CHAPTER 6

Types and Characteristics of Aids

CONTENTS

ILLUSTRATIONS

6–1 TYPES OF AIDS

6–1–1 Lighted Aids—

A. Lighted navigational aids consist of the following:

(1) *Primary seacoast lights.*—These lights are established on seacoasts, bays, sounds, and lakes for the purpose of making landfalls and coastwise passages from headland to headland, and in harbors where powerful candlepower is necessary. The light source is designed to obtain the maximum geographic range.

(2) *Secondary lights.*—These lights are established on seacoasts where the need for high candlepower and long range is less necessary, and on other large inland waterways as intermediate important aids, in harbors and other inshore channels as important aids, in all places where the requirements of navigation indicate that the range and candlepower of this class is necessary.

(*a*) Both primary and secondary lights may be attended or automatic in operation and may not necessarily be exhibited from the prominent towers associated with important lighthouses in the past.

(*b*) Lights are placed so that they will best serve the interests of marine navigation and the location,

height of the lantern, type and candlepower of illuminant are all designed to meet these interests. For daytime use the light structures are often distinctively marked or painted to provide easier identification.

(c) See chapters 21 and 29 for additional data on primary and secondary lights.

(3) *Lightships.*—These are attended vessels displaying the light characteristics of Primary or Secondary lights, located off the entrance to harbors, bays, and sounds, and along the seacoast at points where a major aid is necessary but where location precludes the building of a structure. They possess advantages over a fixed structure in that they may be moved when changing conditions indicate; also, they provide a light, fog signal, and radiobeacon that a vessel may steer for without danger *so long as collision with the lightship is avoided.*

(a) A lightship is distinctive in structure and paint color to distinguish it from other vessels.

(b) Due to the limit of height of the masthead lights of lightships and motion of the focal plane in a seaway, the use of high intensity lights on lightships has lagged behind the use of similar lights on shore structures. See chapter 29 for additional data on lightships.

(4) *Range Lights.*—These are pairs of lights so located as to form a range in line with the center of channels or entrance to a harbor. The rear light is higher than the front light and a considerable distance in back of it, thus enabling the mariner to use the range by keeping the lights in line as he progresses up the channel. The length of the range and width of the channel governs the height and distance of separation necessary between the lights. Range lights are often used in daylight hours by means of high candlepower. Otherwise the range light structures are equipped with daymarks for ordinary daytime use.

(5) *Directional lights.*—A directional light is a single light which will project a beam of high intensity, separate color, or special characteristic in a given direction. It has limited use for those cases where a two-light range may not be practicable or necessary, and for special applications. The directional light is essentially a narrow sector light with or without adjacent sectors which give information as to the direction of and relative displacement from the narrow sector.

(a) *Directional drum lens.*—This consists of a specially designed 200 mm. drum lens that projects a beam of high intensity in one direction while showing a beam of less intensity around the remainder of the horizon.

(b) *Polychrome light.*—This light shows a white light over a narrow sector with adjacent narrow sectors showing red and green respectively on each side of the central white beam.

(c) Other types of directional lights are being considered; however, the two mentioned above are more generally used in the Coast Guard.

(6) *Minor lights.*—These are lights of relatively low candlepower usually established in harbors, along channels, rivers and isolated locations. They are generally unattended and unwatched and operate automatically.

(a) These lights may be displayed from towers resembling the more powerful major lights or from modest skeleton structures or group of piles, dependant upon circumstances.

(b) They are colored to provide ready distinguishment from the surrounding background and from adjacent structures. Where these structures are a part of the lateral system of buoyage, they are painted to correspond with that system.

(c) See chapters 20, 21, and 24 for further description and data on minor lights.

(7) *Lighted buoys.*—These are floating aids showing an automatically-operated low candlepower light of various colors and characteristics from the upper part of their structures. Lighted buoys are established for the purpose of marking definitely identified spots such as the entrances, bifurcations and side limits of natural and dredged channels, centers of fairways, obstructions and wrecks, isolated natural dangers in offshore or restricted waters and for special purposes such as quarantine or general anchorages. They are illuminated by acetylene gas or electricity. See chapters 20, 21, and 24 for further data on lighted buoys.

6–1–5 Unlighted Aids—

A. Unlighted navigational aids consist of the following:

(1) *Unlighted buoys.*—These are floating aids of various size, shape and color serving the same general purposes as the lighted buoys and are used in areas of lesser importance and as intermediate aids to supplement the lighted buoys in the more important areas. See chapter 24 for a description of various types of unlighted buoys.

(2) *Daybeacons.*—Although all aids whether lighted or unlighted serve as a daymark to the mariner, daybeacons are specifically designated as unlighted structures used to mark isolated dangers or edges or alignment of channels. As most daybeacons are not intended to be used at long range, they are relatively small and simple structures.

6–1–10 Sound Fog Signals—

Sound fog signals are sound producing devices operated mechanically or by the action of the sea, consisting of horns, sirens, diaphones, bells, gongs, and whistles. They are installed on shore structures, lightships and buoys. Most fog signals on structures and lightships are attended. Fog signals on a few minor shore structures and buoys are automatically operated, the remainder of the signals on buoys are operated by action of the sea. Fog signals are intended to warn of danger and provide the mariner with the best practicable means of determining his position with relation to the sound signal station at such times as the station or any light that it might display is obscured from view by fog, haze, smoke, or general poor visibility.

B. To be effective, fog signals must be capable of a useful range and be of such characteristic duration as to permit its direction to be judged with reasonable accuracy by ear. It must be remembered

that due to the uncertainty of passage of sound through the atmosphere, the range of sound signals cannot be depended upon or specifically fixed.

C. *Major and minor fog signals.*—A major fog signal is a sound signal of normal range of 1½ miles or greater. A minor fog signal is a sound signal of limited power generally having an average range of 1 mile or less.

D. See chapter 25 for further data on various types of fog signals.

6–1–15 Marine Radiobeacons—

A. Marine radiobeacons are radio stations installed on important charted structures and lightships for the purpose of sending out radio signals in all directions to guide marine navigation. Vessels equipped with radio direction finder receivers may obtain lines of bearing from these stations, useful in fixing their position. Any number of vessels equipped to take radiobeacon bearings may do so simultaneously without interference with each other just as in the case of bearings of a visible light. Because of the much greater range of radiobeacons over primary seacoast lights, relatively fewer installations have been made along the coasts in comparison to these lights. Although primarily designed to assist the mariner in fog, radiobeacons are available and recognized as an all-weather aid. They are grouped in four classes: Class A has a reliable average range of 200 miles; class B, 100 miles; class C, 20 miles; and class D, 10 miles.

6–1–20 Loran System—

A. The Loran system is a modern electronic aid to navigation by means of which navigators on or over the ocean can determine their position accurately and quickly, day or night, and under practically any condition of weather and sea. The name loran was derived from the words "Long Range Navigation" which describe in general terms the system's relative utility when compared to ranges of other electronic navigational aids. The effective range of loran is as great as 1,400 nautical miles at night and 700 miles during the day.

B. The accuracy obtained is comparable to that which may normally be expected from good celestial observations. Loran lines of position may be crossed with other loran lines, soundings, radar ranges or bearings, radiobeacon bearings or celestial lines of position to provide fixes. Loran lines are fixed with respect to the earth's surface; their determination is not dependent upon the ship's compass, chronometer, or other mechanical or electronic devices. Loran shipboard equipment requires no special calibration and is not affected by the arrangement or disarrangement of shipboard antennas, cargo booms, ventilators, etc., as in the case of radio direction finders.

C. The loran system makes use of special radio transmitting stations on shore (loran transmitting stations), specially designed radio receivers with an electronic time-measuring device (loran receiver-indicator) and special charts or tables (loran charts or tables).

D. Loran transmitting stations, strategically located on shore, operate in pairs as part of a group of three or more transmitting stations separated at distances of from 200 to 600 miles. When the number of stations in a group exceeds two, the intermediate stations are paired with both adjacent stations. Any pair or all pairs of stations in a group of loran transmitting stations can be used by the navigator in determining position or lines of positions.

E. For a further description of loran, see chapter 18.

6–1–25 Radarbeacons (Racon)—

A. Responder-type radarbeacons transmit only when called, or interrogated, by coded pulses from the radar of the unit desiring the service of the beacon. When so interrogated, the racon will reply by sending out a set of coded pulses which will be indicated on the PPI scope of the unit's radar. Responding beacons of this type provide range as well as azimuth by permitting measurement of the elapsed time between the triggering of the beacon and the arrival of its responsive pulse at the unit.

B. Racons can only be used by units having radars capable of sending out the proper interrogating pulses.

6–1–30 Radar Reflector—

A. The radar reflector is a physical arrangement of such material and design as to reflect back to an ordinary radar most of the energy which strikes its surface. To the user this has the effect of presenting a much clearer and larger target than any random geometric-configuration of similar size, and one which can be picked up at relatively longer ranges. The radar reflector is not an amplifying device and therefore cannot improve the reflecting quality of any object which is in itself a good radar reflector. It will, however, make a good radar target out of an object that normally reflects little or no radar energy. Its primary application is for mounting on buoys, important landmarks, etc., so as to facilitate their being picked up and "seen" by radar.

6–2 CHARACTERISTICS OF FIXED STRUCTURES

6–2–1 Primary and Secondary Lights—

A. *Identification.*—Lights are given distinctive characteristics so that one light may be distinguished from another or as a means of conveying definite information. This is achieved by employing lights of various colors, by fixed lights, and by lights flashing of various duration with varying periods of intervals. In this manner a great variety of characteristics may be obtained.

(1) Lights are referred to as "flashing" when the light period is shorter than the dark period, and as "occulting" when the light period is equal to or longer than the dark period.

(2) At short distances and in clear weather, flashing lights may show a faint continuous light.

CHARACTERISTIC LIGHT PHASES

Illustration	Symbols and meaning		Phase description
	Lights which do not change color	Lights which show color variations	
	F.=Fixed	Alt.=Alternating.	A continuous steady light.
	F. Fl.=Fixed and flashing.	Alt. F. Fl.=Alternating fixed and flashing.	A fixed light varied at regular intervals by a flash of greater brilliance.
	F. Gp. Fl.=Fixed and group flashing.	Alt. F. Gp. Fl. =Alternating fixed and group flashing.	A fixed light varied at regular intervals by groups of 2 or more flashes of greater brilliance.
	Fl.=Flashing	Alt. Fl.=Alternating flashing.	Showing a single flash at regular intervals, the duration of light always being less than the duration of darkness. Shows not more than 30 flashes per minute.
	Gp. Fl.=Group flashing.	Alt. Gp. Fl.=Alternating group flashing.	Showing at regular intervals groups of 2 or more flashes.
	Qk. Fl.=Quick flashing.	----------	Shows not less than 60 flashes per minute.
	I. Qk. Fl.=Interrupted quick flashing.	----------	Shows quick flashes for about 4 seconds followed by a dark period of about 4 seconds.
	S-L. Fl.=Short-long flashing.	----------	Shows a short flash of about 0.4 second, followed by a long flash of 4 times that duration.
	Occ.=Occulting	Alt. Occ.=Alternating occulting.	A light totally eclipsed at regular intervals, the duration of light always equal to or greater than the duration of darkness.
	Gp. Occ.=Group occulting.	----------	A light with a group of 2 or more eclipses at regular intervals.

