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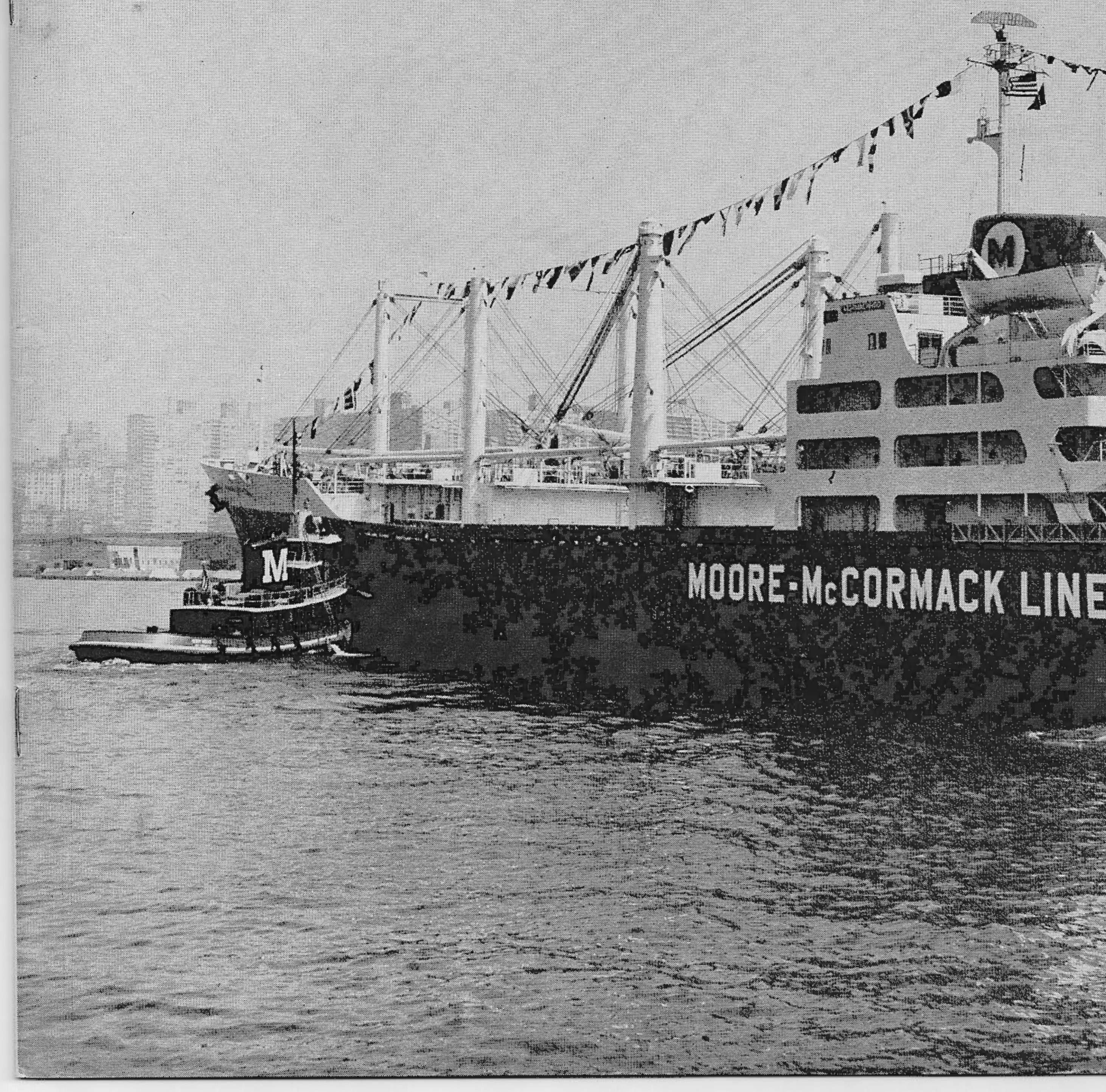


What are the general ground rules which the Coast Guard applies to the problems of manning and safety as they relate to automated vessels? Rear Admiral Charles P. Murphy, Chief of the Office of Merchant Marine Safety, remarked on some of them at the National Propeller Club Convention at Galveston, Tex., in October.

New Developments Affecting Ship Design and Operation

Rear Admiral Charles P. Murphy, USCG

ONE OF THE major developments of the past few years which is affecting ship design and operation is *automation*. The discrepancy between crew costs on a U.S. flagship and a foreign flagship is probably the major factor keeping U.S. ships from being competitive in the world market, and since it will lessen this discrepancy, automation is being given careful study. Serious efforts are being made in this direction, and a number of ships have already been built with varying degrees of and utilizing various approaches to automation. These efforts are meeting with considerable success, and we should be optimistic that the further development of automation will enable the American merchant marine to occupy a much stronger position than it does at the present time.

We often read that the aim of automation is to reduce the manning of a ship to the minimum that will be approved by the Coast Guard from the point of view of safety. This is an oversimplification, both of the aims of automation, and of the problem of determining the proper manning of a ship. However, in view of the questions which are raised, it is important that there be a clear understanding of how the Coast Guard approaches the problem of manning, of what the Coast Guard required manning means, and of how the Coast Guard weighs the effects of the changes brought about in this field by automation.

There are a number of specific requirements in the law which affect manning standards and these must be taken into consideration. Examples of these specific laws are 46 U.S.C. 223, 46 U.S.C. 672, and 46 U.S.C. 673. These sections provide, among other things, that every oceangoing vessel of the United States propelled by machinery shall have on board one duly licensed master. In addition, every such vessel of 1,000 gross tons and over must have on board three licensed mates who shall stand in three watches while such vessel is being navigated. They also require that 65 percent of the deck crew shall be able seamen, that the crew shall be divided into at least three watches, that seamen shall not be shipped to work alternately in the fireroom and on deck, and that no licensed officer or seaman shall be required to work more than eight hours in one day. Section 46 U.S.C. 222 requires:

"No vessel of the United States subject to the provisions of title 52 of the Revised Statutes or to the inspection laws of the United States shall be navigated unless she shall have in her service and on board such complement of licensed officers and crew including certificated lifeboatmen, separately stated, as may in the judgment of the Coast Guard be necessary for her safe navigation. * * *"

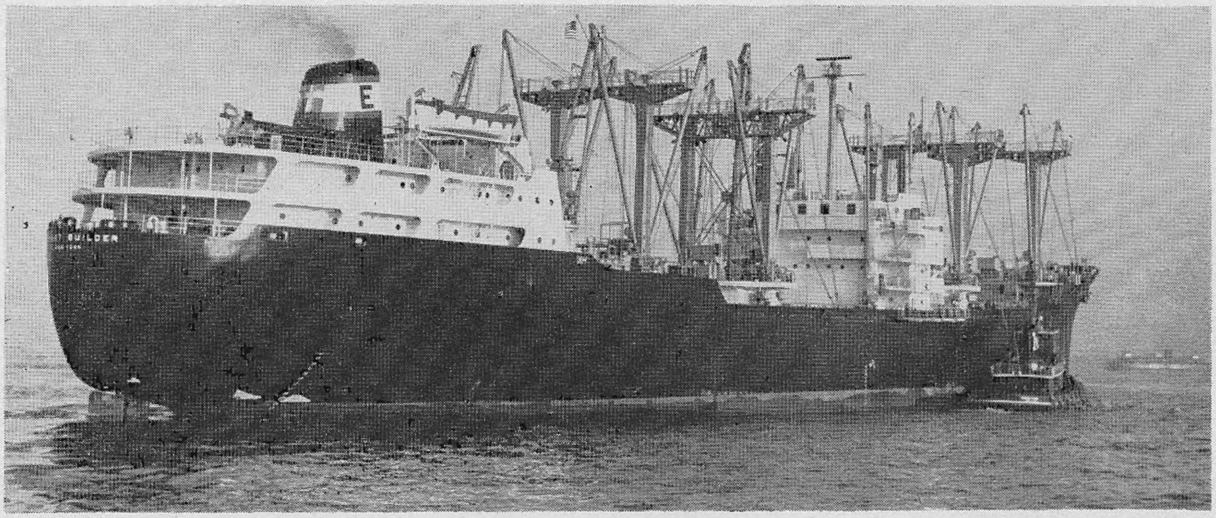
The Coast Guard's regulations which establish the minimum manning requirements for a ship are quite simple—the complete statement of what is to be done is contained in the following two sections:

"157.15–1 (a) After inspecting a vessel pursuant to law and applicable regulations in this chapter, the Officer in Charge, Marine Inspection, shall specify in the Certificate of Inspection of all vessels * * * the minimum complement of officers and crew necessary for the safe navigation of the vessels."

"157.15–1 (b) The manning requirements for a particular vessel are determined by the Officer in Charge, Marine Inspection, after a thorough consideration of the applicable laws cited in section 157.01–10 (b) and the regulations in this part together with the many factors involved, such as size, type, proposed routes of operation, cargo carried, type of business in which employed, etc."

The statement is simple but the problem can get very complex. Complications arise because of the various restrictions contained in the laws mentioned above, and because of the wide variations which are possible in the other factors referred to in the regulation, that is, in the size of the vessel, its type, route, cargo, etc. Before we discuss the effect of automation on manning it will be helpful to look at the results of applying this process to an ordinary ship, and to simplify the discussion we will consider only an oceangoing freighter.

The minimum required crew on a typical ocean freight ship before automation was generally a master, three



Courtesy Moran Towing Co.

mates, radio officer, six able seamen, three ordinary seamen, chief engineer, three assistant engineers, three firemen/watertenders, and three oilers. This adds up to a total of 24 men, and for many years prior to the advent of automation there was no argument or discussion regarding this minimum prescription by the Coast Guard for the simple reason that all ships carried crews well in excess of this minimum.

The average freighter before automation carried a crew of about 45 men, and in order to understand the difference between this figure and the number required by the Coast Guard Certificate of Inspection we must remember that the Coast Guard specifies only the minimum number necessary for the safe operation of the vessel. This includes the crew necessary for the navigation of the vessel, which includes such duties as lookout, wheelsman, docking and the safe operation of all the machinery. It must provide for the work necessary to maintain personnel safety on board, which includes supervision of cargo stowage, taking soundings, inspection of hatches, and maintenance of the lifesaving equipment. The crew must also include adequate personnel to properly man the emergency stations. The minimum manning specified by the Coast Guard does not make provision for the functions of the steward's department, for carrying out maintenance of a type which, at the owner's option, could be done either at sea or in port, or for the manpower which is necessary to carry on the ship's business.

If we now turn our attention to the automated ship it will immediately be clear that we cannot reduce the manning of this ship to the minimum that will be approved by the Coast Guard because we have just seen that there would be no steward's department, and so no one would eat. In addition there are other functions which an owner may wish to have performed at sea or in foreign ports by members of the crew of the ship, and he may augment the crew for these purposes. In the current efforts toward crew reduction many of these other functions are being carefully examined to see if they can be reduced or eliminated.

As an example of efforts in this area I would like to mention the new coatings which are being applied to the exposed structure on deck, which are expected to eliminate the need for continuous chipping and painting. Such an application may result in a possible crew reduction, but I mention this only to make clear that this is an area with which the Coast Guard is not primarily concerned. The personnel originally required to do the chipping and painting were not required by the Coast Guard, and their removal would not necessitate any change in the Certificate of Inspection. As a result there has been room for appreciable change in a ship's complement without affecting the minimum crew required by the Coast Guard.

However, it was inevitable that some of the changes to be proposed and considered would be aimed at reducing also the minimum crew required for safety. If this effort in the direction of automation is to achieve the maximum efficiency it must also examine these functions. By discussing three of these areas which have been given extensive consideration I can illustrate the kind of problems which arise and describe how the Coast Guard determines solutions to these problems.

First let us consider the unlicensed deck department. I mentioned above that this department on a typical ocean freighter would consist of six able seamen and three ordinary seamen. Experience has indicated that this provides a reasonable number of men to perform the duties of the deck department, and in determining this number the OCMI has also taken into consideration certain statutes which must be complied with. One law requires that the licensed officers, sailors, coal passers, firemen, oilers, and watertenders shall, while at sea, be divided into at least three watches. The above complement thus provides two able seamen and one ordinary seaman per watch. Another law requires that 65 percent of the deck crew have a rating not less than able seaman, and the above numbers take care of this.

The three-man watch thus provided makes available an able seaman to stand watch at the wheel, another able seaman for lookout, and an ordinary seaman whose duties at sea have in the past included serving as messenger, doing deck maintenance work, taking soundings, patrolling the vessel, and relieving the lookout as necessary during a 4-hour watch.

There have been a number of proposals aimed at eliminating the need for the ordinary seaman on each watch, thereby making it possible to reduce the ship's complement by three members. These proposals have endeavored to find other means of accomplishing the duties of the ordinary seaman by providing call bells or telephones to eliminate the need for a messenger, reducing the need for deck maintenance work or planning to do it with shore gangs when the ship is in port, etc. These items have been carefully considered and discussed, and many were found to be feasible, but to date no reasonable substitute has been found for the last item mentioned—relieving the lookout as necessary. It is the practice for the ordinary seaman to go forward at some time during each watch. He relieves the A.B. on the bow who in turn, after a few minutes and probably after taking on a cup of coffee, provides similar relief for the A.B. on the wheel. This whole process takes about half an hour, at the end of which everything has settled down again with an A.B. on the wheel and on lookout, and the ordinary seaman again available for his miscellaneous duties.

It has been argued that such relief is not necessary. However, a break of this kind in the middle of a 4-hour watch has become standard practice, and I might point out that even among people who work sitting down in heated offices ashore the coffee break has become part of their way of life. It has been argued that under many circumstances at sea a bow lookout is not necessary to the safety of the ship. This is a matter for the Master to determine, but everyone agrees that there are times at sea when a lookout *is* essential, and this points up another factor by which the Coast Guard must be guided. The manning required must be adequate to provide for foul weather as well as good weather, and *by law* such manning must be divided into watches and kept on duty successively.

It has been argued that it is unreasonable to require a man to stand a 4-hour watch, recognizing that his specified duties will keep him busy only about half an hour during this period. This again is a matter over which the Coast Guard has no control under the present law; however there is no restriction regarding the productive use he may make of the remainder of his time. This is a matter which has been dealt with in negotiations between labor and management, and further discussions in this area might lead to improved productivity, and thus a stronger and more competitive American merchant marine.

To sum up the above discussion, regarding the deck department, the Coast Guard has concluded that, based primarily on the above arguments, the unlicensed deck department on a typical large oceangoing freighter should remain as in past, composed of six A.B.'s and three ordinary seamen.

Now let us see what has been proposed for the unlicensed members of the engine department as a result of automation. A large part of engineroom automation relates to the automatic controls being provided for the boilers. You might say that boilerroom automation began when we shifted from coal to oil. There used to be an engineroom rating known as the coal passer, but this rating is no longer necessary with oil fuel. The same evolution is now taking place with respect to the fireman/watertender. The duties of this rating are effectively being taken care of by automatic equipment which provides all necessary control of the boiler, and on vessels which are shown to have such controls the required manning scale prescribed by the Coast Guard makes no requirement for any men with the rating of fireman/watertender.

