FACTORS IN THE PREVENTION OF COLLISIONS AT SEA

by

J.F. Kemp, Extra Master,
Fellow of the Royal Institute of Navigation

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Supervisors:- R. Phillips, B.Sc., Ph.D. (Director of Studies)
S.H. Hollingdale, M.A., B.Sc., Ph.D., D.I.C.

Preface

In recent years, the International Regulations for Preventing Collisions at Sea have been the subject of lengthy and sometimes heated public discussion. Many suggestions, at various levels of practicality, have been made for amending the regulations both by individuals and by committees. Two features make an assessment of the discussion difficult. Firstly, the sheer mass of verbiage, often in the form of complex arguments, makes it difficult and time consuming to isolate the essential and important principles from opinionated and sometimes irrelevant comment. Secondly, the self-styled "practical" contributions to the discussion have almost always been based on assumptions, beliefs, opinions and similar subjective and uncertain foundations relating to the experiences of the individual commentators. Inevitably, people with different backgrounds have disagreed.

This thesis is intended to improve the situation in respect of both features. Chapters II and III present a summary and critique of what the author considers to have been the most significant contributions to the development of the Rules for Preventing Collisions at Sea. Chapters IV and V describe an attempt to establish some objective evidence on which a more rational discussion may be based. This attempt is necessarily of an exploratory nature. The collection of Rules in the appendices provides a historical foundation for further study of the collision avoidance problem. As far as is known, such a collection has not previously been published.

Many people have contributed to making this thesis possible. I am particularly indebted to Captain C. Turquand and the staff of the Radar Section of the City of London Polytechnic's School of Navigation for the long hours of time that they have willingly given and for the numerous helpful suggestions that they have made. My thanks are also due to the many subjects who took part in the experiments and who all gave their time freely. Mrs. E.M. Goodwin commented very constructively on the mathematical and statistical sections of the thesis and Mrs. E. Ellis performed wonders in converting a nondescript manuscript into an attractive and neatly presented finished product. Finally, my greatest debt is to my supervisors, Dr. R. Phillips and Dr. S.H. Hollingdale. Without their enthusiasm and unfailing encouragement, this thesis and the programme of work on which it depends would never have been possible.

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CHAPTER I

Introduction

In contemplative fashion
And in tranquil frame of mind,
Free of every kind of passion
Some solution let us find.

The Gondoliers W.S. Gilbert

THE COLLISION PROBLEM

Internationally recognised rules for the prevention of collisions at sea have been in existence since 1840, but collisions between ships continue to occur with unacceptable frequency.

Rules are, of course, only one factor amongst many which may contribute to the avoidance of collisions. Other factors include the training, competence and reliability of navigators, the availability of information concerning the movements of other craft, the performance of ships, the reliability of engines and steering gear, the establishment of routeing systems, etc., but these factors are not the subject of the present study.

Meaningful figures for the actual number of collisions per annum are difficult to come by. Tables published by The Liverpool Underwriters Association show that, for ships of 500 gross tons and upwards, total losses due to collisions were 0.042% of the world fleet per annum for the average of the years 1965/69 and that 0.018% of the world fleet was lost due to collisions in 1970. Partial losses as a result of collisions represented 6.55% of the world fleet per annum for the average of the years 1965/69 and 5.18% of the world fleet for the year 1970. A total of 1483 ships of over 500 gross tons were lost or damaged as a result of collisions in 1970 and, as the statistics above indicate, this was a good year.

It is not suggested that more than a small proportion of these collisions were due to infringements of the Rules for preventing collisions at sea. Many will have occurred in docks, rivers and harbours as a result of misjudgements and misadventures during local manoeuvres. In other cases, collisions may result from defective or deficient information. Nevertheless, the figures quoted give an indication of the size of the total collision problem. No one study is likely to lead to more than a marginal improvement in the overall collision rate, but a worthwhile improvement seems likely only as the result of the sum of a number of marginal improvements.

PUBLIC CONCERN

Collisions at sea have always been of concern to mariners, to whom they may literally be a matter of life or death. At a less dramatic level, navigators of ships also have a personal involvement in that the denting of their ships which results from collisions is accompanied by similar damage to their professional pride. Additionally, navigators' certificates of competency may be suspended by Courts of Formal Investigation and parties to collisions may find that shipowners are subsequently reluctant to employ them.

The general public and the politicians elected by them showed a great interest in collisions at sea during the middle years of the nineteenth century when many passengers lost their lives in a series of shipping casualties. As a result, there was considerable politically generated activity aimed at achieving a satisfactory code by which ships could avoid collisions.

Towards the end of the nineteenth century, shipbuilding standards had much improved and legislation was introduced in 1876 to prevent ships sailing in a dangerously overloaded condition. These developments ensured that collisions at sea were less likely to result in disasters and so, starved of its favourite sustenance, public interest transferred to more rewarding pastures. Political interest followed, as ever, in line astern so that in 1895 Mr. Thomas Gibson-Bowles, M.P. was able to say "As to the House of Commons, if you mention the words "Rule of The Road at Sea", the whole of the members, with one accord, slide away to the dining-room or the tea-room, including the President of the Board of Trade for the time being".

The Titanic disaster of 1912 brought with it a tremendous renewal of interest in safety at sea but, since it was due to the ship striking ice, it did not focus attention on the rules for preventing collisions between ships. What it did bring about was a highly effective impetus to the introduction of safety measures, particularly aboard passenger ships. The carriage of adequate lifeboats and the establishment of the North Atlantic Ice Patrol are examples[1]. A result of the concentrated effort, and subsequent steady improvement over the years, is that ships have long been a particularly safe means of transport. The progress to greater safety at sea is well described by Sir Westcott Abell in his book "The Safe Sea"[2] and later by J.W. Bull in "An Introduction to Safety at Sea"[3].

With a notable passenger safety record disguising a collision rate that continued to be responsible for considerable damage and some crew casualties it is not surprising that public and political interest in the prevention of collisions at sea remained at a low ebb. Occasional spectacular incidents such as the Andrea Doria-Stockholm collision in 1956 captured peoples' imaginations for a time but memories soon faded. This case, in fact, is a good example of the low loss of life which can result from a collision of the most dangerous kind. Two large passenger ships collided at virtually full speed and yet only 40 passengers and crew out of a total of 1706 were lost aboard the Andrea Doria and none of the 534 passengers aboard the Stockholm.

The recent resurgence of public interest in collisions at sea has been due to the development of widespread concern with man's pollution of his environment. The leakage of fuel and cargo into the sea as a result of marine accidents is seen as an important cause of pollution of the seas.

The arousal of public concern has brought, in its wake, political activity not only bearing on the International Rules for preventing collisions but also involving the establishment of routeing systems for the separation of opposing streams of marine traffic, the reassessment of standards of ship design and improvements in the training of navigators. It may be noted here that the possibility of environmental damage does not seem to be an important factor in motivating mariners themselves to avoid collisions, according to the result of a limited investigation by the author in 1972[4].

THE NEED FOR RULES

In this study, it is not taken for granted that Rules are in fact necessary for the satisfactory avoidance of collision. Pedestrians, for instance, in general are not subject to rules for avoiding collisions with each other, but appear to manage very successfully even when moving rapidly in many different directions under crowded conditions such as obtain, for example on the concourse of a railway terminus at rush hour, or in a busy market place.

It may be calculated (see Appendix I) that the collision rate for ships in the Dover Strait is only about one thousandth of what it would be if, with the same traffic density, the ships moved with random velocities as the molecules in a gas. This is an interesting conclusion but does not of course necessarily reflect on the efficiency of collision regulations or routeing schemes. Pedestrians navigating across an open concourse without guidance from formal rules achieve a similar improvement in collision rate compared with the random velocities case. They appear to operate almost entirely upon natural reactions determined by subconscious, between the ears, computing in response to the visual perception of the relative velocities of adjacent persons. Learning appears to play some part in their disengagement manoeuvres but, from casual observation, it would seem that traffic conventions such as "gentlemen give way to ladies" have a negligible effect. A possible exception is the case of encounters between long-legged blondes and jaded business men, when pursuit patterns seem to become established more frequently than one would expect by chance. The topic of collision avoidance amongst pedestrians is one which might well repay further and rather more serious study.

PRINCIPLES UPON WHICH RULES MAY BE BASED

If it is considered desirable to have rules for preventing collisions at sea then these must be based upon certain principles. Such principles are discussed in the following section.

If two craft are embarked upon collisions courses, it is necessary that they should take complementary and, generally, different action so that a safe passing is achieved. In order to distinguish the two craft so that different responsibilities may be laid upon them a frame of reference is frequently used.

In the case of road traffic, the road system itself, supplemented by various signs and markings, forms the basic frame of reference. Traffic moving in opposite directions is segregated within the frame of reference by the convention of keeping to the right (or to the left in non-conformist societies). At intersections, vehicles are distinguished by their situation as being on minor or major roads and are given either the obligation to yield or the right of way respectively.

AD HOC BASES FOR RULES

In the open sea there is no such obvious and convenient frame of reference as exists for road vehicles. Because of this, rules have been devised in the past which did not depend upon a frame of reference. Thus an early rule to prevent collisions between ships of war was that ships commanded by junior officers should give way to ships commanded by senior officers. This was a splendid rule when applied to the ships of a fleet. It was all-embracing and it appealed to the sailors' sense of the natural order of things. However, it would have suffered from obvious difficulties of identification and

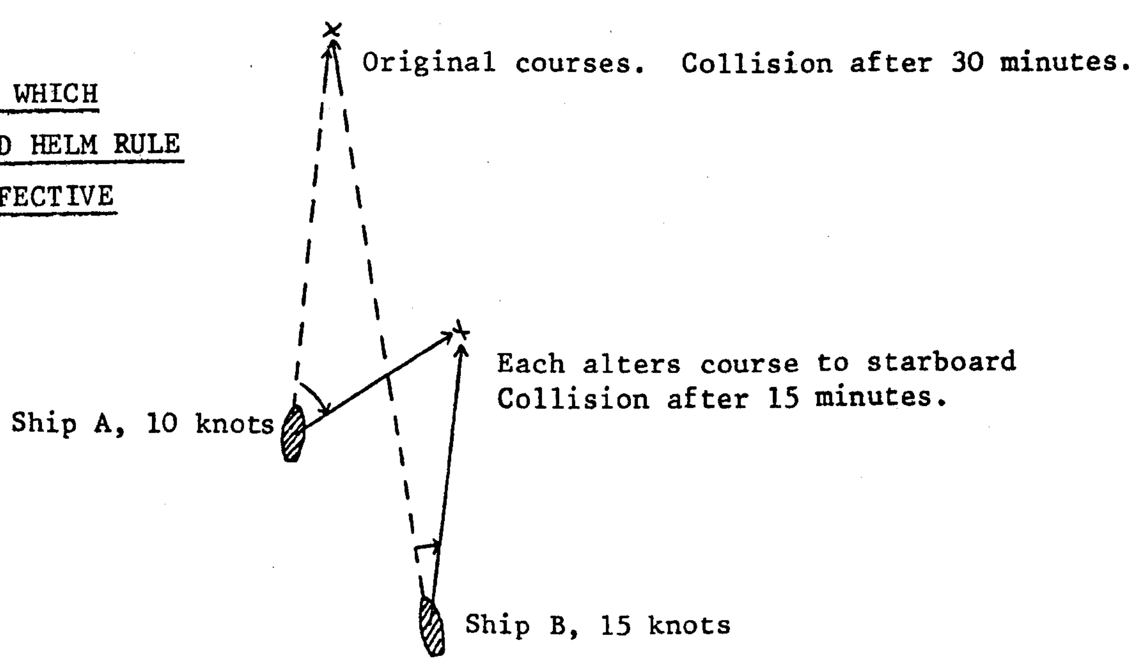
and establishing precedence if applied internationally and to merchant ships as well as to warships.

A similar principle is to assign responsibility for avoiding collision according to the types of vessel involved in an encounter. For example, the current rules require that vessels which are not fishing should give way to vessels which are fishing. Suggestions have also been made that deep draft ships in particular situations should be given right of way over other vessels[5]. Rules of this kind can only be supplementary to more general rules because they do nothing to resolve encounters between ships of similar types. Also they depend upon mutual recognition of the ship types involved in each encounter and, since this cannot be achieved by primary radar information, the scope of such rules for ships fitted with current marine equipment, is restricted. For these reasons it could be argued that rules of this kind are undesirable complications to a basic set of collision avoidance rules which must necessarily be founded upon some other principle.

Another way of working without a frame of reference would be to require similar action from both parties to every conflict. If the parties are not given different obligations there is no necessity to distinguish between them and hence no necessity for a frame of reference as a basis for allocating collision avoidance manoeuvres. An example of this approach was the "larboard helm" rule by which each party to a collision situation was required to alter course to starboard irrespective of the exact geometry of the situation. This rule had the great merit of simplicity but the defect that it did not always work. Nevertheless, it held sway for 22 years (1840 to 1862) for steamers and as a universal rule, applicable to all ships, for half the time.

<u>Fig. 1</u>

<u>CASE IN WHICH</u>
<u>LARBOARD HELM RULE</u>
<u>IS INEFFECTIVE</u>



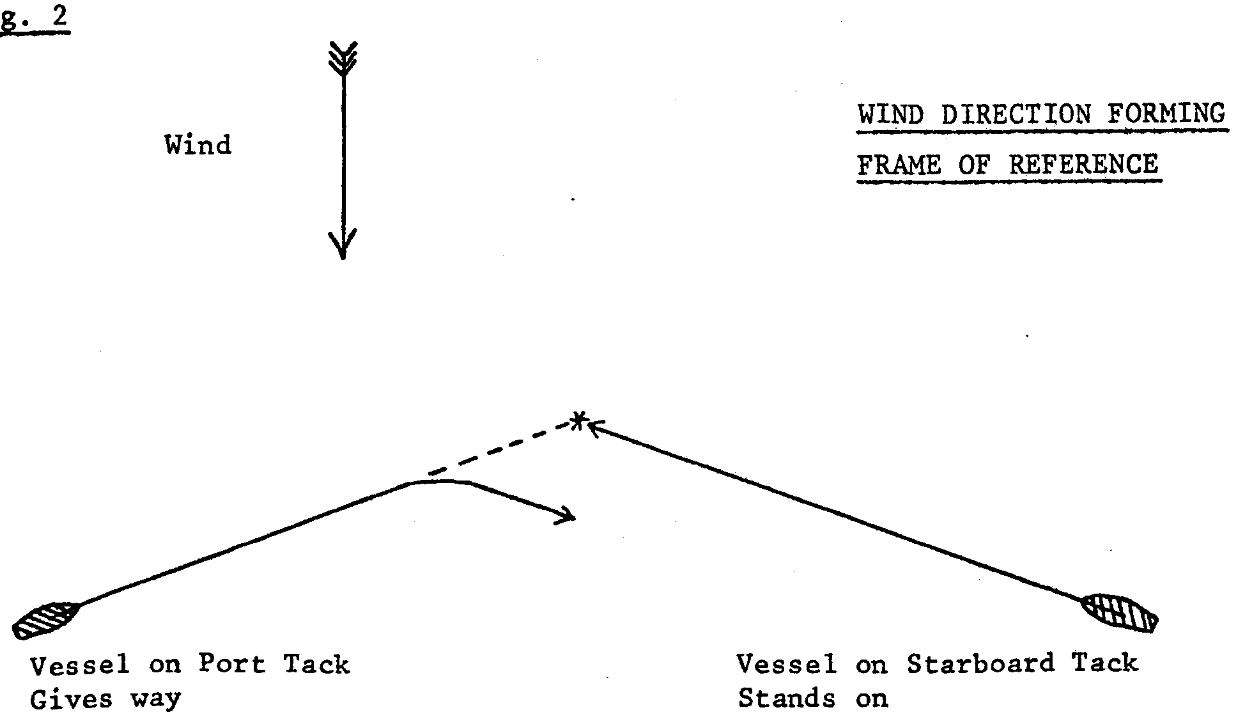
FRAME OF REFERENCE BASES

Generally, in order to establish a satisfactory set of rules for preventing collisions at sea, it is necessary to assign different and complementary action to each of the two parties to an encounter. Frames of reference provide a suitable means of distinguishing ships for this purpose and there are several which could be used by mariners.

WIND DIRECTION

The direction of the wind was a matter of supreme importance to the navigators of sailing ships and thus formed a natural frame of reference for the first generally accepted rule for the prevention of collisions at sea. This rule stated that vessels on the port tack should keep out of the way of vessels on the starboard tack.

Fig. 2



Note: A tack is named port or starboard according to which is the windward side of the ship

Apart from a brief eclipse (for 11 years) by the larboard helm rule, this rule has remained in force from at least as far back as the 18th century. It is still in force, in a rather more general form, for sailing vessels today. It is of interest to note that it was the only rule considered necessary prior to the introduction of steamships and that it dealt with the case in which sailing ships on collision courses would have the greatest speed of approach. Encounters between vessels on the same tack, both vessels running free or even one vessel running free and the other close hauled involved a lesser speed of approach. These cases were left to be resolved by such nebulous factors as common sense, ordinary practice, seaman's instinct, natural reactions, etc., presumably because they were not considered particularly dangerous.

COMPASS DIRECTIONS

Compass directions also provide a frame of reference familiar to mariners. These have been used by airmen to segregate aircraft so that those flying in the same general direction are assigned particular flight levels. Thus:

(i) On headings from 000° to 089°, the aircraft flies at an odd thousand of feet of altimeter reading.

(ii) On headings from 090° to 179°, the aircraft flies at an odd thousand of feet plus 500.

(iii) On headings from 180° to 269°, the aircraft flies at an even thousand of feet.

(iv) On headings from 270° to 359°, the aircraft flies at an even thousand of feet plus 500.

Where these rules are applied, they prevent conflicts arising between aircraft whose headings differ by more than 90°. Since aircraft at any one level are moving in the same general direction, their relative velocities are small and the number of encounters is reduced (see appendix I). Also, when an encounter does occur, there is more time for manoeuvre.

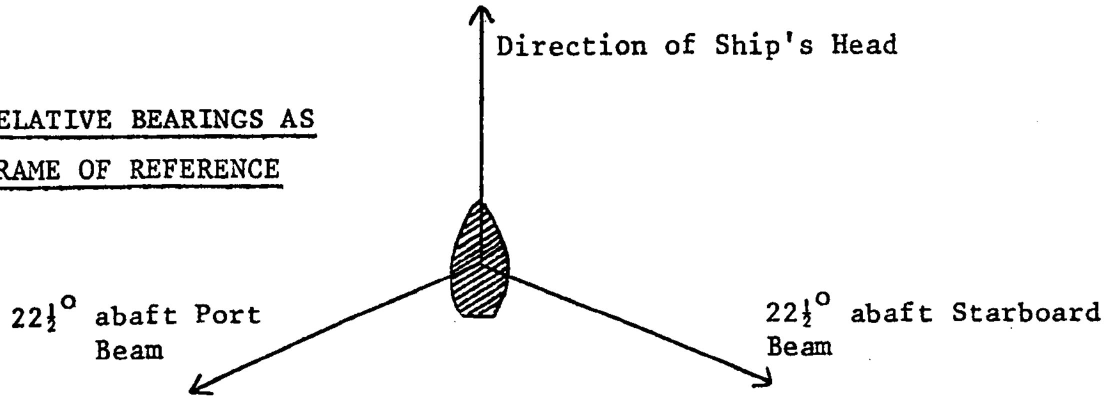
As far as is known, compass directions have never been used at sea as a basis for either specifying collision avoidance manoeuvres or for traffic segregation. In principle they could form such a basis but the simplicity of height separation used in the air rules would not be possible in the two dimensional marine situation. It may be noted that the French delegation to the 1929 Safety of Life at Sea Conference proposed that vessels heading in the North, East, South or West quadrants respectively should be assigned distinguishing fog signals, but this was not adopted. It was later suggested by Fendig[6] that compass directions should be used for assigning responsibility to ships so that a ship to the south or east of another should have the duty of taking avoiding action. This also was unadopted.

RELATIVE BEARINGS

A ship carries around with it a frame of reference which may be thought of in general terms as specifying such directions as port and starboard, forward and aft, etc. More precisely, the orientation of a ship at any given time defines relative bearings which are conventionally measured in degrees, clockwise, taking the direction of the ship's head as zero. Relative bearings can, however, be measured from any direction definable by reference to the ship so that a relative bearing of 112½° measured in the conventional way from the direction of the ship's head could also be quoted as 22½° abaft the starboard beam.

Fig. 3

RELATIVE BEARINGS AS FRAME OF REFERENCE



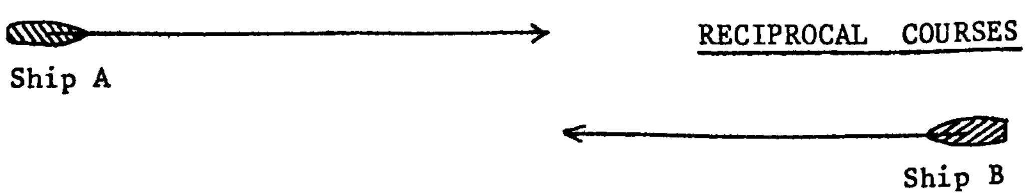
This direction, together with its mirror image 22½° abaft the port beam, and the direction of the ship's head itself, are the critical reference directions on which three of the international rules for preventing collisions between power-driven vessels are currently based. (See appendix II for full text)

When two ships are on collision courses, each has its own frame of reference. In general, however, each ship sees the other in a different direction within the frame of reference used and so it is possible to lay different and complementary obligations upon the two ships in order that a safe passing may be achieved.

Particular cases in which vessels see each other in similar directions within their respective frames of reference are when they are heading in parallel but opposite directions as in figures 4, 5 and 6 below.

Fig. 4

RECIPROCAL COURSES



Ship A's view of ship B is symmetrical with ship B's view of ship A.

Fig. 5

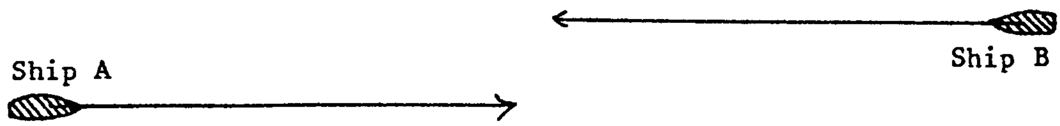
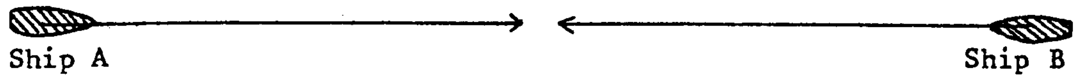


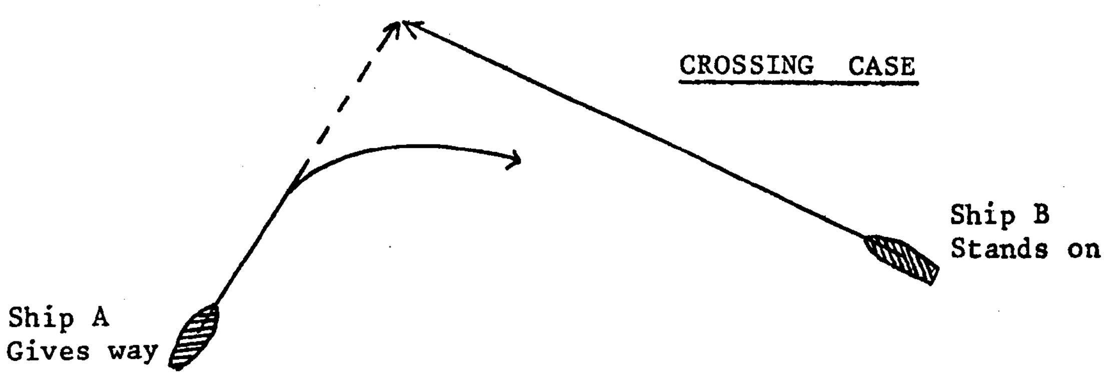
Fig. 6



These are only collision situations near the limiting case in which the vessels are end on to each other as in figure 6. Since these vessels cannot be distinguished by their positions within the frames of reference used, they are necessarily given the same instructions. In fact this case is the last refuge of the old larboard helm rule, each vessel being required to alter course to starboard so as to pass on the port side of the other.

Crossing situations are defined in the present rules as those which are neither end-on nor overtaking situations. In crossing situations, one vessel, using its own frame of reference, sees the other bearing within an arc from right ahead to $112\frac{1}{2}^{\circ}$ ($22\frac{1}{2}^{\circ}$ abaft the starboard beam). The other vessel, using its own frame of reference, sees the first vessel bearing within an arc from $247\frac{1}{2}^{\circ}$ ($22\frac{1}{2}^{\circ}$ abaft the port beam) to right ahead. A typical situation is illustrated below in figure 7.

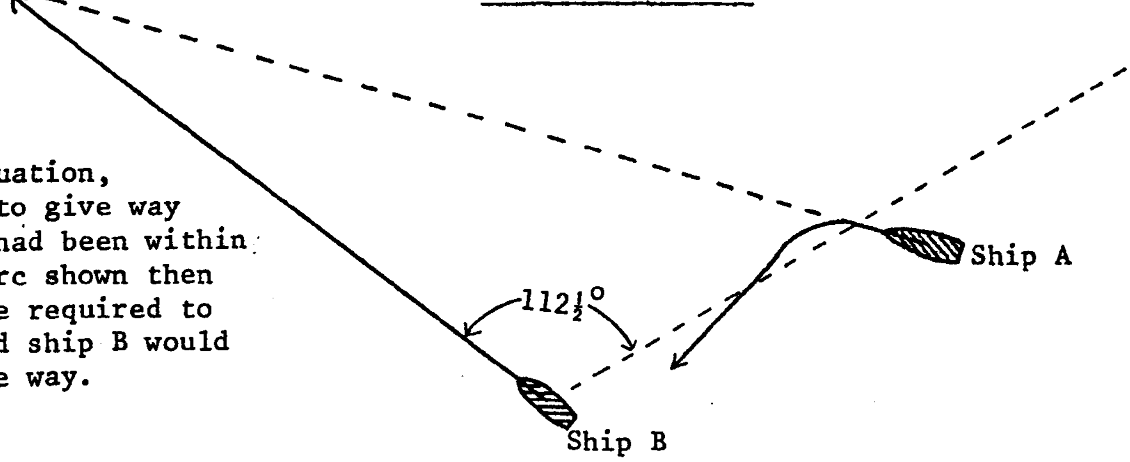
Fig. 7



The rules state that the ship with the other on her own starboard side (ship A in figure 7) shall keep out of the way but avoid crossing ahead of the other. The other ship (ship B in figure 7) seeing the first ship on her port side, is required to maintain course and speed in order to complement the avoiding action of the first ship.

The current overtaking rule is different in kind from the end-on and crossing rules in that the anti-collision roles assigned to the two vessels depend upon their positions within the frame of reference of only one of them. Thus an overtaking situation is defined when one of two vessels sees the second in a direction more than 22½° abaft the beam. The second ship is then designated as the overtaking vessel and is required to keep out of the way; the first ship being required to maintain course and speed. It should be noted that the position of the first ship within the frame of reference of the second ship is not considered when responsibilities are assigned. Since it is the overtaken vessel's frame of reference which is used, she can easily verify that an overtaking situation exists by observing the relative bearing of the other. A vessel which suspects that she is overtaking another within the meaning of the Rules can only confirm this if she is able to estimate the orientation of the other vessel's frame of reference. Such estimation is not easy by day but the screening of a vessel's green and red sidelights, with a cut off direction 22½° abaft the beam on either side, is of great assistance at night. It seems perhaps slightly paradoxical that the ship which can always verify the situation with certainty is the one which is required not to take action to resolve it. Thus, in figure 8 below, ship A's action depends upon a knowledge of ship B's frame of reference. Generally, the principle by which one of the two parties to an encounter has to act according to its position within the frame of reference of the other does not appear to be a very satisfactory one.

<u>Fig. 8</u> <u>OVERTAKING RULE</u>



In this situation, ship A has to give way but if she had been within the 112½° arc shown then she would be required to stand on and ship B would have to give way.

It may be noted here that there are less obvious cases in which one vessel's action is dependent upon its position within the frame of reference of the other party to an encounter. The requirement (rule 22) that a giving way vessel should avoid crossing ahead of another vessel implies that she must have a knowledge of the other vessel's orientation. Also, the definition of an "end on or nearly end on" encounter (rule 18) requires that <u>each</u> ship sees the other nearly ahead. This means that a ship, seeing another ship ahead, must know also how she, herself, appears within the frame of reference of the other, before she can know whether the rule applies. This difficulty has formed one of the main criticisms of the "end on" rule.

PHYSICAL FEATURES AS REFERENCES

In particular situations physical frames of reference, similar to those used by road traffic, may be used by ships. These references may take the form of natural features such as river banks or artificial features such as buoyed channels. Obligations to ships may be allocated with reference to these features. For example, it is an international rule that power driven vessels should keep to the right, (i.e. to the starboard side) of narrow channels. Also, local rules in rivers often require that vessels proceeding upstream shall give way to vessels proceeding downstream and local rules for harbours may give outward bound ships precedence over inward bound ships.

ABSTRACT REFERENCES

Artificial frames of reference may be created for road traffic by means of white lines and other markings but they cannot be created with this facility at sea. It is possible, however, to create abstract frames of reference by marking them on charts, provided that the position fixing capability of ships is sufficiently accurate. Each ship using such a system must be able to relate its position relative to the chart markings to the order of accuracy. required by the system design.

To avoid collisions between aircraft, this principle has been used to establish highly complex, three dimensional systems of airways in areas of high traffic density. These are supported by networks of position fixing aids and agreements as to minimum standards of navigational equipment for aircraft flying the airways. In the marine field an early example of frames of reference defined by marking charts was the system of routes for separating eastbound and westbound traffic established by the North Atlantic Track Agreement in 1898. More recent examples are the IMCO routes for the separation of the main traffic streams in the Dover Straits which were established in June 1967. So far, chart markings have been used only to provide for the separation of opposing traffic streams but they could, in principle, be used as a basis for assigning collision avoidance responsibilities in the case of crossing encounters. It has been suggested, for instance, that traffic crossing recommended routes should give way to traffic proceeding along the routes[7].

SUMMARY

In this chapter, the need for formal rules for preventing collisions at sea has been brought into question and the bases for the various systems of rules have been discussed.

Historically, the International Rules for Preventing Collisions at Sea seem to have been developed in a tentative fashion. There were particularly frequent changes in the 19th Century but, by the end of that century, agitation for further amendment died down and the Rules were consequently assumed to be satisfactory for many years. In recent years, and particularly since 1960, the effectiveness of the Rules has again been called into question.

The development of the Rules is the subject of the next chapter.

CHAPTER II

Historical Development of the Rules for Preventing Collisions at Sea

> Stick close to your desks
> And never go to sea
> And you all may be,
> Rulers of the Queen's Navee.
>
> H.M.S. Pinafore W.S. Gilbert

PRELIMINARY NOTE

In this chapter, rules are quoted which contain some nautical terms of a confusing nature. In many cases, a clarifying note is included in parenthesis and a fuller discussion of the meaning of such phrases as "larboard helm", "wind at large", etc. is contained in appendix IV.

EARLY RULES CONCERNING COLLISIONS BETWEEN SHIPS

The earliest sea laws of which record has been found are the Rhodian Laws. These appear to date from about the 3rd or 2nd Century B.C., or perhaps earlier, and were certainly incorporated into Roman Law by A.D. 161, although Ashburner[8] suggests that the earliest known copy dates from Byzantine times between 600-800 A.D.

The Rhodian Laws were mainly concerned with the commercial aspects of shipping such as the carriage of goods, the rights of merchants, the authority of ship-masters, etc. However part three, chapter 36, translated by Ashburner, deals with collisions as follows:

> "If a ship in sail runs against another ship lying at anchor or with sails slackened, and it is daylight, the collision and the damage lie against the captain and crew of the first ship. Moreover let the cargo come into contribution. If it happens at night, the ship at anchor or with the sails slack must light a fire for warning. If he has no fire let him shout. If he neglects to do this and a collision takes place, he has himself to thank. If the sailsman was negligent and the watchman dozed off, the man who was sailing perished as if he ran on a shoal and let him keep harmless him who he strikes."

This passage deals with the consequences of collision rather than the means of preventing it. It seems to imply that, whenever collisions occur, one ship is the aggressor and the other is the victim and that it is the responsibility of a ship when sailing to keep out of the way of a ship which is stopped or moving only slowly. It also implies that a proper watch should be kept aboard both moving and stationary ships and that a light or a sound signal should be made aboard a stationary ship at night. Ashburner suggests that this signal could have been achieved by the sailors taking it in turns to sing through the night, but one would hardly expect this idea to have commended itself to the rest of the crew trying to catch up on their sleep.

The Rhodian Laws formed the basis of a number of Mediterranean codes and it seems likely that a knowledge of these was brought to North-West Europe by returning crusaders.

In about 1150, the Roll of Judgements of Oleron was made. Sir Travers Twiss[9] suggested that the Judgements were a result of legal privileges granted by the Dukes of Guyenne to the people of the Isle of Oleron off the coast of Brittany. A more imaginative, if less authoritative, suggestion[10] is that they were instigated by Eleanor, Duchess of Aquitaine and heiress of William, Duke of Guyenne, after her return from the Holy Land and that they are therefore really English laws and not French laws at all, on the grounds that Eleanor later became Richard the Lionheart's mother.

The intention of the Oleron judgements appears to have been to codify existing practices and they were directly descended from the Rhodian and Mediterranean laws. The small importance given to collision avoidance at that time is reflected in the fact that only one of the forty-nine Oleron articles referred directly to collisions between ships and then not directly to conventions for avoiding collisions. The article (see appendix III) stated that, if a ship accidentally collided with another then the cost of the damage caused should be equally divided between the two ships. It was a condition that masters and crews should swear that they did not fall foul willingly. The reason for this law was so that old ships should not purposely be put in the way of better ships. The effect would certainly have been to cause small, old and low value ships to keep out of the way of large, new and high value ships because, in the event of damage, the former would have had proportionally more to lose.

The Laws of Wisbuy (dating from the 13th Century) were similar to the Laws of Oleron but were based on practice in the Baltic area. The comparable collision also stated that the cost of damage should be borne equally by the parties to an accidental collision but that, if the collision was caused wilfully by one party then they should make full satisfaction.

The Admiralty Black Booke, in section B20, (c. 1338 according to Twiss) says much the same thing but with different emphasis, i.e. "If any shipp or vessell of the fleete through obstinacy, hatred or envy endamage any other shipp, full satisfaction is to be made. But if the damage be done by reason of storme or unwillingly then but halfe of the damage is to be paid at the discretion of the Lord Admiral."

Oleron and Wisbuy seem to imply that collisions should be taken as accidental unless proved to the contrary. The Admiralty Black Booke seems to imply that a presumption of wilful collision might be made in the absence of evidence to the contrary. In the case of a collision between a junior officer's ship and a senior officer's ship it might have been very difficult for the junior officer to show that the accident was not a result of his obstinacy, envy or hatred. The effect of this rule would certainly have been to cause junior officers to give way to senior officers.

The Black Booke Rule thus imposed a certain measure of coercion on junior officers to give way to their senior, and the principle that they should do so was reportedly[11] the subject of a note by Sir Richard Hawkins in 1593 and general practice in the Navy in the time of Charles II. Similar instructions were later included in the Earl of Warwick's Sailing Instructions of 1645 and the Duke of York's Sailing Instructions of c. 1670[12].

As a convention for avoiding collision, this principle is not taken very seriously today, based as it was on considerations of etiquette rather than geometry. Nevertheless it did have two important advantages.

(i) The instruction that Junior officers should give way to Senior officers coincided with the mariners' natural inclinations, and was therefore very likely to be obeyed.

(ii) In general, one would expect Junior officers to be in command of smaller and more manoeuvrable ships than Senior officers and so would be able to take effective avoiding action more easily.

As points of comparison it may be noted that a defect of the present rules is that they sometimes prescribe action which does not coincide with a mariner's natural inclinations and so they are not always obeyed. Also, a serious criticism of the present rules is that they frequently require the less manoeuvrable party to an encounter to take avoiding action and, at the same time, require the more manoeuvrable party to maintain course and speed.

As noted previously, although a collision avoidance convention based on seniority was satisfactory amongst ships of a fleet, it would have been difficult to establish precedence internationally and particularly between merchant ships. Nevertheless its advantages were important and worth noting.

RULES FOR MANOEUVRING SAILING SHIPS

By the end of the 18th Century, the Rule that vessels on the port tack should give way to vessels on the starboard tack appeared in writing although it had probably been the ordinary practice of seamen for some time previously. The consequence of this rule (see diagram on page 6) was that vessels passed port to port and it is possible that the practice originated from the convention of keeping to the right on highways ashore.

The framing of this Rule has been attributed to Lord Howe (c. 1780)[12], but it was in existence prior to 1780 in the form of Instructions for the Conduct of Ships of War, issued with Royal Naval Signal Books. These stated that;

> "In order to avoid inconvenience from the customary practice founded on the regulations in the General Printed Instructions, with respect to the conduct of Senior Officers towards their Juniors, the ships of war are to bear up (i.e. alter course) for each other, shorten sail, etc., without regard to the seniority of the Commanders, or other claim of distinction, in such manner as shall be found most convenient on either part, and may best guard against the hazard of falling on board each other. But, when ships are upon different tacks and must cross near each other the ship on the starboard tack is to keep her wind (i.e. maintain course) while that on the larboard (port) tack is always to pass to leeward." (See appendix II sections A and B).

Royal Naval instructions in 1816 left out the former part of this extract, as far as the word "when" and added at the end the words "bearing up (i.e. altering course) in time for that purpose if necessary."

These rules were clearly intended to apply irrespective of the seniority of the officers commanding the ships, but old habits seem to have died hard as indicated by the following comment from Richard Hall Gover in 1808[13].

> "It is a universal rule with seamen that, where there is doubt, the vessel upon the larboard (port) tack is to bear up or heave about for the vessel upon the starboard tack; and were this prudent maxim never overruled by the obstinacy of parties, and the occasional imperiousness of men of war who pay not for damage, fewer accidents would happen."

Gower gives no authority for this rule but the way in which he takes it for granted implies that it was, by 1808, already a long established rule for merchant ships.

A rule for sailing ships on opposite tacks seems to have sufficed for many years. Possibly this was because, in other classes of encounter, the speed of approach of the two ships is less and more time is available for manoeuvre. An additional reason could be that, when vessels are on opposite tacks, neither has an advantage in manoeuvring capability and so an arbitrary rule was necessary to establish a convention for disengagement. In other cases, e.g. if one of the parties was running free (i.e. sailing with the wind) or if one of the parties was to windward, then such a ship would have more scope for manoeuvre and might reasonably be expected to take any necessary avoiding action. This principle is suggested in the first part of the Royal Naval Instructions previously quoted, i.e. that "the ships of war are to bear up for each other, shorten sail, etc. in such manner as shall be found most convenient on either part." This surely means that avoiding action should be taken by the ship best able to do so although no explicit mention of ships running free, with the wind at large, etc., in this context has been found prior to 1828. In that year an Admiralty Court judgement[12] included the statement that "The ship which has the wind at large (i.e. sailing with the wind) may go either to leeward or to windward; but as a general rule she ought to expect that the ship which is close hauled (i.e. tacking against the wind) will keep to windward and therefore she ought to go to leeward unless it is quite clear that she can go to windward with safety."

EARLY RULES FOR STEAM SHIPS

In 1831 a Committee of the House of Commons (see appendix II C) recommended that when two steam vessels found themselves "unexpectedly near" to each other "stem-on", they were to put their helms a'starboard (i.e. alter course to port). This was to be consistent with the rules for river navigation at that time, but it was different in kind from the river rule. The physical frame of reference provided by the river banks is the same for both craft but, in the open sea, the stem-on situation depends upon the relative position of each vessel within a frame of reference defined by the direction of the other ship's head. Two frames of reference are involved and a knowledge of both is necessary in order to recognise the situation.

In 1836 a Royal Commission (see appendix II D) declared that the rule for sailing vessels "that when two vessels meet on contrary tacks the one upon the larboard (port) tack should bear up and that upon the starboard tack should keep her wind (i.e. maintain course), had been attended with the best effects."

In addition, they proposed that steamers in rivers should keep on that side of the river or channel which lies on their starboard hand. Note that this is a reversal of the 1831 Committee's assumption that vessels in rivers kept to the port side.

In 1839, the Royal Navy rules included two for steam ships in addition to the larboard (port) tack rule for sailing ships. Thus "when steam vessels not under sail, but on different courses, must unavoidably or necessarily cross so near that by continuing their respective courses there would be risk of coming into collision, they are always to pass on the port side of each other."

Also "a steam vessel passing another in a narrow channel must always leave the vessel she is passing on the port hand."

It is of interest to note that these are the first rules in which "risk of collision" is mentioned specifically and the instruction is that risk of collision itself should be avoided. At a later date (1863) we shall see a change in principle whereby the rules do not come into operation until after risk of collision has been established.

A UNIVERSAL SET OF RULES

In 1840, the Corporation of Trinity House took the important step of promulgating what the Elder Brethren (the Corporation's governing body) considered were, at that time, generally accepted practices for avoiding collisions between ships (see appendix II E)

For the first time it was explicitly stated that sailing vessels with the wind fair (i.e. sailing with the wind) should give way to vessels "on a wind (i.e. sailing against the wind)."

The well-established rule that sailing vessels on the port tack should give way to vessels on the starboard tack was repeated.

A third rule was suggested by which, if two sailing vessels had the wind at large (i.e. sailing with the wind) or abeam (i.e. sailing at right angles to the wind) then each should alter course to starboard so that each would pass on the port side of the other.

Vice-Admiral Colomb later suggested that neither the first nor the third of these rules were known in either the British or French Navies at that date[11]. As regards the first rule, this comment may be a little hard because, as noted previously, the 1780 Royal Navy instructions implied that vessels with the wind free should give way to vessels which were close hauled, and this was confirmed by the Admiralty Court ruling in 1828[12]. There does, however, seem to be some justification for his criticism in the case of the third rule, particularly since this was made the basis of the general rule for collision avoidance between steam ships.

Trinity House contended that steam ships should be considered to have the same capabilities as sailing vessels with the wind at large. They therefore suggested two additional rules:

> "When Steam Vessels on different courses must unavoidably or necessarily cross so near that, by continuing their respective courses, there would be risk of coming in collision, each vessel shall put her helm to port (i.e. alter course to starboard), so as always to pass on the larboard (port) side of each other.
>
> A steam vessel passing another in a narrow channel must always leave the vessel she is passing on the larboard (port) hand."

The Trinity House rule differs from the 1839 Royal Navy rule for steam vessels crossing in the requirement for each vessel to alter course to starboard, so that a broad convention as to how collision avoidance should be achieved was replaced by explicit manoeuvring instructions.

The Trinity House rules did not have the force of law, but they were taken by the Courts as authorititive evidence as to what was the ordinary practice of seamen at the time. They did therefore have a legal standing which provided a strong incentive for mariners to obey them.

FIRST LEGISLATION

In 1846 the two rules for steam vessels were combined into a single rule in an "Act for the Regulation of Steam Navigation " and, pursuant to this Act were given the force of law from January 1847 (see appendix II F). The convention that steam ships should resolve encounters by passing port to port was retained, but the stringent requirement that each should put her helm to port (i.e. alter course to starboard) was omitted. Sailing ship rules were not included in this legislation.

The 1846 Act also gave authority to "Admiralty Regulations" as to lights which were promulgated in 1848. These regulations provided that steamers should distinguish their sides at night by carrying a green light on the starboard side and a red light on the port side, in addition to the white masthead light which they had previously carried. This order made it easier at night to obey the rule requiring conflicting steam vessels to pass port to port.

PIECEMEAL LEGISLATION

In 1851 a "Steam Navigation Act" was introduced (see appendix II G). The regulations were amended to require each of the two vessels in an encounter to put her helm to port (i.e. alter course to starboard) so as to pass on the port side of the other, thus effectively reverting to the 1840 Trinity House regulations. Even more important, the 1851 regulations included sailing ships within their compass, by mistake it has been suggested[11]. Naturally, such a radical change did not please everyone and the magazine "Naval Science", with a nice turn of phrase, later complained that "a chance sentence abolished the existing law for sailing vessels and introduced a new one, untried, undiscussed and uncalled for[14]".