Light colors used and abbreviations: W=white, R=red, G=green.

FIGURE 6–1.—Characteristic light phases.

CHARACTERISTICS OF PRIMARY AND SECONDARY LIGHTS

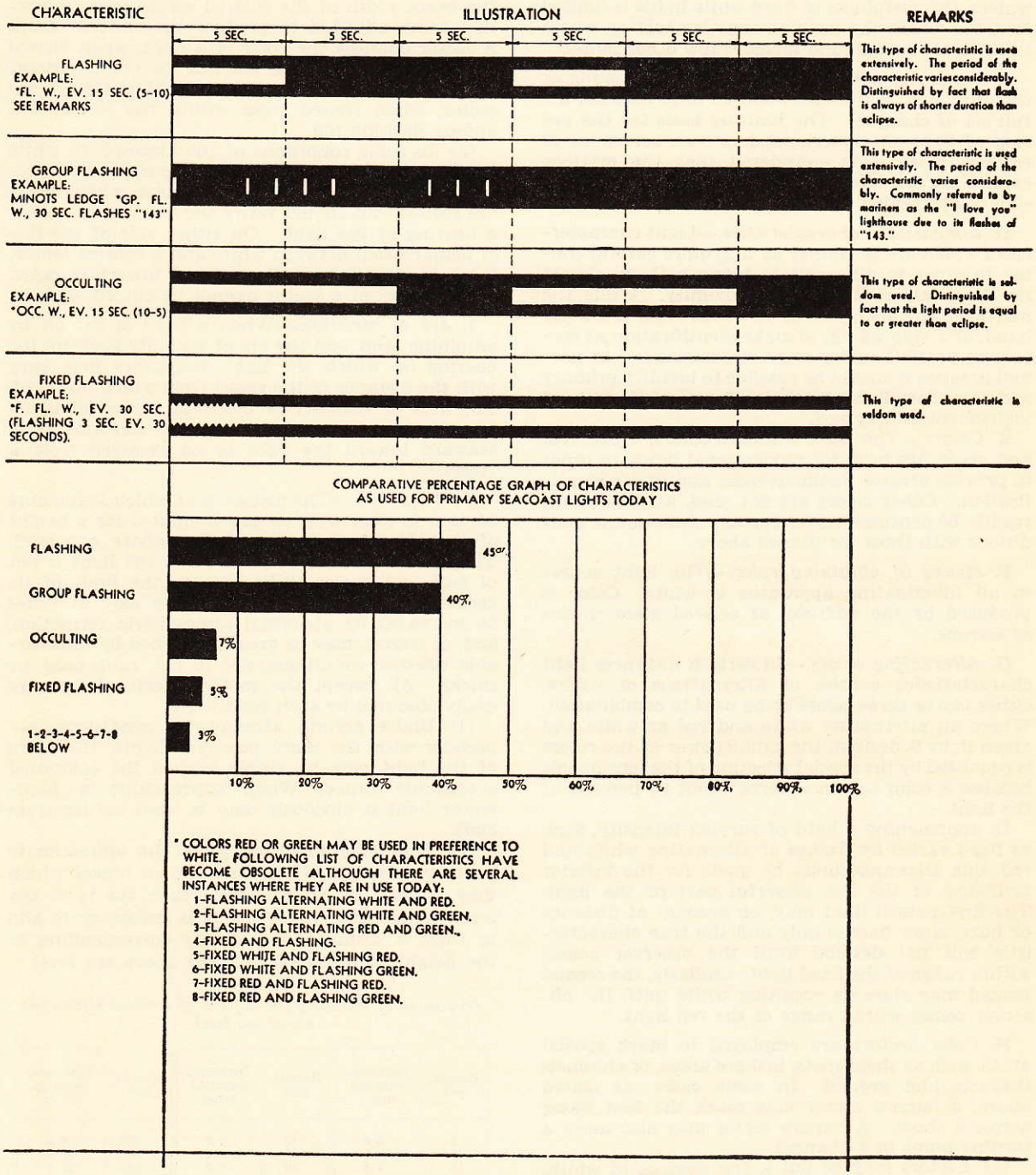


FIGURE 6–2.—Characteristics of primary and secondary lights.

B. *Limitations on use of white lights.*—Due to the increase in shore illumination along navigable waters, the usefulness of fixed white lights is limited to areas where the usable range is short or where the natural background includes few other lights.

C. *Length of period.*—The period of a flashing or occulting light is the time required to go through the full set of changes. The limiting basis for the period of light characteristics has been set up as 60 seconds since it is considered that the mariner cannot always safely watch the light to the exclusion of everything else for a longer period.

D. *Similarity of characteristics.*—Light characteristics which are so similar as to require careful timing in order to differentiate between them, should not be established in close proximity. While the mariner may wish to use a watch with a second hand, or a stop watch, to make identification as certain as possible under some circumstances, in normal practice it should be possible to identify primary and secondary lights by their characteristic without instruments of any sort.

E. *Colors.*—The three standard colors, white, red, and green are used for navigational lights in order to provide greater distinctiveness and easier identification. Other colors are not used, as they might readily be confused under certain atmospheric conditions with those mentioned above.

F. *Means of obtaining color.*—The light source in all illuminating apparatus is white. Color is produced by the addition of colored glass shades or screens.

G. *Alternating colors.*—In certain instances light characteristics consist of alternations of colors, either two or three colors being used in combination. Where an alternating white and red or white and green light is desired, the candlepower of the colors is equalized by the special selection of the lens panels because a color screen absorbs about 80 percent of the light.

In approaching a light of varying intensity, such as fixed varied by flashes of alternating white and red, due allowance must be made for the inferior brilliance of the less powerful part of the light. The first-named light may, on account of distance or haze, show flashes only and the true characteristic will not develop until the observer comes within range of the fixed light; similarly, the second named may show as occulting white until the observer comes within range of the red light.

H. *Color sectors* are employed to mark special areas, such as shoal spots, inshore areas, or channels through foul ground. In some cases, as stated above, a narrow sector may mark the best water across a shoal. A narrow sector may also mark a turning point in a channel.

(1) Sectors may be but a few degrees in width, marking an isolated rock or shoal, or of such width as to extend from the direction of the deep water toward shore. Bearings referring to sectors are expressed in degrees as observed from a vessel toward the light.

(2) Colored sectors, where the light is to appear either red or green over a certain arc of the horizon, are produced by mounting appropriately colored sheets of glass next to the glazing of the lantern, the exact width of the colored screen and its position being adjusted to produce the desired result. A sector changes the color of a light, when viewed from certain directions, but not the characteristic. For example, a flashing white light having a red sector, when viewed from within the sector, will appear flashing red.

(3) In some conditions of the atmosphere white lights may have a reddish hue; the mariner, therefore, should not trust solely to color where there are sectors, but should verify the position by taking a bearing of the light. On either side of the line of demarcation between white and a colored sector, there is always a small sector of uncertain color, as the edges of a sector cannot be cut off sharply.

I. *Arc of visibility.*—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. The arcs of visibility or obscured sectors of lights are given in degrees in a clockwise direction from seaward toward the light or as observed from a vessel.

J. *Miles seen.*—The distances at which lights may be seen in clear weather are computed for a height of the observer's eye of 15 feet above sea level. The luminous range is given when the light is not of sufficient power to be seen to the limit of its geographic range. These distances may at times be increased by abnormal atmospheric refraction, and, of course, may be greatly lessened by unfavorable weather conditions, due to fog, rain, haze, or smoke. All except the most powerful lights are easily obscured by such conditions.

(1) Under certain atmospheric conditions, especially with the more powerful lights, the glare of the light may be visible beyond the computed geographic range. When approaching a high-power light it obviously may be seen earlier from aloft.

(2) The table following gives the approximate geographic range of visibility for an object which may be seen by an observer whose eye is at sea level; in practice, therefore, it is necessary to add to these a distance of visibility corresponding to the height of the observer's eye above sea level.

Distances of visibility for objects of various elevations above sea level

Height, feet	Distance, nautical miles	Height, feet	Distance, nautical miles	Height, feet	Distance, nautical miles
5	2.5	70	9.6	250	18.2
10	3.6	75	9.9	300	19.9
15	4.4	80	10.3	350	21.5
20	5.1	85	10.6	400	22.9
25	5.7	90	10.9	450	24.3
30	6.3	95	11.2	500	25.6
35	6.8	100	11.5	550	26.8
40	7.2	110	12.0	600	28.0
45	7.7	120	12.6	650	29.1
50	8.1	130	13.1	700	30.3
55	8.5	140	13.6	800	32.4
60	8.9	150	14.1	900	34.4
65	9.2	200	16.2	1,000	36.2

K. *Candlepowers* of lights are approximate and are stated in English candles. When the power of a light varies, as in the case of a white light with a red sector, or a fixed light varied by flashes, the candlepower of both white and red, or fixed light and flash, is given. From the stated candlepowers the mariner may judge the relative brilliancy and power of the various lights.

L. *Methods of producing light characteristics.*—Though infrequently used at the present day, rotating opaque shutters and colored glass screens are a means of producing certain phases of light characteristics. Such shutters or screens are arranged to pass between the light and the observer's eye at certain regular intervals, either cutting off the light or changing its color. They may be mounted upon a ring or chariot rotated by an electric motor or weight-driven clock mechanism. Adjustment of the width of the shutter in connection with the speed with which it rotates controls the length of the dark period or colored flash.

(1) Flashing lenses, which must be rotated to produce the desired results, are composed of various elements of panels designed to produce a given characteristic. The number of flash panels, the width or arc of the fixed lens sections or of the dark sections, and the speed with which the entire lens assembly is rotated determine the exact length of the various parts of the characteristic. In such lenses, the light, whether it be electric, acetylene, or kerosene oil, burns steadily.

(2) Other flashing characteristics are obtained by interrupting the light source (i. e., electric).

(3) Description of the various types of rotating apparatus and drives of large lenses is given in chapters 21 and 29.

M. The helical bars and curved panes of glass used in modern lanterns avoid the production of sectors of reduced candlepower which would result from vertical astragals and secondary flashes due to reflections from the lantern glass of polygonal lanterns. The lantern panes are installed in sections with vertical height at least equal to the height of the lens so as not to obscure the light.

N. *Allowable tolerances.*—The maximum allowable tolerance for light characteristics has been established at 0.5 second per period or 2.0 seconds per minute, whichever is smaller. Whenever a light exhibits a characteristic which exceeds this tolerance it shall be considered as operating improperly and remedial action shall be taken.

6–2–5 Minor Lights—

A. Minor lights on fixed structures are given characteristic color, shape and flash as a means of distinguishment or as a means of conveying definite information. They are identified at night by the light color and flashing characteristic, and by the color, number and construction during the day.

B. *Light characteristics.*—Minor lights may display fixed, flashing, quick flashing, interrupted quick flashing, or occulting characteristics and when located along channel edges, will display characteristics in accordance with the lateral system of buoyage to be described in part 6–3 below.

C. *Daymarks.*—Special consideration is given to the daytime visibility of daymarks or targets of minor lights on fixed structures, particularly if rendered difficult to see on account of the scenic background or lack of it. Endeavor is made to retain the paint color and shape significance if possible without sacrifice of daytime visibility, but if white paint will increase the daytime visibility it may be used on either side as a solid color or in some combination with black or red for the daymark indication.

