

INTERNATIONAL MARINE

AIDS TO NAVIGATION

VOLUME I

PARTS C & D

SECOND EDITION

BRIAN CLEARMAN

MOUNT ANGEL ABBEY

1988

DEDICATION:

To My Parents

For my Dad (1909-1980);

My Mom (1910-1973);

My step-Mother, Jennie (1911-1977);

My step-Mother, Mary

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Library of Congress Cataloging-in-Publication Data

Clearman, Brian.

International marine aids to navigation.

Updated ed. of: Transportation markings, v. 1,
parts C & D. 1981.

Bibliography: p.

Includes index

1. Signals and signaling. 2. Aids to navigation.

I. Clearman, Brian. Transportation markings. II. Title.

VK381.C53 1988 623.8'561 88-8960

ISBN 0-918941-01-6

Classification for 1st ed.: TA1245.C56 1981
629.04'2 80-6184

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PREFACE

This monograph is the second edition of Volume I, Parts C and D of what was formerly termed *Transportation Markings: A Study in Communication*. The first edition of Volume I also included Parts A and B. The original edition was published by University Press of America.

The original volume was composed of Part A: introductory and foundational materials (including semiotics and communications); Part B: review of transportation markings in one nation; the U.S.; and Parts C and D. But the marine materials became all but buried in a volume containing many other materials and hence, requires republishing as a monograph in itself.

The second edition is more than a reprinting of the 1980-1981 monograph. It includes updating of statistics, rearrangement of materials, expansion of some topics and replacement of buoy and topmark illustrations, which are now joined by illustrations of light phase characteristics and of daybeacons. It is hoped that the revised edition will have an enhanced value.

The original title of the book now serves as the title of the monograph series so that "Transportation Markings: A Study in Communication" is the monograph series title. The title for Parts C and D becomes the title for the monograph: International Marine Aids to Navigation.

Since the original book was brought out a first segment of Volume II has been published *International Traffic Control Devices*, which is Part E. Part E is available from Mount Angel Abbey as well. Part F, International Railway Signalling, is in preparation.

ACKNOWLEDGEMENTS

For the Second Edition

Abbot Bonaventure Zerr

Claude Lane

Hugh Feisss

Maximilian Ferrell

Simon Hepner

Justin Hertz

Philip Waibel

Monks of Mount Angel

Sister Therese Eberle, OSB, Mount Angel Abbey Library

Sue Watkins and Vincent Zollner, Benedictine Press

The Library of Congress

The National Archives

U.S. Coast Guard, Long Beach

U.S. Naval Observatory

Scott Turnquist and Arinc Research Corporation

Jim Estes of Alpha Farm

National Swedish Administration of Shipping and Navigation, Nordköping

Finnish Board of Navigation, Helsinki

Service Technique des Phares et Balises, Bonneuil-Sur-Marne

And all who assisted through supplying of materials and permissions in the first edition

ABBREVIATIONS

Al	Alternating light
AN	<u>Aids to Navigation Manual</u> , USCG
Bowditch	Original author of <u>American Practical Navigator</u> ; publication often referred to by Bowditch alone.
CANS	<u>Canadian Aids to Navigation System</u>
CIM/IMC	<u>International Maritime Conference</u> , St. Petersburg, 1912; often referred to as 1912 Conference of St. Petersburg Conference; Not to be confused with International Marine Conference, 1889.
DMA	Defense Mapping Agency
EB	Encyclopedia Britannica, 1911 edition
EQ	East Quadrant
F	Fixed light
FF1	Fixed and Flashing light
F1	Flashing light
F1(3)	Group-Flashing light (3 is given as an example)
F1(3+1)	Composite Group-flashing light (3+1 is given as an example)
Hz	Herz
IALA	International Association of Light-house Authorities/Association Internationale de Signalisation Maritime
IALA BCR	IALA <u>Buoy Conference Report</u>
IDAMN	<u>International Dictionary of Aids to Marine Navigation</u>
IHB	International Hydrographic Bureau
IMC	International Marine Conference, Washington, D.C., 1889
IMCO	International Maritime Consultative Organization
IQ	Interrupted Quick Flashing light
Iso	Isophase light
IUQ	Interrupted Ultra Quick light

IVQ	Interrupted Very Quick light
Kc	Kilocycle
Khz	Kiloherz
LF	Low Frequency
LF1	Long-flashing
LL	Light list
LN	League of Nations
LNB/LANBY	Large Navigational Buoy
LOP	Line of Position
MBS	<u>Marine Buoyage Systems</u>
Mo(U)	Morse Code light (U is an example)
NCMH	<u>New Cambridge Modern History</u>
NE	Northeast
NQ	North Quadrant
NW	Northwest
Oc	Occulting
Oc(2)	Group Occulting (2 is an example)
Oc(2+1)	Composite Group Occulting (2+1 is an example)
OED	<u>Oxford English Dictionary</u>
Q	Quick light
Q(3)	Group Quick light (3 is an example)
Q(6)+LF1	Group Quick with Long-flashing light (6 is an example)
RHDEL	<u>Random House Dictionary of the English Language</u>
SE	Southeast
SMBB	<u>Systems of Marine Buoyage and Beaconage</u>
SQ	South Quadrant
SW	Southwest
UK 1846	Report of Buoyage Practices
UK 1883	UK Uniform System of Buoyage
UQ	Continuous Ultra Quick light
USB	Uniform System of Buoyage
USCG	U.S. Coast Guard
USNOO	U.S. Naval Oceanographic Office (now named DMA)
VLF	Very Low Frequency
VQ	Continuous Very Quick light
VQ(3)	Group Very Quick (3 is an example)

VQ(6)+LF1 Group Very Quick with Long-flashing light (6 is an example)
WLB 1820 World's Lighthouses Before 1820
WQ West Quadrant
WNID Webster's New International Dictionary
WNID, 2nd ed. Webster's New International Dictionary, Second Edition
WTNID Webster's Third New International Dictionary

CHAPTER ELEVEN

INTRODUCTION:

MARINE INTERNATIONAL TRANSPORTATION MARKINGS

(MARINE AIDS TO NAVIGATION)

It is not the intent of the author to compartmentalize the floating and fixed portions of marine transportation markings into separate and distinct units. Any such compartmentation might lead to a sense of independent spheres in the mind of the reader and that, in turn, could lead to an impression that fixed and floating markings are two areas of study rather than two aspects of a single discipline. Nevertheless, for reasons of practicality and convenience - and despite the inherent risks - the coverage of this subject will be subdivided, though not the subject. This seems necessary because of the strikingly different milieu of fixed as opposed to floating markings. It is also necessary because of the need to explore in some detail a diverse subject, and this is more difficult to accomplish under one heading than it would be under two; fixed and floating markings have special requirements and necessitate special attention.

The basic commonality of these markings should be seen in this introduction, and the focus of this monograph - as expressed in the Preface and in the classification schemas - should clearly illustrate that the research is not dealing with several subjects but rather with several facets of one subject.

It may first appear easy (and even precise) to divide marine aids to navigation into either

fixed or floating location. And while this is probably the only practical division, a problem arises in that fixed aids to navigation can be further divided into marine locations, though fixed, as well as land-based; therefore the difference between a fixed marine light, in the water, and a buoy may not be as great as their fastenings might indicate.¹ Nevertheless, the fastenings of an aid can serve as a distinguishing point between floating and fixed markings. Fixed and floating markings have distinguishing characteristics within the respective markings; this is in addition to the differentiation based on the type of fastening of aids to navigation.

These distinguishing characteristics include the structures supporting the light and the intensity, or power, of the light. Historically there are more variations in fixed aids than in buoys. The fact that systems of buoys are long-established is an indicator of the standardization to be found among buoys and messages. Fixed aids not only are less likely to be standardized but are frequently few in number for many nations - other than major lights or lighthouses. Recent years have seen increasing standardization of fixed aids for some nations; this is true of Canada and of the United States. With the advent of International Association of Lighthouse Authorities (IALA), fixed beaconage is increasingly part of the buoyage pattern.

It is common to divide fixed light aids into major aids, which include those lights with distinctive towers on headlands and outlying rocks (often referred to as lighthouses), and minor aids, which are found in harbors, bays, and rivers. Both major and minor aids are found both on land and in the water.

Major lights have been the subject of books, articles and photographs; there is little need to provide details for those lights. In brief, most traditional towers are enclosed. Smaller and more modest towers are found on high headlands and promontories; the more lofty towers are on low-lying elevations. Massive towers and nearly as massive lantern houses and lenses keynote the older versions. Newer towers are often unenclosed and unpretentious in the extreme. Light mechanisms are no longer massive save for the intensity of the light.

Many minor lights on marine locations are found atop a single or multiple-pile structure. In some instances the facility is little more than a simple light directly mounted on the structure. In other cases a superstructure or small house or box has been added to the underlying structure. Permanence of structure is not a major consideration for many of these lights.

In many cases a pole with some type of daymark is added to fixed land marine markings. More complex structures for these landed lights include towers - often skeleton or open - small houses, or battery boxes. As is the case with marine fixed markings, land markings are easily constructed, and easily removed. As previously mentioned, a variety of nations including West Germany, Norway, Finland, the Netherlands, and Indonesia incorporate many fixed marine aids into floating message systems. In these cases, distinctive features, such as color, lettering and numbering, have a symbolic value which correlates to message systems of buoys.

Not all fixed marine markings are lighted. Simple markings, known as daybeacons in the U.S., or simply beacons, may be nearly identical with fixed lighted aids except for the light. In other situations they may be nothing more than a painted pole atop a rock or single piling. These markings are for lesser used channels. Acoustical and

electronic markings - the non-visual portion of marine markings - are the final parts of fixed marine markings; they complement, extend and enhance visual aids to navigation; electronic aids not only supplement but also can supplant visual aids for ocean and coastal navigation. In some instances acoustical and electronic aids are found with visual markings, while in other situations they are independent of them.

Acoustical, or fog, signals are commonplace in some northern nations but are nearly unknown in less foggy locales. Fog signals can be found on both buoys and fixed locations. Formerly, there was a greater distinction between floating and fixed fog signals than at present. Buoys employed one of several types of signals all of which were sea-activated. Land signals utilized one of several types of air-driven or air-assisted mechanisms. But buoy signals not infrequently include electric horns and thereby emulate land-based signals, though sea-activated signals continue in use and some electronic signals can imitate traditional sound signals.

The distinctiveness of a fog signal is important. An electric-powered signal can provide a characteristic signal by the varying of pitch and the length of the period of sound. Sea-activated signals, even if the range of possible sounds is greater, can not provide a signal incorporating length of a period of sound. Such signals are also handicapped by their reduced efficiency in calm seas - when fog is a greater navigational hazard - and when the need for sound signals is greater.

Electronic aids to navigation supply longer/long-range navigation capabilities; hence the growing significance of such aids. Visual markings cannot supply long-range aid, and are not infrequently handicapped for even short-range operations. Visual lighted markings remain

important, but coastal landfall beacons have been overshadowed by their electronic counterparts.

Loran and related devices are examples of long-distance markings; radio-beacons constitute short- to medium- range devices. Passive electronic markings, such as radar reflectors, enable ship-based radar units to more easily and precisely determine their locations.

Systems of buoyage shape and influence the types of buoys and their message-producing abilities. The recognized systems began with the International Marine Conference in Washington, D.C., in 1889. English practices (1846 and 1882), while not strictly international, spread beyond the borders of the U.K. The 1889 effort included both cardinal and lateral buoyage systems. A European conference in 1912 at Saint Petersburg reversed the position of red and green/black. A League of Nations conference at Lisbon (1930) and at Geneva (1936) established and concretized the second approach to buoyage (termed the "Uniform System of Buoyage"). The 1889 approach has been followed by many nations in the Western Hemisphere and some in East Asia, and is sometimes loosely termed the "U.S. System." Many Eastern Hemisphere nations, particularly in Europe, have traditionally followed some version of the Uniform System. The 1970s and 1980s are the era of the IALA buoyage and beaconage system. This system was originally labeled "System A" and "System B" but both were amalgamated into a single system with regional variants. The new system incorporates many of the features of older systems but creates a simpler and more uniform approach to buoyage and beaconage which is more nearly global than past efforts.

An essential difference between the Washington Conference-derived systems and the Uniform System is also a basic difference between the

two regional variants of the IALA system. Namely, reverse meanings are given to the use of red and green. The Uniform System and IALA European variant have red to port; Washington and the second IALA variant have red to starboard. Black/green represent reverse positions in the aforementioned systems. Topmarks, a major feature of the Uniform System, have been simplified in IALA. Topmarks have found little use in the Western Hemisphere, though they may become more significant under IALA.

The U.S. and Canada have long employed separate types of buoys for lighted purposes and unlighted purposes; many other nations, and for that matter both the Uniform System and IALA, adopted identical shapes of buoys for both lighted and unlighted functions of a specific nature. Formerly, the U.S. also employed special-shaped buoys for sound signals, but an increasing number of sound buoys utilize a light buoy without the light support structure and mechanism; special sound buoys are, however, to be found in substantial numbers even with this change.

In past times many nations made use of only parts of one or other agreed-upon system of buoyage; in other instances variations were built into a basic system of buoyage. This resulted in a broad and chaotic spectrum of systems and messages. The IALA system eliminates much of the chaos, and also individuality - which was a keynote of buoyage systems in the past. Some measure of distinctiveness may well continue in systems with special-shape buoys; for example, West Germany and Norway make use of substantial numbers of a design unique to those systems. Despite special shapes of buoys it would appear that standard color and light characteristics will be in use in all systems.

Two other forms of floating aids are lightships and large navigational buoys. Lightships,

watched and unwatched, are very much on the decline. Large navigational buoys are increasing in numbers and to a large extent at the expense of lightships. The large buoys, which are 30 or more feet in diameter, are usable in deepwater stations and the open sea. The United Kingdom, the U.S. and several other nations utilize this form of aid.

In sum, international marine aids to navigation cover a broad range of devices and mechanisms ranging from the primitive to the sophisticated, from the ancient to current technologies.

This study will survey the general rules and guidelines and attempt to suggest the range of significant differences. Part C will include floating aids to navigation; Part D will examine all types of fixed marine aids: visual, sound, and electronic.

Endnote

¹An interesting blurring of the distinction is found in Finland, where the "edgemark," a fixed aid to navigation, operates as a buoy. The functional dimension of the aid overtakes the physical dimension even though the latter would seem to be paramount (letter of Rolf Backstrom of the Board of Navigation, Helsinki, November 7, 1983).

PART C

CHAPTER TWELVE

HISTORICAL DEVELOPMENT OF BUOYS & BUOYAGE SYSTEMS

12A Development of the Buoy
and the Impact of Technology

1 The Impact of the Industrial Revolution on
Buoys

An added dimension to the study of present-day buoys and buoyage systems can be gained in a brief review of the historical background of the buoys. Some attention has been given in Chapter 14 to the lexicography of buoyage terms, but little attention has been given to the history of buoys and the development of message systems.¹

Though buoys and lightships extend back in time for several centuries, the principal era of this history is the Industrial Revolution in the Victorian and Edwardian periods. The Industrial Revolution can be viewed as the "period roughly from 1750 to 1825, during which the accelerated application of mechanical principles ... to manufacturing in Great Britain produced an identifiable change in economic structure and growth."² The term can be applied not only in a narrow sense but also in a more general sense, thereby encompassing large portions of the eighteenth, all of the nineteenth and some of the twentieth centuries.³

There is considerable agreement that the Industrial Revolution began in the mid- to late eighteenth century; its ending is less agreed upon.⁴ For some it ends in about 1830, for others about about 1870. For some it is a unified period; for others it contains subdivisions or phases.⁵ If the Industrial

Revolution per se ends in about 1870 what can the post-1870 era be termed? Possibly a second industrial revolution, or a scientific revolution, or an age of technology.⁶ What is the place of the development of the buoy in these various segments of time and events? The buoy is in its "pre-history" in the early years of the nineteenth century which fall within the strict Industrial Revolution. The 1820/1825 to 1870 era is significant for industry but not for floating aids to navigation; change has begun but it has not reached its zenith. The buoy undergoes major change and advance from 1870 to about 1900; hence the second industrial revolution, or age of technology, is of greater significance.

The years from 1870 to 1900 are distinguished from earlier developments by several characteristics: The era of amateur craftspersons in bringing about major advances in technology has declined;⁷ the heavy emphasis on coal and iron is also past its prime;⁸ much the same can be said of a few basic industries dominating the industrial scene. The time after 1870 is one of more heavily employed scientific and theoretical processes;⁹ more organization is utilized;¹⁰ older industries give birth to new and more diverse offerings.¹¹ While new industries of this era may turn out more products, change has spread beyond the sites of heavy and even primitive industry.¹²

Advances in late Victorian technology include electro-technics, transportation, chemistry, and biology.¹³ Electro-technics include diverse offerings such as electric locomotives, studies in high and low voltage, the incandescent light globe and electric power plants.¹⁴ Transportation changes include not only expansion of railway trackage, but new inventions including the internal combustion engine, the diesel engine, automobiles and improved steam-propelled ships.¹⁵ Chemistry provided new processes and technology including applications encompassing even lighthouses

lighthouses and buoys. Biology is far removed from transportation markings and need not be considered.

Much of the growth and advances in buoyage stems from changes in electrical and chemical industries, and advances in metal technology processes and practices.¹⁶ Transportation changes in seaways and harbors and in modes of transport created the need for more buoys. Bruun, who views the later nineteenth century as a "technological age," notes that the years from 1867 to 1881 produced "many new instruments of power and precision."¹⁷ This frame of reference can encompass the specialized world of the buoy.

12A 2 The Buoys and its Development in the Nineteenth Century

The progression and expansion of the buoy during, and before, the Industrial Revolution(s) may be divided into three parts; the significance of the parts is in inverse proportion to the length of time for each. The first period - which may be termed the "pre-history" period - began in perhaps the fifteenth or sixteenth century.¹⁸ The Oxford English Dictionary is of the view that buoys began in the sixteenth century, while the West German buoyage agency suggests the previous century.¹⁹ The period ended in about 1820. The notion that that year is a juncture points for marine aids is promoted by Alan Stevenson in his book The World's Lighthouses Before 1820.²⁰ Though his comments are directed more to lighthouses than to buoys they may be applied to buoys. Stevenson notes that 1820 marks the end of simple lighthouses employing primitive lenses and utilizing crude and unprocessed fuels.²¹ Those earlier lights were built with the aid of sailing ships and primitive construction methods.²² After 1820 coal-fired construction and transportation systems began to be available and, more significantly, the

means of production of messages improves dramatically;²³ for example, Augustin Fresnel, a French physicist, developed in 1823 a lens that was capable of throwing more light more efficiently and farther than any previous lens system; this lens, bearing his name, is still in use.²⁴

The period from about 1820 to 1870 sees increasing changes in buoys though the most notable changes are still in the future. The Industrial Revolution, during the mid-years of the century, offered new technologies and materials that effected a major change in buoy construction and design through the use of iron.²⁵ Buoys would be of predominantly wood construction for decades more, but the increasing number of iron buoys allowed flexibility and versatility that led to the addition of audio and/or acoustical capabilities.²⁶

It is not until about 1870 that the modern era of buoys can be said to have begun. Bruun notes that the 1870s are a "decade of unparalleled expansion" and this can be applied to buoys as well.²⁷ Many of the advances in buoys are in the field of lighting. Gas-powered buoys with fixed or occulting lights began operation in 1878.²⁸ The English introduced the incandescent oil-vapor light in 1893;²⁹ the U.S. began experiments with a gas-lighted buoy in 1881 and finally added the new buoy to the "fleet" in 1884.³⁰ Experiments with electrically lighted buoys were conducted between 1888 and 1903. These experiments ended in failure because the power cables to the buoys were affected by water and weather conditions.³¹ The U.S. engaged in experiments centering on various forms of acetylene gas in the first decade of the twentieth century.³² Dalen', the Swedish Nobel Prize winner in physics, also worked to advance the use of acetylene gas during this time.³³

Dalen' also invented the first automated light control mechanism. This device, known as a "sun valve," activated the light when the sun set and

deactivated it when the sun rose.³⁴ It was this invention that won him the Nobel Prize in 1906. Despite various forms of photoelectric cells, the "sun valve" is still a useful device for operating lights and also for saving fuel.³⁵

The iron that permitted lighted buoys also permitted the introduction of sound buoys and mechanisms. The U.S. introduced the whistle buoy in 1876;³⁶ gong buoys were introduced in the second half of the nineteenth century.³⁷ Sea-activated bell buoys followed in 1885.³⁸

Other inventions and advances, though not originally designed for buoys, found applications or at least influenced buoy systems. For example, the French extended the range of possible light-phase characteristics in 1892 by the introduction of quick-flashing lights.³⁹ England contributed an "automatic occulter" in 1883.⁴⁰ Supporting systems, including Kitson's incandescent oil-burner, also improved the quality and range of buoy and other lights.⁴¹ Not only were inventions occurring during this time but manufacturing processes meant that more and more lighthouses and buoyage equipment were being manufactured more efficiently and more cheaply.⁴²

By about the turn of the century, the basic types of buoys were established; this was also true of the major forms of sound signals. A variety of light-phase characteristics were already in use, though fixed lights would continue to dominate for quite some time. In short, what was available in buoys during the late nineteenth century materially shaped the form of British and IMC buoyage systems of the 1880s, and influenced the 1912 Saint Petersburg and the 1930 League of Nations buoyage systems; this in turn made a discernible impact on the IALA system of the 1970s and 1980s. Components of buoyage systems, and in many respects the buoys themselves, are to a considerable degree the same today. Lights are

more often electric, sound signals are increasingly electric, some "monster buoys" have been added,⁴³ buoys are welded not riveted; but the shapes, colors, numbers and seemingly mysterious - to the uninitiated - patterns and arrangements of those colors and numbers can be substantially traced to the late Victorian period. That same era can be said to be the sum total of changes in transportation, manufacturing, and illumination throughout the nineteenth century.

12B The Development of International Buoyage Systems

1 International Buoyage Systems 1846-1936

Finally, it is necessary in this chapter to consider the buoyage systems that have transcended national boundaries as well as developments in the types of buoys and equipment for buoys. There were four buoyage systems before IALA: The British "Union System of Buoyage" (1883),⁴⁴ the International Marine Conference buoyage system (1889),⁴⁵ the League of Nations Uniform System of Buoyage" (1930/1936),⁴⁶ and the International Maritime Conference at Saint Petersburg (1912).⁴⁷ One might include a government report of the United Kingdom of 1846 that described buoyage practices in that nation. Those practices, especially that of red to starboard for buoyage influenced U.S. practice and greatly helped to establish red in the starboard position.⁴⁸ The first named system (UK 1883) may appear to be that of a single nation. However, this system encompassed the British Isles and included three independent aids to navigation agencies as well as several smaller lighthouses and buoyage authorities.⁴⁹ In addition British dependencies followed this system to a considerable degree for quite some time.

The British system of 1883 focused on several principles. The basis of the system, if reduced to a single point, is the shape of the buoy.⁵⁰

Contrary to IMC, neither color, letters, nor numbers, were the ultimate basis of the system.⁵¹ These basic forms of buoys included can for port-hand; conical for starboard, spherical for "end of the middle grounds," as well as other types of buoys including pillar, spar, and sound buoys.⁵² Color had importance, though specific colors for certain functions were not included in the nomenclature.

The British system is significant not only because it served many of the principal ports and shipping lanes of the late Victorian period, but because it has influenced the IMC system; for example, the types and shape of can and starboard buoys correspond to IMC usage.⁵³ Of course, it is not very likely that the buoyage system of the principal maritime nation of the 1880s could have failed to influence international navigation of that period.

The International Marine Conference has a unique place in buoyage and beaconage systems. It represents the first truly international attempt at uniformity in these matters, and the system continued to exercise an important role in the buoyage systems of many nations until the present time; this was especially true in the Western Hemisphere.⁵⁴ IMC was organized under the auspices of the United States. While the U.S. played a pivotal role in the forming of the Conference, other nations were involved in bringing about the meeting.⁵⁵ Some 28 nations were represented at the Conference;⁵⁶ this number - though minuscule by late twentieth century perspective - constituted the large majority of independent nations in the late nineteenth century.⁵⁷

It may overstate the case to say that IMC deliberations constituted a system, since the provisions of the conference on buoys were limited. This brevity was probably necessary since, as the premier international effort toward

buoyage uniformity, the "jump" from many national systems to something that all nations could agree upon was monumental in itself.⁵⁸ If a system can be defined as a unit with two or more interrelated and functioning parts, then IMC may qualify as a system.⁵⁹ Greater uniformity was theoretically possible except for the fact that any change meant great expense and a more elaborate - even if superior - system would not have met with approval by many.

Color and number were given precedence over buoy shape in IMC.⁶⁰ Paint and stencils caused fewer problems and less expense than redesigning entire fleets of buoys. The issue of shape surfaced and surfaced heatedly during the conference. The U.S. system then in use definitely included and followed shape.⁶¹ The British and German delegates, especially that of Germany, maintained that shape was not a basic and integral dimension of the U.S. system.⁶² The U.S. statutes pertaining to buoys would appear to support the European contention.⁶³ The IMC proposal was adopted so as to include shape but stated that the signatories would not be obligated to include shape in their respective systems.⁶⁴

The discussion of development in buoyage heretofore presented focus on lateral buoyage. Considerably fewer problems are found in the area of cardinal systems. The cardinal system found in IMC was established before that conference in several northern European nations. IMC largely took over what already existed. Much the same system is to be found in the USB. What already existed influenced first IMC then USB. IMC did not essentially influence USB in this matter.⁶⁵

The 1912 conference in Saint Petersburg overturned the colors of IMC. The problem engendered by that move is considered in the

following and final segment of this chapter.⁶⁶

12 B2 Red/Green to Port--Red/Green to Starboard A Special Problem in International Buoyage

An underlying problem in buoyage and beaconage systems has been that of which side are the red buoys on and which side are the green buoys on? That may oversimplify the problem, but it comes close to the core issue. The IMC system did not provide a long-lasting solution to the future crisis. The foundations that IMC laid down would become in time an element in the divergent approaches to buoyage messages. Divergent practice continues to this day and is in all likelihood permanent. A strictly logical pattern of buoyage has not existed either in the inception of systems in the nineteenth century or in the development of systems in the twentieth. After nearly a century of illogical and contradictory practices it would not be easy to overcome the problems; IALA has come as far toward bridging the gaps as is possible.

It is not altogether clear how the problem of red and green and their use came about. Nonetheless enough of the salient features are known to permit some review of the problem. An early development in the green/red imbroglio is a government report of the U.K. noting the placement of red buoys on the starboard side of channels in 1846, and the commencement of red to port, and green to starboard for ship lighting in 1847.⁶⁷ It is curious that the government report noting the red to starboard buoy practice, and the beginning of ship lighting, occurred almost simultaneously. A related development was the practice of harbor lights in the later nineteenth century in Europe. This utilized red to port and is possibly based on shipboard lighting practice.⁶⁸

It is true that IMC in 1889 did not face a

a great number of lighted aids to navigation. There were few lights, other than the major coastal landfall lights, of a complex and sophisticated nature. During the ninth decade of that century there were some lighted buoys in operation, but these were either in an experimental state or little removed from it. And a heavy usage of different colors of lights is not all that likely. Therefore, IMC, following UK 1846 and other usages, adopted red for starboard, not green for starboard. Black continued as a primary marking color until the implementation of IALA, and can still be found in use though to a declining degree.

No international standards for lights had been established by the time of the preliminary work of the Technical Committee for Buoyage and the Lighting of Coasts of the League of Nations during the 1920s. But the practice of the U.S. and other nations was to place red lights with red to starboard.⁶⁹ But not in Europe. Europe followed the strange practice of red buoys to starboard (as in IMC) but red lights to port. This practice stemmed from the situation with harbor lights in Europe which in turn was presumably based on ship lighting practices (green to starboard, red to larboard).⁷⁰

The 1912 conference seems odd in the retelling. The conference did not send out invitations to all maritime nations (including the U.K. and Canada) and the invitation received by the U.S. was presented not long before the convening of the conference.⁷¹ Saint Petersburg 1912 was short in duration and was supposedly only a preliminary meeting. In fact only three nations adopted the conclusions of the conference. The conference was nonetheless valid: to right the problem of red buoys on one side and red lights on the other.

But that problem was only in Europe (and possibly colonies of European nations).

France became very much concerned during the 1920s over the problem and the resulting confusion.⁷² The Technical Committee began work on a new system in 1925, a system that was to attempt to overturn IMC and to adopt the conclusions of Saint Petersburg. Putnam notes what might be termed the myopic vision of Europe: They represented a minority yet they promoted their regional needs over the majority; seemingly they saw themselves as the majority.⁷³ Positive support for the Technical Committee came from European nations. The same nations were represented on that committee, and the same nations were represented at the 1912 conference. Perhaps Bury's "political intrigue" (discussed later in this segment) has reference to this situation.⁷⁴

Work on the Technical Committee led to the League of Nations conference at Lisbon, 1930, and Geneva, 1936. Those efforts expanded and extended the 1912 effort.⁷⁵ The League of Nations report and system, while followed to varying degrees, never gained official status. Bury's comment that the 1889 conference "fell afoul of political intrigue and two world wars" may have considerable reference to the League of Nations system which was the final outcome of what had begun in Saint Petersburg.⁷⁶ The upheaval of war ended any official system, and IALA's work did not come about until more than four decades later. War was also to block completion of a system of markings in a different sphere: that of traffic control devices (see Volume IIE for discussion of problems of reaching accord in that area). A conservative dynamic seems to be at work in transportation markings (and possibly other systems of symbols as well) so that people, nations, and cultural

groupings can become wedded to a specific approach to, for example, buoyage message meanings, and it becomes of little consequence if those symbols are illogical, arbitrary or accidental in execution.

The buoyage situation, prior to IALA, presented this pattern of messages: All European nations (including the USSR) followed the red to port rule. Seemingly all Western Hemisphere nations obeyed red to starboard. A variety of African and Asian nations conformed to the European practice. Yet other nations, including some in the Northwest Pacific, employ the red to starboard pattern of the Western Hemisphere. As a result of these long-standing policies, IALA was not able to establish a single color-code for the world.⁷⁷ Originally IALA contemplated two systems or buoyage, but a further movement toward consensus altered this to one system with two regional variants.⁷⁸

12C IALA Buoyage Systems

The various buoyage efforts before IALA each in its turn further splintered efforts toward uniformity and simultaneously compounded the confusion. In the view of J.E. Bury - possibly the most knowledgeable person on the history of buoyage systems - the Washington Conference "fell afoul of political intrigue and two world wars."¹ The Uniform System of Buoyage, despite its official appearing character, was "never ratified and officially introduced."² It was the victim not only of politics and war but of its inherent problems and non-global application.

This mingling of multiple conferences, politics and strife suggest the massive difficulties in working toward a universal system. Perhaps the most significant component of the problem was the abandoning of the "red to starboard" of IMC

and its replacement, at least in Europe and selected other nations, by the diametrically opposed green to starboard of the Saint Petersburg and later League of Nations approaches.³

Any solution to the problem of disunity would presumably have to come through the one organization that has universal status because of the many maritime nations in its ranks. the International Association of Lighthouse Authorities/Association Internationale de Signalization Maritime (IALA/AISM), founded in Paris in 1957.⁴ IALA, beginning with a limited objective, broadened its goal and finally established a new system which combines what was usable from the past with new thinking and research.⁵

The first stage of IALA's effort consisted of examining and improving upon existing harbor lighting.⁶ But this proved to be too narrow a study, and a new study group was formed and mandated to supplement and update the Lisbon and Geneva system.⁷ The broader study was required because of new aids to navigation, new systems, and new problems.⁸

The second stage was successful in introducing new rules for "ocean data acquisition systems" and for (in Europe) setting up a system for dividing recreational waters into boating and bathing zones by the use of buoys.⁹ But then a series of major shipping disasters involving supertankers occurred; and, as a result, IALA was asked by the Inter-Maritime Consultative Organization (IMCO) to take up a much-needed project of unifying the various buoyage systems with special attention to marking wrecks.¹⁰ The membership of the committee that took up this more basic challenge overlapped with that of the earlier group.¹¹ Stumbling blocks to unification of existing systems soon arose. The U.S. refused to change from the red to starboard pattern of 1889, and both the U.S. and Canada noted that

North America was already unified to the point of a lateral system without a cardinal system, and both employed systems lacking the complexities of the League of Nations approach.¹²

But, in turn, abandonment of the cardinal system, which is largely European in usage, met opposition by many European nations.¹³ The committee did establish a cardinal system for wreck marking, but since this limited system "would be overtaken by further work on overall problems" it was never used.¹⁴ A basic working plan was assembled in 1971 that called for placing green to starboard and red to port in various combinations.¹⁵ But this proposal proved unworkable since it would be unrealistic to expect the U.S. and Canada to reverse their already simple system.¹⁶ And it was thought equally unrealistic for the Europeans to adopt the North American pattern.¹⁷ It should be noted that various nations neither European nor North American follow either the green to port or green to starboard as well.¹⁸

The realization of the incompatibility of the two regions led to the significant, and at that time necessary, decision to split the world into two regions.¹⁹ This decision excluded the special danger buoy, which was to be universal in scope.²⁰ It is not known to this writer how the IALA group saw the problem of areas such as Asia, where both red to port and red to starboard systems were in use. It may have been presumed that individual nations would choose the system most akin to the current practice of the nation.²¹

The course of events at IALA following the two-zone resolution is not fully understood by this writer. But at some point after the adoption of that resolution the committee came to a conclusion of not using the North American approach, a simpler Geneva system, or a lateral

system based on zones.²² By 1973 the IALA group had not reached a solution.²³ It was at that juncture that a new director of the buoyage group was selected, and "new terms of reference for the project were established."²⁴ J.E. Bury, the new director, came to the conclusion, after agreement was reached on the new terms, that a more fundamental change was needed; that establishing a new system "upon the wreckage of Washington and Geneva was not feasible."²⁵ The beginnings of real progress date from that fundamental decision. In the next three to four years what was known, until 1980, as "System A" was established.²⁶ The then System A was approved by members of IALA at the IX Conference in Ottawa in 1975.²⁷

A key difference between Geneva and System A was the combining of lateral and cardinal systems, and thereby extending the use of the cardinal approach.²⁸ Green became an exclusively lateral color and was thereby dropped from the long-established function of wreck marking.²⁹ No mention of ogival or spindle buoys was made in System A; those buoys have apparently been eliminated from usage.³⁰ Various standards for buoyage sizes, light characteristics and a number of other problems were worked through by the IALA group.³¹ Finally, in March of 1977, Northwest Europe lighthouse authorities signed the agreement implementing the use of System A. System B was to follow later.³²

In 1975 there was agreement by IALA members to harmonize what was to become Systems A and B while simultaneously admitting that the contradictory notions of the meaning of red and green could not be bridged.³³ One system would include both cardinal and lateral approaches with red to port (A). B would be exclusively lateral with red to starboard. A would be found largely in the Eastern Hemisphere and B largely in the Western Hemisphere.