The 1851 regulations reiterated the 1846 rule requiring steam ships to keep to the starboard side of rivers or narrow channels. This was a slightly stronger form than the Trinity House regulations which only required that steamships in rivers and narrow channels should pass port to port and not that they should necessarily keep to the starboard side at other times.

It is of incidental interest to note that the 1851 regulations were the only ones to be addressed to the master or other person in charge of a ship. All the previous and subsequent regulations have been addressed to the ship itself as if it had some intelligent and responsible will of its own. A quaint but useful concept.

In 1852 an Admiralty Notice respecting lights was published and this came into force in August of the same year. The requirements for steamship lights were practically the same as the 1848 regulations, but, in addition, sailing ships were required to show a white light when approaching or being approached by other vessels.

The Merchant Shipping Act of 1854 (see appendix II H) confirmed the port helm rule and explicitly stated that it applied to sailing vessels "whether on the port or starboard tacks and whether close hauled or not." "Naval Science" did not think very highly of this piece of legislation either and commented that it "seems to have been the hasty judgement of pure indolence, wearied with a three years wrangle over the law of 1851 and unwilling to reopen a question assumed to have been settled."[14] These regulations came into force in May 1855.

In 1858 a further Admiralty Notice respecting lights was published. The principle change was the requirement that sailing vessels should carry green and red sidelights. For the first time fog signals were also prescribed in the form of steam whistle signals for steam ships, fog horn signals for sailing vessels on the starboard tack, and bell signals for sailing vessels on the port tack.

DISSATISFACTION WITH THE "PORT HELM" RULE

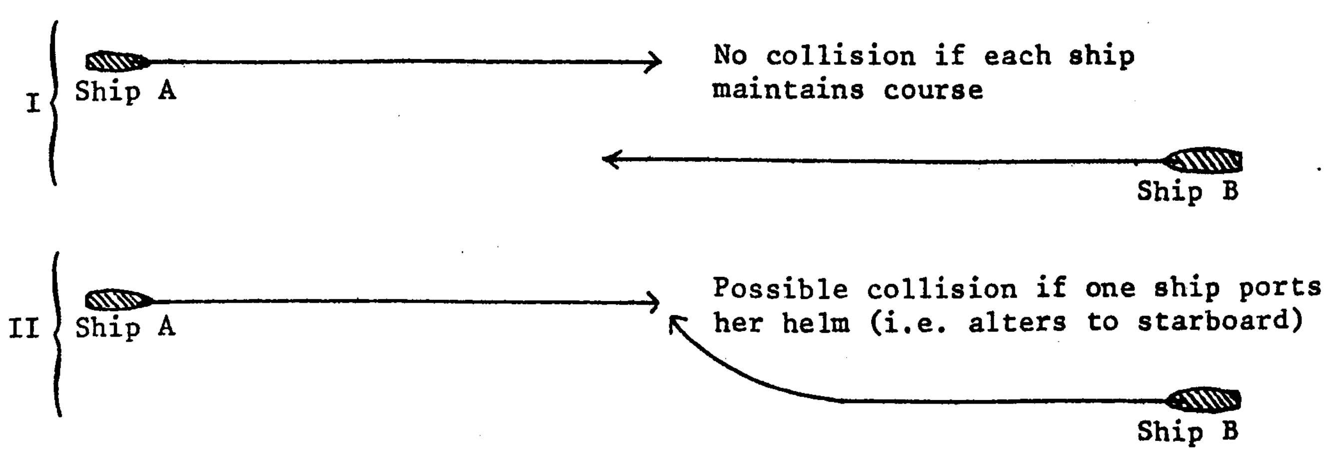
Whilst the 1854 regulations held sway, the requirement was that whenever any ship met another ship, so that if both were to continue their courses they would pass so near as to involve risk of collision, the helms of both ships should be put to port so as to pass on the port side of each other. This requirement was defective in that putting their helms to port (i.e. altering course to starboard) did not necessarily avoid risk of collision nor necessarily lead to a port to port passing, (see figure on page 5). Nevertheless, in collision cases, any vessels which had not put their helms to port were censured very severely by the Courts who were, after all, only earning their more or less honest living by more or less administering the law as it then stood. As a result, mariners tended to port their helms in all encounters, irrespective of the effectiveness of the manoeuvre, on the grounds that at least they would be "in the right" if a collision occurred.

Captain J.H. Ridley was disenchanted by the whole situation[15], and, in 1854, was of the opinion that "Schoolboy rules for handling vessels are both useless and dangerous, and a great responsibility rests, not only upon those who undertake to make them, but on those who enforce them, as does there also upon those who decide cases in courts of law by wrong decisions."

Dissatisfaction with the port helm rule was recognised officially when a Select Committee of the House of Commons on Merchant Shipping reported in 1860 that the Rule of the Road at Sea "is most unsatisfactory, however the decisions of our Courts of Admiralty may have modified its dangerous tendency." What the courts had done, in fact, was to hold that for sailing vessels crossing at a wide angle, the old rule and not the new one applied. They could not, of course, limit the steamship rule in this way because there was no old rule to fall back on.

A powerful criticism of the port helm rule was given to the committee by Captain Drew who pointed out clearly the dangers of any bilateral rule in which each of two vessels is required to make specific manoeuvres in response to a risk assessment which is a matter of individual judgement. Of the port helm rule he says, "Here is a necessity for an agreement between both parties as to any danger, utterly unmindful as to differences of opinion: one may think that if each continues his course there is no danger, the other, to be on the safe side, ports his helm and causes the collision, and the collision then becomes a justification for concluding that there was danger."

Fig. 9



EXAMPLE OF CAPTAIN DREW'S POINT. Ship B causes the collision but, under port helm rule, ship A would be found to blame.

REFORM AND UNIFICATION

Shortly after the Select Committee's report, the Board of Trade received, from the French Government, a proposal that an international conference of maritime powers should be convened to discuss the rule of the road at sea. The Admiralty agreed, but the Board of Trade thought that an "understanding" should be reached first and, in the event, no conference was held as a result of the French initiative.

By December 1860, the BOT had produced a draft of a completely new set of rules. This draft was sent to France in May 1861 and returned with a counter-proposal by the French Government in the September. In the first draft, there was provision for steamships meeting end-on, but none for steamships crossing; the BOT comment being that "this, it is considered, must be left to the judgement of those in charge." The only important change in the French counter-proposal was the inclusion of a new rule for steam-ships crossing. This was accepted by the Admiralty and Trinity House as well as by the BOT and the new regulations were included in the Merchant Shipping Amendment Act of 1862. Oddly enough, the regulations in the 1862 Act were found to contain clerical errors but it seems unlikely that Queen Victoria was amused at the time since she had to spend part of a stay at her holiday residence at Osborne House in January 1863 in making an Order in Council, to put things right. The new rules came into operation in June 1863 and, by the end of 1864 they had been adopted by over thirty maritime states.

The 1863 Rules (see appendix II I) were important for several reasons, quite apart from the extraordinary rapidity with which they were accepted internationally. For the first time all the collision avoidance rules, whether steering and sailing rules or rules concerning lights, were given equal force of law. Also the rules were completely recast into a format of articles and with a literary style which set the pattern for all subsequent sets of rules and which are still clearly evident today. Finally the substance of the rules underwent radical changes, the most important being the repeal of the universal port helm rule and its replacement by separate rules covering six circumstances under which ships might come into conflict. These rules, it may be noted, were to come into operation after risk of collision was established and not, as previously, in time to prevent risk of collision. The six relevant rules were as follows:-

Article 11 stated that two sailing vessels meeting end-on or nearly end-on should each alter course to starboard.

Article 12 dealt with other encounters between sailing ships, reinstating the rules that port tack gives way to starboard tack, that a vessel to windward gives way to a vessel to leeward and that a vessel with the wind free gives way to a vessel which is close hauled.

Article 13 stated that steamships meeting end-on or nearly end-on should each alter course to starboard.

Article 14 introduced the completely new rule proposed by the French Government. This rule stated that when two steam vessels are crossing so as to involve risk of collision, the ship with the other on her own starboard side should keep out of the way.

Article 15 stated that, if a steam and a sailing vessel are proceeding in such directions as to involve risk of collision, the steam vessel shall keep out of the way of the sailing vessel. This was simply the old Trinity House principle (see appendix II E) that a steam ship should be considered in the light of a sailing vessel with the wind fair, but extended to infer that steamships have rather better capabilities. This is reasonable, since steamships have the facility for rapid braking by going astern on their engines.

Article 17 dealt with the overtaking situation as a separate case for the first time and stated that every vessel, whether a sailing vessel or not, should keep out of the way of the vessel being overtaken. This again seems a very reasonable rule, since the faster of two vessels is almost always the one which can contribute most effectively to the avoidance of collision.

Apart from the rules for these six specific situations, more general rules were also introduced. Thus every steamship approaching another ship so as to involve risk of collision was required to slacken her speed or if necessary, stop or reverse; and every steamship was required to go at a moderate speed in fog. Also, where by any of the six specific rules, one vessel was to keep out of the way, the other vessel was required to keep her course.

Comprehensive regulations for the carriage of lights were included in the 1863 rules, and fog signals for steamships, sailing ships and ships at anchor were also specified.

The statements that special circumstances might render a departure from the Rules necessary in order to avoid immediate danger and that nothing in the rules should exonerate mariners from the consequences of the failure to keep a proper look-out or the neglect of normal precautions, appeared in virtually the form which they retain today.

The pervading principle of the 1863 rules was that of assigning responsibility for avoiding collision mainly to one of the two parties to an encounter, with the complementary requirement that the other vessel should maintain her course. The principle of laying down specific manoeuvres which had been followed since 1840 was dropped except in the special case of vessels meeting end-on or nearly end-on. Even the rule that steamships should keep to the starboard side of narrow channels was repealed.

CONTROVERSY IN THE WAKE OF THE 1863 RULES

The changes wrought in 1860 by the drafters of the new rules were certainly comprehensive and perhaps even revolutionary. It is remarkable that they should have been adopted nationally and internationally with apparently practically no comment on the reasons for the changes. Only three years previously the BOT had objected to rules based on similar principles on the grounds that "the steps to be adopted to avoid collision depend upon the following questions:- Whether the approaching vessel is a sailing vessel or a steamer? Whether she is on the port tack or the starboard tack? Whether she is on a wind or free? At night and in thick weather, when there is risk of collision, and when there is a need of prompt decision and immediate action, it is impossible to be sure on these points; mistakes will be made, time will be lost, and the result will be increase of danger."[10]

These and similar objections do not seem unreasonable and to jettison them so rapidly and so completely shows a remarkable capacity for change on the part of the BOT. Naturally, the 1863 Rules did not please the more conservative mariners, some of whom lacked the BOT's astonishing mental agility. Nor, for that matter, did they please the more progressive thinkers.

In 1866 there was published "The Law of Port Helm - An examination into its history and dangerous action with suggestions for its abolition" by Colomb and Brent[16]. Commanders Colomb and Brent (as they then were) argued that "right of way" rather than "risk of collision" should govern the conduct of ships.

They concluded that the institution of the Rule of port helm for steamers by Trinity House in 1840 was a departure from the principle which had hitherto obtained in the rules for passing vessels. Also that such departure was "vicious in the extreme" and that the 1863 Rules, being mainly developments of this vicious principle were, with exceptions, "probably productive of the accidents they were designed to prevent." Strong words indeed, but Colomb and Brent were not yet out of steam.

They suggested that the pre 1862 attempts to find simple, all embracing, rules were on the right lines although the actual rules produced were bad. The 1862 Act they declared, had a disintegrating effect which was wholly wrong. It tacitly condemned the end sought in previous laws (i.e. simplicity) when it should have upheld the end but condemned the means.

They thought that the complexity of the 1863 rules was too great for practical use at sea, "however valuable they might be as a standard of appeal in Admiralty Courts for the purpose of putting one party clearly in the wrong after the event."

Colomb and Brent considered that Article 14 (for steamships crossing) was the most important of the new rules and that it should be made the basis for all the rules. They also stressed the importance of signals to indicate helm alterations or an intention to maintain a steady course and suggested a system of warning lights for this purpose.

The 1863 Rules were not, however, without their champions and in particular Mr. Thomas Gray, Assistant Secretary to the Marine Department at the Board of Trade, who published in 1867 a Rule of the Road at Sea pamphlet which was to run to many editions. His object was to show that the Rules were "simple, sufficient and intelligible."

He justified the new principle that the Rules should come into operation only after risk of collision was established by pointing out that it would be idle and vicious to make rules for ships which could not possibly come into collision if they both kept their respective courses.

He justified the retention of the alter course to starboard rule for end-on or nearly end-on vessels by suggesting that the only option in such situations would be to require each vessel to alter course to port which, as he rightly pointed out, would have been neither simpler nor more effectual. He further argued that if it was right to alter course to starboard for end-on situations, why should it not also be right to do so for nearly end-on situations.

The point which Gray missed in both these arguments is the danger of situations in which one vessel considers that risk of collision exists and the other does not. (See Captain Drew's evidence, page 22).

The bulk of Thomas Gray's pamphlet consisted of advice and instructions as to how the rules applied and how they should be followed in particular situations.

Apparently not satisfied that his prose would have the desired impact on his readers, and, never by nature a flower born to blush unseen, Gray then launched into poetry (see appendix V). Possibly, in this, he was inspired by his namesake of the previous century and, if he could not quite match the lyrical erudition of his predecessor, his work was nevertheless an instant success with his public and is by no means forgotten amongst mariners today. Thus, where the first Thomas Gray, in a slightly different context, could warn:-

"Know one false step is ne'er retrieved
And be with caution bold."

The second Thomas Gray's more direct though more mundane advice was:-

"To act as judgement says in proper
To Port - or Starboard - Back - or Stop her!"

A rhyme calculated to cause the first Thomas Gray to turn in his Stoke-Poges resting place, despite having been on the watch-below for nearly a hundred years. But there is no doubt that Thomas Gray II was highly successful in explaining and popularizing the Rule of the Road at Sea, from the 1863 regulations onwards. His verses were translated into French, German and Italian and altogether about a quarter of a million copies were printed.

In retrospect there seems little question that Thomas Gray's work was both useful and effective, but not everyone was convinced of this at the time. The magazine "Naval Science" commented tartly[14] on "the circulation by the Board of Trade of a pamphlet by one of its officers, putting a construction on the existing rules which might or might not be advantageous, but which was certainly not in the minds of the Board when they framed them, and was directly in the face of decisions of the law courts."

More importantly, no less a body than the Judicial Committee of the Privy Council, in a patronizing style appropriate to its august standing, objected that "in the eyes of the class of persons whose duty it is to apply the sailing regulations, the interpretation would be apt to supercede the enactment." The Committee added that "the interpretation of the rules must, according to all sound legal principles, rest with courts of justice alone, and cannot safely be assumed or anticipated by any administrative department of Her Majesty's Government."

This criticism almost sounds as though Mr. Thomas Gray were usurping the authority of Queen Victoria herself, but he seems to have avoided incarceration in the Tower of London, possibly because Messrs. Gilbert and Sullivan had already reserved it as a set for the forthcoming production of one of their own comic operas.

A result of the Privy Council Committee's opinion was that the Board of Trade's interpretation of the meaning of the end-on rules (Articles 11 and 13) was promulgated by Order in Council in the form of the "Explanatory Clauses" of 1868; a sense of urgency being given to this action by the disastrous Amazon-Osprey collision in 1867. These Clauses had the force of law and explained at length (see appendix II J) not only what was meant by the phrase "end-on or nearly end-on" but also what was not meant by it.

Thus, with respect to steamships, the explanation ran:- "The said article, numbered 13, only applies to cases where ships are meeting end on or nearly end on in such manner as to involve risk of collision. It consequently does not apply to two ships, which must, if both keep on their respective courses, pass clear of each other.

The only cases to which the said Article applies are when each of the two ships is end on or nearly end on to the other; in other words, to cases in which by day each vessel sees the masts of the other in a line or nearly in a line, with her own; and by night, to cases in which each vessel is in such a position as to see both the sidelights of the other.

It does not apply, by day, to cases in which a vessel sees another ahead crossing her own course, or, by night, to cases where the red light of one vessel is opposed to the red light of the other, or where the green light of one vessel is opposed to the green light of the other, or where a red light without a green light, or a green light without a red light is seen ahead, or where both green and red lights are seen anywhere but ahead."

CONSOLIDATION OF 1863 PRINCIPLES

In 1876, the report of a committee, appointed by the Admiralty, the Board of Trade and Trinity House, was published. This recommended amendments to the Rules for Preventing Collisions, but no radical changes in principle or format.

Thus the report suggested that the showing of a sternlight by overtaking vessels should be made clearly lawful, doubt as to its legality having been expressed in the Courts.

Also, it was suggested that the system of sound signals used by steamships on the coasts and in the rivers of the United States should be adopted on the high seas.

Additionally, it was recommended that the rule requiring steam ships to keep to the starboard side of narrow channels should be reinstated.

In 1879, an Order in Council was made promulgating Regulations for Preventing Collisions at Sea in 26 articles (see appendix II K for the full text). These new regulations came into force in September 1880. The changes were important but not radical.

In a new article 5, identifying lights and shapes were prescribed for vessels laying or picking up telegraph cables or otherwise not under command.

A new article 10 revised the identifying signals for fishing vessels but this particular rule was never in fact adopted.

Also new was article 11 which unambiguously specified that vessels being overtaken should show a white light from their stern.

Article 12 prescribed coded signals for vessels in fog, mist or falling show, i.e. one prolonged blast on the whistle for steamships; one, two or three blasts on the fog-horn for sailing ships on the starboard tack, port tack and with the wind abaft the beam respectively; a ringing of a bell for vessels not under way. This extended the 1862 regulations which had only specified that a whistle should be used by steamships, a fog horn by sailing ships and a bell by vessels not under way, but not the particular signals.

Article 13 required that every vessel should go at a moderate speed in fog, mist or falling snow. A similar requirement had appeared in the 1862 rules but its importance was emphasised by giving it the status of a separate article in the 1880 regulations.

A new article 14 gave rules for sailing vessels approaching one another so as to involve risk of collision and specified that one of them should keep out of the way of the other as follows:-

(a) A ship which is running free shall keep out of the way of a ship which is close hauled.

(b) A ship which is close hauled on the port tack shall keep out of the way of a ship which is close hauled on the starboard tack.

(c) When both are running free with the wind on different sides, the ship which has the wind on the port side shall keep out of the way of the other.

(d) When both are running free with the wind on the same side, the ship which is to windward shall keep out of the way of the vessel which is to leeward.

(e) A ship which has the wind aft shall keep out of the way of the other.

The port helm rule for sailing vessels meeting end-on or nearly end on was thus repealed and this new article 14 replaced the two 1862 articles for sailing vessels meeting and sailing vessels crossing respectively.

The 1880 article 15 for steamships meeting end-on was similar to the corresponding 1862 article but specified an alteration of course to starboard in place of putting the helm to port; i.e. it specified what should be done with the ship rather than what should be done with the helm. Also, the 1868 "Explanatory Clauses" were included as an integral part of the new article.

New in 1880 was article 19 which laid down permitted whistle signals for the purpose of indicating certain manoeuvres by steamships, the signals being founded upon existing practice in the United States. Specifically, an alteration of course to starboard, an alteration of course to port and full speed astern could be indicated by one short blast, two short blasts and three short blasts respectively.

Article 21 of 1880 reinstated the rule that steamships should keep to the starboard side in narrow channels.

Also new in 1880 were article 25 reserving the position of local rules for harbours and inland waters, and article 26 allowing special lights to be shown by ships in company.

The short life of the 1880 Regulations ended when they were replaced by the Sea Regulations of September 1884 on the authority of an Order in Council made the previous month (see appendix II L).

There were, in fact, few significant changes. Article 5 was recast to provide for separate signals for vessels not under command and for vessels laying or picking up telegraph cables. Article 10 for fishing vessel signals was amended, and a new article 27 specified the signals to be used by vessels in distress and requiring assistance.

The 1884 Regulations thus contained 27 articles of which article 10, concerned with lights for fishing vessels, was amended twice within the year; that is in January and June of 1885.

If it had been left to Captain Colomb (as he then was) many of the other articles would have been amended too. In 1885 he returned to the attack with a book entitled "The Dangers of the Modern Rule of the Road at Sea, and the manoeuvring powers of ships as affecting collisions"[17].

CRITICISM OF THE 1884 RULES

As a long-standing critic of the port helm rule, Colomb noted, with satisfaction, that it was banished for all cases except that of steamships meeting end-on or nearly end-on. He clearly felt confident that it would not last long for this case either because, in order for it to operate, he pointed out that "there must be a concurrence of opinion between two officers who can neither hear nor see each other, and one of whom may not even see the ship of the other, on two distinct points; namely:- as to whether each ship is end-on or nearly end-on to the other and whether there is risk of collision, and I will ask whether is can be anything but dangerous to retain a rule which requires an improbability to set it into motion?"

Alas for Colomb's hopes. Despite his efforts in writing the best researched and most lucid comment on the Rules for Preventing Collisions to be published in the 19th Century, the port helm rule for steamships meeting is still with us and, far from fading away, it is showing signs of rejuvenation.

Colomb also demonstrated that the regulations of the day did not make the best use of the coloured sidelights which ships carried and he showed, in an excellent chapter on the manoeuvring power of ships, the dangers of including rigid helm orders within the regulations.

During the course of his exposition, Colomb fired the odd salvoe in the direction of Trinity House, but he reserved his broadsides for the BOT, and for Mr. Thomas Gray in particular. Colomb described Thomas Gray's pamphlet as remarkable, "in one way from the authoritative style of the author, writing for seamen on a highly technical subject of which he cannot possibly have any of that knowledge which would properly allow of an authoritative style. Again, as to style, from the mixture of the deprecatory with the authoritative, and side by side with it. Then in the denial that the author is proposing rules of seamanship, when every page bristles with them."

Apart from the subject matter of the pamphlet and Gray's irritating literary style, it was his success that really rankled with Colomb who kept referring to the 10,000 copies of the Gray pamphlet and the 200,000 copies of his verses as though he could hardly believe the facts.

THE FIRST INTERNATIONAL CONFERENCE

In September 1889, a British rule of the road committee drew up a new set of rules in preparation for an International Maritime Conference. This International Conference was convened on the initiative of the Government of the United States of America and took place in Washington in October 1889.

A notable feature of the Washington Conference was the discussion of two practices which were already in common usage on the United States coast and inland waters. Firstly, the carriage of a second white masthead light by steamships to improve the perception of the vessels heading was proposed by Captain Shackford (U.S.) and accepted in a permissive form as an experiment. Secondly, Mr. Goodrich (U.S.) proposed an amendment to the existing article 19 (sound, signals for vessels in sight of one another) to make them mandatory when a vessel altered course to avoid collision. This was opposed by Dr. Sieveking (Germany) who said that they would cause confusion if misunderstood and were of no value since the other vessel was required to maintain course and speed anyway. Goodrich pointed out that the signals worked very well in U.S. inland waters and Mr. Hall (U.K.) said that they were already in constant use at sea, and the amendment was carried.

Sieveking in fact had a somewhat frustrating time at the Conference, most of his other suggestions also being rejected, usually as a result of Anglo-American opposition. He nevertheless proposed a handsome vote of thanks to Thomas Gray for his "valuable services" when the latter gentleman was obliged to return to England in consequence of illness.

Sieveking had a partial success in urging that the term "moderate", as applied to the speed of ships in fog, should be defined for the guidance of judges and sailors. He proposed the wording "so far moderate her speed as is consistent of the care necessary to prevent risk of collision." Hall objected that any attempt at precising the term might afford an excuse for evading it and Goodrich agreed with him that the strength of the law was in its flexibility. Later in the Conference, Sieveking put forward another form of wording which Hall again objected to on the grounds that the true meaning of the term was well known to every sailor. Mr. Carter (Hawaii) suggested that the addition of the words "having careful regard to the conditions and circumstances" after "moderate speed" might reconcile the difference between the two views, and this was accepted.

Sieveking did not even have this luck with a proposal that a steamship should give way to a vessel when towing, nor with a proposal that the rule requiring the stand-on vessel to maintain course and speed should not be applied to overtaking situations.

The introduction of the requirement that a stand-on vessel should maintain speed as well as course was one of the most important and controversial recommendations of the Washington Conference. Since 1863, the regulations had only required the stand-on vessel to maintain course. The proposal for the change was made by Hall, who explained that the object was to decrease the uncertainty of the situation so that the giving-way vessel could more confidently pass astern. Sieveking had reservations on this proposal and, with fatal inevitability, his mention of these was followed by general acceptance of the proposal. Possibly this was because his reservations took the indelicate form of a suggestion that the opinion of practical mariners should be sought in the matter. Such ideas were hardly likely to appeal to administrative delegations such as made up the bulk of the Conference in which mariners were very thin on the ground - unless one counts the Admirals.

The requirement for a stand-on vessel to maintain speed cleared the way for Hall to propose an additional rule, that a giving-way vessel should avoid crossing ahead of the vessel it is avoiding, and this was carried without discussion.

The rigidity of the new stand-on rule, and the danger it imposed on the stand-on vessel if the giving way vessel did not take avoiding action in good time was recognised by the Conference. To provide for this eventuality, the U.K. Delegation proposed a clause to require the stand-on vessel to take avoiding action if the giving-way vessel took no action until collision was imminent. This proposal was not much liked by the Conference but, as an alternative, it accepted that the words "collisions or other" should be inserted before "danger" in the special cases rule (article 23 of 1884). The new rule was then to read, "In obeying and construing these rules, due regard shall be had to all dangers of navigation, and to any special circumstances which may render a departure from the above rules necessary in order to avoid immediate collisions or other danger." The expressed object of this amendment was to impress on the minds of sailors that they must not hold on too long to the rule prescribing that the stand-on vessel must keep her speed as well as her course.

Later in the proceedings, Goodrich moved an amendment which was practically the original clause proposed by the U.K. Delegation. In view of its subsequent history, it is worth quoting, thus:-

> "When in consequence of thick weather or other causes, two ships find themselves so close to each other as to make it doubtful whether by the action of one ship alone a collision can be avoided, the ship which by the above Article is directed to keep her course and speed shall also take such action as will best avoid collision."

Goodrich suggested that this provision should be placed so as to catch the mariner's eye immediately after the Rule which required the holding-on vessel to maintain course and speed. He pointed out that he was acting on the advice of a distinguished New York judge but the Conference remained unimpressed and, when a vote was taken, the U.S. was in a minority of one. Unsupported by the perfidious British who had brought up the idea in the first place, and even Sieveking finding himself, perforce, on the winning side for once.

The Washington Conference recommended new Rules for Preventing Collisions at Sea (see appendix II M). These incorporated the amendments agreed upon but were otherwise without radical changes of either principle or format compared with the Rules (i.e. the 1884 Rules) current at the time. There was no rush to put the new rules into operation.

SECOND THOUGHTS ON THE WASHINGTON PROPOSALS

In 1890, a British Committee was set up to consider what alterations were needed to the rules agreed at Washington. Amongst a few minor and uncontroversial suggestions, this Committee proposed an addition to the Washington rule (article 21) requiring a stand-on vessel to maintain course and speed. This addition was to the effect that such a vessel should maintain course and speed, "unless in consequence of thick weather or other causes she finds herself so close that collision cannot be avoided by the action of the giving way vessel alone, when she also shall take such action as will best aid to avert collision." Virtually identical with the clause which had been rejected so decisively at Washington a few months previously.

The Committee was clearly worried that the Washington recommendation for standing on vessels to maintain speed as well as course would lead to danger unless it were qualified. In fact William Watson so far forgot his position as the only plain Mr. amongst an assortment of Admirals, Baronets, etc., as to produce a dissenting report suggesting that the requirement to maintain speed should be dropped altogether. He also objected to the Washington recommendation that the sound signals to indicate alterations of course should be made compulsory.

Outside the Committee, there were many other objections to the Committee's report and indeed to the Washington recommendations themselves. These ranged from sweeping condemnations as in a letter from the General Shipowner's Society, London, to the Board of Trade on 29th June 1891 suggesting that "the alterations in the Regulations for Preventing Collisions at Sea recommended at the International Maritime Conference at Washington are inopportune and uncalled for and would be likely to bring about more collisions than there at present are," to more specific criticisms such as a letter from the Liverpool Steamship Owners Association to the Board of Trade coincidentally (?) of the same date, suggesting that the proposed addition to article 21 was dangerous and the proposed sound signals in fog, confusing.

Comments from foreign governments were also received and the Committee decided that general acceptance of their recommendations was not likely to be achieved. As a compromise, they decided, in June 1892, to recommend that their controversial clause should be added as a note to article 21, thus: "Note - When in consequence of thick weather, such vessel finds herself so close that collision cannot be avoided by the action of the giving-way vessel alone, she also shall take such action as will best aid to avert collision (see articles 27 and 29).

Mr. Watson, maintaining his own course and speed in exemplary fashion, still dissented from the Committee's report and in July 1893 a further Committee was appointed of which Mr. Watson was a notable if somewhat surprising member. This new Committee's terms of reference were to consider objections from

Foreign and Colonial Governments and from British Shipowners' Societies but, after due consideration, it saw no reason to change any of the recommendations of the previous Committee and submitted a majority report to this effect in December 1893. Mr. Watson, as usual, dissented.

In March 1894, the Board of Trade, in a circular letter to shipowners, stated that "The Board of Trade feel that this important subject has now been very fully discussed and considered in all its bearings, and that it is most desirable that no further delay should occur in securing an International Agreement which, if it does not meet the views of all concerned, is at least as satisfactory an arrangement as can reasonably be anticipated."

Some people, however, were not feeling at all reasonable on the subject and interpreted this letter as a restatement of what Mr. Thomas Gibson-Bowles, M.P. had suggested was the Board of Trade's position after the first Committee's report; i.e. "We have been going on with this matter for three years and it is time the thing was settled. Everyone has been considered except the practical men, and we don't care about them."

Nevertheless, the time of the practical men was at hand and the occasion was the "Great Meeting" convened at Liverpool by the Mercantile Marine Service Association in January 1895.

The purpose of the meeting was to protest against the Board of Trade proposals for new rules. A particular objection was to the proposal (Washington article 28) to introduce compulsory sound signals for vessels altering course and to the proposal (Washington article 15) for additional sound signals in fog. In addition, the Great Meeting objected to the general complexity of the proposed regulations and to the "Vessels sidelights regulations", introduced by Order in Council in 1893 to ensure that ship's red and green sidelights should show 4° across the bows. It may be noted here that four degrees is a little less than the half point ($5\frac{5}{8}^{\circ}$) which the Washington Conference had recommended. Also that the screening of sidelights was already under consideration by a BOT Committee which was to report in March 1895 and recommend that the 1893 Order should be cancelled[18], this recommendation being implemented in 1897.

The principal tactic of the speakers at the Great Meeting was to censure, to ridicule and to pour scorn on the Board of Trade, and there is little doubt that the delegates enjoyed themselves hugely in the process.

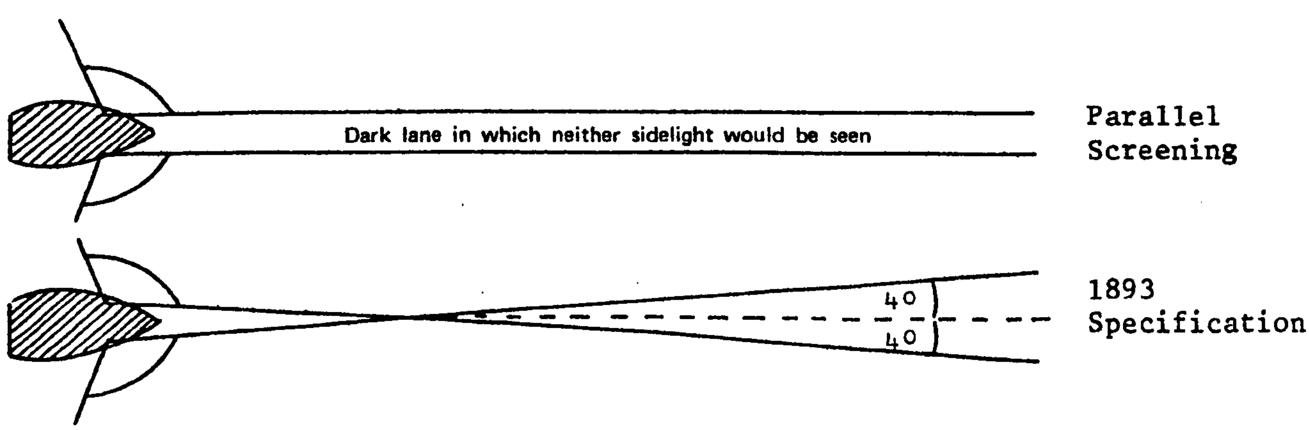
Mr. Thomas Gibson-Bowles was in particularly trenchant form and his speech is worth reading for its entertainment value alone. He seemed to summarize the mood of the meeting with his comment that "It seems the root of the whole of our trouble from 1862 up to the present time is the determination of the Board of Trade to meddle in everyone's business. It is a kind of departmental cuckoo that lays its eggs in everyone's nest and hatches the most fearful wild fowl."

Mr. Gibson-Bowles extended his critique of the Board of Trade into a scathing, personal attack on specific, named officers claiming that, amongst other things, they were proposing "a Rule of the Road to suit anything, that ships are like men and if not like men are like cabs, and if not like cabs they are like omnibuses." An impressive performance, if in slightly bad taste, although Thomas Gray, by this time resting knighted in his grave, was past being worried by it.

With the clarity of vision and the counterfeit wisdom which we acquire from hindsight, it might seem to us now that the indignation, the anger and indeed the venom generated at the Great Meeting was out of all proportion to the magnitude of the issues under discussion.

Jibes were made by sundry delegates against the BOT contention that a dangerous "dark lane" would exist ahead of a ship with sidelights screened so as to show in a line exactly parallel to the fore and aft line of the ship but their own worries about the consequences of fitting "squinting" sidelights seem grossly exaggerated when one considers the modest angle of convergence (4^{o}) specified in the 1893 order.

Fig. 10



Great objection was taken to the many alternative sound signals proposed for ships in fog or when altering course and chaos was predicted in crowded waters. Generally, the Great Meeting endorsed the view of the matter expressed by Admiral De Horsey in a letter to the Times the previous month in which he foresaw "pandemonium not unlikely to result in disaster" if the sound signals recommended by the Washington Conference were adopted; adding, darkly, that it was all due to "the great mistake of convening a Conference in another country." In fact, the forebodings of Admiral De Horsey and the Great Meeting were not fulfilled because the rapidly reducing number of sailing ships meant that three of the fog signals were not destined to be heard at all frequently in future years, and the sailor's natural independence ensured that, when the sound signals prescribed to indicate changes of course were made compulsory (in 1897), they were still treated as so far optional that their use was (and is) unusual, except in the special circumstances of the Board of Trade's (D.T.I.'s) examination rooms.

Probably the real reason for the dissatisfaction which led to the Great Meeting was the apparent refusal of the Board of Trade to be influenced by external criticism, rather than the importance of the criticism itself. Also there was a general feeling that the Rule of the Road was too complex, and frustration by the difficulty of developing this argument may have been the cause of the over emphasis of the simpler but less important criticisms on which the speakers spent most of their time.

A CODE FOR AN ERA

In 1896, an Order in Council promulgated new Sea Regulations which came into force in July 1897 (see appendix II N). These regulations were based firmly on the Washington Conference proposals and the 1892 and 1893 BOT Committee reports. For all the effect it had, the storm of protest in the form of letters to the Board of Trade, correspondence and editorial comment in the press[19] and the Great Meeting at Liverpool, might never have been.

Comparing the 1897 rules with the 1884 rules which they superceded, there are several important changes and many minor ones.

A preliminary article dealt with the application of the Rules, defined the terms "steam vessel" and "under way" and distinguished between steam vessels and sailing vessels in the same way as the 1884 Article 1.

The 1897 Article 1 defined the term "visible" as applied to lights and specified that the prescribed lights should be exhibited from sunset to sunrise.

Article 2 dealt with the lights for steam ships. It replaced Article 3 of 1884 and also contained provision for an optional white light to be carried in line with the compulsory masthead light to give an improved indication of a vessel's heading.

The 1897 Article 3 prescribed an additional white light for tugs towing more than one vessel where the length of the tow was more than 600 feet.

Articles 4, 5 and 6 were almost identical with Articles 5, 6 and 7 respectively of 1884, and a new Article 7 was introduced providing for limited lighting for small vessels.

A new Article 8 contained the provisions of the 1884 Article 9 for lights for pilot vessels and also the provisions of an Order in Council made in 1892 concerning lights for steam pilot vessels.

New regulations for fishing vessels' signals were not agreed by 1897 and so Article 10 of 1884 continued in force until 1906. The 1897 regulations thus had no Article 9 for nine years until new rules for fishing vessels were adopted.

Article 10 of 1897 replaced Article 11 of 1884 and extended it so that the white light to be shown from the stern of a vessel being overtaken could be a fixed light.

Article 11 dealt with anchor lights in similar terms to Article 8 of 1884 but with the additional provision for a light near the stern of vessels over 150 feet in length and a special signal for a vessel aground.

Article 12 was a new one, giving all vessels discretion to use a flare up light or to make a detonating signal in order to attract attention.

Article 13 included the provisions of 1884 Article 26, allowing special lights for vessels in company.

New in 1897 was Article 14 which provided a day signal for a vessel having her funnel up but proceeding under sail only.

Article 15 extended the number of fog signals as compared to the corresponding 1884 Article. As a result of opposition which had developed to the complexity of the Washington recommendations, these were simplified to just two additional signals; two prolonged blasts on the whistle for steam vessels not making way through the water and a prolonged blast followed by two short blasts for hampered vessels.

Article 16 was developed from Article 13 of 1884. It reiterated the requirement that all vessels should go at a moderate speed in restricted visibility and added the Washington proviso that this should be with careful regard to the existing circumstances and conditions. Also added was the requirement that steam vessels should stop their engines and then navigate with caution if they hear apparently forward of the beam the fog signal of another vessel, the position of which is not ascertained.

A new paragraph was added before Article 17 as a preliminary to the steering and sailing rules. This explained that risk of collision should be deemed to exist if the compass bearing of an approaching vessel did not appreciably change.

Article 17 provided for two sailing vessels approaching one another and was identical with Article 14 of 1884.

Articles 18 and 19 dealt with the cases of steam ships meeting end-on or nearly end-on and steamships crossing, and were similar to Articles 15 and 16 respectively of 1884. Article 20, providing for encounters between steam vessels and sailing vessels, repeated Article 17 of 1884.

A revised Article 21 replaced Article 22 of 1884 and provided that, where by any of the Rules one of two vessels was to keep out of the way, the other should keep her course and speed. This was an important change since, by the 1884 regulations, the requirement for such ships was only to maintain course. In fact for steam ships Article 18 of 1884 actually required that they should slacken their speed when approaching another ship whether it was their duty to keep out of the way or not. In this respect therefore, the new Article 21 requirement for the stand-on vessel to maintain speed was a reversal of principle.

Even more interesting was the addition of a note to article 21. This was none other than the proviso that the stand-on vessel should take action if ships found themselves too close, and in almost identical wording to the proposal that had been defeated so decisively at Washington.

Article 21 paved the way for a new Article 22 which directed that a giving way vessel should avoid crossing ahead of the other vessel.

Article 23 specified that a giving way vessel should slacken her speed or stop or reverse if necessary. It replaced Article 19 of 1884 but with the difference that it no longer applied to stand-on vessels which were covered by the new Article 21.

Article 24 provided that overtaking vessels should keep out of the way of the vessels they are overtaking in the same terms as Article 20 of 1884, but with the addition of paragraphs which the Washington Conference thought necessary to define precisely what was meant by the word "overtaking".

Article 25 was identical with the 1884 Article 21 requiring that steam vessels should keep to the starboard side in narrow channels.

Article 26 was the result of a somewhat timid step taken by the Washington Conference towards recognition of the long observed principle that vessels not fishing should keep out of the way of vessels which are fishing. It only applied to sailing vessels and left the rule of the road for steam trawlers in particular in an unsatisfactory state[20].

Article 27 stated that due regard should be had to all dangers of navigation and collision and to any special circumstances which might render a departure from the Rules necessary in order to avoid immediate danger. The wording was identical with Article 23 of 1884 except for the addition of the words "and collision." This addition had been a Washington recommendation in place of the note to Article 21 discussed above so that, in the event, instead of one or the other, we got both.

Article 28 specified sound signals for indicating course alterations. These were the same as those specified in Article 19 of 1884 except that they were made compulsory instead of optional and a definition of "short blast" was added.

Article 29 providing that no vessel under any circumstances should neglect proper precautions was identical with Article 24 of 1884 except for the substitution of the word "vessel" for "ship". It is perhaps of interest to note that this substitution was made throughout the 1897 Regulations as a result of a United States sponsored recommendation by the Washington Conference. In British law, however, the Regulations still only applied to those vessels which were defined as ships because of the wording of the Merchant Shipping Act of 1894, section 418(1), which gave authority for the subsequent Orders in Council making Regulations for the Prevention of Collisions at Sea.

Article 30 reserved the position of local Rules for harbour and inland waters in almost identical terms to Article 25 of 1884.

Article 31 described distress signals and was similar to Article 27 of 1884 but with the addition of a signal consisting of a continuous sounding of any fog-signal apparatus.

The 1897 Regulations thus contained many minor alterations as compared to the 1884 Regulations, and a few important alterations, but none of a particularly revolutionary character. Their promulgation marked the end of half a century of rapid change in the Rules for Preventing Collisions at Sea and the beginning of half a century of stability such as would have delighted the Medes and the Persians. During this latter period, the immutability of the Rules became accepted as almost beyond question so that, by 1947, when the author first went to sea, navigating officers and lecturers in nautical colleges spoke of the Rules with a reverence bordering almost on awe. This touching, if perhaps slightly unhealthy, faith in the infallibility of the Rules appears to have been shared by the U.K. delegates to the 1948 Safety of Life at Sea Conference. Also, the certificate of competency examinations requirement, that candidates should know the Rules word for word, added further to the notion that each syllable had the status and timeless application of a divine revelation. A far cry from the knock-about atmosphere of the 19th Century.

However, although the Regulations did not change appreciably between 1897 and 1954, there was some activity.

MINOR AMENDMENTS AND INTERNATIONALIZATION

In 1905 an Order in Council amended the fog signals for fishing vessels. Another Order in Council in 1906 completely revised the regulations for fishing vessels which were then styled as Article 9 to be read as if included within the Sea Regulations of 1897.

In 1910, an International Maritime Conference was held in Brussels to consider the unification of rules of law in regard to collisions at sea. The rules in question were not those for preventing collisions but legal rules pertaining to such things as assessing fault, liability and damages after a collision has taken place. Nevertheless, although the Rules for Preventing Collisions at Sea were almost unchanged, they were for the first time placed upon a true international basis and a sequel to the Conference was an Order in Council made in October 1910 promulgating Sea Regulations which came into force at the same date.

These 1910 regulations were identical to the 1897 regulations in all but a few very minor respects. Article 8 was amended to take account of the fact that the special all-round red light for steam pilot vessels had been accepted by foreign maritime powers and so was not restricted to British waters. Notes were added to Article 9 to modify certain provisions in particular areas and a note was added to Article 15 describing a special fog signal used by Dutch pilot vessels. (See appendix II O).

The Titanic disaster of 1912, in which 1,500 lives were lost, gave the impetus for the convening of the first International Conference on the Safety of Life at Sea (Solas) which was held in London early in 1914 on the invitation of the British Government. This Conference was concerned with safety of navigation, design and placing of bulkheads, fire prevention and fire fighting appliances, and life saving appliances including the provision of adequate lifeboats.

The Rules for Preventing Collisions were discussed, but the only changes agreed were of minor importance. These included:-

Article 2 - The second white light to be compulsory for steam ships over 150 feet in length.

Article 10 - A permanent, fixed sternlight to be compulsory.

Article 14 - A special day signal to be compulsory for motor ships.

Article 15 - A special sound signal to be established for use by a vessed being towed.

Article 31 - The international radio-telegraph distress signal to be included.

Had the Conference been delayed for a few months until after the Empress of Ireland collision during May of 1914, with the loss of over 1,000 lives, major changes in the Rules for Preventing Collisions might have been discussed. As things turned out, it did not much matter what was agreed or not agreed. The Conference recommendations, designed broadly to keep ships afloat, were set aside for four years whilst other committees of equally ernest men developed more efficient ways of causing ships to sink. After the 1914-1918 war, some of the recommendations of the Conference were adopted, at least nationally, but not any of the collision rule amendments. The position was not satisfactory and, in 1927, the U.K. Government proposed a second International Conference on the Safety of Life at Sea.