RADM C. P. Murphy

Thus the engineroom watch is reduced to one licensed engineer and one unlicensed man, nominally an oiler. Many of the present efforts to apply automation to the functions of a ship's engineroom have as their ultimate objective the reduction of the engineroom manning to a one-man watch, this man to be the licensed engineer. These proposals, as described to the Coast Guard during the design stages of some recently constructed ships, did not contemplate removing the unlicensed man from the ship. Instead it was planned that the three unlicensed men would be necessary to assist in the performance of certain types of machinery maintenance work, and it was felt that this could be done in a most productive manner if these men worked together as day workers rather than watch standers. However to accomplish this would require a change in the required manning on the Coast Guard Certificate of Inspection, and this raises several questions.

While the step from a three-man watch to a two-man watch was accomplished with relative ease as indicated above, the further reduction to a one-man watch requires careful consideration of a number of factors. This of course contemplates bridge control of the main propulsion plant so that the engineer on watch is relieved of full time standby on the engineroom telegraph. There must be careful attention to the location and arrangement of all controls, indicating devices, alarms, etc. There must be provision for calling the next watch, and for indicating to the bridge if the man on watch should become injured or incapacitated.

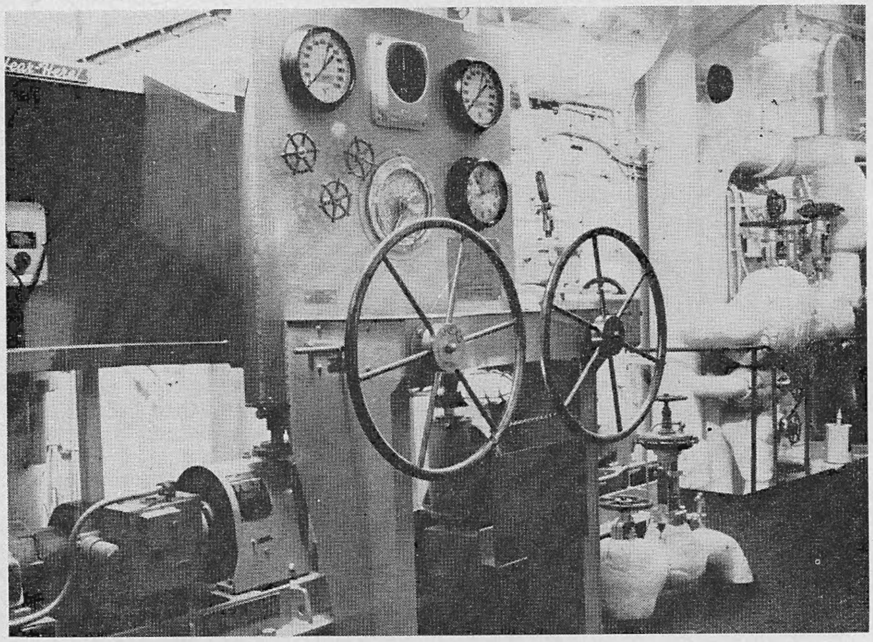
With proper attention these items can be accomplished. A problem could arise if the residual duties of the unlicensed man included duties which might arise at any time on any watch, and these duties were necessary to the safe navigation of the ship. If that were the case such a man would have to be on watch under the same legal requirement referred to above in the case of the seaman on deck. However, if these duties are of such nature that they need to be done only once a day, or once every few days, and they can be taken care of during normal daytime working hours, a ruling has been made that personnel to handle these duties can be required as day workers on the Certificate of Inspection.

These are the general ground rules under which this problem has to be considered. The determination that the above conditions prevail and that a one-man engineroom would be adequate, must be based on experience with an individual ship at a point long enough after delivery so that the operation of all components can be considered routine.

The comments I have made do not by any means discuss all of the manning problems which relate to the present trend toward automation. I hope that they do give some indication of the factors which must be considered in efforts to reduce manning. The development of what we now describe as automation is still in a relatively early stage, and many of these problems have not yet been fully resolved. They are being studied carefully, and the evidence to date of progressive shipowners and enlightened labor leaders, working together with ship designers and shipbuilders, gives us confidence that efficient, safe, and acceptable solutions will be found to these problems. Progress in this direction will improve the worldwide competitive position of American merchant ships. ⚓

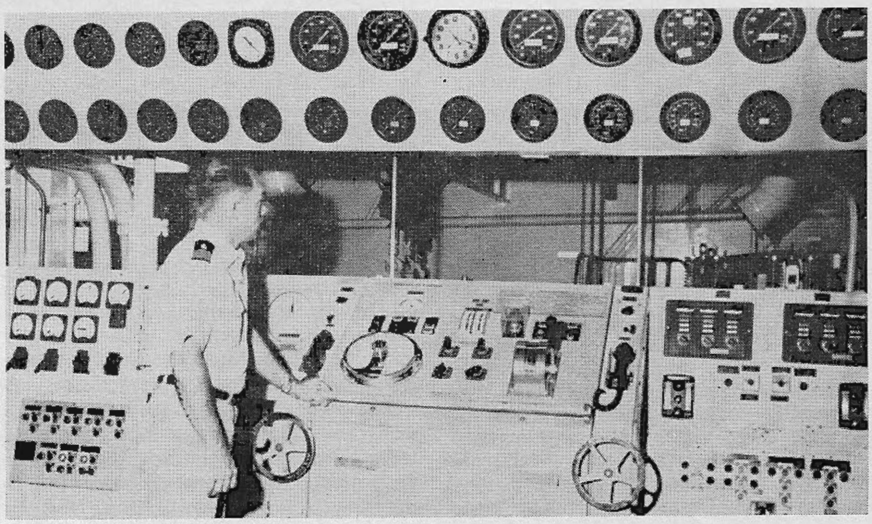
Courtesy Bethlehem Steel Corp.

AUTOMATED bridge on new tanker.
SPEED, ahead or astern, is set on the bridge with a simple control.



BRIDGE and machinery space central controls are superimposed on familiar manual controls for emergency operation.

ENGINEROOM console *Mormacargo*.



This year has undoubtedly been IMCO's most active and productive since the International Conference for the Safety of Life at Sea in 1960. Some of the work of IMCO during 1965 is reported here.

IMCO 1965

Cdr. Lloyd W. Goddu, Jr., USCG

THE EFFORTS of the Intergovernmental Maritime Consultative Organization (IMCO) during the past year have been many and varied culminating in the 4th Assembly which took place in Paris, France, from 15–29 September 1965. With the exception of the first Assembly that set IMCO in motion, this was undoubtedly the most important IMCO meeting to date. The Assembly not only settled many internal matters, but, approved the work of the subcommittees to date and indicated its confidence by continuing the subcommittees in being in order that they may be able to pursue their studies in maritime safety. It also approved arrangements for two new international conferences, one on load lines and one on tonnage measurement. In considering the work of the Maritime Safety Committee, three new international codes were approved by the Assembly, as well as three new studies being taken under consideration.

Fifty of the 60 member states sent delegations to the 4th Assembly. The United States delegation consisted of 14 members from Government and industry. There were observers from 16 nonmember states and 12 international organizations. At its first meeting, Mr. Jean Morin, Secretary General of the Merchant Marine of France, was elected President of this 4th Assembly.

INTERNAL MATTERS

Among the internal matters discussed at the 4th Assembly were the work program and budget, the apportionment of expenses, and consideration of changes to the Convention and Rules of Procedure. The membership of the Council and Maritime Safety Committee ended with this Assembly and elections were subsequently held. Council members are elected for 2 years and Maritime Safety Committee members for 4 years. The Council and Maritime Safety Committee members were reelected and are as follows:

COUNCIL

Australia	Madagascar
Belgium	Netherlands
Canada	Norway
Federal Republic of Germany	Sweden
France	Union of Soviet Socialist Republics
Greece	United Kingdom
India	United States of America
Italy	
Japan	

MARITIME SAFETY COMMITTEE

Argentina	Netherlands
Canada	Norway
Federal Republic of Germany	Pakistan
France	Union of Soviet Socialist Republics
Greece	United Kingdom
Italy	United States of America
Japan	
Liberia	

At the 3d Assembly it was voted that the Council membership should be increased from 16 to 18 members. This amendment has not as yet been ratified by sufficient member states to be placed in effect. As of 10 September 1965, 18 states have accepted the amendment. This amendment will become effective 1 year after ratification by two-thirds of the members of the Organization; i.e., 40 ratifications. A similar proposal was made to enlarge the Maritime Safety Committee, but this was deferred.

With the expansion in membership and the wish of many smaller countries to play an active role in the Organization, a desire to increase the membership of the Maritime Safety Committee (MSC) was manifested at the 4th Assembly. This resulted in the adoption of a change to the Convention increasing by two the number of members in the MSC as well as altering the method of election. The new method of election calls for members to be selected from the top 10 countries possessing the largest fleets in terms of gross tonnage. The next group of four will be selected on a geographical representation basis, one each from Africa, the Americas, Asia and Oceania, and Europe. The remaining group of four will be selected from members not otherwise represented. As with the Council amendment, this amendment will require ratification by two-thirds of the member states and then become effective 1 year subsequent to these required ratifications.

The responsibilities attendant with IMCO's participation in the United Nations Expanded Program of Technical Assistance were discussed at length during this Assembly which finally approved the establishment by the Secretary General of a Technical Assistance Fund. IMCO's functions as laid down in its Convention and its activities since its establishment are ample evidence of the technical aid which can be furnished in contributing to help solve many different problems. These problems range from the administration of merchant shipping to the training of specialists in technical maritime fields.

As with prior conventions, the SOLAS 60 Convention made provision for countries, so desiring, to establish regulations for the carriage of large numbers of unberthed passengers. Subsequent to the 1929 SOLAS Convention, a set of rules was formulated at a conference in Simla, India, in 1931. These Simla Rules are in great need of updating. India has indicated her intention to convene a conference to amend these rules. At the request of the Indian Government, the

4th Assembly approved arrangements for IMCO to assist by giving expert advice relative to the technical and administrative operations of running such a conference. This conference will be sponsored by India and not by IMCO.

CONTINUING STUDIES

The 4th Assembly approved the continuance of the many maritime studies being carried out in the work program of the Organization. There have been 25 meetings under the aegis of IMCO during the past year. The great majority were technical in nature and concerned some particular facet of maritime safety including, inter alia, subdivision and stability, fire protection, bulk cargoes, oil pollution, code of signals, dangerous goods and tonnage measurement.

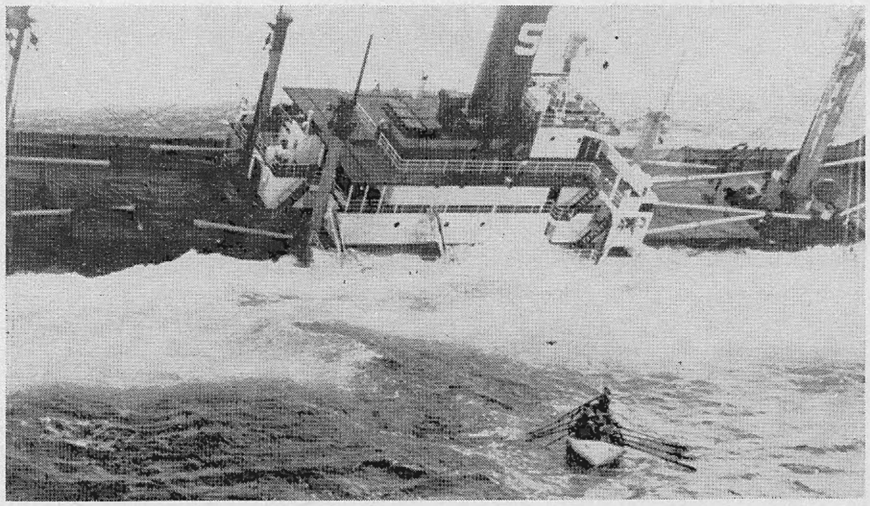
IMCO had early recognized the necessity of simplifying and reducing the number of documents required of ships entering or leaving port. The 2d Assembly recommended steps be taken by member governments and IMCO to facilitate maritime transport. In heeding this call, the IMCO Council established an Expert Group on Facilitation of Travel and Transport. Acting upon the results of this group's recommendations, the 3d Assembly initiated preparations for an international conference. This conference, held in the spring of this year, adopted an International Convention on the Facilitation of Maritime Travel and Transport. This new convention, when put in effect by the requisite number of ratifications, will inaugurate a new era in maritime trade by encouraging a more expeditious movement of persons and goods. The 4th Assembly adopted a Resolution to accept the obligations arising from this Convention and the Conference Recommendations. As a result of this, when the Convention comes into force, an Ad Hoc group will be established by IMCO to examine from time to time any amendment proposed by member states and to consider special measures of facilitation to make the transport of persons and goods as efficient as possible.

FUTURE CONFERENCES

The 3d Assembly of IMCO decided to convene an international conference for the adoption of a convention on load lines. Early last year the United States submitted the first proposal for a new text on load lines. IMCO concluded that, wherever possible, proposals from other nations should be submitted in the form of comments on our proposal. Since that time 18 countries have submitted comments. The U.S.S.R. has also submitted a proposed text of its own. The 4th Assembly has now approved the final arrangements for the conference to be held in London from 3 March to 5 April 1966. The U.S. proposal was the result of many years of work accomplished by the U.S. Load Lines Committee. The Committee was established in 1958 and represents a cross section of Government and industry interested in maritime shipping.

A Tonnage Measurement System, which would permit the closing of tonnage openings, was approved by the 3d Assembly. It has been recommended to member nations and is now under consideration by several governments including the United States. There appears to be little opposition, either here or abroad, other than the technicalities of legislative changes. The Subcommittee on Tonnage Measurement is still working on a universal system of tonnage measurement that will include many features, in addition to permitting closure of tonnage openings, that will be an improvement over any existing measurement system. The 4th Assembly agreed that the universal system of tonnage measurement to be finally adopted would have to be embodied in an international convention. Therefore, steps toward this end have been approved. Unfortunately, due to the heavy workload of IMCO this convention cannot take place before 1968.

Cdr. Goddu, a 1946 graduate of the U.S. Coast Guard Academy, is Assistant Chief, International Maritime Safety Coordinating Staff. He participated in this year's Maritime Safety Committee and Assembly meetings of IMCO in Paris.



LIFEBOAT from the rescuing cutter *Rockaway* pulls close to two *Smith Voyager* survivors.

NEW CODES

Work of several committees presented to the 4th Assembly resulted in the adoption or approval of three new codes. These are the International Code of Signals, Code of Safe Practice for Bulk Cargoes and the International Maritime Dangerous Goods Code. These codes bring to fruition the concerted efforts of the Organization and its member states in carrying out not only its stated obligations under the Convention but also the will of the International Conference for the Safety of Life at Sea, 1960, as expressed in the latter's list of recommendations.

The International Code of Signals, adopted by the 4th Assembly, updated the present code, which dates to 1931, in the light of technological developments. The Code has been considerably revised with particular emphasis on the ease of coding and decoding. It is mainly concerned with safety, emergency and health matters. This Code will be placed in effect upon final concurrence by the International Telecommunications Union of the figure spelling table and procedural signals. This, hopefully, will take place around 1 January 1968.

The Code of Safe Practice for Bulk Cargoes resulted from studies on this subject as suggested by Recommendation 55 of SOLAS 60. This code was approved by the 4th Assembly and will be submitted to member states for adoption as a basis for national regulations. The aim is to bring to the attention of those concerned an internationally accepted method of dealing with the hazards to safety which may

(Continued on page 289.)