(1) The solid paint color white for an aid in the lateral system is considered a neutral color and is often used on either side and has no lateral significance.

(2) Except in the case of the Intracoastal Waterway, where the use of yellow has been adopted as a distinctive marking in combination with lateral colors, daymarks used throughout the Service shall be painted either white, black or red, these colors being used either alone or in combination as desired to be most effective. In the case of red color there is no objection to the use of international orange, Federal color 1205. The Light Lists and Notice to Mariners will make reference, however, to the three colors only, red, white, and black, in describing the daymarks.

D. *Numbering.*—Minor lights along channels are numbered in sequence with adjacent buoys when practicable.

E. *Allowable Tolerances.*—The maximum allowable tolerance for minor light characateristics has been established at 0.5 second per period or 2.0 seconds per minute, whichever is smaller. Whenever a minor light exhibits a characteristic which exceeds this tolerance it shall be considered as operating improperly and remedial action shall be taken.

6–2–10 Daybeacons—

A. Daybeacons that are placed along channel edges are painted and numbered to conform to the lateral system as described in part 6–3. Those that mark isolated dangers are constructed and painted so as to be distinctive and conspicuous. Being devoid of signaling equipment, the daybeacon depends on its height, coloring, and size to make it conspicuous and thus useful to mariners. Daybeacons may be iron spindles, piles, or elaborate iron or wooden skeleton structures fitted with slatted targets and may be equipped with reflectors for night navigation.

B. Where daybeasons are used to mark isolated dangers, the tendency has been to add to their distinctiveness by rather wide variation in design, especially where a number of such structures are to be found within a somewhat limited area. In the Intracoastal Waterway and other places where large numbers of daybeacons are used to delineate channel margins, the tendency has been toward a greater uniformity of design, and the coordination of design and lateral significance.

6–3 CHARACTERISTICS OF BUOYS (LIGHTED AND UNLIGHTED)

6–3–1 General

A. The waters of the United States are marked for safe navigation by the lateral system of buoyage. (See fig. 6–4.) This system employs a simple arrangement of colors, shapes, numbers, and light characteristics to show the side on which a buoy should be passed when proceeding in a given direction. The characteristics are determined by the position of the buoy with respect to the navigable channels as the channels are entered from seaward toward the head of navigation. As all channels do not lead from seaward, arbitary assumptions must at times be made in order that the system may be consistently applied. The characteristics of buoys are based on the assumption that proceeding in a southerly direction along the Atlantic coast, in a northerly and westerly direction along the Gulf coast, in a northerly direction on the Pacific coast, and in a westerly and northerly direction on the Great Lakes (except Lake Michigan), and in a southerly direction on Lake Michigan, is proceeding from seaward.

B. On the Intracoastal Waterway proceeding in a general southerly direction along the Atlantic coast, and in a general westerly direction along the gulf coast, is considered as proceeding from seaward. On the Mississippi and Ohio Rivers and their tributaries the aids to navigation characteristics are determined as proceeding from sea toward the head of navigation although local terminology describes "left bank" and "right bank" as proceeding with the flow of the river.

6–3–5 Daytime Identification—

A. *Colors.—When proceeding from seaward:*

(1) Black buoys mark the port (left) sides of channels, or the location of wrecks or obstructions which must be passed by keeping the buoy on the port (left) hand.

(2) Red buoys mark the starboard (right) sides of channels, or the location of wrecks or obstructions which must be passed by keeping the buoy on the starboard (right) hand.

(3) Red and black horizontally banded buoys mark junctions or bifurcations in the channel, or wrecks or obstructions which may be passed on either side. If the topmost band is black, the preferred channel will be followed by keeping the buoy on the port (left) hand. If the topmost band is red, the preferred channel will be followed by keeping the buoy on the starboard (right) hand. (NOTE.—*When proceeding toward seaward,* it may not be possible to pass on either side of these buoys, and the chart should always be consulted.)

(4) Black and white vertically striped buoys mark the fairway or midchannel and should be passed close to, on either side.

B. *Shapes.*—In order to provide ready identification certain unlighted buoys are differentiated by shape.

(1) Red buoys, or red and black horizontally banded buoys with the topmost band red are conical shaped and called nun buoys.

(2) Black buoys, or black and red horizontally banded buoys with the topmost band black are cylindrical shaped and called can buoys.

(3) Black and white vertically striped buoys may be either nun or can buoys. The shape has no significance in this case. Lighted buoys, sound buoys, and spar buoys are not differentiated by shape to indicate the side on which they should be passed. No special significance is attached to the shapes of these buoys, their purpose being indicated only by the coloring, numbering, or light characteristics.

(4) See chapter 24 of this manual for complete data on type and shape of buoys.

C. *Numbers:*

(1) All solid red and solid black buoys are numbered, the red buoys bearing even numbers and the black buoys bearing odd numbers, the numbers for each increasing from seaward. The numbers are kept in approximate sequence on both sides of a channel by omitting numbers where required.

(2) No other color buoys are numbered; however, any color buoy may be lettered for the purpose of identification. For example: buoys not actually in the channel but pertaining to areas immediately adjacent thereto may be suffixed with a letter A, B, etc., after the number of the nearest main channel buoy in order to maintain sequence. Numbers followed by letters such as "1 DR" are used on important buoys, particularly those marking offshore dangers. The letters are the initials of the station name and the number has its usual significance.

6–3–10 Nighttime Identification—

A. *Light color characteristics.*—Red lights on buoys are used only on red buoys or red and black horizontally banded buoys with the topmost band red. Green lights on buoys are used only on the black buoys or black and red horizontally banded buoys with the topmost band black. White lights on buoys are used on any color buoy. No special significance is attached to a white light on a buoy, the purpose of the buoy being indicated by its color, number, or its light phase characteristic.

B. *Light phase characteristics:*

(1) Lights on red buoys or black buoys, if not fixed, will always be regularly flashing or regularly occulting. For ordinary purposes the frequency of flashes will be not more than 30 per minute (slow flashing). For purposes when it is desired that lights have a distinct cautionary significance, as at sharp turns or sudden constrictions in the channel, or to mark wrecks or dangerous obstructions, the frequency of flashes will be not less than 60 per minute (quick flashing).

(2) Lights on red and black horizontally banded buoys will always show a series of quick flashes interrupted by eclipses about eight times per minute (interrupted quick flashing).

(3) Lights on black and white vertically striped buoys will always show a white short-long flash, this combination recurring at the rate of about eight times per minute.

C. *Summary of principles.*—It will be noted that in the preceding assignment of colors and characteristics, the following simple and easily remembered principles have been followed:

(1) Solid color buoys show regularly recurring flashes of uniform length.

(2) Parti-colored buoys show group flashing characteristics.

(3) The quick-flash is of a distinctly cautionary significance.

(4) Lights on wreck marking buoys will always show cautionary characteristics, quick flashing on red or black buoys, interrupted quick flashing on horizontally banded buoys.

D. *Reflectors* are placed on certain unlighted buoys to assist the navigator, using a searchlight,

STANDARD LIGHT CHARACTERISTICS

FOR

LIGHTED BUOYS

AND

MINOR LIGHTS

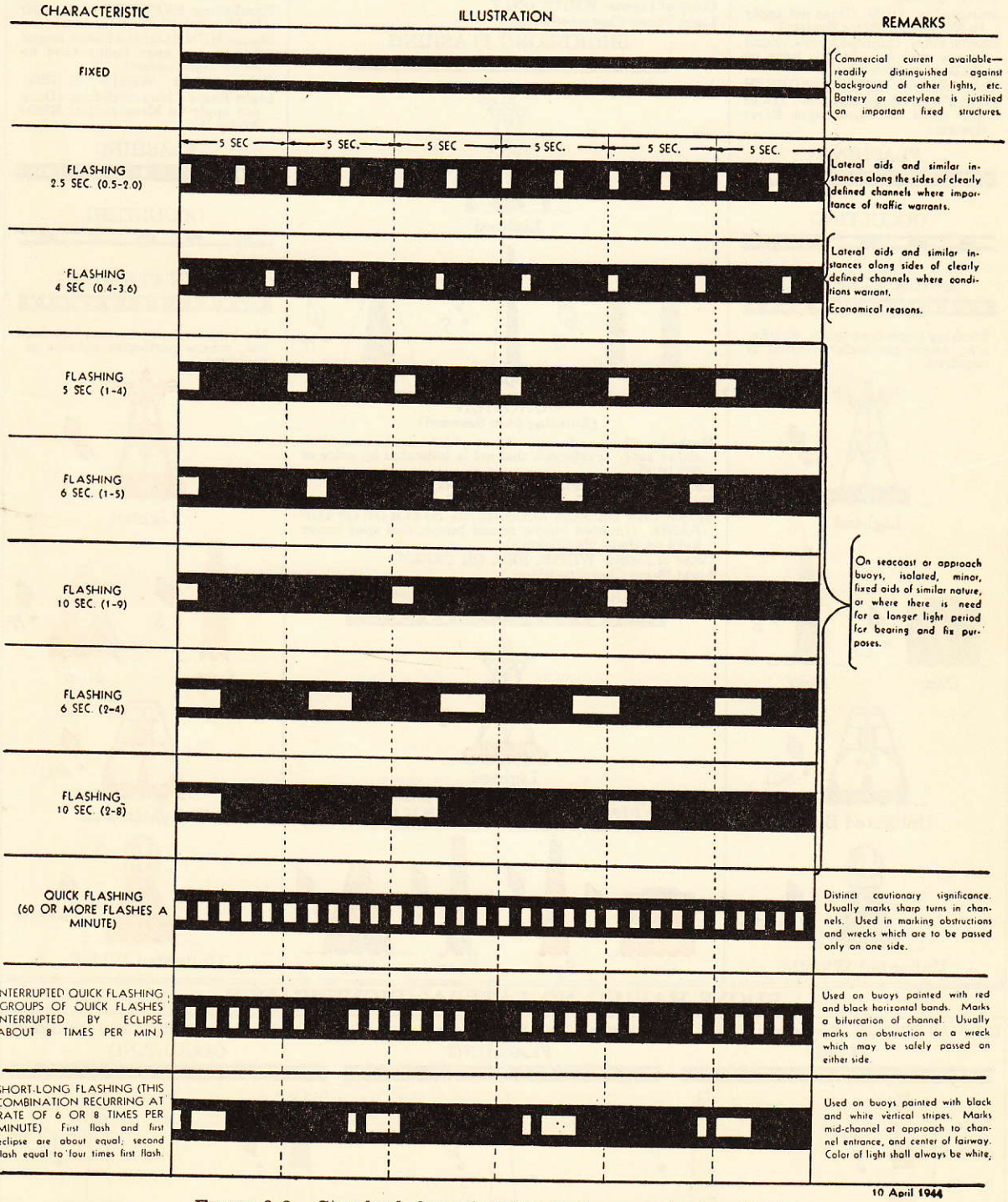


FIGURE 6–3.—Standard characteristics for buoys and minor lights.

