph of compass deviation vs. boat heading.

<u>Gyro Compasses</u> are used in larger vessels and brief mention will be made of them here. They contain a spinning weight suspended on three moveable axes permitting the weight to remain in an essentially fixed orientation even while the vessel changes heading and rolls and pitches to wave motions. The compass is calibrated to indicate True North and is not affected by magnetic Variation or Deviation as is a magnetic compass. This compass will, however, also develop errors and these too must be accounted for in navigation.

Gyro compass error may be viewed in a similar manner as the magnetic compass and the following table may be used. The rules for applying Gyro Error are similar to those previously described:

- **Moving from <u>True to Gyro</u> in this table, add Westerly and subtract Easterly.**
- **Moving from <u>Gyro to True</u> in this table, add Easterly and subtract Westerly.**
- **Moving from <u>True to Compass</u> in this table, add Westerly and subtract Easterly.**
- **Moving from <u>Compass to True</u> in this table, add Easterly and subtract Westerly.**

Calibration and adjustment of gyrocompass involves an entirely different technology than magnetic compasses, and for a primer on this the reader is referred to References 1 & 2.

H	G	GE	T	V	M	D	C
Ship's Heading psc	Gyro Compass Bearing to Sun °G	Gyro Compass Error °E or W	True Azimuth to Sun °T	Magnetic Variation for your present position °E or W	Magnetic Bearing to Sun °M	Compass Deviation °E or W	Compass Bearing to Sun °psc
N							
NE							
E							
SE							
S							
SW							
W							
NW							

Appendix K
Leeway Angle Determination

Determining the leeway of your boat for various wind strengths and directions, sail combinations, sail trim, sail condition, boat speed, steering consistency and more is not an easy task, and published data for your boat design may not account for all of the real world variables that you are likely to encounter. But the leeway made by your boat is real and actually quite significant, and it can be an important factor in the accuracy of your navigation.

Thus, I offer the following method for determining the leeway of your boat under a given set of conditions. You may not ever be able to measure leeway under all conditions, but if you have real data for a few conditions, then you'll be able to make informed estimates to other conditions.

Starting with a very basic example, most sailors have experienced strong cross winds while traversing a narrow channel. It's instinctive to steer into the wind to compensate for the leeward motion imparted by the wind. In doing so, we keep a keen eye on the next channel marker to ensure that we meet it as planned; the harder the wind blows, the more we crab into the wind. But, while we're looking at the marker ahead, the previous marker astern is quietly drifting off to windward. Actually, we're drifting off to leeward and out of the channel while faithfully keeping our bow pointed at the next mark. It's essential in this case to regularly look back over your shoulder at the previous mark and keep your COG aligned with both the astern mark and the ahead mark.

This example points up the magnitude of leeway in a cross wind, but also suggests a method for quantifying, putting a number, on leeway. And that simply is to select two fixed markers, determine the direction between them from the chart, and sail or motor from one mark in the charted direction between them; if you stay on that heading, the wind will blow you off to the side of the second mark. When you draw abeam of the second mark, turn toward it and measure the distance to it as shown in *Figure K-1.*

As shown in *Figure K-2*, you now know the lengths of two sides of a right triangle and solve for the leeway angle either graphically or by trigonometry as follows:

$$\text{Tangent of Leeway Angle} = \frac{\text{Distance D2 to the second mark when abeam of it}}{\text{Distance D1 between marks measured from chart}}$$

For the existing conditions of wind-sail-motor-speed you have thus established a data point for future reference. Make note of this information and repeat the procedure for different conditions. If GPS or Loran are available, you can use these electronics to determine COG and compare with course steered, C to calculate leeway angle.

This procedure assumes that there is no current flowing and that all of the error is due to wind leeway.