Capt. Howard L. Peterson

Search for Survivors

An officer of the Radio Technical Commission for Marine Services bares some little known intelligence regarding the standardization of Emergency Position-Indicating Radio Beacons in an article written to set background for the SAR Seminar papers that follow on this subject.

SEAFARERS HAVE a long tradition of service to their fellowmen—particularly when disaster strikes at sea. For centuries, any ship in distress could expect all nearby ships to provide all possible assistance. In the days of sail, such assistance often was slow in arriving. Mechanical propulsion provided reliability not possible with sail. Over the years, speeds of mechanically propelled ships increased slowly, but in the past quarter century, average operating speeds of merchant ships have doubled. The 10-knot pre-World War II freighter has been replaced by the 20-knot Mariner. These increased speeds have contributed to greater safety at sea in two ways: (1) By permitting greater search participation, and (2) by shortening time required for actual rescue.

For nearly a half century, aircraft also have been used successfully as a means of providing assistance to ships. Assistance by aircraft takes many of the same forms as those rendered by ships: Search, communications relay, transfer of emergency equipment or supplies, and sometimes direct rescue of distressed persons.

In all cases, however, no assistance can be rendered until there is an awareness by someone that a distress situation exists. In many cases, the distressed craft is able to provide a timely distress alert. Sometimes the distress alert is raised only when a craft is overdue at its destination. This type of delayed alert makes the task of searchers much more difficult.

Many techniques have been devised to alert others of the need for assistance, and research is still going on to find other possibilities. Similarly, many techniques have been used to locate the scene of distress. One of the newest pieces of equipment to assist in this location problem is the Emergency Position-Indicating Radio Beacon (EPIRB). This issue of the *Proceedings* describes several approaches to the problem of locating quickly the scene of distress.

In any search, one of the most critical factors is the element of time; a lengthy search or a delay in searching may result in locating *victims* rather than *survivors*.

Another seemingly insurmountable problem is that of alerting to a distress. If the SS *Marine Sulphur Queen* ever sent a distress alert, no one ever received it; consequently, a search was not begun until the ship was reported overdue at its destination. But the problem of *alerting* to a distress is distinct from that of *locating* a scene of distress.

In the past, *alerting* by radio has been accomplished primarily by transmitting either SOS or MAYDAY. Similarly, *locating* usually has been either by latitude and longitude or by bearing and distance from a known geographical position. Owing to many unpredictable factors (such as wind, current, inadequate positions, etc.), the location problem has not always been solved. One big reason is that all position information degrades with time. Another reason is that searchers may be looking for a now nonexistent craft; only a liferaft or perhaps one lone survivor might still be afloat. To assist in overcoming these problems, the concept of the EPIRB was formulated. This concept provides up-to-date positional information by means of radio signals capable of being used for homing. At the same time, the portability of the EPIRB means that it can accompany survivors whether they are in some type of survival craft or afloat in life jackets. The search craft is homing on the beacon—rather than looking for an indefinite object.

A recent classic example of the need for an EPIRB was that of the SS *Mormackite*. Bound for Norfolk, the ship encountered heavy weather, and part of the 9,000-ton ore cargo shifted. Soon afterward, the ship sank at 0945 on 7 October 1954. Although the ETA was 1400, 7 October, the Coast Guard was not notified until 1553 on 8 October that the ship was overdue.

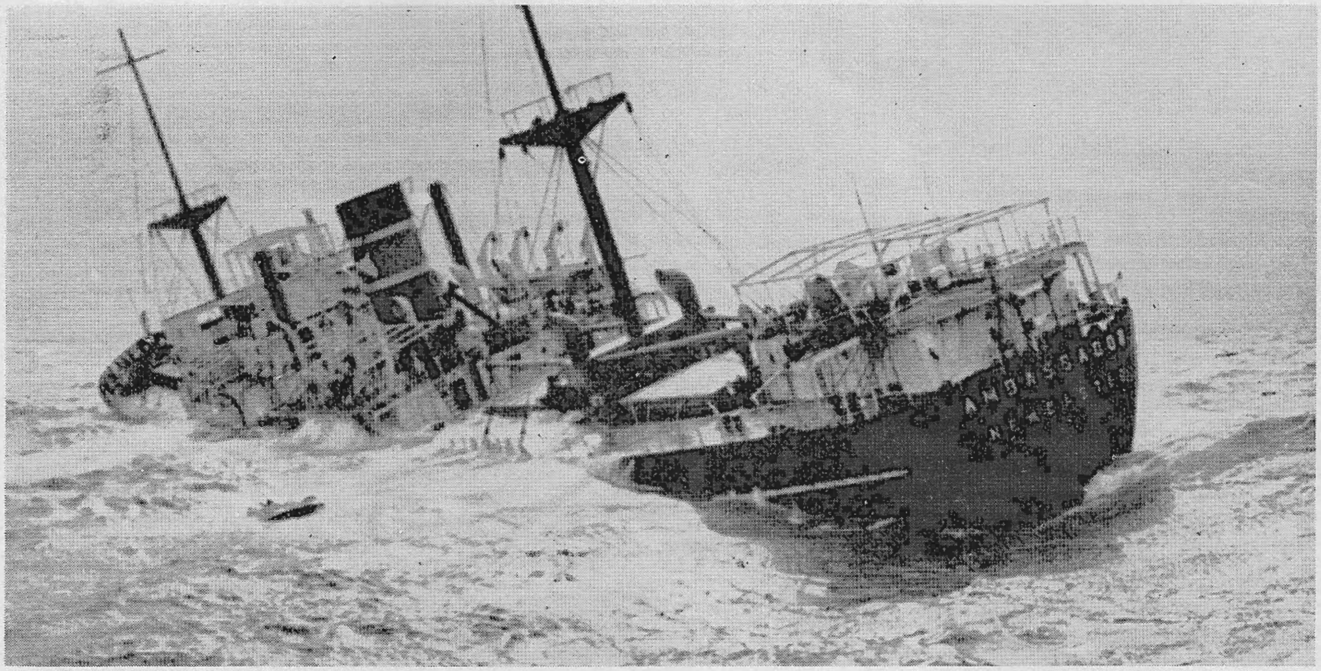
Within 6 hours, a Coast Guard plane had completed and returned from a search for the ship. Although 20 ships had been sighted, the *Mormackite* had not been identified. Meantime, an "All Ships" message had been sent on 500 kc/s to alert shipping. At 0220 on 9 October, the Greek SS *Makadonia* heard voices in the water and put boats over to search. Two Coast Guard planes were sent out to drop flares.

Testimony subsequently established that distress messages had been sent. [Apparently the ship's list reduced effectiveness of the antenna because there is no record of anyone receiving the message.] Because of the heavy list, no boats could be launched, but all survivors wore life jackets, and the lifeboat portable radio set was retrieved. Unfortunately, the set was not designed for operation when floating in the water.

If an EPIRB had been available, there is little doubt that many more crewmembers would have survived. All 11 survivors were rescued within 48 hours of the ship's sinking. On its first search flight, the Coast Guard plane had sighted 20 ships. Signals from an EPIRB could have been detected either by one or more of those surface craft or by the Coast Guard plane.

Alerting Signals or Locating Signals

Many devices or techniques have both a primary function and one or more secondary functions. And sometimes these functions are changeable. For example, *locating signals* have the primary function of assisting searchers to locate the survivors; however, in certain situations, these signals may have another function as well.



Radio aided in speedy *Ambassador* rescue.

If no previous *alerting signal* has been received, anyone hearing an appropriate *locating signal* is actually detecting an *alerting signal*; the functions of the *locating signal* have temporarily changed and alerting is now the primary function. As soon as the locating signal is recognized as the indication of a distress alert, the signals revert to their original function of aiding in locating the survivors.

An EPIRB is capable of changing its function. Signals transmitted by the EPIRB are distress alerting signals until someone is aware of the distress situation. This awareness may be by means of the EPIRB signal or it may be by means of one of the usual alerting signals. Regardless of the means, *after* the alert is received, the EPIRB's function reverts to that of homing. Distress alerting techniques have long been available as have certain locating techniques. But the concept of homing on survivors by means of the EPIRB was created to meet a specific need not heretofore solved—local homing. Basically, the EPIRB concept presupposes that an alert has been transmitted or an overdue notice has been given to appropriate authorities.

Obviously, improved techniques and procedures for searching the vast ocean areas are possible. All such improvements are justified by two major factors: (1) To insure that all lives in jeopardy are saved, and (2) to reduce costly search time. No tangible value can or should be placed on the lifesaving aspect, but the time and money spent by searching ships and aircraft can be significant. For example, 4-engined search-and-rescue aircraft flight time costs approximately $800 per hour. And typical ship operating costs run into thousands of dollars per day.

Ancient Mariners

Early mariners search activities were limited to their natural senses—primarily eyes and ears. Before long, the eyes were aided by colored objects which have evolved into our present-day flags and other visual identification signals. Even this seemingly outdated system of visual aids is still of immense value and is still being revised and improved. Rule 31 of the 1960 Rules of the Road lists the presently allowable visual and other distress signals. And a new International Code of Signals has recently been prepared by the Intergovernmental Maritime Consultative Organization (IMCO).

In this hemisphere, the Canadians recently designed a smallcraft-to-aircraft visual identification signal. This signal is a variation of the old "distance signal" described in Rule 31 (a)(vii) of the 1960 Rules of the Road. But by skillful use of colors and by adaptation to a specialized need, this signal should help to save lives. Although intended to be displayed horizontally on top of a small craft, the signal could be flown vertically from a mast or other support so that nearby surface craft could learn of the need for assistance. (See Figure 1)

Aerial rockets and explosives and other sound signals have also been used and are still included in the Rules of the Road and the International Code of Signals. But all visual and aural signals are limited by comparatively short ranges; it remained for radio to free man from the natural limitations of his eyes and ears.

Radio's Contribution to Safety at Sea

Radio is still in its infancy—less than 70 years young—when compared to man's centuries of seafaring activities. But radio has undoubtedly been the one single thing responsible for the greatest advances in safety at sea.

When the SS *Titanic* sank with help nearby but unaware of the impending disaster, an international furor arose. This furor culminated in the first Safety of Life at Sea (SOLAS) Conference in 1914. Although passenger ships received priority, other

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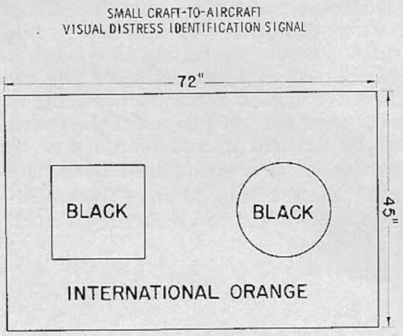

Figure 1

requirements were inaugurated. One of those was a requirement that radio equipment be installed and manned for safety at sea. Other elements stemming from the *Titanic* and SOLAS 1914 are the International Ice Patrol[1] and the North Atlantic Routes[2] used to avoid icebergs and ship collisions. World War I prevented adoption of this SOLAS Convention, but many of its thoughts still exist today.

Meanwhile, U.S. shipping had been subject to its own national safety legislation as early as 1910 when the "Ship Act" was passed. This act, amended in 1912, required radio and radio operators on oceangoing ships carrying or licensed to carry 50 persons or more. In 1915, enactment of the LaFollette Seaman's Act introduced certain other SOLAS provisions into U.S. maritime safety legislation.

Not until 1929 was the second Safety of Life at Sea Conference called. The Convention [document] produced by this Conference [meeting] was the first such agreement ratified and adopted on an international basis. Radio highlights of SOLAS 1929 included the revised requirements for radio equipment based on cargo ship tonnage rather than on number of persons carried. Passenger ships continued to carry radio equipment based on their status as passenger carriers rather than on tonnage. Ships thus compulsorily equipped with radio were required to monitor the radiotelegraph distress frequency. Lifeboat radio equipment was an added requirement for some ships.

During World War II, emergency conditions existed everywhere, and new equipment was developed to overcome new problems. Intership communications were aided by the portable TBY set operating in the VHF band. Emergency lifeboat radio equipment having a comparatively short range on the frequency of 500 kc/s transmitted on that frequency for the benefit of nearby ships and also transmitted on 8280 kc/s, a long-range frequency in the high frequency (HF) band.

SOLAS Since World War II

Events experienced during World War II necessitated another Safety of Life at Sea Conference in 1948. Previous radio requirements for some ships were virtually unchanged; radiotelegraph and licensed operators were still required aboard (a) passenger ships and (b) cargo ships of 1,600 tons gross tonnage and upwards. Other ships were allowed the option of voluntarily equipping with radiotelegraph and licensed operators. [A U.S.-Canadian agreement of 1952 ("Promotion of Safety on the Great Lakes by Means of Radio") now governs that area.] And for the first time, a SOLAS Conference placed radiotelephone on an acceptable basis for safety purposes. Cargo ships of 500 tons gross tonnage and upwards but less than 1,600 tons gross tonnage were given the option of carrying either medium frequency radiotelephone equipment or radiotelegraph equipment. An International Mobile Radiotelephone Distress Frequency of 2182 kc/s had already been allocated by the 1947 Atlantic City Radio Conference for use by either ships or aircraft.

Radio backup requirements were strengthened. When specified, lifeboat portable radio apparatus was required to transmit on 2 frequencies—one a medium frequency (MF) and the other, a high frequency (HF). Thus, distress signals originating from lifeboats could be heard at different distances.

Specific frequencies are not required by SOLAS; instead, the requirements state "a frequency in the —band." The specific frequencies allowable for distress purposes are allocated by the International Telecommunication Union (ITU). In 1948, those frequencies were 500 kc/s (MF) and 8364 kc/s (HF).

Providing assistance to distress requests still remained a problem because each ship and each aircraft still represented a potential distress situation. Ship speeds and seakeeping ability had improved considerably. But the *average* age of ships at sea increased after World War II. Thus, the possibility of potential surface craft distress situations increased. Meanwhile, the advent of jet aircraft had increased aircraft speeds to supersonic figures. At the same time, the total number of aircraft making transoceanic flights grew steadily larger year by year. Air traffic over the North Atlantic has nearly reached the saturation point. Consequently, the International Civil Aviation Organization (ICAO) in 1965 recommended that minimum track separation be decreased from the present 20-minute separation to a minimum track separation of 15 minutes.

Radio also had made great advances during and since World War II. Shipping continued to use the traditional low and medium frequencies including 500 kc/s and selected parts (4–22

The opinions or assertions in this article are the private ones of the author and are not to be construed as official or necessarily reflecting the views of the Radio Technical Commission for Marine Services (RTCM), or of its Government or non-Government members. Neither do they necessarily reflect the views of the U.S. Coast Guard.

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[1] "International Ice Patrol." *Proceedings of The Merchant Marine Council*, Vol. 21, No. 3, March 1964, pp. 39–40. U.S. Coast Guard, Washington, D.C.

[2] "North Atlantic Lane Routes." *Pilot Chart of the North Atlantic Ocean*, [H.O.] Chart No. 1400, April 1965. U.S. Naval Oceanographic Office, Washington, D.C.

Mc/s) of the high frequency (HF) spectrum. Largely because of antenna problems, aircraft had abandoned frequencies below 1500 kc/s in favor of the longer range high frequencies. As aircraft speeds and maximum flight altitudes reached new levels, aviation made increasingly greater use of even higher frequencies. Today, most aircraft radio communications are in the VHF (30–300 Mc/s) frequency band except when aircraft - to - surface communication distances exceed about 200 miles.