THE 1929 CONFERENCE

The 1929 Convention was the result of this initiative. It dealt in the main with structural factors, life saving and fire fighting requirements, radio installations, ice patrols and routes for the North Atlantic passenger trade. The Regulations for Preventing Collisions at Sea were also revised.

The recommended amendments to the Collision Regulations were later submitted by the U.K. Government to the other Governments which had been parties to the Convention. This resulted in some counter-proposals and international agreement was not reached in the ten years preceding the start of the second world war in 1939.

The Safety of Navigation Committee of the 1929 Conference dealt with such matters as the International Ice Patrol, the provision of navigational aids and the transmission of radio distress, urgency and danger signals in addition to considering the Rules for Preventing Collisions at Sea. Of particular importance was the Committee's recommendation that, after midnight on 30th June 1931, helm and steering orders should be given in the direct sense, i.e. when the ship is going ahead an order containing the word "starboard" or "right" shall only be used when it is intended that the wheel, the rudder blade and the head of the ship, shall all move to the right (see the discussion in appendix IV). This recommendation was adopted and ended a confusing situation in which an order to put the helm (i.e. the ship's tiller) to starboard corresponded to an alteration of course to port so that an unqualified order of "port" or "starboard" could be interpreted either way according to whether it was presumed to apply to the tiller or to the ship's head. To make matters worse, the tiller was often unobservable from the position of the wheel which operated it remotely and the connection between wheel and tiller was not always made in the same sense. Thus on British ships a starboard movement of the wheel caused a port movement of the helm or tiller but on French ships a starboard movement of the wheel at one time caused a starboard movement of the tiller[12]. The rationalization of the situation had been discussed but not resolved in 1914 and was long overdue by 1931. In fact, in the U.K. it did not come into operation until January 1st 1933 under the authority of the Merchant Shipping (Safety and Load Line Conventions) Act of 1932, and the corresponding Article was not formally included in the International Rules for Preventing Collisions until 1954.

The 1929 Conference recommended numerous changes in the Rules for Preventing Collisions at Sea, although none were of a radical character Articles 16-30 which included the important steering and sailing rules dealing with the geometry of collision avoidance were not touched.

The French delegation suggested that a third category of vessel (of mixed propulsion) should be designated between vessels propelled only by machinery and vessels propelled only by sails. This suggestion was not accepted by the Conference.

The Conference agreed that the second white masthead light for steam vessels should be made compulsory for vessels of 150 feet or upwards in length as a result of proposals by the British, French and United States delegations, thus confirming a 1914 Conference recommendation. The Dutch and the Scandinavian Countries had reservations on this recommendation in the case of vessels carrying sails, but these were discounted.

Minor amendments were also agreed, mostly concerning the carriage of lights and shapes, to Articles 1,3,4,7,8,9,10,11,12 and 14.

Article 15 was amended by making provision for an additional fog signal to be sounded in the after part of vessels over 350 feet in length when at anchor, and in providing for distinctive fog signals for vessels being towed and for vessels aground in or near a fairway.

The Conference also recommended that the distress signals contained in Article 31 should be extended to include radio-telegraphy and radio-telephony signals. This recommendation was dealt with as a special case and was incorporated in the Regulations by Order in Council in 1932 (S.R. & O, 1932, No. 945).

No changes were agreed to the remaining articles, although Finland, France and the United States suggested that Article 26 should be more comprehensive. This Article stated that sailing vessels under way should keep out of the way of sailing vessels when fishing. It was unsatisfactory in that no provision was made for encounters between sailing vessels under way and steam vessels when fishing or between steam vessels under way and any vessels when fishing. Guidance for ships in these latter situations was given only by Admiralty Court decisions.

Another unadopted suggestion by the United States was that Article 28 should include a new paragraph as follows: "If when steam vessels are approaching and in sight of each other, either vessel fails to understand the course or intention of the other from any cause, the vessel so in doubt shall immediately signify the same by giving several short and rapid blasts, not less than 4, of the steam whistle." Commander Austin (U.S.) explained that this signal had been used for many years on the inland waters of the United States and had proved of great value.

It was also suggested by the United States that special provisions should be made for seaplanes on the water but this also was not agreed.

THE FATE OF THE 1929 RECOMMENDATIONS

In the event, it was a purely academic point as to whether the Conference accepted any of the amendments or not. As already pointed out, the recommendations of the Conference concerning the Rules for Preventing Collisions were never ratified and never came into force.

The reason for this was, perhaps, that many of the delegates thought that a more comprehensive revision of the Rules for Preventing Collisions was necessary. Thus The Netherlands, Germany, Denmark, Finland, Norway and Sweden suggested that a special international conference should be called to revise the Collision Regulations as a whole. Despite the support for this idea, its implementation had to wait until 1948.

In the meantime, mens' minds were again turned to the destruction of merchant ships and to countermeasures, the most successful of which was simply to produce new ships at a faster rate than that at which they were being destroyed. During this period, however, a method of finding the position of enemy ships or aircraft by radio means was developed and this system, with the acronym Radar, was to prove of great use to merchant shipping in the post-war years. The term "target" to describe a craft whose echo appears on a rader screen is a reminder of the original use for which the system was developed. An unfortunate term perhaps to retain for the context in which merchant ships use radar today.

THE 1948 CONFERENCE

Experience in the second world war held many lessons pertaining to the safety of merchant ships and the U.K. Government acted with commendable speed in convening an International Conference on the Safety of Life at Sea in April to June 1948. The main purpose of the Conference was to produce a new Convention to replace the International Convention for the Safety of Life at Sea, 1929. The Conference also considered it desirable to revise the International Regulations for Preventing Collisions at Sea. These were to replace the existing (1910) Regulations and it was agreed that the revised Regulations should come into force not less than one year after the Government of the U.K. had established that substantial unanimity had been reached as to their acceptance by other Governments.

The Rules for Preventing Collisions were discussed at meetings of the Conference's Safety of Navigation Committee and at a Collision Regulations Sub-Committee.

The U.K. delegates took a strongly conservative line at the Conference, summed up by an early statement from Mr. O'Neill that it was the policy of the U.K. to make as few changes as possible in existing regulations, "remembering always that they were regarded as the gospel of seamen."

The United States delegation, as in previous international conferences, played a leading part in the debates. The highly professional performance of Captain Farwell of the U.S. Coastguard, rates him arguably as the man of the Conference, certainly as far as the work of the Safety of Navigation Committee and the Collision Regulations Sub-Committee was concerned. Much of the interest of the proceedings was provided by his eloquent promotion of the U.S. proposals for changes in the regulations in the face of the entrenched U.K. delegates who saw the proposals generally as "uncalled for, unnecessary and undesirable."

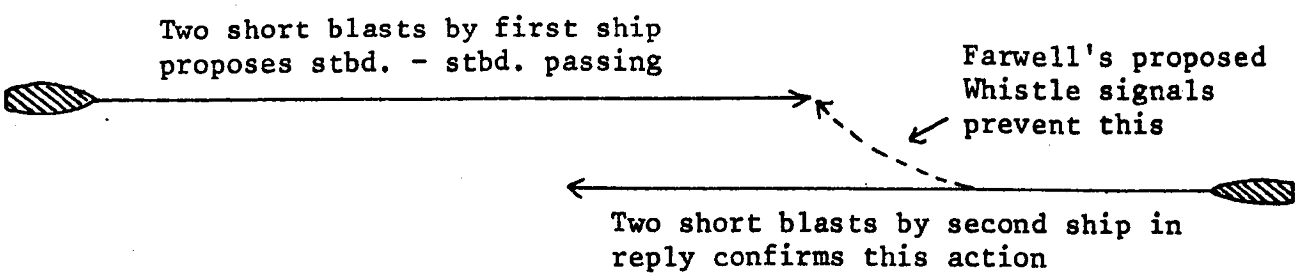
The most important change put forward by Farwell was that whistle signals between power-driven vessels should be revised in two respects.

(1) An exchange of whistle signals should be provided for so that, in any encounter, one vessel could indicate the side on which she intended to pass and the other could acknowledge. This was suggested as a replacement for the unilateral alteration of course signals prescribed in Article 28.

(2) An additional whistle signal consisting of four or more short blasts was proposed as a danger signal to indicate that immediate precaution to avoid collision was required. A throw-back to the 1929 Conference at which a similar proposal was rejected.

Of particular interest was Farwell's point that the exchange of whistle signals to indicate and confirm a starboard to starboard passing would lessen the danger in nearly end-on situations similar to that illustrated below.

Fig. 11



The omission of such signals was serious, he suggested, because, particularly in borderline cases one vessel or the other might suddenly decide to "port her helm and show her red." An interesting reversion by Farwell to the pre-1931 wording for helm orders and a tribute to the indestructibility of Thomas Gray's phraseology.

While dealing with the topic of steam vessels meeting nearly end-on, Farwell touched on the inadequacy of Article 18 in such cases and drew attention to the U.S. proposal for a new rule to replace it. This new rule made a sub-division of "nearly end-on" meetings into three classes.

(i) Meetings in which action to avoid collision was necessary and for which appropriate whistle signals and starboard alterations of course were prescribed.

(ii) Port to port passings for which no alterations of course were necessary but for which whistle signals were prescribed.

(iii) Starboard to starboard passings for which no alterations of course were necessary but for which whistle signals were prescribed.

Captain Coombs (U.K.) proved to be one of the rocks on which Farwell's proposals foundered. He thought that the U.S. suggestions for changes in Article 18 were unnecessary and emphasised the U.K. opposition to making changes in the rules simply for the sake of change. Also he feared that additions to Article 18 would be at the expense of clarity.

In opposing the whistle signals, Coombs adopted the somewhat unkind tactic of quoting extracts from Farwell's own book "The Rules of the Nautical Road," a ploy calculated to make any author's blood run cold. Farwell's objection that it was misleading to make short quotations out of context was countered by Captain Soderman (Finland) who produced some much longer quotations until eventually the Chairman, M. Anduze-Faris (France), humanely called a halt.

The final decision of the Conference was to reject the U.S. proposals for revising Article 18 and for introducing a new system of bilateral whistle signals. A proposal that an amber light should be used as a visual indication of whistle signals was also rejected. The danger signal was accepted in a modified form, (at least five short blasts instead of four), on a permissive basis (rather than the proposed compulsory basis) and with restricted application (permitted only for ships required by the Rules to maintain course and speed instead of for all ships.) A small reward, one might think for all Farwell's efforts but, in practical terms this danger of "shake-up" signal was well worth while for the comfort it provided to the mariners who were subsequently allowed to use it.

Other amendments to the Regulations were of a minor character, such as the substitution of the term "Rule" for the term "Article" and the substitution of the term "power driven vessel" for "steam vessel" throughout. (See appendix II P for text).

RULE AMENDMENTS

Rule 1 replaced the Preliminary and Article 1 of 1910, the main change being the inclusion of seaplanes within the application of the new Regulations. Clauses concerning seaplanes on the water were also appended to other appropriate Rules throughout the text.

Rule 2 was similar to Article 2 of 1910 except that a second white masthead light was made compulsory instead of optional for steam vessels over 150 feet in length. This provision had, of course, been agreed by both the 1914 and 1929 Conferences but its implementation was a long time in maturing. In fact it did not come into operation until 1954, just 40 years after it had first been internationally agreed.

Rules 3 and 4 were in similar terms to the 1910 Rules but Rule 5 which prescribed lights for vessels being towed included a new paragraph describing the lights required for vessels being pushed ahead.

Rules 6,7 and 8 contained only minor amendments compared to the 1910 Regulations.

Rule 9 prescribing lights and shapes for fishing vessels contained some amendments, notably special signals to indicate nets or lines extending more than 500 feet horizontally.

Rule 10 was amended to make the fitting of a fixed stern light compulsory, again repeating an agreement which had previously been reached at both the 1914 and 1929 Conferences.

Rule 11 prescribing lights and shapes for vessels at anchor included the day signals agreed previously in 1929 for vessels at anchor or aground.

Rules 12 and 13 were the subject of minor alterations and Rule 14 prescribed a new day signal for vessels proceeding under sail as well as under mechanical power.

Rule 15, prescribing fog signals, was amended to include the sounding of a gong at the stern of vessels over 350 feet in length; another belated adoption of a 1929 recommendation. Additional signals were also included for vessels at anchor, vessels aground and vessels being towed. New also was an optional signal for fishing vessels described as a blast consisting of a series of alternate notes of higher and lower pitch. This signal was included in sub-section C(ix) and was sponsored at the Conference by the U.K. Delegation who proposed that it should be compulsory. Farwell referred to it disparagingly as a "two-squawk" signal and objected on the grounds that it had not been properly evaluated and that it might warn the fish as well as other ships. It could possibly be alright, he implied for ships catching stupid European cod, but intelligent American salmon might soon learn to avoid ships making the signal. The signal could only be accepted on a compulsory basis, Farwell suggested, if an additional sub-section were added to Rule 15 to the effect that, "No salmon shall be permitted to take advantage of the above signal and alter course to avoid being caught."

The Conference took his point and accepted the signal on a permissive basis only.

Rules 16 to 24 were not significantly altered although the preliminary to the steering and sailing rules was expanded and the note previously attached to Article 21 was incorporated within the new Rule 21.

A new section was added to Rule 25, making provision for power-driven vessels to sound a prolonged whistle blast when approaching a bend in a channel.

Rule 26 was at last amended to make it clear that all vessels not fishing should keep out of the way of any vessels fishing with nets or lines or trawls. The 1910 Article 26 had only dealt with the case of encounters between sailing vessels and sailing vessels when fishing and had given no guidance as to the status of steam or motor fishing vessels.

Rule 27 contained an additional phrase to make it clear that the limitations of craft might render a departure from Rules necessary.

Rule 28 was extended to include the "wake up" signal of not less than five short and rapid blasts on the whistle as well as a proviso that special whistle signals could be used by warships or vessels in convoy.

Rules 29 and 30 were unchanged but Rule 31 was recast to include the radio telegraphy and radio telephony distress signals prescribed by the 1932 Order in Council and the new signal of a red parachute flare.

Finally, a new Rule 32 was included to confirm the 1929 agreement and the 1932 regulation that steering orders should be given in the direct sense.

IMPLEMENTATION

It was agreed that the new Rules for Preventing Collisions at Sea should come into force not less than 12 months after ratification of the Convention by a substantial number of Governments. As a result, the Regulations agreed in 1948 came into force in 1954.

THE ROLE OF RADAR IN COLLISION AVOIDANCE

The 1948 Conference had been very circumspect in making any mention of the use of radar for the prevention of collisions between ships, on the grounds that there was insufficient experience in the use of these equipments. The only pronouncement was the Conference's recommendation 19 stating that the possession of a radio navigational aid in no way relieves a master of a ship from his obligations under the International Regulations and under Rules 15 and 16 in particular.

By 1948, however, public discussion of the use of radar as an aid for the avoidance of collision was already under way particularly in the pages of the

Journal of the Institute of Navigation. This led to a more critical atmosphere generally and eventually the principles of the Collision Regulations as a whole were brought into question.

Captain F.J. Wylie of the Chamber of Shipping's Radio Advisory Service made much of the early running in the discussion of the role of radar information in the avoidance of collisions.

One of the points at issue was whether the Steering and Sailing Rules applied to vessels which were in radar contact only. Wylie pointed out[21,22] that the Rules were specifically stated to apply only when ships were in sight of one another and he suggested that this could only mean in visual sight. In justification, he referred to the fact that identification of ships encountered was essential if the Rules were to be followed. Also that, under the Rules, action by one party could only be taken with confidence on the assumption that the other party would play its correct role and that this was not a reasonable assumption in the case of radar contact only.

Most subsequent thinking appeared to endorse Wylie's interpretation, so that shipmasters, navigating in poor visibility, whether using radar or not, were left with guidance from only a knowledge of the fog signals prescribed in Rule 15 and the Rule 16 instruction to stop engines on hearing a fog signal forward of the beam. In addition they had the assurance from the special circumstances Rules (27 and 29) that, in the event of a collision, whatever action they may have taken would be judged to have been wrong.

Another point on which a ruling was required was whether an operational radar was a "circumstance" which should be considered in interpreting the Rule 16 instruction that vessels should go at a "moderate" speed in restricted visibility. Also as to whether a radar contact was sufficient to "ascertain" the position of another ship within the meaning of the Rule.

In practically every case of collision between two ships in fog, Admiralty Courts have found that immoderate speed on the part of one or both vessels was at least a contributory cause. This led Wylie to suggest[22] that the effect of speed was given too much weight by the Courts and that ships were blamed for immoderate speed when in fact the fundamental cause of the collision was an unwise, though legally permissible, alteration of course. This was, perhaps, a little unfair on the Courts who were concerned with administering the law and not with making it, and who had more time but no more real guidance than the mariner in arriving at decisions as what was correct or incorrect action. Since the only specific rule governing ships' actions in poor visibility was Rule 16, it was almost inevitable that, if blame was to be attached to the navigators, it had to be for an infringement of this Rule. A possible alternative was for Courts to ascribe the collisions to Acts of God and to hold the navigators blameless but such judgements, although popular at one time, became unfashionable in the materialistic 19th Century and unacceptable in the atheistic 20th Century. What the Courts might constructively have done was to have attributed some blame for collisions to inadequacies in the Rules for Preventing Collisions, but perhaps their position as administrative bodies rather than legislative bodies inhibited this course.

More guidance was plainly needed by mariners for the poor visibility situation in which radar contact was made but not visual sighting so that the Steering and Sailing Rules (17-24) did not apply. Collisions occurred between ships which had manoeuvred under such circumstances when, if they had each maintained course and speed, they would have passed clear - the so-called radar assisted collisions. A series of such casualties, culminating in the Andrea-Doria-Stockholm collision in 1956, (see appendix VIII(A)), served notice that the International Rules for Preventing Collisions at Sea would need attention at the next Safety of Life at Sea Conference which was convened in London in 1960.

THE 1960 CONFERENCE

The 1960 International Conference on the Safety of Life at Sea was notable in that it was the first to be held under the auspices of a United Nations body, the Inter-governmental, Maritime, Consultative Organisation (IMCO). Previous conferences had been convened on the initiative of particular governments.

Prior to the Conference, an international working group, with British, French and German representation was set up by the British and French Institutes of Navigation and the Ausschuss für Funkortung, to study the desirability of amending the Collision Regulations to take into account the use of radar.

The Group recommended that an addition should be made to Rule 16 to make it clear that the use of radar should be considered one of the "existing circumstances and conditions" for assessing "moderate speed". It also suggested that guidance was needed on whether the position of a vessel could be "ascertained" within the meaning of Rule 16 by radar information and on how the phrase "navigate with caution" should be interpreted by a vessel using radar.

The Group emphasised that the Steering and Sailing Rules, based as they were on complementary action, could only be applied to vessels in visual sight of one another. For the situation in which radar contact but not visual contact had been made, the Group suggested, that guidance should be provided in a supplement to the Rules. This was to include advice on when and how to use radar as well as recommendations as to suitable manoeuvring action. The French members of the Group submitted a different version of the suggested guide.

The German Federal Republic formally drew the attention of the IMCO Conference to the report of the Working Group, but there were many other proposals for changes in the Rules to be considered and not all to do with radar.

The outcome of the Conference was that numerous amendments were recommended but were mainly of a minor nature designed to clarify rather than to change the character or format of any of the rules. (See appendix II Q for text).

RULE AMENDMENTS

At the suggestion of Denmark, the German Federal Republic and the Netherlands, supported by France and the USSR, the revised Regulations were split into six parts A,B,C,D,E and F instead of the four parts as previously, on the grounds that this was a more logical division. The numbering of rules relating to particular subject matter was not affected by this change.

A Belgian, German and USSR suggestion that Rule 1 should be amended to allow lights to be exhibited in daytime during conditions of restricted visibility was adopted. Also a new definition of the term "in sight of one another" was included in Rule 1 by general agreement so that it applied only when one ship could be observed visually from the other and the case of radar contact only was specifically excluded.

The USSR proposal that the requirement to show a second white masthead light as prescribed in Rule 2 should also be applied to towing vessels exceeding 150 feet in length was adopted but a proposal by the US delegation that the second white light should also be required for vessels of less than 150 feet was rejected.

Denmark, the Netherlands and Norway all suggested that Rule 3 should prescribe a day signal consisting of a black cylindrical shape to indicate long tows and, as a result, the Conference somewhat contrarily recommended a black diamond shape for this purpose.

The Belgian delegation suggested that Rule 5 should include an additional, optional signal for sailing vessels to be more conspicuous than their sidelights. The proposal was for a red light over a green light to be carried at the foremast and, despite some opposition, it was adopted.

Only minor amendments were made to Rules 6,7 and 8, but Rule 9, prescribing lights and shapes for fishing vessels, was altered significantly. The most important changes were that vessels trawling were required to show green over white masthead lights in addition to normal sidelights, and vessels fishing with long nets and thus having less manoeuvrability were required to show red over white masthead lights. These lights were more efficient and simpler than the previous lights. The Conference's recommendations arose from a general dissatisfaction by many delegations with the previous provisions for fishing vessels and were developed by a Working Party under the chairmanship of Captain H. Topley from specific US proposals. The change in the lights required for trawlers was an interesting example of the Rules being amended to legalize an existing practice. In this case American trawler skippers had found that the old tri-coloured lantern, prescribed since 1885, did not give a sufficiently accurate indication of a vessel's heading and so they had used normal sidelights in addition, evidently considering that the increase in safety was worth contravening the Regulations for.

Proposals for Rules 10-15 included only minor amendments, but the new Rule 16, agreed by the Conference, contained an important additional paragraph laying down that a power driven vessel, detecting the presence of another vessel forward of the beam before hearing her fog signal or sighting her visually could take early and substantial action to avoid a close quarters situation but, if this could not be avoided, she should stop her engines in time to avoid collision and then navigate with caution. The UK delegation had opposed any changes to Rule 16 on the grounds that it, together with Rules 15 and 29, was admirable in its brevity and clarity and, if strictly obeyed, adequate to prevent collisions. They pointed out that all the collisions which had occurred to radar fitted ships, which had been investigated in the UK, were due to flagrant breach of the existing rules, suggesting that it was navigators who needed proper training rather than the Rules which needed changing.

There was, however, a strong body of opinion in favour of the requirement in the new Rule 16 to stop engines etc. if a ship was detected by radar at close range forward of the beam. The provision that ships should be permitted to take "substantial action" at long range was more controversial but was proposed by the Netherlands, Norway and Sweden and agreed by the Conference. The USSR went even further and suggested the inclusion within Rule 16 of a convention for such long range manoeuvres; this being that they should be made so as to result in the diminishing of the bearing from one vessel to the other. This was advanced thinking and was not accepted.

There was general support for a new sentence to be added to the Preliminary to the Steering and Sailing Rules to make it clear that they only applied to vessels in visual sight of one another.

It was proposed by Belgium and the UK that Rule 17, dealing with encounters between sailing vessels, should be simplified to conform with the International Yacht Racing Rules. The proposal was not greatly different in principle from the old Rule 17 and stated that when each of two vessels had the wind on different sides the vessel with the wind on the port side should keep out of the way of the other, and that when each vessel had the wind on the same side the vessel to windward should keep out of the way of the vessel to leeward. The new Rule was more appropriate for the fore and aft rigged sailing craft which had replaced square rigged ships as the majority form. It included a paragraph defining the windward side as the side opposite to that on which the mainsail is carried. This definition was necessary for the proper interpretation of the Rule but a defect was that there was no means of ascertaining which side another vessel was carrying her mainsail at night. The basic difficulty was that a vessel's navigation lights were designed to give information regarding one frame of reference (the direction of the vessel's head relative to an observer) but the Rule was based on another frame of reference (the direction of the vessel's head relative to the wind).

The substance of Rules 18 and 19 was not altered, but the Belgian delegation's suggestion for an addition to Rule 20 was adopted. This was to the effect that the Rule, which required that power driven vessels should give way to sailing vessels, should not give to a sailing vessel the right to hamper in a narrow channel, the safe passage of a power driven vessel which could only navigate within the channel. In order to be consistent, it was necessary also to provide that small power driven vessels should not impede the safe passage of vessels which could only navigate within a narrow channel, and the Conference agreed that an additional paragraph should be added to Rule 25 for this purpose.

Rule 21 was not altered, but an additional phrase was added to Rule 22 to emphasize the importance of early action.

Rule 24 also was not changed, nor Rule 27, but Rule 26 was given an explanatory clause to make it clear that vessels not under command or engaged in underwater operations, etc. should not be expected to keep out of the way of fishermen.

At the suggestion of the United States' delegation, with support from West Germany, the Netherlands and Sweden, an addition to Rule 28 was adopted. This was to permit a whistle-synchronized light to be fitted so that a visible indication of whistle signals was available to supplement the sound. The same proposal as had been made at the 1948 Conference except that a white light was specified instead of an amber one. The UK delegation still did not much like the idea.

Rules 29 and 30 were unaltered, but some amendments were made to the Distress Signals prescribed in Rule 31.

Rule 32, prescribing the sense in which helm orders should be given, was quietly dropped as having served its purpose during its short life.

SPECIAL CONSIDERATION OF THE USE OF RADAR

Finally, the Conference considered the question of providing advice to mariners on the use of radar. The UK delegation suggested that guidance on the proper use of radar in complying with the Collision Regulations should be published separately from the Regulations. The Conference preferred that such guidance should be included as an annex to the Regulations and appointed its own working group under Captain Wylie to prepare a draft. The UK proposals, together with the International Working Group's report formed the basis on which the final annex was agreed. It was not thought appropriate to include advice on the technical operation of radar but a moving last minute plea by the US delegate for the safety of Grand Banks fishermen, led to the inclusion of an additional clause to the effect that "small vessels, small icebergs and similar floating objects may not be detected by radar."

As might have been expected, the recommendations of the annex were generally somewhat vague and diffuse. They included a warning that assumptions made on scanty information should be avoided. It was pointed out that radar information was one of the factors to be taken into account when determining "moderate speed" and that radar indications of other vessels in the vicinity might mean that it should be slower than a mariner without radar might consider moderate but, rather coyly, no mention was made as to how an absence of echoes might be construed except for the oblique warning concerning small vessels, small icebergs, etc. already noted.

It was stated that, when navigating in restricted visibility, the radar range and bearing alone do not constitute ascertainment of the position of the other vessel under Rule 16(b), but the question of whether a succession of plotted radar observations would constitute such an ascertainment was carefully avoided.

Appropriate action to avoid a close quarters situation was discussed but no specific convention or manoeuvring guidance was given. It was recommended that alterations of course and/or speed should be substantial and a very hesitant suggestion was made that, particularly when vessels are approaching on opposite or nearly opposite courses, an alteration of course to starboard is generally preferable to an alteration to port. A very watered down version, perhaps, of the USSR proposal that manoeuvres should be such as to cause a decrease in bearing. (See appendix II Q for the full text of the annex).

IMPLEMENTATION

The 1960 Regulations were ratified by a sufficient number of governments and came into operation on 1st September 1965. They included no radical changes to the rules pertaining to collision avoidance manoeuvres but pressure for such changes was building up.

SOME RADICAL CRITICISMS OF THE COLLISION REGULATIONS

In 1955, Rear Admiral Gauw of the Royal Netherlands Navy had suggested[23] that new rules were needed to take account of the use of radar and to replace outdated rules with a simpler system. He had been particularly critical of Rule 21 (which required that a stand-on vessel should maintain course and speed right up to the last moment and was then required to take some unspecified action) on the grounds that it had resulted in unpredictable action at the last minute and consequent collisions. He had also suggested that modern sailing vessels were usually small and handy and well able to play their part in avoiding collision with power driven vessels.

His suggestion was for a new rule for universal use, thus: "When two vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall cross astern of the other, whereas the vessel which has the other on her port side shall cross ahead of the other." He conceded that a secondary rule would be needed to the effect that fishing vessels, vessels not under command, etc. should maintain course and speed.

Gauw's system had virtues and shortcomings which are discussed in more detail in the next chapter (p. 93). At the time of publication, his suggestions, which were both original and constructive, did not appear to arouse the interest that they deserved. They were not even mentioned at an international conference on the avoidance of collision, sponsored by the UK, the French and the German Institutes of Navigation in 1957.

At the 1957 Conference, the Technical Secretary of the French Institute of Navigation, P. Hugon, proposed[24] a number of recommendations and instructions relating to the use of radar in fog. These, he suggested, were necessary because the existing regulations could not be readily applied to ships using radar only. The discussion papers which followed, particularly those by Captain Harries of the German Ministry of Transport and Captain Swallow of the UK Radio Advisory Service, served vividly to illustrate the difficulty of achieving international agreement on proposals that are basically matters of opinion rather than matters of fact.

A paper at the Conference which provoked less discussion, perhaps because it did deal with matters of fact, was "The Mathematics of Collision Avoidance at Sea",[25] by D.H. Sadler. His analysis of what he called "collision geometry" was a first necessary step towards a treatment of the collision avoidance problem as a unified whole instead of a fragmented study of a number of different and arbitrarily defined types of encounter. As a non-mariner, Sadler discreetly drew no conclusions as to how the results of his analysis should be used in practice.

CONTROVERSIAL SUGGESTIONS FOR COLLISION AVOIDANCE

Less reticent in this respect was E.S. Calvert who, in 1960, proposed[26] a system of collision avoidance manoeuvres for ships. His suggestions were developed from research which had been carried out at the Royal Aircraft Establishment into the avoidance of collision between aircraft, some details of which he had presented in a paper in 1958[27]. Calvert followed Sadler in suggesting that both parties to an encounter should take action, but his important contribution was in defining a simple and easily established frame of reference within which complementary manoeuvres could be carried out. This frame of reference was the sightline between the two ships and Calvert proposed that each ship should normally manoeuvre so that its own action would cause an anti-clockwise rotation of the sightline. He further devised a simple diagram summarizing the manoeuvres which would cause the required rotation, the manoeuvres depending only upon the bearing of the threat. A more detailed analysis of Calverts' suggestions is included in Chapter III, but at this point it is worth noting that similar conclusions had been arrived at as a result of independent research work in the USSR and were reported in Morskoi Flot No. 5 of 1958.

At the time of publication, a most surprising result of Calverts' ideas was the suspicion and indignation with which they were received. One of the virtues of Calverts' system was that a vessel could manoeuvre without a knowledge of the heading of the other craft in the encounter but mariners (except those old enough to have experienced the pre 1863 rules) had all their lives been used to rules which were based on such a knowledge and looked upon its redundancy as a condemnation of the system.

There was widespread comment on Calverts' suggestions, most contributors reacting with circumspect antagonism. Often there was the implication that mathematicians should keep their place and not dabble in semi-mystical matters which could only be resolved by the application of such nebulous factors as the seaman's eye, the mariner's distilled experience, the navigator's sixth sense, etc. etc. This implication was inaccurate in that Calvert was a human factors engineer and not a mathematician, and unworthy in that it obscured the issue instead of attempting to resolve it rationally.

Captain F.J. Wylie was particularly severe in his criticism of Calvert's paper and he mounted an attack[28] on such a broad front that it tended to irrelevance at the edges. His important comments were that:

1. Calvert's manoeuvres would be dangerous in encounters between more than two ships.
2. That they would be ineffective when changes of course and speed were made other than for collision avoidance purposes.
3. That the requirement to increase speed in certain cases could be "unnerving".

The first two of these comments could equally well have been levelled at the rules then (and now) current, but the third was, uncharacteristically, understated in that many ships carry no reserve of speed so that an increase is often not merely unnerving but actually impossible.

Calvert's reaction to his critics was energetic and incisive[29] and makes excellent reading. In Wylie's case he accused him of laying down rigid criteria which only the existing rules could meet and using these as a standard for assessing other systems. In Calvert's view, such a procedure was quite useless: "One might as well lay down criteria for the laws of motion, or pass a law to make π equal to 3".

Meanwhile Dr. S.H. Hollingdale, a mathematician and a colleague of Calvert, had published a paper[30] showing that Calvert's system of manoeuvres was mathematically consistent, and further that it was the only system which met the requirement that manoeuvres should depend only upon the bearing of the threat.

Fortified with this support, Calvert returned to the offensive in 1961[31]. In this paper he compared his proposals with the existing regulations for preventing collisions. The latter he thought suffered from idiomatic rather than scientific wording, from the absence of effective rules covering the use of radar, and from an arbitrary division between crossing and overtaking encounters. He also suggested that the general requirement that only one of two vessels was to manoeuvre meant that complicated exceptions (hierarchical secondary rules) had to be made which distinguished between classes of traffic.

Calvert's knack of arousing controversy was again demonstrated by the response to his paper from many directions but again with Wylie in the vanguard.

Certainly Wylie was as unconverted by Calvert's second paper as he had been by the first. In a superbly unanswerable paragraph[32] he suggested that the conflict between "certain mathematicians and certain mariners" was philosophic rather than mathematical and that "Although it would never be suggested that the mathematical system is anything but flawless in isolation, there are grave doubts that it would work, even on a planet composed solely of deep water and supporting ships staffed by mathematicians, having collision avoidance as their single preoccupation."

At this stage it is fascinating to compare the Calvert-Wylie confrontation with the Colomb-Gray confrontation a hundred years earlier, one notable difference being that in the earlier case the seaman took the role of the radical and the landsman the role of the conservative but that these roles were reversed in the later case. To underline the comparison, the Ghost of Thomas Gray was invoked in support of Wylie by Captain Wynne-Edwards[33] who thought that the mathematics of collision avoidance was extremely simple (unlike Sadler who thought it could lead to some surprisingly complicated geometry). To justify his contention, Wynne-Edwards quoted some of Thomas

Gray's verse (without recognising the authorship), the point being to show that the essence of the existing rules could be condensed to a few simple phrases.

Undaunted by this further hail of criticism, Calvert merely commented[34] that, many mariners were subject to "confused thinking which resulted from the weasel wording of the existing regulations". He further suggested that Wylie's attempt to bring philosophy into the discussion was "to return to the attitudes of the middle ages and to obscure technical issues which are perfectly clear and simple".

Wylie reacted by noting that Calvert's mathematical treatment of "imponderables" was incomplete and that he could not therefore afford to dismiss philosophy. He followed this with the oblique comment that the place of mathematics had been described by Sadler "with authority, diplomacy and obvious understanding", the clear inference being that some other party to the discussion was deficient in just those qualities.

From this point onwards, both Calvert and Wylie continued to contribute to the discussion of collision avoidance but each tended thereafter, in print at any rate, to maintain his own position and to ignore the work of the other. The debate became more restrained and perhaps more rational, but certainly much duller as a consequence.

Two examples may be given to show the strength of the feelings aroused by Calvert's work. The first was an incredible attempt to put pressure on him professionally to mind his own business. The second was an attack on him, which might well have been actionable, in a letter in the Daily Telegraph. The writer subsequently refused to retract on the splendid grounds that, like Shaw's Sergius Saranoff, he never apologised. He did, however, undertake never again to publish any views on the subject of collision avoidance at sea.

Meanwhile, some thought-provoking contributions to the discussion had come from Dr. J.S. Morrel[35,36]. Morrel's contention was that the Calvert-Wylie controversy was irrelevant in that the main requirement for improved safety was better information for the reliable and timely prediction of collision risk. Morrel suggested that, in essence, Calvert's remedy was better rules, Wylie's remedy was better mariners and his own remedy was better data. To intercede here, the author's opinion is that, since these remedies are not exclusive it is likely to be more fruitful to try to implement all three rather than to argue about their respective merits.

Subsequently, Hollingdale added substance to Morrel's points with a mathematical analysis of the effects of observational errors[37]. An important practical conclusion was that, in a potential collision encounter, a working rule is to spend half the "time to go" on observation and half on manoeuvre.

AN ORIGINAL COLLISION AVOIDANCE SYSTEM

At about the same time, Captain J. Garcia-Frias of the Spanish Navy began to plough a lone furrow of his own. His suggestion[38] was that, in a collision situation, each ship should alter course to put the other in a prescribed relative bearing sector. He evolved one rule for ships taking co-operative action and another rule for the radar situation in which one ship in an encounter might be unaware of the presence of the other. He followed this by showing that the two rules were compatible. One important principle was that non-radar ships should always operate at a slower speed (say less than 6 knots) than ships using radar (say more than 6 knots). Garcia-Frias' system thus had the unique merit that it took account of the advantage that a faster ship enjoys over a slower ship in taking action to avoid collision. In its own way, his system was as controversial as Calvert's but it failed to arouse the same level of interest. This was perhaps because, although Garcia-Frias' concept was basically simple, his arguments were difficult to assimilate and to understand, and not many people were prepared to make the effort.

The comparison is interesting. The deceptive simplicity of Calvert's arguments evoked responses from many directions, often from people who did not fully appreciate the underlying principles. The deceptive complexity of Garcia-Frias' arguments on the other hand seemed to deter comment almost completely. One should also perhaps note that the reaction to Calvert was that of a profession to an outsider's suggestion of a simple solution to a long-standing and apparently intractible problem. It was much more comforting to hear from a member of the profession, Garcia-Frias, that the solution was apparently hideously complex. Every profession has its pride.

After 1959, Garcia Frias produced a series of papers refining his collision avoidance system. Despite his originality of thought, or perhaps because of it, his ideas never seem to have been taken seriously as a basis for a practical system of rules. The mechanics of his proposals are discussed in more detail in the next chapter.

MORE CONTRIBUTIONS TO THE COLLISION AVOIDANCE DISCUSSION

In 1964, the author suggested some specific amendments to the rules for preventing collisions at sea based on an independent analysis of the problem but having some common ground with Gauw and Calvert. The original feature of these suggestions was that co-operative action by the two parties to an encounter should be permitted but not required, thus avoiding a number of operational difficulties which arise if co-operative action is made a requirement. The volume of critical comment was rewarding, but the variety again showed the difficulty of obtaining international agreement on regulation changes other than in terms of broad generalities.

Subsequently, suggestions for amending the regulations were made by P. Clissold[40], W. Burger and A.G. Corbet[41], D. Bunn[42], P.A. Thompson[43], A.N. Cockcroft[44] and others. Important work was also carried out in the USSR. This was summarised by Captain I. Buchanovski in 1967[45] and the development of an anti-collision indicator was described by O. Mitrofanov the following year[46].

Meanwhile, in the USA, the main effort to reduce the incidence of collisions was directed towards improving equipment and methods of processing and presenting information rather than towards changing rules. Papers by J.D. Luse[47], T.D. Mara[48], R.F. Riggs[49], A. Manara[50], A.E. Fiore, R.E. Anderson and L.J. Kapanka[51] and by K.H. Chase and B.V. Tiblin[52], typified this approach; an important one but not directly relevant to this thesis.

By 1968, preliminary work had already started in preparation for a Safety of Life at Sea Conference to discuss, amongst other things, the Collision Regulations. This Conference was to be held in London under the auspices of the Intergovernmental Maritime Consultative Organization (IMCO). It therefore became important to try to find if some consensus of opinion could be established from amongst the many varied proposals for revising the regulations and the UK Institute of Navigation set up a working party, with international representation, for this purpose. The working party found it impossible to agree on detailed recommendations but a majority did agree certain matters of principle on which new rules should be based. Perhaps most important in the working party report[53] was the clear opinion that changes in the Collision regulations were necessary and an indication of the areas which needed particular attention.

ROUTEING SCHEMES FOR REDUCING ENCOUNTER RATES

During the period from 1960 onwards, an offshoot from the discussion of the collision regulations was a number of suggestions for the segregation of marine traffic moving in opposite directions. This resulted from the unsatisfactory nature of the rule for ships meeting nearly end-on and, to circumvent this, the routeing of ships to reduce the frequency of such encounters has obvious attractions.

Routeing for anti-collision purposes had been in successful operation in the Great Lakes for many years and some suggestions for traffic separation schemes in international waters had been put forward by G.C. Forrest[54] and Garcia Frias[55]. However the real impulse which triggered off widespread discussion of routeing schemes came from associated papers by Captain J. Poll who was chief of the Nautical Service in Antwerp and Capitaine de Fregate L. Oudet of the French Hydrographic Service. These papers were first published separately but were subsequently presented together at a meeting of the UK Institute of Navigation in 1960[56].

The subsequent progress of routeing schemes was rapid, the early ideas being fostered by the Institutes of Navigation and the responsibility for practical development and implementation being later taken over by IMCO. A recommended routeing scheme was established for the Dover Strait in June 1967 and schemes for other areas followed.

THE 1972 IMCO CONFERENCE

In October 1972, an IMCO Conference on the Safety of Life at Sea met in London and considered, amongst other topics, a revision of the International Rules for Preventing Collisions at Sea. The Rules had last been revised in 1964, but the changes then were relatively minor and there had been no major amendments since 1897. It was a surprise therefore to see the extent of the changes recommended by the 1972 Conference. These included changes in arrangement, changes in principle and changes in the wording of the rules. The text of the 1972 rules is contained in appendix II R.

CHANGES IN ARRANGEMENT

The revision of the format of the rules is the most obvious and probably the least important of the changes. In some cases it is simply the numbering of the rules which is changed and in other cases the content of the rules has been redistributed. Thus the content of the 1960 annex on the use of radar is incorporated within a number of rules in the body of the new regulations.

The new rules are arranged in four parts, lettered A to D, comprising a reshuffling and renumbering of the contents of the old rules into a more logical sequence.

Part A contains three rules of a general character. These deal with the application of the rules, general definitions and a statement on responsibility which includes the contents of the old rules 27 and 29.

Part B comprises 16 steering and sailing rules in three sections these being

(i) For any conditions of visibility.

(ii) For vessels in sight of one another.

(iii) For conditions of restricted visibility.

Part C contains 12 rules concerning identification lights and shapes to be carried by vessels of differing classes.

Part D consists of six rules prescribing light and sound signals for use when manoeuvring, when in restricted visibility and when in distress.

A final rule in part E allows the exemption of existing ships from certain of the new specifications for lights and for sound signal appliances.

Attached to the new rules is a series of annexes, numbered I to IV. These include technical details of lights and sound signals, some of which were previously contained within the body of the 1960 rules.

CHANGES IN PRINCIPLE

Within the new format of the 1972 rules, most of the principles of the 1960 rules have been preserved, but there are a number of new principles which are worthy of note.

A new rule 9 is concerned with navigation in narrow channels and provides that a vessel shall not cross a narrow channel or fairway if such crossing impedes the passage of a vessel which can safely navigate only within the channel or fairway. By this rule, large vessels proceeding along the course of a channel are given precedence over vessels crossing from either side.

A new rule 10 deals with the conduct of vessels in relation to traffic separation schemes. The ten sub-sections of this rule vary from those which are so innocuous that they might well be omitted, through those that are contentious in that they are based on untested principles, to those that seem so restrictive as to be unworkable.

An example of the first class is sub-section (f) which states that "A vessel navigating in areas near the termination of traffic separation schemes shall do so with particular caution", presumably implying that, in other areas mariners do not need to be particularly cautious.

An example of the second class is the requirement that vessels crossing traffic lanes should do so at right-angles; a procedure which may or may not be better than the merge and diverge method of crossing lanes.

An example of the third class is the requirement that sailing vessels shall not impede the safe passage of power driven vessels following a traffic lane. In light winds, sailing vessels making less than six knots or so can hardly avoid being obstacles to ships proceeding at 20 knots, and so, if complying strictly with the rules, might be precluded from crossing the Dover Strait at all.

A new rule 12 for sailing vessels meeting is similar to the 1960 rule 17 except that it contains an additional paragraph to deal with the situation where one vessel is not always able to decide whether the other vessel has the wind on the port side or the starboard side.

A new rule 17 prescribes that, where one of two vessels is to keep out of the way, the other shall keep her course and speed, and also prescribes last minute action in similar terms to the 1960 rule 21. An innovation is that the new rule allows permissive action, other than an alteration of course to port, by the stand-on vessel "as soon as it becomes apparent to her that the vessel required to keep out of the way is not taking appropriate action."

This is a controversial innovation. It may be thought of as a step forward towards a more rational set of rules based on complementary manoeuvres by the two parties to an encounter, or it may be thought of as a retrograde step; the first move in a reversion to the old larboard helm rule of the mid-19th century which required both parties to an encounter to alter course to starboard irrespective of the exact geometry of the situation. It is of interest to follow some of the arguments which led to the acceptance of this new principle.