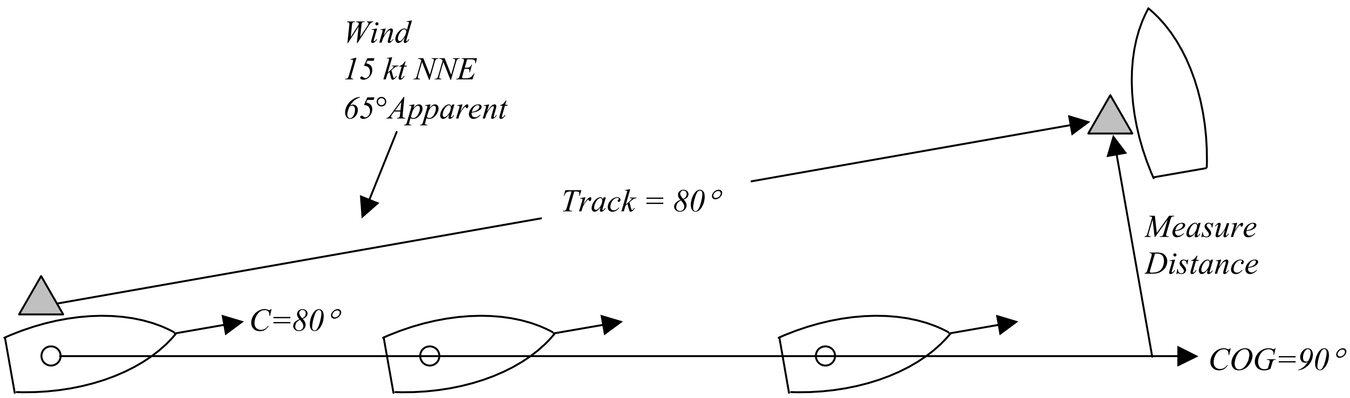


Figure K-1: Determine leeway angle by sailing a compass course equal to the bearing from one mark to the next as measured on the chart, then turn toward the second mark and measure the distance to it.

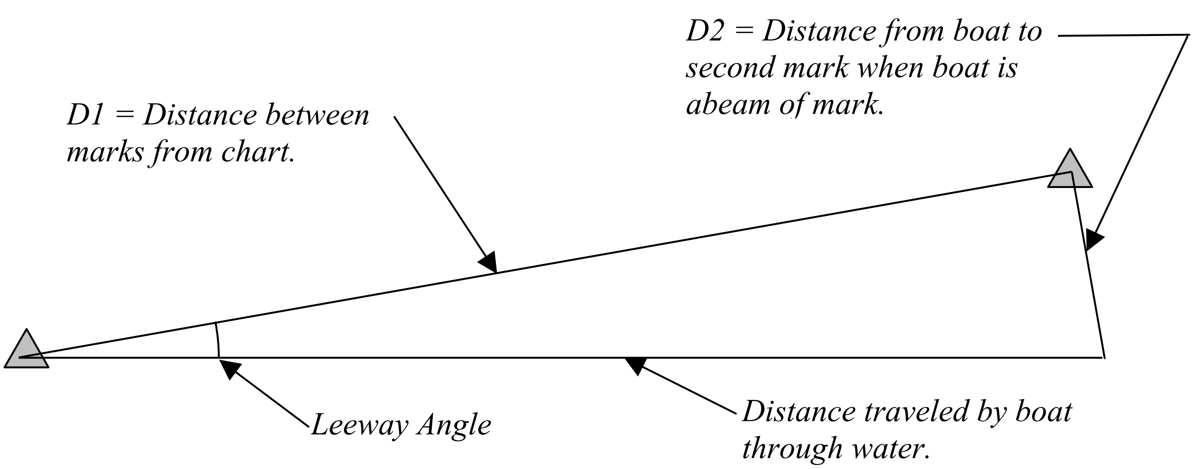


Figure K-2: The distance, D1 between the marks from the chart and the distance, D2 to the mark when abeam of it give the trigonometric tangent of the Leeway angle.

Practice Exercise

You decide to check the leeway angle of your boat by motoring between two fixed marks; the chart shows these marks to be 2.7 NM apart on a bearing of 135°T. Wind is 15 knots from the NE. You motor at 6 knots close by the first mark and head toward the second mark maintaining a heading of 146°psc. When the second mark is abeam, you turn 90° directly toward it. As you pass the second mark, your distance log indicates that it was 0.2 NM from the turn. What was your leeway angle? __________ °

Appendix L
Publication Details

Websites referred to in this appendix can be linked from http://www.american-sailing.com/ Sailing Resources.