Radiocommunication had undergone still another great change. Aviation had adopted radiotelephone for the required two-way communication. In this evolution, English was accepted as the standard radiotelephone language for international air traffic.

SOLAS 1960

In 1960, another Safety of Life at Sea Conference (SOLAS 1960) was convened. This Conference recognized the ever-increasing potential value of radio in maritime distress situations. Radiotelegraph systems requirements of SOLAS 1960 were carried forward from SOLAS 1948; all cargo ships of 1600 tons gross tonnage and upwards and all passenger ships continued to be required to carry radiotelegraph equipment and licensed operators. The Conference did make several changes, among which were:

(1) Lowering the tonnage limit for compulsory radio equipment from 500 tons gross tonnage to 300 tons gross tonnage. (Previously, the tonnage requirement for compulsory radio equipment had been 500 tons gross tonnage and upward but less than 1600 tons gross tonnage.) As before, radiotelegraph continued to be the preferred system. Again, however, ships required to carry compulsory radio equipment were authorized to substitute radiotelephone installations *if* within the smaller tonnage range.

(2) Authorizing the optional substitution in portable lifeboat radio apparatus of radiotelephone transmitting and receiving equipment in the medium frequency (MF) band (2182 kc/s) in lieu of the previously required high frequency (HF) radiotelegraph transmitter equipment.

This authorization is at the discretion of individual countries. In the U.S.A., the Federal Communications Commission (FCC) continues to maintain the high frequency (HF) band radiotelegraph transmitter requirement. However, radiotelephone equipment operating in the medium frequency (MF) band (2182 kc/s) may be carried in addition to the required radiotelegraph apparatus operating on 500 kc/s and on 8364 kc/s. Table I lists all acceptable combinations.

Considerable time often is needed to obtain necessary ratification of international agreements. SOLAS 1960 was no exception, and not until 26 May 1965 did the Convention become effective for those countries which had already deposited instruments of acceptance.[3]

At the Conference, many recommendations also were incorporated in SOLAS 1960. Most of these were items recognized as being worthy, but they had failed to win complete worldwide acceptance as mandatory requirements. Among these was Recommendation No. 48.

[3] "Council Activities. International Convention for the Safety of Life at Sea, 1960." *Proceedings of The Merchant Marine Council*, Vol. 21, No. 9, September 1964, pp. 155–157. U.S. Coast Guard, Washington, D.C., 20226.

"48. Emergency Position-Indicating Radio Beacons [EPIRB][4]

The Conference, recognising that an automatic non-directional emergency position-indicating radio beacon will improve safety of life at sea by greatly facilitating search and rescue, recommends that Governments should encourage the equipping of all ships where appropriate with a device of this nature which shall be small, light-weight, floatable, watertight, shock-resistant, self-energising and capable of 48 hours' continuous operation. The Organization should consult with the International Civil Aviation Organization and the International Telecommunication Union with a view to determining the standard of worldwide application to which the radio characteristics of that equipment should conform."

Recommendation No. 48—for an EPIRB—is the basis for the several papers reprinted in this issue of the *Proceedings*. As indicated, these professional papers were disseminated at the U.S. Coast Guard's NorthAtlantic Search and Rescue Operations Seminar (NASAROS).[5,6] This Seminar—first of its kind—was held in New York City during May 1965. A review of the various papers will show clearly that no world-wide unanimity exists as to what the optimum EPIRB specifications should be.

[4] *International Conference on Safety of Life at Sea, 1960.* Annex D–Recommendations, p. 494 [Published for] Inter-Governmental Maritime Consultative Organization, London, England.

[5] "Search and Rescue Operations Seminar." *Proceedings of The Merchant Marine Council*, Vol. 22, No. 5, May 1965, p. 119. U.S. Coast Guard, Washington, D.C.

[6] "Search and Rescue Seminar." *Proceedings of The Merchant Marine Council*, Vol. 22, No. 8, August 1965, p. 174. U.S. Coast Guard, Washington, D.C.

TABLE I.—SOLAS 1960: ACCEPTABLE COMBINATIONS OF PORTABLE RADIO APPARATUS FOR SURVIVAL CRAFT INCLUDING LIFEBOATS

Combination	Acceptability		Communication mode	Frequency requirements		Apparatus requirements	
	SOLAS	FCC		Band	Frequency (kc/s) (1)	Transmitter	Receiver
1	Yes	Yes	Radiotelegraph	MF	500	Required	Required.
			Radiotelegraph	HF	8364	Required	(2).
2	Yes	No	Radiotelegraph	MF	500	Required	Required.
			Radiotelephone	MF	2182	Required	Required.
3	Yes [3]	Yes [4]	Radiotelegraph	MF	500	Required	Required.
			Radiotelegraph	HF	8364	Required	(2).
			Radiotelephone	MF	2182	Required	Required.

[1] All frequencies listed are designated for survival craft use: 500 kc/s is international radiotelegraph distress frequency; 2182 kc/s is international radiotelephone distress frequency; 8364 kc/s is authorized high frequency radiotelegraph survival craft frequency.

[2] FCC regulations require a receiving capability for the band 8320–8475 kc/s.

[3] SOLAS 1960 requires only combination 1 or combination 2. If all three frequencies are provided, transmitting and receiving capabilities for either 8364 kc/s or 2182 kc/s must comply with applicable requirements listed in combination 1 or combination 2.

[4] Acceptable only if transmitting and receiving capability are provided for both 500 kc/s *and* 8364 kc/s.

One important point should be emphasized; the objective of the EPIRB is to assist in *locating* survivors and thus assist in saving lives. Lifesaving is humanitarian and cannot fairly be equated in terms of dollars. Nevertheless, costs of such equipment must be realistic. Undoubtedly, the final key to cost lies in the standardization and mass production aspects. As total production of EPIRBs increases, unit costs will decline.

IMCO

In its Recommendation No. 48, the Conference again recognized that most of the SOLAS 1960 implementation would be accomplished through the Inter-Governmental Maritime Consultative Organization (IMCO). Accordingly, the Conference stated that IMCO should consult with the International Civil Aviation Organization (ICAO) and the International Telecommunication Union (ITU) with a view to determining the standard of worldwide application to which the radio characteristics of the EPIRB should conform.

To implement Recommendation No. 48, IMCO requested assistance from the International Radio Consultative Committee (CCIR) of the ITU. In response, CCIR queried both ICAO and IMCO in 1963 with the following questions:

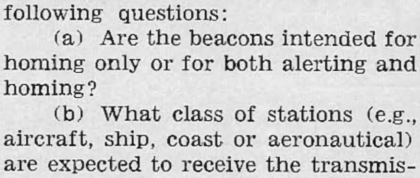
(a) Are the beacons intended for homing only or for both alerting and homing?

(b) What class of stations (e.g., aircraft, ship, coast or aeronautical) are expected to receive the transmissions from the beacons?

(c) Up to what distances must the beacon signals be receivable?

In turn, IMCO addressed its member governments with the same three questions. The answers received were not entirely conclusive. A majority of replies indicated that homing was the primary function; but others suggested that the beacon could serve both purposes—alerting and homing.

Greatest diversity of opinion was in answer to the second question: "What class of stations are expected to receive the transmissions from the beacons?" This question actually is of prime importance because the class of receiving station greatly affects and may actually determine the radio frequency to be used. For all practical purposes, those nations placing greatest reliance on surface craft as search craft are expected to favor use of a maritime radio frequency. Conversely, those nations favoring aircraft as the primary search craft prefer use of a radio frequency most effective for surface-to-air transmissions over the required minimum distance.



Answers to the desired reception range of signals also reflect member government's views as to the preferred class of station expected to receive the beacon signals. In general, VHF signals are not receivable beyond the horizon; but greater heights lengthen distance to the horizon, so VHF signals are receivable up to approximately 100 miles or more for aircraft at 10,000 foot altitudes. The lower maritime frequency signals, however, are receivable beyond the horizon *providing* that suitable antennas can be used.

Even though 5 years have elapsed since the SOLAS 1960 Conference, some background information is still available. Although not explicitly stated in Recommendation No. 48, it is understood that two basic concepts were contemplated.

(1) Only military craft (including SAR ships and aircraft) would need to be equipped to receive the signals; commercial craft need not be so equipped.

(2) By *not* limiting its application only to the giving of signals automatically triggered, the use of voice transmissions was permissible.

Ship and Aircraft Standardization

By their very nature and size, ships can be equipped to send and receive signals on aircraft frequencies; but for these same reasons—nature and size—aircraft cannot easily adopt all maritime frequencies. For example, to transmit effectively on 500 kc/s, an aircraft would need to trail an antenna wire approximately 350 feet long. Obviously, trailing a wire of this length is undesirable. In addition to being a safety hazard, there are operational problems involved in paying out and retrieving the wire. Conversely, to transmit on an aircraft or ship VHF frequency, a ship needs only a whip antenna less than 2 feet long. For receiving transmissions of sufficient power, only small antennas are needed. But aircraft and ships both need a certain amount of 2-way communication capability. Furthermore, aircraft flight altitudes often provide aircraft with VHF communication ranges equaling those obtained by surface craft using lower frequencies; an aircraft's altitude extends the horizon to extremely long distances. Nevertheless, Recommendation No. 48 calls for determining the standard of worldwide application to which the radio characteristics of the EPIRB should conform.

As indicated previously, the unit cost of a device may depend greatly on the total number of units produced. Because aeronautical interests are also concerned with adoption of a beacon such as the EPIRB for distress purposes, coordination between maritime and aviation interests is desirable. Actually, unless there are overwhelming reasons to the contrary, marine and aeronautical EPIRB units should be identical in frequency and identification signals. Commercial airlines already have FCC-approved EPIRBs in use on the aircraft frequency of 121.5 Mc/s; however, the FCC has not yet licensed similar beacons for use in the maritime service.

Standardization of maritime and aeronautical requirements means that the same beacon could be used in search and rescue work over water or over land. Slight outer packaging differences might be needed to meet differing operational requirements, but the basic transmitter components could be identical. U.S. military forces already have standardized on a basic military transmitter component; thousands of these units have been purchased, and development costs now have largely been written off. As a result, the unit cost per U.S. military-type beacon has dropped below $100 each. (See Figure 2)

Advantages of the EPIRB have been cited by many U.S. Government activities among which was the U.S. Coast Guard Marine Board of Investigation convened to investigate the loss of the SS *Marine Sulphur Queen*.[7] That Board was of the opinion that the carriage of an EPIRB aboard ship should be implemented at the earliest practical date. During the search for the ship, 83 flights totaling 500 hours searched nearly 350,000 square miles of ocean.

The Federal Aviation Agency (FAA) is concerned with a similar problem—that of homing on the scene of an aircraft disaster occurring over land. Nearly 2 years ago, FAA endorsed the use of a so-called "crash-locator beacon" operating on 121.5 Mc/s. This beacon was to serve essentially the same purpose as the EPIRB. FAA expressed hope that such beacons could be produced at a low cost, thus

[7] "Commandant's Action on . . . the SS *Marine Sulphur Queen* . . ." *Proceedings of The Merchant Marine Council*, Vol. 21, No. 7, July 1964, pp. 118–121. U.S. Coast Guard, Washington, D.C., 20226.

encouraging aircraft owners to buy or rent the beacon.

What Is an EPIRB?

Other than the operational definition contained in Recommendation No. 48, there is no complete definition of the Emergency Position-Indicating Radio Beacon (EPIRB). For example, no technical parameters are listed in the Recommendation. Even the frequencies mentioned for possible use in the EPIRB are in somewhat of a state of ambiguity. Internationally, the EPIRB is most closely allied to a survival beacon—a kind of survival craft radio station such as is available for use in lifeboats and liferafts. At present, the Geneva Radio Regulations (of the ITU) define a survival beacon as a kind of survival craft radio station. The Geneva Regulations authorize such stations to operate on the five frequencies listed in Table II.

Of these five frequencies, only two have any direct and compatible relationship; 121.5 Mc/s and 243 Mc/s are harmonically related ($121.5 \times 2 = 243$) and are generally used for radiotelephone. It is practical to build a transmitter capable of transmitting either alternately or simultaneously on these two harmonically related frequencies. Equipment capable of this type operation has already been built by at least two manufacturers.

None of the other frequencies are related in any way, and, in fact, they differ greatly; 500 kc/s is allocated to radiotelegraph use; 2182 kc/s, to radiotelephone; and 8364 kc/s, to radiotelegraph.

EPIRB Identification Signals

These foregoing inconsistencies are not important, however; regardless of the frequency used, the EPIRB should transmit a signal having its own unique characteristic. In Special Committee Report No. 49 (officially accepted on April 23, 1963), the Radio Technical Commission for Marine Services (RTCM) concluded that the optimum signal for a survival beacon would be dependent on the frequency used. Specific conclusions of the Report are:

(1) For the radiotelegraph frequencies (500 kc/s and 8364 kc/s), the signal should be the universally used radiotelegraph autoalarm signal.

(2) For the radiotelephone frequency of 2182 kc/s, the signal should be the universally used two-tone autoalarm signal. (See Figure 3)

In each of the above situations, the EPIRB thus would activate already existing autoalarm receivers; however, generation of these particular signals by beacons introduces technical and economic factors that might hinder their use in a practical beacon.

For the two VHF aeronautical frequencies, no prescribed autoalarm signals existed at the time of the study. Several types of signals were available for comparison, however. For these aeronautical frequencies, the RTCM Special Committee concluded that the recommended VHF signal should be a swept-tone signal rather than a single-tone or other

Courtesy of Magnavox Co.

Figure 2. AN/URT–21 Personnel Rescue Beacon. (243 Mc/s)

TABLE II.—FREQUENCIES AUTHORIZED FOR SURVIVAL CRAFT RADIO STATIONS

Frequency	Band	Prescribed mode	Description
500 kc/s	MF	Radiotelegraph	International radiotelegraph distress frequency.
2182 kc/s	MF	Radiotelephone	International radiotelelephone distress frequency.
8364 kc/s	HF	Radiotelegraph	International survival craft frequency and search-and-rescue frequency.
121.5 Mc/s	VHF	Radiotelephone [1]	Aeronautical emergency frequency.
243 Mc/s [2]	VHF	Radiotelephone [1]	Survival craft frequency.

[1] Emission not specifically prescribed but generally used for radiotelephone.
[2] Referred to as UHF frequency by some military organizations.

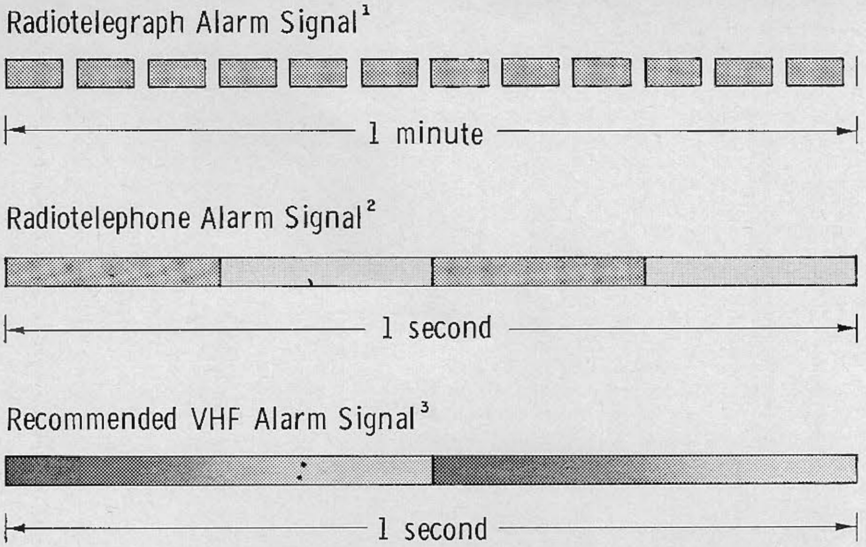


Figure 3. Graphical Representations of Recommended EPIRB Identification Signals.