UNITED STATES COAST GUARD

BUOYAGE OF THE UNITED STATES

Significance of Shapes, Coloring, Numbering, and Light Characteristics

Symbols shown adjacent to Buoys are those used on Charts to indicate such Aids

LATERAL SYSTEM

PORT SIDE
(Entering from Seaward)

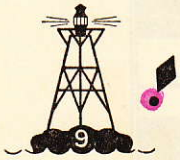
Marks port side of channels and obstructions which must be passed on port hand
Color: BLACK
Numbering: ODD. (Does not apply to Mississippi River System)
Shape: CAN. (Lighted buoys, sound buoys, and spar buoys, have no shape significance)
Color of Light: WHITE OR GREEN
Light Phase Characteristics: (Does not apply to Mississippi River System)

FLASHING

OCCULTING

QUICK FLASHING

Marking important turns, wrecks, etc., where particular caution is required.



Lighted

Can Spar

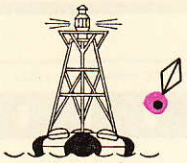
Unlighted Bell

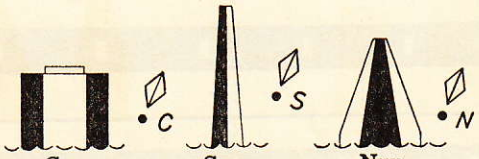
Unlighted Whistle

MID-CHANNEL
(Entering from Seaward)

Marks Mid-channel
Color: BLACK AND WHITE VERTICAL STRIPES
Numbering: NONE. May be lettered
Shape: NO SHAPE SIGNIFICANCE
Color of Lights: WHITE ONLY
Light Phase Characteristics:

SHORT-LONG FLASHING


Lighted



Can Spar Nun

JUNCTION
(Entering from Seaward)

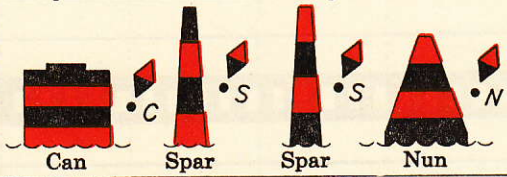
Marks junctions and obstructions which may be passed on either side. Preferred channel is indicated by color of top band.
Color: RED AND BLACK HORIZONTAL BANDS
Numbering: NONE. May be lettered
Shape: CAN OR NUN ACCORDING TO COLOR OF TOP BAND. (Lighted buoys, sound buoys, and spar buoys have no shape significance)
Color of Lights: WHITE, RED, OR GREEN
Light Phase Characteristics:

INTERRUPTED QUICK FLASHING


Lighted

Where preferred channel is to STARBOARD the topmost band is BLACK

Where preferred channel is to PORT the topmost band is RED



Can Spar Spar Nun

STARBOARD SIDE
(Entering from Seaward)

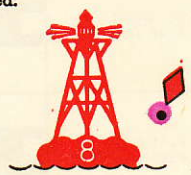
Marks starboard side of channels and obstructions which must be passed on starboard side
Color: RED
Numbering: EVEN. (Does not apply to Mississippi River System)
Shape: NUN. (Lighted buoys, sound buoys, and spar buoys have no shape significance)
Color of Light: WHITE OR RED
Light Phase Characteristics: (Does not apply to Mississippi River System)

FLASHING

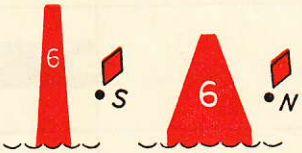
OCCULTING

QUICK FLASHING

Marking important turns, wrecks, etc., where particular caution is required.



Lighted



Spar Nun

Unlighted Bell

Unlighted Whistle

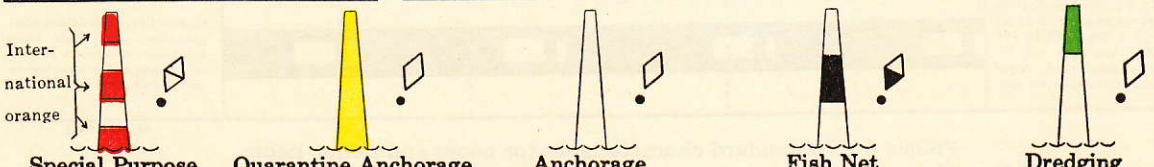
BUOYS HAVING NO LATERAL SIGNIFICANCE

Color: AS SHOWN. Numbering: NONE. May be lettered. Light Phase Characteristics: Color of Lights: ANY EXCEPT RED OR GREEN

FIXED

FLASHING

OCCULTING



Special Purpose Quarantine Anchorage Anchorage Fish Net Dredging

FIGURE 6-4.—Buoyage of the United States.

Average height of unlighted buoys above water

Class	Type								
	Tall		Standard		Special		Mississippi River		Spar
	Nun	Can	Nun	Can	Nun	Can	Nun	Can	
First	14′0″	9′9″	8′6″	6′0″	7′8″	6′6″	3′0 to 4′6″	1′10″ to 3′4″	15′ to 20′
Second	11′0″	7′6″	4′11″	3′11″	5′9″	4′5″			10′ to 15′
Third	8′0″	4′10″	2′7″	2′3″	4′4″	3′3″			7′ to 10′
Fourth									7′

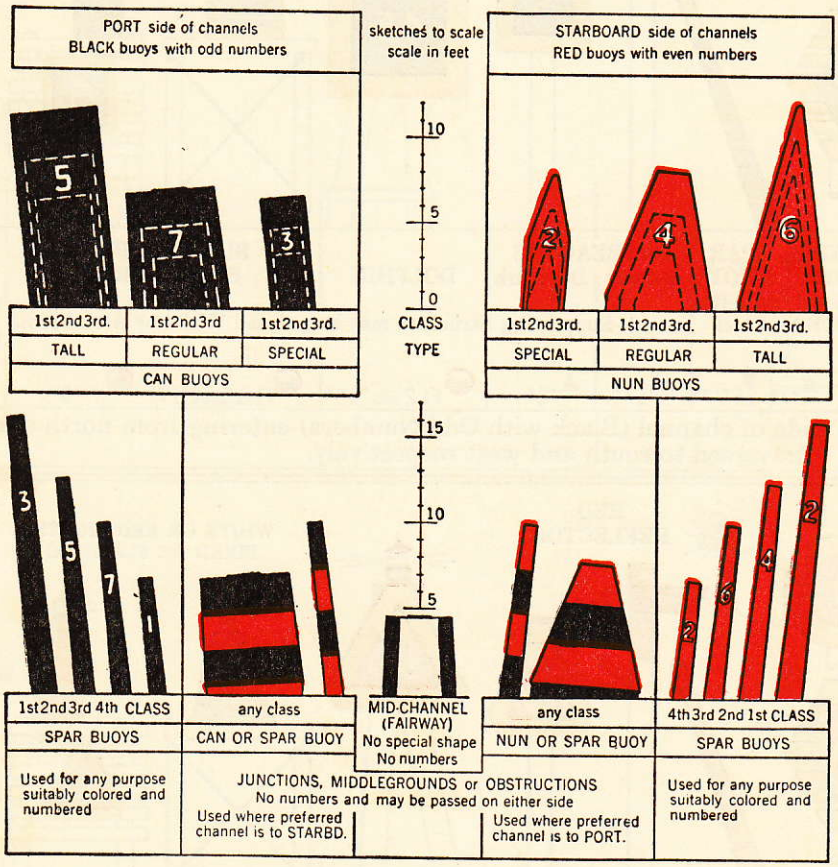


FIGURE 6–5.—Characteristics of unlighted buoys.

to more readily locate them at night. The colors of the reflectors have the same significance as the colors of lights.

6–3–15 Sound Signals—

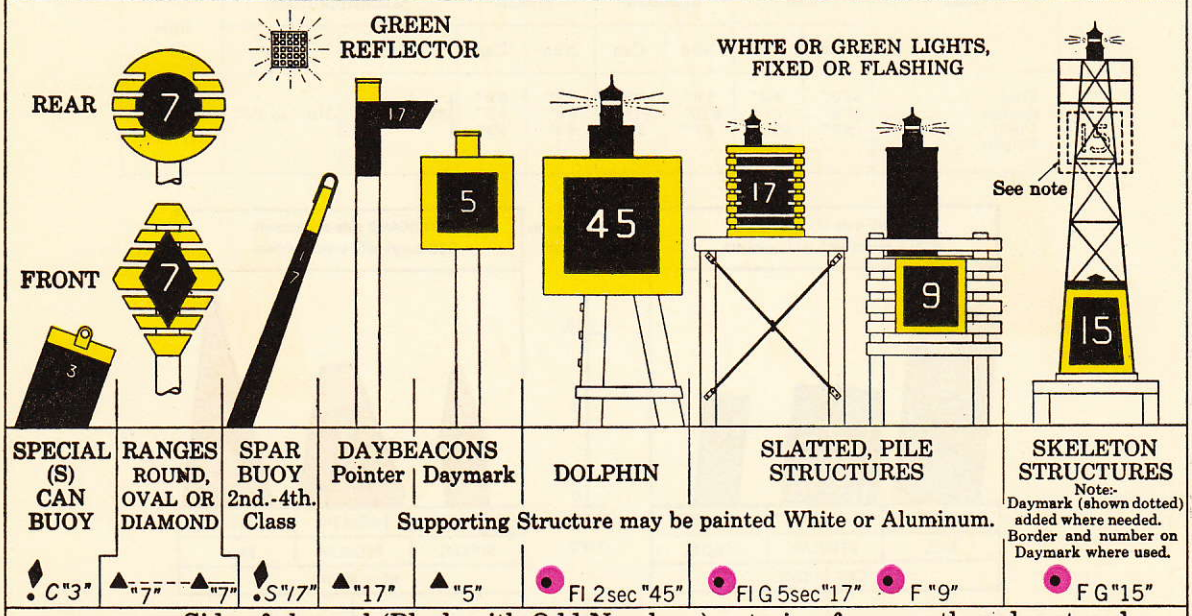
A. Lighted and unlighted buoys may be equipped with sound signals such as a bell, gong, horn, or whistle to aid in identifying the buoy in low visibility and at night.

6–3–20 Special Purpose Buoys—

A. *Color.*—Buoys for special purposes which have no lateral significance are colored as follows. White buoys mark anchorage areas. Yellow buoys mark quarantine anchorage areas. White buoys with green tops are used in connection with dredging and survey operations. White and black alternate horizontally banded buoys mark fish net areas. White and international orange buoys alternately banded, either horizontally or vertically, are for special purposes to which neither the lateral system colors nor the other special purpose colors apply. Yellow and black vertically striped buoys are used for seadrome markings and have no marine significance.