Much preliminary work was done at sub-committee and working party level prior to the October 1972 IMCO Conference. In March 1969, a Safety of Navigation

Sub-Committee under Captain F. Sohnke gave general consideration to revision of the collision regulations. It was agreed that later meetings should discuss, inter alia, the "fundamental issues" of

(a) Action in clear weather and action in reduced visibility.

(b) If, and in what circumstances, action would be required by both vessels.

(c) The concept of hampered vessels.

With reference to the sub-committees findings, the Royal Netherlands Shipowners Association produced a paper which included, in respect of item (b), a discussion of the possibility of adopting a set of rules based on anti-clockwise rotation of the sightline. The reasoning and the final suggestion for rules for crossing vessels followed closely the 1965 paper by Kemp[39]. The key rules suggested were:-

19a When two power driven vessels are crossing, so as to involve a risk of collision, the vessel which has the other on her own starboard side shall keep out of the way of the other, and shall, if the circumstances of the case admit, avoid crossing ahead of the other.

19b If, however, by any of these rules, the vessel which has the other on her own portside has to give way she then shall, if the circumstances of the case admit, avoid crossing astern of the other.

An Independent but strikingly similar discussion was contained in a submission by the Government of the USSR (Nav IX/2/8) to the Safety of Navigation Sub-Committee in April 1970. The note comprised a particularly clear and authoritative discussion of the collision avoidance problem and the full text is included for reference as appendix VI.

The note pointed out that, for power driven vessels crossing; "the provision of rule 21 requiring a vessel which is given the right of way to keep her course and speed until collision cannot be avoided by the action of the giving way vessel alone, is too rigid. Over recent years this provision became apparently unsuitable because of broadening the range of speeds used at sea; in case of vessels with greatly different speeds it is difficult for the slower craft to keep out of the way of the fast one." The possibility of requiring both ships to manoeuvre so as to rotate the bearing anti-clockwise was also rejected. It was felt to be unsatisfactory in the case of a threat approaching from a port relative bearing "since in poor visibility the manoeuvre proposed is in conflict with such a usual action as reduction of speed. For conditions of clear weather the proposed manoeuvre is also unsuitable in cases where a vessel should keep out of the way of a hampered vessel which is seen ahead the port beam, since both a reduction in speed and an alteration to port in order to pass by the stern lead to an increase of bearing, i.e. the proposed principle is broken."

Having rejected the principle of assigning responsibility for collision avoidance to both parties to an encounter, the USSR paper suggested that, in crossing encounters, responsibility for giving way should continue to be assigned to one vessel but that the other should be permitted to take early action. The paper further suggested that the permissive action should be limited to alterations of course to starboard, a proposal that was compatible with but more restrictive than the Netherlands suggestion.

On the basis of these, and other submissions along similar lines, rules were developed so that the vessel which was not given the prime responsibility for avoiding collision was permitted to take certain avoiding action. The wording took the form of forbidding such a vessel to alter course to port rather than forbidding it to cross astern of the other vessel or requiring it to alter course to starboard, but the sense was much the same. The text of the key rules passed through several drafts at sub-committee stage before the final form was adopted at the October 1972 Conference. These final rules for power driven vessels crossing were:-

(15) When two power-driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way and shall, if the circumstances of the case admit, avoid crossing ahead of the other vessel.

(17)(a)(i) Where by any of these rules, one of two vessels is to keep out of the way, the other shall keep her course and speed.

(ii) The latter vessel may however take action to avoid collision by her manoeuvre alone, as soon as it becomes apparent to her that the vessel required to keep out of the way is not taking appropriate action in compliance with these rules.

(b) When, from any cause, the vessel required to keep her course and speed finds herself so close that collision cannot be avoided by the action of the giving-way vessel alone, she shall take such action as will best aid to avoid collision.

(c) A power-driven vessel which takes action in a crossing situation in accordance with sub-paragraph (a)(ii) of this rule to avoid collision with another power driven vessel shall, if the circumstances of the case admit, not alter course to port for a vessel on her own port side.

(d) This rule does not relieve the give-way vessel of her obligation to keep out of the way.

The increased freedom of action given to a "stand-on" vessel by the new rule 17 section (a)(ii) is likely to be welcomed by most mariners. It is a pity that the action should be made dependent upon such imprecise phrases as "becomes apparent" and "appropriate action".

Other changes of principle are contained in a new rule 18 which lays down a hierarchy of manoeuvrability and responsibility for different classes of vessel including power-driven vessels, sailing vessels, fishing vessels, vessels constrained by their draught, vessels not under command, etc. This rule emphasises the need for identifying another vessel before taking action to avoid collision with it. Such identification is purely an eyeball exercise so that, for better or worse, rules of this sort preclude any complete automation of the collision avoidance process. This view is confirmed by a new rule 5 which states that "every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing conditions ..." Whatever technological advances are made, ships will not be able to operate with unmanned bridges whilst rules of this type are in existence.

An additional change of principle in rule 18 is that it is no longer necessary for vessels taking action under this rule to avoid crossing ahead of the other vessel.

New rule 19 deals with the conduct of vessels in restricted visibility and includes some of the material from the 1960 rule 16 and annex. The preference for starboard rather than port alterations of course is retained and it is recommended that alterations of course should not be made towards a vessel which is abaft the beam. The requirement to stop engines when hearing a fog signal forward of the beam is amended to a requirement to reduce speed to bare steerage way. Overall there is a small but welcome improvement in the precision of the manoeuvring rules for the conduct of vessels in restricted visibility.

CHANGES IN LIGHTS AND SIGNALS

A general change in the rules concerning lights and shapes is that the ranges of lights have been increased as far as practicable. In addition there are some minor changes such as the change in the characteristic of the optional red-over-green lights for sailing vessels to all round lights, the specification of a special towing light and the prescription of signals for vessels constrained by their draught. The requirements for the lighting of small vessels have also been amended.

New rule 34 includes the content of the 1960 rule 28 concerning sound signals for indicating manoeuvres. In addition it prescribes flashing light signals which may be used to supplement the whistle signals so that one flash shall indicate an alteration of course to starboard, two flashes an alteration of course to port and three flashes an astern movement. These signals differ from the 1960 signals, which were synchronised with the whistle, in that they may be repeated as appropriate, independently of the whistle, whilst the manoeuvre is being carried out. The new signals seem simple, sensible and long overdue and could well be the most significant of all the 1972 changes in contributing to safety at sea. The rule might still be usefully extended so that the signals could also be made by daylight signalling lamp. They might then be directed more effectively at a particular ship.

Another innovation in the new rule 34 is the provision of "intent" and "consent" whistle signals for vessels overtaking and being overtaken respectively in narrow channels. This may be considered as the belated acceptance of a principle put forward by Farwell at the 1948 Conference, but even the 1972 Conference would not accept the principle for use in open waters.

Annex I contains technical specifications of lights and shapes, the principle changes being in the rounding off of distances from feet to metre equivalents and in the more precise specification of lights. Annex II prescribes signals for certain specialised fishing vessels and annex III gives technical details of sound signal appliances with much greater precision than the 1960 rules. Annex IV describes signals to be used by vessels in distress and replaces rule 31 of 1960.

CHANGES IN WORDING

In many sections of the 1972 rules, the wording of the 1960 rules has been retained but in other sections changes of wording have been made with apparently no intention of changing the meaning.

An example is that the term "moderate speed" has been replaced by the term "safe speed" and that more guidance has been provided as to how this should be interpreted. The argument against attempting to define this term too exactly was put succinctly by Hall at the Washington Conference in 1889, when he pointed out that the meaning of "moderate speed" was perfectly well known to every sailor and that any attempt at precising it might afford an excuse for evading it. Apart from the desirability or otherwise of defining the term, the word "safe" in itself seems inappropriate and even nonsensical in that it is an absolute term whereas safety at sea can only be relative. Certainly there is no such thing as a safe speed in the English Channel on a foggy night, which implies that every shipmaster in the area would be breaking the new rule. To be stopped in such a situation is clearly not safe and whilst there may be speeds which are safer than this, there are none for which the unqualified adjective "safe" would be appropriate.

This is not simply a question of the niceties of language. From the navigators' point of view it is possible to make an acceptable estimate of "moderate speed" depending upon the prevailing conditions when entering a region of poor visibility, but it seems that an interpretation of whether a speed is "safe" can only be made after leaving the region of poor visibility. If there was no collision, it was a safe speed; if there was a collision, it was manifestly unsafe. If Courts should put this sort of interpretation on the word "safe" then mariners will stand automatically condemned for having proceeded at an unsafe speed whenever their ships have been in collision, even though their speeds might well at the time have been moderate.

Much of the new wording in the 1972 rules can be similarly questioned so that there will be doubt as to the exact meaning of certain phrases until they have been clarified by court decisions. Case law which has been built up for over a century in respect of the old wording will no longer apply. The term "moderate speed" has been with us for well over 100 years and its meaning has been the subject of many Court rulings during that period. Similarly the wording of the rule for power driven vessels meeting has been virtually unchanged since 1868 and the 1972 substitution of "reciprocal or nearly reciprocal courses" for the phrase "end-on or nearly end-on" would seem to have been made merely for the sake of change. The unqualified word "course" is itself so imprecise and ambiguous that air navigators long ago and very properly made it redundant, and there are many more examples of apparently unnecessary changes in wording. These will require fresh interpretation, thus making out of Court settlements of collision cases more difficult to arrive at.

A separate, but not unimportant issue associated with changes in the wording of the 1972 rules is the frequent sloppy use of the English language, in the first draft at least. It remains to be seen how far this can be rectified in respect of a document on which formal agreement has been reached.

Overall there is a considerable increase in verbiage in the new rules (by about 33%) as compared to the 1960 rules and the impression is of much more in the way of explanation, cautionary phrases and advice, but little more of real help to the navigator.

APPRAISAL OF THE 1972 RULES

At every international conference held to discuss the collision regulations, at least one of the delegations has made a plea for simplification and yet every conference has, in the end, consistently agreed to make the rules more complicated. The new rules are daunting in the sheer mass of words that they contain. It will be a time consuming task for lawyers to interpret them and the mariner, who may sometimes have to make a very rapid and impromptu interpretation, is in an unenviable position. Much of the additional wording, as for instance the long discussion as to what should constitute a "safe speed", is so diffuse as to be almost meaningless and merely obscures the hard core of real rules which could and should be presented more concisely.

In summary, it seems to the author that the new rules contain a few important and very desirable changes in principle but that these are quite unnecessarily paid for by comprehensive but unimportant changes in format, by undesirable changes of wording and by an unfortunate increase in complexity. The 1972 rules have yet to be ratified.

CONCLUSIONS

The International Regulations for Preventing Collisions at Sea have grown up over many years and are based on contributions from many sources. This history has resulted in a set of disconnected and unco-ordinated rules. The 1972 Conference made an attempt to bring uniformity to the previously disorganised wording of the rules and a logical order to the previously haphazard sequence of the rules. The penalties incurred have been mentioned and would hardly seem justified in the absence of a concurrent simplification and integration of the principles of the rules. An analysis of the principles of systems for avoiding collisions between ships is attempted in the next chapter.

Chapter III - Survey of Thinking

Let us grasp the situation
Solve the complicated plot,
Quiet and calm deliberation
Disentangle every knot.

The Gondoliers W.S. Gilbert

CLASSIFICATION OF COLLISION AVOIDANCE SYSTEMS

Over the years, many systems have been adopted or proposed for avoiding collisions between ships at sea. In order to study these systems, it is convenient to sub-divide them into classes and, in this chapter they will be compared under the following headings:-

1. No Formal Rules. Freedom for every ship to avoid collision in its own way.

2. Omnipotent Rules, which give the same instructions to each ship in every encounter.

3. Hierarchical Rules which differentiate between the two parties to an encounter according to the nature of the ships involved.

4. Geometrical Rules which differentiate between the two parties to an encounter according to the geometry of the situation.

5. External Overall Control of traffic according to economic, political or operational expediency.

Note: Any of rule classes 2, 3 or 4 may be further sub-divided into:-

(a) Rules which specify responsibilities.

(b) Rules which specify manoeuvres.

1. NO FORMAL RULES

INTRODUCTION

Navigation without formal collision avoidance rules may be thought of as an absence of system rather than a system. It is the doctrine of anarchy in the strict sense of freedom from laws governing the actions of individuals; but it does not necessarily imply the state of chaos which is often automatically associated with anarchy. As previously pointed out, pedestrians manage to avoid collisions remarkably well without the benefit of formal rules.

As far as the author has been able to establish, no serious proposals have been made that rules for preventing collisions at sea should be abolished completely. There are, however, people who cherish the traditional freedom of the seas and who believe that any rules should be as general as possible and that the choice of specific manoeuvres should be left to the discretion of the mariner. Oudet[57] saw this point of view as a national characteristic of the British "because the British prefer to legislate as little as possible and to rely as much as possible on sea sense." Oudet's criticism of this principle was that many of the persons in charge of ships could not be relied upon to have much "sea-sense" and this is perhaps a fundamental criticism of the concept of doing without rules altogether.

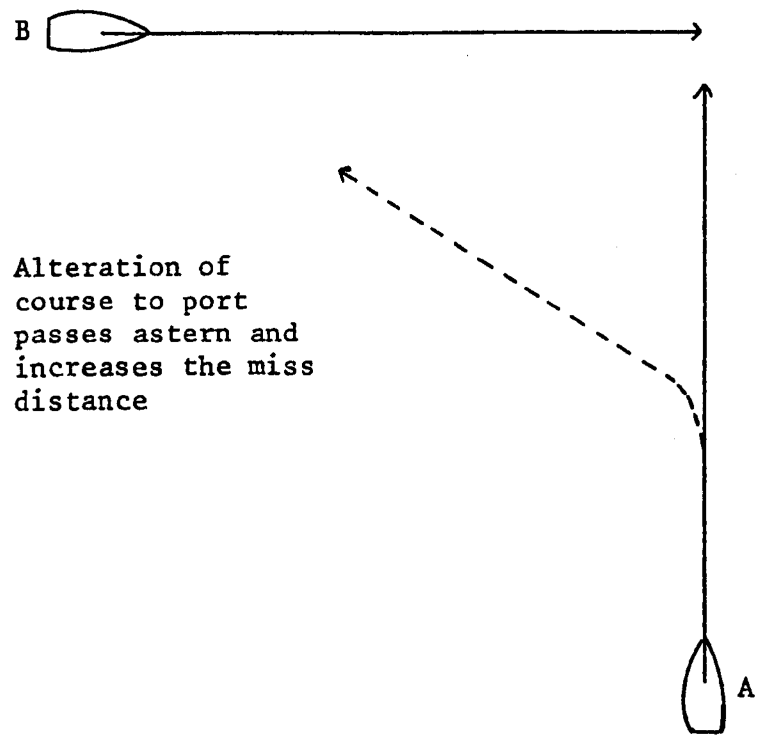
PRINCIPLES OF DISENGAGEMENT GIVEN FREEDOM OF ACTION

The principles which mariners would use to avoid collisions in the absence of a formal set of rules must remain the subject of conjecture. This is because mariners experienced in the handling of ships are "contaminated" for experimental purposes by their knowledge of the Collision Regulations. Some indication of the avoidance action that would be taken by individuals in the absence of rules can be derived from a study of the manoeuvres made by subjects with no marine experience at all. Some experiments of this type will be reported later in chapter IV, but the results must be treated with some caution because the subjects with the required ignorance of the Collision Regulations were also extremely naïve concerning the characteristics and behaviour of ships in general. Bearing these limitations in mind it would seem that, in the absence of formal rules, the avoidance of collision would be based upon two main principles plus a general reluctance to reduce speed. The principles are:-

(1) Manoeuvres would be made to pass astern of the vessel being avoided.
(2) Manoeuvres would tend to increase whatever miss distance is originally estimated.

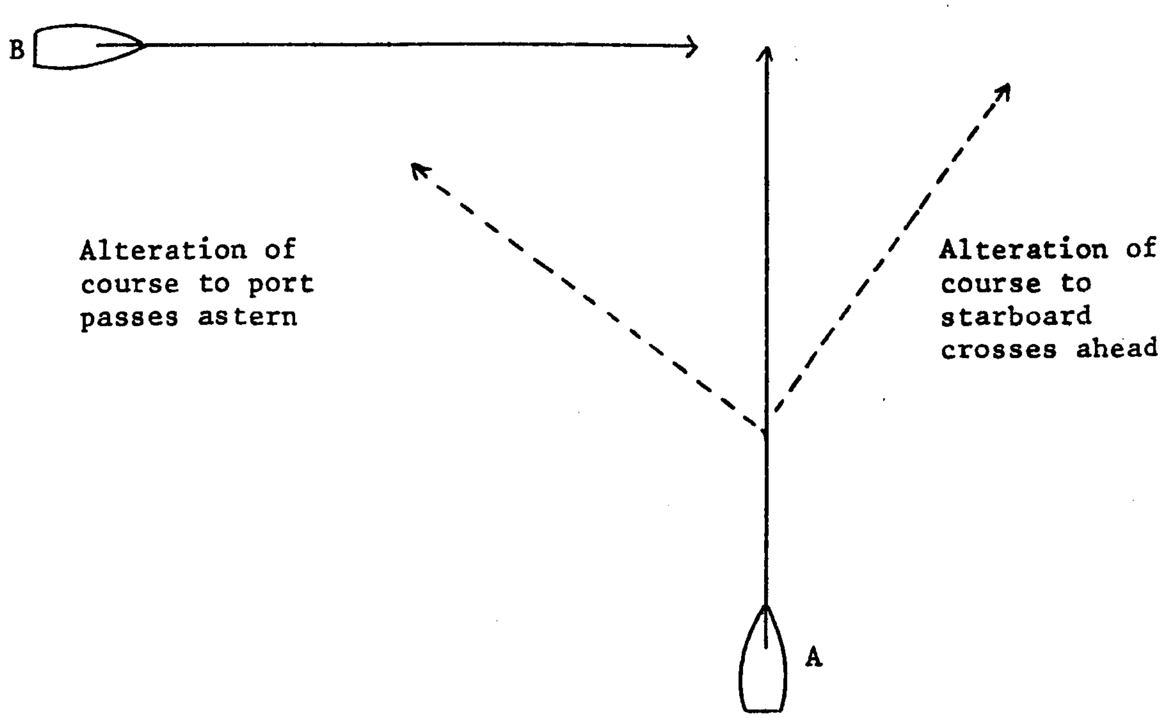
In some situations, these two principles are compatible but in others they are mutually conflicting and there is a break point at which one manoeuvre gives place to theother. Thus, if two ships were crossing at right angles as illustrated below (fig. 12) so that, if each maintained course and speed ship B would pass close ahead of ship A, then ship A could alter course to port in conformity with both the principles noted above.

Fig. 12



In another case of two ships crossing at right angles, again illustrated below (fig. 13) ship A would pass ahead of ship B if each maintained course and speed. In this case, ship A would have to alter course to starboard to increase the existing miss distance but would have to alter course to port to pass astern of B.

Fig. 13



An obvious danger in either case is that if each of the two vessels manoeuvres simultaneously to pass astern of the other they may find themselves again on near collision courses and there will then be a further conflict. In general, one of the two parties is more able (or perhaps more willing) to manoeuvre and so the other can safely maintain course and speed or make a complementary manoeuvre. The possibility of nearly simultaneous and cancelling action is certainly a defect of the free for all situation but it seems unlikely that it would be as chaotic as is sometimes assumed.

An advantage over the present system is that the vessel in the best position to manoeuvre is able to take the initiative. The existing rules assign reponsibility for manoeuvre according to an arbitrary geometrical convention and such responsibility frequently falls on the vessel least able to take effective action.

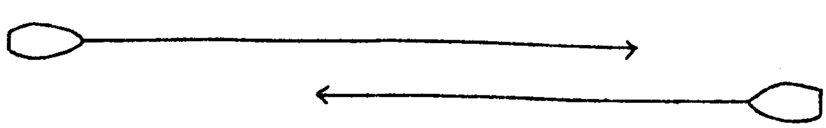
THE REQUIREMENT TO COMMUNICATE

A condition for the successful operation of a system of individual freedom is the ability of the participants to communicate. Pedestrians can and do signal their intentions to each other by a variety of visual cues and their manoeuvres are immediately observable. In good visibility, the actions of ships can similarly be made clearly evident.

The author, when in charge of a highly manoeuvrable craft, on being confronted with a large and ponderous craft crossing from the port side, has occasionally taken an early initiative and altered course emphatically to port to pass astern of the other craft. There is little doubt that the author is not alone in having taken such action, which amounts to a reversion to anarchy (in its strict sense, of course). Given the right circumstances, the manoeuvre is to both parties a safe and attractive alternative to the existing rules which would require the ponderous vessel to take avoiding action and the highly manoeuvrable craft to stand on. Such rule infringements, in the interest of expediency, are only safe in so far as the action taken by one vessel is clearly evident to the other.

Another example of an encounter which presents a temptation to revert to anarchy is when two vessels are meeting on nearly reciprocal courses such that, if neither alters course, they would pass starboard to starboard with an uncomfortably small miss distance. The situation is illustrated below (fig. 14).

Fig. 14



The current rules state that vessels meeting nearly end-on so as to involve risk of collision should each alter course to starboard but, as indicated by experiments to be described in the next chapter, many mariners faced with the above situation prefer to alter course to port to increase the existing miss distance. They justify this action by suggesting that, since there is no initial risk of collision the Rules do not apply; i.e. they choose quite deliberately and consciously to operate under anarchical conditions in which they may do as they please. The counter to their argument is to suggest that, if there were really no risk of collision there would have been no need to alter course at all; but argument and counter-argument are inconclusive in the absence of a precise definition of the phrase "risk of collision". Suffice it to be said that an alteration of course to port is safe and expeditious in good visibility when action taken by either vessel is immediately obvious to the other; but the same manoeuvre could be dangerous in the absence of a facility for mutual observation or an equivalent exchange of information.

It is, above all, the fact that effective communication between the parties to an encounter is frequently lacking which condemns the principle of anarchy as a universal means of avoiding collisions at sea. If this hypothesis is correct, the improvements in the manoeuvring signals prescribed in the 1972 rules may be expected to give rise to an increase in the number of occasions on which the collision rules are violated although not, of course, to an increase in the number of collisions.

CONCLUSIONS

In considering alternative collision avoidance principles it is important to bear in mind the tendency of mariners to revert to anarchy when conditions make action under the existing rules unattractive and when a formal or informal communication channel exists between the ships involved. It might be considered that such a reversion is almost encouraged by the existing special circumstances rule which states that "due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the craft involved which render a departure from the Rules necessary in order to avoid immediate danger."

The alacrity with which mariners throw the Rule Book overboard when it becomes inconvenient was noted by Fricker[58]. In discussing a US Coastguard Report he observed that "the most startling revelation of the report was the prevelent tendency of the parties involved to disregard the basic rules for preventing collisions at sea."

The author's conclusion is not that rules are undesirable or unnecessary but that they should be designed to prescribe actions which mariners will always find reasonable and attractive.

2. OMNIPOTENT RULES

DEFINITION

Omnipotent rules may be defined as single rules which give the same instructions to every ship in every encounter. They may be sub-divided into (a) rules which prescribe specific action and (b) rules which assign responsibility.

THE PORT HELM RULE

An example of the former class of rule is the previously mentioned nineteenth century "port helm rule in which each party to an encounter was required to alter course to starboard irrespective of the exact geometry of the encounter. The history of this rule indicates a general failing of rules which prescribe specific action. The danger is that if they are applied indiscriminately "so as to be on the safe side" they may convert safe passing situations into collisions. (See the examples of fig. 9, p.12 and appendix VIII E). It was thought so necessary to impress this danger on mariners after the port helm rule was repealed in 1863 that the cover of the Board of Trade pamphlet publishing the new Regulations carried the slogan "The reckless use of port helm leads to collision."

The lesson is that such rules are unsatisfactory unless either an objective criterion is set up to determine when they become operative or communication exists between the parties to an encounter so that agreement to use the rules can be reached. Vague criteria such as "when risk of collision exists" which may be interpreted differently by each of the two parties to an encounter are not sufficient.

A further deficiency of the port helm rule was that it did not always work, even when applied by both vessels in a geometrically precise collision situation (see page 5 for illustration).

It appears that these defects are by no means obvious because the wording of both the 1960 and 1972 Regulations on the action to be taken in poor visibility suggests that a starboard alteration of course is the preferred manoeuvre and gives only nebulous guidance as to when it should be applied.

As recently as 1962 it was suggested by Fairbairn[59] that aircraft should avoid collision by altering course 10° to the right in all cases, although he did not suggest that such a rule would be suitable for ships.

MODIFIED PORT HELM RULES

Rules of the same lineage but more flexible in character were suggested for ships using radar in poor visibility by G.C. Forrest[60] and D. Bunn[42].

Forrest suggested that ships using radar should make broad alterations of course to starboard only and should not alter course at all within a range of five miles from the other vessel although they might reduce speed or stop.

Bunn's proposal was that ships in conflict should disengage by altering course to starboard or, if they cannot alter course to starboard, they should stop.

Both these writers suggest that the primary means of disengagement should be an alteration of course to starboard in all cases where it is practicable and to this extent their rules have the same defects as the port helm rule. The alternatives of reducing speed or stopping are valuable options in cases where an alteration to starboard might precipitate rather than avoid a collision, but in practice it seems likely that these manoeuvres would be reserved only for emergency situations. This appears to be the use which Forrest and Bunn intended for these options.

Compared to the port-helm rule, these proposals would decrease the predictability of the actions which vessels might take in resolving an encounter. The advantage claimed for both proposals was the certainty that remained, i.e. that no ship would resolve an encounter in fog by an alteration of course to port.

THE "NAVAL SCIENCE" RULE

An example of an omnipotent rule specifying responsibility was suggested in 1872 in an article in "Naval Science", Vol. I, p.326. The article, closely reasoned and supported by statistical evidence, came to an interesting conclusion: "It would appear from the outline we have traced that the true form of the Rule of the Road at Sea should be negative. Instead of prescribing what ships should do, it should prescribe what they are not to do; and anomalous as it seems at first sight a law which ran in the following terms looks as though it would tend immensely to reduce the number of accidents - No ship shall cross the path of another, unless there is space to do so without alteration of course."

The deliberate choice of a negative form for this rule is worthy of note in that it anticipates a similar conclusion by Colomb in 1885. In the same vein, the author pointed out, at a Symposium in Liverpool in 1970, that in any encounter there are many more manoeuvres that will avoid collision than will cause it, the corollary being that it is simpler and less restrictive to forbid the dangerous manoeuvres than to list and require compliance with alternative safe manoeuvres.

The "Naval Science" rule itself does not specify particular manoeuvres to be used to avoid crossing the path of another ship, both alterations of course and/or speed being allowable. The discussion leading up to the formulation of the rule does, however, consider what manoeuvres might best be employed by ships complying with the rule. The conclusion is "that all ships should seek safety in making their courses parallel and opposite by turning towards each other to that extent and no more," unless a threat is approaching from well abaft the beam, in which case "parallel courses may be sought by turning away from each other." Examples of these manoeuvres are illustrated in figures 18 and 17 respectively on page 87 .

A major advantage claimed for this system is that ships already on parallel courses would not be "tempted out of safety" and, in view of the many nearly end-on encounters which have resulted in collision, this claim must be conceded as important.

A difficulty is that, for a ship to seek a parallel course with respect to another ship, she must have a knowledge of the other ship's heading. This difficulty is not inherent in the rule itself, but only in the means suggested for implementing it.

A difficulty which <u>is</u> inherent in the rule is that, if each vessel attempts to pass astern of the other, the manoeuvres tend to cancel. The manoeuvres to pass astern are in conformity with what appears to be the natural choice of action in crossing encounters but, for efficient disengagement, only one of the two parties should be required to make such a manoeuvre.

COLOMB'S RULE

In 1885 Captain P.H. Colomb,R.N.[17], suggested a single, simple, omnipotent rule which avoided the difficulties of the Naval Science rule. He held the belief that rules should be based on matters of fact rather than matters of opinion. He therefore based his rule on "right of way" rather than "risk of collision" on the grounds that "risk of collision" was a highly subjective assessment on which the two parties to an encounter would frequently disagree. The form of Colomb's rule was: "No ship shall have the right to cross the bows of any other ship from port to starboard." The operation of this rule is illustrated in fig. 15(i), below.

Like other rules assigning some general responsibility, although it does not prescribe explicit manoeuvres, a set of manoeuvres is implicit in Colomb's rule. He was, of course, aware of this and explained them in the following terms.

"Given some plain rule as one which said: 'You may cross a ship's bows leaving her to your port (or left) hand; but you must not cross a ship's bows leaving her on your starboard (or right) hand; then:-

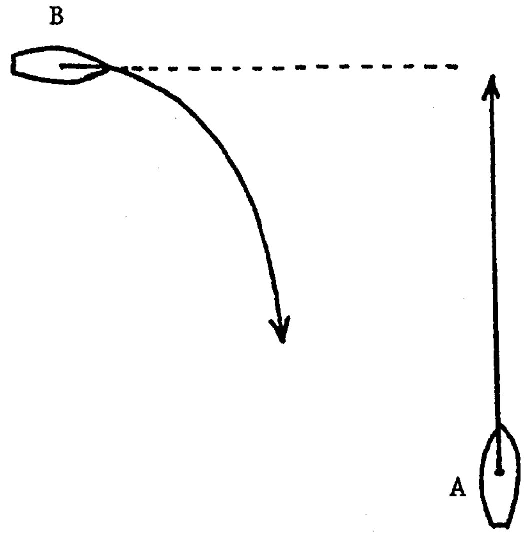
1. It will always be right to port your helm (i.e. alter course to starboard) to avoid a ship which has the right to cross your bows.
2. It will always further be right for you, when you port your helm, to reduce your speed by all means in your power.
3. It will always be right for you, when you port (i.e. alter course to starboard) to turn as short as your manoeuvring powers allow.
4. On approaching a ship whose bows you have the right to cross, you must always be guarded. If you have the slightest doubt whether she can, or will allow you to exercise your right, you must instantly yield it by turning towards her, by starboarding your helm (i.e. altering course to port). But you must understand that you may, at any later moment, get a signal from the other ship to right your helm, which signal you must instantly obey." (See fig. 15(ii) below).

The signal that Colomb refers to in his last paragraph is the changing aspect of the other ship as it alters course to starboard to comply with his rule. This change of aspect would be indicated at night by the shutting out of the other vessel's green sidelight and its substitution by the red sidelight. Whistle signals and flashing light signals to indicate an alteration of course would nowadays amplify these signals.

Colomb's basic rule has merits apart from its simplicity. It avoids the problem of cancelling manoeuvres that was implicit in the Naval Science rule. Also it allows the mariner to take a natural action, i.e. to alter course to pass astern of the vessel he is avoiding.

Fig. 15 Colomb's Rule

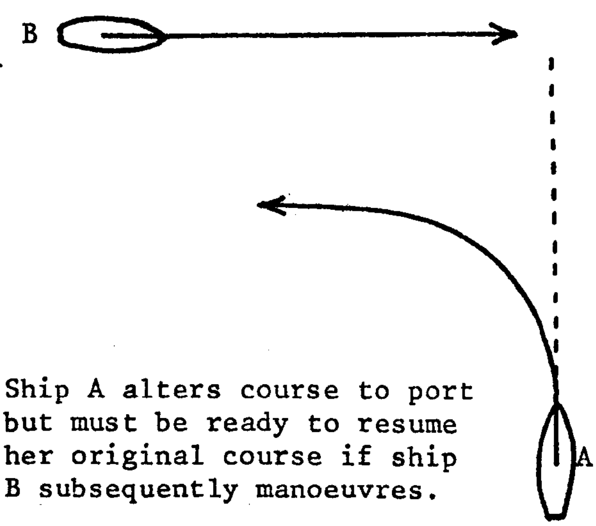
(i) Normal Action



Ship B avoids crossing ahead of ship A

Ship A stands on

(ii) Emergency Action



Ship B does not or cannot manoeuvre

Ship A alters course to port but must be ready to resume her original course if ship B subsequently manoeuvres.

A defect is that it assigns "right of way" according to an arbitrary geometrical convention and without regard to the speeds or manoeuvring capabilities of the craft involved in an encounter. Colomb was aware of this and hence his explanatory paragraph (4) quoted above. This amounts effectively to an escape clause that should be appended to his rule. It would presumably be brought into operation, not only when a normal ship on a collision course to port neglected to manoeuvre in good time, but also when a fisherman or any other hampered vessel was observed on a collision course to port.

COLOMB's RULE COMPARED WITH 1972 IMCO RULE 17

In principle, Colomb's suggestion that the ship which is entitled to stand on should give way if the other ship does not manoeuvre, is similar to the 1972 rule 17. It differs in that Colomb's basic rule did not require the privileged ship to maintain course and speed and so it avoided the illogicality of the 1972 rule which states in successive sections that:-

(i) The stand on vessel shall maintain course and speed.

and (ii) The stand on vessel need not always maintain course and speed.

The 1972 rule 17 differs more dramatically in that Colomb prescribes only an alteration of course to port in this situation whilst the 1972 rule proscribes an alteration of course to port but permits any other manoeuvre.

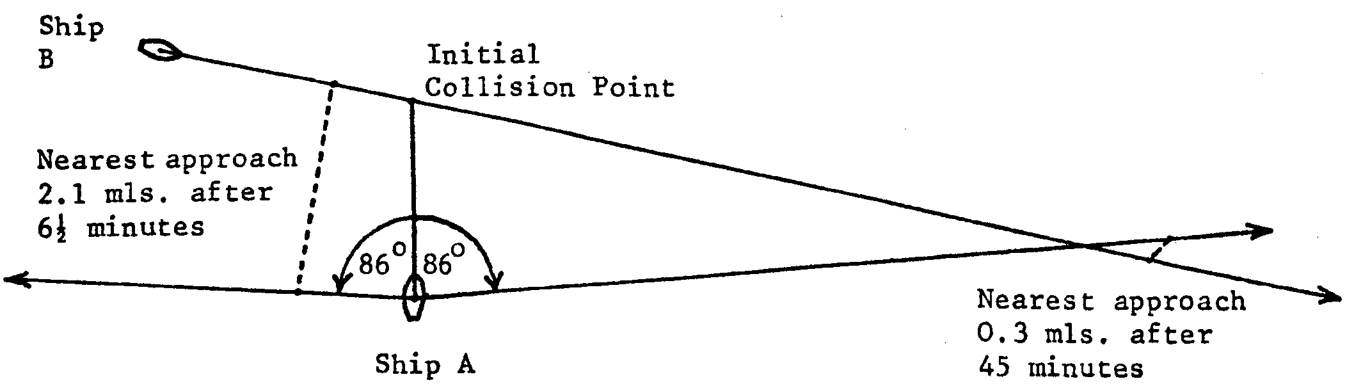
This is a crucial conflict of opinions and it is important to probe more deeply to see how such diametrically opposed instructions can both be seriously suggested as providing the safest manoeuvre.

There is an attraction in the rule 17 instruction that alterations of course to port are to be avoided since this precludes the possibility of cancelling action should the other vessel make a late alteration of course to starboard. Turning away from the other vessel reduces the relative velocity between the two craft and is therefore generally a safe action, particularly on paper where exact collision situations can be drawn and manoeuvres investigated with geometrical precision.

In favour of Colomb's alteration of course to port is the fact that it appears to be the most natural action in such crossing cases, and this alteration of course towards the other vessel is also a more efficient manoeuvre in the sense that it gives rise to a larger miss distance for a given change of heading. Colomb himself said that, for avoiding a vessel crossing from the port side, an alteration of course to port is seven times more effective than an alteration of course to starboard. His rationale for choosing the factor seven for this purpose seems to have been similar to Mr. Heinz's rationale for choosing the magic number 57 in quite another context, but it served to publicize his point equally well.

It is not clear how Colomb measured the effectiveness of a manoeuvre but figure 16 below illustrates the sort of situation he may have had in mind. Ship A is proceeding at 10 knots with 2 miles to go to a collision point. Ship B is proceeding at $12\frac{1}{2}$ knots with $2\frac{1}{2}$ miles to go to the collision point. If ship A alters course 86° to port the closest point of approach is seven times greater than if she alters course 86° to starboard. Equally important is the fact that if ship A alters course to starboard, the time interval to the point of nearest approach is seven times longer and the deviation from track seven times greater than if she alters course to port. The analysis of this situation is contained in appendix VII.

Fig. 16



For the practical navigator, on the bridge of a ship, when faced with another vessel crossing from the port bow, the choice is not at all clear cut. An alteration of course to starboard is safe if it is large enough to put the two vessels onto parallel courses, but it has the effect of prolonging the encounter. If the alteration is less than this it results in a comparatively small miss distance which, in practice, may only be of the same order as the error in assessing the other vessel's relative track. An alteration of course to starboard also, at some stage, exposes the whole vulnerable port side of a ship to an approaching threat which is something no mariner is likely to be happy about. On the credit side, an alteration to starboard has the advantage that the privileged ship can safely and easily return to her original course if the give way vessel takes late action.

An alteration of course to port has the attraction that a comparatively modest change of heading produces a miss distance which is ample to swallow up any errors in assessment of the other vessel's track. It increases the closing rate but this has an advantage in that the encounter is very quickly resolved. The possibility of the privileged ship's alteration to port being cancelled by a late alteration by the give way vessel to starboard is sufficiently remote that it does not seem to be an effective deterrent. Colomb's advice to resume course in the event of cancelling action is not without difficulties and could lead to a "dance of death" situation in which each vessel reverses her helm more than once.

In tests to be described in the next chapter, inexperienced subjects with no prior knowledge of any rules, consistently altered course to port for a threat from the port side, having presumably made an intuitive appreciation that this manoeuvre would give the largest miss distance and the most rapid disengagement. Experienced mariners, whose knowledge of the rules should have inhibited them from altering course to port were almost equally divided between those who altered course to port and those who altered course to starboard thus suggesting that, in the absence of a knowledge of the rules the majority would have altered course to port. For these tests, a fog situation was assumed in which the action of one ship was not immediately apparent to the other so that the risk of cancelling action was greatest. In good visibility there seems little objection to Colomb's recommendation.

Essentially the choice is between a safe but not very efficient alteration of course to starboard and a much more efficient but riskier alteration of course to port. Experiments (to be reported later in this thesis) indicate that most people would go for the latter option and this finding is in accord with an observation that Nevil Shute made in respect of Captain Samuelson in his novel "No Highway";[16] "Like every pilot in the world, he veered instinctively away from a policy of playing safe." The present author, in his more introspective moments, noticed this tendency in his own navigation but, not having had the universal acquaintance with every other navigator that Mr. Shute enjoyed with every pilot in the world, had considered it a personal character defect and had kept quiet about it.

The tendency of most people to make the riskier choice of action in this situation may perhaps be explained in terms of behaviour theory as developed by B.F. Skinner[62]. The alteration of course to port leads to rapid disengagement and relief from anxiety so that it is reinforced on every occasion that it is successful. The alteration of course to starboard may break the initial collision situation but it leads to a prolongation of the encounter and therefore to a continuing period of anxiety before disengagement is finally achieved and the giving way vessel can resume her original course. If this suggestion is correct, then alterations of course to port for a threat on the port bow should be more common amongst the more experienced mariners. Experimental evidence, to be described in the next chapter, suggests that there is indeed a positive correlation between length of experience and the probability of altering course to port in this situation.

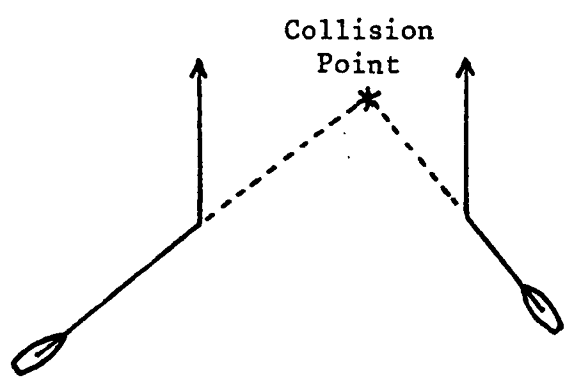
In summary, it would seem that Colomb's rule is workable although not by any means perfect. It is likely to appeal to the practical man who has a feeling for the uncertainties and difficulties of operational decisions. It is less likely to appeal to the pencil and paper navigator who can demonstrate its defects (by simple geometry) more easily than he can demonstrate its virtues (which depend upon an analysis of probabilities). The simplicity of Colomb's rule is possibly its greatest merit.

TURN TOWARDS OR TURN AWAY

There are two other omnipotent rules which make an interesting comparison.

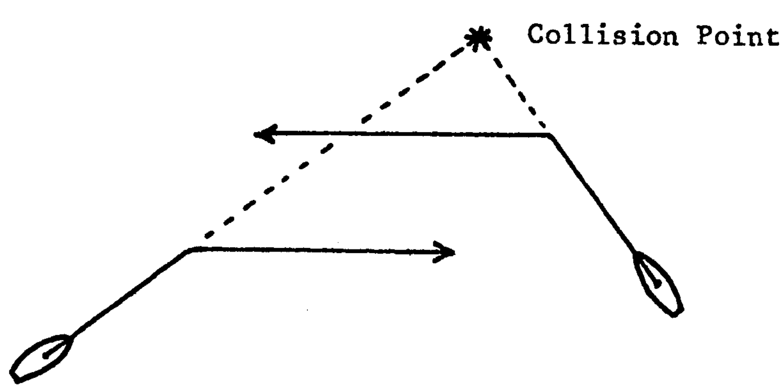
One rule is of the form; when two vessels are approaching one another so as to involve risk of collision, each shall disengage by turning away from the other. A possible implementation of this rule is illustrated in figure 17 below.

Fig. 17



The other rule is of the form; when two vessels are approaching one another so as to involve risk of collision, each shall disengage by turning towards the other. A possible implementation of this rule is illustrated in figure 18 below.

Fig. 18



The relationship between these two rules is simply a more general case of the relationship between the port and starboard alterations discussed in the previous section.

If both ships turn away from each other their speed of approach is reduced and the action is safe but it tends to prolong the encounter and, in special cases, does not resolve it at all. If both ships turn towards each other, their speed of approach is increased and the action is riskier but it is more efficient in the sense that it leads to a more rapid disengagement. Again it seems likely that the decision as to which is the preferable action is likely to depend upon the personality and the experience of the navigator.

The "turn away" rule is likely to appeal to the more cautious or less confident navigator in that it is safer and in that it "buys" time. The "turn towards" rule is likely to appeal to the more confident navigator who prefers to retain the initiative in resolving a situation. To such a person, the old "fighter pilot" technique of keeping the other craft ahead may be more attractive than turning away and so relinquishing control of the situation to the other party.

In the form quoted, with no specification of the extent of manoeuvres, neither rule in itself gives a guarantee that its implementation will always avoid collision. Neither rule has in fact been suggested in quite the form given here but the principles involved have their supporters, albeit with qualifications.

The avoidance of collision by turning away from a threat was advocated for ships by Captain E.M. Robb[63] and for aircraft by Dr. J.S. Morrel[64].

The avoidance of collision by turning towards a threat was suggested for ships by Dr. R. d'E. Atkinson[65] and for aircraft in Flight Safety Bulletin No. 2/70 published by the General Aviation Safety Council.

The "Naval Science" analysis, discussed on page 81 , suggests that each rule has its application.

SUMMARY OF OMNIPOTENT RULES

In summary, it may be said that omnipotent rules have two important merits: (i) they are simple and therefore easy to remember, easy to understand and easy to operate; (ii) they require a minimum of information for their application. There is no need to identify other ships or to have a precise knowledge of their headings within a frame of reference.

The main deficiency of the omnipotent rules discussed is that, in themselves, they do not guarantee the avoidance of collision. Even if followed by both ships in a geometrically exact collision encounter, the manoeuvres made may generate a second collision point. More importantly, if only one of two ships takes the prescribed action in a marginal case, it may convert a close passing encounter into a collision encounter (see diagram 9 on p.22). This second case leads to the paradox that, if a collision occurs, the ship whose action caused it would have been following the rules and would be held blameless. It was just this difficulty that caused the abandonment of the port helm rule in 1863, the only omnipotent rule to have been tried in practice.

3. HIERARCHICAL RULES

DISCUSSION

Hierarchical rules differentiate between ships according to some definable characteristic. On the basis of this discrimination they then lay different responsibilities upon the two parties to an encounter. In theory it would also be possible to devise rules which specify manoeuvres on such a basis but none appear to have been developed.