[1] 1463 § 39. (1) The radiotelegraph alarm signal consists of a series of twelve dashes sent in one minute, the duration of each dash being four seconds and the duration of the interval between consecutive dashes one second. It may be transmitted by hand but its transmission by means of an automatic instrument is recommended.
Radio Regulations, ITU, Geneva, 1959. Chapter VIII, Article 36, Section VIII.

[2] 1465 § 40. (1) The radiotelephone alarm signal consists of two substantially sinusoidal audio frequency tones transmitted alternately. One tone shall have a frequency of 2200 cycles per second and the other a frequency of 1300 cycles per second, the duration of each tone being 250 milliseconds [0.25 second].

1466 (2) The radiotelephone alarm signal, when generated by automatic means, shall be sent continuously for a period of at least thirty seconds but not exceeding one minute; when generated by other means, the signal shall be sent as continuously as practicable over a period of approximately one minute.
Radio Regulations, ITU, Geneva, 1959. Chapter VIII, Article 36, Section VIII.

[3] *6. RECOMMENDATIONS*
a. That the signal adopted for survival craft radiobeacon purposes, except as noted in "6b" [6b. That the survival craft radiobeacons designed for operation on 500 kc/s and 2182 kc/s shall use the present international alarm signals.], shall be an amplitude modulated signal (A2) sweeping downward approximately 700 cps between the audio range of 1,600 cps and 300 cps. These sweeps shall be at the repetition rate of 2 to 3 sweeps per second.
Standardization of Distinctive Signals (A2 Emission) for Use in Survival Craft Radiobeacons. Special Committee No. 49 Report, April 23, 1963. Radio Technical Commission for Marine Services, Washington, D.C.

type of signal. Not only does the swept-tone signal have a more distinct characteristic, but it is less likely to be mistaken for a heterodyne signal or for interference. Even in a beacon, generation of a swept-tone signal is not considered to be a difficult technical problem.

Until the Emergency Position-Indicating Radio Beacon is fully defined both operationally and technically, choice of a beacon frequency apparently need not be limited to the five frequencies listed previously. For example, 156.8 Mc/s in the Maritime Mobile VHF–FM Band is recognized internationally as a calling and safety frequency. Although it is not designated as a "distress frequency," it is available and may be used under the provisions of the International Radio Regulations for signals of distress.

Pending International Conferences

Hopefully, the present situation will be clarified within the next 2 years. The International Telecommunication Union (ITU) has already queried member nations as to the desirability of calling an Extraordinary Administrative Radio Council (EARC). Purpose of such a meeting would be to deal with problems of the Maritime Mobile Service. Indications are that a Maritime EARC will be convened in 1967 or 1968. At such a meeting, the EPIRB could be fully defined, at least from the maritime viewpoint, and one or more acceptable frequencies could be allocated for its use.

The Distressed and the Searchers

In every distress alert, two groups of people are involved: The distressed and the searchers. Disasters strike most often in periods of inclement weather, and those in distress often find themselves adrift on a rough sea in cold, stormy weather. Frequently, the survivors may be injured, weak, sick, or otherwise not be capable of performing physical action such as was required by the World War II "Gibson Girl," a hand-cranked unit transmitting on the two radiotelegraph frequencies. For this reason, SOLAS Recommendation No. 48 and all governments are generally agreed that an EPIRB should be capable of automatic operation. Nevertheless, the possibility of additional capability—such as voice transmission—has not been ruled out.

Some governments have expressed concern that amateur seafarers might use such equipment indiscriminately when no genuine distress exists. For years, this problem has existed with the present equipment. To overcome this possibility, it has been suggested that use of the EPIRB be limited to watercraft with licensed ship radio stations. This limitation would, for example, prohibit rowboats and canoes, etc. from using the EPIRB. Lives might still be in jeopardy in such craft; but the costs of placing search-and-rescue equipment in action for every such case may be prohibitive when weighed against the possibility of tying up that equipment if a distress situation of large proportions occurred at nearly the same time. Search-and-rescue facilities are not unlimited, and searchers cannot be in two places at the same time.

Choice of the EPIRB radio-frequency will largely determine who the searchers will be. Most Search-and-Rescue (SAR) aircraft and surface units are equipped to receive signals on at least several of the five most commonly considered frequencies. Civil aircraft are generally limited to the nonmilitary aircraft frequencies but may also have 2182 kc/s. Larger commercial surface craft usually have the capability of listening on the two radiotelegraph frequencies and, in general, also have radiotelephone (2182 kc/s). Most smaller craft are limited to radiotelephone reception (2182 kc/s). But regardless of the type of craft or the equipment carried, that equipment must be in use and monitoring the chosen EPIRB frequency during any actual or suspected distress case. Otherwise the mission of the EPIRB—to furnish radio signals for homing—will have been thwarted. (See Table III)

When all factors are considered, selecting the optimum radio frequency for an EPIRB is somewhat like buying a new car. The most basic need must take precedence. To illustrate, the basic function of every car is to provide transportation. But a person with a large family must choose a large car; a small garage dictates a small car; a need to haul articles suggests a truck or at least a station wagon; a need for prestige implies a luxury car.

Even the area of use must be considered: convertible or closed top; air conditioner or heater. And maintenance of many complicated accessories may be a major consideration if one lives far from a mechanic. Finally, after all these myriad factors are considered, price alone may be the decisive factor.

Choosing an optimum radio frequency for the EPIRB is just as complicated as is choosing the optimum type of car. Unfortunately, the multipurpose station wagon has no radio frequency counterpart.

With respect to the EPIRB, some factors are obvious: The need to save lives is worldwide; the characteristic EPIRB signal should be distinctive, recognizable on any frequency, and identify its particular mission as that of a homing signal.

Operational conditions in which the EPIRB might be used are not the same throughout the world, however. In Northern European waters, the many small commercial ships would seem to make 2182 kc/s a logical choice if interference is not a problem; radio discipline is good, and there are experienced personnel aboard these ships. In U.S. waters, there are many more small craft equipped with 2182 kc/s but interference is a serious factor; also, radio discipline is poor, and most personnel aboard these small craft are amateur seafarers. In midocean, small ships seldom venture, and there are very few large or small ships listening on 2182 kc/s. Recognizing this potential hazard, the Federal German Republic has adopted a safety requirement: all of its small radiotelephone-equipped ships transiting the North Atlantic must carry a special auxiliary transmitter operating on 500 kc/s and transmitting a predetermined message.[8] In the event of distress, a signal on 500 kc/s undoubtedly would be heard by one of the many larger radiotelegraph-equipped ships usually nearby.

Searchers also need to be considered. Speeds of conventional surface ships are nearing a practical maximum unless new breakthroughs in power research are achieved; the future, however, undoubtedly will produce longer range, exotic types of surface craft such as hydrofoils and ground effect machines (GEMs). These longer range craft should be capable of operating at comparatively high speeds in midocean.

Aircraft speeds have increased steadily in the past, and there seems to be no practical limit as to their potential top speed. Obviously, speed is an asset in locating the scene of distress promptly. High speeds may make possible a brief search resulting in the locating of survivors—not victims.

In the near future, it is highly probable that artificial satellites could be used as effective search vehicles. Because of their extreme altitudes, each satellite could sweep a wide band of the earth's surface. If the EPIRB radiated a signal with sufficient strength to be detected by a "high-flying" satellite, distress locations could be pinpointed within minutes.

Rescues

Regardless of the search craft involved, most actual rescues will be performed by surface craft (or perhaps by undersea craft). Offshore, aircraft can supply survivors with interim aid such as flotation gear, water, and supplies. Nearshore, helicopters and fixed wing aircraft may be able to pick up survivors. But regardless of *how* or *who* makes the rescue, survivors must first be located. A brief successful search is imperative to accomplish the goal of locating (live) survivors rather than (dead) victims.

International Safety Programs

Safety at sea can be enhanced in several ways. As usual, the U.S. Coast Guard is one of the international leaders. For 7 years, the Coast Guard has operated AMVER—a voluntary system of ship-position reporting.[9] This system has double value: (1) In the event of a distress alert without an accurate position, the ship's approximate location can be predicted by means of the AMVER computer; then aid can quickly be rushed to the scene. (2) In the event of a known distress situation happening to any craft, the AMVER computer can determine quickly which ships are nearest to the scene of distress. Appropriate assistance then can be dispatched promptly. Obviously, it is to the benefit of all shipping to participate voluntarily in the AMVER system; *the ship supplying assistance today may be the ship in distress tomorrow.*

In the field of international coordination, the U.S. Coast Guard recently conducted the North Atlantic Search and Rescue Operations Seminar (NASAROS). Results of this Seminar have been reported in various issues of the *Proceedings* for the past half year. Such seminars are invaluable in promoting greater search-and-rescue coordination among the maritime nations.

Recommendations for Action

In addition to these herculean efforts by the U.S. Coast Guard, other efforts are needed from all those interested in greater safety at sea. Contributions of ideas, techniques, research and development, equipment, and even legislation all are valuable in helping solve the total problem; after all, safety at sea is a *total* problem that defies dismemberment into minute segments.

Expand Research and Development

For example, every effort should be made to develop new techniques and to refine existing devices. Additional alerting methods need to be introduced. One, SOFAR, a SOund Fixing And Ranging system, may become a very useful alerting system.[10]

Midocean locating techniques need improvement. Efforts should be made to increase the accuracy of shipborne direction finding equipment for use in the 2 Mc/s band (specifically on 2182 kc/s). Alternatively, a small and perhaps portable transmitter for emitting 500 kc/s signals suitable for direction finding with present radio beacon direction finders should be developed. And for long distances, consideration should be given to installing high frequency (HF) direction finding equipment at judiciously selected sites. Such strategic locations might provide a worldwide HF direction finding network of particular value in such farflung vastnesses as that of the southern Indian Ocean.

Small inflatable balloons might be used to increase transmitting antenna heights to hundreds and perhaps thousands of feet; perhaps the U.S. Weather Bureau already has the nucleus for this device in their radiosonde program. Transmitting predetermined distress signals from aloft should be vastly simpler than what is done now by these time-proven radiosondes.

At the same time, homing on survivors should not be overlooked. New

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[8] "Germany Increases Safety of Radiotelephone Equipped Ships." *Proceedings of The Merchant Marine Council,* Vol. 22, No. 9, September 1965, pp. 203, 214. U.S. Coast Guard, Washington, D.C.

[9] "AMVER Revisited; AMVER Expanded." *Proceedings of the Merchant Marine Council,* Vol. 22, No. 8, August 1965, pp. 182–184, 190. U.S. Coast Guard, Washington, D.C.

[10] *American Practical Navigator (Bowditch),* [H.O.] Pub. No. 9, 1962, pp. 346–347. U.S. Naval Oceanographic Office, Washington, D.C.

Table III.—Comparison of Frequencies Considered Available

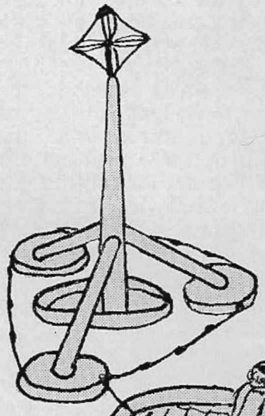
Frequency	Band	Receiver distribution and signal monitoring: surface and air	DF/ADF equipment (ADF Automatic Direction Finder)
500 kc/s	MF	Radiotelegraph-equipped ships: Continuous monitoring for alarm signal mandatory. Few aircraft equipped to listen.	DF: Most ships equipped with marine radiobeacon band (LF/MF) direction finders.
2182 kc/s	MF	Many ships equipped. Some aircraft equipped. Listening mostly voluntary.	DF: Few ships equipped with 2182 kc/s direction finders.
8364 kc/s	HF	Larger ships equipped. Listening not mandatory. Coast stations "sweep" across frequency.	Not suitable for direction finding from ships or aircraft.
121.5 Mc/s	VHF	Many civil aircraft equipped: Listening not mandatory. All U.S. SAR aircraft equipped. No commercial surface craft known to be equipped.	ADF: SAR aircraft equipped with ADF.
243 Mc/s	VHF	All U.S. Military and SAR aircraft equipped. Nearly all NATO aircraft equipped. All U.S. Coast Guard craft 83' length and above equipped. Few civil aircraft equipped. No commercial surface craft known to be equipped.	ADF: U.S. Military and SAR aircraft equipped with ADF. NATO aircraft equipped with ADF. All U.S. Coast Guard craft 83' and above equipped with ADF.

[1] These antenna lengths are based on quarter wavelengths, with variations to allow for system of coupling to radio transmitter. An antenna should have an effective radiation length of at least one-quarter wavelength. Antennas shorter than a quarter wavelength can be used satisfactorily but additional input power and additional loading inductance is needed to maintain given ranges and proper resonance adjustment.

[2] Based on antenna lengths practical for mounting on a floatable EPIRB and on the absence of noise or interference from other signals. In the case of 121.5 Mc/s

concepts and refinements for the EPIRB should be considered. A dual-frequency transmitter/receiver using the harmonically related frequencies of 121.5 Mc/s and 243 Mc/s might be particularly useful. Seawater-activated battery research should be encouraged with longer life and smaller size as the twin goals.

Inflatable antenna masts capable also of acting as radar reflectors should be adapted for maritime use. Perhaps these masts could be inflated with some of the new chemical foam mixtures that solidify with millions of tiny air bubbles. An antenna mast such as this could incorporate three distinct lifesaving features: (1) Antenna support, (2) radar reflector, and (3) buoyant apparatus. Any one of these features alone might be the means of saving life.



Modernize Legislation

All existing safety equipment legislation should be examined with an eye to practicality and economics. Basic criteria should be to omit all overlapping and redundant requirements.

This important point was developed at a recent Comité International Radio-Maritime (CIRM) meeting. Considerable discussion revolved around characteristics of a particular EPIRB transmitting on 2182 kc/s. One representative present concluded that it seemed to him there was now very little difference between that EPIRB and a Portable Lifeboat Set. Redundancy was well on its way to becoming entrenched even before technical characteristics of the EPIRB had been internationally agreed on.

Attempt to provide modular automatic or semiautomatic devices. Several such devices might be far more effective than one elaborate piece of equipment. For example, present survival craft radio transmitters now are required to have a capability for transmission of 500 kc/s and 8364 kc/s signals. Two separate transmitters might provide greater safety and perhaps even at lower cost; each such transmitter could be placed in a different lifeboat rather than placing the one combination transmitter in one boat.

Furthermore, such modular devices would be far more flexible in outfitting ships for different operating areas. For example, ships operating in the North Atlantic might find more safety with two separate portable lifeboat sets—one each on 500 kc/s and 2182 kc/s. But for the lesser traveled and larger ocean areas, more safety might be provided if separate lifeboat sets were provided for 500 kc/s and 8364 kc/s. Diversified frequencies might provide greater safety *on a worldwide basis.*

Consider allowing the use of portable leased or rented equipment to be required aboard only when at sea. Equipment of this type could well be maintained by a central activity rather than allowed to deteriorate aboard ships temporarily laid up. This procedure would be an extension of the maintenance service now performed with CO_2 cylinders used as fire extinguishers.