The nations that were following red to starboard then began to construct rules which would meet their specific needs but "which would be compatible, to the extent possible, with System A rules."³⁴ It would appear that System A nations, through USB, had more points of commonality than potential System B members. And, in fact, red to starboard was often times the only point the B nations had in common. Captain L.W. Garrett, USCG, notes that on remaining issues there was a broad range of positions.³⁵ The meetings of B committee went on for four years, and the result was a series of rules very close to those of System A except for the position of red and green. It is interesting that even though - in the light of the literature on A - one system seemed impossible, in the developments leading to System B, one system became quite possible except for the red and green issue.

By the end of the committee on rules for System B it became apparent that both sets of rules could be merged into one set with allowances for regional differences. In Toyko, in November of 1980, the single system was approved; instead of System A and System there were Region A and Region B.³⁶ A key point in bringing together the two systems together was the matter of cardinal markings. Captain Garrett notes that without the common cardinal system the possibility of divergence rather than convergence would have been quite strong.³⁷ However, the use of cardinal markings remains optional for IALA members.

Other points in the merged systems that affect Western Hemisphere nations center on topmarks and color patterns.³⁸ Topmarks are strongly recommended though optional; the U.S. - until IALA - never employed topmarks though any use of cardinal markings would require such supplemental marks.³⁹ The U.S. has employed black and

white for mid-channel marks (termed safe water marks by IALA), but since it has been found that the black and white pattern appears gray in certain lights a new scheme of red and white has replaced the black and white. The U.S., as well as many other nations, utilized black buoys for port but these are being phased out in favor of green. Green has been found to be at least equal to black in visual appearance.⁴⁰ This change is the most vivid of any change brought about by IALA. The U.S. has already employed green for daymarks and these have performed satisfactorily. Black and red horizontally banded buoys for junctions and other purposes have been replaced by buoys with a red and green pattern.⁴¹

Regional variations do not pertain to cardinal marks, isolated danger markings, safe water marks, special marks or new danger markings.⁴² The differences come in the lateral system: the use of green and red. Differences in buoy types, light phase characteristics and other matters are very limited.⁴³ Region A and Region B - where differences are found - are virtually mirror images of each other.

The two regions, in general terms, encompass the Eastern Hemisphere (Region A) and the Western Hemisphere (Region B).⁴⁴ Geography only infrequently follows precise limits, and therefore some artificial adjustments are necessary to fully define the limits of the regions. The international dateline is the primary boundary in the Northern Hemisphere. But at 10 degrees north latitude the regional boundary travels east until reaching 120 degrees west longitude. The boundary then moves south along that line. This division of the Pacific places most of the islands within Region A, and Hawaii and islands in the far Eastern Pacific in Region B. A significant exception is the placement of Japan,

South Korea, and the Philippines with Region B. Those three nations have historically followed red to starboard; hence their choice of regions.

The remaining boundary, that between Africa and South America, moves north along 20 degrees west longitude. It then jogs west to 35 degrees west longitude and follows that line until reaching 55 degrees north latitude. The remaining boundary then proceeds in a northwesterly direction between Canada and Greenland.

Endnotes for 11A and 11B

¹More attention is given to buoyage than to the background of fixed aids for that reason.

²International Encyclopedia of the Social Sciences, Volume VII, "Humo to Intro," p. 253, "Industrialization." New York: Macmillan and Free Press, 1968

³Various sources including An Encyclopedia of World History, W.L. Lange, compiler and editor. Boston: Houghton and Mifflin, 1968, p. 603. Note debate on one, or several, or a "continuing revolution."

⁴1750 or 1770 are almost universal dates; sources questioning this include C.J. Hayes in Contemporary Europe Since 1870, who begins the Industrial Revolution in 1830.

⁵Including Bruun, a general historian; Derry, a historian of technology, and Heaton, an economic historian. Hayes, for example, speaks of industrial evolution from 1800; industrial revolution in England from 1830 to 1870; industrial revolution after 1870 in the U.S., and continental Europe. (Hayes, Contemporary Europe, pp 3-4).

⁶Gollwitzer, H., Europe in the Age of Imperialism, 1880-1914. New York: Harcourt, Brace and World, 1966, for the first two entries; Bruun,

Nineteenth Century European Civilization, 1815-1914, New York: Oxford University Press, 1972, for the third entry.

⁷Gollwitzer, p. 24.

⁸New Cambridge Modern History, Volume XI, "Material Progress and World-wide Problems, 1870-1898." Chapter 1, "Introduction," F.H. Hinsley, pp. 2-3; Chapter 3, "Science and Technology," T.I. Williams, pp. 94-95.

⁹⁻¹⁰NCMH, Chapter 3, pp. 76ff.

¹¹⁻¹²NCMH, Chapter 1, p. 3.

¹³⁻¹⁵Gollwitzer, pp. 24-26.

¹⁶Derry, T.K. and Williams, T.I., A Short History of Technology. New York: Oxford University Press, 1961, pp. 355ff and p. 475.

¹⁷Bruun, p. 139; see also Hayes, who regards the 1870s as a separate unit of history without preceding and succeeding times.

¹⁸Oxford English Dictionary, Volume I, "A-B," p. 1180. London: Oxford University Press, 1935; Alan Stevenson, The World's Lighthouses Before 1820. New York: Oxford University Press, 1959.

¹⁹Oxford English Dictionary, Vol. I, p. 1180.

²⁰Alan Stevenson is of the family of lighthouse engineers bearing that name; also including Robert Louis Stevenson.

²¹⁻²³Stevenson, p. v. ff.

²⁴White, Dudley, The Lighthouse. Boston: New York Graphic Society, 1975, p. 21.

²⁵The U.S. introduced these in 1850 (Weiss, The Lighthouse Service: Its History, Activities, and Organization. Baltimore: The Johns Hopkins Press, 1926, Institute for Government Research Service Monograph of the U.S. Government, #40).

²⁶For example, in 1915 only 28% of the total number of buoys were of iron construction; that is 1772 or 6272. (Conway, John S., The U.S. Lighthouse Service, 1915. Washington, D.C.: Government Printing Office, 1916).

²⁷Bruun, p. 39.

²⁸Encyclopedia Britannica. Volume 4, 1910 ed., p. 808.

²⁹Putnam, George R., National Geographic Magazine. Volume 24, #1, January, 1913, "Beacons of the Sea," p. 31.

³⁰⁻³¹Conway, p. 51.

³²Gibbs, James R., Sentinels of the North Pacific. Portland (OR): Binford and Mort, 1955.

³³American Gas Accumulator Company (General Catalog), undated, probable date: 1927-39). This publication describes the use of acetylene gas in aids to navigation. Dr Dalen' was intimately involved in the company, as AGA was an offshoot of of the parent Swedish firm.

³⁴Scott, F.D. Sweden: The Nation's History. Minneapolis: University of Minnesota Press, 1977, p. 453; Evlanoff, Michael and Fluor, Marjorie, Alfred Nobel: The Loneliest Millionaire. Los Angeles, the Ward Ritchie Press, 1969, p. 287.

³⁵ESNA Corp., "ESNA Aids to Navigation," lecture at USCG Training Station, CN, 1965, p. 34.

³⁶Weiss, p. 40.

³⁷Second half of the nineteenth century.

³⁸Weiss, p. 40.

³⁹Putnam, NGM, January, 1913.

⁴⁰EB, Vol. 16, "L-LOR," 1910, ed., p. 646, "Lighthouse."

⁴¹EB, Vol. 16, 1910, p. 654; this work resulted in an improved light source by 1885 but it was not practical until the Welsbach mantle of 1893; later EB coverage indicates 1901 as the time of the successful oil burner mechanism by Kitson.

⁴²Hayes notes that "machine industry predominant in Britain (and Belgium) by 1871." (Generation of Materialism, 1871-1900. New York: Harper and Row, 1941, p. 92). A similar situation existed in Germany and the U.S. by 1900; France was involved in similar processes to a considerable degree. Hayes further notes that mass-produced consumer goods and not merely industrial and transportation goods were commonplace by the first or second decade of the twentieth century.

⁴³By "monster buoy" I am referring to those buoys that are known as Large Navigation Buoys in the U.S. (or LNBs) and LANBYs in the U.K. (Trinity House). They can measure as much as 40 feet (12.3 meters) in diameter. They are found, under one or other name, in a number of nations.

⁴⁴Report of the Conference Appointed to Consider the Proposal For a Uniform System of Buoyage for the UK, Together With Minutes of Evidence and Appendices. London, 1883. See also: Uniform System of Buoyage, Report to Right Honourable Joseph Chamberlain, M.P. London, 1883.

⁴⁵Protocols of Proceedings. 3 Volumes. Washington, D.C., October 16-December 31, 1889.

⁴⁶Agreement For a Uniform System of Buoyage and Rules Annexed Thereto. Lisbon, 1930, Geneva, 1936.

⁴⁷Conference Internationale Maritime. Actes, March, 1912, Saint Petersburg, 1913.

⁴⁸O'Dea, Social History of Lighting, p. 68; also documentation for the conferences.

⁴⁹These are: Trinity House, Commissioners of Irish Lights, Commissioners of Northern Light-houses. The smaller agencies include Mersey Docks and Harbour Board, Clyde River Trustees, and the Admiralty. Yet other smaller organizations administer the River Tyne, the River Tay, the Thames and the Hull.

⁵⁰USB Reports, points 3 to 7.

⁵¹USB Reports, points 9 to 11.

⁵²USB Reports, points 3 to 7.

⁵³USB Reports, and Protocols.

⁵⁴IALA with regional variation A is in substantial operation; B is well along though perhaps to a lesser degree than A.

⁵⁵Protocols, Vol. I, pp. v. and vi.

⁵⁶Protocols, Vol. I, pp. v. and vi.

⁵⁷Palmer, R.R., and Colton, Joel. A History of the Modern World. New York: A.A. Knopf, 3rd. ed., 1965, pp. 557-559. Palmer and Colton speak of three economic zones. The first zone includes Western Europe and the northeastern U.S. The second zone comprises Latin America, much of the remaining U.S. and the less industrialized parts of Europe. The final zone includes Africa and Asia - save Japan. IMC centers on the first zone, the area of the major participants, and the second zone.

⁵⁸Protocols, Vol. III, p. 340.

⁵⁹System can be defined as "(1) something consisting of a set of entries, (2) among which a set of relations is specified so that, (3) deductions are possible from some relations to others or from the relations among the entries to the behavior of the history of the system." These could include a language or a solar system; buoyage systems also qualify. (International

Encyclopedia of the Social Sciences, Vol. 15, "Soci to Thin," p. 453, "Social Analysis."

⁶⁰Protocols, Vol III, pp. 331-332.

⁶¹⁻⁶²Protocols, Vol. II, pp. 1326-28.

⁶³U.S. Statutes of 1850 (Weiss, p. 40).

⁶⁴Protocols, Vol. II, p. 1389.

⁶⁵Protocols, Vol. II, p. 1321.

⁶⁶CIM, Actes. See also Bury.

⁶⁷O'Dea, Social History of Lighting, p. 86.

⁶⁸To some degree this is the view of the compiler.

⁶⁹Putnam, G.R., "Statement," pp. 4, 8.

⁷⁰_____, "Statement," p. 9.

⁷¹_____, "Statement," p. 10, Appendix C.

⁷²Garrett, "International Harmonization of Buoyage Systems," p. 3.

⁷³Putnam, pp. 6-7.

⁷⁴Bury, J.E., "Background to IALA Buoyage System A," International Hydrographic Review. LV (1). January, 1978, p. 136.

⁷⁵Putnam, p. 1.

⁷⁶Bury, p. 136.

⁷⁷Bury, pp. 137-143; see also IALA Buoyage Conference Report (hereafter BCR), 1980.

⁷⁸IALA BCR, 1980.

Endnotes for 12C

¹Bury, p. 136.

²Bury, p. 136 (footnote); IALA Supplement #6; DMA Pilot Chart, 1977 (reverse side).

³Bury, p. 136; IMC Conference papers; also those of Lisbon and Geneva; DMA Pilot Chart.

⁴IALA/AISM, #43 Avenue du President-Wilson, Paris.

⁵⁻⁷Bury, pp. 135-36.

⁸⁻¹⁰Bury, p. 136.

¹¹Bury, p. 136; IALA Supplement # 6, pp. 1-2.

¹²⁻¹⁷Bury, p. 137.

¹⁸IALA Supplement # 6, p. 1.

¹⁹IALA Supplement # 6, p. 1; Bury, p. 137.

²⁰Bury, p. 137.

²¹IALA Supplement # 6, p. 1.

²²Bury, pp. 137-38.

²³⁻²⁶Bury, p. 138.

²⁷Garrett, "International Harmonization ...", p. 5.

²⁸IALA Supplement # 6, pp. 1-2; Bury, p. 139.

²⁹Bury, p. 139.

³⁰These were significant buoys in USB especially in cardinal situations. See Conference papers, Lisbon and Geneva; also IHB SP #38, 1956, 1971.

³¹Bury, p. 138ff.

³²Bury, p. 143.

³³⁻³⁵This and following notes are from a paper of Captain L.W. Garrett, USCG, entitled "International Harmonization of Buoyage Systems," pp. 1, 5, and 6.

³⁶Letter of Garrett to writer, 17 December, 1980.

³⁷Garrett, p. 8.

³⁸Garrett, pp. 6-8.

³⁹Garrett, p. 8.

⁴⁰Garrett, pp. 6-7.

⁴¹Garrett, p. 7.

⁴²⁻⁴³"The Proposed IALA Buoyage System," an addendum to Garrett essay.

⁴⁴IALA BCR, 1980, Annex 3, Section 2.

CHAPTER THIRTEEN
CLASSIFICATION OF BUOYS IN INTERNATIONAL USAGE

13A The Classification

12 Lighted Buoys

121 Standard Single Types

1210 Can

1211 Spherical

1212 Conical

1213 Pillar

122 National/Regional Types

1220 Canadian

1221 U.S.

1222 Greece A/Thailand A

1223 USSR

1224 Thailand B

1225 Greece B

1226 Norway

1227 Beacon Buoy-Lateral, West Germany

1228 Beacon Buoy-Cardinal, West Germany

14 Unlighted Buoys

141 Conical

1410 USB

1411 IALA

1412 Nun, U.S.

1413 Denmark A

1414 Denmark B

1415 Italy

1416 Poland, France

1417 Canada

142 Can/Cylindrical

1420 IALA/USB

1421 U.S.

1422 Denmark

1423 West Germany

1424 Taiwan

1425 Sweden, USSR

1426 Canada

- 143 Spar Buoys
 - 1430 Standard, USB/IALA
 - 1431 Modified Standard, USA/IDAMN
 - 1432 Modified Standard, Norway
 - 1433 Modified Standard, Canada
 - 1434 Special, Spar on Can Base, Iceland, et.al.
 - 1435 Special, Spar on Modified Can Base,
 - Iceland
 - 1436 Special, Spar on Modified Can Base,
 - Netherlands, Poland
 - 1437 Special, Spar on Conical Base-A, Iceland
 - 1438 Special, Spar on Conical Base-B, West
 - Germany
- 144 Standard Single
 - 1440 Ogival
 - 1441 Spindle
 - 1442 Spherical
 - 1443 Pillar
- 145 Miscellaneous Buoys
 - 1450 Beacon Buoy-Lateral, West Germany
 - 1451 Beacon Buoy-Cardinal, West Germany
 - 1452 Barrel, Sweden, USSR
 - 1453 Oil-Drum, U.S.
- 15 Sound Buoys
 - 150 National/Regional Types
 - 1500 Bell, IALA¹
 - 1501 Whistle, IALA
 - 1502 Bell, U.S.
 - 1503 Whistle, U.S.
 - 1504 Gong, U.S.
 - 1505 Carillon, France
 - 1506 Bell, France
- 17 Combination Buoys
 - 170 Lighted Sound Buoys
 - 1700 Lighted Bell, Canada
 - 1701 Lighted Whistle, Canada
 - 1702 Lighted Bell, U.S.
 - 1703 Lighted Whistle, U.S.
 - 1704 Lighted Gong, U.S.
 - 1705 Lighted Horn, U.S.

- 1706 Lighted Bell-Conical, USB
- 1707 Lighted Bell-Conical, USB
- 1708 Lighted Bell-Can, USB
- 1709 Large Navigational Buoy, U.S., U.K., et.al.²
- 1710 Non-Buoyage Aid: Lightship

13B Notes on Classification
of Buoys in International Usage

This classification will not achieve as much precision as found in the U.S. counterpart of this classification.³ Differences in national approaches to marine safety, differences in design and manufacture, and the sheer number of individual systems preclude a classification that would include every slightly variant form of buoy. For example, the U.S. has various sizes of the basic buoy types, and these sizes or classes have been incorporated into the U.S. classification in Volume IB.

Because of the welter of nations, manufacturers, and design nuances it is necessary to focus on the general types of buoys and not enter the arena of buoy sizes and sub-sizes.⁴ These factors lead to several practical conclusions: All buoys listed in IHB - and supplemented by the actual USB documents -, and listed in IALA will be regarded as standard if they visually and descriptively conform to the Uniform System of Buoyage of 1936, the U.S. System, or the IALA System of 1980.⁵ All discernible differences will be classified as either modifications or variants.

Buoys which are slightly larger or smaller or vary slightly in shape from the standard models will be classified under the appropriate standard or variant heading. This should result in a workable classification which neither glosses over significant differences nor overemphasizes minute and minor distinctions. It would appear to this compiler that the IHB uses a stylized

form of illustrations for its publications. That is, if a national marine agency does not provide illustrations contrary to the stylized form then those stylized forms are seemingly used. For example, the 1956 edition of IHB's Systems of Marine Buoyage and Beaconage⁶ shows the can buoy for the U.S. as identical to can buoys of European countries even though there are visual differences. It would then appear that the IHB has determined, and probably correctly, that if the basic form is present, and that the failure to give nuanced differences will not present problems, then the basic form is sufficient for safe navigation. Seemingly, special illustrations will be included if provided; for example, the 1971 edition includes a Norwegian light buoy that is quite distinct from those of other nations that have a separate light buoy.⁷ Of course the shape of a buoy is only one dimension of marine aids to navigation; the size of a buoy is a possible dimension though a less important one. The colors and other message systems are as least as important and probably more so. It is the hope of this compiler that a very precise classification may eventually be possible, but this simpler version seems to be a necessary prologue to that eventuality.

Detailed notes on the individual buoy types will be found in Chapter 14. The following explanatory notes provide general information on the buoy type divisions which should assist the reader in using the classification chart.

Lighted buoys are divided into two sections: 121, Standard Single types, and 122, National/Regional types. The first section includes buoys that are found in official international agreements and have both lighted and unlighted counterparts. The second group includes buoys that are found in a variety of nations, have a shape peculiar to that buoy, and do not have

unlighted counterparts. At least one nation, the U.S., makes use of lighted buoys, but without the light apparatus, for sound buoys.⁸ Some of the second group may be used for combination light and sound buoys.⁹

Unlighted buoys, 14, come in a great many sizes and shapes. They may be divided into four main groupings: Conical (141), Can/Cylindrical (142), Spars (143), Standard Single (144), and Miscellaneous (145).

Conical buoys cover a range of shapes. The conical buoy of USB is a cone above the water line (1410). There are several other versions which include cones of steeper or shallower slope, and conical-shaped buoys which range from slightly to severely truncated variations. The severely truncated cone of West Germany (1423) is included with can buoys since it more closely resembles a can buoy than a conical buoy.¹⁰ It is not clear if there is an actual difference between USB and IALA conical buoys; visual appearances suggest a difference, and therefore they are listed separately (1410 is USB, 1411 is IALA).

USB labelled buoys in lateral service as Can and the same buoy in cardinal service as Cylindrical, and this dual appellation is retained.¹¹ Earlier comments about uncertainty of significant differences, or lack thereof, between various buoys can apply to these buoys as well. There are less variations in shapes of can buoys than of conical though some differences are present. Two are somewhat sloping in appearance, and others exhibit a variety of sizes.

Spar buoys in this classification encompass a range of buoys for which a more suitable general term is not available. Therefore, any buoy with a narrow, elongated appearance is here regarded as a spar. These include the basic spar buoy as well as spars with an extension above the

water line of a variant form. Further complexities in classifying these buoys occur in those national systems in which the term spar is not used for spar or near-spar buoys.¹²

Miscellaneous includes several buoys that do not fit other classification categories. These include the German beacon-buoy or bake, which is a general purpose buoy for that nation.¹³ Barrels, oil-drums and casks are not infrequently employed by marine safety agencies as buoys, but they are not always regarded as "official." The barrel buoy pictured in IHB publications appears to be a stylized illustration.¹⁴ The U.S., in the past, has augmented its buoyage with oil drums which are the equivalent of barrel and cask buoys.¹⁵

Standard unlighted single types (ogival, spindle, spherical and pillar, 1440-1443) along with the spar buoy - are the only buoys to have official status. IALA has added the pillar (1443) to official status but has dropped the spar and the ogival.¹⁶ But because of the position of those buoys in USB, and the phasing out of them over a period of time they are here retained.¹⁷

Sound buoys (15) are not listed or illustrated in IHB works. But they are included in IALA and USB publications. IALA has representations of sound-only buoys but USB refers only to sound-light combination buoys.¹⁸ The U.S. formerly utilized special sound buoy types but light buoys minus the light apparatus are employed at present. Therefore there is an overlap with some buoys though they are distinct types.¹⁹ The LANBY and Large Navigational Buoy are the same or similar buoys and are classified together; other buoys of similar proportions and equipment can also fit this classification.²⁰

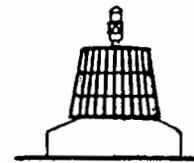
Combination buoys for this classification are largely light and sound buoys. Many buoys contain radar reflectors, but this is a nearly

ubiquitous feature so that it does not warrant referring to nearly all of the buoys in some systems as being combination in nature. The large navigational buoys are light-sound-electronic combination buoys.

13C Illustrations

12 Lighted Buoys

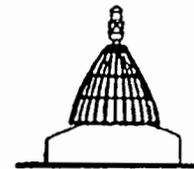
121 Standard Single Types



1210 Can



1211 Spherical



1212 Conical



1213 Pillar

122 National/Regional Types



1220
Canadian



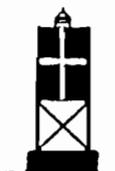
1222
Greece A/Thailand A



1224
Thailand B



1226
Norway



1221
USA



1223
USSR



1225
Greece B



1227
W. Germany



1228
W. Germany



14 Unlighted Buoys

141 Conical Buoys



1410 USB



1412 Nun



1414 Denmark B



1416 Poland, France



1411 IALA



1413 Denmark A



1415 Italy



1417 Canada

142 Can/Cylindrical Buoys



1420
IALA/USB



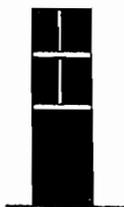
1422
Denmark



1424
Taiwan



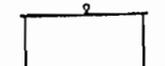
1426
Canada



1421
USA



1423
W. Germany



1425
Sweden, USSR

143 Spar Buoys



1430
USB/IALA



1431
USA/IDAMN



1432
Norway



1433
Canada



1434
On Can Base
Iceland, et. al.



1435
Modified
Can Base-A
Iceland



1436
Modified
Can Base-B
Netherlands,
Poland



1437
Conical Base-A
Iceland



1438
Conical Base-B
W. Germany

144 Standard Buoys, Single Types



1440 Ogival



1441 Spindle



1411 Spherical



1443 Pillar



1450 Beacon-buoy
Lateral,
W. Germany



1451 Beacon-buoy
Cardinal
W. Germany



1452 Barrel
Sweden, USSR



1453 Oil-drum
USA



15 Sound Buoys

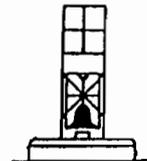
150 Sound Buoys, Single Types



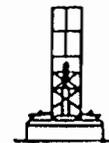
1500 Bell
IALA



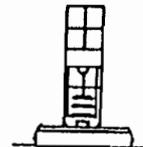
1501 Whistle
IALA



1502 Bell
USA



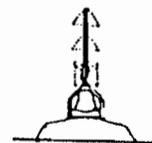
1502 Whistle
USA



1504 Gong
USA



1505 Carillon
France

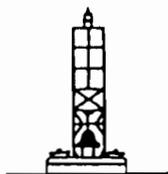


1506 Bell
France

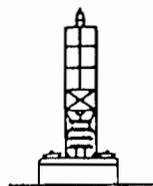
17 Combination Buoys
 170 Lighted Sound Buoys



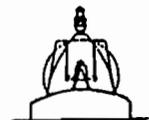
1700 Bell
Canada



1702 Bell
USA



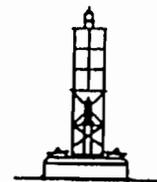
1704 Gong
USA



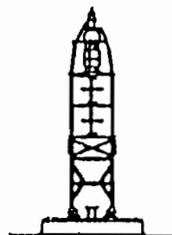
1706-07-08
Bell/Conical/
Spherical/Can
USB



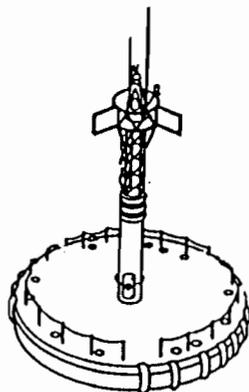
1701 Whistle
Canada



1703 Whistle
USA



1705 Horn
USA



1709 Large Navigational
Buoy, USA, UK

Endnotes for 13A and 13B

¹This comes from IDAMN; there is no specific mention of a sound buoy in the IALA buoyage system though this does not rule out the possibility of them. This pertains to 1501 as well.

²Identical or nearly-identical buoys of this type may be known by others, for example, U.K. refers to this buoy as a LANBY.

³See Volume I, Part B, Chapter 9.

⁴The classification, so far, has not achieved a single format for all worldwide transportation markings, so some dichotomy between U.S. and international classifications currently exists.

⁵The Uniform System of Buoyage is described in IHB publications, Systems of Marine Buoyage Adopted by Various Countries, SP#38, 1st ed., 1956, and Maritime Buoyage Systems Adopted by Various Countries, SP#38, 2nd ed., 1971; Conference documents of the League of Nations establishing the Uniform System of Buoyage, Lisbon, 1930, and Geneva, 1936; "U.S. System" as described in American Practical Navigator (Bowditch); Conference documents of International Marine Conference, 1889.

⁶SMB, p. 136.

⁷SMB, pp. 58-59.

⁸USCG, Aids to Navigation Manual, Amendment #2, 1964 edition.

⁹For example, Canada, West Germany.

¹⁰MBS, p. 37.

¹¹MBS, pp. 7, 10.

¹²MBS, For example, the Netherlands, Poland.

¹³MBS, pp. 33-37; IDAMN, 2-6-220, figure # 60.

- ¹⁴MBS, For example, Sweden, p. 70.
- ¹⁵USCG, Aids to Navigation Manual, Ch. 2, 1964 edition.
- ¹⁶IALA Supplement #6, to the IALA Bulletin, 1976.
- ¹⁷IALA in 1980 worked out a schedule for the changeover to the IALA buoyage system, but not all of the necessary changes have taken place.
- ¹⁸Material from either organization is probably not complete, so forms of buoys other than those listed could be in operation in one or more nations.
- ¹⁹That is, many sound buoys are in effect lighted buoys in shape and dimensions; only one element is missing from many of those buoys. Many U.S. buoys are not 100% different from other buoy types.
- ²⁰The "Superbuoy" mentioned in DMA and the Superboj of Sweden are two other possibilities.

Endnotes for 13C

- 121, League of Nations, Uniform System of Buoyage (1213 to be found in other publications as well).
- 1220, CANS; 1221, USCG; 1222-1228 IHB save 1226, Norway,
- 141 Computer graphics based on IHB save 1417, based on CANS.
- 142 Previous note applicable.
- 143 Previous note applicable save 1433, CANS, and 1431 USCG, IDAMN; 1430 also IALA.
- 144 IHB save 1433, US model.
- 1500-1501, IDAMN; 1502-1504, USCG; 1505-1506, Service Technique des Phares et Balises.
- 1700-1701, CANS; 1702-1705 and 1709, USCG; 1706-07-08 USB.

CHAPTER FOURTEEN

DESCRIPTION OF BUOY TYPES

The description of buoy types will be based on the classification outlined in Chapter 13. Each of the segments of this chapter will include two components: a discussion of the derivation of the name of the buoy at least in its English form, and an examination of the function of the specific type of buoy. The written and illustrated parts of the previous chapter are integral to an understanding of this chapter.

14A Lighted and Lighted-Sound Buoys

There is no buoy of an exclusively lighted nature in IALA or in USB. The U.S., Canada, Norway and several other nations do have such a buoy. Lighted buoys for USB, and presumably for IALA as well, share the same shapes as the unlighted buoys. The buoys for lighted purposes are modified to carry out that function but have the same general physical appearance. For those nations with a separate light buoy, the buoy contains a tank base with a tower-like superstructure; such buoys may be further equipped with a radar reflector.¹ The U.S. light buoy has undergone several design changes: the "wasp-waist" look of another era has given way to a straight-line shape in the current era.²

The Canadian light buoy is not shown in the 1971 edition of IHB. Nonetheless, there is a distinct light buoy in that system.³ The Canadian model is of a squared-off design but with a slightly sloping appearance.⁴ Norway makes extensive use of light buoys in both lateral and cardinal systems. The light buoy is retained in post-IALA publications.⁵ This buoy is mounted on a tank that is apparently somewhat smaller than its U.S. and Canadian counterparts.⁶ The superstructure angles in steeply from its base and a second structure is mounted athwart the top of the underlying

structure and, in effect, surrounding the light apparatus.⁷

IHB provides what appears to be a stylised light buoy for Greece and Thailand. This buoy has the typical shape of a tank surmounted by a sloping structure.⁸ Thailand has a second light buoy but with a smaller tank; the light buoy of the USSR bears enough resemblance to require separate classification.⁹ Greece has has a second light buoy, termed a Pillar buoy, which is a simple vertical cylinder topped by a light.¹⁰ West Germany's Bake buoy also comes in lighted forms and appears in two variant forms; one for cardinal, one for lateral usage.¹¹

Non-standard buoys still exist in IALA-sanctioned systems. Even if the shape is non-standard, no doubt the color and other message systems have been altered to fit the changes.

Combination buoys include those with light and sound mechanism on the same buoy. Radar reflectors are too common and also a peripheral electronic aid, and are not included within the combination equation. These buoys include the same range of sound devices that sound-only buoys contain. Detailed coverage in international publications is not available so that only an approximation of the types of lighted sound buoys is possible. Bell, and whistle are common forms with or without a light. In all likelihood electronic horns are more common. Seemingly only the U.S. makes use of gong buoys. And apparently only France employs a carillon buoy.

14B1 Unlighted Buoys:

Conical and Can/Cylindrical Buoys

Conical-shaped buoys (141) include a diversity of standard and variant forms. In the classification there are two "standard" conical buoys.

One is the conical buoy of USB, and the other, that of IALA. The nun buoy of the U.S., seemingly influenced by IMC, may arguably be a third "standard." The basic term of cone may refer to either a perfect geometric cone or "anything shaped more or less like a mathematical cone."¹ A conical structure would then include both "perfect cones" and partial ones. In buoyage systems both types are found. Cone of course refers to the above-water part of the buoy. Many buoys out of water will present a double cone or possibly other shape. Conical buoys, and all other buoys for that matter, are analogous to icebergs in that much of the mass is under water.

The stylized IHB conical buoy exhibits a perfect cone shape; the IALA presents a cone with a more pronounced curvature.² The IDAMN defines a conical buoy (and this includes the nun buoy as well) as "a buoy of which the upper part of the body (above the water line), or the larger part of the superstructure, has approximately the shape of a cone with vertex upwards."³ This definition quite obviously allows for some measure of latitude in buoy shape.

Conical buoys, and can buoys as well, are more frequently employed in USB lateral and cardinal systems than any other forms of buoys; they are also the most common in IALA lateral but not in IALA cardinal.⁴ Conical buoys are used as wreck buoys in USB but not for isolated dangers in IALA or for that matter in IALA at all except for lateral purposes.⁵ USB also employed conical and can for lateral positions of sides of channels.⁶ Some nations, which otherwise follow IMC, have opted for the conical buoy rather than the nun buoy; Canada is perhaps the outstanding example of this practice though the buoy in question seemingly rides closer to the waterline than other conical buoys.⁷

The origin of the term "nun" (as in nun buoy) stems from the term "nun-gigge" which can be defined as having small ends with a larger middle.⁸ A contemporary definition describes a nun buoy as a "red metal buoy made up of two cones joined at the base."⁹ The buoy in modern usage is conical in shape rather than a perfect cone shape. The definition from IDAMN of conical buoys encompasses the nun buoy as well.¹⁰ Modern nun buoys are actually can-shaped with a nun-shaped radar reflector added on.¹¹

Denmark, in IHB, had two forms of conical buoys both of which were at variance with the basic IHB model. One of these appears to be an ogival buoy except for a slightly less pronounced curvature; Denmark classes this buoy as a conical nonetheless.¹² The other Danish conical buoy is of a straight-line design but steeply elongated in shape.¹³

The Italian buoyage system includes a variant conical buoy as well as the standard conical type. The variant form is a cone atop a cylindrical base. The appearance is of a complete cone attached to a shallow cylinder above the water line.¹⁴ Unlike many other systems the Italian uses both of the conical buoys on both sides of the channel.¹⁵ Of course other message factors vary so the purpose of a given buoy is evident.