EXAMPLES

An example of a hierarchical rule is the old rule mentioned in the previous chapters, that junior officers should give way to senior officers. To suit modern conditions, this rule would have to be recast into a form such as "smaller ships should give way to larger ships" or "when two vessels are proceeding in such directions as to involve risk of collision the more manoeuvrable of the two vessels shall keep out of the way of the other."

The 1960 Regulations contained ad hoc examples of this class of rule so that vessels not fishing should keep out of the way of vessels which are fishing and that power driven vessels should keep out of the way of sailing vessels, etc.

It is possible to devise a more formal hierarchical structure of ship classes so that any vessel at a higher level is required to give way to a vessel at a lower level of manoeuvrability. A six class hierarchy was suggested by Brett Hilder[66] in 1959 and a seven class hierarchy is implied by rule 18 of the 1972 Regulations.

A major disadvantage is that rules based purely on a hierarchical principle do nothing to resolve conflicts between vessels of the same class. In theory it might be possible to avoid this difficulty by placing ships on a continuous spectrum of manoeuvrability instead of in discrete classes, but this would not seem to be a practicable alternative because of the difficulty of distinguishing between two vessels close together in the spectrum. Even when discrete divisions are used it may be difficult to identify the class of another ship in an encounter in order to establish precedence. Light signals might be effective at night but day signals to identify a ship's manoeuvring status are not so satisfactory. Responders to identify a ship's status by radar are possible technically but not operationally.

SUMMARY

In summary, it is suggested that hierarchical rules are attractive for encounters between ships of easily distinguishable classes, but that they can never form a collision avoidance system of universal application. It may be that no basis can be found for any rules which will give the simplicity of universal application, in which case, hierarchical rules may well be used in the future, as they are now, as a supplementary system.

4. GEOMETRICAL RULES

DISCUSSION

Geometrical rules differentiate between the two parties to an encounter according to the geometry of the situation. They may prescribe specific action or general responsibility or both.

The point of distinguishing between the two parties is so that they may be assigned different but complementary roles in avoiding collision.

Some observers distinguish between "unilateral rules" in which only one of two vessels in an encounter is charged with responsibility for taking collision avoidance action and the other has to maintain course and speed, and "bilateral rules" in which both vessels are required to take action. To the author, this seems a false division because the requirement that a vessel shall maintain course and speed is simply a highly specific example of prescribing a course of action and no different in kind from prescribing say an alteration of course to starboard.

EXAMPLES OF GEOMETRICAL RULES FROM THE CURRENT REGULATIONS

(see appendix II Q)

An example of the class of rule specifying responsibility for one vessel and specific action for the other is the current rule by which a sailing vessel with the wind on the port side is given the responsibility of giving way to a sailing vessel with the wind on the starboard side. The vessel with the wind on the starboard side is given the specific instruction to maintain course and speed.

It says much for the efficiency of this rule that its general form has persisted from the 18th century and is still satisfactory today. It is also true to say that the rule is not generally required to be operated under very difficult conditions. Most modern sailing craft are highly manoeuvrable and encounters usually occur between craft of very similar capabilities. Encounters in fog conditions, or even at night, are not frequent and, if collisions do occur, the low rate of approach and the moderate size of the craft ensure that they are very rarely disasters.

For the purpose of this rule, the direction of the wind provides a frame of reference which is the same for both vessels. The heading of each ship with respect to the wind direction and the existence of collision risk are the factors which determine the geometry of the situation.

Another example of a geometrical rule specifying both responsibility and specific action is the current rule which requires that when two power driven vessels are crossing so as to involve risk of collision the vessel which has the other on her own starboard side shall have the responsibility for keeping out of the way and the vessel which has the other on her own port side shall take the specific action of maintaining course and speed.

This rule has been in force since 1863. It is adequate for avoiding collisions in encounters between manoeuvrable ships in good visibility. A disadvantage is that, in encounters between ships the very different manoeuvring capabilities it requires, in about half the cases, that the less manoeuvrable ship shall take action and that the more manoeuvrable ship shall do nothing. This is obviously not desirable and in extreme cases, is not even practicable so a reversion to a hierarchical rule is necessary and a power driven vessel is required to give way to a hampered vessel on the port bow. The effect of this is to make the conditions under which the rule applies less clear cut, and identification of a craft on the port bow is needed before it can be decided which rule should be used.

Another defect of the rule is the too specific requirement that one of the two vessels shall maintain course and speed. After considerable controversy, this was made a stringent requirement in 1897 so that such vessels had to maintain course and speed right up until the last possible moment, at which juncture some unspecified escape action had to be taken. This defect was recognised by the 1972 IMCO Conference and the new rule permits the "stand on" vessel to take action at an earlier stage (see appendix II R). This seems to be a necessary step, but it again has the effect of making the application of the rule less clear cut.

For the operation of this rule, each vessel has its own frame of reference defined by its heading. The geometrical considerations are the directions, within those frames, in which each ship sees the other and the fact that risk of collision exists.

The current rule for overtaking situations is similar in that it lays responsibility for manoeuvre on the overtaking vessel and requires that the overtaken vessel shall maintain course and speed. A difference in geometric principle is that the definition of an overtaking vessel (i.e. every vessel coming up with another vessel from a direction more than $22\frac{1}{2}^{\circ}$ abaft her beam) depends upon the relative position of the two vessels within the single frame of reference defined by the heading of one of them. The orientation of this frame of reference cannot be known with precision by the overtaking vessel, to whom it is of the greater importance. This defect has contributed to collisions, notably the Pacific Glory-Allegro case in 1971 (see appendix VIII B), but in general the overtaking situation is not a highly dangerous one because speeds of approach are low. It may be, however, that with the development of routeing schemes which tend to create concentrations of vessels going in the same general direction, more attention now needs to be paid to this class of encounter.

In both the crossing and the overtaking cases, avoidance manoeuvres are restricted by an additional rule which requires that the giving way vessel should avoid crossing ahead of the other. This implies that the giving way vessel must have at least an approximate knowledge of the frame of reference defined by the heading of the other.

The current rule that vessels meeting end-on or nearly end-on should each alter course to starboard is an example of a geometrical rule which assigns specific action to each of the two parties to an encounter. It is necessary to give the same instructions to each vessel since the end-on situation is geometrically symmetrical and provides no reference by which one of the two vessels can be distinguished from the other. The requirements for the operation of this rule are deceptively complex in that each vessel needs to know her own position within the other vessel's frame of reference as well as the position of the other vessel within her own frame of reference. The imprecise knowledge of the other vessel's frame of reference degrades the effectiveness of this rule in a similar way to the overtaking case, but the resultant inefficiency of the rule is more dangerous since, in the end-on situation, speeds of approach are much greater.

Those rules which require one of two vessels to have a knowledge of the frame of reference defined by the other are imprecise in operation even in good visibility. In fog such frames of reference are even more difficult to identify so that, until the introduction of radar, the only rules which applied in restricted visibility were omnipotent rules designed to reduce speeds of approach rather than to lay down a convention for disengagement. The use of radar does not give a direct or accurate indication of another vessel's heading so that rules based on a knowledge of this parameter are unsatisfactory in fog.

GAUW'S PROPOSED GEOMETRICAL RULE

The rule suggested by Rear Admiral Gauw in 1955[23] suffered from the fact that it required each vessel to know the heading of the other, but it had points of interest which are worth consideration. The form of his rule was that "When two vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall cross astern of the other, whereas the vessel which has the other on her own port side shall cross ahead of the other." He suggested that this rule should have universal application except that hampered vessels such as fishermen, etc. should be treated separately on a hierarchical basis.

In the sense that Gauw's rule is universal and prescribes action for both parties to an encounter, it is similar to the old 19th century port helm rule. It differs in that it does not give the same instructions to each party and in that it prescribes what the outcome of the manoeuvres should be rather than the specific manoeuvres.

An advantage of Gauw's rule is that, in all encounters, it allows the faster and more manoeuvrable craft to contribute to the avoidance of collision. Also, if, due to fog or other cause, only one of the two ships is aware of the presence of the other the situation can be resolved safely by the action of that vessel alone. Simplicity and the absence of a need to identify the class of another ship before avoiding action is taken are other important advantages.

Most criticisms of Gauw's rule were based on the fact that, since neither vessel was required to maintain course and speed, the development of an encounter would be less predictable than under the existing rules, and consequently more dangerous. Having lived for sixty years with the rule requiring one of two vessels in an encounter to maintain course and speed, it seemed that mariners were as worried about losing it as we had been about accepting it at the time of the Washington Conference. A more rational criticism of Gauw's rule was that, although it is always possible to take effective action to pass well astern of a crossing vessel, either by altering course or by reducing speed, it is not always possible to take effective action to pass well ahead of a crossing vessel. This is because a substantial increase in speed is sometimes required to pass safely ahead of another vessel and most merchant ships do not have this capability.

The frame of reference required for the operation of Gauw's rule is defined by the heading of one's own ship. A knowledge of the relative bearing of the other ship and the direction of her head is also required and, as noted previously, this latter information is difficult to establish with precision, particularly in fog.

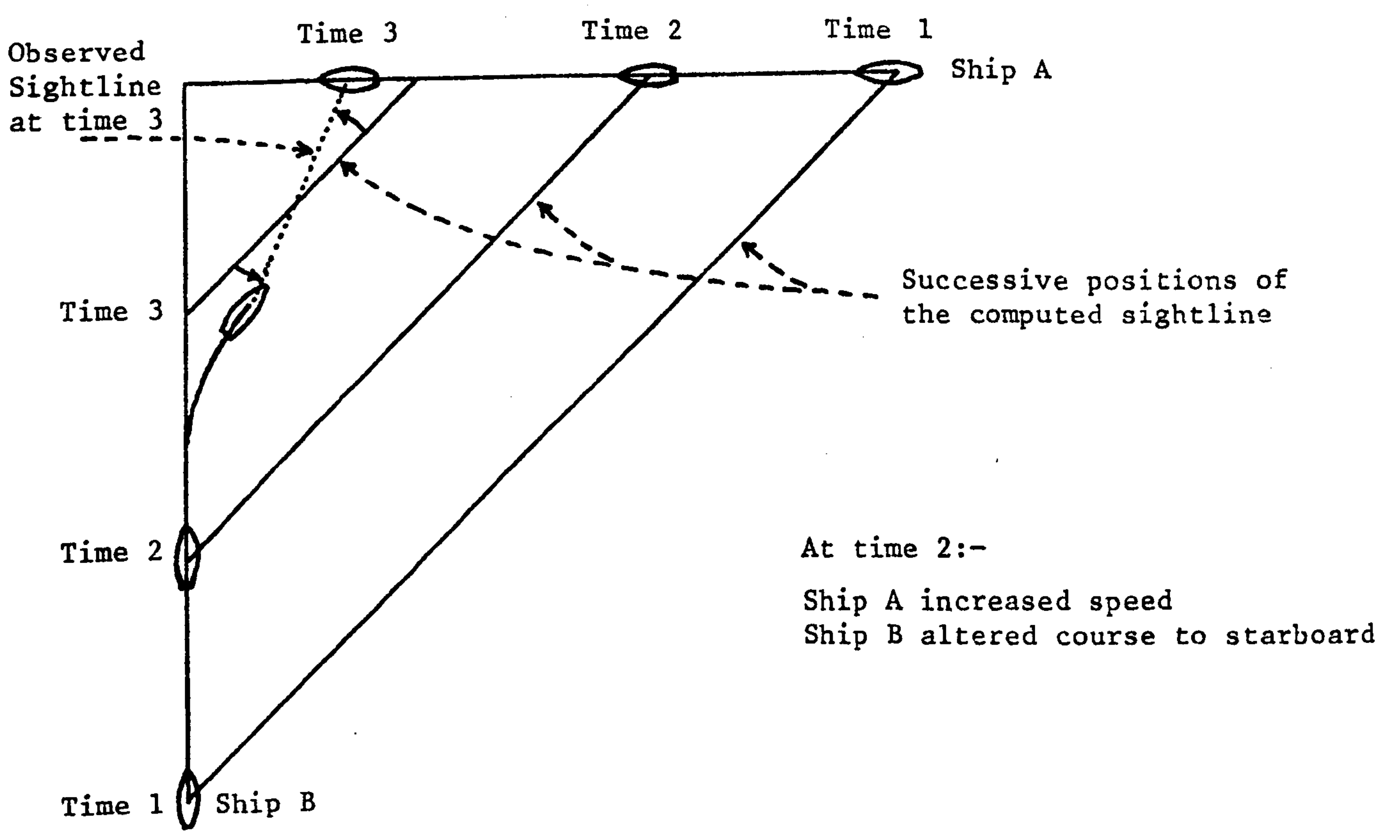
THE CALVERT/HOLLINGDALE SYSTEM OF MANOEUVRES

To avoid this difficulty, collision avoidance manoeuvres which do not depend upon a knowledge of another ships heading have been developed, notably by Calvert[26]. The geometrical validity of Calvert's system was later demonstrated by Hollingdale[30].

Calvert suggested a system of manoeuvres by which ships on conflicting courses could take co-operative action to avoid collision. It was a geometrical system in that sets of manoeuvres were allocated to the two ships according to their headings in relation to the "sightline" joining them, thus using the same easily observable frame of reference for each ship.

The "computed sightline", which defines the frame of reference in Calvert's system is that which would move with each ship if it made no manoeuvre and if the other ship remained on a collision course. Such a line would translate but would not rotate. Calvert then suggested that each ship should manoeuvre so that its own action would cause an agreed direction of rotation of the "observed sightline". He suggested that an anti-clockwise rotation should be accepted as conventionally positive since this was compatible with the existing rules and that a clockwise or negative rotation should only be adopted in special circumstances after communication and agreement between the two parties to an encounter. Figure 19 below illustrates the principle for three successive stages of a simple crossing encounter.

Fig. 19



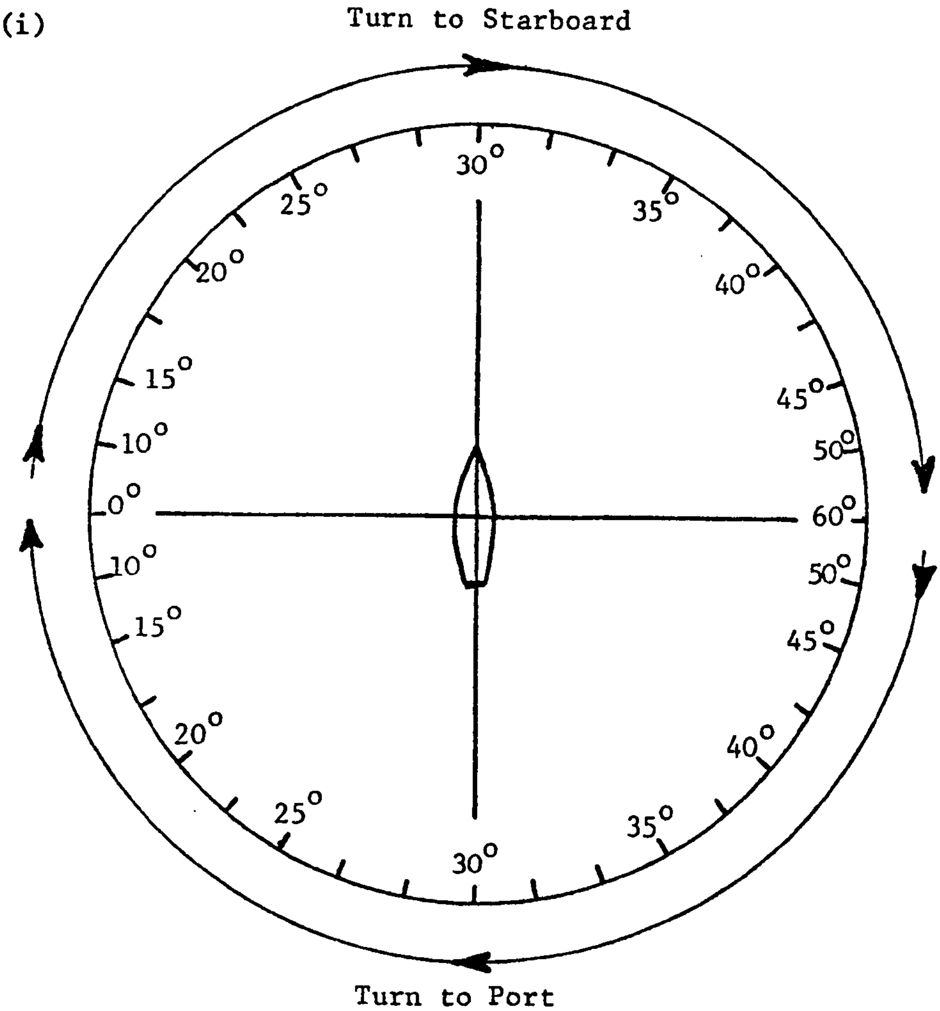
The computed sightline divides an area into two halves and the convention for rotation allocates one half of the manoeuvring space to one ship and the other half of the manoeuvring space to the other ship. Calvert pointed out that the allowable manoeuvres for each ship depended only on the relative bearing of the other and could be summarised on a diagram.

Several versions of such a diagram have been suggested and two, due to Hollingdale[67], are illustrated below (Fig. 20). The first, (i), shows alterations of course which, if made co-operatively, lead to a miss distance equal to half the range at which the alterations were made. The second, (ii), shows general manoeuvres involving both course and speed changes.

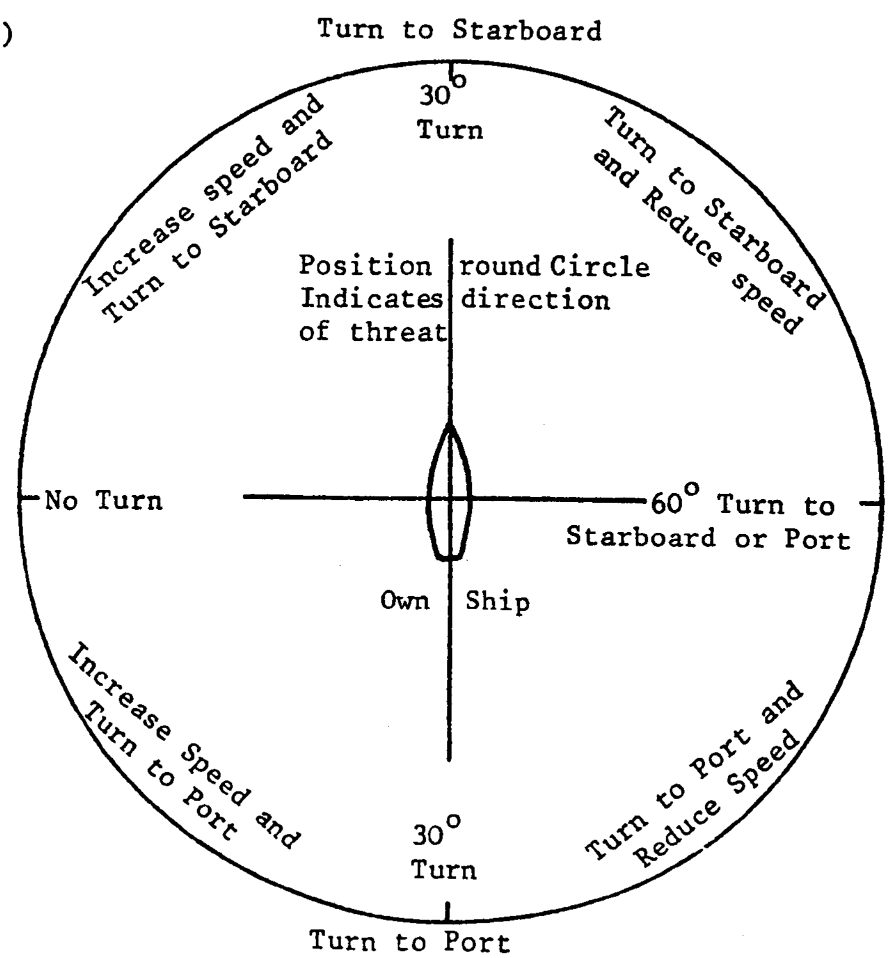
A feature of Calvert's concept of a computed sightline is that it is possible to devise a radar display, stabilized to this frame of reference, so that each vessel's contribution to the avoidance of collision is directly indicated at any stage of the encounter. In addition, the geometry of the system is such that the rate at which each vessel builds up its contribution to the miss

Fig. 20

(i)


Turn to Starboard
30°
25°
35°
20°
40°
15°
45°
10°
50°
0°
60°
10°
50°
15°
45°
20°
40°
25°
35°
30°
Turn to Port

(ii)


Turn to Starboard
30°
Turn
Increase speed and Turn to Starboard
Turn to Starboard and Reduce speed
Position round Circle Indicates direction of threat
No Turn
60° Turn to Starboard or Port
Own Ship
Increase Speed and Turn to Port
Turn to Port and Reduce Speed
30°
Turn
Turn to Port

distance may be easily calculated. A formula giving the build up of miss distance for alterations of course was published by Calvert in 1973[68]. A derivation of this formula and its extension to include changes of speed as well as changes of course is presented in the next chapter.

The advantages of Calvert's proposed system are important and include:-

1. Simplicity. A simple, integrated system of manoeuvres covers all the circumstances under which ships might meet instead of having separate rules for crossing, end-on and overtaking situations, hierarchical rules for encounters between ships of differing classes and alternative regulations for use in restricted visibility.

2. Precision. A frame of reference which can be easily and accurately observed visually or by radar is used as a basis for the system geometry.

3. Ease of Assessment. The effectiveness of action taken within the system may be conveniently assessed at any time as an encounter develops.

There are also disadvantages:-

1. Impracticability. In certain cases, i.e. when another ship is closing from the port beam, the only positive action which a ship can take is to increase speed and this may be impossible or unacceptable.

2. Dependence on Communication. In certain situations, reverse manoeuvres to rotate the sightline clockwise may be necessary. Communication between ships to agree to such a reversal of the convention may be impossible.

3. Inefficiency. The more manoeuvrable party to an encounter may be allocated a very small course alteration and, in the limit when the other vessel is approaching from the port beam, no course alteration at all. In such a case the main contribution to the avoidance of collision has to be made by the vessel least able to manoeuvre.

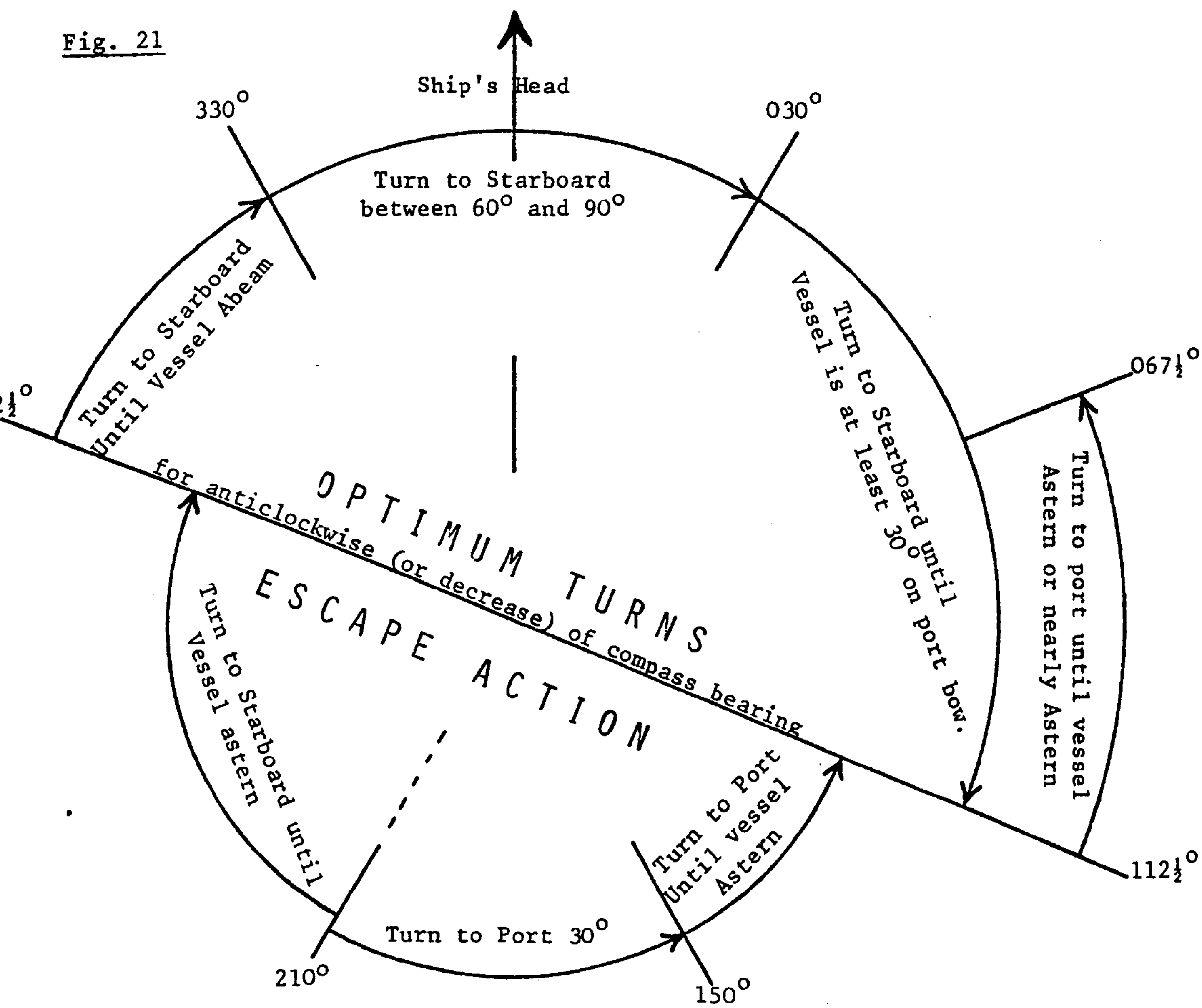
The disadvantages listed above are important but should not be taken in isolation since similar disadvantages may be noted for other collision avoidance systems which do not enjoy the advantages of Calvert's system.

COMPROMISE SUGGESTIONS

Suggestions for amending the International Regulations to take account of Calvert's proposals but at the same time avoiding the disadvantages were made by Kemp[39] and by Burger and Corbet[41], but were necessarily compromises between geometrical desirada and operational limitations.

Later, a UK Institute of Navigation Working Party suggested a manoeuvring diagram in which recommended action was related to the bearing of the threat. This was on similar lines to the Calvert and Hollingdale diagrams but it avoided the difficulty of requiring a ship to increase speed for a threat from the port side. The diagram is illustrated below (Fig. 21). The diagram shows course alterations only and is intended for use primarily in avoiding a vessel detected by radar but not in sight visually. The alterations shown in the "Escape Action" sector are intended for use only if the other vessel fails to take avoiding action. The diagram was not included in the Working Party's report[53].

Fig. 21



Clearly the diagram violates Calvert's system in the sector from 210° to $292\frac{1}{2}^{\circ}$. The price to be paid is that the manoeuvre of turning away from a threat on the port side causes a clockwise rotation of the sightline which tends to cancel the expected manoeuvre of the other vessel. The action is considered safe because turning away from the threat causes a reduction in the rate of approach, but this in turn causes the disengagement to be prolonged. A possible criticism is that evidence to be presented in chapter IV suggests that mariners often prefer a more rapid and definite disengagement manoeuvre. Certainly Calvert himself was not enamoured with the diagram to the extent that he disassociated himself with the Working Party's recommendations.

Despite the criticisms, the general principles implied in the manoeuvring diagram were included in the 1972 rules for preventing collisions. In crossing encounters, the rigid requirement, that a vessel with the other on her port side should maintain course and speed right up to the last minute, was relaxed. Such a vessel was to be allowed to take evasive action at an earlier time but was not to be allowed to alter course to port. This was certainly thought of by some people as a conscious step towards the system proposed by Calvert but, in truth, a very small and hesitant step.

THE SECTOR RULES OF GARCIA-FRIAS

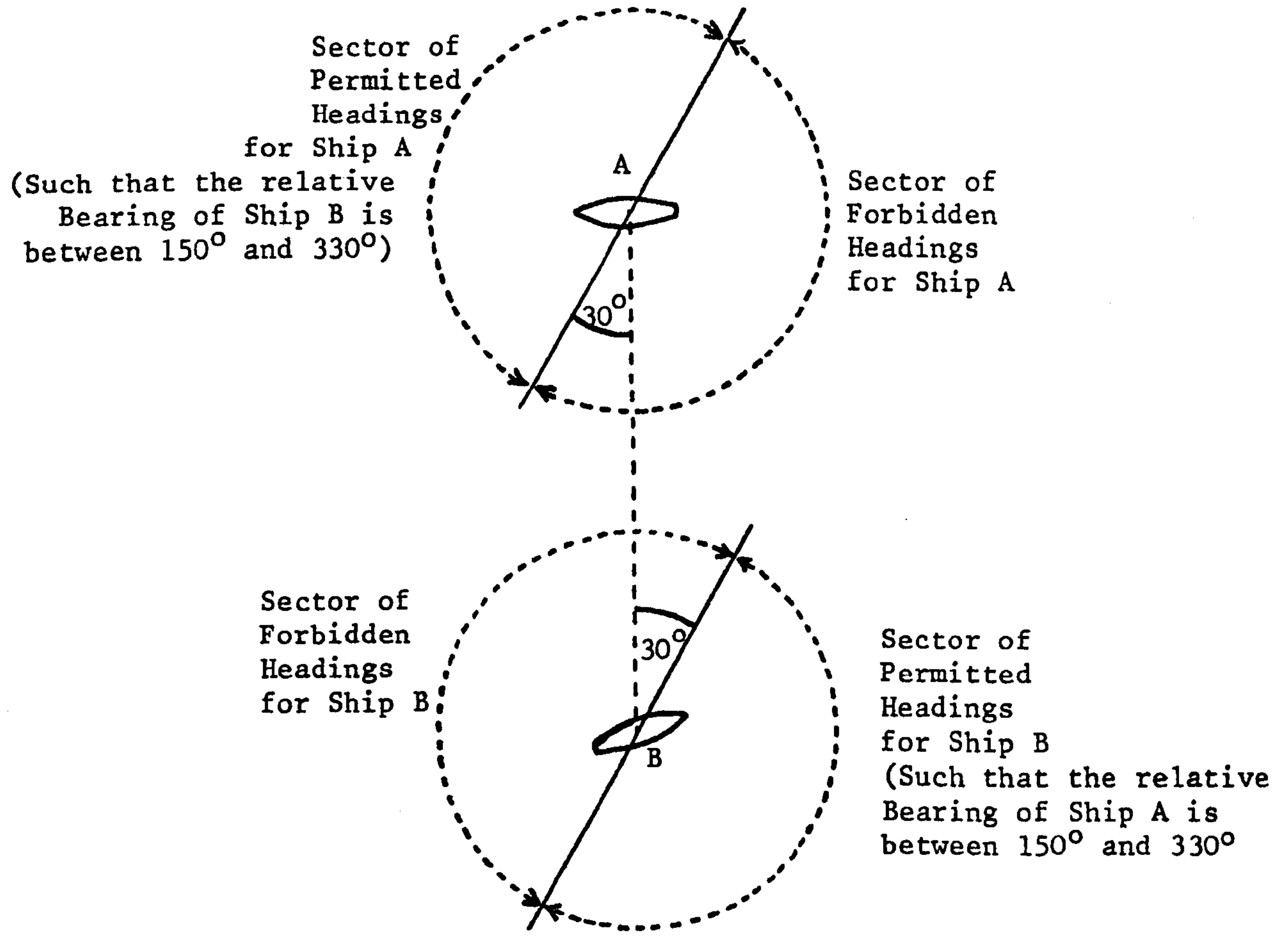
Another geometrical collision avoidance system was proposed by Garcia-Frias in a series of papers from 1960 onwards,[38,69,70,71 and 72].

The basis of Garcia-Frias' suggestions is that each party to an encounter should alter course to put the other within a specified relative bearing sector. The frame of reference for a particular ship is thus provided by its own heading and the direction in which it observes the other, both of which are easily and accurately definable. As with Calvert's system, a knowledge of the other ship's heading is unnecessary.

An original feature of Garcia-Frias' rules is that they specify action in relation to the headings required for disengagement rather than the headings for which collision risk originally exists. This makes the rules superficially more complex, but the provision of supplementary manoeuvring diagrams is unnecessary and so the overall system is not difficult to apply.

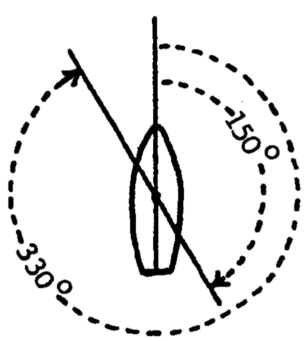
For the clear weather case, Garcia-Frias allocates permissible sectors for the headings of each party to an encounter in terms of the relative bearing of the other. Each is permitted to head in such a direction that the other lies

Fig. 22



Note:- Relative bearings are conventionally measured, clockwise from the direction of a ship's head from 0° to 360° , e.g.

Fig. 23



They may also be measured from the direction of a ship's head up to 180° to starboard (or green) and up to 180° to port (or red), but these forms have been avoided in this thesis.

on a relative bearing between 150° and 330°. The sectors of permissible and forbidden headings are shown above (Fig. 22) for two ships A and B. It is clear that, when each ship is heading within its permitted sector, the ship's courses are diverging and risk of collision is eliminated.

Garcia Frias also devised a system for avoiding action by only one of the two parties to an encounter. This is primarily to meet the situation in poor visibility when only one of the two vessels is using radar. His manoeuvring system recognises that there is no infallible means by which a slow ship can avoid collision with a faster one and so an essential part of his system is that non-radar ships should operate at less than some arbitrary speed (he suggests 6 knots) and that ships using radar should operate always faster than this arbitrary speed.

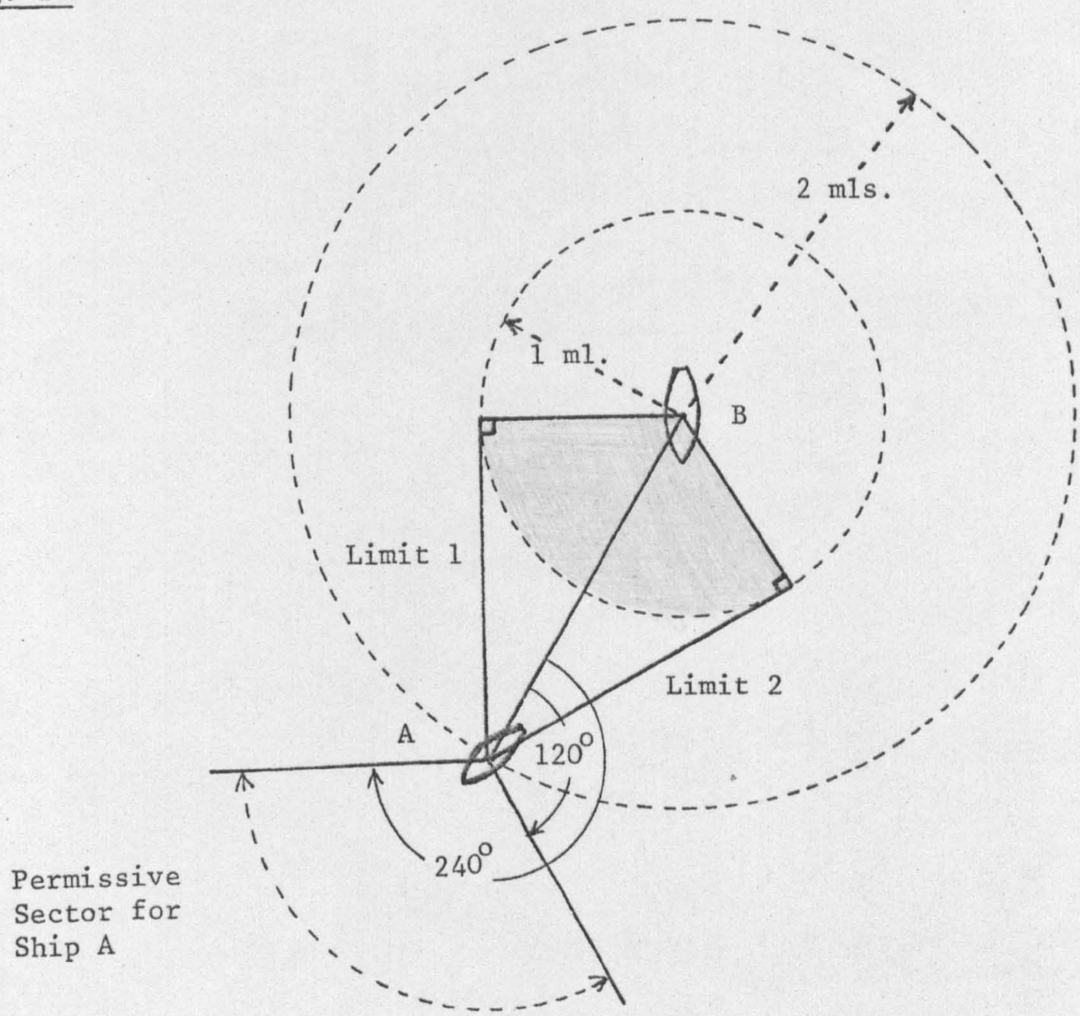
The action taken by the ship with radar is designed to be effective whatever the action of the ship without radar. To achieve this, Garcia-Frias suggests that action should be taken at a range of two miles so that the nearest approach between the two ships is not less than one mile. The following diagram (Fig. 24) shows the sector within which the ship with radar (A) can head. For headings within this sector, the relative bearing of ship B is between 120° and 240° from ship A. Provided that ship A heads within the prescribed sector, the vector difference between the two ships velocities will always be such that a nearest approach of at least one mile is achieved. The worst that can happen is that the two ships have the same speed and settle onto parallel courses; Garcia-Frias calls this the "inoperative" case.

If the heading of ship B is outside the shaded sector the ship courses are diverging and no risk of collision exists.

If the ship B has any heading within the shaded sector, the relative velocity of A with respect to B is such that it lies outside limits 1 and 2 on the diagram. The nearest approach is therefore at least one mile.

The two systems proposed by Garcia Frias for co-operative and unilateral manoeuvres respectively are compatible in that sectors exist which satisfy both simultaneously. If a ship detects a collision encounter by radar it can alter course to put the other on a relative bearing of between 150° and 240° and this action is effective whether the other ship co-operates or not. For vessels in sight of one another, the less restrictive sector rule for co-operative action applies, and each vessel alters course to put the other on a relative bearing between 150° and 330°.

Fig. 24



Additional noteworthy points in Garcia-Frias' papers were his discussion of encounters involving more than two ships and his treatment of encounters which are near misses rather than geometrically exact collision encounters.

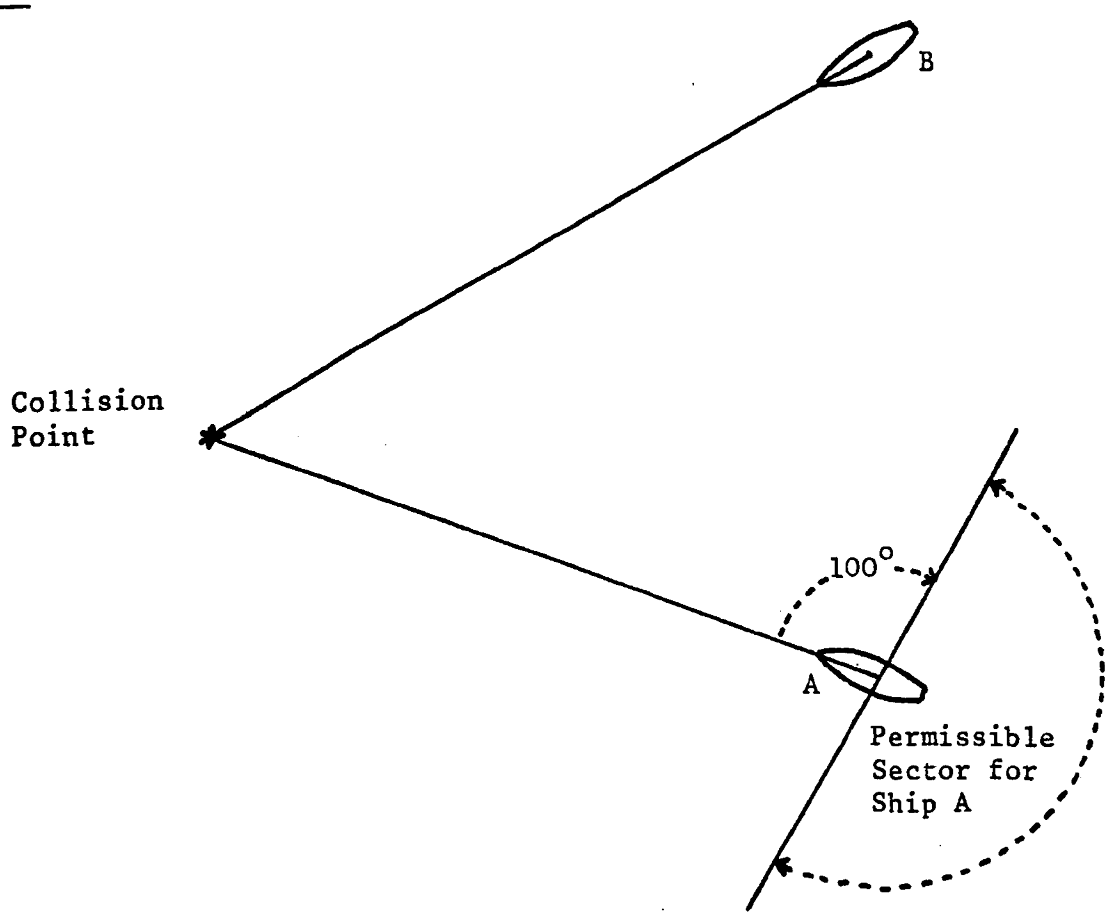
Garcia-Frias' suggestions have much originality and merit. The following advantages are important:

1. The basis of his system is simple although the arguments he uses to justify it are complex and sometimes difficult to follow.
2. Action to be taken depends only upon the relative bearing of the threat and the existence of risk of collision. A knowledge of the heading of the other ship (or even the initial heading of one's own ship) are unnecessary.
3. Specific limits are laid down for ship speeds and for the range at which action should be taken. Nebulous and subjective phrases such as "moderate speed" and "close quarters" are avoided.

Garcia Frias' suggestions are also subject to some criticisms:-

1. The action required by his sector rules is often exaggerated so that very large and therefore unattractive alterations of course are necessary to resolve quite simple encounters. Thus in the encounter illustrated below (Fig. 25), ship A would have to alter course at least 100° to starboard (the theoretical alternative of altering at least 80° to port being less likely to resolve the encounter so effectively).

Fig. 25



2. Alteration of speed is not provided for in the sector rules although in some cases it might be a more efficient way of resolving an encounter than an alteration of course.

3. Whilst it is desirable to make rules as objective as possible, the arbitrary ranges for avoiding action suggested by Garcia Frias are far too large for small ships and far too small for large ships. A sliding scale would be possible but would add to the complexity of the system and would be difficult to apply in encounters between ships of different sizes.

In summary, it is suggested that, although Garcia Frias' papers are not easy reading, they are worth careful study for the way in which he analyses the shortcomings of the present rules and suggests an alternative system which avoids those shortcomings and which is also simpler and more consistent. The fact that Garcia Frias' proposals are not in an entirely practical form detracts from their value but, as a theoretical study, they are of great interest, particularly for his specification of manoeuvres according to the geometry of disengagement rather than the geometry of collision.

MIXED COURSE AND SPEED CHANGE RULES

Also in the category of geometrical rules which prescribe specific action are those which distinguish between two ships according to the geometry of an encounter and then allocate an alteration of course to one ship and an alteration of speed to the other.