Pilot Charts are used for ocean passage planning, and there is one chart per month for each ocean of the world. These include information such as magnetic variation; great circle routes; wave heights; frequency of gales; tropical cyclones and extratropical cyclones; air temperatures; ocean currents; wind strengths and directions; barometric pressures; visibility factors; icebergs; seawater temperatures and much more, and can be downloaded from the internet at the NGA website. Chart titles are as follows:

- **Pub 105- South Atlantic Ocean**
- **Pub 106- North Atlantic Ocean**
- **Pub 107- South Pacific Ocean**
- **Pub 108- North Pacific Ocean**
- **Pub 109- Indian Ocean**

Light Lists for US waters give details of man made navigational aids; these are discussed in Chapter 2 and *Appendix C* and can be purchased in printed form or downloaded and database queried from the internet at the NGA website. Volume titles are as follows:

- **Volume I Atlantic Coast from Maine to New Jersey**
- **Volume II Atlantic Coast from New Jersey to South Carolina**
- **Volume III Atlantic & Gulf Coasts from South Carolina to Florida; Puerto Rico & US Virgin Islands**
- **Volume IV Gulf Coast from Florida to Texas**
- **Volume V Mississippi River System**
- **Volume VI Pacific Coast & Pacific Islands**
- **Volume VII Great Lakes**

List of Lights for non-US waters give details of man made navigational aids; these are discussed in Chapter 2 and *Appendix D* and can be purchased in printed form or downloaded and database queried from the internet at the NGA website. Volume titles are as follows:

- **Pub 110- Greenland; East Coast North & South America; West Indies**
- **Pub 111- West Coast North & South America; Australia; Tasmania; New Zealand; North & South Pacific Islands**
- **Pub 112- Western Pacific; Indian Ocean; Persian Gulf; Red Sea**
- **Pub 113- Mediterranean; Black Sea; Sea of Azov**

- **Pub 114- British Isles; English Channel; North Sea**
- **Pub 115- Norway; Iceland; Arctic Ocean**
- **Pub 116- Baltic Sea; Gulf of Bothnia**

<u>Pilot Charts</u> are used for ocean passage planning, and there is one chart per month for each ocean of the world; these are available as printed charts or by download from the NGA website. Pilot charts include historical data and information such as magnetic variation; great circle routes; wave heights; frequency of gales; tropical cyclones; extratropical cyclones; air temperatures; ocean currents; wind strengths and directions; barometric pressures; visibility factors; icebergs; seawater temperatures and much more. Volume titles are as follows:

- **Coast Pilot No 1- Eastport to Cape Cod**
- **Coast Pilot No 2- Cape Cod to Sandy Hook**
- **Coast Pilot No 3- Sandy Hook to Cape Henry**
- **Coast Pilot No 4- Cape Henry to Key West**
- **Coast Pilot No 5- Gulf of Mexico, Puerto Rico, and Virgin Islands**
- **Coast Pilot No 6- Great Lakes**
- **Coast Pilot No 7- California, Oregon, Washington, and Hawaii**
- **Coast Pilot No 8- Dixon Entrance to Cape Spencer**
- **Coast Pilot No 9- Cape Spencer to Beaufort Sea**

<u>Sailing Directions</u> focus on the needs of oceangoing vessels but are useful to small boat sailors in unfamiliar areas. These can be downloaded from the NGA website and can be purchased in hard copy at nautical book stores.

- **Planning Guides**
  - **Pub 120- Pacific Ocean and Southeast Asia**
  - **Pub 140- North Atlantic, Baltic Sea, North Sea, and Mediterranean Sea**
  - **Pub 160- South Atlantic Ocean and Indian Ocean**
  - **Pub 180- Arctic Ocean**
  - **Pub 200- Antarctica**
- **Enroute Guides**
  - **Pub 121- South Atlantic Ocean**
  - **Pub 123- Southwest Coast of Africa**
  - **Pub 124- East Coast of South America**
  - **Pub 125- West Coast of South America**
  - **Pub 126- Pacific Islands**
  - **Pub 127- East Coast of Australia and New Zealand**
  - **Pub 131- Western Mediterranean**
  - **Pub 132- Eastern Mediterranean**
  - **Pub 141- Scotland**
  - **Pub 142- Ireland and the West Coast of England**
  - **Pub 143- West Coast of Europe and Northwest Africa**
  - **Pub 145- Nova Scotia and the Saint Lawrence**
  - **Pub 146- Newfoundland, Labrador, and Hudson Bay**