Encourage Cooperation

Search for better communications cooperation between surface craft and aircraft. The goal should be to have *every* craft monitor at least one frequency all the time. Preferably, as few frequencies as possible should be available for this purpose. (Presently, the U.S. Coast Guard is routinely involved in guarding four frequencies with the possibility of being forced to

DF/homing capability	Quarter-wave antenna length (feet) [1]	Predicted signal ranges (nautical miles) [2]	
		Surface (seawater)	Air [3]
Good direction finding and homing capability.	450 to 500.	0 to 3.	0 to 5.
Requires careful installation and calibration. In general, not accurate for DF bearings more than 30° on each bow. Considered by USCG to be fair to good for homing purposes by their surface craft.	Approximately 95.	0 to 10–20.	0 to 10–50.
Very long ranges make direction finding practical from land locations.	Approximately 25.	0 to approximately 10; then 200–500 by day and up to 3000 by night.	0 to approximately 10; then 200–500 by day and up to 3000 by night.
Good for homing.	1.5 to 2.0.	0 to 0.5–5 dependent on height of receiver antenna.	0 to 150 with sensitive, frequency-stable receivers.
Good for homing.	0.75 to 1.0.	0 to 0.5–5 dependent on height of receiver antenna.	0 to 150 with sensitive, frequency-stable receivers.

and 243 Mc/s, antennas having quarter wavelengths (or longer in the case of 243 Mc/s) are practical. For the MF and HF frequencies, antennas shorter than quarter wavelengths must be used on floatable EPIRB.

[3] Based on aircraft search altitudes of 10,000 feet. At typical transoceanic jet aircraft flight altitudes of 30,000 feet, VHF signals can be detected up to 250 miles providing radiated signal strength is adequate.

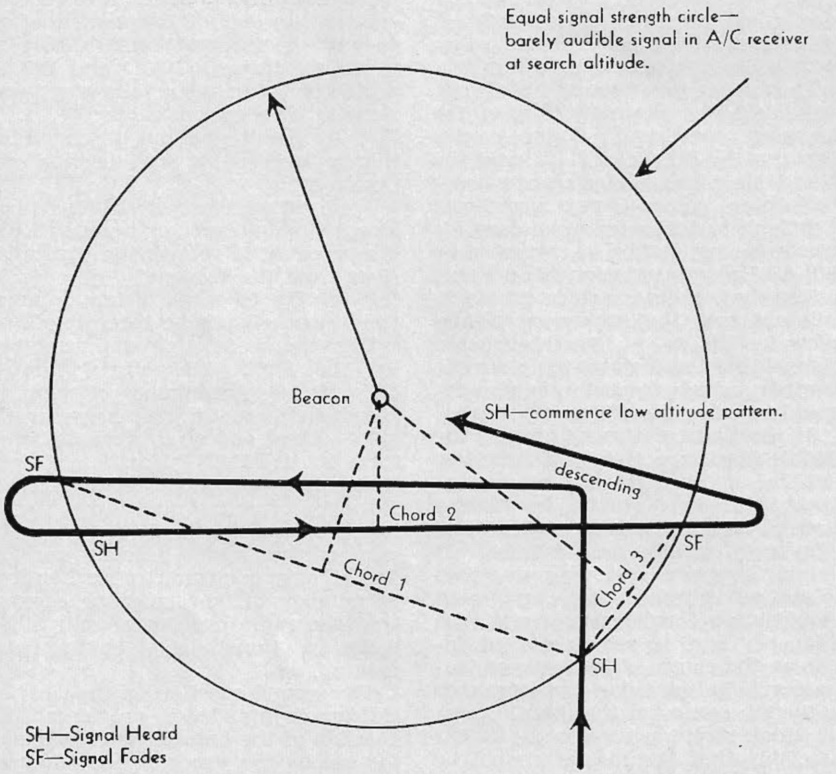


Figure 4. Geometrical Search Pattern suitable for use either by aircraft or by surface craft.

add a fifth frequency soon.[11]) Larger radiotelegraph-equipped ships already monitor 500 kc/s continuously. Smaller ships and aircraft should likewise monitor some safety frequency continuously. Such action would greatly enhance the possibility of random detection of distress signals emanating from an EPIRB or other similar device.

Attempt to find some justification for having all surface craft and all aircraft on overwater flights to continuously monitor one or both of the VHF frequencies now considered available for EPIRB use. This monitoring could be either completely or partially by automatic devices similar to the existing radiotelegraph and radiotelephone autoalarms. Such continuous monitoring would give the EPIRB a dual function—that of an alerting device as well as a homing device. Having once detected a signal, any craft can locate the EPIRB without using a direction finder. With the short ranges of VHF frequencies, all that is needed is an uncomplicated geometrical search pattern. (See Figure 4)

Peer into the future, and be alert to exploit all possible avenues for increasing safety of life at sea. Extend the AMVER system beyond the Pacific and into the southern oceans. Predict ways to use satellites for maritime safety. Above all, critically examine every type of proposed maritime development to see how each proposal can increase safety. ⚓

[11] "Radio: The Vital Search and Rescue Link." *Proceedings of The Merchant Marine Council*, Vol. 22, No. 8, August 1965, pp. 179–181, 190. U.S. Coast Guard, Washington, D.C.

What channel for EPIRB?

The North Atlantic SAR Seminar at New York in May heard several views on the problem of standardizing Emergency Position–Indicating Beacons. These several views were divergent in certain technical and operational areas. The U.S. position, for example, differed from that of some European participants. A paper given by RTCM setting forth the U.S. position is carried below. IMCO recommendations and a European presentation follow.

SHIPS SOMETIMES sink and aircraft sometimes crash. Except in the most unfortunate circumstances, there are survivors. Although alive, they may be injured and be hundreds of miles from the nearest land. Consequently, it is imperative that the survivors be located in the least possible time.

Either ships or aircraft may be used to search for the survivors. If survivors are to be rescued, time is vitally important. Therefore, it is necessary to have a radio locator system which will enable the searching craft to "home" on them in the minimum of time.

This report deals with the selection of a frequency to best perform the desired function irrespective of the amount and distribution of radio equipment adaptable to its use at the present time.

The International Situation

It is evident from the following international developments that no worldwide or even areawide uniformity exists at present in regard to the particular frequency to be used for survival craft beacons.

In pursuance of Recommendation 48 of the International Conference on Safety of Life at Sea (SOLAS), 1960, the Inter-Governmental Maritime Consultative Organization (IMCO), in cooperation with the International Telecommunication Union (ITU) and the International Civil Aviation Organization (ICAO), initiated a study of the radio characteristics of an emergency position-indicating radio beacon.

The subject was referred to the IMCO Group of Experts on Co-ordination of Safety of Life at Sea and in the Air which was invited to formulate an IMCO view on this matter. The Group of Experts confined its attention to the problem of the appropriate frequency for such a beacon without reaching concrete conclusions. The Group noted that in some countries the requirements for the equipment were based on the fact that search and rescue is carried out primarily by maritime units, while in other countries the emphasis is on facilitating the search by aircraft.

The matter was discussed at Secretariat level by representatives of the agencies concerned (Inter-Agency Group of IMCO, ICAO, ITU, and the World Meteorological Organization). This Inter-Agency Group also found it difficult to decide on a standard for worldwide application as requested by SOLAS Recommendation 48 and concluded that, while for ships sailing in different seas the equipment should allow for the use of two frequencies, it should rest with states to determine whether a single frequency equipment would be adequate for small ships.

In the light of these findings, the IMCO Maritime Safety Committee (MSC), at its 6th session, decided "that 2182 kc/s should be recommended as a first choice operational frequency for these radio beacons. It should, however, rest with states to determine whether the equipment should allow for the use of a second frequency and, in such cases, to decide on the choice of that second frequency." This decision was submitted to the 8th session of the IMCO Council which recommended to the IMCO Assembly that the matter should be referred back to the Maritime Safety Committee for reexamination. The Assembly accepted this recommendation.

Meanwhile, following Recommendation 48 of the 1960 SOLAS Conference and the findings of the Inter-Agency Group, the IMCO Secretary-General requested the International Radio Consultative Committee (CCIR) of the ITU to consider the standard of worldwide application to which the radio characteristics of these emergency beacons should conform. This CCIR Committee, taking into consideration the text of Recommendation 48 and the information available at that time through ICAO and IMCO, decided to address the following questions to both organizations:

(a) Are the beacons intended for homing only or for both alerting and homing?

(b) What class of stations (e.g., aircraft, ship, coast or aeronautical) are expected to receive the transmissions from the beacons?

(c) Up to what distances must the beacon signals be receivable?

In response to a circular sent out by the IMCO Secretariat, dated May 13, 1963, a number of member governments made their views available. These appear in a summarized form in the IMCO Maritime Safety Committee Document MSC VIII/13. Regarding the first question concerning *"homing–alerting,"* the majority view is that radio beacons are intended only or primarily for homing. A number of governments suggest that the radio beacons should fulfill both functions, i.e., alerting and homing.

The second question on the *class of stations* is intended to provide an indication of the appropriate frequency for use by the beacons. As summarized apparently by IMCO officials, the answers indicate that "the beacons are expected to be heard by vessels, aircraft and coast stations, *in that order of preference.*" However, the answers do not specify whether "aircraft" in this case means "civilian aircraft" or "SAR-aircraft" or both. Five answers specifically mention the radiotelephone distress frequency (2182 kc/s) as the most suitable transmitting frequency for the beacons.

On the question of the *range*, there is a diversity of opinion. The most common view is that a maximum of 50 miles is required. Some countries suggest a minimum of 10 miles at sea level.

In consequence, the IMCO Maritime Safety Committee was invited to formulate the answers which should be given to the questions posed by CCIR, and to express the MSC views on the problem of the frequency or frequencies to be used by position-indicating radio beacons. Accordingly the views of the Maritime Safety Committee, resulting from the 8th session held in April of 1964, on the requirements of the position-indicating radio beacons are:

(1) The beacons are intended primarily for homing;

(2) Stations expected to receive the transmissions from the beacons are: Primarily ships and SAR aircraft;

(3) Except in areas of difficult propagation the signals from the beacon must be receivable at a distance over the sea of at least 30 nautical miles;

(4) The frequency of 2182 kc/s is recommended as a first choice operational frequency for the radio beacons. It should, however, rest with Administrations to determine whether the equipment should allow for the use of a second frequency and, if so, to decide on the choice of that second frequency;

(5) The beacons should transmit intermittently;

(6) If it is possible, within the specifications stated above, the beacon should incorporate an identification signal which should not be the two-tone alarm signal. This would serve to alert ships which had not heard the alarm.

For more detailed information regarding the international situation in reference to any particular frequency that should be adopted for use by emergency position-indicating radio beacons, see MSC VIII/13.

Concepts Adopted Basic to the Selection of a Single Optimum Frequency

The Radio Technical Commission for Marine Services concurs with the position of the IMCO Maritime Safety Committee in respect to the prime function of Emergency Position-Indicating Radio Beacons in that these are intended primarily for "homing." This function is more clearly defined by the International Maritime Radio Association (CIRM) in its Technical Paper No. 114 of August 30, 1963, wherein the following is stated:

> On the assumption that the rescue service has previously been alerted by the main or emergency equipment of the distressed ship or aircraft, it is considered that the emergency radio position-indicating beacon should be employed for homing only.
>
> The purpose of the beacon is to mark the position of a distressed ship or aircraft and/or survivors, after the main and emergency radio equipment has become inoperative through sinking or some other cause; and to provide signals to enable ships and aircraft endeavoring to give assistance to locate the position by "homing" on them.

Clearly, the term "Emergency Position-Indicating Beacon" does not refer to survival craft radio equipment now required to be carried by ships under the provisions of Chapters III and IV of the Safety of Life at Sea Convention, 1960.

The second point made by the IMCO Maritime Safety Committee is that transmissions from the beacons are expected to be received primarily by ships and SAR aircraft. RTCM takes exception to the IMCO statement regarding "order of preference." ("The beacons are expected to be heard by vessels, aircraft and coast stations, in that order of preference." IMCO MSC VIII/13, 14 February 1964, para. 8.) Referring to this IMCO document, it is noted that the three *questions posed did not call for order of preference.* Order of preference was specifically indicated by only three replies: CIRM, Denmark, and the U.S.A. Because order of preference was *not* specified by other countries, no valid conclusions can be drawn from these replies as to the order of preference. RTCM considers that preference should be expressed for *either* ships *or* SAR aircraft in order to establish the correct basis on which to select a *single optimum* beacon frequency. In consequence, the following text is intended to bring out the important relevant differences between these two kinds of mobile units when they are to be utilized in supplying assistance to distressed or survival craft at sea.

Events leading to the rescue of survivors at sea generally come under three distinct phases of action, listed as follows:

(1) *Search:* Confirmation or determination of the exact location of the survivors.

(2) *Interim Aid:* Providing interim early aid to survivors when necessary; usually by means of material dropped from aircraft, i.e., medical supplies, water, food, instructions, maps, flares, radio equipment, and, in some cases, life rafts and possibly personnel of a "rescue team" (from a helicopter).

(3) *Rescue:* Actual rescue of the survivors, emergency treatment of them when necessary, and transporting them to a larger vessel or to land.

It is realized that operations (1) and (2), as well as operations (1) and (3) may occur in prompt succession as a single mission. To avoid possible confusion concerning the purpose of the beacon frequency to be selected, however, they are listed separately.

Search

Whether a ship or an aircraft should be primarily depended upon to determine the exact location of a position-indicating radio beacon depends upon certain principal factors which are described herewith.

(A) With reference to the precision of available initial information:

(1) Initial location of survival craft reported specifically and precisely, generally in latitude and longitude or in bearing and distance from a known specific geographic point.

(2) Initial location known precisely but subject to change because of—

(a) uncontrolled movement of survival craft due to wind, current, or loss of steering ability in the case of a distressed vessel still afloat;

(b) distressed ship still afloat and moving under control in attempt to reach land, shoal water, or another ship.

(3) Initial location known or suspected* not precisely but anywhere within a limited general area (Example: Gulf of Mexico).

(4) Initial location known or suspected* not precisely but anywhere within a wide general area (Example: central North Atlantic Ocean).

(B) With reference to the availability of potential search vessels:

(1) Water areas well traversed by ships of potential value as search craft (majority of ship distress situations).

(2) Water areas usually not traversed by ships of this kind, or traversed only occasionally by this kind of ship (minority of ship distress situations) (Examples: Bering Sea; South Pacific Ocean).

(C) With reference to surface conditions of weather and sea over the route to be travelled by the search

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*The possibility and probable location of survivors from a distress incident, although not known, may be suspected as the result of a severe storm, tidal wave, or dangerous cargo; together with the fact that a ship is overdue at its anticipated destination and has not been heard from for a significant period.

vessel and at the location of the survivors:

(1) Speed of search vessel reduced by adverse wind, adverse heavy seas, or restricted visibility caused by rain, sleet, snow, ice, or partial or dense fog.

(2) Speed of search vessel reduced because of damage caused by heavy weather.

(D) With reference to the relative urgency of the need for assistance by the survivors:

(1) Saving the life of one or more survivors depends upon the earliest possible availability of needed medical aid, fresh water, food, protective garments, etc.; consequently, the element of time immediately becomes of paramount importance.