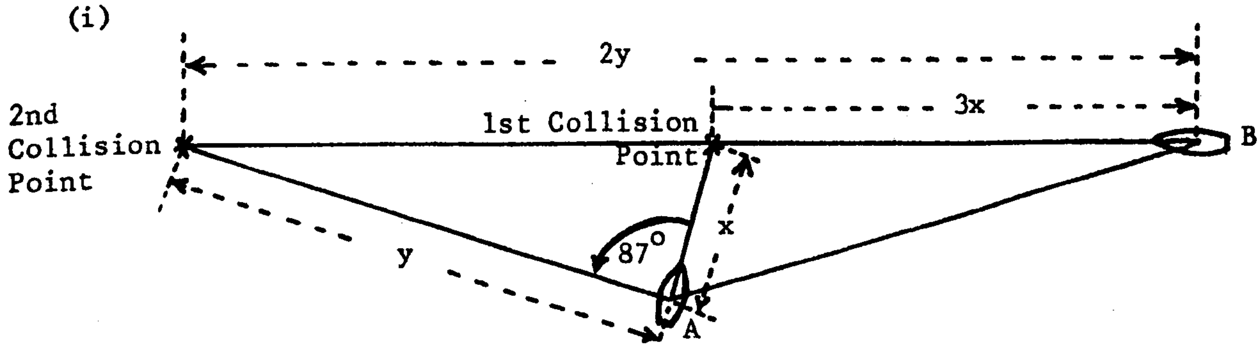
A rule of this type was proposed for use in fog by G.A.A. Grant in 1956[73]. Thus, "When a vessel sees another on her radar screen and it appears that there is danger of collision, then, if the other is on her starboard side, she shall avoid collision by altering course to port and if the other is on her port side she shall avoid collision by reducing speed."

It was claimed for this system that the actions are complementary and that, if only one of them is put into operation, the collision is avoided; but in fact neither of these statements is necessarily true.

Figure 26(i) below shows that the prescribed alterations may sometimes cancel so that a new collision situation is produced. Figure 26(ii) shows that an alteration of course to port alone can also give rise to a new collision point.

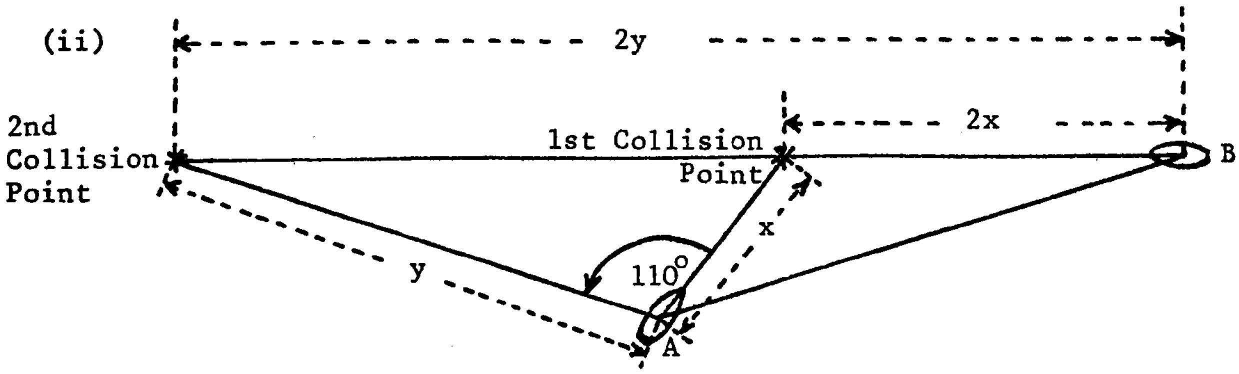
Fig. 26

(i)



Initially the speed of ship B is three times that of ship A. If ship B reduces speed by 33⅓% and if ship A alters course 87° to port, a second collision point is generated.

(ii)



The speed of ship B is twice that of ship A.
If ship A alters course 110° to port and ship B maintains speed, a second collision point is generated.

An amendment which would avoid the possibility of cancelling actions would be to require the ship with the other on her port side to stop instead of simply reducing speed. Such a rule was suggested in a note by the Government of Canada to the 9th session of the IMCO Safety of Navigation Sub-Committee (Nav. IX/2/5, March 1970). It was intended as a universal rule for use in all conditions of visibility.

The Canadian suggestion for crossing vessels was that:-

(a) If a vessel with which risk of collision exists bears from 20 degrees to port of the course to 90 degrees to starboard of the course, the speed shall be maintained and course shall be altered not less than 30 degrees to starboard so as to leave the other vessel not less than 10 degrees to port of the course."

"(b) If a vessel with which risk of collision exists bears more than 20 degrees to port of the course but not more than 90 degrees to port of the course, the course shall be maintained and speed shall be reduced to bare steerage way provided that action is not required by paragraph (a)."

This rule differs from Grant's in that part (a) requires an alteration of course to starboard, i.e. towards the threat instead of away from it. The part (b) requirement for one of the ships to practically stop instead of making an unspecified reduction of speed is sufficient to make the rule geometrically sound so that collision is avoided if either vessel or if both vessels manoeuvre. A high price is paid in the magnitude of the manoeuvres required of both ships.

In summary, it would seem that the Canadian suggestion provides an effective but not an efficient method of avoiding collisions at sea. In particular, a reduction of speed is not a popular manoeuvre amongst mariners, presumably because of the time penalty incurred and because it relinquishes most of the initiative in resolving a situation to the other party. Navigators, like motorists, sometimes lack faith in the competence of the drivers of other vehicles. Tests to be described in the next chapter suggest that inexperienced subjects also show a reluctance to use a reduction of speed as a means of avoiding collisions between ships so that the obvious reasons noted above may not be the only ones.

SUMMARY OF GEOMETRICAL RULES

As a class, geometrical rules have the capability of providing for the resolution of conflicts between ships with greater precision and greater efficiency than either omnipotent or hierarchical rules. Such greater efficiency is not always realised in practice and there is a disadvantage in that additional information is required before geometrical rules can be put into operation. This is the information necessary to define the frames of reference used and to define the positions and orientations of the ships within those frames of reference.

A general problem in navigation, and particularly in collision avoidance, is that decisions often have to be made on the basis of inaccurate and incomplete information. An early decision may mean that there is a high probability of the decision being wrong but that, if it is right, the action taken will be effective. A late decision usually means that better information is available so that a decision has a higher probability of being correct, but it also means that the action taken will not be so effective. The information pre-requisite for geometrical rules thus creates a difficulty in their application.

Workers in the field of collision avoidance have been well aware of this problem. Çalvert, in typically graphic style advocated[31] the "market square" technique of taking late but substantial action on the basis of good information. Hollingdale, as a mathematician, preferred to make a numerate recommendation and suggested[37] that a working rule for collision avoidance should be to spend half the time to go on observation to gather information and half on manoeuvre. Morrel, who was never lost for an elegant turn of phrase, discussed at length [33,36] what he called the "striking of a balance between long range uncertainty and short range impotence," but he made no definite recommendation.

Apart from the problem that the information necessary for their safe implementation may not always be available, geometrical rules have a further disadvantage. This arises from the fact that, if action is assigned according to the geometry of an encounter, no account is taken of the manoeuvring capabilities of the ship involved. This, in turn, means that in an encounter between a large, slow and ponderous ship and a small, fast and highly manoeuvrable ship, the former may be required to take the predominant action. In practice, in some cases under the present rules, this requirement is so clearly at variance with common sense that the rules are disregarded.

In general, geometrical rules are attractive in their positive nature and in their apparent precision, but consideration of the rules discussed in this section indicates that each particular case is subject to operational difficulties.

5. EXTERNAL OVERALL CONTROL OF TRAFFIC

CHARACTERISTICS

This is a collision avoidance method which demands a highly developed communications system. Within the area to which it is applied, the identity, position and velocity of every craft must be known to the central control unit. Technical provision is required so that manoeuvring instructions can be relayed to individual ships and legal provision is necessary to give force to the instructions.

Traffic control does not replace manoeuvring rules but does provide a means by which rules may be implemented effectively and efficiently. The principal advantages of having a single controller responsible for the manoeuvres of both parties to an encounter are that:-

(i) There is no difference of opinion as to whether risk of collision exists.

(ii) The manoeuvres allocated to the two ships can always be chosen to be complementary.

The controller may allocate manoeuvres according to a geometrical convention such as Calvert's, but hierarchical rules based on manoeuvring ability are more attractive when traffic is of mixed types of ship. The main objection to hierarchical rules is the difficulty of establishing precedence and this is eliminated when one man is responsible for both ships. The controller may act as arbitrator to assess the relative manoeuvring capabilities of two ships in conflict and can then allocate manoeuvres according to his assessment, thus permitting highly efficient disengagement. Economic factors, safety factors and political factors can also be included in rules for allocating manoeuvres, although not all are equally desirable.

SUMMARY

The cost of establishing and maintaining a marine traffic control system is high and the problem of acquiring legal force for controller's instructions to ships in international waters is formidable. Despite its attractions, it seems likely that external control of marine traffic will remain for many years restricted to terminal areas and port approaches such as Rotterdam, Hamburg, London and San Francisco. Comparisons between air traffic control systems and sea traffic control systems have been drawn by Van Hoof[74] and Griffiths[75].

CHAPTER IV

Description of Experiments

Merely corroborative detail
Intended to give artistic verisimilitude
To an otherwise bald and unconvincing
Narrative

The Mikado W.S. Gilbert

THE NEED FOR RESEARCH

In almost all the collision cases on which judgements have been passed, at least one of the two ships involved has been found to have contravened the International Regulations for Preventing Collisions at Sea. This statement may be confirmed by a study of Marsden's "The Law of Collisions at Sea"[76], and many workers in the field of collision avoidance have arrived at similar conclusions. Fricker, in particular, when commenting on a US Coastguard Report in 1965[58] noted that "The most startling feature of the Coast Guard analysis was the prevalent tendency of the parties involved to disregard the basic rules for preventing collisions". It seems reasonable to conclude that many contraventions of the regulations also occur which do not lead to collisions.

Disobedience of the collision regulations is usually assumed to be a human failure on the part of a ship's officer. It is further pointed out by some observers that, since collisions are almost always due to breaches of the regulations, then strict enforcement of the regulations would solve the problem. A corollary often drawn is that there is little point in changing the rules if mariners are not going to obey them anyway.

This sort of thinking seems to the author to oversimplify the problem. Firstly, the International regulations are so complex and beset with what Calvert has called "weasel wording"[77] that, whatever the circumstances of a collision, some contravention can almost always be discovered. In this respect, the additional verbiage of the 1972 regulations is not likely to help matters when they come into force. Secondly, the fact that the Regulations are sometimes disobeyed may be because they conflict with what mariners consider to be the best and most expedient action in certain situations. If this is the case, it is likely that changes in the rules could be devised which would lead to their greater acceptance by mariners. Such changes would possibly, but not necessarily, lead to a reduction in the collision rate.

It is desirable that a set of rules for preventing collisions should prescribe manoeuvres which are geometrically and logically consistent. It has been shown by Calvert in 1960[26] and Hollingdale in 1961[30] that, although the present regulations do not meet this requirement, it is possible to devise a set of rules which does. It is also desirable that a set of rules should prescribe manoeuvres which are attractive to mariners since there is no means of rigidly enforcing unpopular rules on the high seas, however efficient they may appear to be on paper.

It is possible that these two conditions of mathematical validity and operational acceptability cannot be satisfied together, in which case some compromise solution will have to be found.

The fact that the rules for preventing collisions at sea are often disregarded indicates, at the least, that certain rules, in certain situations are unacceptable to certain mariners. Most practising mariners have their own ideas in this matter, but planned research is needed to establish which rules and which situations are the critical ones for mariners as a whole.

Ultimately it is possible that rules which are found to be unpopular can be amended to make a better match with the intuitive reactions of the mariners who have to use them, thus leading to more predictable disengagement manoeuvres.

THE AIMS OF THE EXPERIMENTAL PROGRAMME

The experiments to be described were designed to test the effectiveness of the current rules for preventing collisions at sea in certain chosen situations. The experiments had three main purposes:-

1. To establish the problem encounters in which mariners at present tend to disregard the rules and thus in response to which mariners take varied and unpredictable action.
2. To establish what sort of patterns of manoeuvring behaviour mariners tend to follow in resolving the problem encounters.
3. To investigate whether or not manoeuvre patterns of behaviour are related to individual differences in personality or length of experience.
4. To establish what patterns of manoeuvring behaviour naïve subjects (with no knowledge of the collision regulations) tend to follow in problem encounters.
5. To compare the findings of 2 with those of 4.

EQUIPMENT

All the experiments were carried out using a marine radar simulator. This was considered to be the nearest approach possible to the real life situation whilst at the same time retaining full control over the experimental conditions. Use of the simulator also ensured repeatability of standard encounters within close limits for a number of trials.

The City of London Polytechnic's Solartron radar simulator was used throughout. This is a "three own ship" simulator in which the radar screens of three ships can be simulated completely and independently in three separate compartments. A subject in any one compartment has direct control over the speed and the heading of his own ship. The experimenter has up to four moving "target ships" over which he has complete control and which he may cause to appear on any or all of the subjects' radar screens.

The experimenter can monitor the heading and speed of all the subjects' ships from direct read-outs at his console. The positions of all the ships in the playing area may be taken from digital voltmeter readings in the form of X, Y coordinates for plotting on squared paper. Alternatively, tracings may be made from a Kelvin-Hughes "photoplot" device which projects the positions of all the ships in the playing area at selected intervals. Both these methods were used for recording experimental results.

An outline specification of the simulator performance is contained in appendix IX.

THE DEPENDENT VARIABLES

In response to a potential collision situation, a subject may take avoiding action by altering the course and/or the speed of his ship. He may make an early or a late decision and his action may take the form of a single manoeuvre or a sequence of manoeuvres. Some manoeuvre patterns are highly complex.

In order to compare the behaviour of different subjects in response to a particular encounter, some assessment of the style of their manoeuvres is required. Clearly, if experiments are to be meaningful and repeatable by other experimenters, any assessment should be in terms of objective measurements.

Possible measurements considered from the outset of the research programme were as follows:-

1. A binary classification of alterations of course into port or starboard manoeuvres. The significance of such a classification depends upon the geometry of the given encounter.

2. A binary classification of alterations of speed into increases or decreases. Generally an increase represents a more confident and aggressive action and a decrease represents a less confident or more cautious action.

3. A measurement of the final miss-distance achieved between the two ships. This parameter is easy to measure but not easy to interpret. A small miss-distance, deliberately engineered could indicate boldness and confidence but a similar small miss-distance could arise unintentionally due to hesitancy, indecision or an imperfect assessment of the situation.

4. A count of the number of manoeuvres used to resolve an encounter. Generally the single, efficient manoeuvre would be expected to result from a competent and confident assessment of the situation. A series of manoeuvres, and particularly reversals of manoeuvres, would be expected from a less competent and confident subject.

5. The range at which action is first taken. Again this is easy to measure but not so easy to interpret. Late action could be attributed to over-confidence, indecision or a slow assessment of the situation. Early action could be attributed to over-anxiety or to the ability to make a rapid assessment of the situation.

As the programme developed, it became apparent that it would also be useful to distinguish between maneouvres which resolve an encounter quickly but which involve a certain level of risk and manoeuvres which take longer to resolve an encounter but which are more conservative and involve a lower level of risk. For particular encounters, these classes of manoeuvres can be distinguished by noting whether subjects alter course to port or to starboard or whether they increase or decrease speed. A simple binary distinction of this sort, between two classes of manoeuvres, represents a very crude measurement and clearly, within each class, there are degrees of risk and longer or shorter times for achieving disengagement. Some more precise measure of the effectiveness of a manoeuvre is very desirable, and the development of such a measure is attempted in the following section.

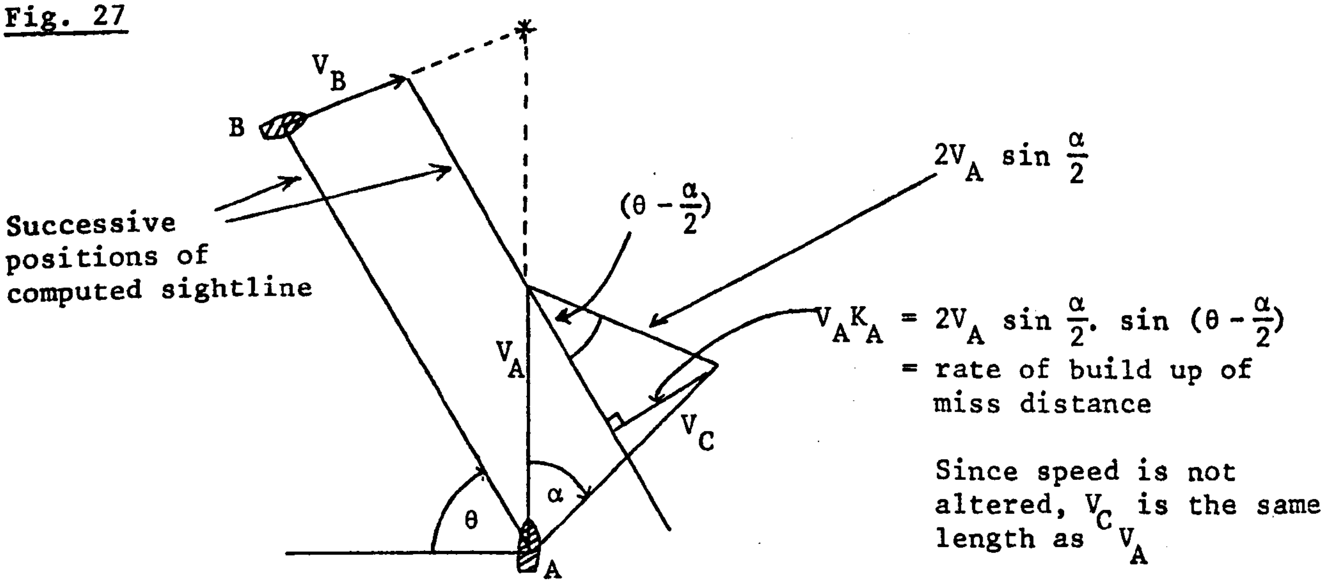
THE GEOMETRICAL UTILITY OF A MANOEUVRE

Generally, those manoeuvres which resolve a given encounter quickly are those which result in a rapid build up of miss-distance. Manoeuvres which lead to a prolonged disengagement are those which result in a slow build up of miss-distance. The rate of build up of miss-distance resulting from a given manoeuvre is therefore likely to be a useful experimental measurement.

In 1973 Calvert[68] published a formula giving the build up of miss-distance in terms of the geometry of the original encounter and the alteration of course by either or both of the ships involved. For full generality, a formula is required giving the build up of miss distances for changes of speed by either or both ships as well as changes of course.

A derivation of Calvert's original formula, and its extension to include the effect of speed changes as well as course changes, is presented below.

Fig. 27



In figure 27, V_A and V_B are velocity vectors of ships initially in positions A and B respectively and on collision courses. θ is the angle between ship A's port beam and the sightline AB, always measured clockwise. Ship B maintains course and speed, and ship B maintains constant speed but alters course through angle α, always measured to starboard. The contribution which ship A's manoeuvre makes to the miss distance in unit time is represented by the perpendicular distance from the end of the new velocity vector V_C onto the computed sightline. This length is designated V_AK_A and is given by:-

$$V_AK_A = 2V_A \sin\frac{\alpha}{2} . \sin(\theta - \frac{\alpha}{2}) \qquad \left[\text{Since } V_C \text{ is same length as } V_A\right]$$

In time t_A, the miss distance M_A, built up by the action of ship A is given by:-

$$M_A = V_AK_At_A \qquad \left[\text{where } K_A = 2\sin\frac{\alpha}{2} . \sin(\theta - \frac{\alpha}{2})\right]$$

In a general case, both ship A and ship B may alter course for differing periods of time t_A and t_B. Also instead of a precise collision encounter, a small miss distance, m, may exist even if neither ship manoeuvres. The total miss distance generated, M, is then given by:-

$$M = m + K_A V_A t_A + K_B V_B t_B$$

Any of the three components of M may be positive or negative depending upon whether they are associated with anti-clockwise or clockwise rotation of the observed sightline respectively. It is therefore possible for M to be zero as a result of cancelling manoeuvres or as a result of manoeuvres converting an initially safe situation into a collision. The final miss distance, M, is that which results if both ships return to their original courses after their manoeuvres have been maintained for periods t_A and t_B respectively.

Calvert's formula for the rate of build up of miss distance due to a given alteration of course is very valuable in that it provides a measure of the efficiency of a manoeuvre.. For full generality, however, the effect of an alteration of speed should also be included so that the rate of build up of miss distance can be calculated for any change of velocity. The derivation of such a formula is attempted with reference to figure 28, below.

Fig. 28

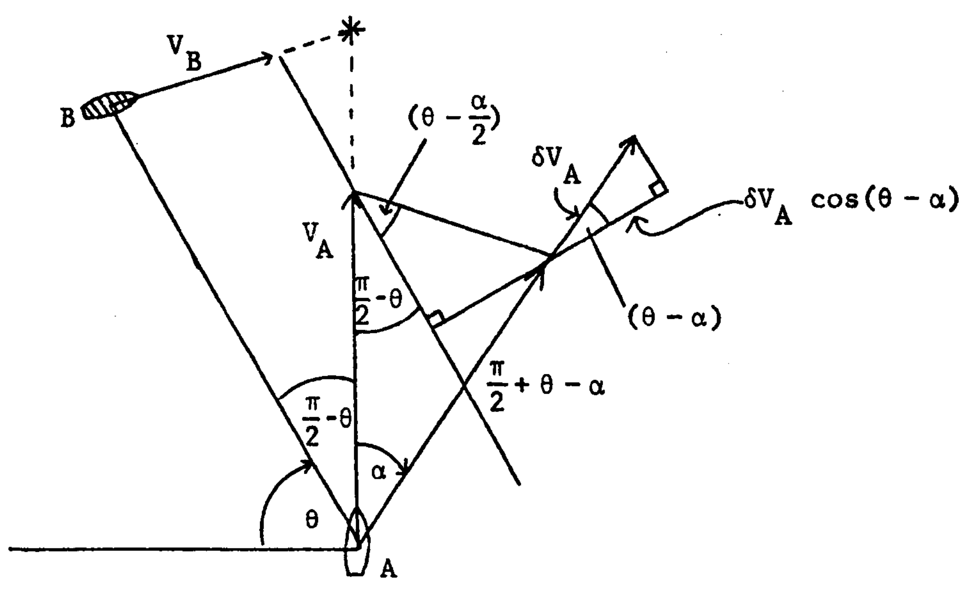


Figure 28 is similar to the figure 27 except that, as well as altering course through an angle α, ship A increases speed by the quantity δV_A. The geometry of the diagram is such that the angle between the new velocity vector and the perpendicular to the computed sightling is $(\theta - \alpha)$. The component added to the miss distance in unit time by the increase in speed is therefore $\delta V_A \cos(\theta - \alpha)$.

If we designate the rate of build up of miss distance due to an increase in speed of δV_A as $\delta V_A.L_A$, we have:-

$$\delta V_A.L_A = \delta V_A.\cos(\theta - \alpha)$$

The total contribution, M_A of ship A's manoeuvre to the miss distance after time t_A is thus:-

$$M_A = K_A.K_A.t_A + \delta V_A.L_A.t_A \qquad \text{where } L_A = \cos(\theta - \alpha)$$

In general, the total miss distance achieved by the combined manoeuvres of two ships is given by:-

$$M = m + V_A.K_A.t_A + \delta V_A.L_A.t_A + V_B.K_B.t_B + \delta V_B.L_B.t_B$$

This formula may be extended to cover cases where the ships make more than one velocity change by including separate terms for the periods during which each velocity change is maintained.

An an experimental measure for assessing the attractiveness of a manoeuvre to a subject, the rate of build up of miss distance (R_A) due to the manoeuvre of his own ship (A), is preferred to contribution which his manoeuvre makes to the final miss distance (M_A). This is because a high rate measurement implies a rapid as well as an effective disengagement. It is suggested that the rate of build up of miss distance resulting from a given manoeuvre may be taken as an approximate measure of the "geometrical utility" (G_A) of that manoeuvre to the subject. Knowledge of the collision regulations, reluctance to deviate too far from track, inhibitions regarding reduction of speed, lack of confidence and other difficult to quantify influences, may cause subjects to choose manoeuvres which do not maximise geometrical utility.

In the case of precise collision encounters, the formula for the geometrical utility of a manoeuvre is thus the formula for the rate of build up of miss distance due to the manoeuvre of the subject's ship:-

$$\text{Geometrical Utility, } G_A = R_A = V_A K_A + \delta V_A L_A$$

where
- V_A = Initial speed of subject's ship, A
- δV_A = Increase in speed
- $K_A = 2 \sin\frac{\alpha}{2} \cdot \sin(\theta - \frac{\alpha}{2})$
- $L_A = \cos(\theta - \alpha)$
- α = Course alteration of subject's ship, always measured to starboard.
- θ = The angle between the subject's ships port beam and the direction of the target ship at the time of manoeuvre.

It may be noted here that an alternative approach to measuring the effectiveness of avoiding action was proposed in 1973 by Hasegaw, Kasahara, Yamazaki and Kai[78]. They published a formula for the change in direction of the relative velocity vector due to changes in the velocities of the two ships involved in an encounter, and also a formula for the change in the length of the relative velocity vector due to changes in the velocities of two ships involved in an encounter. Neither measure, on its own seems to be directly related to the utility which a manoeuvre might have to a subject.

THE USE OF GEOMETRICAL UTILITY

Although it is an attractive measure in theory, it is not easy to use the geometrical utility of a manoeuvre in practice. There are two main reasons:-

1. The formula depends upon the alterations of velocity being instantaneous. Some observed manoeuvres are, in fact, abrupt enough to be considered as instantaneous but many are made over a period of time during which the subject's ship follows a curved path or undergoes a continuous change of speed. Quite often, new manoeuvres are instigated before previous ones have been properly completed.

2. In cases where the initial situation is not a precise collision encounter, the original miss distance must be taken into account in comparing the utility of different manoeuvres. If ship A makes a manoeuvre which increases the original miss distance, geometrical utility (G_A) may be defined as the rate of miss distance build up (R_A) adjusted by adding a quantity equal to the original miss distance divided by the time for which the manoeuvre is held. If a manoeuvre is made which at first decreases the original miss distance before building up a miss distance in the opposite direction, the geometrical utility may be defined as the rate of miss distance build up adjusted by subtracting a quantity equal to the original miss distance divided by the time for which the manoeuvre is held. Thus:-

$$G_A = R_A + \frac{m}{t}$$

where m = original miss distance, designated positive if associated with anti-clockwise rotation of the sightline and negative otherwise.

t_A = time for which the manoeuvre is held.

Although adjustment of this sort is possible, it seems doubtful whether this degree of sophistication is justified for measuring so impreeise a quantity as utility.

Because of the practical difficulties mentioned, it was decided that geometrical utility could not be used systematically as one of the independent variables in any of the experiments. Nevertheless, the concept is considered to be important and will be noted where it seems appropriate in the description of the experimental results.

THE INDEPENDENT VARIABLES

The independent variables of interest in this programme are those that might be expected to be related to a subject's manoeuvring behaviour in response to the simulated encounters with other ships. Those chosen for study could all be assessed objectively.

1. Knowledge of the Rules for Preventing Collisions at Sea

This is an important factor since the influence of the rules on the manoeuvring patterns of mariners is the prime object of this study. It did not seem practicable to grade subjects according to the depth of their knowledge of the rules and so a simple binary division was made into subjects with a knowledge of the rules and those with no knowledge at all of the rules.

2. Length of Experience

This was measured in years (and in some cases years and months) from the time at which a subject first went to sea. Any systematic change of behaviour patterns with length of experience is clearly of great interest.

3. Eysenck Personality Inventory (EPI) "E" and "N" scores

These variables were considered suitable for study because they could be measured conveniently and objectively. Also, the behaviour patterns noted by Eysenck and Eysenck (1964)[79] as having been related to EPI scores are such that manoeuvring patterns might be expected to be similarly related to EPI scores. Specific predictions are made in hypotheses H_1 and H_2 to follow.

4. Embedded Figure Test (EFT) scores

The embedded figure test developed in 1950 by H.A. Witkin[80], provides an easily administered and objective measure related to his concept of field-dependence and field independence. The test measures the time taken to identify simple geometric figures hidden in a more complex design, the overall time being then a measure of a subject's field dependence.

Results relating EFT score positively with the frequency of a subject's accident involvement were published by Harano in 1970[81]. These results were in respect of motor vehicle accidents, but they suggested that performance in embedded figure tests might also be related to manoeuvring patterns used by subjects to avoid collisions between ships. A specific prediction is made in hypothesis H_3 to follow.

EXPERIMENTAL DESIGN

The experimental programme consisted of three divisions.

1. General Encounters. Three standardized encounters, graded in complexity, and involving differing numbers of target ships, were presented to experienced navigators. The length of experience of all the subjects was noted and EPI and EFT assessments were made in as many cases as possible.

The performance of each subject was noted in terms of (a) the miss distance achieved, (b) the number of manoeuvres used to achieve disengagement and (c) the range at which action was first taken. Alterations of course to port or to starboard and increases or decreases of speed were also noted.

2. End-on and Nearly End-on Encounters. Five standardised encounters between two ships on opposite and parallel courses in each case, but with their course lines displaced by differing distances, were presented to subjects of high and low levels of experience but all with a knowledge of the collision regulations. Two of these standard encounters were presented to naïve subjects with no knowledge at all of the collision regulations.

The performance of the subjects was measured in terms of port or starboard alterations of course and increases or decreases of speed.

3. Right-angled Crossing Encounters. Two standard crossing encounters between ships, one in which the target ship approaches from the port side and one in which the target ship approaches from the starboard side were presented to navigators of varying levels of experience but all with a knowledge of the collision regulations. The same two encounters were also presented to naïve subjects with no knowledge of the regulations. EPI and EFT assessments were made of some of these subjects.

The performance of subjects in these encounters was measured in terms of alterations of course to port or to starboard and increases or decreases in speed. The performance of experienced subjects was also measured in terms of

(a) the miss distance achieved, (b) the number of manoeuvres used to achieve disengagement and (c) the range at which action was first taken.

HYPOTHESES

The experimental programme was originally designed to test eight hypotheses. As the programme developed, results suggested that some additional hypotheses could usefully be tested. These "auxiliary" hypotheses are introduced at appropriate points as the need for them becomes apparent. The original hypotheses were as follows:-

(H_1). For manoeuvres made in response to general encounters, there is a positive correlation between a subject's final miss distance and his EPI "E" score.

This prediction is made on the grounds that an extraverted subject, i.e. having a high "E" score, might be expected to take bolder and more extravagent action than a subject with a low "E" score.

(H_2). For action taken in response to general encounters, there is a positive correlation between the number of manoeuvres used to achieve disengagement and the subject's EPI "N" score.

This prediction is made on the grounds that a stable subject with a low "N" score might be expected to make a firm decision and then stick to it but that a less stable subject with a high N score might have a greater tendency to change his mind or amend his decision.

(H_3). For action taken in response to general encounters, there is a negative correlation between the range at which a subject first makes a manoeuvre and his EFT score.

This prediction is made on the grounds that a subject scoring high in the EFT is "field-dependent" and therefore likely to take longer to isolate the essential features of the situation on which his action must be based. The low scoring "field-independent" subject might be expected to make a more rapid analysis and therefore taken earlier action.

(H_4) In some encounters, it is possible to divide subject responses into two classes.

Class (q) (q = quick) is defined to include those manoeuvres which result in rapid disengagement but which entail a measure of risk. Class (t) (t = tardy) is defined to include those manoeuvres which prolong the time to disengagement but which are safer and more conservative. The hypothesis is that the subjects who choose class (q) manoeuvres are of stochastically greater experience than those who choose class (t) manoeuvres.

This prediction is made on the grounds that early relief from anxiety reinforces class (q) responses so that they become more common as a mariner becomes more experienced. See also the discussion on page 135.

(H_5) In precise end-on encounters between two ships, the proportion of alterations of course to port is less for subjects with a knowledge of the collision regulations than for naïve subjects with no knowledge of the regulations.

This prediction is made on the grounds that the collision regulations recommend alterations of course to starboard rather than to port for this type of encounter if fog. For naïve subjects, the symmetry of the situation means that no apparent advantage attaches to either a port or a starboard alteration of course.

(H_6). In encounters between two ships on parallel and opposite courses such that a starboard to starboard miss distance of one mile will occur if no manoeuvre is made, it is possible to divide responses into nominally "natural" actions which maintain or increase the existing miss distance and nominally "unnatural" actions which cut across the track of the other ship. The hypothesis is that the proportional of "unnatural" actions is less for naïve subjects than for subjects with a knowledge of the collision regulations.

This prediction is made on the grounds that the collision regulations recommend alterations of course to starboard rather than to port so that subjects with a knowledge of the rules are under pressure to take action classes as "unnatural". Naïve subjects are expected to choose the "common sense" or "natural" alternatives more often.

At this stage, the terms "natural" and "unnatural" are merely labels considered intuitively to be appropriate to the classes of manoeuvre defined above. The justification or otherwise of these terms is dependent upon the experimental results.

(H_7) For right-angled crossing encounters it is possible to divide responses into:

(i) "Natural" actions which cause an initial increase in the rate of approach of the two ships but which lead to rapid disengagement. These actions give early escape from anxiety by taking a little extra risk.

(ii) "Unnatural" actions which cause an initial decrease in the rate of approach but which lead to a later disengagement and thus a longer period of anxiety.

The terms "natural" and "unnatural" may again be considered merely as intuitive labels.

The hypothesis is that, in right-angles crossing encounters where the target ship is approaching from the port side, naïve subjects take a smaller proportion of "unnatural" actions that subjects with a knowledge of the regulations.

This prediction is made on the grounds that naïve subjects may be expected to take the more expedient "natural" action on most occasions but that subjects with a knowledge of the regulations may be inhibited by that knowledge from making the alteration of course to port or the increase of speed required to implement "natural" class action.

(H_8) Using the same definitions of "natural" and "unnatural" action as for H_7, the hypothesis is that, in right-angled crossing encounters where the target ship approaches from the starboard side, subjects with a knowledge of the regulations take a smaller proportion of "unnatural" actions than naïve subjects.

This prediction is made on the grounds that the preference of the rules for starboard alterations of course encourages subjects to take action classes as "natural" in this type of encounter. Subjects with a knowledge of the rules may therefore be expected to take "natural" action more often than naïve subjects.

GENERAL ENCOUNTERS - EXPERIMENTAL PROCEDURE

The subjects used for these experiments consisted of experienced Merchant Navy Officers who presented themselves for courses at the City of London Polytechnic. They were all male and all had watchkeeping experience, and they were aged within the range from 22 to 55. They are designated group (i) subjects.

Three standard encounters (a),(b) and (c), graded in complexity, were presented independently to the subjects, using the radar simulator previously described. Each encounter was designed to develop into a collision or a near collision if the ships maintained their initial velocities.

In type (a) encounters, one target ship was presented and this was made to alter course to starboard after 15 minutes. The initial situation is illustrated in figure 29.

In type (b) encounters, two target ships were presented and both were made to maintain course and speed throughout the experiments. The initial situation is illustrated in figure 30.

In type (c) encounters, three target ships were presented. Two of these were made to maintain course and speed throughout the experiments and the third was made to alter course to starboard after 15 minutes. The initial situation is illustrated in figure 31.

The subjects' ships were simulated to be of 10,000 tons gross with a full speed of 16 knots. initially the speed was set at "slow ahead", equivalent to 8 knots. The subject thus had the facility to increase or decrease the speed of his ship as well as to alter course either way. No instructions were given to subjects other than the specification of their ships and that they should progress their ships through the playing area safely and expeditiously. They were requested to record the times of any manoeuvres that they might make.

The name, age and length of experience of each subject was recorded. In addition, EPI and EFT were administered when subjects were agreeable and when time permitted. These data are tabulated under "results" (pp.129, 130 & 131).

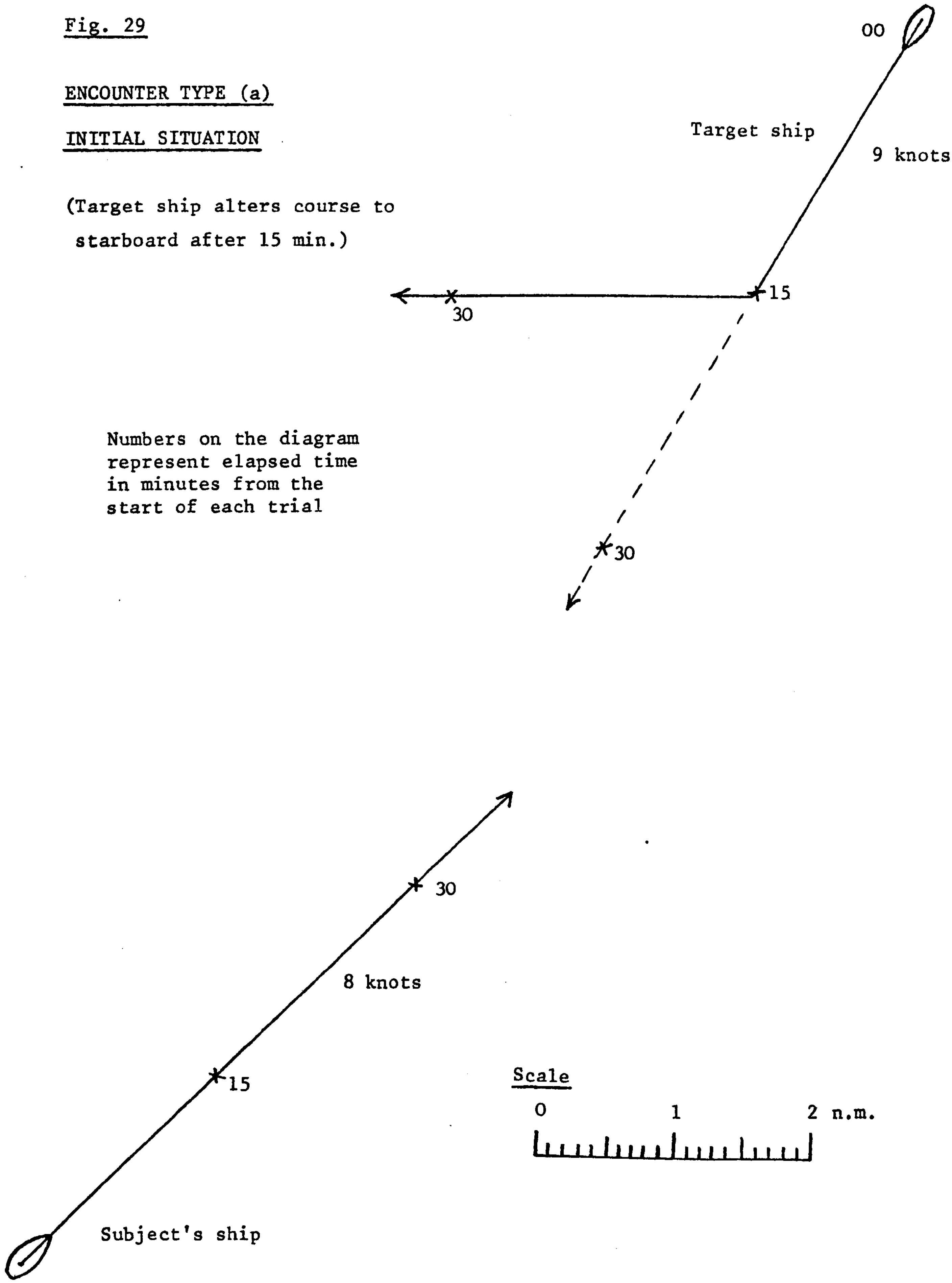
The development of each trial was plotted in real time on the Kelvin-Hughes photoplot equipment as the manoeuvres were made. A permanent record was obtained by tracing the completed plot onto cellulose film. The time required to resolve an encounter depended upon the action of the subject under test, but most plots covered a period of between 30 minutes and an hour. Measurements were taken primarily from the plot and the records kept by the subjects were used only as supporting material since these latter were not always completed reliably, particularly when subjects felt under stress. The dependent variables measured were:-

Fig. 29

ENCOUNTER TYPE (a)

INITIAL SITUATION

(Target ship alters course to starboard after 15 min.)



Numbers on the diagram represent elapsed time in minutes from the start of each trial

Fig. 30

ENCOUNTER TYPE (b)

INITIAL SITUATION

Numbers on the diagram represent elapsed time in minutes from the start of the trial.

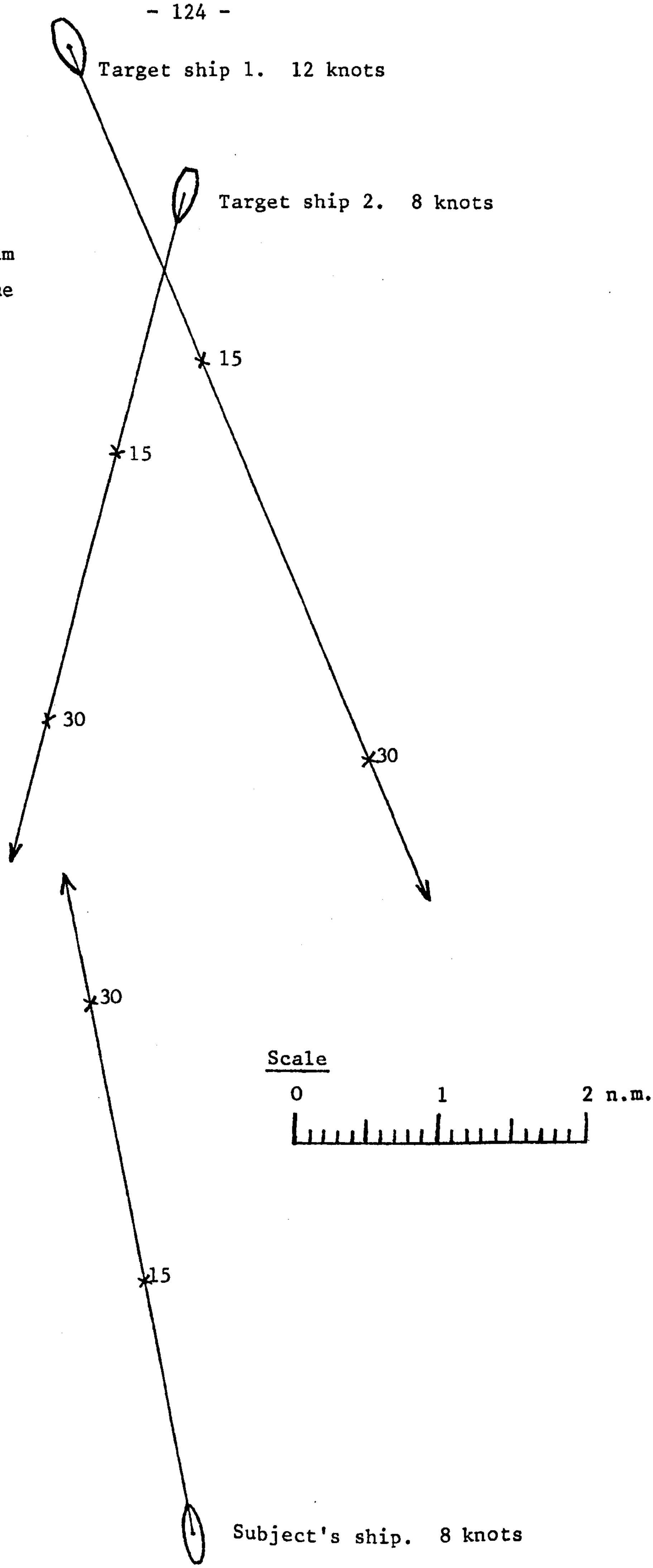
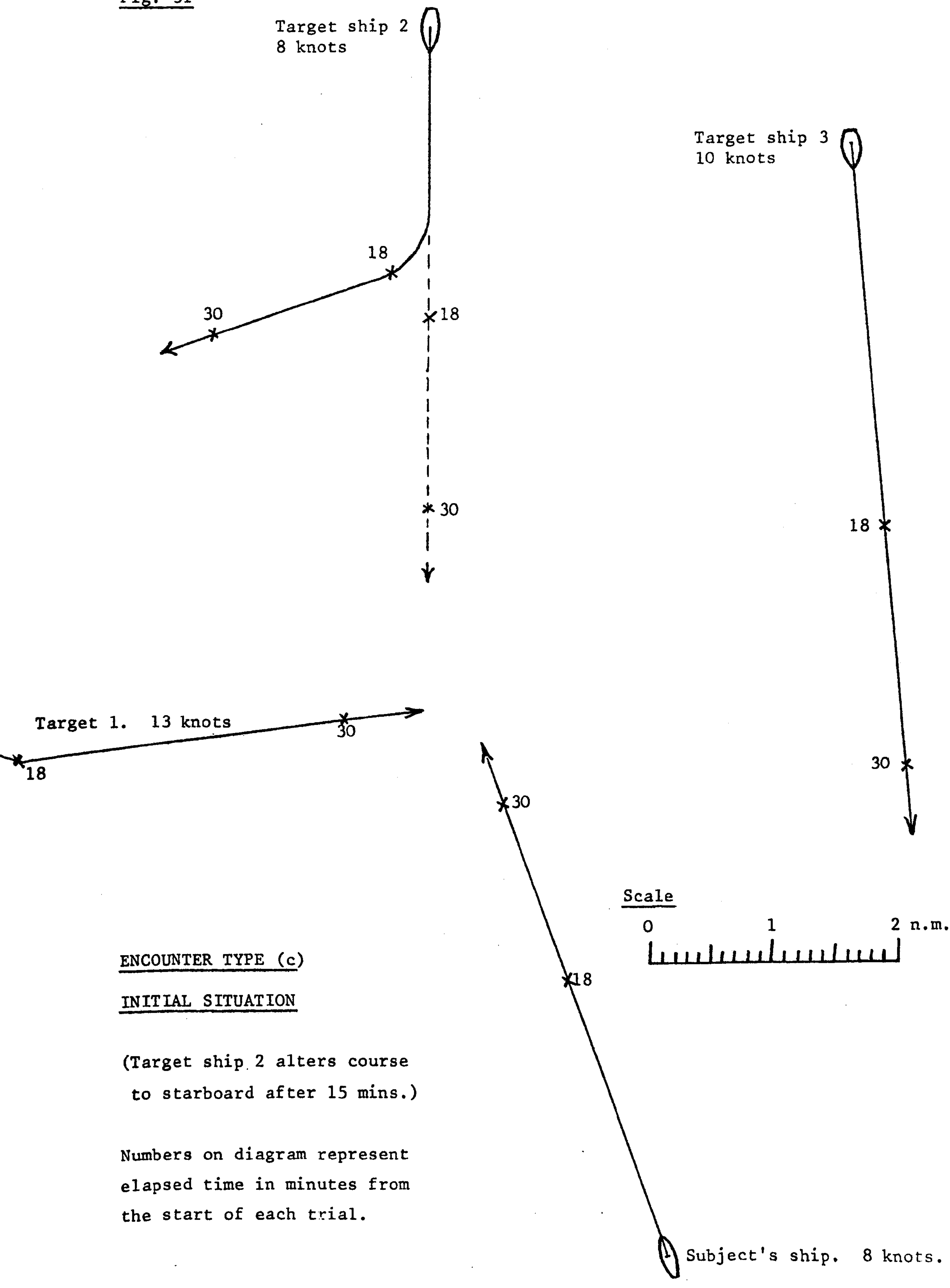


Fig. 31



ENCOUNTER TYPE (c)

INITIAL SITUATION

(Target ship 2 alters course to starboard after 15 mins.)