A final variant form is found in France. This buoy is a standard conical buoy that is moderately truncated but to such a degree that the buoy will be regarded as a sloping cylinder or can buoy.¹⁶ The buoy was used only in limited situations; Poland at one time made use of an identical buoy but it was dropped.¹⁷

There would appear to be no need to explain can and cylindrical buoy terms since they seem to be self-explanatory. Upon examination the terms become less clear. The Oxford English Dictionary,

normally an accurate source for word origins, greatly confuses the matter by describing a can buoy as a "large cone-shaped buoy."¹⁸ This would appear to be more of a definition of a conical or nun buoy. The "cone-shaped buoy" may be greatly truncated, but the definition as it stands is meaningless. OED defines a "cylindrical" as having the "form of a cylinder," and that is certainly the case.¹⁹ A cylinder can be a geometric shape or an object with that shape. More precisely, a can buoy can be described as "truncated with a flat top" or as "truncated or flat."²⁰

IDAMN defines can and cylinder as those buoys "of which the the upper part of the (above the waterline), or the larger part of the superstructure, has the shape of a cylinder or nearly so."²¹ This last definition is preferable to the earlier one. In USB can buoy has reference to lateral and cylindrical to cardinal. IALA and various national systems make reference exclusively to can buoy.²²

Can buoys, along with nun/conical buoys, are the most common buoys in USB and IMC systems; the "mix" of major buoy types is somewhat different in IALA. A number of nations with simple message systems opted exclusively for can and conical buoys in the older systems.²³ The U.S. can is a taller version than that of IALA and USB - at least judging by stylized illustrations; it is possible that the ratio of width to height is greater in non-U.S. forms. The U.S. can is equipped with the ubiquitous radar reflector.²⁴

In the first edition of IHB Denmark maintained a can buoy similar to the stylized type except for an appearance both narrower and taller. The new edition of IHB does not list any type of can buoy for Denmark. Presumably, IALA norms may cause the addition of a can buoy to that system.²⁵

The West German system has, in addition to

standard can buoys, a conical buoy so severely truncated that it bears a greater resemblance to a can buoy than to a conical buoy.²⁶ IALA notes in a footnote to its definition of can/cylindrical buoys that the "German term 'Stumpftone' also includes buoys of truncated cone shape," which supports the view that the truncated conical buoy is by appearance a can rather than a conical buoy.²⁷

Taiwan has a single type of buoy for its entire system. This buoy is a moderately truncated buoy which suggests a conical buoy though of a very muted cone shape. Its shape is sufficiently can-like to be considered more as belonging to that category.²⁸ The can buoy of Canada appears, by visual representation, to be somewhat smaller, somewhat closer to the waterline than other can buoys; it - like the conical counterpart buoy of Canada - is therefore seen as a variant form.²⁹ A final can buoy is that of Sweden and of the USSR. It has a definite can shape but of a more bulky and squat form and is also to be regarded as a variant form of buoy.³⁰ The previously described U.S. can buoy may be regarded as a variant form, but the great masses of that buoy may justify it being regarded as a second "standard" buoy along with the U.S. nun buoy.³¹

14B2 ' Unlighted Buoys:

Spar, Standard, and Miscellaneous

The word "Spar" can be defined as "a general term for any mast, yard, boom or gaff" ³²

It has reference primarily to maritime usage during the era of sailing ships; more narrowly it refers to ship masts. Spar buoys will then be an upright mast or spar. IDAMN defines spar buoys in similar terms: "a buoy in the shape of a spar floating nearly vertically."³³ At an earlier stage of development spars used for buoyage

purposes were of wood rather than of iron or steel construction. It is possible that some older spars may have come from the same yards as those that produced ship masts.³⁴ More modern versions are more likely of metal than of wood construction.

Spar buoys can be divided into two segments: the standard - which includes several modified standard models, and the special spar forms of which there are at least 5 models. The special spars all share a common feature of combining a base with a spar.

The standard spar quite possibly has more functions than any other buoy in either USB or in IALA. In USB the spar has several exclusive roles and also serves as an alternative to one or other of the remaining standard buoys.³⁵ In IALA the spar is an option in lateral systems and, though the cardinal system does not call for a precise shape of buoy, the spar is one of two normally used in those situations; it is also an option for miscellaneous purpose situations in IALA.³⁶ The Finnish system, at least before IALA, employed only spar buoys.³⁷ The spar buoy was heavily used at one time in the U.S. but it is no longer listed in the current U.S. Coast Guard Manual. Since it was listed in the previous manual - that of 1964 - and was, until relatively recently an important buoy, it is listed in the classification.³⁸ The U.S. and IDAMN both present a spar with a slightly tapered appearance; therefore they are included together in the classification.³⁹

The spar of Norway is both severely tapered and pointed as well. It constitutes a separate listing in the classification.⁴⁰

Canada, contrary to the practice of the U.S., continues to include spar buoys in its operations. Canada employs a slight varying form of the spar along with the standard version. A

flat-topped model, which follows IHB design, provides an alternative to the can buoy. The variant form is pointed and can provide an alternate to the conical buoy.⁴¹ In other nations the spar buoy is the same shape for both can and conical functions. Belgium formerly used the flat and pointed top spars, but this feature has been dropped in the second edition of IHB.⁴² The buoy may suggest a spindle buoy, but nonetheless the spar resemblance seems stronger.

The next to final variant form is the spar buoy on can. Denmark, Norway, and Iceland all have this buoy.⁴³ The local name of the buoy varies, but the appearance remains the same. In Denmark the buoy is termed a perch. A perch can be either a buoy or a fixed aid. Supposedly the perch is not the same as a spar from the view of lexicography.⁴⁴ But a perch on a buoy, and a spar buoy on a can base, are visually the same. It is not known if a separate term describes this buoy type in Iceland. The Netherlands also uses this buoy, and it is referred to as a "floating beacon" - a term applied to a previously described buoy.⁴⁵ In Norway this selfsame buoy is termed a spar; Norway also includes the standard spar.⁴⁶

The final variant form are those mounted on a base with a conical shape. Iceland is a user of such a buoy while West Germany has a buoy consisting of a conical base and a slightly sloping spar buoy.⁴⁷ The buoy may suggest a spindle buoy, but nonetheless the spar resemblance seems stronger.

The Netherlands and Poland exhibit a buoy attached to a base that is both can and conical in shape. The Netherlands terms this buoy a "floating beacon," not spar buoy, but this beacon is much like other variant spars.⁴⁸ Iceland's "fleet" of spar buoys also includes a can-shaped spar with a rounded top base. The spar itself is standard in appearance.⁴⁹



It is possible that further study may determine that all buoys with a base and spar combination ought to be a separate classification apart from spar buoys. But at this stage of study it would appear that these buoys belong to the class of spar notwithstanding the distinctive shapes.

Standard single types of buoys include the ogival, the spindle, the spherical and pillar buoys. Since there are no recognized variant forms they are included within a "singles" category. These buoys are found within USB, and since the movement to IALA is not yet complete it may be acceptable to label all of them standard.⁵⁰ They are not found in IMC. The pillar buoy, which is listed as an optional shape in IHB, becomes a major buoy in IALA. These buoys are also included within lighted buoys, but the larger coverage will come in this unlighted segment.

The pillar buoy is illustrated in IHB publications but not named. It does not have regular stated duties in IHB.⁵¹ The 1911 EB includes the buoy, and it seems to have been regarded as having some importance and even a regular status.⁵² For IALA it has both name and importance; in fact it is one of five official buoys.⁵³ This buoy is made up of a large tank base and is topped with a superstructure of lattice work construction; it is an acceptable option for all buoys in lateral and special positions.⁵⁴ It is one of two buoys for IALA cardinal usage.⁵⁵

The term "ogival" is not found in common English marine parlance. According to OED the term refers to objects with the "form or outline of an ogive or pointed ('Gothic') arch."⁵⁶ An ogival buoy is one that has the appearance of such an arch. The term is of French ancestry.⁵⁷ This compiler would speculate that the arch is the source of the name of the buoy.

Ogival buoys are included in USB and

publications of the IHB.⁵⁸ IDAMN does not include the buoy.⁵⁹ It found use in the eastern quadrant of the USB cardinal system, and also for wreck marking.⁶⁰ France was apparently the only nation that specifically included the buoy under USB and in IHB publications.⁶¹ Other nations included it for optional use. The buoy was the least familiar among standard USB buoys. The Danish system contained a buoy somewhat like an ogival though it bore greater resemblance to a conical buoy.⁶² The stylized illustration of an IALA conical buoy has a modest curvature reminiscent of an ogival buoy; the inclusion of the ogival into IALA could have created a measure of confusion, or so it seems to this compiler.⁶³

Various dictionaries, including OED, WTID, and RHDEL, make mention of a marine marking termed a spindle.⁶⁴ But in all of these cases the spindle is a fixed aid to navigation, not a floating one. The use of fixed spindles, at least by that name, appears to be confined to the U.S. judging by available literature.⁶⁵ Spindles, outside of aids to navigation, are of course found in spinning, and also as the upper section of wooden ship masts. The source of the term presumably comes from ship usage though speculation might suggest spinning spindles as well. IDAMN speaks of the spindle as having a "spindle-like shape" which offers little aid in determining the derivation of the term.⁶⁶

The spindle buoy is found in the USB cardinal system; it is not found in the lateral systems of USB or IMC.⁶⁷ It is not found at all in IALA. The spindle buoy has had a variety of functions in individual buoyage systems; France, Spain and the Netherlands all employ it.⁶⁸ Various nations, including Egypt, Turkey, and Portugal were listed in IHB as having adopted the cardinal system, and this includes a possible use of the spindle. Spain uses the spindle, though the USB cardinal system is not in use in that country.⁶⁹

The spherical buoy, obviously, derives its name from the notion of sphere; possibly from a mathematical context. There does not appear to be a non-marking usage of that term that directly leads to a maritime adoption of it as is the case, or possible case, of spindle and ogival. According to the 1882 Conference at London, a distinction was made between buoys with flat tops (can buoys) and those with domed tops (spherical buoys).⁷⁰ Dictionaries, whether general or specialized, do not give a background for the term that has a marine connection. Of course spheres are a basic geometric form and could easily have been perceived as a suitable candidate for buoyage systems. IDAMN defines a spherical buoy as a "buoy of which the upper part of the body (above the waterline), or the larger part of the superstructure, is spherical."⁷¹

In USB the spherical buoy is primarily found in lateral usage; it is applied to bifurcation and junction marks, and for wreck markings.⁷² There is no use of it in the USB cardinal system, though the buoy is employed for uses "common to both systems" including isolated danger markings and for limited optional situations.⁷³ IALA uses it for safe water marks and in special marks needs.⁷⁴

The miscellaneous buoys include the barrel and oil-drum buoys, and the two forms of the German Bake buoy. The Bake buoy was the most important buoy for West German under USB; it is not known if that buoy has retained its significance under IALA (other special buoys of several nations continue to exercise their roles under IALA after necessary message modifications). In many instances the Bake buoy replaces both can and conical buoys.⁷⁵ The buoy has two forms. The first has a conical shape but one that is built up of slats rather than of a solid form.⁷⁶ The second version

is used for the cardinal system, and the slats in this case are bowed or concave rather than flat.⁷⁷ The first version is for lateral usage and is used for both port and starboard sides of channels.⁷⁸ The second edition of IHB indicates that there is increased usage of standard forms of buoys; nonetheless, the Bake continued to find substantial employment in the system.⁷⁹

A rather informal buoy type is that of the barrel buoy. It is not mentioned in USB, IMC, or IALA, but is frequently found in many national buoyage systems. The positions that it occupies are largely peripheral. For example, it marks quarantine moorings and general moorings. But in some instances the barrel is an integral and significant buoy. Sweden is probably the best example of heavy usage of the barrel.⁸⁰ IHB offers a stylized form of the barrel but there are varying sizes and shapes of barrels. The name for it can also vary greatly. In some systems it is a tun buoy or a ton buoy; in at least one nation it is a cask buoy.⁸¹ But despite the different names, various forms of it share a substantial similarity in shape.

At one time the U.S. included an oil-drum buoy in its system. It was used for marking channels in rivers of shallow depth.⁸² It bears some resemblance to a barrel though it is probably of a more cylindrical shape. The previously described ton buoy can be defined as a "large wine-vessel, a cask; hence a measure of capacity used for; now spelt Tun."⁸³ Tun can be seen as a cask or barrel which is now "less common than cask."⁸⁴

14B3 Sound Buoys

Sound buoys constitute the smallest portions of international buoyage systems. IHB does not mention sound buoys, and this may

suggest that they are not a major aid to navigation. And it is true that globally they do not rank very high. But a number of nations operate sound buoys in substantial numbers, and hence these buoys have at least regional importance.⁸⁶ IDAMN lists three types of sound buoys, and one variant form. The Secretary-General of IALA notes an additional type: the electric horn.⁸⁷

The shape of these buoys is not very significant though they follow the color message systems of buoys. They therefore maintain a visual value in addition to the acoustical one. USB and IALA sound buoys maintain the same shapes common to light and unlighted buoys. Other nations make use of special sound buoys which are a cut-down version of a lighted buoy.⁸⁸ West Germany uses the Bake buoy for sound purposes.

The four traditional traditional types of buoy signals are the gong, the whistle, the bell, and the horn. France has a variant of the bell buoy known as a carillon buoy.⁸⁹ This last named buoy refers to a buoy "bearing a group of bells."⁹⁰ A gong buoy, which is found only in the U.S., is "fitted with a group of saucer-shaped bells of different tones."⁹¹ The resulting sound approximates that of chimes. The French carillon and the U.S. gong buoys are quite similar. The U.S. has 3 of the special shaped bells with a clapper for each; the French has 4 saucer-shaped bells with 2 clappers. Each clapper is so designed as to strike two of the bells.⁹² Bell buoys usually have a single bell and presumably several clappers which is the reverse of the carrillon/gong situation.⁹³ Whistle buoys contain a whistle mounted upright on the buoy tank and activated by the motion of the sea; horn buoys are electrically activated.⁹⁴ Bell buoys have tappers or hammers, and these are mounted on the outside of the bell rather than on the inside.⁹⁵ Presumably the number of activators and their location increases the noise-producing ability of the buoy.

The traditional means of activating these buoys has been by the motion of the sea. This has been a problem in that the sea is frequently calm, or nearly so, during foggy weather when the sound signal is most necessary. Hence, the sea-activated forms of buoys are somewhat declining in numbers and there is a corresponding increase in electric-activated versions. The use of consistent power also means that a fixed and unvarying message character is also possible.

Endnotes for 14A

- ¹USCG, Aids to Navigation, 1977, p. 4.
- ²See older editions of USCG Light Lists for illustrations.
- ³⁻⁴CANS, 1975, centerfold sheet.
- ⁵⁻⁷MBS, pp. 57-59.
- ⁸MBS, pp. 39, 72, 74.
- ⁹MBS, p. 72.
- ¹⁰MBS, p. 39.
- ¹¹MBS, pp. 36-37.

Endnotes for 14B1, B2, and B3

- ¹Webster's New International Dictionary, 2nd ed., p. 563.
- ²IALA Buoyage Conference Report, Tokyo, 1980,
- ³IDAMN, 2-6-230.
- ⁴SMB, pp. 7-11; IALA BCR, Annex 3.
- ⁵See above.
- ⁶SMB, pp. 7-11; MBS, p. 2.
- ⁷MBS, p. 16.
- ⁸Oxford English Dictionary, Vol. III, p. 262.

- ⁹Webster's Third New International Dictionary, Vol. II, p. 1551.
- ¹⁰IDAMN, 2-6-230.
- ¹¹MBS, p. 136; USCG, AN, p. 4; see also EN # 9.
- ¹²⁻¹³MBS, pp. 23-4.
- ¹⁴⁻¹⁵MBS, pp. 46-7.
- ¹⁶MBS, p. 31.
- ¹⁷SMB, p. 117.
- ¹⁸OED, Vol. II, pp. 57-58.
- ¹⁹See above.
- ²⁰WTNID, p. 325.
- ²¹IDAMN, 2-6-225.
- ²²SMB, pp. 7-10.
- ²³For example, Mexico and Argentina.
- ²⁴MBS, cp U.S. on p. 79 with European nations such as Spain on p. 68.
- ²⁵SMB, p. 41. Special needs may perhaps be recognized and met, but the basic provisions of this agreement will be presumably followed. The rationale of the new system is to simplify and standardize buoyage systems as far as possible. See Bury article for background of the new system.
- ²⁶SMB, p. 63; see also MBS, p. 33.
- ²⁷IDAMN, 2-6-225.
- ²⁸MBS, p. 19.
- ²⁹CANS, 1975, centerfold.
- ³⁰MBS, pp. 71, 76.
- ³¹See Chapter 13A.
- ³²WTNID, 2nd ed. p. 2410; see also WTNID; see also OED, Vol. X, p. 511.

- ³³ IDAMN, 2-6-235.
- ³⁴ OED, Vol. X, p. 511.
- ³⁵ MBS, pp. 7, 10.
- ³⁶ IALA, BCR, Annex 3, "The IALA MBS."
- ³⁷ MBS, pp. 28-29.
- ³⁸ USCG Manual, 1964, Amendment # 2, p. 8-3.
- ³⁹ USCG Manual, 1964, Chapter 3, p. 8-3; IDAMN 2-6-040, and Figure 49.
- ⁴⁰ Kystdirktoratet/fyravdelingen (Oslo), "Norse Sjømerker - Norwegian Seamarks."
- ⁴¹ CANS, centerfold sheet.
- ⁴² SMB, p. 24.
- ⁴³ MBS, pp. 23, 41, 58.
- ⁴⁴ WTNID, Vol. II, p. 1675.
- ⁴⁵ MBS, p. 52.
- ⁴⁶ SMB, p. 108.
- ⁴⁷ MBS, pp. 41, 43.
- ⁴⁸ MBS, pp. 52, 63.
- ⁴⁹ MBS, p. 41.
- ⁵⁰ IALA Buoyage Conference Report, 1980, Annex 5, "IALA Buoyage System (Region A and Region B) Implementation" indicates that some areas will not be installed before the end of 1987, and possibly it may take longer than that in some areas.
- ⁵¹ SMB, p. 14.
- ⁵² EB, Vol. IV, pp. 806-808.
- ⁵³⁻⁵⁵ IALA, BCR, pp. 4-5, 7.
- ⁵⁶ OED, Vol. VII, p. 90.
- ⁵⁷ OED, Vol. VII, p. 90.

- ⁵⁸ SMB, p. 10.
- ⁵⁹ IHB, 1956, 1971.
- ⁶⁰ SMB, pp. 10-11.
- ⁶¹ SMB, p. 31.
- ⁶² SMB, p. 31.
- ⁶³ See IALA BCR for illustrations.
- ⁶⁴ OED, Vol. X, p. 605; WTNID, Vol. II.
- ⁶⁵ USCG, Light List, Atlantic, Vol. I, 1985, especially the North Atlantic coast.
- ⁶⁶ IDAMN, 2-6-240.
- ⁶⁷ SMB, pp. 10, 15.
- ⁶⁸ MBS, pp. 31, 53, 69.
- ⁶⁹ MBS, p. 69.
- ⁷⁰ Report of the Conference, 1883.
- ⁷¹ IDAMN,
- ⁷² SMB, pp. 7-9.
- ⁷³ SMB, p. 11.
- ⁷⁴ IALA, BCR, p. 6.
- ⁷⁵⁻⁷⁹ SMB, pp. 58-67.
- ⁸⁰ MBS, p. 70.
- ⁸¹ SMB, pp. 32, 104, 145.
- ⁸² Enclosure to J.M. O'Connell letter to author, 19 November, 1974.
- ⁸³⁻⁸⁴ OED, Vol. IX, pp. 124, 464.
- ⁸⁵ IALA Survey, 1984/3, pp. 16-19.
- ⁸⁶ IDAMN, 2-6-180, 2-6-185, 2-6-190; Secretary-General's letter, 30 December, 1977.
- ⁸⁷ SMB, pp. 64-65.

88-89 IDAMN- 2-6-180.

90 IDAMN, 2-6-185.

91 IDAMN, 3-2-310.

92 "Bouee A Carillon FB-12 A;" USCG, Aids to Navigation-Technical Manual, 1979, p. 2-21. The 1964 edition speaks of 3-gong and 4-gong models.

93 Prunieras, 30 December, 1967.

94-95 USCG, 1979, pp. 2-23 and 2-19 respectively.

CHAPTER FIFTEEN

MESSAGE SYSTEMS FOR FLOATING AIDS TO NAVIGATION

It is not enough in this study to simply describe the types of buoys. It is equally necessary to examine the ways in which buoys exhibit their messages of information, of warning, or of guidance. The shape of a buoy while a vital part of the message system is not the total message. The color of the buoy, how the color is arranged, the lettering and the numbers are also significant. The buoy and its messages are also arranged into patterns in relation to geographical features, points of the compass, or other buoys, and these matters are also part of the message system.

The systems of buoys can be as varied and diverse as the sponsoring nations. International conferences have narrowed, at least to some extent, the range of diversity. This conformity is reduced by the many nations that only partially follow the tone set by such conferences; other nations ignore more substantially the international attempts at uniformity. Nonetheless, some degree of order exists. This chapter will follow the provisions of the international systems with necessary notations on qualifications of implementations created by divergencies. The chapter will begin with what was, until relatively recently, the most frequently utilized system; the Uniform System of Buoyage. Coverage of USB includes a review of the abstract provisions, how the system was treated by nations subscribing to it either fully or partly. Chapter 15 includes a similar review of IMC and supporting nations, the new system of IALA, and a summation of provisions of selected buoyage systems.

15A Uniform System of Marine Buoyage¹

USB contains both a lateral system and a cardinal; the lateral being the more frequently adopted system. The starboard side - of side channels - is marked by either conical or spar buoys. Black or black/white checked buoys (for spar buoys the upper half is white and the lower half is black) are the colors and color combinations permitted. Lights, if any, are white and can exhibit either a flashing or an occulting pattern; one or three flashes or occults per period are prescribed. Green lights, if they do not interfere with light characteristics for wrecks, are permitted, as are green/white combinations. Topmarks, if added, are to be black cones or diamonds for conical buoys, and cone-shaped brooms for spars.² Only odd numbers, when numbers are present, are permitted.

The port side of channels require spar and can buoys. Can buoys are painted in red/white checks; spars present red or red/white combination patterns. Numbers, if used, are even. Topmarks for can buoys are red cans or red Ts. Spar topmarks are inverted cone-shaped brooms. Lights are red in color and can have either a flashing or occulting pattern with one of several characteristics. White lights exhibit variant characteristics; white/red combinations follow these same patterns. Yellow checks can be substituted for the white checks in secondary channels for both starboard and port positions.

In middle-ground situations if the main channel is to right (outer end), spherical buoys with red and white horizontal bands are required. Topmarks are to be red can; lights are to be distinctive. Spars are also to display red and white bands, and topmarks are to be a "red can over a red sphere."³ The inner end of the channel calls for the same pattern except for a red T topmark



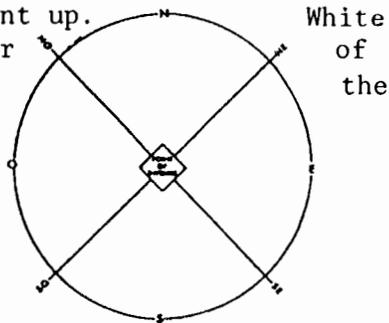
for spherical buoys, and a "red T over a red sphere" for spar buoys.⁴ Main channel to port requires buoys and light characteristics similar to those listed under the instructions for main channel to starboard. Spherical buoys are to exhibit a black cone with the point up for the outer end topmark, and a black diamond at the inner end. Spar buoys contain a verted black cone over black sphere at the outer end and a black diamond over black sphere at the inner end.

"Channels of equal importance" follow the injunction for middle grounds main channel to the right, except for the topmarks.⁵ Spherical buoys have red sphere topmarks for the outer end and red Saint George's Crosses for the inner end. USB specifications for mid-channel markings are very general. The shape of buoys must be easily distinguished and at variance with conical, can or sphere-shaped buoys. Lights are also to be easily distinguished from side of channel markings.

Wreck markings require special colors and other characteristics. If the wreck is "to be passed on the starboard-hand the buoy should be a green conical or spar buoy."⁶ Lettering, if any, should consist of a white W. Topmarks are to be green cones; lights are to have a group flashing combination. If the wreck is "to be passed on the port-hand" the buoys should be a can or spar buoy with letters as previously described.⁷ In this case the light should have a green group flashing indication. The topmark is to be a green can. If either side of the wreck is acceptable for passage, a spherical or spar buoy is standard. Topmarks in that case would be sphere-shaped and a light would be an occulting green indication with a single flash. There are also USB rulings for situations in which the wreck itself can be used as a marking.

The cardinal system of buoyage for USB can be

viewed under three headings: danger markings, simplified cardinal system markings, and wreck markings. Spar buoys can be employed in any or all of the quadrants for danger markings. Each of the quadrants has, in addition, a specific buoy type assigned to it. In the NQ (NW to NE from a point of danger) conical or spar buoys are adopted. These buoys are black with a broad white middle band. Topmarks, if used, are to be a black cone with the point up. lights with an odd number of flashes can be added to



In the SQ (SE to SW) the buoys are either cylindrical or spar. These buoys exhibit a broad white middle band but are otherwise red. Topmarks are to be inverted red. Light periods contain an even number of flashes, and red lights are to be given preference though white lights are permissible. Ogival or spar buoys are found in the EQ (NE to SE). The upper part of these buoys are to be red and the lower half are to be white. Topmarks are red diamonds ("two cones base to base").⁹ Red lights are preferable, though again white is acceptable; the light characteristics call for odd or uneven variations.

The cardinal system requires spindle or spar buoys for the WQ (SW to NW). The upper portions of WQ buoys are painted black, the lower parts white. Topmarks are "two black cones point to point";¹⁰ USB offers a simplified alternative for the previously described cardinal system. This alternative has conical buoys in both the north and east quadrants, while cylindrical buoys are in the south and west quadrants. It is also permissible, according to the standard cardinal system, to have a single buoy type; that buoy is

to be a spar buoy. This option is followed by Finland. In this last variation it is recommended that the dark colors be reversed. This would result in a white buoy with a broad black middle band in the NQ and in the EQ a buoy with a white upper and red lower patterns.

Wreck marking rules complete the cardinal system. These markings are found on in the EQ and WQ. In the EQ ("NE to SE from wreck") buoys are to be conical, ogival or spar and, as with lateral wreck buoys, these are to be green with a white W.¹¹ Topmarks are two green diamonds. Any light on a wreck buoy is to exhibit an interrupted flashing green pattern. WQ buoys are cylindrical, spindle, or spar. Color and letters are to match wreck buoys of the EQ. Topmarks are "two green cones point to point."¹² Green lights are exhibited with a flash rate similar to that of WQ buoys; the light is a regular flash, not an interrupted flash. There are also some buoy message patterns common to both USB systems.

USB also contains a limited range of miscellaneous markings. A principal buoy of this category is the isolated danger buoy. This is a spherical or spar buoy banded with broad black and red bands divided by a slender white band. Topmarks are red or black spheres with black/red horizontal stripes. White or red lights flash a "rhythmic" pattern.¹³ Landfall buoys require no specific shape or topmarks providing they do not give misleading messages that can cause confusion with other buoys. Landfall buoy colors consist of black/white vertical stripes or red/white vertical stripes; any light is to be "rhythmic" in character. Transition buoys follow the optional shape and topmark rules. Colors are to form red/white or black/white spiral band patterns.

Quarantine buoys are yellow in color; outfall

and spoil-ground buoys are yellow (for the upper part) and black (lower part). Any other characteristics employed are not to create confusion with similar banded buoys. Military practice area buoys are optional in shape. The color code is quite the contrary. The buoys are to be "white with two blue stripes intersecting at right angles at the upper extremity of the mark and extending to the water line, thus representing a cross when observed from above, in combination ... with letter indicating in the national language a dangerous area."¹⁴

In retrospect, the USB rules for buoyage are only that; only a minority of nations adopting USB adopted all of the lateral and/or cardinal systems. The attitudes toward the system take several forms. Some nations have adopted the system in its entirety, others made slight changes, while others were influenced by USB only to a limited extent.

According to the International Hydrographic Bureau, Belgium, India, Iran, New Zealand, Portugal, Spain, Turkey, Indonesia and Yugoslavia indicated that they had adopted the lateral system - or simply the USB - in all of its points. France, Poland, the Netherlands, South Africa, the United Kingdom, Australia, and Pakistan made limited changes.

France offers a truncated conical buoy as an option for wrecks. Poland includes a modified conical-based spar buoy for the port-hand position in fairways and channels. Poland has included a standard spar buoy for the port-hand position whole markings, white uppers and red lowers, are contrary to USB norms. Poland has also adopted several special and miscellaneous buoys not found in the standard regulations. Australia has accepted the USB cardinal system but not the entire lateral system; Australia does not list specific buoy types for fairways and channels. Wreck

situations also allow for optional shape buoys.

Pakistan substitutes a solid red landfall buoy for the standard striped model; wreck buoys include a checkered buoy option. South Africa follows the USB in large part except that certain starboard-hand buoys are painted white. The United Kingdom has adopted the USB norms but certain exceptions are to be noted. For example, in Scotland there are exceptions for wreck buoys. These are to be spherical buoys which "may be passed on either side and carries an interrupted quick flashing green light instead of an occulting green light."¹⁵ Interrupted quick flashing lights are also used when a distinctive light is deemed necessary. Normally, topmarks are not found on either lighted or unlighted buoys in Scotland. English and Welsh wreck buoys have WRECK spelled out on the buoys instead of the abbreviation W. Interrupted quick flashing green lights are substituted for occulting lights. Eire and Ulster, which share the Commissioners of Irish Lights aids to navigation agency, follow USB rulings except for wreck buoys, which emulate UK practice.

The Netherlands is in conformity with USB with one exception in color markings. The Netherlands lack a green/red spar buoy for wrecks in which mariners are to pass on the left of the wreck. There are considerably more variations in Dutch buoy shapes. For example, the Netherlands' aids to navigation agency has special variants of spar buoys and expands the usage of the standard spindle buoy into uses where USB calls for notable uniformity. Nevertheless, the color patterns and banding designs of the Netherlands are identical to USB except for the previously mentioned differences.

Two unique buoyage systems are those of Sweden and Finland. Perhaps paradoxically, the

two systems are standard since they comply with USB norms. The Finnish system is exclusively cardinal. There are no lateral marks, unless the "dangers of small extent" buoy can be regarded as lateral.¹⁶ The standard spar buoy is virtually the only buoy in the Finnish system; the use of the spar follows USB guidelines. There are differences in the topmarks of the system from those of USB. The NQ requires a single black cone, with point up, or a single black cone with point up over a black sphere. The WQ allows for two cones, back in color, one verted and one inverted, or the same topmark over a black sphere. A single inverted red cone or a single red cone inverted over a red sphere is the hallmark of the SQ. Finally, the EQ topmark is either two red cones point to point or two red cones point to point over a red sphere.

The Finnish wreck markings are at variance with the USB cardinal system. The Finnish system has a north to south and east to west arrangement instead of a northwest to southeast and northeast to southwest orientation. The topmarks are flags instead of the USB arrangement of cones. All Scandinavian nations substitute flags for regular topmarks in wreck markings.

The Swedish system combines the lateral and the cardinal systems of USB. This system has three primary characteristics: a) the merging of cardinal and lateral into one unit; b) the extensive use of barrel buoys, which are normally peripheral; c) the wide spectrum of topmark options for most buoy positions.

For fairways and channels, red spar or barrel buoys are employed for north and west positions. N and W spar buoys have an inverted cone, an inverted cone/sphere, or two inverted cones for the topmark. S and E locations have black buoys and the exact reverse of topmarks. N and W

barrel buoys have a single inverted cone topmark. S and E have a black/white spar topmark for tons or barrel buoys. The spar buoy for S and E is identical to the topmark color pattern for barrel buoys.

Swedish middle-ground buoys are similar to the USB middle-ground buoy except for a two-sphere topmark option that is available. A ton buoy with a single sphere topmark offers an additional option. The barrel buoy in this situation is banded with a vertical black and red pattern.

The arrangement of danger buoys is complex. The color markings, except for the SQ, follow the USB pattern; the SQ has a solid red motif instead of the red/white pattern. In each case either a spar or a ton buoy can be adopted. The Swedish NQ topmarks are a single verted cone, an inverted cone, and a single sphere over a single verted cone and two spheres. The SQ is the exact opposite. The WQ has either two cones joined together at the base, or two cones joined at the base with the addition of a single sphere, or two cones joined at the base and two spheres. The color is black in all of these cases. The EQ is identical in regard to the spheres; however, the cones are joined at the points and all are red.

Wreck markings resemble those of Finland. In addition, Sweden provides for the marking of the wreck itself. The vessel markings are two lights or balls to the left of the masthead in the SW square and one to the right; the NE square has the reverse position. Bells can be added when wrecks are directly marked. For the NE the bell is struck in "groups of two over ten" every two minutes;¹⁷ the SW position calls for a single ringing in the same pattern. Quarantine buoys are yellow and in a variant can buoy form.

Iceland incorporates the meanings that black and white have for USB, but that is the end of

the resemblance to USB norms. Icelandic buoys for fairways, channels, and middle-grounds are ogival buoys and three variant forms of spar buoys. Wreck and spoil-ground buoys are also ogival; danger and submarine cable buoys are either ogival or a special spar. Red/black bandings and the green of wreck buoys are two additional areas in which USB norms are followed.

Topmark, in Iceland, for port-hand fairways and channel buoys are one, two, or three inverted black cones. Middle ground buoys have one, two, or three red spheres with a black horizontal stripe. Danger area buoys have a single yellow sphere with a black horizontal stripe.

Malaysia has adopted the USB practice in most instances but there are several exceptions. Wreck buoys are green but the light characteristics are of Malaysian design, and outside the lateral system. Light buoys are red; fairway buoys, in some instances, are all white with can or conical daymarks. There are a selected number of other buoys outside the lateral system described in detail in IHB.

Thailand's system partially resembles the USB pattern. Fairway and channel buoys are red and black in accordance with USB. Major buoy types include a light buoy, the standard spar buoy, and an optional choice buoy. The topmark is a square for the starboard side and a black cone for port. Landfall buoys conform to USB. Wreck buoys are green, and they may be a special light buoy, a spherical buoy, or a spar buoy. The topmarks - except for the light buoy - are cone over square. Spoil ground and quarantine buoys conform to USB. Isolated danger buoys are either a light buoy or an undescribed optional choice. This last one is white with a horizontal black band; topmarks are sphere-shaped or a cone over square. Thailand conforms to USB markings for military practice buoys, but the buoy is yellow, not blue. Submarine

buoys are black with a white T.

Italy conforms to color, pattern, and topmarks of USB with few exceptions. However, the buoy types or shapes and their positioning are at variance with the established norms. Italy uses a variant conical buoy, a standard conical buoy, and a spar buoy for all positions in fairways, channels, and middle grounds. In all other positions, lateral and cardinal, only the special conical and the standard conical buoys are employed save for optional choice in quarantine and sewer outfall situations. The same buoys are found in both port and starboard positions; shape is generally not a major factor for these buoys and their messages.

Norway has a modified lateral system and a standard cardinal system. There are only three buoys in use: the Norwegian light buoy and two special spar buoys. Topmarks are limited. Black buoys, lateral or cardinal, have verted black cones; red buoys have inverted red cones. Most buoys are in a solid color, but there are instances in which a buoy with a white horizontal band is offered as an option. Middle-ground buoys are black and red in a horizontally-banded pattern with a matching sphere.

Greece included a modified conical buoy and two light buoys for port-hand positions. These are solid in color. The conical buoy has a cone-shaped topmark. Starboard-hand buoys are the same two light buoy types and a slightly modified can buoy with a square topmark. Middle-ground conical buoys are banded white and red with a diamond topmark for bifurcation purposes, and a white and red banded buoy with two cones point to point for junction topmarks. Dangers in channels are marked by white and red banded spherical buoys for navigation to port and black and white banded spherical buoys for starboard

navigation. Wreck buoys are green conical buoys, and isolated danger buoys are banded in horizontal black and red stripes with red sphere topmarks.