- **Pub 147- Caribbean Sea, Vol. I**
- **Pub 148- Caribbean Sea, Vol. II**
- **Pub 153- West Coasts of Mexico and Central America**
- **Pub 154- British Columbia**
- **Pub 155- East Coast of Russia**
- **Pub 157- Coasts of Korea and China**
- **Pub 158- Japan, Volume I**
- **Pub 159- Japan - Volume II**
- **Pub 161- South China Sea and Gulf of Thailand**
- **Pub 162- Philippine Islands**
- **Pub 163- Borneo, Jawa, Sulawesi, and Nusa Tenggara**
- **Pub 164- New Guinea**
- **Pub 170- Indian Ocean**
- **Pub 171- East Africa and the South Indian Ocean**
- **Pub 172- Red Sea and the Persian Gulf**
- **Pub 173- India and the Bay of Bengal**
- **Pub 174- Strait of Malacca and Sumatera**
- **Pub 175- North, West and South Coasts of Australia**
- **Pub 181- Greenland and Iceland**
- **Pub 182- North and West Coasts of Norway**
- **Pub 183- Northern Coast of Russia**
- **Pub 191- English Channel**
- **Pub 192- North Sea**
- **Pub 193- Skagerrak and Kattegat**
- **Pub 194- Baltic Sea (Southern Part)**
- **Pub 195- Gulf of Finland and Gulf of Bothnia**

VHF Radio Channels are assigned as shown in the following table. Some channels are available only in certain areas; for details, refer to the FCC website.

Type of Message	Appropriate Channel(s)
DISTRESS SAFETY AND CALLING - Use this channel to get the attention of another station (calling) or in emergencies (distress and safety).	**16**
INTERSHIP SAFETY - Use this channel for ship-to-ship safety messages and for search and rescue messages and ships and aircraft of the Coast Guard.	**6**
COAST GUARD LIAISON - Use this channel to talk to the Coast Guard (but first make contact on Channel 16).	**22**
NONCOMMERCIAL - Working channels for voluntary boats. Messages must be about the needs of the ship. Typical uses include fishing reports, rendezvous, scheduling repairs and berthing information. Use Channels 67 and 72 only for ship-to-ship messages.	**9, 67, 68, 69, 71, 72, 78, 79, 80**
COMMERCIAL - Working channels for working ships only. Messages must be about business or the needs of the ship. Use channels 8, 67, 72 and	**1, 7, 8, 9, 10, 11, 18, 19,**

88 only for ship-to-ship messages.	**63, 67, 79, 80, 88**
PUBLIC CORRESPONDENCE (MARINE OPERATOR) - Use these channels to call the marine operator at a public coast station. By contacting a public coast station, you can make and receive calls from telephones on shore. Except for distress calls, public coast stations usually charge for this service.	**24, 25, 26, 27, 28, 84, 85, 86, 87, 88**
PORT OPERATIONS - These channels are used in directing the movement of ships in or near ports, locks or waterways. Messages must be about the operational handling, movement and safety of ships. In certain major ports, Channels 11,12 and are not available for general port operations messages. Use channel 20 only for ship-to-coast messages. Channel 77 is limited to intership communications to and from pilots	**1, 5, 12, 14, 20, 63, 65, 66, 73, 74, 77**
NAVIGATIONAL - (Also known as the bridge-to-bridge channel.) This channel is available to all ships. Messages must be about ship navigation, for example, passing or meeting other ships. You must keep your messages short. Your power output must not be more than one watt. This is also the main working channel at most locks and drawbridges.	**13, 67**
MARITIME CONTROL - This channel may be used to talk to ships and coast stations operated by state or local governments. Messages must pertain to regulation and control, boating activities, or assistance to ships.	**17**
DIGITAL SELECTIVE CALLING - Use this channel for distress and safety calling and for general purpose calling using only digital selective calling techniques.	**70**
WEATHER - On these channels you may receive weather broadcasts of the National Oceanic and Atmospheric Administration. These channels are only for receiving. You cannot transmit on them.	**Wx-1 162.55 Wx-2 162.4 Wx-3 162.475**