Numbers on diagram represent elapsed time in minutes from the start of each trial.

Fig. 32

Encounter type (a)

Superimposed plots of three independent trials run simultaneously on 21.6.71. Numbers on plot represent elapsed time in minutes from the beginning of each trial.

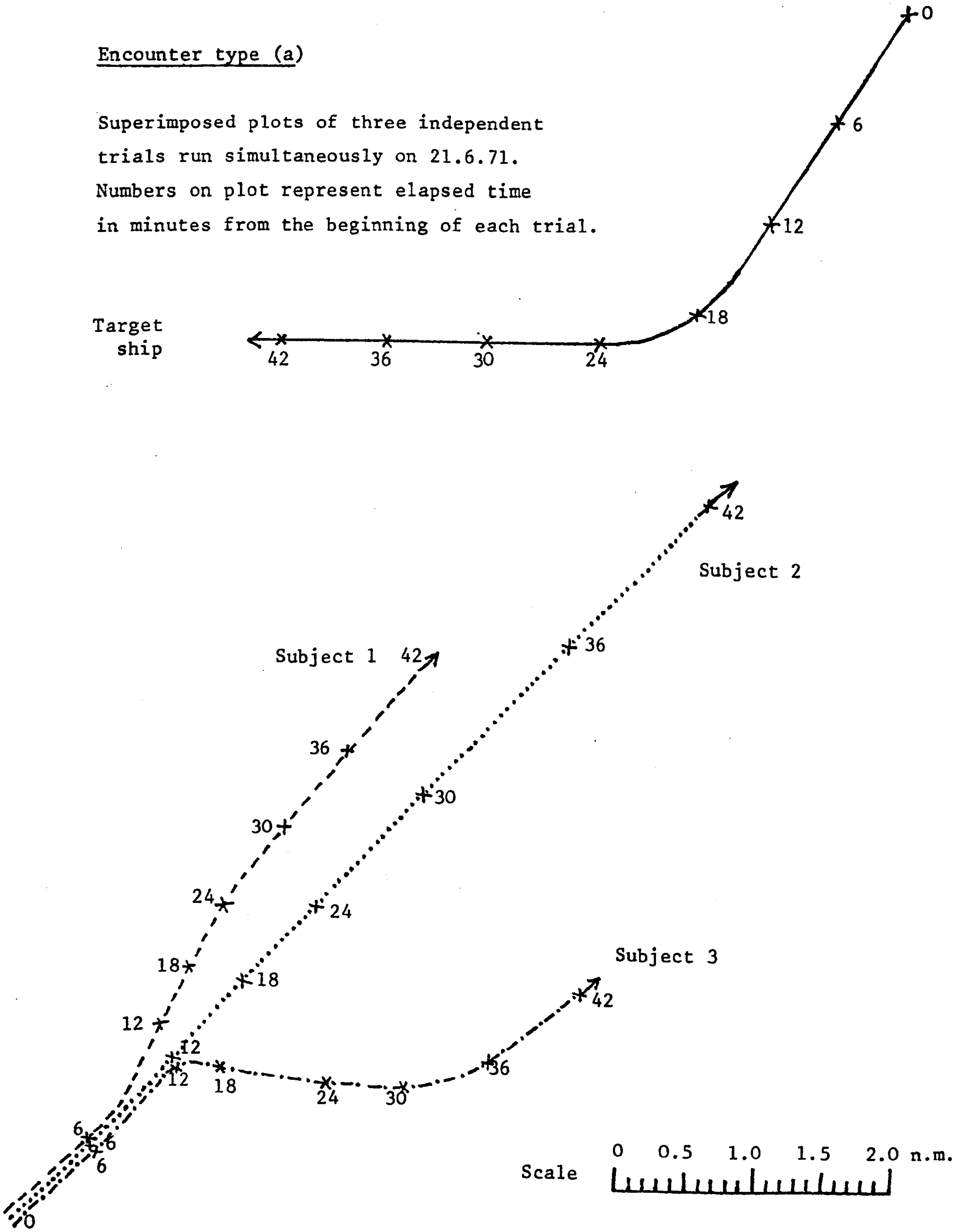
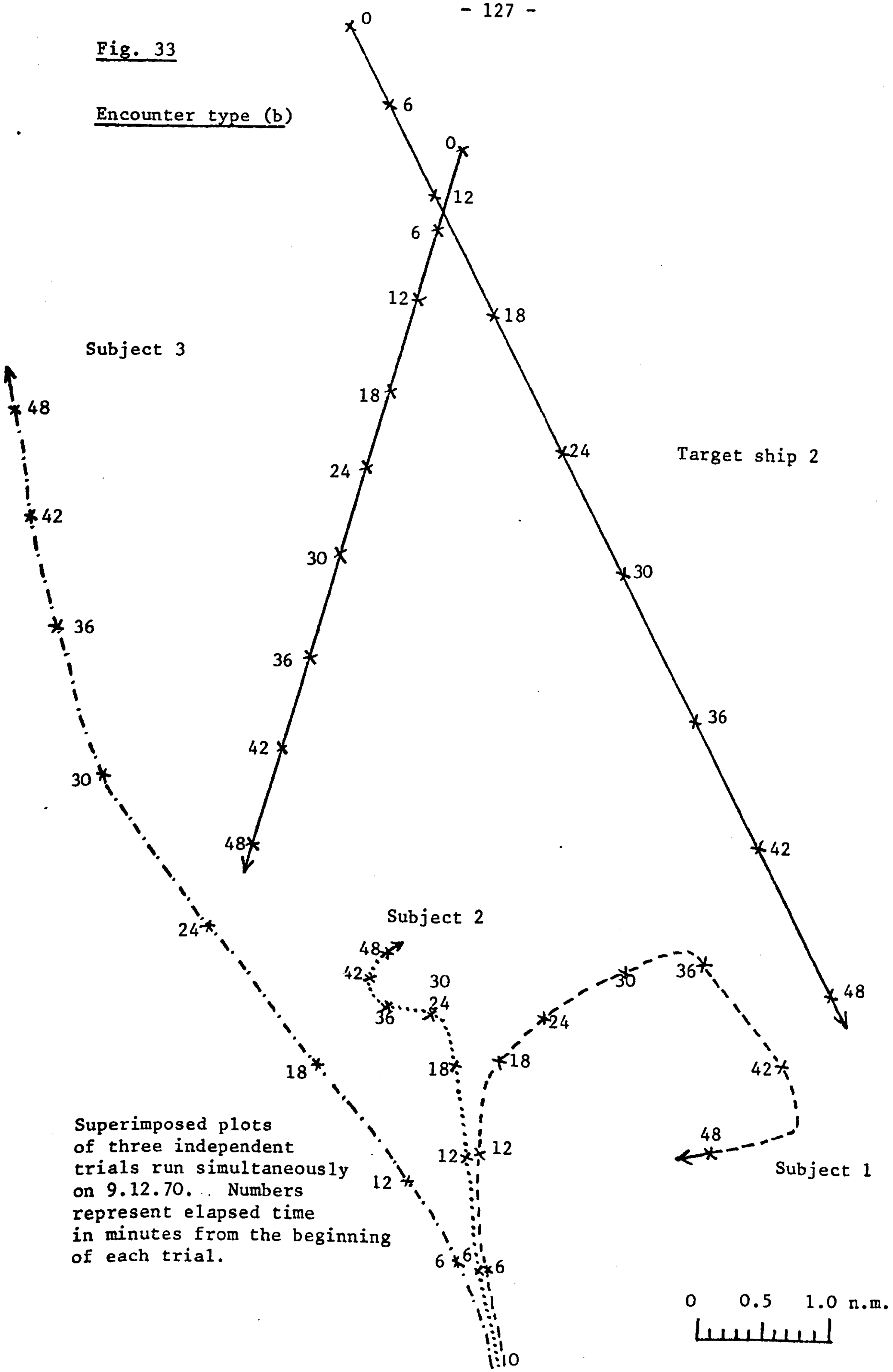


Fig. 33

Encounter type (b)



Superimposed plots of three independent trials run simultaneously on 9.12.70. Numbers represent elapsed time in minutes from the beginning of each trial.

Superimposed plots of three independent trials run simultaneously on 9.12.70. Numbers represent elapsed time in minutes from the beginning of each trial.

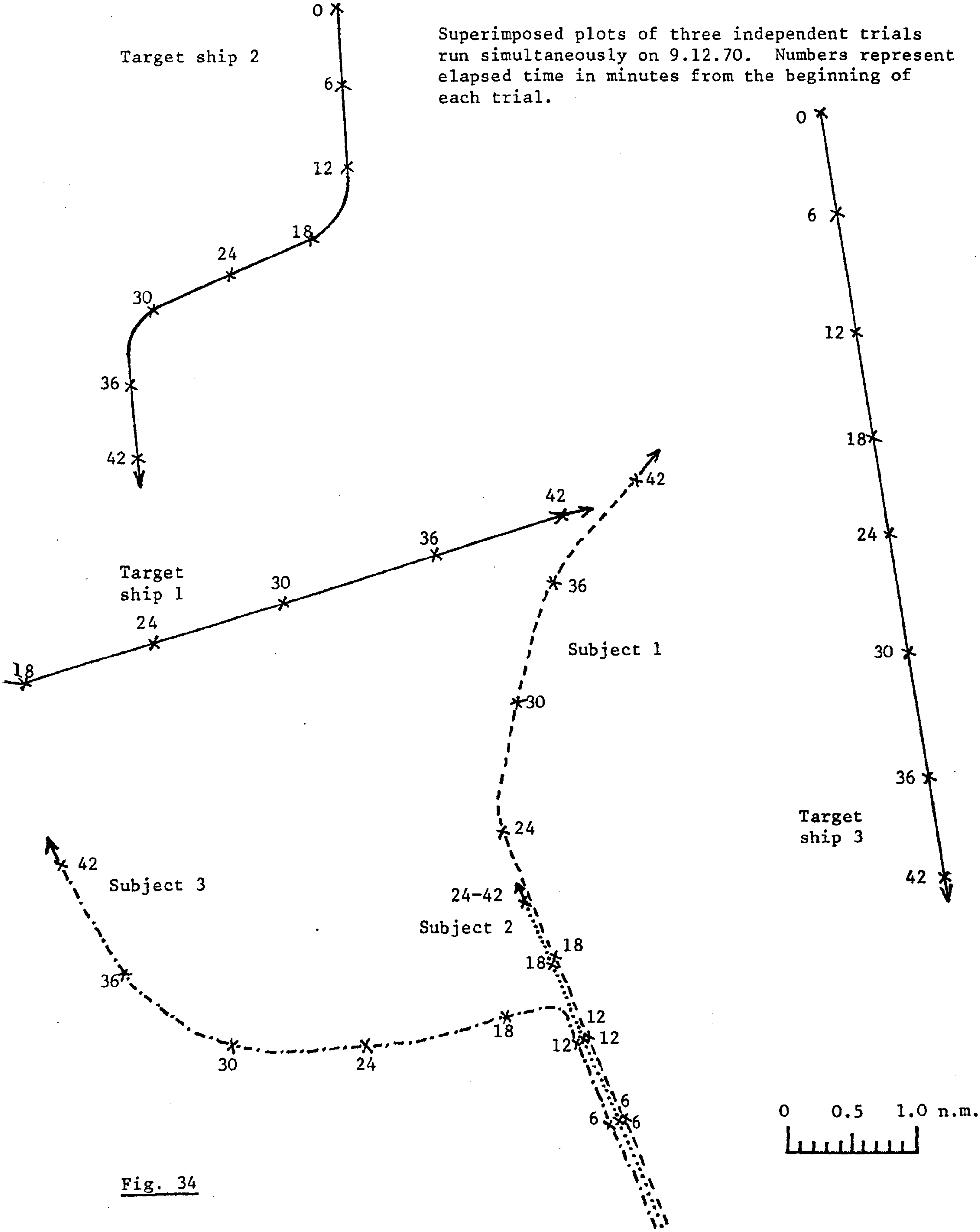


Fig. 34

Encounter type (c)

GENERAL ENCOUNTERS - RESULTS

Type (a) Encounters

Subject	EXP	EFT	N	E	MISS	A	R	C	Remarks
1	11	698	-	-	5.5	3	8.0	Stbd	
2	21	898	-	-	5.3	2	7.5	Stbd	
3	11	317	6	11	3.0	2	7.0	Stbd	
4	23	-	11	8	4.0	3	8.5	Stbd	
5	10	-	8	10	6.0	1	7.0	Stbd	
6	11	503	12	6	4.5	4	8.3	Stbd	
7	23	559	-	-	3.5	1	4.0	Stbd	
8	9	373	7	9	5.0	4	8.7	Stbd	
9	37	408	16	4	2.6	1	7.8	Port	
10	14	-	5	14	2.6	1	3.3	Incr	{Manoeuvred after target and so not used for tests}
11	9	439	12	9	5.2	4	8.3	Stbd.	
12	21	-	10	6	3.5	2	6.0	Port	
13	14	1190	10	16	4.5	1	7.4	Stbd	
14	28	1273	1	11	3.0	4	6.6	Slow	Reduced speed to stop
15	30	-	-	-	3.5	0	-	-	No manoeuvre made
16	31	514	6	8	3.0	4	7.5	Port	
17	9	411	2	11	5.1	1	6.2	Stbd	
18	11	698	13	14	2.2	3	6.2	Port	
19	7	299	12	8	3.2	1	5.0	Stbd	
20	9	-	11	11	3.5	1	7.5	Slow	
21	11	-	7	15	6.0	2	8.0	Stbd	
22	18	-	2	8	2.6	2	6.5	Port	(Round turn)
23	39	-	-	-	3.3	1	4.0	Incr	Increased to Full Ahead
24	39	-	4	7	3.2	2	5.0	Port	Reversed to Stbd. after target

EFT = Embedded Figure test score, seconds.

EXP = Seagoing experience, years

N = Eysenck Personality score, Form A

E = " " "

MISS = Miss distance, miles

A = Number of manoeuvres (alterations)

R = Range of target, in miles, at time of first manoeuvre

C = Character of avoiding action.

Type (b) Encounters

Subject	EXP	EFT	N	E	MISS	A	R	C	Remarks
1	11	698	-	-	2.8	3	7.5	Port	Clear
2	15	554	-	-	2.0	3	6.0	Port	Clear
3	11	317	6	11	1.6	2	6.7	Stbd	Full Ahead, Clear
4	23	-	11	8	3.0	2	7.5	Stbd	Full Ahead, Clear
5	10	-	16	18	1.0	3	6.1	Stop	Between
6	19	373	7	9	2.0	3	7.3	Port	Clear
7	23	559	-	-	2.8	8	6.3	Stbd	Clear
8	37	408	16	4	2.3	3	6.8	Port	Clear
9	14	-	5	14	1.5	3	5.2	Stbd	Clear
10	21	-	10	6	2.0	8	6.0	Stbd	Round turn, between
11	14	1190	10	16	1.2	6	4.7	Stop	Between
12	10	-	-	-	1.3	6	3.0	Stop	Between
13	25	991	6	11	2.5	2	6.0	Port	Clear
14	11	-	-	-	1.9	3	7.3	Stbd	Dead slow, between
15	11	-	-	-	1.5	4	7.8	Stop	Between
16	9	411	2	11	0.7	5	4.0	Stbd	
17	11	698	13	14	1.5	1	2.6	Stbd	
18	11	-	12	17	1.4	2	1.9	Stbd	
19	11	-	13	12	0.9	3	3.5	Stop	Between
20	9	-	11	11	2.2	1	5.6	Stop	Between
21	11	-	3	11	1.5	3	5.6	Stop	(Stbd.) Between
22	19	-	2	8	1.6	2	6.5	Stbd	Full Ahead, Clear
23	39	-	-	-	2.2	1	4.4	Port	Clear
24	12	-	11	19	1.6	1	5.5	Stbd	Full Ahead, clear

EFT = Embedded Figure test score, seconds

EXP = Seagoing experience, years

N = Eysenck Personality Score, form A

E = " " "

MISS = Miss distance, miles

A = Number of manoeuvres (alterations)

R = Range of target in miles, at time of first manoeuvre.

C = Character of avoiding action.

Type (c) Encounters

Subject	EXP	EFT	N	E	MISS	A	R	C	Remarks
1	12	484	-	-	1.3	5	6.6	Stop	
2	9	253	-	-	2.0	1	8.0	Port	Full Ahead
3	10	508	8	14	2.4	5	7.0	Stop	
4	15	1496	13	12	2.7	1	4.6	Stop	
5	10	-	8	10	3.2	3	6.5	Stop	
6	19	-	12	6	1.8	5	6.3	Mar.	Stbd. and Full Ahead
7	8	252	5	16	2.5	3	6.0	Port	
8	7	-	12	17	1.3	3	6.0	Stop	Stbd. then port
9	13	500	12	17	1.9	5	5.4	Port	
10	10	-	4	8	2.0	5	6.7	Stop	
11	15	363	19	9	1.5	5	2.2	Stop	
12	11	436	-	-	2.0	4	4.8	Stop	
13	28	1273	1	11	2.0	3	5.4	Stop	
14	30	-	-	-	2.0	1	5.4	Stop	
15	31	514	6	8	2.5	4	6.5	Stop	Port, clear
16	13	-	-	-	2.8	2	4.3	Stop	
17	29	-	11	7	2.3	4	3.5	Stop	
18	19	861	3	10	2.7	4	4.2	Stop	
19	27	-	11	12	2.0	1	4.0	Stop	
20	13	-	8	18	2.0	1	4.0	Stop	
21	11	-	10	0	2.0	1	4.0	Stop	
22	7	-	9	14	3.0	2	6.5	Stop	
23	12	429	7	23	2.7	2	5.8	Stop	
24	19	-	-	-	2.2	3	5.3	Stop	

EXP = Seagoing experience, years

EFT = Embedded figure test score, seconds

N = Eysenck Personality score, form A

E = " " "

MISS = Miss distance, miles

A = Number of manoeuvres, (alterations)

R = Range of target, in miles at time of first manoeuvre

C = Character of avoiding action

1. Alteration of course to port or starboard.
2. Increase or decrease of speed.
3. Final miss distance achieved in nautical miles.
4. The number of manoeuvres made.
5. The range, in nautical miles, at which the first manoeuvre was made.

Typical plots, showing three developments of each of the three standard encounters (a), (b) and (c) are illustrated in figs. 32, 33 and 34 above.

END-ON AND NEARLY END-ON ENCOUNTERS - EXPERIMENTAL PROCEDURE

The subjects used for these experiments fell into three groups.

Group (ii) Experienced Merchant Navy Officers all with at least First Mates Certificates of Competency. All in this class were male and they were all within the age range 24-40.

Group (iii) Merchant Navy Cadets with between one and two years seagoing experience, none of which was in charge of a watch. All had a knowledge of the collision regulations but no practical experience in applying them. All were male and within the age range 17-20.

Group (iv) Inexperienced (naive) subjects with no seagoing experience and no knowledge of the collision regulations. These subjects were city clerical workers or members of staff of the City of London Polytechnic other than School of Navigation lecturers. One third were male and two thirds female. They were within the age range 20-55.

Five standard encounters (d),(e),(f),(g) and (h) were used, with a single target ship on a parallel and opposite course to the subjects' ship in every case. The type (d) encounter was with ships exactly end-on to each other. The type (e), (f),(g) and (h) encounters were such that the ships would pass on each others' starboard side with miss distances of 0.5, 1.0, 1.5 and 2.0 nautical miles respectively if no manoeuvres were made. In every trial the target ship was made to maintain course and a constant speed of 10 knots throughout. The subjects of groups (ii) and (iii) were each given in turn all five encounters to resolve although not always in the same order. The subjects of group (iv) were given encounters of types (d) and (f) to resolve.

The subjects' ships were simulated to be of 10,000 tons gross with a full speed of 15 knots. Initially the speed was set at "half ahead", equivalent to 10 knots. The subject thus had the facility to increase or decrease speed as well as to alter course either way. The twelve mile range-scale was used on the radar screen and the subjects were told that only one target ship would be displayed. The naïve subjects were instructed on the use of the radar equipment and given time to practice manoeuvring their "ship" before the trials began.

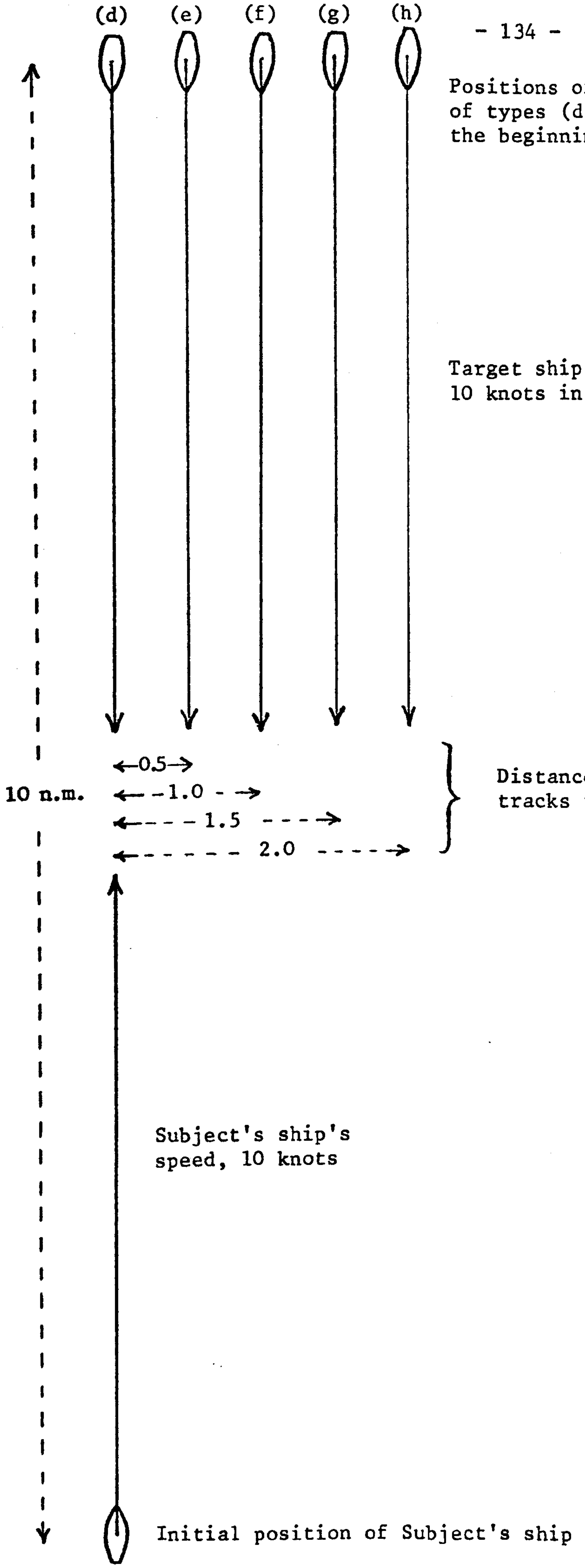
The initial situations for the five types of encounter are shown superimposed on one diagram below. (Fig. 35)

The name, age and length of experience of all the subjects was recorded but these data are not tabulated under "results" since only the broad classification into high experience (group (ii)) subjects, low experience (group (iii)) subjects and naïve (group (iv)) subjects is used for analysis.

The development of each trial was followed by recording digital voltmeter readings giving the positions of the subject's ship and the target ship in cartesian coordinates at three minute intervals. This method gave slightly greater accuracy than using the Kelvin-Hughes photoplot. A pictoral record of the trials was obtained by plotting on squared paper. The time required to resolve an encounter depended upon the action of the subject under test, but was typically of the order of 30 minutes.

The only dependent variable measured was the overall character of the method of disengagement, i.e. by alteration of course to port or starboard or by an increase or decrease of speed. More precise measurements of miss distance, etc. in nautical miles were not thought to be meaningful since the naïve subjects, and to some extent the low-experienced subjects, would have insufficient appreciation of how a miss distance of say 0.5 miles "feels" compared to a miss distance of say 1.5 miles in practice.

Typical plots showing the development of type (d) and type (f) manoeuvres for both experienced and naïve subjects are illustrated below. In each case, the manoeuvres of six subjects are shown superimposed on a single diagram. (Figs.36 and 37)



Positions of target ships in encounters of types (d), (e), (f), (g) and (h), at the beginning of each trial.

Target ship's speed
10 knots in each case

Distance between tracks in nautical miles

Fig. 35

END-ON AND NEARLY END-ON ENCOUNTERS

Fig. 36 Typical Action in an End-on Encounter Type (d)

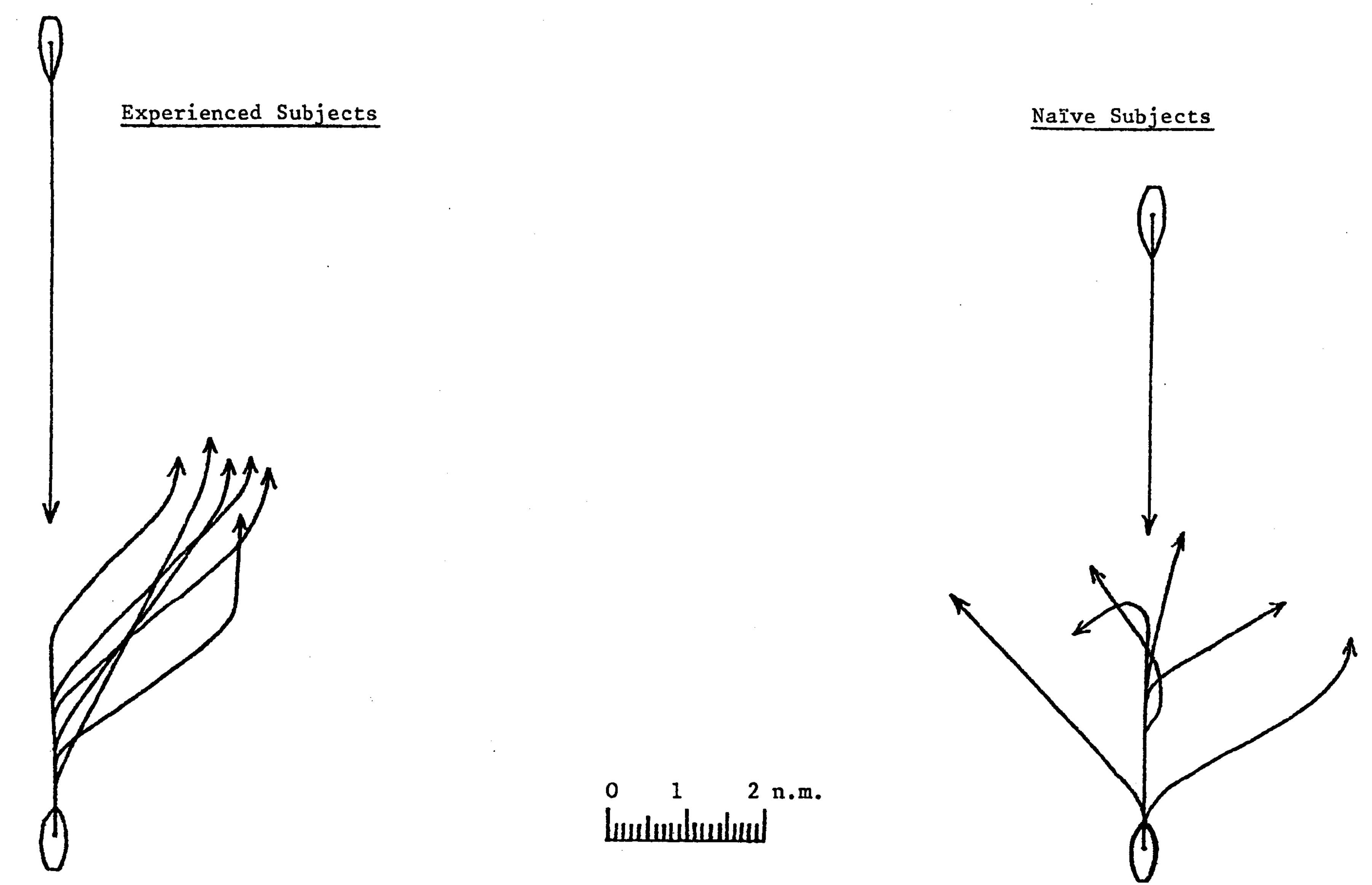
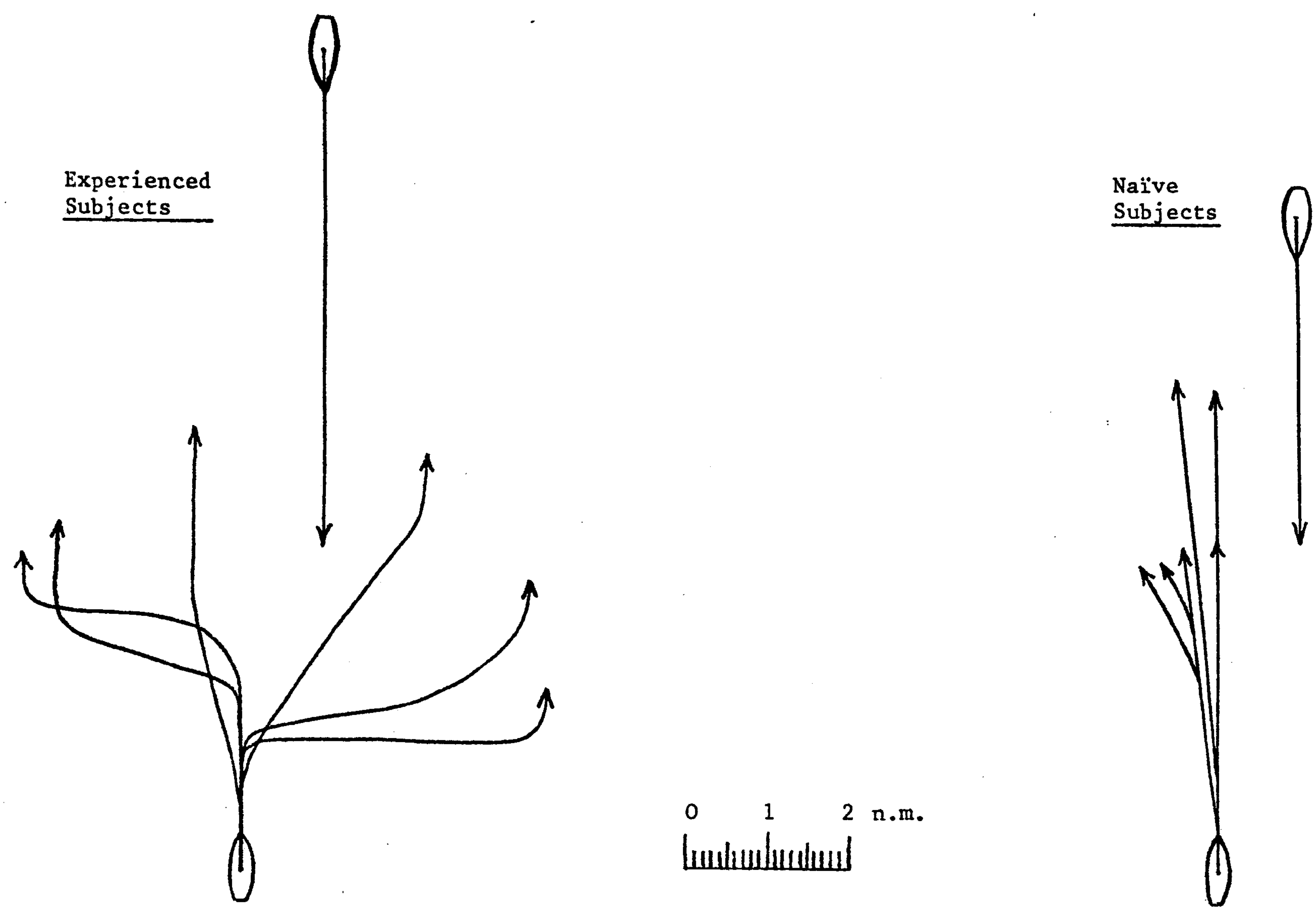


Fig. 37 Typical Action in a Close Passing Encounter Type (f)



END-ON AND NEARLY END-ON ENCOUNTERS - RESULTS

Group (ii) Subjects (High experience)

Table showing the overall action taken by each of the subjects in each of the five standard situations.

Key S = Alteration of course to starboard
P = Alteration of course to port
M = Course maintained
+ = Increase of speed
– = Decrease of speed

Group (ii) Subject	ENCOUNTER TYPE				
	(d) End-on	(e) ½ ml. offset	(f) 1 m. offset	(g) 1½ m. offset	(h) 2 ml. offset
1	S	S	S	M	M
2	S	S	S	P	M
3	S	P	P	M	M
4	S	S	P	P	P
5	S	S	S	P	M
6	S	S	S	P	M

Group (iii) Subjects (Low Experience)

Table showing the overall action taken by each of the subjects in each of the five standard situations.

Key S = Alteration of course to starboard
P = Alteration of course to port
M = Course maintained
+ = Increase of speed
- = Decrease of speed

Group (iii) Subject	ENCOUNTER TYPE				
	(d) End-on	(e) ½ ml. offset	(f) 1 ml. offset	(g) 1½ ml. offset	(h) 2 ml. offset
1	S	P	P	M	M
2	S	S	S	S	S
3	S	S	P	P	M
4	S	S	P	S	P
5	S	S	S	S-	P-
6	S	S	P	P	M

Group (iv) Subjects (Naïve)

Table showing the overall action taken by each of the subjects in each of the standard encounter types (d) and (f)

Key:- S = Alteration of course to starboard
P = Alteration of course to port
M = Course maintained
+ = Increase of speed
– = Decrease of speed
X = No result

Group (iv) Subject	ENCOUNTER TYPE (d) End-on	ENCOUNTER TYPE (f) 1 ml. offset
1	S+	X
2	P+	X
3	P+	X
4	P–	X
5	S+	X
6	P+	X
7	S+	M+
8	P+	P
9	S+	X
10	S	P
11	X	P
12	S	X
13	S	P
14	S	P+
15	X	M

RIGHT-ANGLED CROSSING ENCOUNTERS - EXPERIMENTAL PROCEDURE

The subjects for this part of the programme fell into two groups:-

Group (v). Experienced Merchant Navy Officers similar to those, and occasionally the same as those, who took part in the "general encounter" experiments. They were all male and all had watchkeeping experience and were all aged within the range from 22 to 55.

Group (vi). Inexperienced (naïve) subjects similar to, and often the same as, the group (iv) subjects who took part in "end-on and nearly end-on encounter" experiments. These subjects had no seagoing experience and no knowledge of the collision regulations. They were City clerical workers or members of staff of the City of London Polytechnic other than School of Navigation lecturers. One third were male and two-thirds were female. They were within the age range 20-55.

The independent variable of most interest in these experiments was experience and particularly knowledge of the collision regulations. The division of subjects into groups (v) and (vi) represented a division at two levels of this variable. Additionally, EPI and EFT scores were obtained for some of the subjects and the actual length of seagoing experience in years was noted for the group (v) subjects.

Two standard encounters (i) and (j) were used, with a single target ship on a course at right angles to the course of the subjects' ship in both cases. In the type (i) encounter the target ship approached from the port side and in the type (j) encounter the target ship approached from the starboard side.

For each trial, the simulation was such that a collision would have occurred if both ships had maintained course and speed, and in no case was the target ship made to manoeuvre. The speed of both the target ship and the subjects' ship were initially set at 10 knots and each had 5.5 miles to go to the collision point.

The subjects' ship was simulated to be of 10,000 tons gross with a full speed of 15 knots. Initially the speed was set at half ahead (10 knots), so that the subject had the facility to increase or decrease the speed of his ship as well as to alter course either way. The twelve mile range scale was used for the radar display. The naïve subjects were instructed on the use of the radar equipment and given time to practice manoeuvring their ship on the screen before the trials began.

The initial situations for the two encounters, type (i) and (j) are shown in figure 38.

The development of each trial was plotted in real time on the Kelvin-Hughes photoplot equipment as the manoeuvres were made. A permanent record was obtained by tracing the completed plot onto cellulose film. The time required to resolve an encounter depended upon the action of the subject but most trials lasted of the order of 30 minutes.

For the reasons discussed under "End-on and nearly end-on encounter procedure", the only dependent variable measured was the overall character of the method of disengagement. This was categorised as an alteration of course to port or to starboard and an increase or a decrease of speed.

Typical plots showing the development of type (i) and (j) manoeuvres for both experienced and naïve subjects are illustrated in figures 39 and 40 below. In each case the manoeuvres of six subjects are shown superimposed on a single diagram.