West Germany has what may be the most complex system of buoyage and beaconage of any nation. There is, nonetheless, some influence from the USB in the use of colors for the lateral and the cardinal systems. Approaches to channels include only the German Bake-buoy.¹⁸ For the port-hand the buoy is red, for mid-channel it is black and red vertically striped, and for the starboard it is black. The topmark for port is two cones point to point, for mid-channel it is a modified Cross of Lorraine, and the starboard is an ellipsoid. Lights are white or red for port, red for mid-channel, and white for starboard. A complex of light characteristics accompanies these colors.

The port-hand sides of channels allow for a special spar, a Bake buoy, or a special can. The topmarks include a red can, a T, two spheres point to point or an inverted broom. The starboard permits either a standard cone or a Bake buoy. Letters and numbers are in white for both sides. The port-hand allows for white or red lights, but white only is permitted for the starboard side. Again, various light characteristics are given. Mid-channel buoys are described under "approaches to channels."¹⁹

Additional rules apply to "junctions and bifurcations not caused by middle grounds."²⁰ If the main channel is to the left, the port-hand buoy will be a Bake buoy in black with a red band. The starboard is a solid black buoy. Both have white lights, black cone topmarks and white lettering. If the main channel is to starboard the buoy will be a red buoy with can topmark and white or red light and white lettering. The starboard position is a red buoy with black band and similar lettering, lighting and topmark.

Channels of equal importance have black and red vertically striped buoys with undetermined lighting; lettering is optional. Topmarks are matching spheres.

If the main channel is to right - and if a middle ground - the buoy is red with black band and a red can topmark over a sphere; if the main channel is to left the buoy is black with a red band, and a cone over sphere topmark for bifurcation, and diamond over sphere topmark for junction. A topmark for the junction position is a red T over sphere if channel is to right. Main channel to right has white or red lights, and a junction buoy has only white lights. Lettering is in white for both; numbers, for passage to port only, are in white. For channels of equal importance the buoy is striped vertically in red and black. In this last instance the topmarks are two red spheres with a black vertical stripe; for junctions, a black cross of Saint George over a single black and red vertically striped sphere. Lettering is not required and lighting is undetermined.

The buoy for "shoals and isolated dangers within the channel which may be passed on either hand" is a bake buoy with the upper half red and the lower half black."²¹ A black sphere constitutes the topmark. Lettering is to be white, and the lighting is to be red in an isophere characteristic.

The German cardinal system offers a choice of a concave bake buoy, a special spar buoy, or a standard spar buoy for each quadrant. The name of the shoal is lettered on the buoys, followed by the first letter of the quadrant. NQ and WQ have white lights and a variety of characteristics; EQ and WQ have white lights and a variety of characteristics; EQ and SQ have red or white lights and accompanying characteristics. In the NQ the buoys are black with a white middle band;

in the WQ the upper halves are black and the lower halves. EQ has upper half in red and lower half in white. The SQ have solid red buoys with white bands across the middle. Topmarks are two verted black cones for the NQ, and two black cones point to point for the WQ. The EQ has two red cones base to base, and the SQ has two inverted red cones. Buoys actually on the shoal would be banded in red, white, and black. The topmark would be a black ball. Lighting is in red or white isophases, and the lettering follows the previous injunctions.

For lateral wreck markings, bake buoys or spar buoys can be used for wrecks whether for port passage, either side passage, or starboard passage. For port passage the special spar and special can buoys are also permissable; for either side navigation the spherical buoy is a third option, and for starboard use the standard conical buoy is permitted. The lights are green, and light characteristics permitted include short, long flashing and isophase.

Wreck marking in cardinal buoyage permits one of three buoys: the cardinal bake buoy, the special spar, and the standard spar. Green is the color for all of these buoys. Topmarks are identical with those for shoals and isolated dangers. The lighting varies according to quadrant: group occulting (3) in NQ, interrupted quick flashing in EQ, group occulting (4) in SQ, and quick flashing in WQ. Shoal buoys exhibit fixed green lights. Buoys for roadstead limits are to be black barrel for starboard and red barrel buoys for port. The starboard will have a black cone topmark and the porthand has a red can. The lights are white or red for port, and white for starboard. Each light can have a variety of characteristics.

West Germany has about 15 special buoy patterns. In many instances these utilize barrel buoys. Some special buoy patterns, such as those

of military practice areas, resemble the markings of USB; others are unique to West Germany.

Denmark's buoyage system follows the USB to a considerable extent in color markings but less so in the shape of buoys. Fairways, channels, and middle ground employ two special conical buoys and a special spar. Port-hand buoys are red except for the special spar, which is red on a black base. Topmarks are one, two, or three inverted brooms. Starboard buoys are solid black with one, two, or three brooms. Middle-ground buoys are horizontally banded in black and red, and the topmark is a red ellipsoid.

Danish "mineswept or recommended routes"²² use one of three special conical buoys. The topmark is an ellipsoid that is vertically red with black stripes. These buoys have a white light. Middle-ground buoys have red or white lights, and fairways have red for port and white for starboard. Wreck buoys are of the same types as those found on fairways. These are green except for the base of the spar buoy, which is black. The topmarks are flags, as is the case in all Scandinavian nations. Lights for wreck buoys are green and flashing. Military practices areas are marked with buoys painted in black and yellow bands with yellow ellipsoid topmarks with black bands. Spoil grounds and submarine cables areas employ special conical buoys in solid colors of yellow; submarine cable buoys have green quick flashing lights.

The USSR relies heavily on a few buoys for its system. These are a standard spar buoy, and a light buoy similar to that of Thailand; an undescribed option buoy is listed for nearly all positions. Fairways and channels buoys are red for port and black for starboard. On bend sections of fairways and channels there is a white band across the buoy. Port positions have inverted black cones, while the starboard has verted black

cones. A variety of light characteristics are available.

Middle-ground buoys of the spar type are horizontally banded black and red with sphere topmark that is black for upper part and white for the lower part. Light buoys are vertically banded in red and black as are other shape buoys. Lights are white and flashing. Mid-channel buoys are banded black and white horizontally for straight sections, and red and white for bend sections. The spar topmark is black for the former and red for the latter. Lights are white for straight sections and red for bends. Wreck buoys have the same shape and topmark but are solid green in color. The light is also green.

Cardinal buoys are all white in the NQ with white flashing lights and black cone topmarks. In the EQ they are vertically striped red and white except for the spar, which is white (upper portion) and red (lower part) with a two-cone point to point topmark. The light is red and flashing. WQ buoys are striped black and white with spars painted in an upper black and lower white pattern. The topmarks are black and exhibit base to base cones. The WQ light is white. The SQ buoys are completely red with red flashing lights and inverted red cones. Fishing zones are the same except for using only spar buoys and for different lights patterns. The NQ has a fixed white light, the EQ has two fixed red lights, SQ has one red light, and WQ has two fixed white lights.

Submarine cable areas have banded spar or striped buoys in black and orange. The spar has a flag-shaped topmark and the light is orange in an isophase pattern. Anchorage areas include the standard buoys, a barrel buoy, and a special can buoy; the optional-choice buoy is also available. These are, except for the spar, which is banded, all striped in red and orange. Lights are orange

and flashing. The spar topmark is flag-shaped with diagonal swatches of orange and red. Quarantine areas include the above buoys except for the barrel buoy. Quarantine buoys are solid orange with an orange flashing light.

15B International Marine Conference Influenced Buoyage Systems

There are no current publications outlining a complete IMC buoyage system. But there are a number of nations that follow, at least to some degree, the practices of IMC, or at least are influenced by it.²³ The most striking differences between USB and IMC are the meanings given to black (and later green) and red. USB regarded black as the starboard day color of channels, while IMC perceives red as the starboard-hand color. And, of course, port-hand colors had reverse meanings. Green accompanies black in both USB and IMC but with opposite meanings. Red lights and markings mirror this phenomenon of opposite meanings. Most nations in the Western Hemisphere follow in some manner or other the IMC provisions of 1889. Most other maritime nations follow the lead of USB, though there are exceptions, especially in East Asia.

Argentina states, in the 1956 edition of IHB that its system is in conformity with IMC. Argentine fairways and channels have black port-hand buoys that are can buoys with flashing lights in white; starboard buoys are red conicals with red flashing lights. Can buoys can be augmented or replaced by a "buoy surmounted by a cylindrical shape."²⁴ Conical buoys can be replaced by "a truncated cone buoy with a sharp point or a buoy surmounted by a conical shape."²⁵ There are no topmarks for these buoys.

Middle-ground buoys are of optional-choice

shape and banded black and white. Bifurcation buoys have a black sphere topmark; junction buoys have a half-sphere in black. Mid-channel buoys have a vertically striped motif with "a black cage in the form of an inverted/truncated cone or pyramid" topmark - if there is a topmark.²⁶ Middle-ground buoys are optional-choice buoys with white and red horizontal bands. The topmark is a black sphere. Wreck buoys are green with lights in the same color. Wrecks, in some instances, have an inscription. A ship marking would be painted green with two balls on the left mast and one on the right; three green lights can serve as a substitute. WRECK is painted on the ship in white.

Buoyage does exist in Costa Rica and Peru, but there are no standard rules or systems governing the buoyage in those jurisdictions - at least as listed in the 1971 edition of IHB.

Guatemala has black can buoys with odd numbers on the port-hand side of channels with fixed green lights. The starboard side has red can buoys with even numbers and fixed red lights. There is no further buoyage in Guatemala according to IHB 1971.

Ecuador has black can buoys with odd numbers and green or white lights of varying characteristics on the port side. Starboard buoys are conical or can, and red in color. Red lights and even numbers complete the starboard messages. Middle-ground buoys are can - if the principal channel is to right - with horizontal black and white bands. Lights are green or white and exhibit a group flashing characteristic. If the main channel is to left the conical or can buoys are banded with horizontal red and white colors. Lights are group flashing and red. Landfall and mid-channel buoys are can or conical. These buoys exhibit vertical black and white bands with green group occulting lights.

Miscellaneous buoys are optional shape in all



cases. Mooring and related purpose buoys are yellow with a blue isophase light. Fishing zone buoys are white; leading mark buoys are painted in black and white checks and have a white isophase light. Special purpose buoys are banded in yellow and white. They have isophase lights.

The Chilean buoyage system consists of black and white banded can buoys for the port-hand of fairways and conical buoys of white and red banding for the starboard-hand. Lettering and numbering in both cases are in white. Mid-channel buoys are spherical and banded in vertical white and black stripes. Wreck buoys are conical or spherical in green with a white horizontal band. WRECK is painted on the white band. Yellow barrel buoys mark quarantine areas and red barrels indicate mooring buoys for explosives.

Cuban fairway buoys are cans and spars for port, and conical and spars for starboard. A black topmark in spherical shape is attached to port buoys. Lights are white or green, numbers are odd. A white or red cone topmark (point up) is found with starboard buoys. Lights are white or red and numbers are even. Middle-ground buoys are of the same patterns; all are horizontally banded in red and black. Lights are white and group flashing for both port and starboard. Mid-channel buoys are of optional shape and are vertically banded in black and white. Lights follow the middle-ground pattern.

Japan and South Korea have identical buoyage systems (IHB 1971). All buoys are conical. Black is used for port and red for starboard. Numbers follow the IMC patterns in fairways. Middle-ground bifurcation buoys are banded in horizontal black and white stripes. Junction buoys are solid red or in bands of white and red. Topmarks for port fairways are in the shape of black cans and red cones for starboard. Bifurcation topmarks are

diamond-shaped and junction topmarks are two cones point to point in black. Mid-channel buoys are conical with black and white stripes and a white can topmark. Isolated danger buoys are conical with black and red bands and a red sphere topmark. Wreck buoys are green conicals with WRECK written in English and Japanese or Korean.

The Brazilian buoyage system has only one type of buoy, the conical. Port-hand buoys on fairways are black with even numbers and white flashing lights. Starboard buoys are conical and red with odd numbers. Lights are red and either flashing or occulting. Middle-ground buoys for bifurcation are banded with white and black markings. Lights are white and group flashing or group occulting. Junction buoys are red and white banded with red group flashing or group occulting lights. Mid-channel buoys are vertically striped in white and black with the same light characteristics as bifurcation buoys. Isolated danger buoys are horizontally banded in black and red with junction buoy light characteristics. Submarine cables and pipelines are marked by white buoys with flashing or occulting lights. Wreck buoys have green coloring with green flashing or occulting lights.

Mexico has the familiar pattern of black port can buoys and red conical starboard buoys. Black buoys have odd numbers and green or white flashing or occulting lights. Red buoys have even numbers and red or white flashing or occulting lights. Middle grounds have can buoys with red and horizontal bands - if the channel is to starboard - and green or white interrupted quick flashing lights; if to port, a conical buoy with the same markings and red or white interrupted quick flashing lights.

Mid-channel buoys are conical with white and black stripes. The light characteristics are of the Morse Code A design. All special buoys are

are of optional shape. These include special purpose buoys, which are horizontally banded in white and yellow with light patterns that do not create confusion with other buoys. Landfall buoys are black and yellow vertically striped and white with the same injunctions on lighting. Both of these buoys may be lettered. Quarantine buoys are solid yellow in color; anchorage buoys are solid white. Fish-net buoys are white and black in horizontal bands. Dredging buoys are painted in green - for the upper portion - and white for the lower part. The restrictions on lighting that pertain to special purpose buoys pertain to all of these buoys.

Port buoys in the Congo are black "with a fluorescent white cylindrical topmark numbered in green,"²⁷ and the light is either white or green, with an occulting pattern. Starboard buoys are red with a fluorescent red topmark in the form of a triangle with red numbers. Starboard lights are red and occulting.

The Canadian buoyage system is only partially covered by IHB. A pamphlet, The Canadian Aids to Navigation System, supplies further details.²⁸ Fairways, channels, and middle grounds adopt one of three buoys: can, light, or spar. Port spars are flat topped, while the starboard counterpart is pointed. Port fairway buoys have green reflectors or green lights. The lights exhibit flashing or quick flashing characteristics. Starboard buoys have red reflectors and red lights with the same basic characteristics. Middle-ground buoys are banded horizontally with the top band of port buoys in black and of starboard buoys in red. Reflectors and lights follow standard patterns. Light characteristics are interrupted quick flashing for both sides.

Mid-channel light buoys are marked in vertical white and black stripes. Can and conical buoys

are striped in white and black as well. Reflectors are white and the lights are green with interrupted quick flashing for downstream direction and red in the same pattern for upstream movement. Special purpose buoys are outside the lateral system and have no specific shape. Letters may be present on these buoys but not numbers. Special purpose buoys include white for anchorage, orange for cautionary, and vertically striped yellow and orange buoys for scientific work.

In the U.S. black buoys indicate the port or left side of channels or wrecks; red marks the starboard-hand side.²⁹ Junction and bifurcation are marked by the buoys with red and black horizontal bands; the channel of preference is indicated by the color of the top band. Vertically striped buoys of black and white mark mid-channel or fairway buoys, and the mariner is advised strongly to navigate close to either side of the buoy. Conical-shaped buoys, known as nun buoys, are starboard and red; cylindrical buoys are termed can buoys. Fairway and mid-channel buoys are either can or nun. Shape does not pertain to light and sound buoys. The color and other characteristics will indicate the channel to be followed for those buoys. Buoys of one color are always numbered: Red buoys have even numbers, black buoys have odd numbers. The buoy at the seaward end of a channel has the smallest number. Buoys which are not red, or are multi-colored with black, do not have members. Red buoys have red lights, while black (in pre-IALA terms) buoys have green lights. White lights can be used on buoys of any color.

Red and black buoys exhibit flashing or occulting lights, though fixed patterns are allowed. These buoys usually display a slow flashing pattern, though special situations

allow for a quick flashing characteristic. Buoys that are banded black and red have interrupted quick flashing messages. Vertical striped buoys - in black and white - give forth a Morse Code A message in white. Some buoys - as well as some fixed aids - exhibit reflectors. Reflector messages duplicate lighted messages. Reflectors may be reflective material rather than a reflector in the strict sense.

15C IALA Buoyage System

Provisions of IALA require, whenever possible, can buoys for port-hand and conical buoys for starboard-hand positions for lateral markings.¹ If pillar or spar buoys are used as substitutes, an appropriately shaped topmark is added to the substitute buoy; the topmarks are can-shaped for port, and cone-shaped for starboard.² If a light is added to buoys in lateral service it will be red for port, and green for starboard; the light phase characteristics, or rhythm, can be of any type.³ Black buoys can be substituted for green buoys where it is deemed necessary, but this substitution is not to be widely employed.⁴ Since green/red lights have a limited range, a buoy agency may employ a cardinal buoy - which exhibits white lights of greater range - in such locations as a turning point in a lateral channel.⁵

Buoys in the cardinal part of the system mark the four quadrants (north, west, south, and east).⁶ The quadrants are divided by north-east to south-west and north-west to south-east lines of bearing. If, for example, a cardinal buoy is in the north position then the mariner should pass to the north of it. Cardinal buoys indicate the deepest water for the area of the buoy by their position and markings, if the buoy marks a danger, it indicates the safe side on which to pass. Cardinal buoys also indicate junctions, bifurcations, shoal

perimeters, and channel turnings; many of these functions were formerly allocated to the lateral system. A specific shape is not mandatory for cardinal buoys, but usually they are pillars or spars.

The buoys in a cardinal position follow a distinctive yet complementing pattern that is easy to follow and remember:⁷

North and South buoys -- N upper structure is painted black while the lower part is in yellow; S pattern is the reverse. Topmarks have black cones (point up) for N and inverted black cones for S. When lighted the N buoy has a white light in very quick flashing pattern (VQkF1) or quick flashing arrangement (QkF1). S has a VQkF1 supplemented by a long flash every ten seconds and a QkF1 with a long flash every 15 seconds.

West and East buoys -- E buoy is in black with a single yellow band (horizontal); the W buoy is the opposite. Topmarks for the E buoy contains two black cones base to base while the W has the same topmark but point to point. The E buoy has a VQkF1 characteristic every five seconds or QkF1 every ten seconds; for the W buoy it is every 10 seconds in a VQkF1 pattern or QkF1 every 15 seconds.

No other buoys in the system employ OkF1 or VQkF1 characteristic and white lights.⁸ Therefore the simple existence of such a pattern indicates a cardinal buoy without further investigation by the mariner through time ascertainment. VQkF1 flashing is at a rate of either 120 or 100 flashes per minute; QkF1 is either 60 or 50 flashes per minute. Long flashes are at least two seconds. The characteristics have been so arranged that they are easily memorized: the E buoy three per period, the S six times, and the W buoy nine times; the N buoy flashes but a single time.

This creates, if a clock face is kept in mind, a three-six-nine pattern of flashes whether QkF1 or simply QkF1. The added long flash is added to prevent confusion over counting six or nine rapid flashes from a buoy.

Isolated danger is defined as "a mark erected on, or moored on or above, an isolated danger which has navigable water all around it."⁹ This buoy is either a pillar or a spar. The marks are black with broad bands in red in a horizontal arrangement. Topmarks are two black spheres arranged vertically. If lighted, the color will be white and emitting a group flashing motif of two groups of flashes per period. According to IALA, the message systems of marks "serve to associate isolated dangers marks close to cardinal marks."¹⁰ Safe water marks exhibit the reverse indications of isolated danger marks; they indicate safe water all around the marking. The desired shape for these buoys is spherical though a pillar or spar buoy can be substituted. The day markings are red and white vertical stripes. Pillar and spars in this instance include a single red sphere topmark. The light is white with a choice of iso-phase, occulting or long flash (one per 10 seconds) patterns. They can serve for center lines and mid-channels. They can also substitute for cardinal or lateral markings to "indicate a landfall."¹¹

Special marks are "not primarily intended to assist navigation but ... indicate a special area or feature."¹² In a variety of instances they serve to maintain a keep out or keep away function. Primary areas of use include ODAS marks, Traffic Separation Zones, spoil grounds, military activities areas, cables and pipelines, and recreation zones. They are always yellow. Their shape is of optional design and may include can, spherical, conical, pillar, or spar buoys. Any topmark would be a yellow X. Lights of yellow hue are permitted and can follow any rhythm that

is not used by cardinal, isolated danger, and safe water marks.

New danger marks includes those not listed in nautical publications to date.¹³ They would include a recent ship wreck or newly found underwater obstacles. If lighted they exhibit "an appropriate cardinal or lateral VQkFl or QkFl light character."¹⁴ If a duplicate mark is installed it will be identical to the first. A racon with the code letter D may be added to the mark. A new danger mark may be a cardinal mark in no way different from established cardinal marks except for not being listed in nautical publications due to the freshness of the installation.

Even though some comments comparing IALA with past buoyage efforts have been made, there is value in directly comparing IALA with USB and with IMC. The comparison with IMC contains a prologue to the comparison as well as the comparison. The prologue comprises a review of two major systems that constitute a working out of IMC principles: the buoyage and beaconage of Canada and of the U.S. A brief summary of the view of J.E. Bury earlier in this chapter also affords a comparative view of this topic.

In USB there were eight standard topmarks and combinations in the official system; this does not include variant forms by the nations subscribing to USB.¹⁵ The new system has just four types and combinations of topmarks.¹⁶ Seemingly, widespread variations are not found in IALA.¹⁷ Ogival and spindle buoys have been eliminated from IALA.¹⁸ They may possibly have some optional value but specific inclusion of them is absent.¹⁹ Pillar buoys, which were unnamed and secondary in USB, are now primary.²⁰ Cardinal and lateral systems now form a single buoyage network (though a system may center on

lateral and make little use of cardinal markings).²¹ Black, which was one of the two primary colors for non-light functions in USB, is relegated to a substitute role; green now becomes a basic color - along with red - for both day and night use.²² Wreck markings no longer form a special category; they are subject to regular danger markings: isolated dangers and new dangers.²³ Fixed beacons become a definite and integral part of IALA; they are not a peripheral marking.²⁴ Middle-ground and mid-channel subdivisions of USB are not found in IALA; however, lateral and cardinal messages are available to fulfill the functions formerly carried out by those types of buoys.²⁵ The wide spectrum of lighted messages with accompanying imprecise characteristics has been replaced by a much more coherent and precise system. The isolated danger buoy which existed in USB as a minor category develops a major role in IALA.²⁶ The use of white buoys is now restricted to recreational boating and bathing zones.²⁷

The principles of IMC can be reduced to a few general norms. Those principles are sufficiently broad that a host of national systems could be adduced from them. Essentially, IMC called for red to starboard and black to port; this practice was established before the widespread usage of port and harbor lights, and before lighted buoys were common.²⁸ Buoy shapes - when required - used cylindrical buoys for starboard and can for port; topmarks, if any, were cone-shaped for starboard, and cylinder-shaped for port.²⁹ Numbers and letters were optional.³⁰ Wrecks were marked with green buoys with white inscriptions.³¹ Both Canada and the U.S. conform to the guidelines of IMC rather closely. Port-hand buoys for the U.S. include can for unlighted, and a specially designed buoy for light positions; Canada follows a similar

pattern except that it has retained the spar buoy.³² For starboard positions, Canada includes the lighted buoy, conical buoys and spar with pointed top; the U.S. uses a nun buoy and the light buoy but no spars as a regular and standard buoy.³³

For light colors, Canada applies green exclusively for port and red for starboard; the U.S. exhibits green or white on port and red or white on starboard.³⁴ Canada is more specific in the spectrum of light phase characteristics and allows for color options on each side.³⁵ White may have been retained for lateral usage in the U.S. because of its greater range. Mid-channel buoys are near-identical for both countries; the only appreciable difference is in the exact message of the Morse Code character.³⁶ Junction buoy message symbols are also close in appearance for the two nations; one exception in this component is the red-only meaning and green-only regulations in Canada, and the color option in the U.S.³⁷ The U.S. system can, in crowded waters, establish specific message characteristics so as to eliminate confusion in light messages. Neither nation employed green buoys on a regular basis before IALA. Both have established standards for day-beacons and daymarks, and these correspond to buoyage requirements for messages.³⁸

The long-standing and deeply-rooted difference on whether red is to starboard or to port will in all likelihood continue and never be resolved. IALA recognizes and clarifies that distinction on placement of color in a manner more rational and - more or less - agreeable or tolerable by all parties. But IALA has not eliminated the problem. IALA elevates the cardinal buoyage concept to a higher and more equal footing with the lateral. IMC included a cardinal system as well, but it was based on existing European practices and was unknown in the Western Hemisphere.³⁹ This

historic difference may continue but at a reduced level since cardinal buoys come into play in many nations at least for specific usage.

Topmarks, though provided in IMC, have been rare in the Western Hemisphere. They may be more common in the future in the Eastern Hemisphere than in the Western, but an increase of topmarks is coming about in many nations under IALA.⁴⁰ Topmarks have become rational and easier to understand than in the past when individual systems and a complex official systems were both in operation.⁴¹ IALA does not address the large system of daymarks found in some IMC nations, but that practice grew up independently of IMC as well.⁴²

A striking resonance between IMC-derived systems and that of IALA is simplicity. The official and not so official options and alternatives of USB are being phased out, and a system more easily comprehended has resulted. The North American systems have long exhibited a basic simplicity, and they are now joined - and strengthened - by the work of IALA.

Endnotes for 15A and 15B

¹All of the materials in this section are from publications of the International Hydrographic Bureau: Systems of Maritime Buoyage and Beaconage (SP # 38), 1st ed., 1956, and the 2nd ed. of the same publication, though under an altered title, Maritime Buoyage, 1971. (Except where otherwise noted.)

²"One or more relatively small objects of characteristic shape or colour (or both), placed on top of a navigation mark (or buoy) to identify it" (IDAMN, 2-6-255).

³Systems of Maritime Buoyage, p. 8.

- ⁴SMB, p. 8.
- ⁵⁻⁷SMB, p. 9.
- ⁸Adapted from SMB, p. 15.
- ⁹SMB, p. 10.
- ¹⁰SMB, p.
- ¹¹SMB, p.
- ¹²SMB, p. 10.
- ¹³"A light showing intermittently with a regular periodicity" (IDAMN, 2-5-105).
- ¹⁴SMB, p. 11.
- ¹⁵Maritime Buoyage, p. 78.
- ¹⁶MB, p. 28.
- ¹⁷MB, p. 71.
- ¹⁸Translated as Beacon Buoy in IHB.
- ¹⁹MB, p. 33.
- ²⁰MB, p. 34.
- ²¹MB, p. 35.
- ²²MB, p. 23.
- ²³As described in IHB publications (SMB, MB), CANS, USCG Light Lists; see also Proceedings, Volume III, pp. 331-376 of IMC.
- ²⁴MB, p. 11.
- ²⁵⁻²⁷MB, p. 11.
- ²⁸Ministry of Transport, Aids and Waterways Directorate, Ottawa, 1975.
- ²⁹⁻³⁰USCG, Light List, Pacific, Vol. III, 1979. pp. xi-xii.

Endnotes for 15C

- ¹IALA Supplement #6, p. 4.
- ²⁻⁵IALA Supplement #6, pp. 4, 6-7.
- ⁶IALA Supplement #6, pp. 4-5, 7.
- ⁷IALA Supplement #6, pp. 5 and 7 for entire paragraphs.
- ⁸IALA Supplement #6, pp. 5 and 7. According to Bury, p. 142, propane-fueled lights can not flash more than 90 flashes per minute though the flash rates are given as 120 or 100 flashes per minute (VQkF1).
- ⁹⁻¹⁰IALA Supplement #6, p. 6 and remainder of paragraph.
- ¹¹⁻¹²IALA Supplement #6, pp. 5 and 6 and remainder of paragraph.
- ¹³⁻¹⁴IALA Supplement #6, p. 7.
- ¹⁵IHB, SMB, 1st. ed., 1956.
- ¹⁶IALA Supplement #6, pp. 4-6.
- ¹⁷See above, p. 7; at least a strong implication is found here and in the underlying philosophy of IALA buoyage system which is to greatly simplify the buoyage systems in use.
- ¹⁸No reference to them in the existing literature.
- ¹⁹Some options are available in the IALA buoyage system but they are limited.
- ²⁰A buoy unnamed but listed as a possible option in IHB publications is identified in the IALA system as a pillar buoy. It and the spar are listed more frequently than any other buoys. The pillar buoy would seem to have an edge over the spar due to its greater visibility. DMA, extracting from British hydrographic literature, describes the buoy as being one of several shapes.

²¹Garrett, p. 8.

²²See Supplement # 6, especially p. 7; North American systems continued to include black as a primary color along with red until the implementation of IALA.

²³Bury, p. 139.

²⁴IALA Supplement #6, p. 1 and "fold-out."

²⁵Bury, p. 141, and IALA Supplement #6, p. 7.

²⁶IALA Supplement #6, pp. 6-7.

²⁷IHB, SMB, 1st ed., pp. 11, 16.

²⁸See Appendix II.

²⁹⁻³¹See above.

³²⁻³⁸CANS, centerfold; USCG AN, p. 13.

³⁹IMC, Vol. III, pp. 333-335.

⁴⁰For example, U.S. isolated danger buoys

⁴¹See provisions in IALA Supplement #6.

⁴²For example, in Norway.

PART D

CHAPTER SIXTEEN

INTRODUCTION TO VISUAL MARKINGS

16A The Problem of Methodology,
With Analogic Discursive

This study of transportation markings is intended to be world wide in scope and integrative in method. While this monograph could have been global without an integrative basis, its value would have been considerably reduced if it had been nothing more than a nation-by-nation survey of markings. The method employed in this study has proved workable in many instances since marine markings share many points of commonality, in spite of visible national and regional differences. The integrative method of the work has not meant that divergent systems and markings have been forced into a procrustean vise that suppresses and grinds down local uniqueness for the sake of the over arching system. This system has proved to be sufficiently flexible and open that variations can be included without losing or obscuring the international and integrative foundations.

The hopes of the writer have therefore been realized for many of the topics in the study; the treatment of buoys, electronic and acoustical signals has, it is hoped, portrayed the internationally shared character of marine markings. But upon turning to fixed visual markings, and especially unlighted markings, it soon became apparent that these markings were a province apart from previously studied areas and defied an over arching approach to markings. Fixed visual markings mocked, as it were, the writer's effort to precisely create a system of markings and methodology that could encompass all types of marine

markings through a single, simple approach; if the methodological approach were followed inflexibly, then those markings would be slighted that were of limited numerical significance. The intention of the study has not been to simultaneously ignore or gloss over the richness of variety found in isolated and localized markings.

The principal problem with fixed visual markings - in the context of this study - stemmed from the fact that a small number of nations dominated various areas of such markings. This fact in itself does not affect the character of the study and the methods selected to carry out the research; for example, a nation could dominate a component of markings without that marking losing its universality. Conical buoys are found in nearly every maritime nation; even if one nation owned half of the world's fleet of conical buoys that would not, in itself, eliminate the global nature of such buoys.

The difficulty arises with those aids to navigation which are distinctly local, or at most regional.¹ It seems to this writer that a serious comprehensive study can not ignore a significant number of markings even if these are found in only one nation; otherwise the monograph cannot honestly be called complete. A method needs to be found wherein this area of special markings can be included in a study that primarily centers on markings that can be formed into an integrative whole and which originally did not consider the problem and challenge of local and regional forms of markings. Perhaps the problem of method and a possible solution can be better seen and understood if one examines an area that is more familiar to many readers than transportation markings but illustrates a similar problem of methodology. One such area would be coastal recreational housing. Not only may such an examination provide a more familiar and common example, but the methodological implications can then be applied to the less familiar

study of transportation markings: The lesson from the familiar reflects upon and illuminates the less common.

If researchers were to undertake a study of the architecture of vacation housing along world coasts, they might assume that such housing is dominated by vast and sleek developments of resort hotels and condominiums. The research beginning with this premise might then build up an appropriate methodology; the methodological principle would perhaps center on the international and interrelated nature of such housing. And to some degree this contention would be workable. Condominiums and resort hotels are growing in numbers and spreading to more and more areas. This type of housing may include a limited number of architecturally significant edifices, but many other such structures are not significant. These lesser structures are in all likelihood frequently boxlike in visual outline, containing nearly identical rooms and suites, and of such blandness as is likely to create a response of yawn-permeated indifference: rooms and lounges and pools and bars set out in neat, geometric patterns of mediocrity numbing soul and spirit; a few spasms of creative design barely marring the symmetrical and numbing sameness.

It would not be terribly difficult for a research of beach housing to easily describe this form of habitation as it spreads its enveloping tentacles over sand and surf. But the research, if it was of a serious and comprehensive character, would soon encounter a problem both with the matter under study and with the research method. Not all coastal housing is of the form herein described. Whether the resort settlements are of bland or of significant design, they do not represent all of the housing along ocean and bay front. There is a second kind of housing; and this second level, though declining in numbers,

is still significant even if it is only local or regional. This form of lodging consists of the traditional cottages, bungalows and cabins. Any study purporting to be a comprehensive and international examination of housing must include the form that can be easily described in broad brush strokes and it must also study that type which must be given individual care and precise examination.

Vast blocks of resort housing can be dismissed in a few general comments, and this same treatment can be applied to similar housing in country after country. But when one considers the traditional and individual cottages and cabins it becomes apparent that the description required for a small measure of housing is far more than what is needed to describe the masses of resort lodgings. Even a brief glance at the traditional forms reveals a wide spectrum of differences.

Traditional coast dwellings do not have an assembly-line appearance; they are notably individualist. Older beach dwellings include shacks, cabins, houses, shanties, and bungalows of uncertain vintage and of yet more doubtful architectural inspiration. These habitations have little in common save for a certain stained, bleached, and battered character; providing they have stood and swayed and held back enough storms long enough. Some, as if occupied by old mariners, appear neat and tidy, with every shingle in place, every bit of trim freshly painted, every flower bed mathematically laid out; as if bearing a landlocked resonance to a long-departed sailing schooner newly holystoned. But other seaside housing bears a distinctly contradictory look. Some of this vintage simply and amply testifies to years and decades of neglect; shingles askew, weed-enveloped foundation stones, the very structure leaning away from the battering winds and salt-permeated air. Yet others, of more recent construction, stare

bravely with unsullied eye, or uncomprehendingly, at the deceptively bland sea waiting the first onslaughts. But this montage of habitations, whether holystoned or battered, produces a most untidy and singular appearance. No unvarying lines of boxlike buildings, or of uniform furnishing, or of monotony are found. Instead, a rich and riotous assemblage approximating that of humankind itself is heaped up upon oceanfront and bayside.