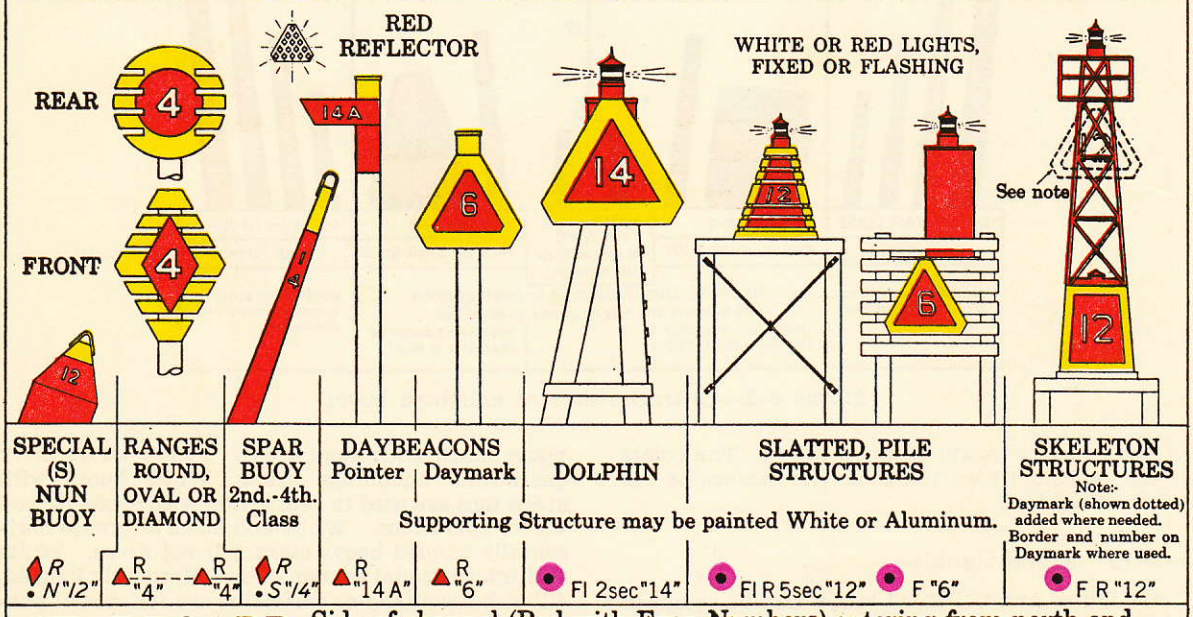
B. *Shape, number, light color, and characteristic.*—The shape of special purpose buoys has no significance. They are not numbered, but may be lettered. They may display any color light except

TYPES OF AIDS TO NAVIGATION
INTRACOASTAL WATERWAY



SPECIAL (S) CAN BUOY	RANGES ROUND, OVAL OR DIAMOND	SPAR BUOY 2nd.-4th. Class	DAYBEACONS Pointer	DAYBEACONS Daymark	DOLPHIN	SLATTED, PILE STRUCTURES	SKELETON STRUCTURES Note:- Daymark (shown dotted) added where needed. Border and number on Daymark where used.
			Supporting Structure may be painted White or Aluminum.				
C "3"	"7" "7"	S "17"	"17"	"5"	Fl 2sec "45"	Fl G 5sec "17" F "9"	F G "15"

PORT Side of channel (Black with Odd Numbers) entering from north and east and traversed to south and west respectively.



SPECIAL (S) NUN BUOY	RANGES ROUND, OVAL OR DIAMOND	SPAR BUOY 2nd.-4th. Class	DAYBEACONS Pointer	DAYBEACONS Daymark	DOLPHIN	SLATTED, PILE STRUCTURES	SKELETON STRUCTURES Note:- Daymark (shown dotted) added where needed. Border and number on Daymark where used.
			Supporting Structure may be painted White or Aluminum.				
R N "12"	R "4" R "4"	R S "14"	R "14 A"	R "6"	Fl 2sec "14"	Fl R 5sec "12" F "6"	F R "12"

STARBOARD Side of channel (Red with Even Numbers) entering from north and east and traversed to south and west respectively.

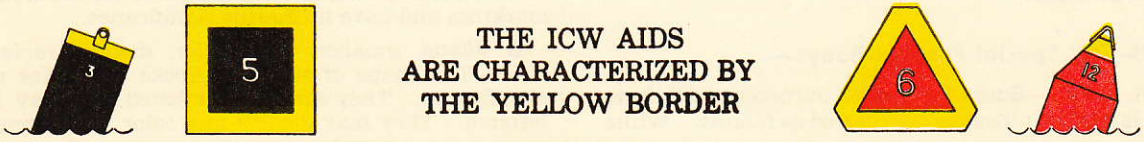
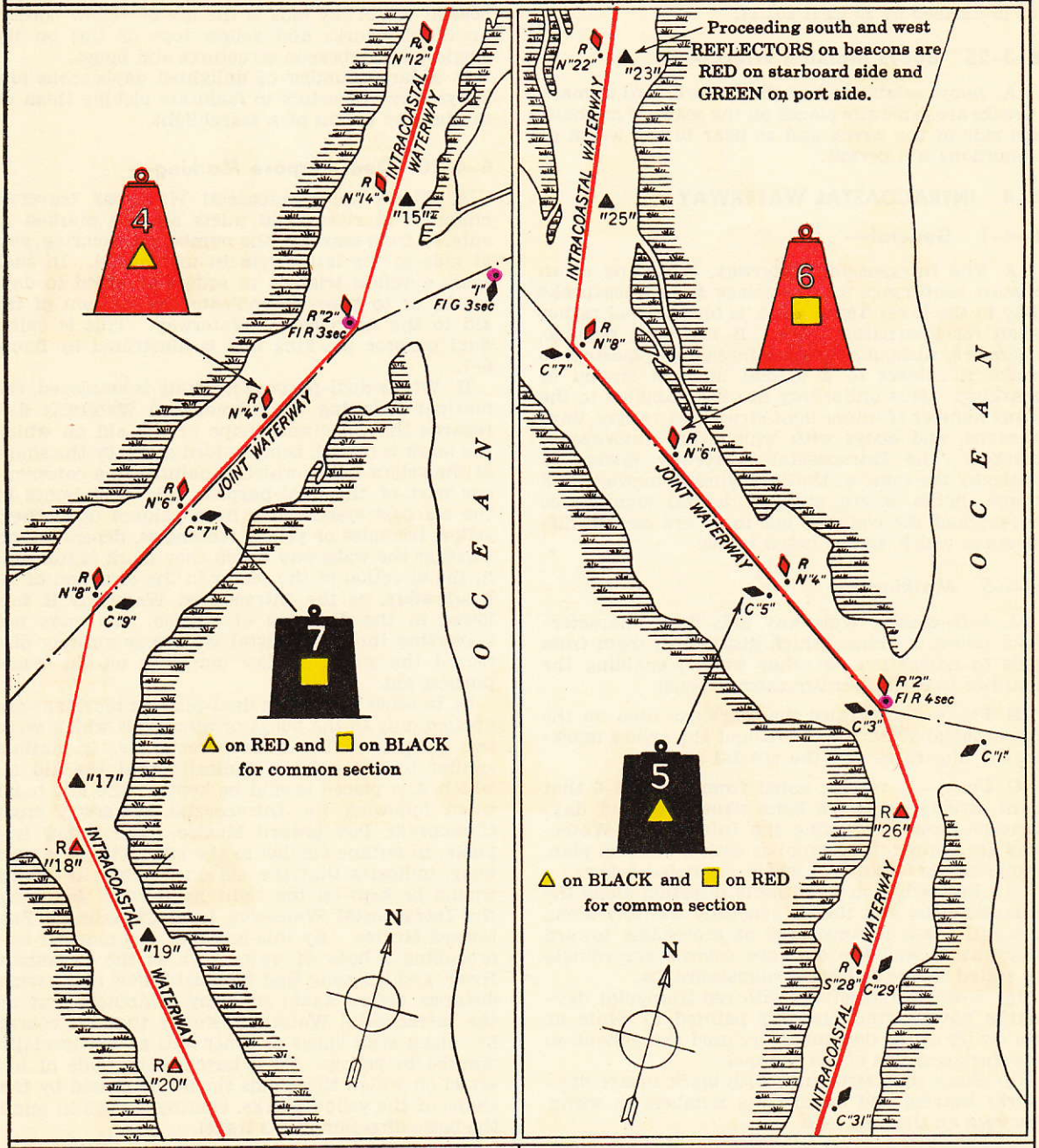


FIGURE 6–6.—Intracoastal Waterway Aids.

ILLUSTRATING THE SYSTEM OF DUAL PURPOSE MARKING WHERE THE ICW AND OTHER WATERWAYS COINCIDE



SKETCH A:

ICW joins another waterway, which is numbered from seaward, at buoy No. 2 and is common with it to buoy No. 9. ICW numbers and yellow borders are omitted in this section but the △ or □ is used on the regular aids to designate the ICW.

SKETCH B:

ICW joins another waterway at buoy No. 8 and is common with it to buoy No. 3. This section is numbered in the opposite direction to that of the ICW. The ICW numbers and yellow borders are omitted from the regular aids but a △ or □ is shown to designate the ICW.

FIGURE 6–7.—Dual purpose marking of Intracoastal Waterway.

red or green. Only fixed, occulting, or slow flashing characteristics are used. This section does not apply to aids to navigation marking floating plant moorings which shall be lighted with fixed red lights as prescribed by 33 CFR 201.11.

6–3–25 Buoys Marking Wrecks—

A. Buoys established by the Coast Guard to mark wrecks are generally placed on the seaward or channel side of the wreck and as near to the wreck as conditions will permit.

6–4 INTRACOASTAL WATERWAY

6–4–1 General—

A. The Intracoastal Waterway, consisting of an almost continuous inside passage from Chesapeake Bay to the lower Texas coast, is for national rather than for international use. It has been possible, therefore, without confusing foreign shipmasters to make it subject to a special uniform system of marking. This uniformity has been applied to the large number of minor light structures, ranges, daybeacons, and buoys with which this waterway is marked. The Intracoastal Waterway system is basically the same as that applying to buoyage and minor lights where given a lateral significance throughout the country, but there are certain differences which will be noted below.

6–4–5 Markings—

A. Intracoastal Waterway aids have characteristic yellow markings which distinguish them from aids to navigation on other waters, enabling the mariner to easily identify them as such.

B. Fig. 6–6 illustrates the markings used on the Intracoastal Waterway. Without the yellow markings it illustrates also the coastal system.

C. *Color.*—It will be noted from figure 6–6 that light structures, range light structures, and daybeacons used in marking the Intracoastal Waterway are colored in accordance with a uniform plan, the principle features of which are noted below:

(1) Proceeding in a southerly direction along the Atlantic coast and thence generally westerly along the gulf coast, is considered as proceeding toward headwaters, and the aids are colored accordingly as stated in the following subparagraphs.

(a) Red superstructures with red triangular daymarks having even numbers painted in white at the center of the daymarks, are used throughout on the starboard side of the channel.

(b) Black superstructures with black square daymarks bearing odd designating numbers in white, are used on the port side.

(c) For daymarks on unlighted daybeacons, black squares with odd numbers are used on the port side, and red triangles with even numbers for the starboard side of the channel.

(d) Single-pile structures on which the triangular or square daymarks are not used, are fitted with a pointer board. The upper portion of the starboard piles including the pointer board are red with even white numbers, and the port piles and pointer board, black with odd numbers in white. The lower part of the pile is either white or aluminum colored.

(e) The most distinctive feature of the Intracoastal Waterway aids is the use of yellow borders on all daymarks and yellow tops or tips on the single-pile daybeacon structures and buoys.

D. A large number of unlighted daybeacons and buoys carry reflectors to facilitate picking them up at night by means of a searchlight.