(2) Survivors are in no immediate danger; the weather is clear, the temperature is moderate, the sea is not rough, and a temporary supply of food and water is available.

Interim Aid

When an urgency exists in respect to providing immediate temporary aid to survivors pending actual rescue, there seems little doubt that modern SAR aircraft, in view of their superior speed and freedom from sea-surface turbulence, are more useful than surface vessels unless severe weather conditions prevent the effective use of such aircraft for this purpose. It is believed that in the majority of cases, SAR aircraft can be used with success. In particular, under favorable conditions and not too far distant from its base, a helicopter can be especially effective in supplying interim aid or even in performing some or all of the actual rescue function.

Rescue

Except for those incidents when helicopters take over or assist in the operations, the actual work of rescuing survivors at sea must be the responsibility of surface craft. Delay involved in reaching the survivors should, of course, be the minimum necessary. In this respect, however, aircraft can assist in directing the surface vessel to the exact location by radio or, if weather conditions and other factors are favorable, by visual guidance.

Aid From Surface Ships

Often a particular ship may, because of geographic location at the time of a distress incident involving another ship or down aircraft at sea, be in the best position to conduct the search for survivors. This ship, however, will not always be fitted, or best fitted, with the radio equipment needed for homing on a position-indicating beacon, *irrespective of the particular frequency on which the beacon transmits,* unless radical changes in international radio regulations are adopted and uniformly enforced, including an effective maintenance schedule to insure workable equipment at all times. The speed of a vessel in conducting a search cannot be compared to the speed of a SAR aircraft, and the ship's speed may be seriously reduced during unfavorable sea or weather conditions. Also, ships differ considerably in their ability to render emergency interim medical aid to survivors and in transporting seriously ill or injured persons to shore or to larger ships better fitted to provide such aid.

It must be recognized that most surface ships, on a worldwide basis, are not intended or fitted *primarily* to engage in the function of search and rescue of survivors at sea.

Aid From SAR Aircraft

In recent years, it has become apparent that in many cases, and under nearly all weather conditions, the modern aircraft is the most effective search vehicle for locating survivors at sea. This is particularly the case with SAR aircraft designed and outfitted for this type of operation and maintained in readiness at all times. The aircraft is particularly effective if the area in which the survivors are thought to be is large and its boundaries are only vaguely defined. For example, to search an area of 60,000 square miles (300 n. miles by 200 n. miles) would take one search-and-rescue aircraft 2 hours flying time at an altitude of 10,000 feet. The aircraft is assumed to be using *VHF* radio equipment and the survivors are assumed to have a *compatible* transmitter giving an omnidirectional radio range of 70 to 90 nautical miles. Aircraft search lanes of 100 nautical miles width would be used. To search the same area using a surface ship traveling at 15 knots would take at least 8 days *under favorable weather and surface conditions.* It is assumed that ship search lanes only 20 nautical miles wide could be used and the survivors' position-indicating radio beacon would be transmitting on the international radiotelephone distress frequency 2182 kc/s. (Reference—"Search and Rescue Problems," a paper by V. G. Sampson, Ultra Electronics Limited, London, England; delivered at the Assembly Meeting of the Radio Technical Commission for Marine Services, March 1962, Atlantic City, N.J.)

From the foregoing comparisons, conditions, and limitations, it seems fairly obvious that, *in respect to water areas not usually traversed by ships, or traversed only occasionally by ships fitted with appropriate radio search equipment,* the SAR aircraft is the better search vehicle.

Considering next those *water areas well travelled by ships fitted with appropriate radio search equipment,* the inter-relation of applicable factors pertinent to a logical conclusion is believed to be shown in table I. In preparing table I, the assumption is

TABLE I: PREFERRED SEARCH VEHICLE UNDER VARIOUS DEGREES OF URGENCY AND WEATHER CONDITIONS
(Preferred search vehicle shown by entry "SHIP" or "AIRCRAFT")

Conditions concerning survival craft	Initial specific location reported precisely and accurately	Location known or suspected anywhere within a limited area	Location known or suspected anywhere within a wide area
Craft remains in initial reported location.	SHIP (cl) (no urgency). AIRCRAFT (urgency). AIRCRAFT (rv) (nv).	AIRCRAFT.	AIRCRAFT.
Craft moving under control in attempt to reach land, shoal water, or another craft.	SHIP (cl) (no urgency). AIRCRAFT (urgency). AIRCRAFT (rv) (nv).	SHIP (cl) (no urgency). AIRCRAFT (urgency). AIRCRAFT (rv) (nv).	AIRCRAFT.
Uncontrolled movement of craft due to wind, strong current, or loss of steering ability.	SHIP (cl) (no urgency). AIRCRAFT (urgency). AIRCRAFT (rv) (nv).	SHIP (cl) (no urgency). AIRCRAFT (urgency). AIRCRAFT (rv) nv).	AIRCRAFT.

EXPLANATION OF DESIGNATORS

cl: Clear weather; good visibility, sea not rough.
rv: Restricted visibility; rain, sleet, snow, high waves, some fog.
nv: No visibility; dense fog.
urgency: Immediate medical or other interim aid is needed.

made and believed to be generally applicable that the SEARCH AIRCRAFT begins its search from a base so located as to provide a distinct speed advantage over the SEARCH SHIP adjudged to be nearest to the location of the survivors.

The availability of SAR aircraft throughout the world is shown in the Air Navigation Plans published by the International Civil Aviation Organization (ICAO). These indicate the existence of extended coverage.

It seems clear that the foregoing analysis supports the choice of SAR AIRCRAFT as the more effective search and interim-aid mobile unit. Although it is realized that this will not hold true in all cases, it is firmly believed that where a choice must be made (for logical selection of the best single beacon frequency) on a worldwide basis, the weight of all relevant factors is distinctly in favor of the search aircraft as the greatest potential aid to the largest number of survivors.

Considering now the third point made by the IMCO Maritime Safety Committee that, except under conditions of difficult propagation, the signals from the position-indicating beacon must be receivable at the distance over the sea of at least 30 nautical miles, the Radio Technical Commission for Marine Services does not, on the concept of surface to aircraft transmission, agree with the Maritime Safety Committee. RTCM concurs with the present position of the U.S. Coast Guard that the beacon signals should be receivable up to 100 nautical miles by an aircraft fitted with a modern radio-beacon receiver in efficient working condition and in flight at an altitude of not less than 10,000 feet above sea level. (Reference—RTCM Distress Systems Study Group document C–1–DS–56, p. E.)

Points (5) and (6) of the IMCO Maritime Safety Committee position are not within the scope of this report. The remaining part of this paper deals with the 4th point of the IMCO position, i.e., the selection of a first-choice operational frequency for emergency position-indicating beacons.

Operational Requirements for Emergency Position-Indicating Beacons

Because the optimum single frequency to be selected for emergency position-indicating beacons is fundamentally related to its operational requirements, these requirements must be taken into account before consideration can be given to comparing the relative merits of the available frequencies. For this purpose, only broad general requirements pertinent to the

IMCO ON EPIRB

Recommendation 48, of the 1960 Conference on Safety of Life at Sea, recommends equipping all vessels where appropriate with floatable, self-energizing radio beacon, the radio characteristics of which should conform to a standard of worldwide application. These characteristics should be determined after consultations with ICAO and ITU. In the course of these consultations, the radio characteristics of such an equipment and the requirements for its worldwide application were the subjects of discussions within the Organization and the views of Member Governments were sought. In the light of the information collected, the problem was considered by the Maritime Safety Committee which formulated the following views:

(1) The beacons are intended primarily for homing;

(2) stations expected to receive the transmissions from the beacons are primarily ships and SAR aircraft;

(3) except in areas with difficult propagation characteristics, the signals from the beacons must be receivable at a distance of at least 30 nautical miles at sea level;

(4) the frequency of 2182 kc/s is recommended as a first choice operational frequency for the radio beacons. It should, however, rest with Administrations to determine whether the equipment should allow for the use of a second or more frequencies and, if so, to decide on the choice of those frequencies;

(5) the beacons should transmit intermittently;

(6) if it is possible, within the specifications stated above, the beacon may also be used for alerting in appropriate circumstances. In that event, the beacon should incorporate a characteristic identifying signal. The CCIR should investigate whether this signal could serve also as an alerting signal or whether the two-tone signal should be introduced for those cases where no alerting had been possible by other means.

The International Radio Consultative Committee (CCIR) of the ITU has been asked to prepare detailed specifications for the radio beacons, on the basis of the requirements of IMCO and ICAO.

Following the Committee's Recommendation, the subject was discussed by other technical bodies outside IMCO. Two points attracted special attention:

(a) *Type of "intermittent" transmission*

The term "intermittent" indicates the need for periods of silence alternating with periods of operation of the beacon.

One view favors short periods "on" and relatively longer periods "off" in order to avoid confusion and cluttering effects, particularly in cases and areas where more than one beacon may operate at the same time. On the other hand it is pointed out that searching aircraft, when passing overhead, may miss the beacon if the passage happens during the "off" period. It seems that the "on–off" ratio should be such as to permit taking bearings for homing purposes.

(b) *Type of "identifying" signal*

In view of the fact that the beacon is intended primarily for homing, it is assumed that the alerting phase has already been completed. Therefore, the identifying signal need not be the two-tone alarm. However, there may be cases where no alerting has been possible by other means. It should therefore be investigated whether the identifying signal (if it is not the two-tone alarm) could also serve as an alerting signal or whether the two-tone alarm should be introduced in the beacon.

It is understood that tests have been carried out recently by the French and German Authorities.

immediate problem will be regarded as the limiting factors. RTCM studies made of this subject indicate that a practical position-indicating beacon for emergency use at sea must meet the following conditions, among others:

(1) Under distress conditions, its operation must be completely automatic.

(2) It must float free from any other unit, and must operate even though a heavy sea is encountered with rain, snow, or sleet.

(3) The antenna (radiator) must be a low vertical rod or mast (nominally about 6 to 8 feet or less) with high radiation efficiency even under conditions of heavy spray and high waves.

(4) The average power consumed by the beacon must be as low as practicable, nominally from 1 to 3 watts input to the transmitter.

(5) The beacon transmitter must have good radio-frequency stability. Consequently, the frequency on which the beacon is to transmit should, in so far as may be possible, be a frequency which will best enable the beacon to comply with the above-listed basic operational requirements.

Comparison of Frequencies

The frequency to be selected must be available under International Radio Regulations for use worldwide without restriction and as free from interference by other stations as is possible. Prior to any consideration of the merits of different characteristic frequencies, therefore, there must first be set forth the relatively few frequencies which may be legally used under the governing treaty. These are 500 kc/s, 2182 kc/s, 8364 kc/s, 121.5 Mc/s, and 243 Mc/s. At the outset, it should be understood that the existence of a watch or automatic monitoring system on any of these frequencies has no bearing on the question of determining the optimum frequency. This is so because, as has already been stipulated, the primary purpose of the beacon is for homing *after* word of a distress situation has arrived possibly via other radio frequencies, even though two of these frequencies, namely 500 kc/s and 2182 kc/s, are international distress frequencies. Thus, listening on the beacon frequency by searching craft subsequent to a distress incident will *each time* be initiated by the normal processes of the established search and rescue facilities. The problem, therefore, is one of deciding which of these five frequencies will provide the *most effective transmission* under the limitations herein set forth concerning the operational requirements, using equipment *not* based upon the number of units of a particular kind predominantly in present use, but instead, equipment which will provide the *best performance* on the condition, of course, that it is technically and economically feasible.

Relevant technical characteristics of the five available frequencies are set forth herewith from the viewpoint of transmission to high-flying SAR aircraft.

500 kc/s and 2182 kc/s

These two frequencies have several characteristics in common. Their effective use under limitations of low power and small-size containers for equipment is very doubtful. The very small antenna possible on the beacon would result in very low radiation efficiency, and the relatively high voltage developed at the low point of the antenna would cause electrical leakage of power from the effect of salt water moisture. Unattended transmission on these frequencies for extended periods of time could cause interference to distress and emergency signals of other stations in certain locations near ships and coast stations. Concerning reception, both frequencies would be subject to interference from other stations and to atmospheric interference, the latter mostly during the summer months and at the lower latitudes. Receiving antennas aboard aircraft present a more troublesome antenna situation for 500 kc/s than for any other available beacon frequency. U.S. Coast Guard aircraft can utilize either 500 kc/s or 2182 kc/s effectively for both direction finding and homing. On small boats, direction finding and homing can be conducted effectively on either 500 kc/s or 2182 kc/s. However, as the size of a vessel increases, with corresponding complexity of superstructure and antenna arrays, direction finding on 2182 kc/s becomes erratic. This is due to irregular cross-over points or locking of the direction finder on a particular bearing. Because of this fact, it has become standard practice in the U.S. Coast Guard to use 2182 kc/s for homing only, restricting calibration to an arc within 30° on each bow.

8364 kc/s

Low power and small physical transmitter space would not be a problem in the case of 8364 kc/s. The small beacon antenna, while not favorable to a frequency of this order, would provide an acceptable degree of radiation efficiency. Unattended transmission on this frequency is not likely to cause interference to a distress signal, although it could do so on rare occasions when this frequency might happen to be carrying such signals at the same time. In regard to reception, atmospheric noise level would be low, and interference from other stations would occasionally give trouble. It has been demonstrated in practice that an efficient network of land-based direction finding receiving stations can determine within rather narrow limits the location of a beacon operating on a frequency of this order, even though transmission is over long distances. Sky wave reception of this frequency is not regarded as useful for accurate homing by search aircraft. Within less than about 15 miles from the beacon, the signals would probably be satisfactory for homing.

121.5 Mc/s and 243 Mc/s—VHF

These frequencies generally have common technical characteristics. The use of low power, small physical space, and small antennas are no problems of significance. The sizes of beacon transmitter antennas, in fact, are about optimum for these frequencies, and high radiation efficiency results. Transmission ranges to high-flying aircraft are limited to the ranges actually useful for effective searching operations. The element of long-distance interference from other stations is, except for very rare occasions of unusual propagation conditions, entirely absent. Further, there is practically no atmospheric interference present at any time. The leakage effect of salt water spray on the antenna is minimized by antenna circuitry that places the lower part of the antenna practically at ground electrical potential. Also, it is within the realm of practicability to employ specially engineered antennas that will provide a significant gain in radiation equivalent to an actual increase in power. Although experience to date indicates that the surface-to-surface transmission range of these frequencies is limited to a very few miles, improvements of this range from possible future technical developments cannot be ruled out. Unattended transmissions on these frequencies could create interference to civil or military aircraft stations while they are within the limited range of the beacon, but this does not appear to be a significant disadvantage; the possibility is rather infrequent, and the interference area is comparatively small. It is assumed, of course, that such beacons would be used solely in actual cases of distress.

At these frequencies, and more especially at 243 Mc/s, frequency instability can cause unreliable opera-

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Norwegian Views On EPIRB

IN ITS RECOMMENDATION No. 48, the International Convention on Safety of Life at Sea (London, 1960) recommends that governments should encourage the equipping of all ships where appropriate with emergency radio beacons in order to facilitate search and rescue actions at sea. Since 1960 the question has been under study by IMCO, ICAO and ITU, but it has proved extremely difficult to solve this problem in a satisfactory way on a worldwide basis with equipment which would use a single frequency.