So far, there would be two major differences at work in such a study: There are more condominiums than cabins, but the smaller number of cabins needs more attention in description than the more numerous resorts. These two points affect whatever method of study is finally developed; however, there is a third point which is as important for this study of architecture. Even though the bland near-standardization is increasingly an ubiquitous band of odds and ends represents more than an anachronistic vignette of local color.² They require attention in a study that claims to be worldwide in scope. Therefore a dual method, or better, a method within a method, must be designed and constructed. Special cases need a place as much as trend-setting forms. Of course, every single cabin existing in isolation and solitary splendor could not be included, but all significant local and regional forms can and should be included.

16B The Problem of Methodology: Towards A Solution

This analogic discursive returns to the scope of the monograph. This study, despite any original and avowed aim of concentrating on the exclusively international and integrative forms of markings, can not ignore isolated and regional types of markings any more than the hypothetical study of recreational housing can ignore the out-of-the-way cabin and bungalow. This presupposes

that these specialized markings are of significance in at least one maritime nation. The book's method must then be altered sufficiently so that the international, integrative, and overarching features can be maintained while attending to special considerations dictated by the limited-location markings. Global and local markings both belong to this study. The parallel with architecture is not intended to suggest that this writer views many of the common markings as being akin to the blight found along developed coastlines. Markings, even when produced in great numbers of similar design, can retain an interest for the viewer and, in some cases, a certain charm undimmed by their profusion. Markings rarely project the bland, blighted and becalmed image of poorly designed dwellings. Perhaps any mass-produced object can be pleasing to the eye if marked by simplicity and functional form, well designed and carefully crafted.

What are some of the major practical results of an alteration in methods that can be drawn at this point?

1. It will be necessary to speak in more general terms and to reduce to some extent the level of precision possible in a more unitary study.

2. The monograph can not represent a tight, uniform "package" of international markings. Instead a messy and untidy aura may be observed about the work. The end result of such a study may well combine segments of distinctly symmetrical precision with other segments that resemble the flotsam and jetsam left by a receding tide. The final result may be akin to glossy and glittering resorts up against tumble-down cottages and cabins.

3. The work, with its uneven and uncertain form and structure, may yet be seen as a resonance to the human society from which it springs and and which can be jumbled, confused and nearly indecipherable in itself. It is hoped the work

will not be altogether indecipherable but will emit some measure of clarity, simplicity, and rational order.

4. The monograph with its multi-lineal methodological framework is universal and comprehensive. It includes both what is common globally and what is common only locally.

5. The seemingly undue emphasis on North America, Western Europe, and Scandinavia is not caused so much by cultural factors - at least by intent - but rather by the predominance of so many specialized markings in those areas. Those same areas contain many of the major sea lanes and merchant fleets, and both lanes and ships are often congested.

What are the nations and the types of markings that notably stand outside the major thrust of marine markings? They include the U.S. for minor lights; the German Federal Republic and Canada for non-structural daybeacons (perches, poles and small trees); Finland for edgemarks; Norway and the U.S. for structural beacons (France, Canada, Finland and the Netherlands also have substantial quantities of beacons).

Endnotes for 16

¹It is possible that the IALA buoyage system will eliminate some, or much, of the diversity. But the literature of the sea and of markings indicates the continuation of much of the present variety in fixed beacons. The new systems give color and light characteristics for fixed beacons but few details in the dimensions of shape because of great disparity found in fixed sea markings. For example, Norway, a member of and participant in IALA, continues its very extensive system of unlighted beacons with few if any changes; this will probably prove true of other nations as

well. In summary, sea marks may never exhibit a single and narrow range of designs.

²This is not meant to suggest that no new traditional housing is to be found along coastlines. See for example, "Small Pleasures" in Architectural Record (Mid-April, 1986, pp. 90-97) which describes the Rosewalk Cottages in Seaside, Florida.

CHAPTER SEVENTEEN
FIXED LIGHTED MARKINGS

17A Determining the Division of Fixed Lighted
Marine Transportation Markings
Into Major and Minor Categories

It is a common practice to divide fixed lights into major and minor divisions. This is true of IALA and various national maritime agencies. While the meaning of "major" and of "minor" may be understood in practice (people know a major light when they see one, or a minor light when they see one), there is considerable difficulty in stating with precision the distinction between them.

For the IALA survey, minor lights are those with a candlepower intensity of under 100, and major lights are all above 100cp.¹ This criterion does not include structures or locations. But the the IALA buoyage system has much more extensive criteria. That system includes all marine markings except lighthouses, lightships, large navigational buoys, and the special categories of sector lights and leading lights/daymarkings.² While it does not employ the terms major and minor, those aforementioned types would be considered as major aids (except for leading lights and daymarks).³ These criteria include locational and structural factors, and combining them with the division proposed by the survey it provides a substantial criterion for determining the classification of various aids to navigation.

Is it possible to be more complete about what constitutes a major aid and a minor aid? If a marking in question is a lighthouse then some degree of precision is possible. IDAMN describes

a lighthouse simply as major, but that proves to be circular and has little value.⁴ Traditionally lighthouses have been imposing structures, usually a tower on an island, rock or headland. More important, a lighthouse has a powerful light which can be seen perhaps 20 or more miles away.⁵ Usually the location is on - or off - a coastline and not inland. One can further say that a light of the major category perhaps represents a major geographical feature and not a narrow, restricted object or channel. Some nations, including Canada and the U.S., designate major lights by type style in light list publications.⁶ These lights are nearly always coastal, though some of a reduced variety may be in major harbors and bays.⁷

Lightships have traditionally been floating lighthouse, where fixed markings would not be practical.⁸ Hence, they are clearly major in function and are not found in sheltered waters, nor do they perform a limited function. Large navigation buoys (LNB) are, in turn, replacements for lightships and are also major aids.⁹

Conversely, minor aids are of much lower light intensity and are less physically imposing, and of a less permanent and more standardized design and construction. Few are classified as coastal, though many are at the approaches of harbors and bays. In those nations which divide light lists into seacoasts, and harbor, river and bay sections, it is quite easy to distinguish major and minor categories.¹⁰

The terms major and minor are not affixed to many navigation aids. Instead, a variety of terms are used which may create confusion as to the level of an aid. In some nations major lights are divided into two types: primary and secondary.¹¹ The primary lights include lightships as well, and these are the landfall lights and most significant markings on a coastline.¹²

A secondary designation indicates lights still classified as major though of somewhat reduced significance.¹³ In the U.S. the secondary major lights are a limited group.¹⁴ IDMAN refers to landfall lights, and that is what the term implies: those lights first seen when coming in from the open sea.¹⁵ They are equipped with powerful lights and can hence be seen at a great distances.¹⁶ Other terms include "Feu de Jalonnement," which is a coastal light marking much akin to landfall lights.¹⁷ It is "particularly used with reference to marks placed on a long straight coastline devoid of many natural landmarks."¹⁸ France also employs "Phare" for major lights.¹⁹

Minor lights go by a variety of terms. Channel, river, and harbor lights are the most common terms.²⁰ France refers to an unlighted beacon as a balise, and channel lights - the most common among minor lights - as a "Feu de Rive."²¹ The French also apply the phrase "Amer Remarquable" to certain aids, though this is more often related to a major aid; it is particularly easily seen, by virtue of its form, size or colour.²²

In summary, large imposing structures with a powerful light along the approaches to a coast or major off-coast body of water are generally major. They represent a significant geographical point, and they are largely independent of other markings. Minor markings are smaller, lower-powered, often standardized and affiliated with similar markings. They represent a small and restricted danger or channel or other object to the mariner. Buoys are associated with the minor category; lightships and large navigational buoys are "stand-ins" for large fixed markings.

17B Classification of Lighted Marine Markings and Explanatory Notes

- 221 Major Structures (Lighthouses): Sea-girt
 - 2210 Towers on Rocks (submerged and above water)
 - 2211 Towers on Skeleton Structures: Screw-pile Towers
 - 2212 Towers on Skeleton Structures: Off-shore Platforms
 - 2213 Conventional Towers on Special Marine Foundations
 - 2214 Conventional Houses on Special Marine Foundations
- 222 Major Structures: Land-based Towers
 - 2220 Tall Coastal Towers
 - 2221 Towers on Promontories and Headlands
 - 2222 Skeleton Towers
 - 2223 Framework Towers
- 223 Major Structures: Non-towers/Composite Structures
 - 2230 Houses
 - 2231 Skeleton Towers
 - 2232 Buildings
 - 2233 Composite: House on Structures
 - 2234 Composite: Tower Attached to House/Building

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- 224 Minor/Lesser Structures: Multi-member
 - 2240 Tripod
 - 2241 Pyramid
 - 2242 Pile Structure: Marine Site
 - 2243 Pile Structure: Land-based Site
 - 2244 Skeleton Structure
 - 2245 Dolphin
 - 2246 Tripodal Tower
 - 2247 Tubular Tower
 - 2248 Skeleton Tower
 - 225 Minor/Lesser Light Structures: Single-Member I (Slender)
 - 2250 Spindle
 - 2251 Spar
 - 2252 Pipe
 - 2253 Post
 - 2254 Pole
 - 2255 Single Pile
 - 2256 Stake
 - 2257 Mast

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226 Minor/Lesser Light Structures: Single-Member II (Stouter)

- 2260 Column
- 2261 Pedestal
- 2262 Pillar
- 2263 Pylon
- 2264 Obelisk
- 227 Minor/Lesser Light Structures: Enclosed
 - 2270 Hut
 - 2271 Small House
 - 2272 Cairn
 - 2273 "Beacon"
 - 2274 Cylinders
- 228 Minor/Lesser Light Structures: Composite
 - 2280 House/Hut on Structure
 - 2281 House/Hut on Pile Structure
 - 2282 House/Hut on Tripod
- 229 Minor/Less Light Structures: Single Types
 - 2290 Stand
 - 2291 Arm
 - 2292 Lighted Bank

Sections of this chapter on message systems and structural types afford a substantial review of fixed and lighted markings. Nonetheless, the terseness and skeletal nature of the classification require some brief notes to further clarify and expand an understanding of markings.

Rocks, submerged and above water (2220), are not to be equated with islands. By rock is meant a solid object large enough for a structure to be built upon it but with little if any rock or other surface remaining. In some instances the rock may be altogether submerged, and even the lower portion of the light tower itself may be underwater at all times; in other situations the rock may be showing at low tides.

Towers and superstructures of this type (2221) can vary greatly in appearance. The point of commonality will be the foundation of pilings driven into the sand or other terrain. In all of these instances the upper structure presents a distinctly skeletal appearance topped by some form of tower.

A contemporary version of the skeletal structure is the offshore platform (2212). They exhibit a variety of designs but they share a visual resemblance to one another; this resemblance stems from the foundation of massive pillars sunk into the sea bottom.

Caissons and cribs form the foundations for 2213 and 2214 markings. Caissons are of several types; nonetheless they are essentially a single type of foundation upon which a conventional tower or house can be erected. A crib foundation, a more sturdy foundation design, provides an essentially basic type of foundation.

Tall Coastal Towers (2220) is a catch-all term which includes towers of varying heights, construction materials and designs. The term as used here includes only enclosed towers.

Towers on Promontories and Headlands is a "blanket" term for the shorter towers on headlands and other elevations. These markings are designated 2221. 2222 and 2223 denote Skeleton Towers and Framework Towers respectively. The terms are to some degree self-explanatory; the differences between skeleton and framework may be a semantic difference reflecting national usage. It may also suggest a nuanced change between towers that are slender and open and towers that are more bulky though lacking enclosed design.

Houses(2230) is a vague term. Perhaps, at most, it can be said that this refers to buildings with a house or near-house appearance which have a tower or raised portion exhibiting a light. A structure with a distinctly tower-like form or a composite form would be excluded.

2231, Skeleton Structures, is a yet more vague and uncertain expression. It can be said to indicate those structures which are not distinct design types whether tower, house, or other form. It includes an object which is not enclosed and which fails to create an image of an enclosed building. It may be only a semantic usage and may indicate an undifferentiated structure. It may suggest a small or bulky construction lacking a sufficient height to be designated a tower.

Buildings (2232) approaches the ultimate in vagueness. In marine parlance building suggests a non-tower, a non-house, a non-skeleton structure. It can include various forms of buildings whether square or rectangular or other shape. Only a small number of light supports are listed as buildings without further clarification or qualification. Identification of such a structure by color and daymark makes immediate and precise identification more of a certain prospect.

Composite: House on Structures, 2233, is a "catch-all" term which includes various types of

of houses constructed upon unspecified kinds of structures. The structures in question may be an integral part of the light or they may have existed before the establishment of a given light. Structures may include piers, pilings, pile structures, and other underpinnings.

Because of a number of towers that are found near various types of dwellings and buildings - there was a perceived need to adopt an umbrella approach to the category of Composite: Tower Attached to House/Building (2134), "Attached" can mean several things: towers growing out of the roof of a house; towers attached vertically to a house or other building; towers adjoining a building though not integrally attached; towers connected to other buildings through tunnels or breezeways. In short, 2234 includes towers clearly attached to other buildings but in a fashion that can take various forms.

The category of Minor/Lesser Structures: Multi-member, 224, is a loose amalgam of diverse elements. The connecting links are the several members that each of these is composed of, and the lack of enclosures as found in many major light structures. The problem of determining whether overlapping terms are semantic or structural differences is not easily resolved. Canadian Aids to Navigation provides assistance in explaining this part of the classification. Among the specific problems in this segment are the possible differences between Tripod and Tripodal Towers(2240 and 2246 respectively). Tripod may be a three-legged structure with a "true" tripod shape; Tripodal may be of much larger dimensions and no more than a suggestion of a tripod appearance. Pyramids (2241) can be of rock, rubble, or timber framework; they may be either an openwork structure or an enclosed form. Skeleton Structures(2244) which are also considered under Major Structures, and

Tubular Structures (2247) suggest similar constructions though one may be of piping or tubing, the other of flat steel or wood construction. Skeleton Towers (2248) are perhaps much like those of major lights though of reduced stature. A dolphin (2245), in many definitions, is a series of several pilings in a tapered arrangement fastened together at the top by cables or other bindings. Marine Pile Structures (2242, 2243) are of piling or timbers in a roughly rectangular or square form; pile structures on land may be similar to marine forms though adapted to materials and construction techniques of land foundations.

If semantic ambiguities are latently present with other portions of this classification they are rampant in 225 and 226. A lengthy study could be made of the single-member forms alone. This compiler has located more than a dozen single-member markings, and this listing is not definitive. It is possible that the division into more slender and less slender may help to distinguish between various forms of Single-Member Markings. This has been done in this classification, though the dividing line is at best uncertain and may be arbitrary. Obelisks, Pylons, Pillars, Pedestals, and Columns represent bulkier parts of the sections while Stake, Spindle, Spar, Post, Pile, and Pipe are the more lean types of Single-Member Markings. Cylinders can be either of this category, or among the enclosed markings types, since Cylinders can be hollow and equipped with a door; this makes them more akin to a small Hut than to a Post; however, cylinders are included only with the enclosed markings in the present classification; further research may clarify the status of the cylinder and expand its presence in the study.

Enclosed minor structures should perhaps be subdivided as well. A possible point of demarcation might be between dwelling-like or hollow forms versus solid and bulky or filled varieties.

But at this preliminary stage a single category is provided. Huts (2270) are presumably small house-like structures; the term is commonly associated with Australia. Small house, 2271, a term found in the U.S., is not necessarily a house at all. Many of these traditional "houses" are three to four feet (about one meter) square and perhaps 10 to 15 feet (3-5 m.) high. The expression hut might be more acceptable than house. Cairns (2272) are heaps of rubble or of masonry; in some instances Pyramids (see 2241) may be similar to cairns in materials though it is more shaped than cairns.

Beacon, 2273, is a most troublesome term and yet it is necessary to include it. Beacon can include many of the components of this classification and it may also be a general term merely indicating the supporting structure, of whatever form, of a minor or lesser light. It can also represent a specific type of marking; for example, in IHB and IALA publications, it is a spindle, spar or perch. It is included in this classification to satisfy any need for it as a marking that may exist in some nations. It is possible that Beacon is a blanket term or it may simply refer to undifferentiated aids to navigation lacking a distinct form.

Many minor lights are found on composite structures (228). These combinations include various supports already found in this classification. Major forms include Small Houses, Huts or Towers (2233). Structures can include Pile Structures, Dolphins, or Tripods. The variety of possible combinations proves difficult to chart.

There are finally isolated markings (229) that fall outside the above described categories despite the broadness of these categories. Two such markings are the Stand (2290) and the Arm (2291). The Stand is difficult to define; it may be akin to

Single-Member markings or to composite forms. For the present classification it seems best to classify it as a special and separate form. The Arm is probably attached to some other structure though this may be, for example, a port building, not an aid to navigation structure. It can also be viewed as a composite structure. The last marking in this category is that of the French Lighted Bank (2292). This aid consists of multiple lights set in a metal railing (in some instances it resembles a U.S. guard rail) and are found in harbor areas.²³

17C Descriptive Treatment of Structures Types

A study of types of towers for structures of marine lights is not easily accomplished. There are no international agreements on sizes and shapes; and as a result of varying needs, designs, cultures, the resulting spectrum of structures is nearly bewildering. There are some general principles and guidelines that can lead to some understanding of the types of structures. One such guideline was proposed by a pair of lighthouse engineers writing in the first years of this century; the engineers in question, W.T. Douglass and N.G. Gedye, wrote their essay for the Encyclopedia Britannica edition of 1910-11.¹ The publication in question, and the age of the essay, may appear to be questionable for this study, but this is not necessarily the case. The early twentieth century represents the late stage of major lighthouse development. Britain represented the most significant center for lighthouse design and construction, and the encyclopedia's article is lengthy, authoritative, and written at a time when lighthouse phenomena were of considerable interest.² Both Douglass and Gedye were practicing engineers; this was especially true of Douglass.³

Douglass and Gedye divided all lighthouses

into two sections: wave-swept towers, and land structures.⁴ The sea-girt towers, though a distinct minority, provide the far more spectacular and even romantic portion, while the land counterparts, though somewhat resembling the exposed versions, provided less challenge in design, construction, and building techniques. The "front-line" towers are either enclosed - of masonry or of cast-iron panels - or openwork structures of a Victorian-era style of the modern oil-well-influenced offshore platforms. The remainder are caisson-based structures which permit of more conventional superstructures.⁵

It is more difficulties to further divide land towers into subcategories; one such possible approach is provided by the U.S. Coast Guard. The Aids to Navigation Manual of that organization (1964 edition) separate land towers into those on islands and headlands, and those on low-lying elevations.⁶ This is not a precise differentiation and can easily degenerate into arbitrariness. But it can at least suggest the massive soaring towers on the one hand - those towers which hold the gaze of postcard photographers and seascape artists - and on the other hand the possibly less photogenic short and even squat towers on high elevations. In turning from major towers to structures of minor lights one finds yet more uncertainty. Some of these structures display lights that are definitely minor, are of greatly reduced candlepower; though the same structure may be found supporting a light defined as major by IALA but which is of lesser significance and not a landfall light. Despite the difficulties, some progress toward defining and classifying structures of minor and lesser lights is possible.⁷

There is a limited range of design

possibilities for towers exposed to direct action of waves. Among enclosed wave-exposed or sea-girt towers, many, if not most, are of a cylindrical or conical shape with a tapered base. Conical towers, which are probably the most common, are cylinders with a slight to moderate upward slope.⁸ Cylindrical towers are of a more straight design though they frequently, as in the case of the great landfall lights of Britain, have a very pronounced taper in the lower section.⁹ Most of these installations were built in the nineteenth century, a few in the eighteenth century, and an even smaller number in this century.¹⁰ These towers are almost uniformly of stone construction without coverings of stucco, paint, or other substances; the action of the sea would prevent anything beyond the solid unadorned surface to survive. Towers fastened to larger outcroppings or small islands are more akin to land installations than to sea-battered towers.¹¹

There are other forms of exposed towers in addition to solid towers. Two of these are skeleton structures or towers. The older versions of this type consists of a tower on iron pilings; the ill-fated Maplin Light in the Thames is one such example.¹² The "popular" lantern house on a "square pyramidal skeleton tower on pile foundation" is a familiar feature of the U.S. Florida Keys, and it bears a substantial resemblance to the Maplin type.¹³ In both instances, iron piles were driven into the subsurface terrain upon which the tower, dwelling, and lantern house were built.¹⁴ Several smaller versions of this type were built in the early years of this century in the Florida Keys.¹⁵ More recently a new form of skeleton structure has been placed at sea. The modern version is designed from offshore oil platforms.¹⁶ It is usually located in shallow waters and serves as a replacement for lightships. It consists of a tower or house on a superstructure which is in turn mounted on four massive

pilings. The elevation of the light can be as much as 100 feet (30.5 m.) above the surface of the water.¹⁷ A final type of exposed structure is the caisson-based light. The caisson, and there are several varieties, is assembled on land, towed to its site and then sunk.¹⁸ This presents a firm foundation which allows for a more conventional tower or tower/house structure. While some caisson-based structures are in exposed waters, they are more generally found near the coastline and do not necessarily belong to the first line of landfall lights.¹⁹

Douglass and Gedye note that land towers are of normal design character,²⁰ and while this may be true - in comparison with exposed towers - Tall Coastal Towers represent a special category and bear at least limited relationship to marine locations. It is not possible to say, for example, that this type of tower is 100 or 150 feet in height. But judging by the height of low-lying towers in various locations it would appear that such towers are from about 150 to nearly 200 feet in height.²¹ Towers on even modest promontories rarely exceed 100 feet, and some may not exceed 50 feet or even 25 feet.²² One may very guardedly suggest 100 feet as an approximate minimum for tall coastal towers.

The range of possible shapes for land towers is obviously greater than for sea-girt towers, though design and construction limitations are still operative. Many or most of the towers are conical or cylindrical in shape; conical are probably the most common form. Other designs include octagonal, pyramidal and hexagonal towers.²³ Composite shapes are in use though relatively rare. Composite forms include truncated-pyramidal-octagonal, which may be the ultimate in combining independent designs.²⁴ Nearly all tall towers are enclosed though a somewhat rare skeleton tower can be found in

in use.²⁵ Despite differences in shape and construction materials, these towers present a quickly identified mark from the sea; hence their value as primary landfall markings.

The types of towers common to low elevations are also found at other locations. Tall coastal towers include a restricted range of forms, but lower elevations include a broad of shapes - which includes shapes associated with tall towers (of course there is a significant difference in height). Towers for other land-based lighthouses include hexagonal, circular, cylindrical, triangular, square, octagonal, rectangular, quadrangular, and conical.²⁶ Some others are truncated: conical, pyramidal, and octagonal. Some are composite; these include truncated-octagonal-pyramidal. Again, many towers are enclosed though some are skeletal. Skeleton towers come in square, pyramidal, and triangular forms. Many are in some way or other attached to other buildings. These other buildings often take the form of houses and other dwellings. Tower-house combinations include a simple attachment of house to tower; in other cases towers are found growing out of the house or other structures. Yet other composite forms include towers on foundation bases, on piers, and on other forms of building construction.²⁷

Some light supports are listed in light lists simply as structures.²⁸ This does not provide very much information as to shape and other dimensions of the supporting structure. Nonetheless, more data can be gained from these barely described, undifferentiated structures than the word "structures" first indicates. For one thing, structures are outside clearly defined types of architecture: they are neither houses nor towers nor buildings. Many are presumably rectangular or square and of various conventional construction materials. In sum, the supporting structures



are an assemblage of materials put into a recognizable form which has some type of simple shape but is outside the standard categories. The building materials would conceivably include wooden beams, pilings, planks. Great height is presumably not a keynote of undifferentiated light supports. It is possible that any dividing line between structures and skeleton towers may well be arbitrary; nevertheless structures in this sense, and skeleton assemblages, suggest a lighter, more open appearance, while structures suggest a bulkier, less "airy" appearance. The shapes of structures include octagonals, pyramidals and quadrangulars; rectangular and hexagonal shapes are also in use.²⁹ Confusion in differentiating between types is heightened by such terms as "skeleton structures."³⁰

Land structures beyond these somewhat distinct types quickly descend into a disorderly mixture of near-countless kinds of light supports. Some of these may well be major structures while others are part of the IALA-defined major structures but are similar to river and harbor types; yet others are definitely in the minor category without regard to what definition is followed. The casual and even the knowledgeable observer will not be able to say that a given light is in this or that category without also considering the intensity of the light, daymarkings and inclusion/exclusion in a buoyage-beaconage system. These structures, upon examination, wend their way in and out of categories that are imposed upon them. A hasty glance at what this compiler terms "single-member" supports will churn up pipes, posts, piles, columns, piling, single piles, masts, stakes, pedestals, pylons, pillars, obelisks.³¹ Supports of multiple members become mind numbing as one reads off frames, pipe towers, tripods, dolphins, tripod towers, stands, trellis-towers, skeleton masts, lattice masts.³² Yet other supports are more solid in girth: pyramids, pile-structures, cylinders, huts;

small houses on tripods, on piles, on dolphins, on piers; huts on piles and other foundations; and columns on towers.³³

This lengthy spectrum of supports still does not exhaust the possibilities. Some nations simply list minor supports as "beacons." It is not easy to determine what these are. It may suggest that the support is not significant to the light; it may suggest that only the daybeacon or marking dimensions are to be considered by the mariner, or that the beacons follow the shapes outlined in international agreements. In some instances details are given, and this at least suggests a form. Some are listed as square beacons or quadrangular or rectangular beacons. This may represent a cairn or a slatted wooden structure as in the case of Norway.³⁴ The beacon forms known as perches and spars are only infrequently found in light lists, though they are the most common terms for beacons in international publications on buoyage and beaconage systems.³⁵ The expressions stake, pile, pole may encompass what are termed perches and spars.

The classification preceding this segment attempts to at least outline and suggest the vast range of types of supporting structures. Despite the diversity and scope of these supports, the listing in this study can not pretend to be exhaustive or definitive.

17D Message Systems for Lighted Aids

Marine lighted markings, of all types, do not have the controlled message indications familiar to road and rail systems. There are not a narrow number of message possibilities and patterns for marine markings and nothing beyond that. Marine messages generally fall into broad general categories, and the specific message for each marking is determined on a

case-by-case basis (though some classes of characteristics may be reserved for specific functions). Marine markings present an unchanging message to the user even though that message may be complex; this is contrary to the changing messages of road and rail situations. Some measure of guidelines and norms for the types of light characteristics are available for buoyage and beaconage areas, but there is little available in the sense of guidelines for major lights and minor lights of the isolate version. Paradoxically, a numerically small portion of marine aids to navigation - that of the major lights - has the greatest measure of complexity and diversity in this study.

The coverage of messages will consist of a review of categories of light phase characteristics. Statistics of how much one pattern is employed as compared to the others are not available, though flashing patterns are obviously the most common. Little can be added on light characteristics for major, and for minor lights. Message characteristics must also include some mention of the role of color.

The basic sources for light phase characteristics are IALA-prepared publications including its study of lighting, the IDAMN books and publications on the buoyage system;¹ the international light lists of DMA (older editions are published by USNOO);² and U.S. Coast Guard, and Canadian publications.³

The fixed light characteristic can be described as a light of a single color of an unvarying, steady and continuing nature.⁴

Occulting lights are those in which the light is of longer duration than the darkness; this is the reverse of flashing. This is also known as a single occulting light.⁵

Group-occluding lights group the occultations together. The amount of light within the group is more than the duration of darkness but the light is shorter than the spaces between the groups.⁵

Composite Group-occluding characteristics follow the previously described patterns except that the groups are of different numbers of occult-units. For example, an occulting light may have a group of three occults and a group of four occults.⁷

Isophase, or equal-interval, consists of dark and light sections of equal duration.⁸ At one time some nations included this type of characteristic under the occulting heading; in those cases occulting included all flashes in which the light was at least equal to the time of the darkness element. This appears to be no longer the case.⁸

Flashing lights, or single-flashing in IALA parlance, can be described variously as a brief showing of light in relation to the accompanying period of darkness, and a light in which the light occupies less time in the period than the time of darkness. The flashes would have to be less than 50 or 60 per minute or they would be classified as Quick Flashing.⁹

Long-flashing light is comprised of a single-flashing light whose flashes are at least two seconds long. Long-flashes are occasionally found in tandem with other light phase characteristics.¹⁰

Group Flashing includes light phase characteristics in which two or more flashes are combined per period. IALA defines this as two or more groups, but DMA and USCG require a minimum of one group.¹¹

Composite Group Flashing is a variation of the above. Composite calls for groups of varying numbers of flashes in a period; for example, a group of two flashes followed by a group of three flashes which in turn is followed by a group of two flashes.¹²

Quick-Flashing lights consist, in IALA's definition, of flashes of "rapid alteration."¹³ But IALA does not give a precise figure. Both DMA and USCG state that such a light will exhibit 50-79 flashes per minute.¹⁴ IALA buoyage system states that Quick-flashing lights are either 50 flashes per minute or 60 flashes per minute, the difference depending on the type of equipment in use.¹⁵

Group Quick lights in DMA nomenclature consist of groups of flashes at regular intervals.¹⁶

Group Quick can be combined with Long Flashing characteristic described earlier.¹⁷

IALA describes the Interrupted Quick Flashing characteristic in terms similar to that of Quick Flashing except that the interrupted form flashes are separated at set intervals by lengthy eclipses of darkness.¹⁸ DMA gives the interrupted interval as four seconds while the USCG indicates they are five seconds in duration.¹⁹ It would not be possible for a light so defined to flash 50 or 60 times per minute but the rate of flashing is in that ratio.²⁰

The IALA buoyage system has developed a new characteristic termed the Very Quick Flashing.²¹ It consists of a steady flashing light of either 100 or 120 flashes per minute (80-159 in DMA).²² The difference in IALA publications of the flash rate is due to the differing capabilities of flash-producing mechanisms.²³ The characteristic was developed for cardinal messages. DMA

terms this characteristic as the continuous Very Quick characteristic.²³

DMA lists three variant forms of the Very Quick. These include the Group Very Quick which includes a series of flashes per period, the Group Very Quick with Long-Flash; and the Interrupted Very Quick which is composed of groups of flashes separated by regular and lengthy eclipses.²⁴

DMA also includes two forms of Ultra Quick characteristics. The continuous form consists of a series of flashes with a rate of at least 160 per minute. The interrupted version contains flashes separated by lengthy eclipses of darkness.²⁵

The final characteristics are long-established light patterns. The Morse code characteristic is made up of flashes of various durations which form a chain of letter emulating Morse code communications.²⁶

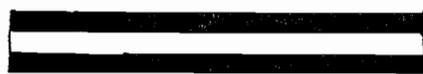
USCG and DMA include a Fixed and Flashing characteristic but this is not found with IALA. This signal consists of a fixed and steady light punctuated at regular intervals by a flash of greater intensity.²⁷ The Fixed and Group Flashing characteristic formerly employed by the USCG appears to be defunct.²⁸

So far, this discussion of characteristics has referred only to single-color lights. Lights of more than one color are referred to as Alternating, which IDAMN defines as "a rhythmic light showing light of alternating colours."²⁹ But no further details are given. DMA notes that alternating lights can be used in tandem with many of the other characteristics. This then can be regarded as a final characteristic in itself.³⁰

West Germany has developed several

characteristics which approximate more commonly known types of lights. The first of these is known as the Blitz. It is defined as an "appearance of light of duration of not more than one second;" this suggests the Quick Flashing type since both are operated at a rate of 60 flashes per minute.³¹ Second, the Schein calls for "an appearance of light between two darknesses, the duration of darkness being not longer than the duration of light."³² At least some forms of the Schein are similar to the isophase characteristic. Finally, the Blink is of a minimum of two seconds duration and it would appear to approximate a number of conventional flash patterns.³³ IDAMN regards the Blitz and Blink as flashing characteristics.³⁴

The IALA buoyage system provides norms on the use of various types of characteristics for many situations. The new Very Quick Flashing pattern was designed for cardinal buoys and presumably is not used elsewhere.³⁵ The Morse code characteristic in North America is reserved for buoys at entrances to harbors and bays and is not usually found with fixed markings.³⁶ Fixed lights, which were once the only characteristic, are a relatively rare pattern, and probably few major lights exhibit such a characteristic.³⁷ Flashing lights of one color are the most common pattern found in marine lights.³⁸



Fixed



Single-flashing



Quick-flashing



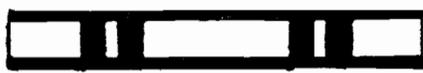
Single-occulting



Long-flashing



Group Quick-flashing



Group-occulting



Group-flashing



Group Quick with Long-Flash



Composite Group-occulting



Composite Group-flashing



Interrupted Quick-Flashing



Isophase



Very Quick-flashing



Ultra Quick-flashing



Fixed and Flashing



Group Very Quick-flashing



Interrupted Ultra Quick



Alternating



Group Very Quick with Long-flash



Morse Code



Interrupted Very Quick

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All of the characteristics exist to identify a given light, to clearly define given functions, and to prevent confusion in areas where a great many lights are located together.

White, red and green are nearly universal colors for marine markings. For major lights white is by far the most commonly employed color. This practice exists in large part because of the greatly reduced range of red and green.⁴⁰ Some high intensity lights exhibit a slightly different white "color" but one that is within an accepted definition of white.⁴¹ Infrequently other colors are in use for coastal and other significant lights. Canada, for example, occasionally uses yellow for designated lights.⁴² And for minor aids yellow has become a standard color for cardinal buoys in the IALA system.

One special type of light within the major category is the sector light.⁴³ This light "presents different characters (usually different colors) over various parts of the horizon of interest to marine navigation."⁴⁴ A major reason for the sector light is to point out special features such as dangers to navigation; red, of course, represents dangers. An example of a sector light - and a three-part one at that - is the Walter Rock Light in British Columbia. The main light of Walter Rock is a group flashing white light. In addition there are sector lights in a fixed color pattern: the white, red, and green sectors each cover from four to seven degrees of the compass.⁴⁵ In some nations the sector light is known as a light with sector(s).⁴⁶ The directional light - which can be seen to be at least distantly related to the sector light - points out multiple channels rather than specific danger points.

Light phase characteristics are complex in the abstract and seemingly shrouded in mystery

for the uninitiated. The actual encounter with marine lights is much simpler. The mariner is coping with one or at most a half-dozen lights at a given time; equipped with charts, light lists and theoretical knowledge honed by experience, the navigator can quickly and accurately identify the correct light.

There are three ingredients in a lighted marine marking: the light and its characteristics, the structure supporting the light, and the day message systems applied or attached to the structure. Only the last category needs be considered here. There are no hard and fast rules for daymarks in aids to navigation which are not part of a buoyage/beaconage system. The daymarks on fixed lights and certainly on major lights vary from nation to nation and even from light to light; nonetheless, some general remarks can be made.