6–4–10 Dual Purpose Marking—

A. Where the Intracoastal Waterway traverses channels in rivers and inlets already marked as entered from seaward, the numbering, coloring, etc., of aids in the latter remain unchanged. In such cases a yellow triangle or square is added to daymarks or to buoys to indicate the relation of the aid to the Intracoastal Waterway. This is called dual purpose marking and is illustrated by figure 6–7.

B. Where dual-purpose marking is employed, the mariner following the Intracoastal Waterway disregards the color and shape of the aid on which the mark is placed, being guided solely by the shape of the yellow mark, which is painted in a conspicuous part of the dual-purpose aid. Can buoys of the seacoast system may have painted upon them yellow triangles or yellow rectangles, depending on whether the waterway which they mark is followed in the direction of the sea or in the direction of its headwaters, as the Intracoastal Waterway is followed in the direction of Mexico. Mariners not traversing the Intracoastal Waterway entirely disregard the special yellow markings on the dual-purpose aid.

C. In other words, the dual-purpose markings are applied only to the buoys or other aids which serve two purposes. The yellow rectangle, in outline similar to a can buoy, indicates that the aid on which it is placed should be kept on the left hand when following the Intracoastal Waterway from Chesapeake Bay toward Mexico. The yellow triangle, in outline similar to the silhouette of a nun buoy, indicates that the aid on which it is placed should be kept on the right hand when following the Intracoastal Waterway from Chesapeake Bay toward Mexico. By this marking, the mariner approaching a body of water such as the Savannah River, and knowing that he must follow it for some distance before again entering a dredged cut of the Intracoastal Waterway, knows that his course lies along such buoys or other aids as are specially marked in yellow. He determines the side of his vessel on which these aids should be passed by the shape of the yellow marks, bearing always in mind the basic direction of his travel.

6–5 CHARACTERISTICS OF RANGES (LIGHTED AND UNLIGHTED)

6–5–1 General—

A. It is a most natural navigating practice for mariners to line their vessels up by the use of ranges

STANDARD LIGHT CHARACTERISTICS
FOR
RANGE LIGHTS

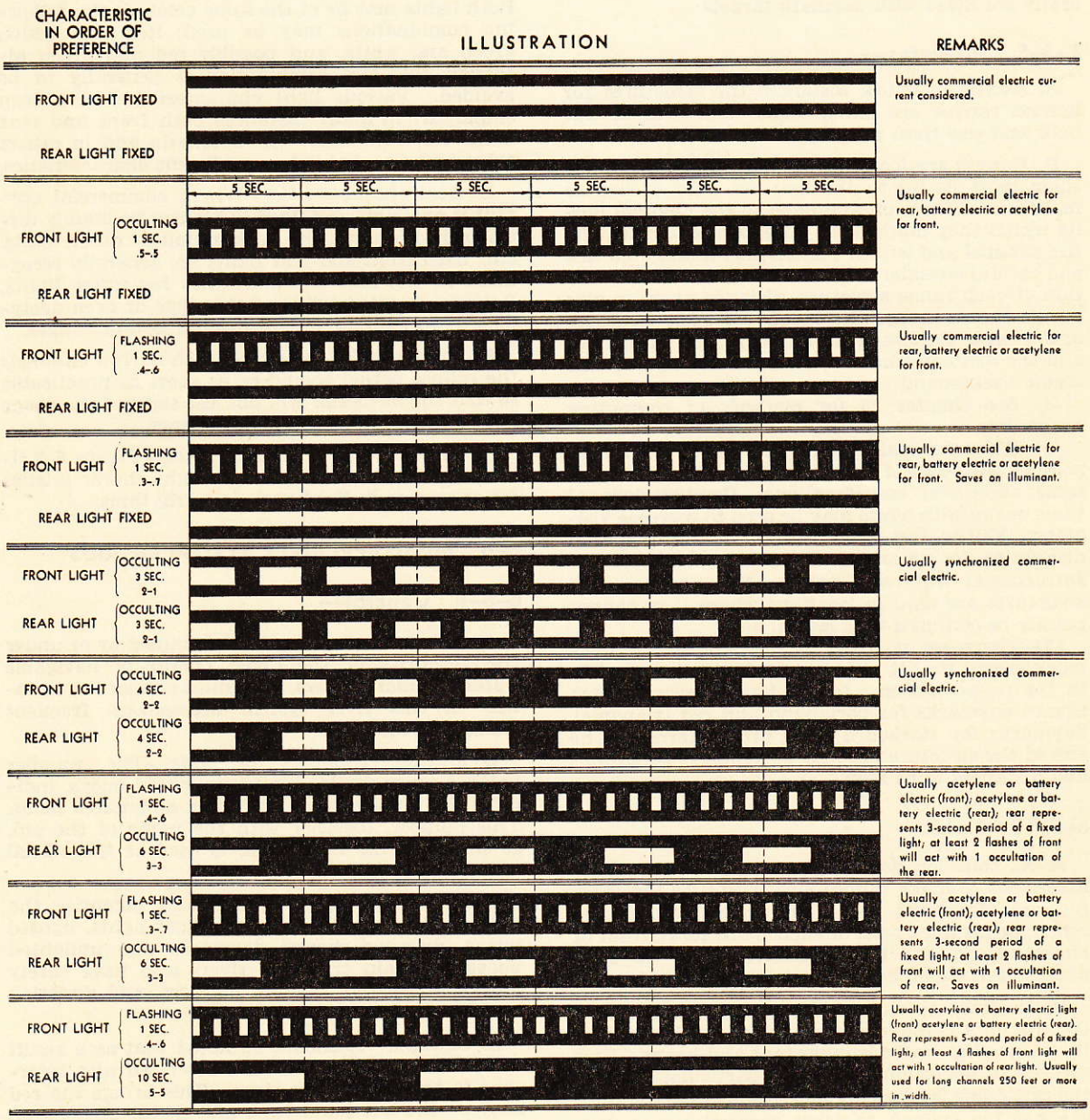


FIGURE 6–8.—Standard characteristics for range lights.

and leading marks to gauge the drift of the vessel from the desired course, using artificial or natural marks. For the purposes of this discussion a range will be considered as two aids to navigation which when in line with each other, define or make within channel limits a theoretical straight line or safe course for the mariner. Ranges may be used ahead or over the stern .

B. Ranges may be lighted or unlighted and generally are fitted with daymark targets.

6–5–5 Structures—

A. Except in a few instances the structures for lighted ranges are minor light structures of less bulk and size than primary or secondary lights.

B. Ranges are located and proportioned to make them most useful to the mariner. He desires to make use of them on approach to the channel limits which they mark, both on entering and leaving the channel and within the channel limits. To this end careful consideration must be given to the location of each range structure, distance apart to give adequate sensitivity, the height of each structure or daymark, the size of the daymark, the paint color and the distinctiveness of the structure against the scenic background.

(1) See chapter 23 for methods of computing range data.

(2) Rules for paint color correspond so far as possible with that of buoys and lateral markers with some additional considerations. Combinations of these colors with white may be used to increase visibility. Yellow has been introduced as a special distinction to indicate that the aids belong to the Intracoastal Waterway system. Many white range structures are used in locations where they cannot readily be confused with lateral aids.

(3) There are no rules as to shape of the daymark except that it be the most distinctive possible in the range system. In the lateral system black square daymarks for port hand and red triangular daymarks for starboard hand are preferred. The size of the structure depends on visibility conditions and distances to be seen.

6–5–10 Lights—

A. As consideration is given to structure characteristics to make ranges most useful to the mariner, so also must the color, vertical separation, reach, or distance seen of each light, its rhythm or characteristic, and the distinctiveness of the light against the scenic background be considered.

B. *Daylight operation.*—Many range lights now operate on a 24-hour basis in regions of low visibility where ship traffic is important and heavy. This method of operation is adopted particularly where the range line is of such a length that the structures are not big enough to serve successfully as daymarks to the distance required. Another important reason for daylight operation is to assist shipping in areas where haze and smoke from factories are prevalent, as in the Delaware River. For daylight use range lights must have a candlepower sufficiently high to serve effectively under various conditions of sunlight.

C. *Selecting characteristics.*—The objective in selecting characteristics for range lights is to insure distinction from other aids to navigation and from lights on shore, and to facilitate the determination of a ship's position in relation to the range line. Both white and colored lights are used for ranges. Both lights may be of the same color, or the following combinations may be used: Red and white, green and white, and possibly red and green although this last combination is generally to be avoided. Various light characteristics have been employed; in many instances both front and rear lights have the same characteristic and in others front and rear lights have different characteristics.

D. *Best characteristic.*—Where commercial current is available and fixed lights can be readily distinguished against the background of other lights, etc., fixed front and rear lights are generally recognized as the best characteristics for range lights. Battery-operated lights of this type or even acetylene lights may be justified on important ranges.

E. *Eclipse period to be short.*—In narrow channels the eclipse period should be as short as practicable so that the navigator will not lose sight of the range any longer than absolutely necessary.

F. *Standard light characteristics.*—Figure 6–8 illustrates Coast Guard standard light characteristics for ranges as to light periods or rhythms.

6–6 MISSISSIPPI RIVER SYSTEM OF AIDS

6–6–1 General—

A. Aids to navigation are maintained by or under the authority of the Coast Guard in navigable waters of inland rivers. Constant changes in channels in this river system necessitates frequent changes in aids.

B. *Mileage Numbers of Aids.*—The number painted on each aid, except unlighted buoys, indicates the number of miles from a designated point. This number, together with the name of the aid, as shown in the Light List, is used as the official name of the aid.

C. Mississippi River System aids comprise the following: minor lights ashore, float lights, lighted buoys, diamond-shaped daymarks and unlighted buoys. Certain tributary rivers also have safety harbor and safety landing markers, and direction boards.

D. *Caution.*—It should be noted that as a result of custom and usage, aids are described with reference to the flow of the river. This brings the red buoy on the left-hand bank and the black buoy on the right-hand bank as seen from a down-bound vessel. When these aids are considered from seaward there is no conflict with the standard system of buoy marking as used throughout the coastal and Great Lakes areas.

E. *Design of structures.*—The general design of minor light and daymark structures along the Mississippi and other western rivers differs from that of structures for similar purposes in other parts of the country because of the special conditions existing upon these rivers. Caving banks have made it desirable to keep these structures as inexpensive as possible because of substantial losses each year. Frequent shifting of river channels, bars, and crossings, and the consequent need for the moving of lights has dictated the design of structures which can be erected quickly and taken apart and re-erected when necessary. The great number of such structures in service has resulted in considerable standardization, with only an occasional departure from the usual types to meet special conditions. These light structures are built of timber, a central post being braced to stakes driven in the ground. A flight of wooden steps leads to a small platform on which the lantern is mounted, and a target and number board complete the assembly.

F. *Type of lights.*—Both oil and electric lights are used in addition to a few natural gas lights. The standard oil lantern has been the "Triangular Lantern," so named from its shape. See chapter 22 for details. Battery lights presently in use are the 90 and 200 mm. lanterns. Commercial electric lights are a 200 mm. duplex lantern. (See chapter 21 for details.)

G. *Daymarks* are standardized at 6′ x 6′ and 10′ set diamond-wise. These are simple lumber structures supported by posts and braces and need no comment.

H. *Direction boards* are made of lumber, 12″ x 48″, each end cut to a point. Directions for traffic are painted on the board surface.