In Norway, urgent need has been felt on several occasions for an emergency position-indicating radio beacon. We have reason to believe that equipment of this nature could have saved human lives in a number of distress situations which have occurred along our far-stretching coast.

In planning the design of an emergency radio beacon as recommended in the Convention on Safety of Life at Sea, we especially considered the following points:

1. Frequency.
2. Class of emission.
3. Range.
4. Way of starting the operation of the beacon.

Frequency.

The rescue vessels of Norsk Selskab til Skibbrudnes Redning (NSSR) (The Norwegian Life-Boat Association) are all equipped with direction finding equipment covering the frequency range 285–535 kc/s as well as a part of the 2 Mc/s band, including the distress frequency 2182 kc/s. There are also at all times in Norwegian waters a number of fishing vessels and coasters fitted with MF radiotelephone installations and to a great extent also with D/F equipment capable of operating on the frequency 2182 kc/s.

In distress traffic, silence may be imposed on the frequency 2182 kc/s, a factor of great importance which may facilitate homing on signals from a low power emergency radio beacon. Another factor is that continuous watch is being kept on 2182 kc/s by the NSSR rescue vessels and by the coast stations. If a receiver with beat-oscillator is used, signals on 2182 kc/s from a low power emergency radio beacon may be picked up without difficulty. On the basis of these considerations, Norway has chosen the frequency 2182 kc/s for an emergency radio beacon for national use.

Class of emission

When considering the choice between keying without the use of a modulating audio frequency (class of emission A1) or keying with the use of a modulating audio frequency (class of emission A2), we took into account the fact that the radio beacon should not necessarily in itself have an alerting capability, nor should the signals transmitted by the beacon cause interference to distress traffic on the frequency 2182 kc/s. Using a low power A1-transmitter, we have carried out practical tests specifically in this connection without observing to any appreciable extent interference to communications on the said frequency.

We have further assumed that normally a distress signal will be transmitted from the ordinary radiotelephone installation of the mobile station in distress. It may however not always be so, but in any case, when a vessel has been reported as missing, it will be possible to listen for signals with the class of emission used by the emergency position-indicating radio beacon. On the basis of these considerations use of A1 class of emission was deemed appropriate.

Range

As to the range of an emergency radio beacon using the frequency 2182 kc/s, there are a number of problems to be considered, e.g., the quality of bearings taken by vessels equipped with conventional loops, field strength ratio of the direct to the indirect wave on the reception site and the signals from the beacon in relation to distress traffic as mentioned under 2 above. We have come to the conclusion that a range of about 50 nautical miles under day conditions might be acceptable for search actions, taking into consideration the transmission conditions on the frequency in question. Our practical tests have shown that a radio beacon with a range of 50 nautical miles under day conditions will have a range of 30–35 nautical miles under night conditions.

Starting the beacon

It has been discussed whether the beacon should start automatically after having been thrown into the sea. In Norway we are of the opinion that this solution is not desirable as beacons may get into the sea accidentally and thereby perhaps set off a costly search action to no purpose. We are therefore at present of the opinion that the beacon should be capable of being mounted by simple means on board craft, lifeboats, rafts, etc. and started by human action.

Norwegian authorities have already, for national use, in conformity with Item 2 of IMCO Doc. IGR 1/2 of 2 June 1962, approved a type of emergency position-indicating radio beacon designed to meet the requirements outlined above.

The frequency used in 2182 kc/s, class of emission A1. It is fully transistorized, self-energizing and capable of 4 to 5 days' continuous operation. The beacon transmits dashes of a duration of 7, 10 or 12 seconds.

The transmitter with necessary accessories, aerial, earth connection and fastening device, is packed as one unit in a plastic case with great buoyancy. The outside measurements are 60 x 21 x 15 cm. and the weight is a total of 10 lbs.

It can, if necessary, be thrown into the sea, then picked up, mounted and started by the survivors. The equipment in question may be modified to a radio beacon which starts operation automatically when thrown into the sea. The class of emission may be changed to A2.

As already stated, we doubt the advantages of such modifications, but we would appreciate very much comments by other nations having experience based on practical tests with emergency position-indicating radio beacons. ⚓

AMENDMENTS TO REGULATIONS

STORES AND SUPPLIES

Articles of ships' stores and supplies certificated from October 1 to October 31, 1965, inclusive, for use on board vessels in accordance with the provisions of Part 147 of the regulations governing "Explosives or Other Dangerous Articles on Board Vessels" are as follows:

CERTIFIED

Solar Chemical Co., 35 Lackawanna Pl., Bloomfield, N.J., Certificate No. 633, dated October 12, 1965, SOLAR DEGREASER #11.

National Chemsearch Corp., P.O. Box 217, Irving, Tex. 75061, Certificate No. 634, dated October 26, 1965, SS–25 SOLVENT DEGREASER.

AFFIDAVITS

The following affidavits were accepted during the period from August 15, 1965, to October 15, 1965:

Barclay Foundry, Inc., 4239 West Lincoln Ave., Milwaukee, Wis., 53246, CASTINGS.[2]

The Sawbrook Steel Castings Co., Shepherd Ave., Lockland, Cincinnati, Ohio, 45215, CASTINGS.

J. D. Gould Co., 4707 Massachusetts Ave., Indianapolis, Ind., 46218, VALVES.

Badger Brass & Aluminum Foundry Co., 5120 West State St., Milwaukee, Wis., CASTINGS.

P. B. & B. Division of Ampco Metal, Inc., 3780 Bristol Pike, Eddington, Pa., 19020, CASTINGS & FORGINGS.

Texas Bolt Co., 3233 West 11th St., P.O. Box 1211, Houston, Texas, 77001, BOLTING.

[2] Those materials conforming to ASTM Specification B–143 only.

The Merchant Marine Council gratefully acknowledges the many constructive suggestions and helpful ideas from its readers during the past year which have assisted in the improvement of our publication.

Merry Christmas and a Safe and Happy New Year.

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SAR

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tion unless good engineering and maintenance measures are effectively applied. This is particularly applicable to receiving equipment in which the frequency of oscillators may not be measured as often as for transmitters. However, this is mentioned as a precautionary note rather than as an unavoidable disadvantage.

Because of their harmonic relation, both of these frequencies may be used either simultaneously or alternately for a single beacon without significant technical complications and thus without a substantial increase in cost.

Conclusion

Considering all factors herein previously reviewed which pertain to a logical choice of one of the five frequencies available for emergency position-indicating beacons, the balance is considered to be definitely in favor of either 121.5 Mc/s or 243 Mc/s. In consequence, the following recommendation is made.

Recommendation

Emergency Position-Indicating Beacons should radiate on 121.5 Mc/s but, when desirable because of the area of operation of the vessel, should also radiate a signal on 243 Mc/s for compatibility with long-range military aircraft equipment. If, however, these frequencies were interchanged in regard to order of preference designated in this Recommendation, the search function would not be affected significantly. ⚓

IMCO

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be encountered when carrying cargo in bulk.

The need for international rules covering the carriage of dangerous goods in ships has been in existence for a considerable time. A recommendation to this effect was made as far back as the 1929 SOLAS Conference. The SOLAS 60 Conference strengthened this need. Acting upon Recommendation 56 of the latter Conference, IMCO undertook a study of the subject. The results of this study were approved by the 4th Assembly. Six of the nine classes have been completed and with the approval of the final three classes by the Maritime Safety Committee the Code will be submitted to member states for adoption as a basis for national regulations.

NEW STUDIES

In approving the work program recommended by the Maritime Safety Committee the Assembly approved the establishing of three new subcommittees on (1) Special Types of Craft, (2) Life Jackets and (3) Efficiency of Navigation Lights and Related Matters.

The Subcommittee on Special Types of Craft was established to study the operational requirements concerning the safety of navigation of vessels such as hydrofoils and hovercraft. This study will also cover the requirements for lifesaving appliances and communications of such craft. The need for a study of this kind was indicated by information gathered by IMCO in regard to the operation of special and new design craft. It is noteworthy that the United States has submitted a proposed amendment to SOLAS 60 to permit the operation of experimental craft on international voyages to assist in furthering knowledge under operational conditions.

Information obtained by IMCO from member states and the International Organization for Standardization pointed to a need for further study of Regulation 22, Chapter II of SOLAS 60. Reports indicated a wide range of children's life jackets and minimum buoyancy allowed by various states. Recognizing the importance of this subject, the 4th Assembly approved the establishment of a Subcommittee on Life Jackets.

Recommendation 51 of SOLAS 60 said that IMCO should gather information concerning transmissivity and chromaticity as they effect ship's navigation lights and if necessary to initiate further studies on an international basis. Information has been provided by members and international organizations. Considerable work is being done on the subject by the Economic Commission for Europe which has produced a draft European Code for Inland Waterways that includes specifications for chromaticity and luminous intensity of lights. Because of its international implications this draft Code will have to be examined not only in regard to Recommendation 51 but also with respect to Recommendation 53 which recommends bringing local rules in as near agreement as possible with the international rules. The Assembly, therefore, approved the establishment of a Subcommittee on the Efficiency of Navigation Lights and Related Matters. However, due to the heavy work schedule this subcommittee will not be activated until 1967.

As can be seen from the foregoing IMCO has spent a very active year in furthering the tenets of its convention "to encourage the general adoption of the highest practicable standards in matters concerning maritime safety and efficiency of navigation". It has been stated that "The ship is the prime instrument of this ceaseless movement around the globe. . . . The ship carries both precious human lives and valuable cargo, and she represents a considerable capital sum; seaworthiness and safety of navigation are therefore imperative. Safety of the ship and safety of navigation—these are the aims to which the Intergovernmental Maritime Consultative Organization is devoted." ⚓

MERCHANT MARINE SAFETY PUBLICATIONS

The following publications of marine safety rules and regulations may be obtained from the nearest marine inspection office of the U.S. Coast Guard. Because changes to the rules and regulations are made from time to time, these publications, between revisions, must be kept current by the individual consulting the latest applicable Federal Register. (Official changes to all Federal rules and regulations are published in the Federal Register, printed daily except Sunday, Monday, and days following holidays.) The date of each Coast Guard publication in the table below is indicated in parentheses following its title. The dates of the Federal Registers affecting each publication are noted after the date of each edition.

The Federal Register may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D.C., 20402. Subscription rate is $1.50 per month or $15 per year, payable in advance. Individual copies may be purchased so long as they are available. The charge for individual copies of the Federal Register varies in proportion to the size of the issue but will be 15 cents unless otherwise noted in the table of changes below. Regulations for Dangerous Cargoes, 46 CFR 146 and 147 (Subchapter N), dated January 1, 1965 are now available from the Superintendent of Documents, price $2.75.

CG No.	TITLE OF PUBLICATION
101	Specimen Examination for Merchant Marine Deck Officers (7–1–63).
108	Rules and Regulations for Military Explosives and Hazardous Munitions (8–1–62).
115	Marine Engineering Regulations and Material Specifications (9–1–64). F.R. 2–13–65, 8–18–65, 9–8–65.
123	Rules and Regulations for Tank Vessels (4–1–64). F.R. 5–16–64, 6–5–64, 3–9–65, 9–8–65.
129	Proceedings of the Merchant Marine Council (Monthly).
169	Rules of the Road—International—Inland (9–1–65).
172	Rules of the Road—Great Lakes (6–1–62). F.R. 8–31–62, 5–11–63, 5–23–63, 5–29–63, 10–2–63, 10–15–63, 4–30–64, 11–5–64, 5–8–65, 7–3–65.
174	A Manual for the Safe Handling of Inflammable and Combustible Liquids (3–2–64).
175	Manual for Lifeboatmen, Able Seamen, and Qualified Members of Engine Department (3–1–65).
176	Load Line Regulations (7–1–63). F.R. 4–14–64, 10–27–64, 9–8–65.
182	Specimen Examinations for Merchant Marine Engineer Licenses (7–1–63).
184	Rules of the Road—Western Rivers (6–1–62). F.R. 1–18–63, 5–23–63, 5–29–63, 9–25–63, 10–2–63, 10–15–63, 11–5–64, 5–8–65, 7–3–65.
190	Equipment lists (8–3–64). F.R. 10–21–64, 10–27–64, 3–2–65, 3–26–65, 4–24–65, 5–26–65, 7–10–65, 8–4–65, 10–22–65, 10–27–65.
191	Rules and Regulations for Licensing and Certificating of Merchant Marine Personnel (2–1–65). F.R. 2–13–65, 8–21–65.
200	Marine Investigation Regulations and Suspension and Revocation Proceedings (10–1–63). F.R. 11–5–64, 5–18–65.
220	Specimen Examination Questions for Licenses as Master, Mate, and Pilot of Central Western Rivers Vessels (4–1–57).
227	Laws Governing Marine Inspection (3–1–65).
239	Security of Vessels and Waterfront Facilities (7–1–64). F.R. 6–3–65, 7–10–65, 10–9–65, 10–13–65.
249	Merchant Marine Council Public Hearing Agenda (Annually).
256	Rules and Regulations for Passenger Vessels (4–1–64). F.R. 6–5–64, 8–21–65, 9–8–65.
257	Rules and Regulations for Cargo and Miscellaneous Vessels (9–1–64). F.R. 2–13–65, 3–9–65, 8–21–65, 9–8–65.
258	Rules and Regulations for Uninspected Vessels (1–2–64). F.R. 6–5–64, 6–6–64, 9–1–64, 5–12–65, 8–18–65, 9–8–65.
259	Electrical Engineering Regulations (7–1–64). F.R. 2–13–65, 9–8–65.
266	Rules and Regulations for Bulk Grain Cargoes (7–1–64).
268	Rules and Regulations for Manning of Vessels (2–1–63). F.R. 2–13–65, 8–21–65.
269	Rules and Regulations for Nautical Schools (5–1–63). F.R. 10–2–63, 6–5–64, 8-21–65, 9–8-65.
270	Rules and Regulations for Marine Engineering Installations Contracted for Prior to July 1, 1935 (11–19–52). F.R. 12–5–53, 12–28–55, 6–20–59, 3–17–60, 9–8–65.
293	Miscellaneous Electrical Equipment List (6–1–64).
320	Rules and Regulations for Artificial Islands and Fixed Structures on the Outer Continental Shelf (10–1–59). F.R. 10–25–60, 11–3–61, 4–10–62, 4–24–63, 10–27–64.
323	Rules and Regulations for Small Passenger Vessels (Under 100 Gross Tons) (2–3–64). F.R. 6–5–64, 6–6–64, 8–18–65, 8–21–65, 9–8–65.
329	Fire Fighting Manual for Tank Vessels (4–1–58).

CHANGES PUBLISHED DURING OCTOBER 1965

The following have been modified by Federal Registers:
CG–239 Federal Registers, October 9, and 13, 1965.
CG–190 Federal Registers, October 22, and 27, 1965.

PROCEEDINGS

OF THE

MERCHANT MARINE COUNCIL

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COVERS

FRONT: A Jeff Blinn photograph of the *Mormacargo* automated vessel, courtesy *Moran Towing* Co.
BACK: A safety poster by the *American Waterways Operators Inc.*

NOTICE

The Feature "Nautical Queries" will not be published in this issue, but will be resumed next month.

Season's Greetings

To Mariners everywhere, I extend my sincere best wishes for a joyous and peaceful Christmas season and a safe and healthful New Year.

E. J. ROLAND,
Admiral, U.S. Coast Guard,
Commandant.

THIS COPY FOR NOT LESS THAN 20 READERS—PASS IT ALONG

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