The great sea-girt towers need not have message characteristics other than the light and tower. The massive visibility of such towers needs few, if any, extra aids. Some of these towers may have the lantern house, gallery, trim and ancillary buildings painted in different hues from the tower; for example, Peggy's Point Light in Nova Scotia, and North Point Light in the Netherlands Antilles, illustrate some uses of alternate color schemes.⁴⁷ Of those towers that are painted, stuccoed or otherwise altered, the greatest number are painted; this seems to be true of lights around the world.⁴⁸ In a great many instances the towers are solid white without additional stripes, bands or other designs. Painting the upper portion of a light tower may well be a common practice, but it is not known how common, since a number of nations do not always indicate in light lists some of the more limited markings on towers. For example, in the U.S. some lights exhibiting a black, red, or other color lantern are not so indicated in the

light list, yet other similarly marked towers are so listed.⁴⁹

For light towers that are not white, what other colors are in use? It would appear, based on various sources, that red is the second most common color.⁵⁰ Red can provide a contrast to nearly towers and it can provide a contrast to a white background; for example, Longstone Light in Scotland is painted red because of the surrounding terrain.⁵¹ Other light tower colors include black, and yellow; chrome yellow is the most common color in Iceland, presumably to create contrasting background hues.⁵² However, the most common color scheme for lighthouses, after white, is not a second color but a composite pattern.

A diverse and numerous grouping of worldwide lights exhibit stripes, bands, checks, diamond or two-color patterns.⁵³ Stripes, which are vertical, are often single, though multiple stripes are not unknown. Black or red stripes on white towers seem to be more common than any other arrangement. Stripes can distinguish one tower from another, and they can provide needed contrast with natural terrain; for example, at least one Canadian tower is painted red with a single white stripe. The red provides contrast with the snow and the white stripe distinguishes the tower from surrounding autumnal patterns of color.⁵⁴

Some nations also paint bands on towers; the colors of these are likely to be those colors used in the painting of towers, and colors used in painting stripes on towers.⁵⁵ Bands also include brown, orange, and blue. Some bands are horizontal, some spiral, others diagonal; the last type presenting a diamond-shaped appearance. Checker patterns are occasionally used; black and white patterns seem the most common design. Yet other towers are in two colors: one color for the upper tower, a second shade for the lower

section; an example would be Saint Davids Lighthouse in Bermuda.⁵⁶ A second two-color arrangement would have the middle section in one color and a second for the top and bottom sections. The range of colors for these designs includes black and white, red and white, red and yellow, aluminum and green, and gray and orange.

To sum up, it is necessary to quickly identify a tower, and to distinguish it from neighboring lights. Buoyage and beaconage follow agreed-upon message systems, but more significant lights fail to have a system of day messages readily at hand. Hence, an easy means of locally identifying each unit is needed. Stripes, bands, checks, multi-colors as well as a welter of solid hues provide a major means of daytime identification.

A review of messages for minor lights requires a different approach: Little of the material for minor lights will appear in this segment. Most of the materials are found in other parts of the monograph and can be located by using the index of such materials found at the end of this section. This format stems from the fact that various parts of light message systems for minor aids are found with major aids, and with buoyage/beaconage materials. There is no need to reprint that information here.

While much of the message systems for minor lights can be found in buoyage agreements, it may be asked if minor markings messages are thereby complete. This is not an easily answered question. According to the IALA system, all minor lights are included except for certain stated exceptions: the category of major aids to navigation, and also range and sector lights.⁵⁷ According to USB, minor markings are included, though one cannot say with certainty that all are.⁵⁸ IMC was couched in more general language,

and therefore it is more difficult to say what was included.⁵⁹ But it does seem that all aids to navigation in proximity to buoys were not included.⁶⁰ In the U.S. minor lights were not formerly marked to the degree that buoys were; however, of late all minor markings are in the lateral systems except for directional and range lights.⁶¹ In Canada, which also stemmed from IMC, it would appear that minor lights are included, especially with the advent of IALA.⁶² Lights of various nations outside of IALA are in the process of being integrated into IALA in many instances.

In general terms, one might say that harbor and river and non-coastal aids to navigation follow the local pattern of messages or at least do not contradict it explicitly. Some attention will need be given to isolates which are more minor than major though they are outside the appropriate message system.

Index of materials for messages of minor lights:

Unlighted Messages	Chapter 18D
Structures (Daybeacons)	18C
Message Systems (Buoyage)	15A-B-C
Light Phase Characteristics	17D

Endnotes for 17A

¹ AISM/IALA Bulletin. 1984/3. pp. 17,10.

² IALA Supplement #6, p. 3.

³ See previous two notes.

⁴ IDAMN, 2-5-005.

⁵ Twenty miles is quite common; some lights of especially great power can be seen that far in daylight; for example, Tiri Tiri Light in Auckland, New Zealand.

⁶ See USCG, Light List, Pacific, Vol. III, 1985; it also includes Western Canada (British Columbia).

⁷ For example, Fort Cornwallis Light at Penang, Malaysia ("Developments in Stone-Chance Navigational Lighting and Fog Signalling," u.d. Stone-Chance, Ltd, Crowley, Sussex, England).

⁸ For example, Sevenstones Lightship on an offshore location in the U.K. would not be feasible for a fixed lighthouse (Bowen, British Lighthouses, 1947, p. 37).

⁹ These are referred to as "Lighthouse Buoys" in the description of "IALA System A" printed in the "Pilot Chart of the North Pacific Ocean," U.S. Defense Mapping Agency, January, 1977 and extracted from Nautical Publication # 37 of the British Hydrographic Office. This term accentuates the major status of such buoys.

¹⁰ Perhaps the best example of difference in definition is that found with divergent practices of the Canadian and U.S. approaches. The U.S. includes virtually all minor aids in the lateral system (as can be seen by the addition of standard daymarks) and this practice plus the "low to moderate" cp gives the U.S. 10,000 minor lights. But Canada apparently does not include river and harbor lights unless they are in a channel or similar situation; instead they are termed major, and Canada has as a result less than 100 "minor" lights according to IALA and the understanding of this compiler. Note: Correspondence with Canadian authorities and the 1984 IALA survey indicate a change in the numbers of minor lights and may also indicate a lack of understanding of Canadian practice in the first place.

¹¹⁻¹⁴ USCG, Light List, Pacific, Vol. III, 1985, p. x-xi.

¹⁵⁻¹⁶ IDAMN, 2-5-050.

17-18 IDAMN, 2-0-005.

19 IDAMN, 2-5-060.

20 USCG, Light List, Pacific, Vol. III, 1985, p. v.

21 IDAMN, 2-5-060.

22 IDAMN, 2-5-000.

23 Service Technique des Phares et Balises, "Bordure Lumineuse."

Endnotes for 17C*

¹Douglass, William Tregarthen, and Gedye, N.G., "Lighthouses," Encyclopedia Britannica, 11th ed., 1910-1911. New York: EB Company, Vol. XVI, pp. 627-51.

²See endnote #10; the general interest in things maritime and especially in lighthouses, can be seen in the exhibits at the Centennial Exposition in Philadelphia in 1876 and the Panama-Pacific Exposition in San Francisco in 1915. Even the awarding of the Nobel Prize for physics for Dalen's sun valve in 1906 suggests the more central position in public awareness of this area of endeavor.

³Douglass held the position of consulting engineer to at least four commonwealth/colonial governments in Australia and Africa. He was the builder of two of the most notable world lighthouses, Eddystone and Bishop Rock Lights in the British Isles. He was also the author of The New Eddystone Light. Gedye held the position of chief engineer for the Tyne Improvement Corp.

⁴Douglass and Gedye, EB, 1910-1911.

⁵USCG Manual, 1964 edition, Ch. 4, "Structures," pp. 4-9 and 4-10.

⁶USCG, Manual, Ch. 4, p. 4-1.

⁷See Chapter 2 of Volume IA of this study.

* No endnotes for 17B.

⁸USCG, Light List, Atlantic, Vol. I, 1985, p. viii.

⁹The current Eddystone Light erected by Douglass (Bowen, British Lighthouses, Longmans, Green, and Co., for British Council, London, 1947, p. 13).

¹⁰For example, costs are too great for older forms such as monolithic stone towers due to very high labor costs; see endnote #5 but pp. 4-1, 4-2; brick towers were common in what the USCG calls "the brick tower era" (1856-81) but again labor costs are prohibitive, (pp. 4-5 of Manual, 1964 ed.).

¹¹In that the requirements for direct sea contact are different from situations where the influence of the sea is indirect or at least muted; for example, in the areas of contact with salt water, rocks thrown by the action of the sea, wave action, etc.

¹²Bowen, p. 7.

¹³USCG, Light List, Atlantic (south), Vol. II, p. 9; USCG Manual, p. 4-3.

¹⁴USCG, Manual, pp. 4-10 and 4-11.

¹⁵USCG, Aids to Navigation, pp. 4-9; IALA Bulletin, 1979-2, p. 37.

¹⁶USCG, Manual, p. 4-10.

¹⁷⁻¹⁹USCG, Manual, p. 4-9.

²⁰Douglass and Gedye, p. 628.

²¹USCG, Manual, p. 4-9.

²²⁻²³Based on publications of USCG.

²⁴USNOO (DMA) Light List, International, 1967-1972, Washington, D.C.: GPO (HO Publ. #111A) Greenland, East Coast of North and South America (excluding continental USA except East Coast of Florida) and West Indies.

25 _____ . (HO #111B). The West Coast of N. and S. America (excluding Continental USA, Alaska and the Hawaiian Islands), Australia, Tasmania and the Islands of N. And S. Pacific Oceans.

26 _____ . (HO #113). West Coast of Europe and Africa, The Mediterranean, Black, and the Sea of Azov.

27-35 These are based on a statistical summation of a broad range of USNOO (DMA) publications.

Endnotes for 17D

¹IDAMN, Chapter 2, "Visual Aids," 1st. ed., Paris, 1970; IALA Supplement #6, 1976.

²DMA, Light List, British Isles, 1983, pp. viii-ix.

³CANS, 1975; USCG Light Lists, USCG AN, 1975.

⁴IDAMN. 2-5-105.

⁵IDAMN, 2-5-170, 2-5-180 (Group Occulting).

⁶See DMA, IALA, USCG on light phases.

⁷IDAMN, 2-5-185.

⁸Bowen, British Lighthouses, pl. 7,9,10; fig. 3.

⁹IDAMN, 2-5-145.

¹⁰DMA, 1983, p. viii.

¹¹IDAMN, 2-5-155; USCG, Light List, Atlantic, Vol. I, 1979, p. viii.

¹²IDAMN, 2-5-160.

¹³IDAMN, 2-5-190.

¹⁴USCG, Light List, Atlantic, Vol. I, 1979, p. viii; see also DMA lists; USCG lists: 50-80 flashes.

¹⁵IALA Supplement #6, "System A," p. 7.

¹⁶⁻¹⁷DMA, 1983, p. viii.

¹⁸IDAMN, 2-5-195.

¹⁹USCG, Light List, Atlantic, Vol. I, 1979, p. viii; also DMA.

²⁰Since the periods of darkness occupy the amount of time that they do, it does not seem likely; perhaps it is theoretically possible.

²¹IALA, VQkF1; Bury, pp. 142-143.

²²⁻²³See above.

²⁴⁻²⁵DMA, 1983, p. ix.

²⁶IDAMN, 2-5-200.

²⁷USCG, Light List, Atlantic, Vol. I, 1985, p. ix; see DMA introductory sections.

²⁸USCG, Light List, Pacific, Vol. III, 1962.

²⁹IDAMN, 2-5-205.

³⁰DMA, 1983, pp. viii-ix.

³¹⁻³⁴IDAMN, 2-5-125.

³⁵IALA, "System A," pp. 3,7.

³⁶CANS, fold out; USCG Light Lists.

³⁷⁻³⁸Based on examination of light lists.

³⁹Illustrations include those of DMA and USCG; others are influenced by IALA; yet others are alterations and assemblages of existing data.

⁴⁰Based on examination of light lists.

⁴¹For example, Xenon-flashing lights.

⁴²USCG, Light List, Pacific, Vol. III, 1985, "British Columbia."

⁴³IALA Supplement #6, p. 5.

⁴⁴IDAMN, 2-5-215.

⁴⁵USCG, Light List, Pacific, Vol. III, 1979, p. 178.

⁴⁶See French-language side of CANS, p. 6.

⁴⁷Sea Frontiers, back cover, Vol. 17, # 6, November-December 1971, Peggy's Point Light, Nova Scotia; also Vol. 19, # 2, back cover, March-April, 1973.

⁴⁸Based on examination of USNOO publications.

⁴⁹For example, Yaquina Head Light (USCG Light List, Pacific, Vol. III, p. 9, 1979).

⁵⁰Based on USNOO publications.

⁵¹Bowen, British Lighthouses, p. 23.

⁵²USNOO publications; Vitar, Sjomerkel, Radiostodvar A Island, 1968.

⁵³⁻⁵⁴Survey of USNOO publications.

⁵⁵For example, Beachy Head, U.K. It is a stone tower with black band, and lantern house (Bowen).

⁵⁶Sea Frontiers, back cover, Vol. 20, #1, January-February, 1974.

⁵⁷IALA, Supplement #6, p. 3.

⁵⁸See Conference papers, League of Nations meetings at Lisbon, Geneva.

⁵⁹See IMC Protocols of Proceedings, 1889.

⁶⁰The Canadian practice of excluding isolated beacons would indicate a buoy and a harbor light which are both in that condition; this would include the buoy though not the light in the message system.

⁶¹Cp 1962 Pacific Light List with a current listing.

⁶²If the writer understands the changes in that system.

CHAPTER EIGHTEEN

UNLIGHTED VISUAL MARKINGS (DAYBEACONS)

18A Introduction, Terms, and History

A study of fixed, unlighted marine transportation markings can prove to be a difficult matter. Obviously, such markings suffer a marked degree of anonymity and this, in itself, can be a problem in a study of markings. While many persons have some awareness of lighthouses, fog signals, and harbor lights, they may know nothing of unlighted, fixed beacons. This anonymity is not due to their small numbers, since they constitute a very large category of marine markings¹, but rather to their usually small, simple form and unpretentious message systems. For example, a cairn or perch will probably be noticed only by the actual user, while a coastal lighthouse by contrast will receive a great amount of attention from tourists, painters and photographers. Yet this anonymity may not be the primary problem in itself (though this anonymity has meant less written documentation for the researcher).

A more basic problem with unlighted fixed markings is one of terminology: what to call these markings. There is no terminology problem, for example, with buoys - since the term "buoy" is both all-encompassing and yet precise. Nor is there a problem with fog signal terminology, and even the naming of fixed lighted markings can be resolved within limits. The long awkward term "fixed, unlighted marine transportation markings" exemplifies the problem. Other terms (beacon, daybeacon, unlighted and/or fixed beacon) compound the problem. Terminology seems especially difficult in English-language publications though perhaps it is no less a problem in other languages.² It is necessary to examine

various terms and to decide what may provide the more adequate term to describe lighted and fixed marine markings.

The most likely term, based on initial examination, is that of beacon. And it is true that frequently the term beacon refers to small marine aids to navigation lacking lights. IALA, for example, reserves that term for unlighted fixed marks in surveys of marine markings.³ However, beacon legitimately includes lighted markings, and even buoys. And to compound the confusion, the word can be used to include all types of transportation markings.⁴ What alternatives to beacon are available? In Canada and the U.S. the word for fixed, unlighted markings is daybeacon. This usage reduces confusion over the previous term, and leaves beacon as a general designation for all marine aids to navigation.⁵ In the U.K. the term beacon is employed for unlighted markings though IDAMN adds "unlighted" in parentheses to eliminate confusion in the definition.⁶

In France the expression "balise" is generally applied to unlighted beacons though IALA adds the qualifying term of fixed.⁷ In the German language the word "bake" includes unlighted fixed beacons.⁸ IHB definition of beacon appears to be all-encompassing in some instances but confined to day-usage in many other situations.⁹

Daybeacon, even though its choice might engender some controversy, appears to be the best possibility for a term for fixed and unlighted markings. It is descriptive of the aid to navigation in question, and it eliminates at least some of the confusion and uncertainty of other possibilities. Use of the French balise and of the German bake may be utilized in appropriate situations in the monograph.

A final term that may increase an understanding of markings (though it may also supply further

confusion to terminology) is that of daymark.¹⁰ This term finds its predominant usage in Canada and in the U.S., though nations outside North America have employed the term.¹¹ In a broad sense it refers to "a distinctive structure serving as an aid to navigation during the day whether or not the structure has a light."¹² The USCG appears to restrict the term to a specific daymark. In both the U.S. and Canada it has a more specific meaning: an object which is an addition to the structure of an aid to navigation and which adds an additional message capability. Both lighted and unlighted aids frequently include a daymark; major coastal lights are usually sufficiently distinctive so as not to require further identification. Many daymarks are of wood construction and come in various shapes including rectangles, triangles, diamonds, and squares. Daymarks are often required to fit into a message pattern dictated by a given buoyage and beaconage system (see 18D).

IDAMN notes that "in the U.S. the word daymark is often used for a topmark."¹³ This is only partially true. Topmarks are frequently small in dimension while daymarks are considerably larger. Though there are instances in which topmarks are about the size of daymarks. This is especially true of topmarks for some types of Norwegian daybeacons.¹⁴ Topmarks are more often associated with buoys, and daymarks with fixed aids to navigation.

D.A. Stevenson considers the history of the daybeacon only briefly in his The World's Lighthouses Before 1820.¹⁵ He notes that most nations maintained daybeacons and in quantities, but no statistics are apparently available. Stevenson remarks that most of these marks were wooden towers or spars while others were stone pillars.¹⁶ This last category may be similar to what are termed cairns in maritime publications.¹⁷

Whether the spar of Stevenson is similar to a perch is not known.¹⁸ Precision in aids to navigation terms is probably only a recent development. Rather surprisingly, WLB 1820 does not mention the "Petit Arbre" at all, though it would appear to be a common marking as well as a natural one for less technological times.¹⁹ Pre-1820 daybeacons exhibited topmarks or painted marks in order to give information and to identify the marking.²⁰ One might assume that messages developed for buoys would be applied to beacons. Admittedly message systems were limited and primitive before the era of international conferences.

Since the early nineteenth century, it may be presumed, evolution in daybeacon design occurred rather slowly. This can be seen by the types of aids described by Stevenson with a long historical background, and the similarity in appearance of many of the older daybeacons with more modern types. For example, a comparison of current German markings with their older counterparts shows a distinct resemblance though some change is discernible.²¹

18B A Classification of Daybeacons And Explanatory Notes

- 241 Simpler Structures
 - 2410 Dolphin/Multiple Pile
 - 2411 Tripod
- 242 More Complex Structures
 - 2420 Bake:
 - 2421 Bake:
 - 2422 Latticework Structure
 - 2423 Skeleton Tower
 - 2424 Wooden Framework

- 243 Uni-Dimensional Artificial Marks
 - 2430 Spindle
 - 2431 Perch/Pole
 - 2432 Pile
 - 2433 Post
 - 2434 Stake
 - 2435 Edgemark
- 244 Natural Marks
 - 2440 Cairn
 - 2441 Small Tree/Petit Arbre
 - 2442 Tree Branch: Natural State
 - 2443 Tree Branch: Tied-Down Branch
 - 2444 Stone Construction
- 240 Daymarks
 - 2400 Daymarks
 - 2401 Daymarks and Structure

Detailed descriptions of types of daybeacons will be found in Chapter 18C. These brief explanatory notes are included as a guide to using the classification and to clarify terms and arrangements of the daybeacons. While it may be arbitrary to divide structures into Simpler and More Complex Structures (241, 242 respectively), this may help to differentiate between types of markings. Are Dolphins and Multiple-Pile Structures (2410) sufficiently different to warrant separate categories? Perhaps they require separation since one is land-based and the other is marine-based. However, for this study they are placed together since they are both composed of several pilings or timbers, and there is not enough data to precisely define the two as independent entities. Tripods (2411) in Norway and in the U.S. may differ though the visual appearance is such that they can be classed together.

The German Bake (2420, 2421) comes in designs sufficiently different to justify division of them. No specific name, other than beacon, is available for the lattice work structure (2422) of Norway. The U.S. Skeleton Tower (2423) is an

ubiquitous construction found in many types of marine aids to navigation. The skeleton tower comes in many sizes and various shapes while remaining recognizable in its variant forms. Wooden Framework (2424) is a nebulous term encompassing in all likelihood a range of structures that do not resemble towers or other specific design types. It is found so described in the literature without more detail.²²

The phrase Uni-Directional Marking (243), while admittedly vague, affords - at this point classification development - adequate clarity and precision for these markings. Uni-dimensional markings probably overlap and may conceivably be, in some instances, identical to one or other of the class. All of the terms are included so as to reduce the possibility of leaving out what may later prove to be a separate marking.

Cairns (2440) are frequently heaps of stones, though the Norwegian version is a more shaped and in some sense a less natural object (see 2444); it is possible that the Norwegian version is closer to artificial than to natural categories of aids to navigation, though it nonetheless retains some resemblance to simple heaps of stones.

Daymarks are considered primarily as message systems. But some daymarks are of substantial size; and since the support structure may be contained within the daymark some daymarks form a distinct type of marking, and not merely a small object that provide messages as is the case with topmarks.

18C Description of Types of Daybeacons

There is such a welter of terms describing uni-dimensional markings - markings with a single vertical dimension - that it becomes difficult to

sum up those markings both briefly and precisely. The various terms may be no more than semantic quibblings; the actual differences may be minuscule. The most frequently employed term for uni-dimensional marks is that of Perch. This may suggest that Perch refers to a narrowly defined object. But IHB uses the term for a variety of national markings, and national markings are not always identical - or nearly so - to one another.²² Therefore, Poles, Perches, Posts may be much the same in outward appearance and the terms may even be interchangeable. IDAMN notes that the Pole Beacon is also referred to as a Spindle and Single-Pile Beacon. Rather strangely, IDAMN does not include the term perch.²³ The spindle and single-pile beacon can probably be regarded as perches despite the silence of IDAMN. The U.S. has installed a few markings known as Stakes and perhaps they too can be included with Perches and similar markings.²⁴ The classification, however, lists the various terms as separate items so as to avoid forcing possibly separate markings types into an incorrect category.²⁵

Topmarks, as already mentioned, are primarily part of the message systems; daybeacons, because of their size and impact, must be considered as part of both the daybeacon structure and message system. Daymarks, in the Canadian and U.S. sense, often require a structure not so much to accompany them or provide extra support but in order to support the daybeacon.²⁶ Daymarks are frequently of wood construction and of varying shapes. Daymarks can measure as much as seven feet per side.²⁷ Some of the traditional forms of unlighted markings in the U.S., such as small houses, are so obscured by the daymark that the original marking is no longer included in the light list describing the aid.²⁸

A composite daybeacon type includes the daybeacons in which the daymark is attached to the supporting structure in such a manner that both daymark and structure are integral parts of the marking; a variety of U.S. marking are of this form.²⁹

The Small Tree, or "Petit Arbre" is a very simple form of marking, and no doubt a traditional one. This marking continues to be frequently used despite the development of more complex and sophisticated aids to navigation. In many instances this marking consists of a tree branch in its natural state. In other instances tree branches are tied down, or a single tree branch serves as a mark.³⁰

Cairns are not mentioned in IHB publications though they are included in IDAMN.³¹ Cairns are piles of stones heaped into a distinctive form at needed navigation points. It is difficult to know how common such markings are since there are limited statistics on the subject. Many may not be found in any list, since local authorities or individuals could pile up such stones at harbor entrance on their own volition; many may not have any official standing.³²

Not all daybeacons are as simple as those previously described. There are two major subdivisions among the more complex types. These are the less complex which may be composed of several posts or pilings bound together into a simple framework or construction, and the more complex of multi-dimension shape and of more substantial construction. The major types in the less complex category can be encompassed under the umbrella term of multiple-piling. This phrase is a frequently used term in the U.S.. IDAMN, however, notes that this type of aid - of which there are two forms - has no name in English.³³ Norway includes a variety of iron tripods for daybeacons; many of these include

a separate topmark; a limited number of U.S. markings are also tripodal in shape.³⁴

More complex structures include the U.S. Skeleton Tower, the West German Bake, the Latticework structure of Norway, and the Wooden Framework mark of the USSR. The U.S. Skeleton Tower is a single type of aid though it is capable of varying heights and widths. The German Bake is of two types: One is a skeleton pyramidal structure, and the other is a rectangular construction made up of vertical corner posts and interspersed with a series of three diamond-shaped panels.³⁵ The Norwegian structure is of a bulky shape and of a latticework pattern; it has a slightly pyramidal appearance.³⁶

18D Message Systems

Daybeacons, even though they lack sophisticated capabilities, are more than pieces of wood or metal posts, pilings, perches, or structures. In many instances they have a message system of some distinctiveness: stripes, bands, patterns; these may be as important as the basic daybeacon construction; daymarks or topmarks may also be included.

A discussion of message systems includes three topics: What systems (or partial systems) provide messages for daymarks? What non-day beacon message systems can be applied to daybeacons? And what national message systems have been developed for daybeacons? Available international maritime publications suggest that efforts at standardization of marine markings have not seriously focused on beacons whether lighted or unlighted. However, occasional references have been made to messages for fixed marks. For example, IMC in 1889 contained the term beacon in its official documents, though they centered on buoyage to a very great extent.³⁷

While references to fixed markings are found in those IMC sections that consider the cardinal system, a system for fixed markings on a par with that of buoys is not to be found. Messages for beacons consist of the statement that beacon messages should conform to those for buoys.³⁸ This means that painted messages are to adopt the standards for buoys; colors are to conform to, or at least not contradict, buoy message patterns. A committee report spoke of the need for uniformity in shape and color for marks and buoys. Topmarks are described by shape and marks, and buoys by color only. The committee remarks did not become part of the final act but they do suggest some correlation between buoy and beacon messages.³⁹ messages.³⁹

The Uniform System of Buoyage, established by the League of Nations conferences in 1930 and 1936, did not include the term beacon or beaconage in the titles of the conference papers; nonetheless, some mention of beacons is made. The USB calls for conformity of beacon light messages to those of buoys by implication, and presumably day messages are to follow suit.⁴⁰

The most recent international buoyage system gives more direct and complete consideration of messages for fixed marks. That system, IALA, specifically applies to "all fixed and floating marks" except "major aids" and certain special markings.⁴¹ And unlike previous international systems "most lighted and unlighted beacons, other than leading marks, are included in the system."⁴² Topmarks for fixed markings normally follow the shape and color of buoyage topmarks. The diagrams in publications describing the system include only buoyage types; this is because of "the variety of beacon structures."⁴³ The structures are therefore not left out because the system does not focus attention on them. Some revision of fixed aids will probably take

place in order to meet the norms of IALA; the Netherlands has already done so.⁴⁴ It may be noted that the injunction that fixed marks should follow the messages of floating markings is found in nearly all international marine message systems, though frequently nothing beyond the injunction is given.

In summary, despite the brief documentation that refers to fixed beacons, some general norms can be inferred; a national maritime agency by extrapolating from those norms could construct a message system for fixed beacons; lighted as unlighted. These norms include guidance on selecting lights, and provide some ideas on the shapes and colors for topmarks and daymarks. But there is little illustrated information which describes the types and shapes of lighted and/or unlighted beacons. The existence of vague and uncertain coverage in this monograph may be partially explained by the failure of international conferences and organizations to construct a coherent system for fixed markings. This monograph may possibly offer a first step toward such a goal.

There are eight major systems of daybeacons and their messages, based on existing data. These include Canada, Norway, West Germany, and the U.S. Other notable users of daybeacons include Finland, Sweden, France and Yugoslavia.⁴⁵ Coverage of many of the major users will be complemented by a brief review of other nations that make limited usage of daybeacons.

Daybeacons in Canada are listed by shape and message content, not by structure. In many instances there is no visible structure other than the daymark.⁴⁶ Port-hand marks are square with a red border, white inset, and black square center. Starboard daybeacons are triangles with a red border, white inset, and fluorescent red triangle centerpiece. Junction daybeacons are diamond-shaped; if the principal channel is to the

right the daybeacon has a fluorescent red border with a small red triangle in three of the points; the fourth and top point is a green triangle. The center exhibits a fluorescent red triangle point downward with a green rectangle atop it. The channel to left beacon is identical except that the center designation is the reverse of the channel to right marking. Contrary to the practice of many European nations, daybeacon messages parallel buoyage message only to a limited degree.

Norway has approximately 40% of the structural daybeacons listed in the IALA survey; Norway also maintains a variety of perch beacons.⁴⁷ For many daybeacons in Norway the message system diverges from the commonly accepted definition of both daymark and topmark. The special message consist of arms attached to the daybeacon that point to the fairway indicated by the marking. In some instances there are two arms since the channel in question has two directions of travel; these pointers are usually omitted for markings in heavy and open seas. Norway also makes use of red, green, and white reflectors. These reflectors follow the color scheme of the buoyage system. A white reflector is added when a longer distance from mark to mariner is a problem and when confusion with other messages will result. In some instances a white/red or a white/green reflector system is added to the marking. At least some portion of the Norwegian beaconage message are direct extensions of the lateral system of buoyage.

West Germany ranks along the largest users of unlighted beacons.⁴⁸ There are six types in the system, of which two are structural and the remaining four are either simple constructions or have a natural character. The later four include two variations of multiple pilings,

the small tree or petit arbre, and the perch or pole beacon. Each of these daybeacons can be found on either the starboard or port-hand sides with the exception of the small tree, which is found only on port-hand sides for channel edges. The message characteristics of color and topmark are identical to those of buoys in parallel positions.

Structural beacons are found in junction and bifurcation, middle ground, and shoal and danger situations. Buoys lack topmarks though some of the corresponding daybeacons have them - at least before IALA. Structural marking topmarks - in junction and bifurcation locations - include a black triangle with the apex up when the "main channel is to the left" and a red rectangle, with the long dimension vertical, when to the right.⁴⁹ The mark has a red and black vertical striped oval "when channels are of equal importance then it is a black cross over a black and red vertically striped oval." Shoals and isolated dangers within the channel may be passed on either hand" and these have a single type of topmark consisting of a black oval atop the structural mark.⁵⁰

This pattern diverges for "shoals and isolated dangers outside the channel" in the cardinal system.⁵¹ In these instances, the structural beacons are joined by perch or pole beacons. The color messages follow the buoy pattern, but the topmark symbols are different. For the northern quadrant the structural mark topmark - and in all cases only this type has topmarks - is a double triangle with the point up; the western quadrant has two triangles, both black with one verted and one inverted inwardly. In the eastern quadrant the two triangles are arranged with bases in parallel, while in the southern quadrant there are two red triangles facing downward. The same marking, when on the shoal, exhibits the black oval.

The first edition of Volume I included U.S. daybeacons and daymarks in Part B rather than in Part D. Since Parts C and D are now separate from Parts A and B it is necessary to review characteristics of daybeacons and for that matter daymarks (referred to as dayboards in USCG manual publications but as daymarks in light list publications).⁵² Lateral markings (general usage) include square boards with "fluorescent green film" for the major color and green reflector borders for the border and reflective numbers for port; starboard utilizes the same materials but in red, and the board is a triangle.⁵³ Junction markers employ the same shapes with the agree-upon meanings. If the preferred channel is to port the triangle includes a letter in reflective red and the upper part of the triangle "filling" is red while the lower portion is green. If the preferred channel is to starboard the letter is green and the upper part of the marking is green, the lower portion red. Borders are green or red depending on the shape of the marking.⁵⁴ Mid-channel markers are eight-sided with white reflector border and letter. The filling is half white film and half black film.⁵⁵ Ranger markers are rectangular in shape with the long dimension vertical. They include three panels, and the panels are of one color and the center panel of the other.⁵⁶ Intracoastal waterway and western rivers markings follow the basic patterns but with some identifying variant message configurations.⁵⁷

While the coverage of daybeacons of other nations will not be extensive it can present some tentative remarks on the range and universality of daybeacons and of the spectrum of visual appearances of them. IHB publications include the message pattern of such markings for Argentina but does not include illustrations.⁵⁸ Argentine daybeacons can be found in fairways and channels, and in middle grounds. Color codes emulate the

buoyage pattern which was - before IALA - based on that of IMC.⁵⁹

Australia also maintains daybeacons but IHB in 1971 did not include illustrations.⁶⁰ Daybeacons are found in fairways and channels, middle grounds and danger situations; topmarks resemble those of buoys. Brazilian daymarks include perches or pole beacons.⁶¹ These include topmarks though the specific term topmark is not used. Buoys and daybeacons share the same messages. Topmarks for fairways and channels include triangles for port-hand, and waffle-patterned spheres for starboard-hand. An inverted double-cone topmark will be found on middle-ground markings. Miscellaneous topmarks include a square for isolated dangers, oval for submarine locations, and diamond-shaped for wrecks. Chilean beaconage is of three types: rectangles for port-hand; fairway and channel locations; elongated conical beacons for starboard positions, and rectangles with rounded tops for mid-channels.⁶² Color messages follow the buoyage regulations.

USNOO describes daybeacons for China but shapes are not given.⁶³ Colors for beacons can be white, red, or black. Seemingly white can be added to red or black marks. White can be either added to the topmark color or used exclusively. Shapes for topmarks are also absent from IHB for China.

Ecuador's single type of beacon is an elongated rectangle; the message of buoys applies to daybeacons.⁶⁴ France, according to IALA, has one of the more significant systems of beaconage, but neither the 1956 or the 1971 edition of the IHB buoyage publication includes any beacons for France.⁶⁵ According to the 1983 IALA survey, France has 2900 markings.⁶⁶ Finland has developed a daymark known as an "edgemark" and

Daybeacons and Daymarks



Australia



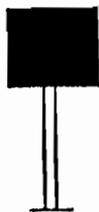
Brazil



West Germany



Italy



Brazil



Norway



Chile



Ecuador



Various Nations



Indonesia



Sweden



Sweden, et.al.

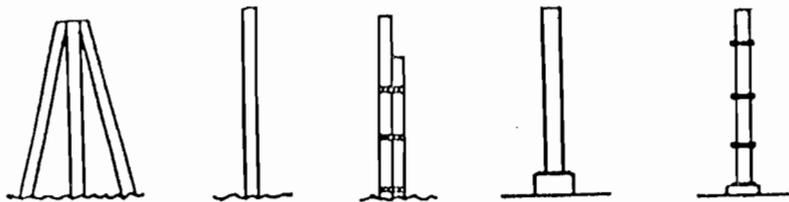


Sweden



Japan and South Korea

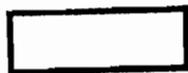




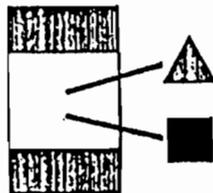
U.S. Coast Guard: Daybeacon Supports



U.S. Coast Guard: Daymark Forms



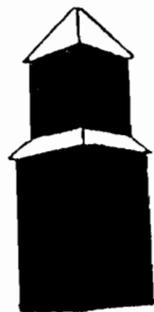
U.S. Daymark



Canadian Daymark



Range Daymarks:
Canada U.S.