I. *Safety harbor signs* are simple wooden signs square on one end, pointed on the other, properly oriented. They are painted white to indicate a safety harbor of 1st class, orange to indicate second class, without any lettering on either.

6–6–5 Characteristics of Aids—

A. All lights are fixed white oil lights unless otherwise indicated in the Coast Guard Light List. Lights having a characteristic other than fixed white are indicated in the Light List by the following abbreviations:

Gp.—Group.	W.—White.
Fl.—Flashing.	R.—Red.
F.—Fixed.	G.—Green.
Occ.—Occulting.	(sec.)—Seconds.

B. Thus, the symbols Gp. Fl. W., 4 secs., 2 flashes (e), shown in the Light List, just below the name of an aid, indicate that the aid is electrically lighted and exhibits a group of two white flashes every 4 seconds. The symbols F. G. (e) indicate that the aid exhibits a fixed green electric light.

C. *Reflectors.*—All light structures and daymarks (a term retained in the Second District because of common usage; otherwise known as daybeacons) are equipped with reflectors, red, or white on the left bank and green or white on the right bank, as seen from a down-bound vessel. All reflectors on lights and daymarks are white unless indicated as red or green under the "Remarks and corrections" column of the Light List.

D. *Buoys.*—Red buoys, nun (cone-shaped), are located on the left-hand side of the navigable channel and black buoys, can (cylindrical), are located on the right-hand side of the channel, as seen from a down-bound vessel. Unlighted buoys are equipped with reflectors to increase night-time visibility by

STANDARD LIGHT CHARACTERISTICS

Characteristic	*Remarks*
Fixed	Located on either side of channel. Commercial electric power or oil. All oil lights will be white.
Flashing 2 sec (0.2–1.8)	Right (looking downstream) bank or side of channel. Battery or acetylene power.
Group Flashing 4 sec. (0.2–0.6–0.2–3.0)	Left (looking downstream) bank or side of channel. Battery or acetylene power.
Flashing 4 sec (0.4–3.6)	Used only where higher intensity in color is required for background contrast. Color *red* for *left* or *green* for *right* (looking downstream) bank or side of channel. Battery or acetylene power.
Occulting 2 sec (1.0–1.0)	On either bank or side of channel. Commercial electric power.
Quick Flashing (60 or more flashes a minute)	Distinct cautionary significance. Usually marks sharp turns. Used in marking obstructions and wrecks which are to be passed only on one side.
Interrupted Quick Flashing. (Groups of quick flashes repeated about 8 times a minute).	Use on buoys painted with red and black horizontal bands. Marks a bifurcation in channel. Used to mark obstructions and wrecks which may be safely passed on either side.
Short-Long Flashing. (Groups of 1 short and 1 long flash repeated 6 to 8 times a minute. First flash and first eclipse about equal with second flash equal to 4 times first flash).	Used on buoys painted with black and white vertical stripes. Marks mid-channel at approach to channel entrance and center of fairway. Color of light shall always be white.

NOTES

will be:

1. Except where specifically noted above, color of light
   WHITE or GREEN for RIGHT (looking downstream) bank or side of channel.
   WHITE or RED for LEFT (looking downstream) bank or side of channel.
2. Reflex Signals (Reflectors):
   WHITE on shore structures either bank or side of channel.
   RED on shore structures LEFT (looking downstream) bank or side of channel.
   WHITE on CAN buoys on RIGHT (looking downstream) side of channel.
   RED on NUN buoys on LEFT (looking downstream) side of channel.
3. Private Aids (Commercial Electric):
   FIXED GREEN light for RIGHT (looking downstream) bank or side of channel.
   FIXED RED light for LEFT (looking downstream) bank or side of channel.

FIGURE 6–9.—Standard light characteristics for Second Coast Guard District.

Fixed white light for either bank or side of channel #red or green conflicts with existing lights

reflected light, nuns with red reflectors, cans with white reflectors. Unlighted buoy tops are painted white to increase their visibility at all times. White should not be regarded as a color characteristic in this case.

(1) Buoy coloring principles are the same as elsewhere in the lateral system of marking. However in this connection it should be noted that on the Mississippi River System customs prescribes that the location of aids and their significance as markers are referenced wth respect to the flow of the river rather than from seaward.

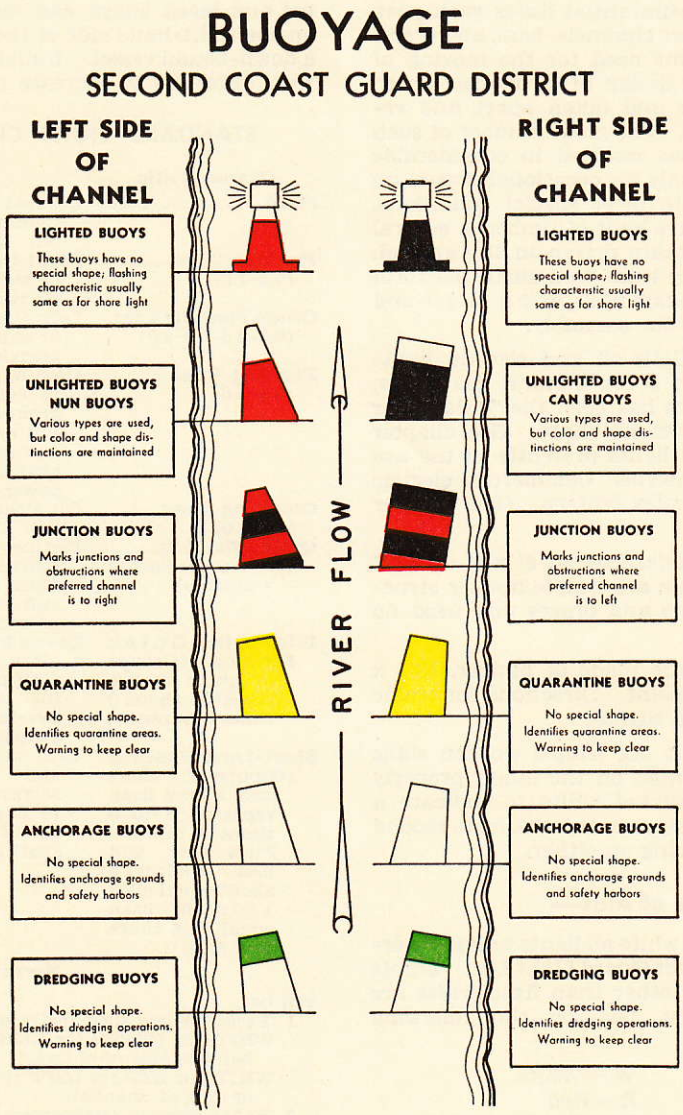


FIGURE 6–10.—Buoyage of Second Coast Guard District.

6–7 CHARACTERISTICS OF LIGHTSHIPS

6–7–1 General—

A. Lightships are distinguished from each other by their light, fog, and radiobeacon characteristic signals in the same manner as any other major aid to navigation.

(1) In order that lightships may be readily distinguished from other vessels, and be properly identified, they are given certain distinctive features. These outward daymark details are important, for without them there would be the possibility of mistaken identity and the complete frustration of their intended purpose. Chief distinguishing features are the high bows, the center hawsepipe, the lantern galleries at the mastheads, the special coloring, and the name painted on the sides in letters as large as the hulls will permit. So carefully are these distinguishing features adhered to

and preserved, that frequently a new vessel replaces an old lightship on station without mariners being aware of the change, except as they are advised by Notices to Mariners.

(2) Lightships under way, or off station, will fly the International Code signal letters "PC" (signifying lightship is not at anchor on her station). Lightships, where so stated, carry riding lights for the purpose of showing in which direction the ship is riding. Lights on lightships are displayed from 1 hour before sunset until 1 hour after sunrise and at all times when the sound signal is in operation.

(3) Light characteristics shown by lightships are similar to those displayed by other major aids described in part 6–1 of this chapter.

B. *Relief lightships* may be placed at any of the lightship stations, and, when practicable, exhibit light, sound and radiobeacon signals having the same characteristics of the station.

C. *Color and name.*—All lightships, except Lake Huron Lightship, are painted red with the name of the station in white on both sides; Lake Huron Lightship is painted black with the name of the station painted in white on both sides. Relief lightships are painted the same color as the regular station ships, with the word "RELIEF" in white letters on both sides.

D. *Identification.*—Lightships, especially relief lightships, will display the international code signal of the station whenever a vessel is approaching or is in the vicinity and there are any indications that such a vessel is in strange waters or fails to recognize the station, or whenever a vessel asks for the information. The International Code signal for each lightship station is stated in the light lists.

E. *Caution.*—Because of casualties and near casulaties to lightships, all mariners are cautioned that courses should invariably be set to pass lightships with sufficient clearance to avoid possibility of collision from any cause. Experience shows that lightships cannot be safely used as leading marks to be passed close aboard, but should invariably be left broad off the course wherever searoom permits. When approaching a lightship on radio bearings, the risk of collision will be avoided by insuring that the radio bearing does not remain constant.

6–8 CHARACTERISTICS OF SOUND FOG SIGNALS

6–8–1 General—

A. The present system of sound signals includes a considerable variety of types of equipment in use and characteristics assigned. These characteristics are chosen primarly, as is the case with lights and other aids, to cause the sound signals to be readily distinguished one from another in any particular region. The limitations of the equipment necessary to produce the variety of characteristics have to be considered.

(1) The quality of the tone is a characteristic which helps the mariner to identify the sound signal. Its tone is determined by the device used to create the sound, such as diaphone, siren, bell, etc.

(2) The signal characteristic is the phase relationship of the recurring sound emissions. Fog signals on fixed stations and lightships produce a specific number of blasts and silent periods each minute, when operating, to provide positive identification.

(3) Fog signals on buoys are generally actuated by the motion of the sea and, therefore, do not emit regular signal characteristics, and when the sea is calm, may emit no sound signals. Certain buoys and minor lights equipped with a mechanical bell striker emit a specific signal characteristic and are thus more easily identified.

B. *Periods of operation:*

(1) Fog signals at stations where a continuous watch is maintained are sounded when the visibility decreases to 5 miles, and also whenever the fog whistle of a passing vessel is heard.

(2) Fog signals at locations where no watch is maintained are operated continuously unless otherwise stated for any particular aid.

(3) Fog signals on buoys are generally operated by the motion of the sea. Buoys equipped with mechanical bell strikers operate continuously.

C. Following is a description of how the various sounds are produced by the several types of fog signals:

(1) Diaphones produce sound by means of a slotted reciprocating piston actuated by compressed air. Blasts may consist of two tones of different pitch, in which case the first part of the blast is high and the last of a low pitch. These alternate-pitch signals are called "two-tone."

(2) Diaphragm horns produce sound by means of a disc diaphragm vibrated by compressed air or electricity. Duplex or triplex horn units of differing pitch produce a chime signal.

(3) Reed horns produce sound by means of a steel reed vibrated by compressed air.

(4) Sirens produce sound by means of either a disc or a cup-shaped rotor actuated by compressed air or electricity.

(5) Whistles produce sound by compressed air emitted through a circumferential slot into a cylindrical bell chamber.

(6) Bells are sounded by means of a hammer actuated by hand, by a descending weight, compressed gas, or electricity.