Finnish



Daybeacons



this is an important aid to navigation for Finland; the name clearly indicates its function.⁶⁷

Indonesian beaconage includes a feature possibly unique to that nation.⁶⁸ The perches or spars employed include reflectors but not those found in other nations. The reflectors consist of mirrors arranged in vertical groups of three. By holding a light on the reflector the light, of course, will be "bounced" back to the ship. According to DMA Sailing Directions, "to prevent being dazzled, it is recommended that only ordinary flashlight batteries, with a high concentrated light be used."⁶⁹ It is estimated that the mirrors can be picked up as much as a half-mile away. Indonesian daybeacons follow the buoyage color pattern as determined for fairways and channels. According to DMA, the fixed beacons are spars not perches; the difference with the IHB characterization may be one of semantics. Port-hand beacons are painted black with one or two verted black cones.⁷⁰ Port-hand beacons with mirror reflectors emit a "white or green glow." For starboard beacons the glow is red or white; these also have a cylinder shape for the daybeacon.⁷¹

Japan and South Korea have identical buoyage and beaconage systems according to IHB.⁷² Their single type of daybeacon is illustrated but not named in IHB. This marking is found in channels, fairways, mid-channels, and isolated dangers. It follows the buoyage message descriptions. IHB lists no daybeacons for Malaysia though DMA does so.⁷³ The daybeacons are not described, though possibly they occupy pile structures as do lighted aids for Malaysia. Day messages possibly emulate lighted messages of red to port and white to starboard.

Daybeacons of the Netherlands are exclusively perch in form.⁷⁴ The perch takes the shape of a small tree. Starboard perches follow the parallel buoy messages and the perch in that position

has the branches tied down. Port-hand perches exhibit tree branches in the natural mode. They are found only in fairways and channels. IHB does not list daybeacons for the USSR though DMA does so.⁷⁵ These are of a wooden framework structure and presumably follow buoyage message patterns. An older DMA publication lists luminous and non-luminous signs instead of the framework.⁷⁶

Endnotes for 18A, B, C, and D

¹IALA Bulletin, 1979-2, "Development of Aids to Navigation During the Year 1977," p. 23.

²IHB publications use the terms beacon and beaconage for both lighted and unlighted aids.

³For lighted beacons the phrase is "Lights on fixed structures" (IALA Survey 1979, pp. 21-2).

⁴WTNID, 1961, Vol. 1, p. 189.

⁵USCG, Light List, Pacific, Vol. III, 1985, p. x.

⁶IDAMN, 2-6-030.

⁷IALA Survey, 1984/3, pp. 16, 18.

⁸DietaI and Lehman, Seefahrts-Worterbuch. Verlag Munchen, 1964, p. 57.

⁹IHB uses the term beacon at times for both lighted and unlighted types; at other times this applies only to unlighted, or only to lighted.

¹⁰USCG, Light List, Pacific, Vol. III, 1985, p. x.

¹¹IALA Bulletin, 1979/2, p. 31.

¹²Bowditch, 1966, p. 920; see also USCG light lists.

¹³IDAMN, 2-6-030.

¹⁴IHB, 1971, p. 57.

¹⁵⁻²⁰Stevenson, D. Alan, The World's Lighthouses Before 1820. New York: OUP, 1959.

²¹Lang, A.W. Entwicklung, Aufbau und Verwaltung des Seezeichenwesens an der Deutschen Nordseekuste bis zur Mitte des 19. Jahrhunderts. Der Bundesminister Fur Verher, Bonn, 1965, pp. 105-06; IHB, 1971, p. 36.

²²It would appear that the various terms are broad in meaning rather than narrowly focused on a given meaning; if this is not the case then there is a possible, or probable, misuse of many terms.

²³Possibly this is due to the fact that IALA perceives the expression as a French word, and thereby translates the term perch as pole for English language usage; IALA Survey 1979/2, p. 20. The Navigation Dictionary (USNOO, 2nd. ed. 1969, Washington, D.C.: GPO, p. 186) includes perch as an English language term. The International Maritime Dictionary of Rene' De Kerchone, 2nd. ed., 1961, D. Van Nostrand, p. 577) lists perch as English and perche as French.

²⁴J.M. O'Connell, USCG, letter to writer, Nov. 19, 1974, and mimeographed handout, "Fixed Aids to Navigation," p. 3.

²⁵It is difficult to determine the correct measure of details in a classification. John Fowles comments ("Seeing Nature Whole," Harper's, November 1979, Vol. #259, pp. 49-70) that it was a regrettable habit of Victorian science to minutely dissect living organisms into categories and subcategories. In the twentieth century the tendency of science is to classify less minutely and to present the larger situation in a given study. The purpose of this classification - which, obviously, does not deal with living organisms - is not to create minute classifications for the sake of

near-microscopic precision but to allow for eventual and more accurate study of the subject. It seems preferable to tentatively subdivide excessively than to create a few categories which may be inadequate, or worse, overshadow and obscure necessary distinctions which may be later lost from sight altogether.

²⁶Canadian daybeacons are listed, in most instances, by the daymark portion only; the light lists usually do not include support structures which are presumably obscured from the mariner's view.

²⁷According to the 1964 edition of the USCG Manual, Chapter 4, "Structures," pp. 4-18 and 4-19, they measure either 3'7" or 4'6" on a side.

²⁸For example, Waterford Light (Columbia River in the State of Washington) is listed as a small house in the 1962 Pacific Light List, but after the addition of a daymark it was re-listed as a daymark only, since the house was thereby largely obscured; see new editions of the light list.

²⁹An example of a composite daymark/structure would be that of the Honga River daybeacon on Tangier Sound in Maryland (Atlantic Light List, Vol. I, 1979, p. 411). The aid is a "square green on black slatted pile structure." Obviously since the painted surface is an integral part of the marking there is no way of separating daymark and underlying structure.

³⁰For example, this is the practice in the Netherlands according to IHB, 1971, p. 52.

³¹IDAMN, "Cairns," 2-6-055.

³²USNOO (DMA), Sailing Directions, Soenda Strait and Western and N.E. Coasts of Borneo and Off-lying Islands. Rev. ed., 1975, pp. 9-10.

³³IDAMN, 2-6-055.

³⁴For example, Craig Point Daybeacon, Alaska, p. 204 of Pacific Light List, 1979.

³⁵IHB, 1971, p. 36.

³⁶IHB, 1971, p. 57.

³⁷IMC, Vol. II, pp. 1388-89. The "Final Act" ("General Division 12") is entitled, "A Uniform System of Buoys and Beacons" but a) and b) mention buoys only. There is a reference to "marks on a rock in fairway" but that is the only explicit reference.

³⁸See above, and Vol. I, p. xii, "Program of subjects, Uniform system of buoyage and beaconage."

³⁹IMC, Vol. II, p. 1322.

⁴⁰Records and Texts of the Conference for the Unification of Buoyage and Lighting of Coasts: Section IV, "Records of the Work of the Committee." Lisbon, 1930, and Agreement for a Uniform System of Buoyage and Rules Annexed Thereto, Geneva, 1936.

⁴¹DMA, Pilot Chart of the North Pacific Ocean Area, 1977.

⁴²⁻⁴³See above.

⁴⁴IALA, 1979, p. 31.

⁴⁵IALA, 1979, p. 37.

⁴⁶CANS, p. 5. Note: All references to Canadian daybeacons in this section are to the same publication. See also USCG Light Lists, Pacific Coast, "British Columbia."

⁴⁷IALA Survey, 1984/3, p. 17; IHB, 1971, p. 57. Note: All references are to IHB in this section except the first, which is from IALA.

⁴⁸IHB, 1971, pp. 33-38. All references are to that source; direct quotes are listed separately.

- 49-51 See above.
- 52-57 USCG, Aids to Navigation-Technical Manual, 1979, Chapter 5, "Daybeacons."
- 58-60 IHB, 1971, p. 11.
- 61 IHB, 1971, p. 15.
- 62 IHB, 1971, p. 19.
- 63 USNOO, Sailing Directions for Western Shores of South China Sea: Singapore to Hong Kong, Rev. ed., 1976, p. 11:
- 64 IHB, 1971, p. 26.
- 65 IHB, 1956, p. 26; IHB, 1971, pp. 49-77.
- 66 IALA, Survey, 1984/3, p. 16.
- 67 IALA, Survey, 1979/2, p. 21.
- 68 IHB, 1971, p. 44.
- 69 USNOO, Sailing Directions, Soenda Strait
pp. 9-10.
- 70-71 See above.
- 72 IHB, 1971, pp. 48-49.
- 73 USNOO, Sailing Directions, Soenda Strait
pp. 9-10.
- 74 IHB, 1971, p. 52.
- 75 USNOO, Sailing Directions for the Northern USSR, Rev. ed., 1975, Vol. II, pp. 13-14, 17-22.
- 76 Vol. III of above, Rev. ed., 1976, p. 14.

Notes for Daybeacon Illustrations

- Page 156, Computer graphics based on IHB
- Page 157, Row I, Left two, computer graphics based on IHB
Row Middle two, IHB
Right two, computer graphics based on pre-IALA Italian buoyage system.
- Row II Computer graphics based on IHB, and Norwegian seamarks
- Row III, IHB
- Row IV, Left three, Svenska Sjukort, Right, IDAMN
- Row V, Left two, Svenska Sjukort.
Right two, IHB
- Page 158 Row I, USCG Manual, 1979
Row II, USCG Manual, 1979
Row III, Left, USCG Manual, 1979
Left-center, CANS,
Right-center, CANS
Right, USCG Light List
Row IV, Board of Navigation, Helsinki

CHAPTER NINETEEN

ELECTRONIC MARINE AIDS TO NAVIGATION

19A Overview and History

Active electronic markings constitute a numerically small but important part of marine aids to navigation. They also constitute a complex and not easily understood component of marine aids. Worldwide, there are little more than 1300 active electronic markings, though some 23000 additional passive markings known as radar reflectors are in use.¹ The significance of electronic devices in marine safety is far greater than the limited number of active aids that are in service. Few electronic markings have a range of less than 10 miles (ca. 16 km.) and most have a range of more than 20 miles. Some types of hyperbolic markings have a range that extends into the thousands of miles. This contrasts with visual markings many of which cannot transmit as much as 10 miles and only a tiny fraction can emit light waves much more than 20 miles.

The various forms of electronic markings share two significant features: All of these aids transmit electromagnetic waves (those that are active), and all - in some sense - are locational markings. This study requires subdivisions of such markings beyond that basic level. The first subdivision is that of the radiobeacon. The radiobeacon is the oldest and numerically the largest segment of electronic markings. They were first established in 1921 and have continued to maintain navigational importance to the present time.² The radiobeacon is a form of beacon - as the name clearly suggests - though through the use of electronic waves instead of light waves. Radiobeacons provide a clear

indication to the mariner of the ship's location in relation to a specific radiobeacon and the harbor or other geographical features represented by that radiobeacon.³ The low-powered radiobeacons known as marker beacons perform less of a locational function and more of a homing function.

A second category of electronic markings is that of radar. Radar is of immense importance to the mariner but has limited direct significance to navigation. The most important use of radar in aids to navigation is in the form of radar reflectors. Radar reflectors represent a passive and indirect use of radar; it is more of a "sounding board" for shipboard radar units than an actual radar mechanism.⁴ The reflectors "capture" the radar unit's sweep and therein provide more efficiently information about obstructions and channels especially in reduced visibility; natural objects and artificial objects without reflectors can be picked up by radar but less adequately. Active radar in the form of radar beacons and racons finds limited duty for special purposes including the marking of wrecks.

The electronic markings so far described are of short-range capabilities. Longer-range aids require different approaches. The principal approach to date is hyperbolic radio-navigation systems.⁵ The name hyperbolic comes from lines of position (LOP) known in geometry as hyperbola or hyperbolic lines.⁶ These lines are produced by various types of transmission equipment and when received can be translated into a moderate to highly precise determination of the location of the ship. The hyperbolic systems differ in a variety of ways, but the production of hyperbolic lines from multiple station, thereby creating intersecting lines, is a constant of the various systems. The older radio-navigation systems, such as Loran-A and Decca, provide navigation assistance from 300 to

to approximately 900 miles.⁷ Neither is capable of what might be termed hemispheric or global range; Loran-C is capable of those ranges. And the newer OMEGA offers worldwide assistance.⁸ Miscellaneous systems, such as Consul and Toran, offer medium-distance assistance to shipping.⁹

The history of electronic markings systems is relatively brief. Radiobeacons, as already mentioned, date back to the second quarter of the century.¹⁰ World War II provided the major impetus for many other developments. For example, radar, though originating in the 1920s, did not become a practical communication and navigation system until World War II.¹¹ And it did not become a commercial possibility until 1946.¹² The beginnings of Loran were also in World War II.¹³ Developments that led to Loran-C occurred in the postwar era.¹⁴ Decca also became a reality in the early postwar period.¹⁵ Further historical details will be found with the coverage of various electronic markings.

19B Classification and Explanatory Notes

The brevity of this classification may seem to belie the significance of electronic markings. This brevity is easily explained. Most of the complexity is to be found with the messages themselves, not with the structural and physical dimensions of the aids (which is contrary to visual forms of markings). And since the classification is centered on the forms of markings there is only a limited amount of information to classify; this is especially true of some of the most vital electronic markings: the hyperbolic radio-navigation systems. The complexity of the classification is to be found mostly with the more peripheral and passive markings.

261. Radiobeacons. This classification shows a plethora of types but the major forms are the

non-directional types that are of the sequence or the continuous forms (2613, 2614).

262. These aids listed as active have an electronic mechanism integral to the marking though of different forms.

263. Radar reflectors represent the peripheral and complex portion of the classification. The physical structures are multiple in form and hence the detailed treatment of them.

264. The dominant form is the Loran-C marking but the others remain operational though of limited usage.



Classification of Electronic Transportation Markings

- 261 Radiobeacons
 - 2611 Rotating
 - 2612 Non-Directional: Circular, Omni-Directional
 - 2613 Non-Directional: Sequence, Group
 - 2614 Non-Directional: Continuous
 - 2615 Directional: Sequence, Group
 - 2616 Directional: Continuous
- 262 Radar: Active
 - 2621 Primary Radar: Racon
 - 2622 Secondary Radar: Ramark
- 263 Radar: Passive: Radar Reflectors
 - 2631 Corner Reflector: Trihedral (Corner - simple)
 - 2632 Corner Reflector: Pentagonal (Corner - five cluster)
 - 2633 Corner Reflector: Octahedral (Corner - eight cluster)
 - 2634 Dielectric Reflector
 - 2635 Dihedral Reflector
 - 2636 Luneberg Reflector
- 264 Hyperbolic Radio-Navigation Systems
 - 2641 Loran-A
 - 2642 Loran-C
 - 2643 Decca, Regular¹⁶
 - 2644 Decca, Dectra¹⁷
 - 2645 Omega
 - 2646 Consul¹⁸
 - 2647 Toran
- 265 Satellite Navigation
 - 2650 Global Positioning System
 - 2651 Transit

19C Descriptions of Types and Message Systems:

Hyperbolic Systems

This coverage will begin with Loran (2641 and 2642) and end with Toran (2647). Loran is an acronym constructed from the words Long Range Navigation.¹⁹ It is the oldest of the hyperbolic systems of navigation presently in use. It is one of two such systems with trans-regional capabilities. More precisely, Loran coverage extends over most of the hemispheres including the North Pacific from North America to Asia, the North Atlantic from North America to Asia and northern Africa; the Arctic Ocean basin and the Mediterranean Sea area.²⁰ While only a few nations maintain Loran stations, the character and range of Loran do not preclude wide coverage. The U.S. maintains 87% of the Loran-C stations, and Japan operates 73% of the considerably reduced Loran-A system; Canada and Denmark operate the remainder of the Loran-A stations, and Canada, Denmark and Tunisia the remaining Loran-C stations.²¹

The significant change in Loran has not been in the total number of stations but in the type of operating units. The U.S. has phased out Loran-A stations and replaced with Loran-C. However, Loran-A (according to moderately current figures) is not altogether obsolete.²²

While Loran-A and Loran-C are hyperbolic in nature they vary to some degree from other hyperbolic approaches. Omega and Decca both contain continuous wave transmission systems, but Loran utilizes pulsed wave transmissions.²³ In addition, Loran is based on a time measuring approach while Omega and Decca determine positions through measurements of phases.²⁴ Loran-A and -C, as well as other hyperbolic systems, operates on a master/slave station arrangement or some form of multiple-stations or multiple transmissions.²⁵

A type of Loran known as the "B" type has been developed but never placed in practical navigation situations.²⁶ It uses the same frequency as "A" but achieves greater accuracy through matching cycles as well as matching "envelopes."²⁷ Loran-B has potential for application in coastal and restricted waters since it is capable of high accuracy.²⁸ Recent documents suggest that Loran-C has the capabilities for that specialized usage, and this may eliminate the possibility of "B" gaining practical use in actual navigation operations.²⁹

In simple terms, Loran uses short-pulse radio broadcast from two stations that are paired.³⁰ Ships require special receivers to benefit from Loran.³¹ The radiobeacon by contrast needs only standard equipment. An indicator in the ship-board receiving set indicates the "difference in time of arrival of the signals" from the transmitting unit, which permits the receiving operator to calculate a "Line of Position" (LOP).³² The calculation of two such LOPs is "crossed to obtain a loran fix."³³ This Loran fix is the location of the ship.

Even though Loran-A is dwindling in use it remains of practical significance. It is therefore appropriate to review "A" in some detail. Loran-A operates on a frequency of 2000 Kc.³⁴ Each station consists of a master and slave unit; in some instances one station serves two pairs. The multiple-use stations directly transmit different signals for each pair.³⁵ At the medium frequencies employed by "A" both ground waves and sky waves are utilized.³⁶ The use of ground waves is a factor in the lower accuracy of "A". At night "A" is capable of being reliably received up to 1400 nautical miles, and during the from 600 to 900 nautical miles.³⁷ The equipment for an "A" station includes a transmitter, an amplifier, and a timer.³⁸ The last named

component supplies timing or trigger impulses which in turn activate the transmitter's pulse emissions. The pulse is set by the master station according to stated and determined practices; the slave unit adjusts its transmissions to the master unit as necessary.³⁹

The reception of the signals aboard ship is through a radio somewhat similar to standard receivers though modified to Loran requirements.⁴⁰ The receiving unit does not transmit the information to a loudspeaker but to an indicator.⁴¹ This indicator is "essentially an electronic watch, whose time record is made visible by the use of a specially designed cathode ray oscilloscope."⁴² Readings of the time differences between the two station transmissions can then be determined and the position of the ship ascertained. To gain a position fix one must have two lines of position (LOP). This requires signals from two pairs of stations, or a Loran chain in which one master or slave station has a double transmission function.⁴³ Since "A" has both ground and sky waves it is necessary to match ground wave impulses with those of other ground waves. Problems result if ground and sky waves are mixed.⁴⁴

The Loran-C system extends and improves the older "A" system. It differs in transmission frequencies and in the measurement of time differences.⁴⁵ The results mean a much greater range and a greatly increased accuracy. "C" operates on the low frequency of 90 to 100 Kc.⁴⁶ This contrasts with the medium frequency of "A." Each installation comprises a master station and two or three slave stations.⁴⁷

Measurement of Loran-C signals is by two methods. Time measurement of the differences in the arrival of signals is augmented by time measurement of the carrier frequency.⁴⁸ The master and slave stations, the components, of which are

synchronized, emit a total of eight pulses per transmission; Loran-A emits a single pulse per transmission.⁴⁹ In addition, the master station has a ninth pulse for identification of the station itself.⁵⁰ Since master and slave engage in sequential transmission with an identical "repetition rate," it is feasible for the vessel to compute two time measurements without altering channel settings; the changing of channels was necessary in order to compute two measurements with "A."⁵¹ Each chain emits an agreed-upon four-digit number and also a group repetition interval designation.⁵²

The use of low frequency brings about transmission synchronization which expands coverage but with the same amount of radiated power.⁵³ Expanding the area covered also means that more of the position line crossing angles are nearer to 90 degrees, and this increases geometric accuracy.⁵⁴

Loran-C had its origins in the late part of World War II. The early experimentation developed problems in achieving high accuracy.⁵⁵ Nevertheless, the experiments indicated that much greater range was possible than with Loran-A.⁵⁶ During 1946, the "Cyclan" project in the eastern U.S. developed the nucleus of the desired new Loran system, which was termed "Cytac."⁵⁷ This experimental Cytac became the present Loran-C with only limited changes.⁵⁸

Decca, a separate hyperbolic system, is based on continuous wave transmission, and on phase comparison measurement.⁵⁹ It operates at approximately 100 KHz and has a daytime range of about 250 miles; the nighttime range is somewhat less.⁶⁰ Each station consists of a master station and two or three slave stations.⁶¹ The slave stations are 70 to 100 miles from the master unit.⁶² Each station transmits a continuous wave at a different frequency, the four frequencies for a chain being

in the ratio of five, six, eight, ten and the entire group in the seventy to one-hundred and thirty Kc band."⁶³

Measurement consists in determine the difference in wave-length received. The receiver is at variance with standard receivers and even hyperbolic receivers of other types.⁶⁴ Put briefly, the receivers, and these are of several types, receive the chain's signals on different frequencies and these are then "brought to a common comparison frequency within the receiver."⁶⁵ The receiver does not merely indicate incoming data to be processed, but carries out a significant role in assembling the data which are then interpreted.⁶⁶ The incoming data create "three intersecting hyperbolic patterns," but mariners do not use all three patterns for determining a position.⁶⁷ They select the two patterns providing the best data for determining position, and the remaining patterns are ignored.⁶⁸

The Decca system was developed during the immediate post-World War II period and is primarily a British development.⁶⁹ The system is extensively used in some areas though it is not global in scope. Some expansion of it has taken place; oldest operating stations are in south-east England (1947) and in Denmark (1948).⁷⁰ Major areas of usage include Western Europe, South Africa, India and Japan.⁷¹

Omega is a hyperbolic system of worldwide capabilities that transmits on a very low frequency channel of 10 to 14 Khz.⁷² Contrary to Loran, it emits a "phase-difference measure technique" instead of the time-difference technique of Loran-A and -C.⁷³ Omega shares the phase-measurement approach with Decca. Omega's foundations date back to the work of J.A. Pierce of Harvard University in 1947.⁷⁴ Subsequently, an experiemental system was developed by the U.S. Navy at San Diego.⁷⁵ This predecessor of

Omega, termed Radux, had a broadcast frequency of 50 Khz.⁷⁶ Radux had a range of approximately 2000 miles and an "accuracy of three to five miles."⁷⁷ While Radux demonstrated the feasibility of very low frequency transmissions and the validity of phase-difference measurements, it lacked sufficient range and was excessively inaccurate.⁷⁸

As a result, a second system was developed that emitted a combined VLF signal of about 10 Khz with the original LF signal of 10 Khz; this second experiment was termed Radux-Omega.⁷⁹ In order to expand the range of transmissions the LF signal, the Radux portion, was eliminated and the eventual result was the present Omega with its multi-frequency characteristics.⁸⁰

Hyperbolic systems, as previously noted, normally employ a master-slave station format, and early Omega followed this pattern. But through the use of a "bank of cesium frequency standards" which brings about the vast range of Omega there is no need for specific pairing of any of the eight worldwide stations.⁸¹ A mariner can pair any two stations in the world to gain a locational fix for the ship.⁸² The system, however, remains a hyperbolic-based positioning navigation aid. The fact of a system composed of little more than a dozen stations encompassing the entire globe suggests the immense range and possibilities of Omega.

Omega, through the utilization of VLF frequencies, gains reliable transmissions for many thousands of miles, and these transmissions are predictable with at most very slight error.⁸³ The stations time-share frequencies, and because of this sharing the system allow for a high quality fix in any location; errors in determining locations are also minimal.⁸⁴ The means for selecting of LOPs are akin to choosing lines of

position in celestial navigation. This further indicates the worldwide character of what is, to date, the most advance navigation system.

19D Descriptions of Types and Message Systems:

Radio and Radar

Radiobeacon, the oldest part of electronic markings, became operative in 1921 - at least in the U.S. - which was shortly after the beginning of commercial radio.⁸⁵ The first three stations began operation in May of 1921, and by 1925 more than a dozen beacons were functioning.⁸⁶ In the earlier history of radiobeacons they were frequently referred to as "radio fog signals," which denotes an important function of such markings, though not the only one.⁸⁷

Bowditch defines the radiobeacon as a "radio transmitter emitting a characteristic signal to permit a craft with suitable equipment to determine its direction, distance, or position relative to the beacon."⁸⁸ IDAMN concurs except for omitting a position determining capability for radiobeacons.⁸⁹ The radiobeacon lacks the intersection lines of a hyperbolic system.⁹⁰ The radiobeacon is a single-unit station in its operation; that is, it does not have the master/slave dimension common to hyperbolic stations and the resulting grid patterns.⁹¹ However, one English source suggests that cross-bearings can be gained through placing a fix on two radiobeacon stations; hyperbolic systems are normally utilized for that purpose.⁹²

The radiobeacon clearly indicates its function by its title; this is contrary to many electronic aids which have almost Orwellian names. The radiobeacon is a radio transmitter with a specialized function, yet it is similar to other transmitters. The radiobeacon is also a beacon:

the sending out of impulses by a single station to mariners, though through different forms of waves. Radiobeacons can provide three kinds of navigation services. Some serve as regular beacons and provide an ongoing message.⁹³ A second type transmits in all weather but increases its transmissions in fog conditions.⁹⁴ The final version emits messages only during times of fog.⁹⁵

Canada and the U.S., which are the largest operators of radiobeacons, normally operate radiobeacons according to the beacon service pattern.⁹⁶ Clear weather beacons include those stations that function less frequently than beacon service but whose transmissions are expanded "during periods of fog or low visibility."⁹⁷ The third type is limited to fog signal usage exclusively.⁹⁸ Calibration radiobeacons provide a service for mariners wishing to improve the accuracy of direction-finding equipment aboard ship.⁹⁹

While some radiobeacons operate alone, many or most operate in groups. Dutton suggests a group sequence pattern of three radio beacons per group, but in the U.S. and in Canada the stations "operate in groups of six, each station in a group using the same frequency and transmitting for one minute in its proper sequence."¹⁰⁰ Low-power marker radiobeacons function singly for local use at entrance to bays, harbors, and rivers.¹⁰¹ An European agreement reached in 1933 established a pattern of regional control and organization for radiobeacons which had the goal to end confusion of overlapping stations.¹⁰² Some North American radiobeacons are synchronized across national boundaries as well.¹⁰³

Station identification is accomplished through dot and dash patterns which are frequently outside the Morse code system though some do follow that system.¹⁰⁴ In some countries special combined radiobeacons and fog signals

are maintained. These radio direction finding stations synchronize the radio beacon message with that of a sound signal.¹⁰⁵

According to the IALA survey there are about 790 radiobeacons in operation.¹⁰⁶ Of these the U.S. has about 29% and Canada about 15%. Japan, France and Norway operate another 18% and England/Wales, South Africa and Denmark 11% of the radiobeacons.¹⁰⁷ So these eight nations are responsible for over 70% of the surveyed radiobeacons.¹⁰⁸

Most radiobeacons are either omni-directional or non-directional. This means that the aids can be picked up by shipboard receivers in all directions.¹⁰⁹ A small number of radiobeacons are directional and therefore can be received in specific directions only.¹¹⁰ All of these beacons are operated by Japan, and they are a combination of directional and non-directional types.¹¹¹

Dutton and other sources classify radiobeacons by range of signals. According to Dutton, "A" range is 200 miles, "B" is 100 miles; "C" transmit up to 20 miles, and "D" a modest 10 miles.¹¹² This classification strongly suggests the short-to-medium-range character of radiobeacons.¹¹³

In summary, radiobeacons continue to occupy an important role in navigation. They are no longer the only electronic aid but their role is, if anything, greater as more and more beacons are added to various national aids to navigation systems.

Radar transportation markings are of three types: ramarks, a form of primary radar; racon, a type of secondary radar; and radar reflectors, which can be described as a variety of passive radar.¹¹⁴ "Ramark" is from the words radar (ra-), and mark.¹¹⁵ Primary radar reflects signals without being "ignited" by the radar

capabilities of shipboard installations.¹¹⁶ Ramark broadcasts are continuous and omni-directional.¹¹⁷ They indicate bearings for a ship but they do not provide distance or range information; a shipboard radar unit, attuned to a ramark unit, receives a "radial line at the bearing of the beacon."¹¹⁸ According to the IALA survey there are slightly over 40 Ramarks, of which Japan has about 60% and Canada just under 40%.¹¹⁹

Secondary radar units, including the racon, need to be triggered before they will transmit the desired pulse; the trigger is the shipboard radar set.¹²⁰ Racon is also regarded as a transponder beacon and at times is included under that designation.¹²¹ In some instances racons produce an individualized code signal, while in other instances the racon emits an unvarying signal; the codes are in the form of dots and dashes.¹²² An uncoded signal is formed by a radial line in the receiver.¹²³ Major users of racons include Canada, Finland, the U.S., England/Wales, Scotland and Denmark.¹²⁴ All racons provide both bearing and distance information; coded racons also provide identification of the specific beacon.¹²⁵ Racons are especially valuable for the marking of wrecks.¹²⁶

Radar reflectors are not in strict terms a form of radar but are rather a "device specially arranged to have the property of reflecting incident electromagnetic energy parallel to the direction of incidence to enhance the radar response."¹²⁷ In simpler terms, they may be described as "certain aids to navigation fitted with special features designed to enhance their ability to reflect radar energy."¹²⁸ Radar reflectors are then objects better able to provide a surface on which radar waves can "bounced" off or be reflected off, and superior to natural and artificial objects' capabilities. In a loose turn of phrase, they can be called passive radar

since they are closely tied to forms of active radar transmission. Radar sets can pick up reflections from other objects, though less precisely and less adequately.

According to the 1983 IALA survey, the U.S. has nearly 70% of radar beacons, Canada has 10% and other large users an additional 13%.¹²⁹ Radar reflectors can exhibit a variety of surface forms. IDAMN lists six possible variations: Trihedral or corner reflector, dielectric, dihedral or right angle reflector, Luneberg reflector or Luneberg lens, octahedral cluster (with eight corner reflectors), and the pentagonal cluster (with five corner reflectors).¹³⁰ They range in complexity from simple two-dimensional surfaces to complex units of eight faces.¹³¹ However, the various forms represent a single type of marking, and light lists do not distinguish between the diverse and nuanced differentiations.¹³²

19E Miscellaneous Navigation And Non-Navigation Systems

Consul and Toran represent two final systems of electronic aids to navigation. Neither is of major significance either regionally or globally. Consul existed as a single station in France, and Toran consists of six stations in France and one in the Netherlands.¹³³ Consul is a derivative of the German Sonne system of World War II and a close companion of that system.¹³⁴ It has been classified as hyperbolic by one source, and azimuthal by another; effectively, it can be regarded as a radiobeacon system though it is of great range and of more precise accuracy than conventional radiobeacons.¹³⁵ Consul has a range of 500 nautical miles in daylight and 900 to 1500 nautical miles at night; it transmits on a medium frequency.¹³⁶

In essence, a Consul installation consists of one transmission station and it provides both directional and rotating radiobeacon characteristics. The transmissions are of medium frequency and these are emitted from three antennae.¹³⁷ "Due to the method of feeding the antennas, the earth's surface from the user's point of view is divided into alternate dot and dash sectors."¹³⁸ During a complete period of transmissions the mariner will hear three transmissions: a "continuous sound of short duration called the equisignal and this will be preceded and followed by cadenced signs (first dots then dashes or vice versa). The count of these signs supplies the user with [her/]his angular position within the section or sector where he [her/] is located."¹³⁹ No special receiver is required with the Consul system. Any standard receiver which can receive medium-frequency waves that are continuous will suffice. This receiver also requires only a "narrow band-pass" if it should lack "automatic gain control."¹⁴⁰

In 1960 there were functioning Consul stations in Western and Southern Europe and a similar version, termed Consolan, on the Eastern coast of the U.S. Only the French station remains.¹⁴¹

Toran is listed as a hydrographic aid in IHB publications.¹⁴² But both IDAMN and IALA list it as an electronic aid to navigation.¹⁴³ It is a hyperbolic system capable of precise information. The ship "can obtain its position by the determination of the phase differences between the HF waves emitted by a pair of confocal transmitters and the transmission from a fixed reference transmitter."¹⁴⁴ It has a range of about 300 miles.¹⁴⁵ The emissions come from a frequency of about 2 MHz.¹⁴⁶ IHB speaks of several applications, but none are specifically for general navigation.¹⁴⁷ IHB perceives Toran as aiding harbor works such as dredging and surveying.¹⁴⁸

There are a variety of hyperbolic systems in use that are outside the transportation markings spectrum. These systems find use in surveying and other hydrographic projects. They are not part of this study, but because they are related to - and touch upon - transportation markings and maritime matters it is necessary to briefly consider them here. Many publications on transportation markings include references - and even extended treatments of - hydrographic hyperbolic systems, and it is therefore necessary to delineate between aids to navigation and hydrographic electronics.¹⁴⁹ There are instances in which a variation of a hyperbolic aid to navigation is in use for hydrographic purposes; the reverse also seems to be true. Hyperbolic systems which are directly related to one or other areas include Lambda, Hi-fix, Raydist, and Shoran.¹⁵⁰

Lambda, an acronym formed from Low Ambiguity Decca, follows the basic feature of Decca.¹⁵¹ However, the master station is aboard ship and the system is designed for hydrographic purposes.¹⁵² A second "phase comparison position fixing system" is that of Hi-fix. It operates at a higher frequency than Lambda and has a shorter range, but it is also a derivative of Decca.¹⁵³

Raydist, of which there are four types: M, N, DM, and F, are "continuous wave phase comparison systems used principally for precision location of a vessel in survey operations."¹⁵⁴ Raydists operate in medium- to high-frequency channels; Raydist M and N are hyperbolic, while DM and F employ a variant approach for gaining the needed coordinates for determining position.¹⁵⁵ Shoran, a separate system from Raydist, also utilizes "circular co-ordinates systems" for determining position and this too finds usage in survey work.¹⁵⁶

Toran is listed as a hydrographic aid in IHB publications, but IALA lists it as an aid to

navigation.¹⁵⁷ It can be considered so here, though it is also under the heading of Toran early in this section. Two final systems are Lorac and Rana. Lorac, a hydrographic system, is similar to the Raydist system.¹⁵⁸ Rana varies from most hyperbolic systems in that each of three units of the system "acts as a master for one frequency and as a slave for the other two frequencies."¹⁵⁹ The result is an approach that creates lines of position of great precision and without ambiguity.¹⁶⁰

In closing this survey of electronic markings it is necessary to review satellite navigation systems of Transit and GPS. The Transit system developed by the U.S. Navy, is also known as the Navy Navigation Satellite System or NSS; there is confusion on whether it is also known as NAVSAT. Transit began operation in 1964 and was available for shipboard usage in 1967. The system is hyperbolic in nature - as are many major shore-based systems. Transit is composed of five satellites in polar orbit at a height of 1110 m; the system broadcasts on frequencies of 150 and 400 MHz. There are about 150 shipboard receivers in operation.

Global Positioning System (GPS; also known as Navstar or Navstar-GPS) began development in 1973 and is now partially operational; full implementation has been delayed by the space shuttle disaster.¹⁶² GPS is very accurate, possesses universal availability and is simple in operation. Simplicity is a key factor in GPS: "the user can turn the set on without further adjustment begin to navigate accurately and continuously." Eventually 18 satellites are scheduled for the system. Six orbit planes will each contain three satellites. These transmit on frequencies of 1575.42 MHz and 1227.6 MHz and are in orbit 20 km above the planet. The user will be able to pick up signals from at least four satellites. Measurement of the incoming signals will give latitude, longitude and time information. GPS employs a pseudo-range and time measurement approach rather than a hyperbolic one. GPS may in time replace other systems. Both the USSR and Europeans are working on similar approaches.

Endnotes for 19A, B, C, D, and E

- ¹Bulletin 1' AISM/IALA, 1979-2, pp. 22-23.
- ²Weiss, U.S. Lighthouse Service, pp. 38-39.
- ³This is similar to the functions of unlighted beacons; not surprizingly, the term beacon is added to these radio signals; many electronic aids assist in determining location of vessels rather than relate a vessel to a pre-determined point on land.
- ⁴IDAMN, Ch. 4, Radio Aids, 1970, 4-3-525.
- ⁵IHB, Radio Aids to Maritime Navigation and Hydrography, 1970, p. 3.
- ⁶IHB, Ch. 4, "On Computing of Hyperbolic Lattices" of Radio Aids ...
- ⁷IHB, Radio Aids, Loran, II.2-03; Decca II.3-10.
- ⁸U.S. Navy Omega Project, Omega Navigation Systems: A VLF Radio Aid to Navigation.
- ⁹IHB, Radio Aids, Consul, II.4-01 ff; Toran, IDAMN, 4-4-340.
- ¹⁰Bowditch, p. 58.
- ¹¹⁻¹³Bowditch, p. 59.
- ¹⁴IHB, Radio Aids, pp. II-2-31 to II.2-33.
- ¹⁵IHB, Radio Aids, II.3-24.
- ¹⁶Only one form is in use but due to the development of DECTRA it seemed necessary to include it in the classification; "regular" denotes the single, standard form.
- ¹⁷IHB, Radio Aids, p. II.3-28.
- ¹⁸Consul based on Sonne, a German development in World War II; it is not in use; see p. II.4-01, IHB Radio Aids.
- ¹⁹IHB, Radio Aids, p. II.2-01.

- ²⁰USCG, Light List, Atlantic, Vol. 1, 1985, p. xxx; Pacific, Vol. 3, 1985, p. xxx.
- ²¹IALA, Survey, 1984/3, pp. 17, 19.
- ²²USCG, Light List, Atlantic, Vol. 1, p. xxx; IALA Survey, 1984/3, pp. 17, 19.
- ²³IHB, Radio Aids, p. 2.
- ²⁴IHB, Radio Aids, Loran, p. II.2-01; Decca p. II.3-01; USN, Omega Navigation Systems.
- ²⁵IHB, Radio Aids, p. II.2-02.
- ²⁶⁻²⁸See above.
- ²⁹If this compiler's understanding is correct.
- ³⁰⁻³³IHB, Radio Aids, p. II.2-02.
- ³⁴⁻³⁵IHB, Radio Aids, p. II.2-01.
- ³⁶IHB, Radio Aids, p. II.2-17.
- ³⁷IHB, Radio Aids, p. II.2-30.
- ³⁸IHB, Radio Aids, p. II.2-07 to 09.
- ³⁹⁻⁴²IHB, Radio Aids, p. II.2-09.
- ⁴³USCG, Light List, Atlantic, Vol. 1, 1985.
- ⁴⁴USCG, Light List, Atlantic, Vol. 1, 1985, pp. xxvii-xxviii.
- ⁴⁵⁻⁴⁸IHB, Radio Aids, p. II.2-31.
- ⁴⁹USCG, Light List, Atlantic, Vol. 1, 1985, pp. xxvii-xxviii.
- ⁵⁰IHB, Radio Aids, p. II.2-33.
- ⁵¹⁻⁵²USCG, Light List, Atlantic, Vol. 1, 1985, pp. xxvii-xxviii.
- ⁵³⁻⁵⁵IHB, Radio Aids, P. II.2-31.
- ⁵⁶⁻⁵⁷IHB, Radio Aids, pp. II.2-32-33.
- ⁵⁸IHB, Radio Aids, p. II.2-33.
- ⁵⁹⁻⁶⁰IHB, Radio Aids, p. II.3-05.

- 61-62 CANS, p. 8.
- 63 Bowditch, p. 345.
- 64-69 IHB, Radio Aids, Ch. II.3.
- 70-71 IHB, Radio Aids, p.II.2-24; IALA, Survey 1984/3, pp. 17, 19 (IALA refers to #71 only).
- 72 IDAMN, 4-4-245; Omega Navigation System, p.1.
- 73-84 Omega Navigation Systems, pp. 1-3.
- 85 Weiss, U.S. Lighthouse Service, pp. 38-39.
- 86 Weiss, pp. 38-39.
- 87 Weiss, p. 38.
- 88 Bowditch, p. 942.
- 89 IDAMN, p. 4-2-000.
- 90 Of course the radiobeacon is intended to aid the mariner to locate position in relation to a fixed object not to locate exact position of the ship in relation to geographical position.
- 91 Only radiobeacons and radar installations are single-station operations.
- 92 Bowen, pp. 43-44.
- 93-95 IDAMN, p. 4-2-025.
- 96 USCG, Light List, Vol. 1, Atlantic, p. xvi, CANS, p. 7.
- 97-99 IDAMN, 4-2-025.
- 100 Dutton, p. 235; USCG, Light List, Atlantic, 1979, p. xvi.
- 101 USCG, Light List, Pacific, Vol. III, 1979, p. xvi. (These have declined in usage, retained by Canada).
- 102 Bowen, p. 45.
- 103 CANS, p. 7.
- 104 USCG, Light List, Vol. III. Pacific, p. xvi.

- 105 IDAMN, 4-2-055.
- 106-108 IALA, 1984/3, pp. 17, 19.
- 109 IHB, p.II.1-06.
- 110 IHB, p.II.1-07.
- 111 IALA, Survey, 1984/3, p. 19.
- 112 Hill, J.C., Utegaard, T.F., and Riordan, G., Dutton's Navigation and Piloting. Annapolis (Maryland): U.S. Naval Institute, 1958, p. 25.
- 113 This does not mean that radiobeacons are one of those four figures; radiobeacons can vary from 10 to 200 miles and all points in between.
- 114 Bowditch, p. 323.
- 115 IDAMN,
- 116-117 IDAMN, p. 4-3-450.
- 118 USCG, Light List, Vol. III, Pacific, 1979, p. xiv.
- 119 IDAMN, pp. 4-3-005, 4-3-010, 4-3-420, and 4-3-455; see also USCG Light Lists.
- 120 IALA, Survey, 1979-2, p. 37.
- 121 IDAMN, p. 4-3-455.
- 122 USCG, Light List, Vol. III, Pacific, 1985, p. xix.
- 123-124 See above.
- 125 IALA, Survey, 1979-2, p. 37.
- 126 See Above
- 127 IDAMN, p. 4-3-525.
- 128 USCG, Light List, Vol. III, Pacific, 1985, p. xix.
- 129 IALA, Survey, 1984/3, pp. 17, 19; see also USCG, Light Lists; CANS.
- 130-131 IDAMN, pp. 4-3-530, -540, -550, -555.

¹³²IALA and other sources do not distinguish between types of radar reflectors and listing of lights and other aids to navigation.

¹³³IALA, Survey, 1984/3, pp. 17, 19.

¹³⁴⁻¹³⁵IHB, Radio Aids, p.II.4-01.

¹³⁶IHB, Radio Aids, p.II.4-01.

¹³⁷⁻¹³⁹IHB, Radio Aids, p.II.4-01.

¹⁴⁰IHB, Radio Aids, p.II.4-01; p.II.4-25.

¹⁴¹IHB, Radio Aids, p.II.4-26; II.4-29.

¹⁴²IHB, Table of Contents.

¹⁴³IALA, Survey, 1984/3, pp. 17, 19; IDAMN, 4-4-430.

¹⁴⁴⁻¹⁴⁶IDAMN, 4-4-430.

¹⁴⁷⁻¹⁴⁸IHB, Radio Aids, III.12-02.

¹⁴⁹For example, IDAMN does not distinguish between hydrographic and aids to navigation types, and IHB includes both in one volume though in separate sections.

¹⁵⁰IHB, Table of Contents; IDAMN, 4-4-25, 4-4-270, 4-4-305.

¹⁵¹IHB, Radio Aids, p. 2; IDAMN, 4-4-225.

¹⁵²IDAMN, 4-4-225.

¹⁵³IDAMN, 4-4-230.

¹⁵⁴IDAMN, 4-4-270.

¹⁵⁵IDAMN, 4-4-285 ff.

¹⁵⁶IDAMN, 4-4-305.

¹⁵⁷IALA, Survey, 1984/3, pp. 17, 19; IHB, Table of Contents.

¹⁵⁸IDAMN, 4-4-380.

¹⁵⁹⁻¹⁶⁰IDAMN, 4-4-390.

¹⁶¹McDonald, K., The Satellite As An Aid to Air Traffic Control, pp. 4-5,9; source for paragraph

¹⁶²Stansell, T.A., The GPS, IHB, July 1986. p. 51ff. See Also: Thompson, S.D. An Introduction to GPS, 1985. And source for remainder of paragraph.

CHAPTER TWENTY

MARINE SOUND SIGNALS

20A Introduction and Classification

With Explanatory Notes

20A1 Introduction

Fog signals are a vital though restricted form of transportation marking. Though not global they are significant within limited regions. Fog signals can be divided into three broad categories: floating, fixed and electronic. This segment focusses primarily on fixed forms of sound signals. The floating types are included with buoys since they are an integral part of buoys. Electronic aids, primarily consisting of radio-beacons on fog signal service, are found in the chapter on electronic markings. With an increasing number of electric-powered floating fog signals there is a somewhat lessened gap between fixed and floating markings. The two segments of this study detailing fog signals are complementary to one another, and not a sign of a widening gap between the fixed and floating markings.

Fog signals represent a broad cacophony of whistles, sirens, diaphragm horns, diaphones, reed horns, gongs, and bells.¹ Increasingly diaphragm horns dominate fog signals and the others appear to be fading out into the fog; this is especially true in the U.S. Fog signals can be uni-directional or omni-directional; the omni form has shown some growth as the technology of acoustics and the need for longer-distance signals has come together allowing for massive multi-emitter units to be produced and positioned.² Fog signals can be powered by the action of the sea, compressed air, steam, electronics, or electricity. More and more signals are electric (more precisely electro-magnetic) in propulsion;

there are also more electronic type signals. The older forms appear to be passing away. Fog signals can be heard from a few hundred yards for traditional gongs, bells, and whistles up to several miles for sophisticated models that can be designed to meet distance requirements that can range up to four miles.

Based on the responses to the IALA survey of aids to navigation in 1984 (for the year 1983) there are slightly less than 1500 fog signals of a fixed character out of a total of about 3700; just over 40% therefore are fixed, and just short of 60% are floating.³ Some members of the IALA, including the USSR, did not participate in the survey, so the resulting figures can offer only an approximate view of aids to navigation. Among the nearly 2200 floating signals Canada has one-quarter, and the U.S. a little over one-half;⁴ England and Wales (Trinity House) and France supply one-eighth of the total.⁵ The location of fixed fog signals is more diffuse: the bulk (more than 75%) is divided into three groups: Canada, the U.S., and a composite of France, Italy, Japan, Scotland, South Korea and Trinity House, each have approximately one-quarter of these signals.⁶

The 1979 survey of IALA (that portion of the 1984 survey received by this compiler did not include trends as such, though comparison of the raw data with 1979 allows an extrapolation of trends). For the period from 1971 to 1977 there was an over-all decrease in fixed fog signals with a corresponding increase in floating aids.⁷ From 1979 to 1984 the data indicate a slight reversal of that earlier trend, though a reversal that is muted in nature.⁸ The 1979 survey did indicate that over a 12-month period floating aids had experienced a slight drop and fixed aids were stable.⁹ J. Prunieras (Secretary-

General of IALA), in a letter to the compiler, notes the replacement of gong, bell, whistle, and horn signals by electric horns.¹⁰ Presumably these declining types were sea-activated, manually-operated or steam- or air-powered. It may be noted that the use of electronics in maritime markings allows for the simulation of traditional sounds without traditional technology.¹¹

The geographical (specifically, climate) borders of fog signals are clear-cut: All of the major users of fog signals are in the Northern Hemisphere. All are north of 30 degrees north latitude and all but one are predominantly -if not exclusively - north of 45 degrees north latitude.¹² The North Atlantic rim is the primary realm of fog signals; the North Pacific is a secondary region. The northern latitudes, of course, are the areas both of heavy fog and of heavy shipping.

20A2 A Classification of Fogs Signals With Explanatory Notes

- 251 Diaphone
 - 2510 Regular
 - 2511 Two-Tone
- 252 Diaphragm Horn
 - 2520 Regular
 - 2521 Nautophone
 - 2522 Chime
- 253 Explosive Signals
 - 2530 Explosives
 - 2531 Gun
- 254 Submarine Signals
 - 2540 Submarine Bell
 - 2541 Submarine Oscillator
- 250 Fog Signals, Single types
 - 2500 Whistle
 - 2501 Bell
 - 2502 Gong
 - 2503 Reed Horn
 - 2504 Siren

The greatest number of distinct fog signal types is to be found in the single types category. No doubt differences in bells, whistles, and gongs exist; nonetheless, each of these represents a specific sound emission system in its own right. And, based on the literature of the field, none can be significantly subdivided into variant forms.

20B Types of Fog Signals and Messages

Quite possibly the oldest types of fog signals are the explosive and gun signals. Gun charges are fired from some form of cannon; explosive charges are fired in midair. Despite their seemingly archaic character, these signals are - or were until recently - in use. For example, Trinity House replaced an explosive sound signal by an electrical one in the 1970s.¹³ At the very most such signals are a minor and declining form of warning devices.

Gong, whistle and bell signals (sea-activated forms at least) are water-based signals. Gongs are exclusively found on buoys and exist in only limited numbers. Whistles are also a buoy signal according to available evidence.¹⁴ Bells are both land- and water-based. They constitute an old type of signal. In former times a lighthouse keeper was required to manually ring the bell; in long periods of fog this hand-ringing might extend over many hours.¹⁵ Bells are frequently wave-actuated, though a device known as a bell-striker can mechanically ring the bell by firing a piston at the bell.¹⁶ Electronic mechanisms now exist that can simulate the sound of gong, whistle, or bell.¹⁷

Submarine bells and oscillators represent an obsolescent - if not an archaic signal. This despite the fact that they have proved to be more reliable as a communicator of sound than mechanical

or air-borne sound waves. The range of water-borne signals is superior to conventional signals and "their bearing can be determined with sufficient accuracy for safe navigation" especially when a submarine bell receiver is aboard ship.¹⁸ The value of the signal may have been reduced by the need of a shipboard receiver and by the special requirements for deployment of the signal.

Sirens are variously described as producing sound by "means of either a disk or a cup-shaped rotor actuated by compressed air or electricity" or by an "emitter using the periodic escape of compressed air through a rotary shutter."¹⁹ Siren sounds are akin to sounds produced by more common sirens such as those used for fire purposes.²⁰

Diaphones "produce sound by means of a slotted reciprocating piston actuated by compressed air."²¹ A variant form of the diaphone known as a "two-tone" contains tones of varying pitches; one high pitch and one much lower in pitch.²²

Reed horns consist of a steel reed that vibrates "when the air is passed across its unsupported end."²³ A nautophone produces a similar tone and range through a diaphragm process and is thereby classified with diaphragm horns.²⁴

The largest user of fog signals, the U.S. approved a broad range of signal types during the 1960s.²⁵ But by the late 1970s only a few forms were approved and nearly all non-wave-actuated forms were diaphragm in character.²⁶ Diaphragm signals consist of various models but they are essentially the same in nature. DMA lists a single diaphragm which can provide sound through electrical, air or steam processes.²⁷ IDAMN divides the diaphragm into the "compressed air horn" and the "electromagnetic oscillator."²⁸ The later is described as a "resonant diaphragm maintained

in vibrating motion by electromagnetic action."²⁹ DMA and IDAMN are presumably describing the same signal; the difference is that DMA sees one signal though powered by various means while IDAMN sees two signals: one of which can be powered by a new means but rather uses a different technology though producing a similar "product." This view of diaphragm signals is slightly blurred by the "pure tone" and long-distance signal produced by Automatic Power - the U.S. supplier of diaphragm horns.³⁰ The signal is not an oscillator mechanism though similar to other diaphragms that have one. Duplex and triplex signals produce a chime signal and seemingly are known by either the number of units or the sound produced.³¹ Fog signals known as "stacked array" consist of a series of emitters combined.³² This produces a distinctive and powerful unit for longer-range applications.

Fog signal operations have become automatic in some instances through the use of fog detectors. Fog signals can generate an improvement in service through the detector. Some increase in their numbers has been noted by IALA.³³

The echo board, which can be seen as a "passive" fog signal, has become a rare marine marking.³⁴ By measuring the echoes of a ship's whistle - as they bounce off the echo board - the distance from the aid can be determined. One such echo board existed in the U.S. Pacific Northwest but was eliminated more than two decades ago.³⁵

Messages for fog signals are composed of two elements: the character of the sound wave produced (the sound tone), and the length of the signal blast/accompanying segment of silence that makes up a signal emission unit.³⁶ International agreements on buoyage and beaconage give little attention to fog signals. There are not, for example, one fog signal message and type for starboard and another for port.

Nonetheless standards for the operation of fog signals exist; those of the U.S. Coast Guard and IALA are two such standards.³⁷ The U.S., for example, has nine message possibilities for fog signals ranging from a one-second blast and nine seconds of silence (1^sb1-9^ssi) to two three-second blasts separate by three seconds of silence followed by a three-second blast and ending with 51 seconds of silence (3^sb1-3^ssi-3^sb1-51si).³⁸ Wave-actuated signals are classified as "random".³⁹ With increasing standardization of sound tones the specific message characteristic assumes greater significance. A possible third element for fog signals is the period of operation. Some signals operate only during the fog, others operate continuously through the year and yet others operate only seasonally.⁴⁰

Even though there are only a few thousand fog signals, and these concentrated in a relatively small area, the fog signal is a vital element in aids to navigation. Electronic advances may have reduced the significance of acoustical signals but the need for such signals continues. There have been advances in acoustics as well as in electronics.

Endnotes for 20A and 20B

¹See introductory sections of any of the various light lists of DMA; for example, List of Lights and Fog Signals, British Isles, English Channel and North Sea, 1983, (DMA, Topographic Center, Washington, D.C., Publication #114).

²USCG, Aids to Navigation-Technical Manual, 1979, pp. 7-3, 7-4.

³IALA Survey, 1979/2, pp. 44-47.

⁴IALA Survey, 1979/2, pp. 18-21.

⁵⁻⁶See above.

⁷IALA Survey, 1979/2, p. 37.

⁸Cp IALA Survey 1979 and 1984.

⁹It is difficult to know if this is a temporary situation or if this change is one of ongoing growth.

¹⁰Prunieras, letter to writer, 3-12-77.

¹¹USCG, Aids to Navigation-Technical Manual, 1979, p. 7-28.

¹²Britannica Atlas, 1974, pp. 2-3.

¹³IALA Survey, 1979/2, p. 51.

¹⁴USCG, Aids to Navigation Manual, 1964, Chapter 2, "Buoys."

¹⁵For example, accounts of manually operated fog bells in Stevenson, World's Lighthouses Before 1820; H.C. Adamson, Keepers of the Lights, 1955; IDAMN, Chapter 3, "Audible Aids," 3-2-245.

¹⁶IDAMN, 3-2-290.

¹⁷Audible and Visual Marine Aids to Navigation, Automatic Power, Inc., Houston TX, "Omni-directional Pure Tone Signals," and "SA-10202/1 Buoy Mounted Sound Signal."

¹⁸DMA, H.O. Publication #114, 1983; for details see Note # 1.

¹⁹IDAMN, Chapter 3, "Audible Signals," 3-2-070.

²⁰For example, Federal Signal Corp. (USA) marketed very similar sirens for fire halls and for aids to navigation, and Cunningham Air Whistles produced similar whistles for ships and fog signals. But these signals are no longer approved by the USCG.

²¹⁻²²USCG, Light List, Pacific, Vol. III, 1985, p. xviii.

²³IDAMN, Ch. 3, 3-2-160 and 3-2-165.

²⁴DMA, H.O. Publication #114, see Note # 1 for details.

²⁵USCG, Aids to Navigation Manual, 1964, Appendix D, p. D-30.

²⁶IDAMN, Ch. 3, 3-155.

²⁷DMA, H.O. Publication # 114; see Note # 1.

²⁸IDAMN, Ch. 3., 3-2-155.

²⁹IDAMN, Ch. 3., 3-2-220.

³⁰"Fog Signal Systems," Automatic Power, Houston, TX.

³¹DMA, H.O. Publication # 114, see Note # 1.

³²IDAMN, Ch. 3, 3-2-065.

³³IALA Survey, 1977/2; p.51;

³⁴⁻³⁵USCG, Light List, Pacific, Vol. III, 1962, Orchard Island Echo Board listed in that edition, p. 173; became a daybeacon subsequently.

³⁶⁻³⁹USCG, Aids to Navigation-Technical Manual, 1979, p. 7-1. See also Automatic Power, Audible and Visual Marine Aids to Navigation, "Sound Signal Systems" regarding IALA fog signal characteristics.

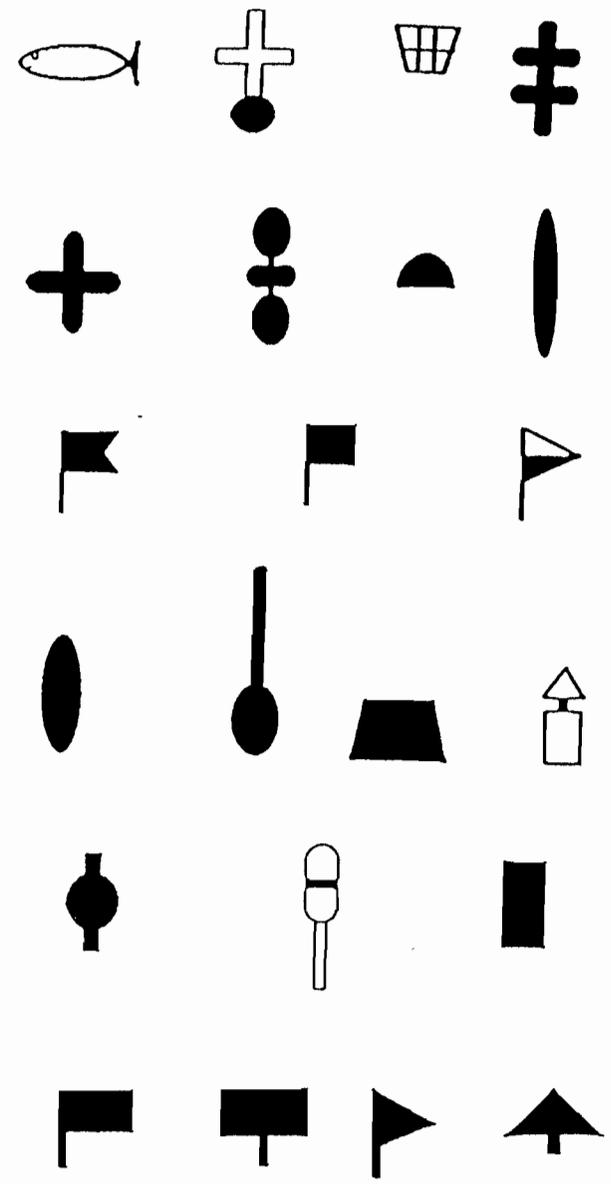
⁴⁰USCG, Light List, Pacific, Vol. III, 1985, p. xviii.

Special Note

An earlier version of the fog signal classification included mention of a fog signal known as a "Sireno." But information supplied by Wayne Wheeler of the U.S. Lighthouse Society - through the assistance of Elinor De Wire, a fog signal specialist - indicated that the Sireno is a trade name for an electric siren signal. Therefore the Sireno was dropped from the classification since it did not appear to represent a variant form of the siren (letter of Wayne Wheeler to the writer, 7-19-87).



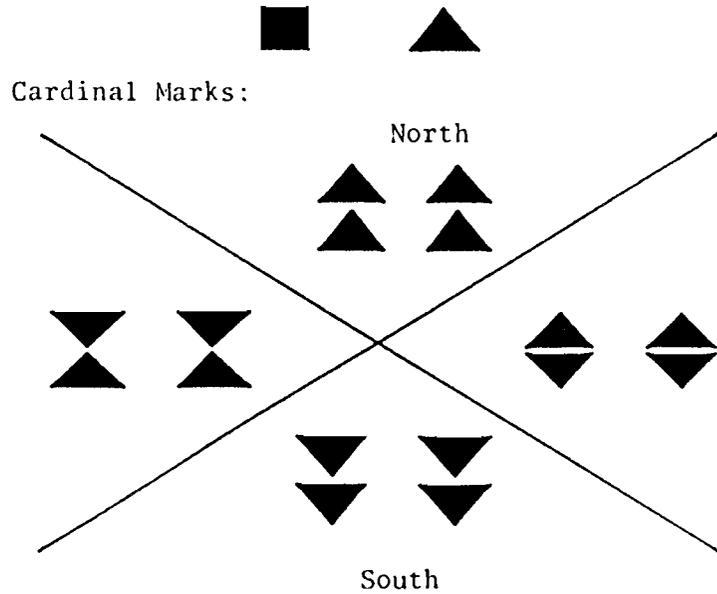
APPENDIX I: SELECTED TOPMARK PATTERNS



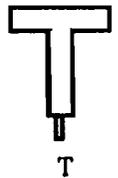
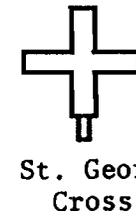
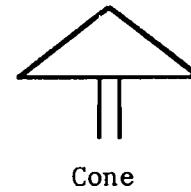
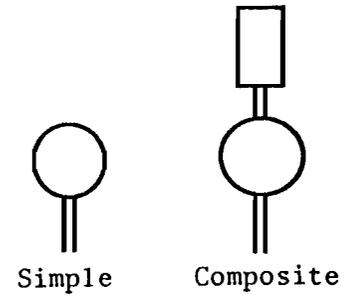
Selected National Topmarks: MBS/SMBB

Topmarks: Types and Usages in IALA

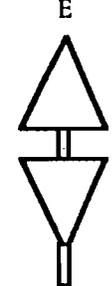
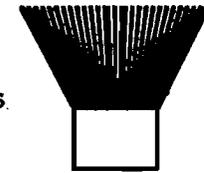
Lateral marks: location and color of can and cone dependent on region; colors; red & green



- Isolated Dangers: 2 black spheres:
- Safe Waters: 1 red sphere:
- Special Marks: 1 yellow "X":



Brooms



Topmarks of the Uniform System of Buoyage

NOTE

The illustrations consist of computer graphic representations based on IALA, USB, and IHB publications. Selected National Topmarks are from the IHB publications on buoyage systems. There are further flag configurations but of only minor differences from those represented here.

The IALA topmarks are from the new buoyage system. The coverage of buoyage message systems in the text provides a fuller representation of the IALA cardinal system though on a reduced scale.

Topmarks of the Uniform System of Buoyage (League of Nations) are based on illustrations of IDAMN. Though official USB material indicates one cone for South and North not two as given in IDAMN.

APPENDIX II: A UNIFIED CLASSIFICATION OF MARINE TRANSPORTATION MARKINGS (AIDS TO NAVIGATION)

- 1 Floating Marine Markings
- 12 Lighted Buoys
 - 121 Standard Single Types
 - 1210 Can
 - 1211 Spherical
 - 1212 Conical
 - 1213 Pillar
 - 122 National/Regional Types
 - 1220 Canadian
 - 1221 U.S.
 - 1222 Greece A/Thailand A
 - 1223 USSR
 - 1224 Thailand B
 - 1225 Greece B
 - 1226 Norway
 - 1227 Beacon buoy-Lateral, West Germany
 - 1228 Beacon buoy-Cardinal, West Germany
- 14 Unlighted Buoys
 - 141 Conical
 - 1410 USB
 - 1411 IALA
 - 1412 Nun, U.S.
 - 1413 Denmark A
 - 1414 Denmark B
 - 1415 Italy
 - 1416 Poland, France
 - 1417 Canada
 - 142 Can/Cylindrical
 - 1420 IALA/USB
 - 1421 U.S.
 - 1422 Denmark
 - 1423 West Germany
 - 1424 Taiwan
 - 1425 Sweden, USSR
 - 1426

- 143 Spar Buoys
 - 1430 Standard, USB/IALA
 - 1431 Modified Standard, USA/IDAMN
 - 1432 Modified Standard, Norway
 - 1433 Modified Standard, Canada
 - 1434 Special, Spar on Can Base, Iceland, et.al.
 - 1435 Special, Spar on Modified Can Base, Iceland
 - 1436 Special, Spar on Modified Conical Base, Netherlands, Poland
 - 1437 Special, Spar on Conical Base-A, West Germany
 - 1438 Special, Spar on Conical Base, Iceland, et.al.
- 144 Standard Single
 - 1440 Ogival
 - 1441 Spindle
 - 1442 Spherical
 - 1443 Pillar
- 145 Miscellaneous Buoys
 - 1450 Beacon buoy-Lateral, West Germany
 - 1451 Beacon buoys-Cardinal, West Germany
 - 1452 Barrel
 - 1453 Oil-drum
- 15 Sound Buoys
 - 150 National/Regional Types
 - 1500 Bell, IALA¹
 - 1501 Whistle, IALA
 - 1502 Bell, U.S.
 - 1503 Whistle, U.S.
 - 1504 Gong, U.S.
 - 1505 Carillon, France
 - 1506 Bell, France



- 17 Combination Buoys
 - 170 Lighted Sound Buoys
 - 1700 Lighted Bell, Canada
 - 1701 Lighted Whistle, Canada
 - 1702 Lighted Bell, U.S.
 - 1703 Lighted Whistle, U.S.
 - 1704 Lighted Gong, U.S.
 - 1705 Lighted Horn, U.S.
 - 1706 Lighted Bell-Conical, USB
 - 1707 Lighted Bell-Spherical, USB
 - 1708 Lighted Bell-Can, USB
 - 1709 Non-buoyage Aid: Large Navigational Buoy, U.S., U.K., et.al.
 - 1710 Non-buoyage Aid: Lightship
- 2 Fixed Marine Markings
 - 22 Lighted Aids to Navigation
 - 221 Major Structures (Lighthouses): Sea-girt
 - 2210 Towers on Rocks (submerged & above water)
 - 2211 Towers on Skel. St.: Screw-pile Towers
 - 2212 Towers on Skel. St.: Off-shore Pltfms.
 - 2213 Convent. Towers on Sp. Marine Fndtns.
 - 2214 Convent. Houses on Sp. Marine Fndtns.
 - 222 Major Structures: Land-based Towers
 - 2220 Tall Coastal Towers
 - 2221 Towers on Promontories & Headlands
 - 2222 Skeleton Towers
 - 2223 Framework Towers
 - 223 Major Structures: Non-towers/Composite St.
 - 2230 Houses
 - 2231 Skeleton Towers
 - 2232 Buildings
 - 2233 Composite: House on Structures
 - 2234 Composite: Tower Attached to House/Bldg.
 - 224 Minor/Lesser Structures: Multi-member
 - 2240 Tripod
 - 2241 Pyramid
 - 2242 Pile Structure: Marine-site
 - 2243 Pile Structure: Land-based site
 - 2244 Skeleton Structure

2245 Dolphin
2246 Tripodal Tower
2247 Tubular Tower
2248 Skeleton Tower
225 Minor/Lesser Light Structures:
 Single-Member I (Slender)
 2250 Spindle
 2251 Spar
 2252 Pipe
 2253 Post
 2254 Pole
 2255 Single Pile
 2256 Stake
 2257 Mast
226 Minor/Lesser Light Structures:
 Single-Member II (Stouter)
 2260 Column
 2261 Pedestal
 2262 Pillar
 2263 Pylon
 2264 Obelisk
227 Minor/Lesser Light Structures:
 Enclosed
 2270 Hut
 2271 Small House
 2272 Cairn
 2273 "Beacon"
228 Minor/Lesser Light Structures:
 2280 House/Hut on Structure
 2281 House/Hut on Pile Structure
 2282 House/Hut on Tripod
229 Minor/Lesser Light Structures:
 2290 Stand
 2291 Arm
 2292 Lighted Banks

24 Unlighted Aids to Navigation
241 Simpler Structures
 2410 Dolphin/Multiple Pile
 2411 Tripod
242 More Complex Structures
 2420 Bake:
 2421 Bake:
 2422 Lattice-work Structure
 2423 Skeleton Tower
 2424 Wooden Framework
 2425 Landmarks
243 Uni-dimensional Artificial Marks
 2430 Spindle
 2431 Perch/Pole
 2432 Pile
 2433 Post
 2434 Stake
 2435 Edgemarks
244 Natural Marks
 2440 Cairn
 2441 Small Tree/Petit Arbre
 2442 Tree Branch: Natural State
 2443 Tree Branch; Tied-down
 2444 Stone Construction
240 Daymarks
 2400 Daymarks
 2401 Daymarks and Structure
25 Sound Signals
251 Diaphone
 2510 Regular
 2511 Two-tone
252 Diaphragm Horn
 2520 Regular
 2521 Nautophone
 2522 Chime
253 Explosive Signals
 2530 Explosives
 2531 Gun
254 Submarine Signals
 2540 Submarine Bell
 2541 Submarine Oscillator

- 250 Fog Signals, Single Types
 - 2500 Whistle
 - 2501 Bell
 - 2502 Gong
 - 2503 Reed Horn
 - 2504 Siren
- 26 Electronic Aids to Navigation
 - 261 Radiobeacons
 - 2610 Rotating
 - 2611 Non-directional: Circular, Omni-directional
 - 2612 Non-directional: Sequence, group
 - 2613 Non-directional: Continuous
 - 2614 Directional: Sequence, group
 - 2615 Directional: Continuous
 - 262 Radar: Active
 - 2620 Primary Radar: Racon
 - 2621 Secondary Radar: Ramark
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