D. *Standard characteristics.*—Although there are presently a number of various signal characteristics in use, the following are suggested for purposes of future standardization:

Blast 2 seconds, silent 8 seconds; period 10 seconds.

Blast 2 seconds, silent 13 seconds; period 15 seconds.

Blast 2 seconds, silent 18 seconds; period 20 seconds.

Blast 3 seconds, silent 27 seconds; period 30 seconds.

Blast 2 seconds, silent 2 seconds, blast 2 seconds, silent 14 seconds; period 20 seconds.

Blast 2 seconds, silent 1 second, blast 2 seconds, silent 25 seconds; period 30 seconds.

Blast 3 seconds, silent 3 seconds, blast 3 seconds, silent 51 seconds; period 60 seconds.

Exceptions may be made when necessary to best serve shipping or to furnish a signal within the power limitations of the existing equipment or storage capacity of air tanks.

E. The above standardization is based on signals acceptable to the mariner. Many practical field tests have shown that the mariner will be adequately served by a "blast" not less than 2 seconds long recurring at intervals of not over 60 seconds. When this 2-second blast recurs at 30-second intervals it is a safer and better signal for identification of the sound signal station; at 15 second intervals, still better. A 2-second blast is of sufficient duration to provide a "pointer" direction indicator for the mariner. The more frequently this sound recurs the better the mariner is served in locating the source of the sound and in determining his position with reference to this source.

F. *Bell characteristics.*—The following characteristics are suggested for power-operated bells:

1 stroke every 15 seconds.
1 stroke every 30 seconds.
1 stroke every 60 seconds.
2 strokes every 15 seconds.
2 strokes every 30 seconds.
2 strokes every 60 seconds.

G. *Caution.*—Mariners are cautioned that the hearing of fog signals cannot be implicitly relied upon. Experience indicates:

(1) That distance must not be judged only by the intensity of the sound.

(2) That occasionally there may be areas close to a fog signal in which it is not heard, and, that the mariner must not assume that a fog signal is not operating because he does not hear it.

(3) That fog may exist not far from a station, and yet not be seen from it, and that, therefore, the signal may not be in operation.

H. *Allowable tolerances.*—The maximum allowable tolerance for fog signal characteristics has been established at 0.5 second per period or 2.0 seconds per minute, whichever is smaller. Whenever a fog signal sounds a characteristic which exceeds this tolerance it shall be considered as operating improperly and remedial action shall be taken.

6–9 CHARACTERISTICS OF MARINE RADIOBEACONS

6–9–1 General—

A. Marine radiobeacons are the most valuable type of fog signals, and are also available for navigation in clear weather. Radiobeacons, installed at light stations, lightships, and other charted locations, operate separately or as part of a group of 2 or 3 radiobeacons. Any one or all of a group of radiobeacons can be used by the navigator in determining position or lines of position.

B. In plotting long-range bearings on a chart of the Mercator projection a correction must be made, as the line of bearing is not a straight line excepting in the meridian.

C. See chapter 26 for complete data on marine radiobeacons.

D. *Caution must be taken in approaching radiobeacons* on radio bearings, and care must be taken to set courses to pass safely clear. The risk of collision will be avoided by insuring that the radio bearing does not remain constant. This caution is applicable to those lightships and stations on submarine sites which are passed close to.

E. *Accuracy and use of bearings.*—Long experience with properly installed and correctly calibrated direction finders maintained in good condition indicates an average accuracy of 1° to 2°. Departures from this accuracy will sometimes be experienced when taking bearings from a position close to the shoreline and over land. Night effect, which is sometimes encountered, particularly near sunrise and sunset, and which is usually manifested in very wide or changing minimum, tends to limit the distance at which reliable bearings can be obtained. In observing marine radiobeacons night effect is not usually encountered at distances less than 30 to 50 miles. The existence of night effect can almost invariably be confirmed by rapidly taking repeated bearings, and when shown to be present, bearings should be used with extreme caution.

(1) Serious errors may result in bearings taken if other shipboard antennas are erected close to the direction finder after calibration or if the direction finder, ship's rigging or other equipment affecting direction finder performance is not maintained in the condition existing at the time of last calibration.

(2) Regular and frequent use of the direction finder under all conditions is one of the best means of insuring ability to obtain accurate bearings and that the direction finder is at all times in proper condition. Clear weather operating periods provide ample opportunity for such use.

(3) Full use should be taken of the opportunity for fixing positions by cross bearings on two or more radiobeacons which is provided through the convenient arrangement of stations as to frequency and sequence of operation and in most cases their favorable geographic location.

6–9–5 Identification—

A. *For station identification* simple characteristics consisting of combinations of dots and dashes are used. These combinations and the length of the dots, dashes, and spaces are chosen for ease of identification when heard by the ship's navigating officer who is not expected to be skilled in radiotelegraphy. They are not transmitted as code letters and are not referred to as such, but as: (— —); (— — .); (— — — —); etc., depending on the combination used. These characteristics are differentiated on the same principle as are lights on a coast. The entire transmission for any station is a repetition of the assigned signal, without variation, except in the case of distance-finding stations described below.

B. Certain low-power radiobeacons use combinations of high- and low-tone dashes and provide additional distinction in their characteristic. The characteristic of marker radiobeacons (class D) is

composed of groups or series of dashes or a continuous signal for part of a 15- or 30-second cycle which is followed by a silent period to complete the cycle.

6–9–10 Operating Schedule—

A. Radiobeacons operate during fog or low visibility and also in clear weather on a specified schedule. (Low-powered marker radiobeacons transmit continuously on a 15- or 30-second period regardless of the weather.) See chapter 26 and radiobeacon charts in light lists for the specific operating schedules used by radiobeacons.

B. *Continuous carrier operation.*—Certain radiobeacons have been modified to transmit with the station characteristic code superimposed on a continuous carrier. This operation is for the purpose of extending the usefulness of marine radiobeacons to aircraft and ships employing automatic radio direction finders. Craft employing the conventional "aural null" direction finders will notice no change in quality of service, and in addition will be able to use these radiobeacons at any time in their assigned sequence throughout the hour.

6–9–15 Calibration Service—

A. United States radiobeacons will broadcast for the purpose of enabling vessels to calibrate their radio direction finders upon request. If it is not practicable to determine the time of calibration sufficiently in advance to contact the District Commander, or if the calibration is desired from a remote station where communication is difficult, request may be made directly to the station by means of telephone, telegraph, or a whistle signal consisting of 3 long blasts followed by 3 short blasts, this whistle signal to be repeated until same is acknowledged by the station through the starting of the transmitter. The same group of signals will be sounded at the termination of calibration.

B. *Visual signal.*—If attention of station or lightship is not attracted by the whistle signals, hoist the international code signal, J over K, to indicate request for radio direction finder calibration.

C. The work of the station personnel is not confined to standing watch and there may be times when the whistle request for calibration is not immediately heard, due to the noise from operating station machinery, etc. Usually, a repeated signal not too far from the station will attract attention.

D. *Schedule of transmission.*—Transmission for calibration purposes will be continuous without the 2-minute silent interval unless another station in the same frequency group is in operation at the time, in which case calibration operation will be "1 minute on, 2 minutes off." No continuous transmission for calibration will be undertaken during regular schedule periods of operation.

E. The position given for the antenna is the point from which the radiobeacon signal is emitted.

F. *Special transmitters.*—In addition to the special operation of regular radiobeacon transmitters for calibration of direction finders, special radio direction finder calibration transmitters of short range are also operated at certain localities to provide continuous calibration service. These stations with information as to position, frequency, characteristic, etc., are listed in the light list.

6–9–20 Distance-Finding Stations—

A. At certain stations the radiobeacon and sound signal are synchronized for distance finding. Whenever the sound signal is operating, a group of two radio dashes (a short and long, 1 second and from 3 to 5 seconds, respectively) is transmitted every 3 minutes at the end of the radiobeacon minute of operation. A group of 2 sound signal blasts of corresponding length is sounded at the same time. When within audible range of the sound signal, navigators on vessels with radio receivers capable of receiving the radiobeacon signals may readily determine their distance from the station by observing the time in seconds which elapses between hearing any part of the distinctive group of radio dashes, say the end of the long dash, and the corresponding part of the group of sound blasts, say the end of the long blast, and dividing the result by 5 (or more exactly 5.5) for nautical miles. The error of such observations should not exceed 10 percent.

B. The 1-second dash preceding the long dash is a stand-by or warning signal as is also the 1-second blast. The latter serves as an identification signal to assure the observer that he is taking time on the correct sound signal blast.

C. For observations on aerial sound signals a watch with second hand is all that is needed, although a stopwatch is more convenient.

D. *Direction finder not necessary.*—Observations for distance off at these stations are not restricted to vessels with direction finders, but may be made by any vessel having a radio receiver capable of receiving in the band 285 to 315 kilocycles within which radiobeacons are operated. A loudspeaker is desirable although not necessary.

E. At distance-finding stations, the sound fog signal characteristic and its time relation for synchronization with the radiobeacon is shown by a diagram. An example of the use of these synchronized signals follows: In the case of Los Angeles Light Station if the interval between hearing the end of the long radio dash marking the end of the radiobeacon minute and the end of the long (5-second) blast of the diaphone is 33 seconds, the observer is $33 \div 5.5 = 6$ miles from the light station.

F. *Warning of fog.*—Hearing the groups of short (1-second) and long (3- to 5-seconds) dashes of the radiobeacon, at stations where the radiobeacons and sound signals are synchronized for distance finding, is an indication that there is fog in the vicinity of the station and that the sound signal is operating.

6–10 CHARACTERISTICS OF LORAN SYSTEM

6–10–1 General—

A. Loran transmitting stations transmit radio signals on preselected frequencies of 1750, 1850, 1900, or 1950 kilocycles which radiate in all directions. The signals are transmitted 24 hours daily. They are emitted as a series of pulses or short bursts of radio energy recurring at selected regular intervals of time. The use of pulse transmission of signals permits the identification of individual pulses on the same radio frequency and the measuring of time difference between reception of pulses from each station in a pair of loran transmitting stations.

B. In the loran system, the time difference of reception of signal pulses from a pair of loran transmitting stations is measured electronically and not the individual distances themselves. This measurement is known as a loran reading. There are many points at which the same loran reading is obtained but all these points fall along a smooth curve which is known as a loran line. Loran readings are shown as lines (loran lines) having geographic position on loran charts or a series of loran readings can be transposed to construct lines having geographic position by the use of loran tables.

C. *Rate designation.*—The loran signals transmitted from two paired transmitting stations determine a loran rate. Loran rates are given designators consisting of a single digit number followed by either the letter "L" or the letter "H," followed by another single digit number. The first digit indicates the frequency channel of the rate and the letter and final digit designate the pulse recurrence rate; i. e., the number of pulses per second transmitted.

D. *Signal warning.*—When loran signals are not synchronized or for any other reason are not satisfactory for navigation, one of the two signals on the unsatisfactory rate will "blink;" i. e., the signal will appear and disappear alternately. Under no circumstances should a loran rate which is blinking be used for navigation purposes.

E. *Caution.*—Caution must be used in matching loran signals to insure that the ground wave signal of one station is not matched with a sky wave signal of the other station of the rate. Tables and charts are computed for determination of position from matching ground waves with ground waves or sky waves with sky waves.

F. For further description of loran, see chapter 18.

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