Fig. 38 RIGHT-ANGLED CROSSING ENCOUNTERS

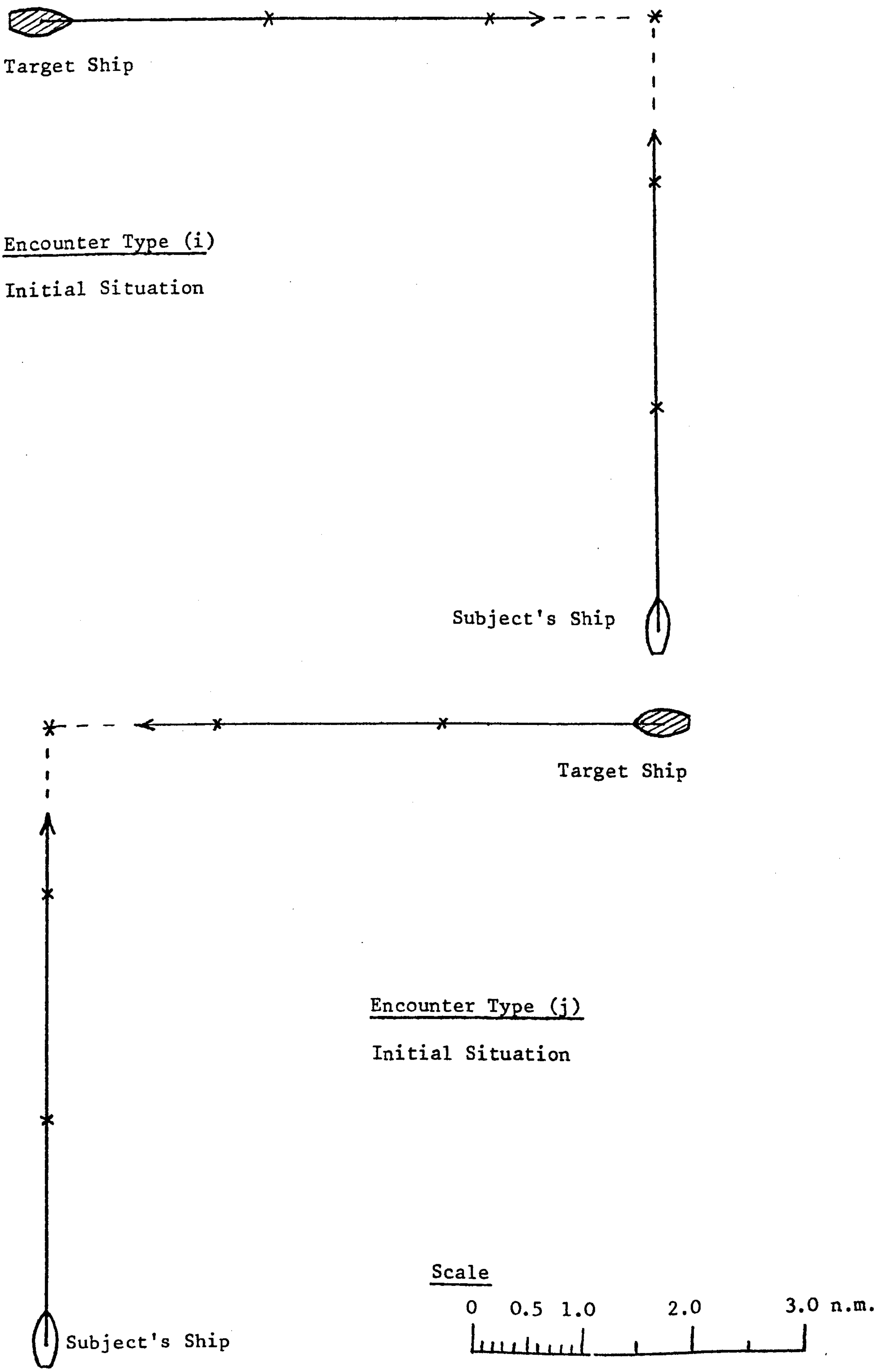


Fig. 39 Typical action in a crossing encounter from the port side. Type (i)

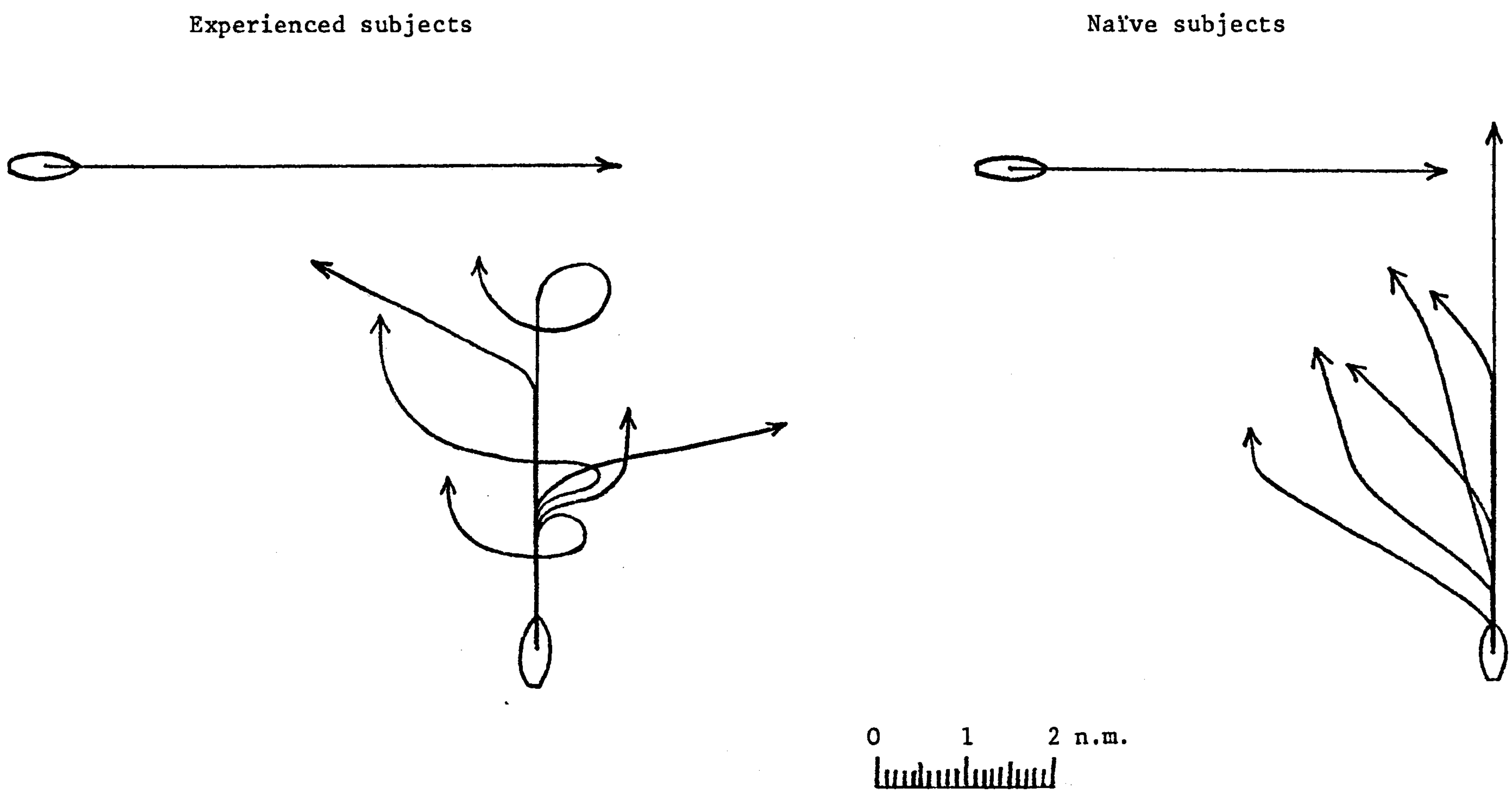
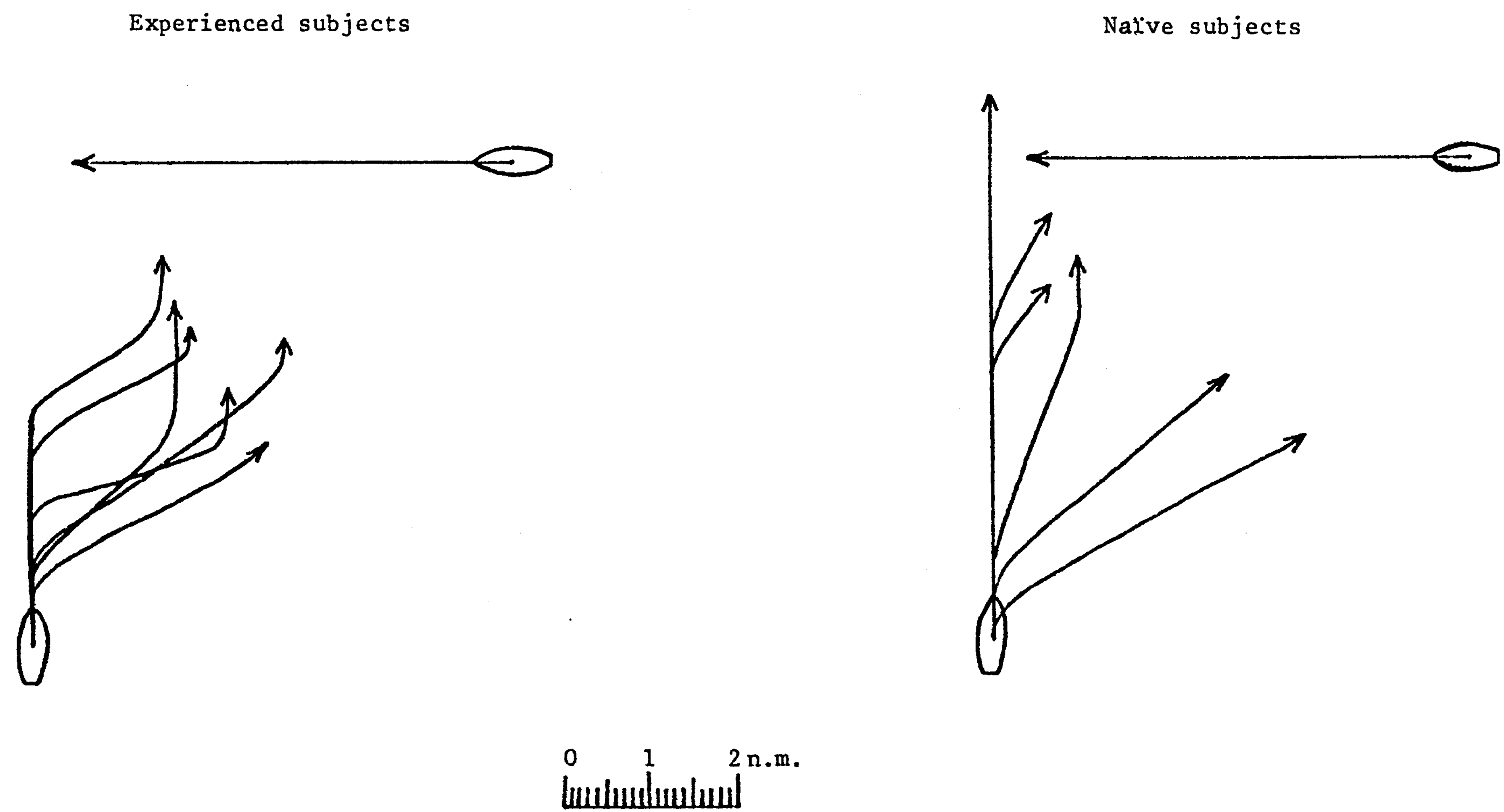


Fig. 40 Typical action in a crossing encounter from the starboard side. Type (j)



RIGHT-ANGLED CROSSING ENCOUNTERS - RESULTS

Encounter Type (i) - Experienced subjects, group (v)

EXP = Seagoing experience, years
EFT = Embedded Figure test score, seconds
N = Eysenck Personality Score, form A
E = " " " " A
O = Overall action taken
P = Pass ahead or pass astern of target

S = Alteration of course to starboard
P = " " " " port
+ = Increase of speed
- = Decrease of speed
AST = Passed astern of target
AH = Passed ahead of target

Experienced Subjects (i)	EXP	EFT	N	E	O	P	Remarks
1	15	359	-	-	P	AST	
2	15	554	-	-	P	AST	
3	10	508	8	14	P	AST	
4	15	1496	13	12	P	AST	
5	10	-	7	19	-	AST	
6	19	-	12	6	S+	AH	
7	8	252	5	16	S	AST	
8	7	-	12	17	S-	AST	
9	13	500	12	17	P	AST	
10	13	1511	5	13	S+	AST	
11	10	-	-	-	-	AST	
12	-	-	-	-	-	AST	
13	11	917	10	16	P	AST	Initially S
14	11	514	6	8	S-	AST	
15	13	-	-	-	P	AST	
16	29	-	11	7	P	AST	
17	19	861	3	10	-	AST	
18	27	-	11	12	+	AH	
19	13	-	8	18	P	AST	
20	11	-	10	0	-	AST	
21	7	-	9	14	S	AST	
22	19	-	-	-	S	Ast	
23	12	429	7	23	S-	AST	

Encounter Type (j) - Experienced subjects, group (v)

EXP = Seagoing experience, years
EFT = Embedded Figure test score, seconds
N = Eysenck Personality Score, form A
E = " " " " A
O = Overall action taken
P = Pass ahead or pass astern of target

S = Alteration of course to starboard
P = " " " " port
+ = Increase of speed
- = Decrease of speed
AST = Passed astern of target
AH = Passed ahead of target

Experienced Subjects (i)	EXP	EFT	N	E	O	P	Remarks
1	12	484	-	-	S	AST	
2	9	253	-	-	S	AST	
3	21	888	-	-	S	AST	
4	16	427	3	9	S	AST	
5	10	-	16	18	S	AST	
6	10	-	8	10	S	AST	
7	23	-	16	4	S	AST	
8	11	503	12	6	S	AST	
9	11	1591	7	12	S	AST	
10	9	439	12	9	S	AST	
11	10	-	4	8	-	AST	
12	15	362	19	9	S	AST	
13	29	991	6	11	S	AST	
14	28	-	-	-	S	AST	
15	31	-	-	-	S	AST	
16	7	299	12	8	S	AST	
17	11	-	12	17	S	AST	
18	12	691	15	8	S	AST	
19	25	1611	3	8	S	AST	
20	11	-	3	11	S	AST	
21	11	-	7	15	S	AST	
22	13	-	16	11	S	AST	
23	12	-	11	19	S	AST	
24	39	-	4	7	S	AST	

Encounter Types (i) and (j) - Naïve Subjects Group (vi)

O = Overall action taken
P = Pass ahead or pass astern
S = Alteration of course to starboard
P = Alteration of course to port

\+ = Increase of speed
\- = Decrease of speed
AST = Passed astern of target
AH = Passed ahead of target
X = No result obtained

Naïve Subjects (ii)	ENCOUNTER TYPE (i)		
	O	P	Remarks
1	P	AST	
2	P-	AST	
3	P+	AST	
4	P	AST	
5	P	AST	
6	P-	AST	
7	+	AH	
8	P	AST	
9	P+	AST	
10	S+	AH	
11	P+	AST	
12	P	AST	
13	+	AH	
14	S+	AH	
15	+	AH	

Naïve Subjects (ii)	ENCOUNTER TYPE (j)		
	O	P	Remarks
1	S	AST	
2	S-	AST	
3	S-	AST	
4	S	AST	
5	S	AST	
6	S	AST	
7	+	AH	
8	S	AST	
9	+	AH	
10	S	AST	
11	+	AH	
12	S+	AST	
13	X	X	
14	+	AH	
15	-	AST	

TESTS OF FIRST HYPOTHESIS (H_1)

For the purpose of these tests, the null hypothesis (H_o) is that, in the three general encounters [types (a), (b) and (c)] the final miss distance achieved by a subject's manoeuvres is independent of his Eysenck Personality Inventory (EPI) score on the "E" scale.

The alternative hypothesis (H_1) is that, in these encounters, there is a positive correlation between a subject's final miss distance and his EPI "E" score.

H_o could be tested by calculating a product moment correlation coefficient, but it is thought safer not to make the assumptions that the use of such a test would imply. The correlation suggested is essentially between EPI "E" score and the utility of a miss distance to a subject. The subjective ability of a miss distance is not, however, expected to be linearly related to the value of the miss distance in nautical miles although it is expected to increase when miss distance in miles increases. Also, there is no reason to suppose that subjects' miss distance scores should be normally distributed.

For these reasons, a statistical test based on ranking the independent and the dependent variables is considered to be the most appropriate. Both Spearman's rank correlation coefficient and Kendall's rank correlation coefficient appear to be suitable statistics and lead to significance tests of equal power. The Kendall rank correlation coefficient (τ) is chosen since it has the advantage of being generalizable to a partial correlation coefficient.

Separate tests are used for the three encounter types (a), (b) and (c) since a subject of given "E" score is likely to achieve quite different miss distances in each case.

The subjects for whom "E" is known are ranked according to this variable in the table below. The miss distances according to this variable are also tabulated. Kendall's τ is calculated and thence the value of the standard normal variate (z) so that a table of probabilities of values as extreme as z in the normal distribution may be used for assessing significance. A 5% level is considered sufficient grounds for rejecting H_o.

Type (a) Encounters

EPI "E" Score
and
Miss distance
in miles

"E"	MISS
4	2.6
6	4.5
6	3.5
7	3.2
8	2.6
8	3.2
8	3.0
8	4.0
9	5.0
9	5.2
10	6.0
11	3.0
11	3.0
11	5.1
11	3.5
15	2.2
15	6.0
16	4.5

Analysis gives: $\tau = 0.169$

$z = 0.98$

The tabulated probability of a value of z as extreme as 0.98 in the predicted direction is 0.1635.

The conclusion is that, although a positive correlation is found between EPI "E" score and miss distance, this is not at the required 5% level of significance and so there is insufficient evidence to reject the null hypothesis in the case of type (a) encounters.

Type (b) Encounters

EPI "E" Score
and
Miss distance
in miles

"E"	MISS
4	2.3
6	2.0
8	3.0
8	1.6
9	2.0
11	1.6
11	2.5
11	0.7
11	2.2
11	1.5
12	0.9
14	1.5
14	1.5
16	1.2
17	1.4
18	1.0
19	1.6

Analysis gives: $\tau = -0.4586$

$z = 2.58$

The tabulated probability of a value of z as extreme as 2.58 in a predicted direction is 0.0049.

In this case, the correlation is in the opposite direction to that predicted and so the value of z, although an extreme one, does not fall within the region postulated for rejection of H_o. The conclusion is that H_o cannot be rejected in favour of H_1, although the evidence casts doubts on the validity of H_o for type (b) encounters.

Type (c) Encounters

EPI "E" Score
and
Miss distance
in miles

"E"	MISS
0	2.0
6	1.8
7	2.3
8	2.0
8	2.5
9	1.5
10	3.2
10	2.7
11	2.0
12	2.7
12	2.0
14	3.0
14	2.4
16	2.5
17	1.3
17	1.9
18	2.0
23	2.7

Analysis gives: $\tau = 0.0906$

$z = 0.5253$

The tabulated probability of a value of z as extreme as 0.52 in the predicted direction is 0.3015.

The conclusion is that, although a positive correlation is found between EPI "E" score and miss distance, this is not at the required 5% level of significance and so there is insufficient evidence to reject the null hypothesis in the case of type (c) encounters.

RESULTS OF TESTS FOR H_1

The result of the test for H_1 in the case of type (b) encounters is a reversal of the predicted correlation and seems incompatible with the results of the tests for the type (a) and type (c) encounters. The reason for the apparently anomalous results is looked for in the nature of the three encounters.

The type (b) encounter is such that it is almost impossible for a subject to disengage by means of extravagent manoeuvres which yield a large miss distance. The test result indicates that the more extraverted subjects take action which, in general, leads to the smaller miss distances. "Taking a chance" in this way is a characteristic of the high "E" score person as described by Eysenck in 1964[79]. This tendency, together with the supression of extravagent manoeuvres, would lead to the observed negative correlation between "E" score and miss distance for type (b) encounters.

On the other hand, the observed positive correlations between "E" score and miss distance in the type (a) and type (c) encounters, although not significant, provide some support for the original hypothesis (H_1) that high "E" score is associated with extravagent manoeuvres in encounters where these provide a reasonable means of disengagement. Such manoeuvres are quite feasible in type (a) and type (c) encounters.

If this assessment is correct, one would expect that, in the type (a) and type (c) encounters, a high "E" score would be associated with both large and small miss distances and that a low "E" score would be associated with miss distances of a moderate size. It is, of course, possible to test this prediction and such a test is now attempted.

TEST OF AUXILIARY HYPOTHESIS (H_{1A})

The independent variable for this test is again the subjects EPI "E" score. Because of reservations previously noted concerning the subjective linearity of the miss distance scale, the median value of miss distance observations is taken as the central value rather than the mean. The independent variable (designated δM) is defined as the modulus of the difference between the miss distance for each subject and the median value of the miss distances for all subjects.

For this test, the null hypothesis, H_o, is that, for type (a) and type (c) encounters there is no correlation between a subject's "E" score and his δM. The alternative hypothesis H_{1A} is that there is a positive correlation between a subjects "E" score and his δM. A 5% level of significance is considered sufficient grounds for rejecting H_o and accepting H_{1A}.

Kendall's rank correlation coefficient is used for testing H_o.

Type (a) Encounters

EPI "E" Score and δM, where δM is the modulus of the miss distance difference the median miss distance. The median miss distance for type (a) encounters is 3.5 miles

"E"	δM
4	0.9
6	1.0
6	0.0
7	0.3
8	0.9
8	0.3
8	0.5
8	0.5
9	1.5
9	1.7
10	2.5
11	0.5
11	0.5
11	1.6
11	0.0
14	1.3
15	2.5
16	1.0

Analysis gives: $\tau = 0.299$

$z = 1.732$

The tabulated probability of a value of z as extreme as 1.73 in the predicted direction is 0.0418.

The conclusion is that the correlation found is significant at the 5% level and that H_o should be rejected in favour of H_{1A} in the case of type (a) encounters.

Type (c) Encounters

EPI "E" Score and δM, where δM is the modulus of the miss distance difference the median miss distance. The median miss distance for type (c) encounters is 2.3 miles

"E"	δM
0	0.3
6	0.5
7	0.0
8	0.3
8	0.2
9	0.8
10	0.9
10	0.4
11	0.3
12	0.4
12	0.3
14	0.7
14	0.1
16	0.2
17	1.0
17	0.4
18	0.3
23	0.4

Analysis gives: $\tau = 0.1198$

$z = 0.6944$

The tabulated probability of a value of z as extreme as 0.69 in the predicted direction is 0.2451.

This result is not significant at the required level and the conclusion is that, although a positive correlation is found, there is insufficient evidence to reject the null hypothesis in the case of type (c) encounters.

SUMMARY OF TEST RESULTS FOR H_1 AND H_{1A}

For general encounters which can be resolved with a wide range of miss distances, subjects with high EPI "E" scores generally choose manoeuvres which lead to either large or small values of miss distance. Subjects with low EPI "E" scores generally choose manoeuvres which lead to moderate values of miss distance.

This finding is based on the result of the test for H_{1A} in type (a) encounters. The result of the test for H_{1A} in type (c) encounters, although not significant, nevertheless yields a higher value of τ and z than the test for H_1 in type (c) encounters, and so may be taken as confirmatory evidence.

The hypothesis, H_{1A}, suggests that, for encounters in which it is not possible to achieve very large miss distances, subjects with high EPI "E" scores would generally choose manoeuvres which lead to smaller values of miss distance than subjects with low EPI "E" scores.

This suggestion receives support from the result of the test for H_1 in type (b) encounters.

New experiments, designed to elucidate further the relationship between a subject's EPI "E" score and his behaviour in collision avoidance trials, might well be worth considering.

TESTS OF SECOND HYPOTHESIS, (H_2)

For the purpose of these tests, the null hypothesis (H_o) is that, in the three general encounters (types (a), (b) and (c)) the number of manoeuvres used by a subject to achieve disengagement is independent of his EPI "N" score.

The alternative hypothesis (H_2) is that, in these encounters, there is a positive correlation between the number of manoeuvres used and a subject's EPI "N" score.

For the reasons discussed previously (p.148) the Kendall Rank Correlation coefficient (τ) is used for these tests. Separate tests are used for the three encounter types (a), (b) and (c) since they are graded in difficulty and a subject of given "N" score is likely to use different numbers of manoeuvres in each case.

Results at a 5% level of significance are considered sufficient to justify the rejection of H_o.

Type (a) Encounters

EPI "N" Score and "A", where "A" is the number of manoeuvres (alterations of course or speed) made by a subject in resolving an encounter

"N"	"A"
1	4
2	1
2	2
4	2
6	4
6	2
7	4
7	2
8	1
10	2
10	1
11	3
11	1
12	1
12	4
12	4
13	3
16	1

Analysis gives: $\tau = -0.08445$

$z = 0.4894$

The tabulated probability of a value of z as extreme as 0.49 in a predicted direction is 0.3121.

The small correlation found is opposite in direction to that predicted and the conclusion is that the null hypothesis should not be rejected in favour of H_2.

Type (b) Encounters

EPI "N" Score and "A", where "A" is the number of manoeuvres (alterations of course or speed) made by a subject in resolving an encounter.

"N"	"A"
2	5
2	2
3	3
5	3
6	2
6	2
7	3
10	8
10	6
11	2
11	2
11	5
12	2
13	3
13	1
16	3
16	3

Analysis gives: $\tau = 0.08626$

$z = 0.4832$

The tabulated probability of a value of z as extreme as 0.48 in a predicted direction is 0.3156.

The small correlation found is opposite in direction to that predicted and the conclusion is that the null hypothesis should not be rejected in favour of H_2.

Type (c) Encounters

EPI "N" Score and "A", where "A" is the number of manoeuvres (alterations of course or speed) made by a subject in resolving an encounter

"N"	"A"
1	3
3	4
4	5
5	3
6	4
7	2
8	1
8	3
8	5
9	2
10	1
11	1
11	4
12	5
12	3
12	5
12	1
19	5

Analysis gives: $\tau = -0.02203$

$z = 0.1277$

The tabulated probability of a value of z as extreme as 0.13 in a predicted direction is 0.4483.

The very small correlation found is opposite in direction to that predicted and the conclusion is that the null hypothesis should not be rejected in favour of H_2.

SUMMARY OF TEST RESULTS FOR H_2

The tests for H_2 in encounter types (a), (b) and (c) all result in an insignificant correlation coefficient, opposite in sign to that predicted.

The results thus give no support at all to H_2 and further trials to test this hypothesis would not seem to be worth considering.

The conclusion is that there is no evidence to suggest that the number of manoeuvres made by a subject in resolving a collision situation is in any way related to his EPI "N" score.

TESTS OF THIRD HYPOTHESIS (H_3)

For the purpose of these tests, the null hypothesis (H_o) is that, in the three general encounters (types (a), (b) and (c)), the range at which a subject first makes a manoeuvre is independent of his Embedded Figure Test (EFT) score.

The alternative hypothesis (H_3) is that there is a negative correlation between the range at which a subject first makes a manoeuvre and his EFT score.

For the reasons discussed previously (p.148) the Kendall Rank Correlation coefficient (τ) is used for these tests. Separate tests are used for the three encounter types (a), (b) and (c) since they are graded in difficulty and a subject of given EFT score would be likely to make his first manoeuvre at different ranges in each case.

Results at a 5% level of significance are considered sufficient to justify rejection of H_o.

Type (a) Encounters

Embedded figure test (EFT) scores and Range in miles at which a first manoeuvre is made

EFT	RANGE
299	5.0
317	7.0
373	8.7
408	7.8
411	6.2
439	8.3
503	8.3
514	7.5
559	4.0
698	6.2
698	8.0
898	7.5
1190	7.4
1273	6.6

Analysis gives: $\tau = -0.1011$

$z = 0.5038$

The tabulated probability of a value of z as extreme as 0.50 in the predicted direction is 0.3085

The conclusion is that, although a correlation in the predicted direction is found, there is insufficient evidence to reject the null hypothesis.

Type (b) Encounters

Embedded figure test (EFT) scores and Range in miles at which a first manoeuvre is made

EFT	RANGE
317	6.7
373	7.3
408	6.8
411	4.0
554	6.0
559	6.3
698	2.6
698	7.5
991	6.0
1190	4.7

Analysis gives: $\tau = -0.2954$

$z = 1.19$

The tabulated probability of a value of z as extreme as 1.19 in the predicted direction is 0.117

The conclusion is that, although a correlation in the predicted direction is found, there is insufficient evidence to reject the null hypothesis.

Type (c) Encounters

Embedded figure test (EFT) scores and Range in miles at which a first manoeuvre is made

EFT	RANGE
252	6.0
253	8.0
362	2.2
429	5.8
436	4.8
484	6.6
500	5.4
508	7.0
514	6.5
861	4.2
1273	5.4
1496	4.6

Analysis gives: $\tau = -0.1832$

$z = 0.8292$

The tabulated probability of a value of z as extreme as 0.83 in the predicted direction is 0.2033.

The conclusion is that, although a correlation in the predicted direction is found, there is insufficient evidence to reject the null hypothesis.

SUMMARY OF TEST RESULTS FOR H_3

The tests for H_3 in encounter types (a), (b) and (c) all result in correlation coefficients of the predicted sign, but in no case does the correlation reach the level of significance required to reject the null hypothesis.

Since all three tests show a correlation in the predicted direction, it is possible that a test of the pooled data might prove significant. In order to conduct such a test, the means and the variances of the three sets of independent variable measurements would need to be made compatible. The validity of applying the required arithmetical processes to these data is doubtful and so no pooled test is included.

The conclusion is that further trials might be worth considering so that H_3 may be tested on the basis of larger samples.

TESTS OF FOURTH HYPOTHESIS (H_4)

In order to test this hypothesis, it is necessary to find encounter types in which experienced subjects take varied action and in which those actions can be grouped into two nominal classes:-

Class (q). Those manoeuvres which result in rapid disengagement but which entail a measure of risk and perhaps a lack of conformity with the collision regulations. (q = quick).

Class (t). Those manoeuvres which prolong the time to disengagement but which are safer and more conservative. (t = tardy).

It was found possible to make this classification, in encounter type (a) in which the subjects' ship is meeting another nearly end-on but converging slightly from the port bow and also in encounter type (i) in which the subjects' ship is meeting another crossing at right angles from the port side. Examples of class (q) and class (t) manoeuvres are illustrated in figures 41 and 42.

For the purpose of these tests, the null hypothesis (H_0) is that there is no systematic difference between the length of experience of subjects who choose class (q) manoeuvres and the length of experience of subjects who choose class (t) manoeuvres. The alternative hypothesis (H_4) is that subjects who choose class (q) manoeuvres are of stochastically greater experience than those who choose class (t) manoeuvres.

Fig. 41

Examples of class (q) and (t) manoeuvres
in response to a type (a) encounter.

Arrow heads show positions of ships
after 30 minutes.

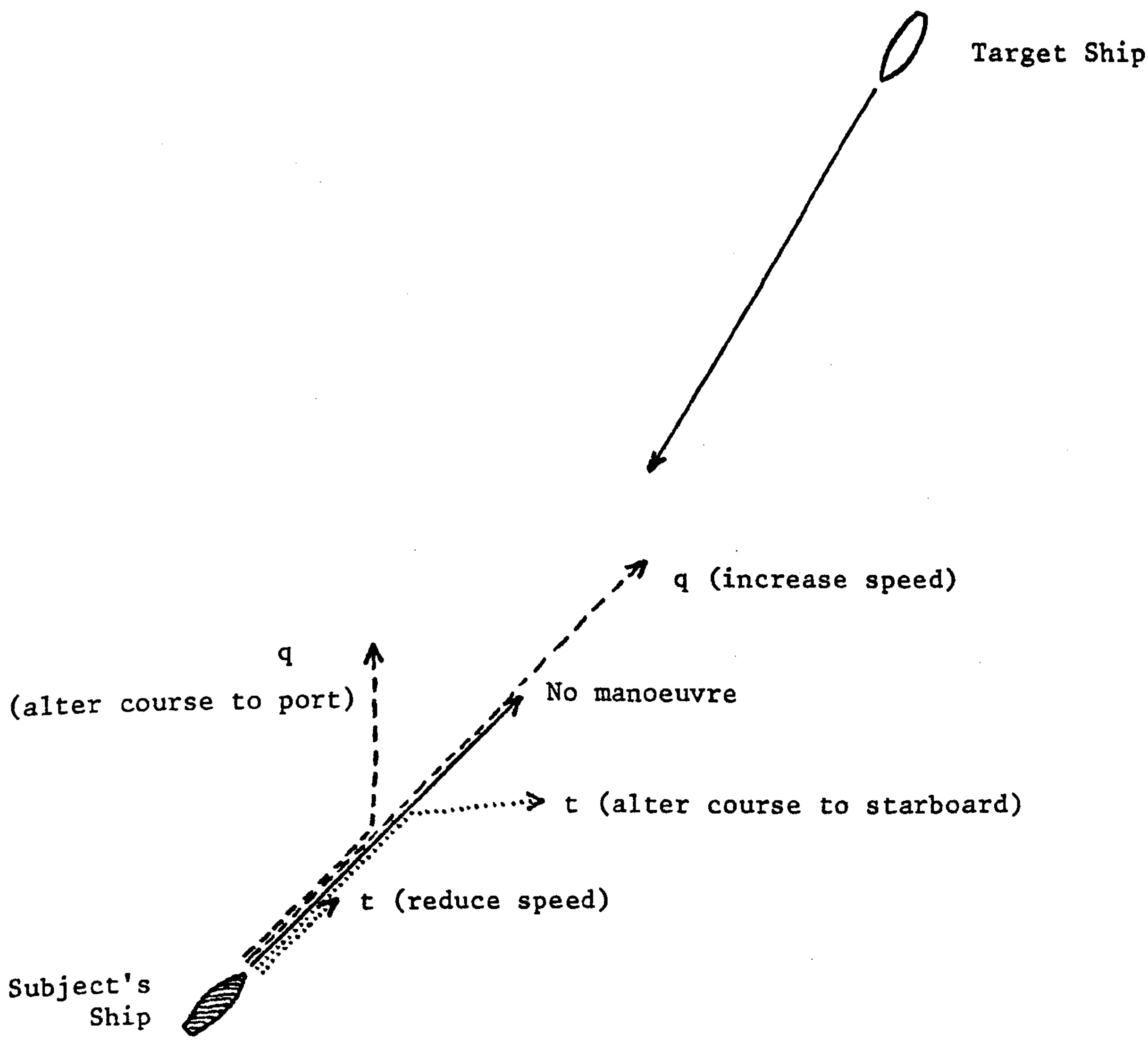
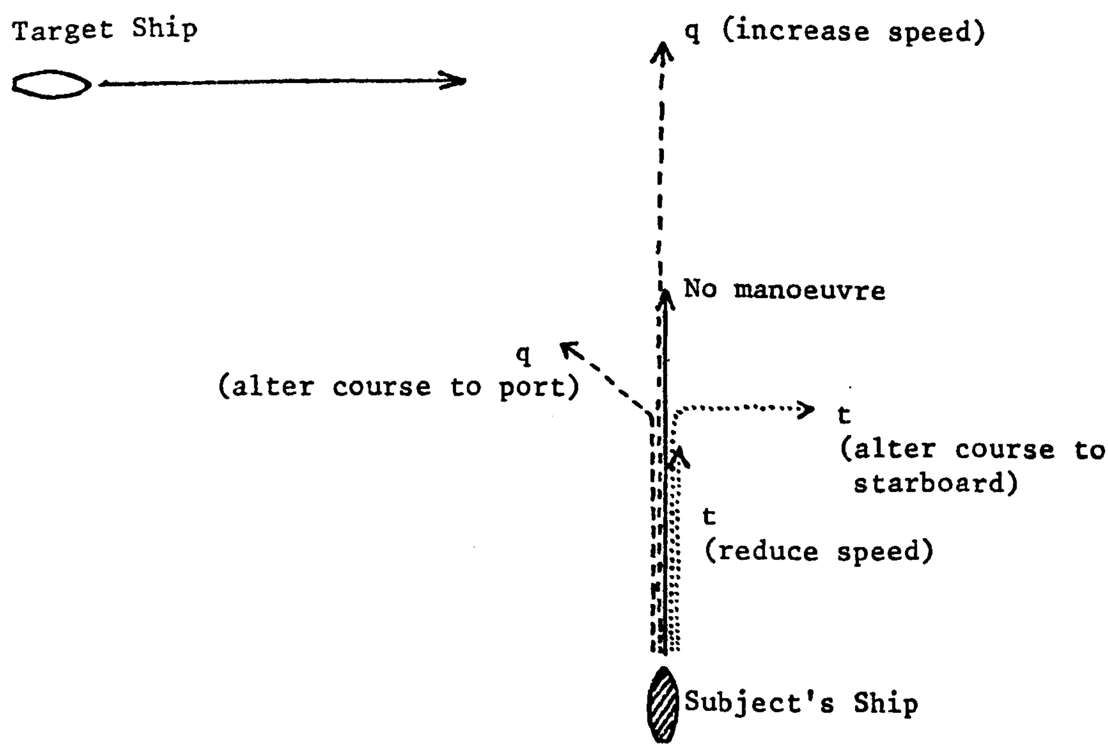


Fig. 42

Examples of class (q) and class (t) manoeuvres in response to a type (i) encounter.

Arrow heads show positions of ships after 20 minutes.



Students "t" test was considered for assessing the validity of the null hypothesis and the appropriate calculation was made in the case of type (a) encounter results. This showed that H_o could be rejected in favour of H_4 at the 5% level of significance, but there are some doubts regarding the validity of applying a Students' "t" test to the experimental data.

1. It does not seem likely that experience is a measure which is normally distributed amongst ships officers. Because of the wastage rate, the number of officers at sea will have some inverse relationship to their years of experience so the distribution would be very skew.

2. Experience is measured in years but this scale does not seem likely to have a linear relationship to the effectiveness of the experience; e.g. the effect of the first ten years of a man's experience in changing his behaviour patterns is likely to be much greater than the effect of his second ten years of experience. This implies that the means and standard deviations calculated arithmetically may not, for this analysis, be valid statistics.

The Mann-Whitney U test seems appropriate because it is reasonable to assume that effective experience, although not linear with years, in nevertheless a continuum which increases as length of service increases. This test depends upon ranking but not on an interval scale and, since it does not assume a particular distribution, it would appear to be valid for the present analysis. Loss of power in the Mann-Whitney as compared to the Students "t" has to be accepted in return for greater generality.

Separate tests are conducted for the results of the type (a) and type (i) encounters.

Type (a) Encounters

In the case of the type (a) (nearly end-on) encounters, alterations of course to port and increases of speed were classified as class (q) manoeuvres and decreases of speed or alterations of course to starboard were classified as class (t) manoeuvres. The length of experience of subjects was established in months as well as years in order to reduce the possibility of ties. The analysis results are tabulated below in a form suitable for calculating the Mann-Whitney U statistic. Data for 23 subjects was available.

Type (a) Encounters

Experience in years and months and Manoeuvre class

Experience	Manoeuvre Class
7-1	t
8-6	t
8-7	t
9-0	t
9-2	t
9-8	t
10-3	t
10-5	t
10-7	t
10-7	t
10-8	q
13-6	t
13-7	q
17-8	q
20-7	q
20-8	t
22-6	t
22-7	t
28-0	t
30-6	q
37-0	q
38-8	q
38-9	q

$n_q = 8$

$n_t = 15$

$U = 17$

The critical value of U for a one tailed test at the 1% level of significance is 24 so the difference between class (q) and class (t) is established at the 1% level of significance.

The conclusion is that, for type (a) encounters, the null hypothesis (H_0) may be rejected at the 1% level of significance in favour of the alternative hypothesis (H_4).

Type (i) Encounters

In the case of the type (i) (crossing from the port side) encounters alterations of course to port and increases of speed to pass ahead of the target ship were classified as class (q) manoeuvres and decreases of speed or alterations of course to starboard to eventually pass astern of the target were classified as class (t) manoeuvres. As before, the analysis results are tabulated below in a form suitable for calculating the Mann-Whitney U statistic. Data for 23 subjects was available.

Experience in years and months and Manoeuvre class

Experience	Manoeuvre Class
6-6	t
6-9	t
7-6	t
9-1	t
9-5	t
9-6	q
9-9	t
10-9	t
11-4	q
11-8	t
12-3	q
12-4	q
12-8	t
13-0	q
14-1	q
14-7	q
14-8	q
18-3	q
18-6	t
19-0	t
26-5	q
28-2	q
29-0	q

$n_q = 12$

$n_t = 11$

$U = 26$

The critical value of U for a one tailed test at the 1% level of significance is 28, so that the difference between class (q) and class (t) subjects is established at this level

The conclusion is that, for type (i) encounters, the null hypothesis (H_o) may be rejected at the 1% level of significance in favour of H_4.

SUMMARY OF TEST RESULTS FOR H_4

Analyses of the results of trials in two different encounter types both lead to the conclusion that H_4 should be accepted.

The inference is that there is a class of encounters (including types (a) and (i)) in which the actions of experienced mariners can be grouped into classes (q) and (t) previously defined. Also that mariners who choose class (q) manoeuvres are of stochastically greater experience than those who choose class (t) manoeuvres.

TEST OF FIFTH HYPOTHESIS (H_5)

The purpose of this test is to determine whether groups of naïve and experienced subjects differ significantly in the proportions of port and starboard alterations of course that they make in order to resolve exactly end-on (type (d)) encounters.

The distinction between port and starboard alterations of course in this type of encounter is purely nominal and so a non-parametric test must be used. The data can be arranged in the form of a 2 x 2 contingency table but the sample size is too small to use the χ^2 test and so the Fisher Exact Probability Test is chosen.

For the purpose of this test, the null hypothesis (H_o) is that, in type (d) encounters, there is no difference between the proportion of alterations of course made to port by subjects with a knowledge of the collision regulations and by naïve subjects with no knowledge of the collision regulations. The alternative hypothesis (H_5) is that the proportion of alterations of course to port is less for subjects with a knowledge of the regulations than for naïve subjects.

For the end-on encounters subjects with a knowledge of the collision regulations comprised groups (ii) and (iii) and naïve subjects with no knowledge of the regulations comprised group (iv). The alterations of course made by these subjects are summarised in the table below.

	S	P	
N	A = 8	B = 5	A+B = 13
K	C = 12	D = 0	C+D = 12
	A+C = 20	B+D = 5	n = 25

N = Naïve subjects
K = Subjects with knowledge of the collision rules
P = Port alterations of course
S = Starboard " " "

Critical tables for D, given the observed values of A + B, C + D and B, confirm that a value of 0 corresponds to a level of significance smaller than 0.025.

The conclusion is that H_o should be rejected in favour of H_5 on the evidence of the experimental results.

TESTS OF AUXILIARY HYPOTHESIS H_{5A}

In addition to establishing that there is a significant difference between the actions of naïve and experienced subjects in response to end-on encounters, it is also of interest to investigate the probabilities of finding results as extreme as those observed on the assumption that alterations of course to port or to starboard were made at random.

For this purpose, the null hypothesis, H_o, is that, in end on (type (d)) encounters, it is equally likely that subjects alter course to port or to starboard. The alternative hypothesis, H_{5A}, is that there is a systematic bias towards alterations of course in one direction rather than the other. A 5% level of significance is looked for.

Under the null hypothesis, there is an equal probability of alterations of course either way and, on this basis, the binomial test may be used to find the probabilities of proportions occurring as extreme as those observed. The necessary condition that all the results are independent is fulfilled. Separate tests are used for the naïve and the experienced subjects.

Naïve subjects Out of a total of 13 naïve subjects, 8 altered course to starboard and 5 altered course to port. The probability of values as extreme as these in either direction is given by:

$$p = 2\sum_{i=0}^{r} {}^{n}C_{i}(0.5)^{n}$$

[where r is the smaller number in the division and n is the total number of actions.]

For the results quoted, the corresponding probability obtained is 0.582.

The conclusion is that there is insufficient evidence to reject the null hypothesis in favour of H_{5A} in the case of naïve subjects.

Subjects with Knowledge of the Collision Regulations Out of a total of 12 such subjects, all altered course to starboard. The probability (p) of a value as extreme as this in either direction, under the null hypothesis, is

$$p = 0.00049$$

The conclusion is that, on this evidence, the null hypothesis should be rejected in favour of H_{5A} in the case of subjects with a knowledge of the collision regulations.

SUMMARY OF TEST RESULTS FOR H_5 and H_{5A}

The result of the test for H_5 indicates that there is a significant difference between the actions of subjects with a knowledge of the collision regulations and those with no knowledge of the collision regulations in response to exactly end-on encounters. Also that experienced subjects are less likely to alter course to port as compared to naïve subjects.

The results of the tests of H_{5A} indicate systematic alterations of course to starboard for end-on encounters by subjects with a knowledge of the collision regulations, but there is no ground for suggesting that the alterations of course observed for naïve subjects are anything but random.

TEST OF SIXTH HYPOTHESIS (H_6)

The purpose of this test is to determine whether groups of naïve and experienced subjects differ significantly in the patterns of manoeuvres that they make in order to resolve encounters of type (f) in which ships are initially on opposite and parallel courses spaced one nautical mile apart.

The problem is very similar to that of testing H_5 and so the Fisher Exact Probability Test is chosen again.

For the purpose of this test, subjects with a knowledge of the rules again comprised groups (ii) and (iii) and naïve subjects with no knowledge of the rules comprised group (iv). Alterations of course to port and maintenance of course are both classed as "natural" (L) actions and alterations of course to starboard are classed as "unnatural" (U) actions.

The null hypothesis (H_o) is that, in type (f) encounters, there is no difference between the proportion of "natural" (L) actions taken by subjects with a knowledge of the collision regulations and by naïve subjects with no knowledge of the collision regulations. The alternative hypothesis (H_6) is that the proportion of "unnatural" (U) actions is less for naïve subjects than for subjects with a knowledge of the collision regulations.

The experimental results are tabulated in the 2 x 2 contingency table below:

	L	U	
K	A = 6	B = 6	A+B = 12
N	C = 7	D = 0	C+D = 7
	A+C = 13	B+D = 6	n = 19

L = "Natural" action
U = "Unnatural" action
K = Subjects with knowledge of the collision rules
N = Naïve subjects

Critical tables for D, given the observed values of A + B, C + D, and B, confirm that a value of 0 corresponds to a level of significance smaller than 0.05.

The conclusion is that H_o should be rejected in favour of H_6 on the evidence of the experimental results.

TESTS OF AUXILIARY HYPOTHESIS H_{6A} IN TYPE (f) ENCOUNTERS

In addition to establishing that there is a significant difference between the actions of naïve and experienced subjects in response to type (f) encounters, it is also of interest to investigate the probabilities of finding results as extreme as those observed on the assumption that manoeuvre patterns classed as "natural" or "unnatural" are made at random.

For this purpose, the null hypothesis, H_o, is that, in type (f) encounters it is equally likely that subjects take "natural" or "unnatural" action. The alternative hypothesis, H_{6A}, is that there is a systematic bias towards alterations of one class rather than the other. A 5% level of significance is looked for.

Under the null hypothesis, there is an equal probability of alterations of either class and, as in the test for H_{5A}, the binomial test may be used to find the probabilities of proportions as extreme as those observed. Separate tests are made for naïve and experienced subjects.

Naïve Subjects. Out of a total of 7 naïve subjects all took actions which were classed as "natural". The probability (p) of a value as extreme as this, in either direction, under the null hypothesis is given by:-

$$p = 0.0156$$

The conclusion is that, on this evidence, the null hypothesis should be rejected in favour of H_{6A} in the case of naïve subjects with no knowledge of the collision regulations, responding to type (f) encounters.

Subjects with Knowledge of the Collision Regulations. Out of a total of 12 such subjects, 6 took action classed as "natural" and 6 took action classed as "unnatural". The probability of an equal division of actions or any more extreme division is, of course, unity.

The conclusion is that the experimental results provide no evidence at all to suggest that the null hypothesis should be rejected in favour of H_{6A} in the case of subjects with a knowledge of the collision regulations, responding to type (f) encounters.

TEST OF H_{6A} FOR TYPE (e), (g) AND (h) ENCOUNTERS

For type (e), (g) and (h) encounters, results were only obtained in respect of subjects with a knowledge of the collision regulations. It is, however, of interest to investigate the probabilities of finding results as extreme as those observed on the assumption that manoeuvre patterns classed as "natural" or "unnatural" are made at random. As in previous tests, alterations of course to port or maintenance of course are classed as "natural" action and alterations of course to starboard are classed as "unnatural" action.

For the purpose of these tests, the null hypothesis, H_o, is that, in type (e), (g) and (h) encounters, it is equally likely that subjects take "natural" and "unnatural" action. The alternative hypothesis, H_{6A}, is that there is a systematic bias towards manoeuvres of one class rather than the other. A 5% level of significance is looked for.

Under the null hypothesis, there is an equal probability of alterations of either class and, as in the test for H_5A, the binomial test may be used to find the probability of proportions as extreme as those observed. Separate tests are made for each of the three encounter types.

Encounter type (e) For this encounter type, out of a total of 12 subjects, 2 took "natural" action and 10 took "unnatural" action. The probability (p) of values as extreme as this in either direction is given as:

$p = 0.038$

The conclusion is that, for type (e) encounters, H_0 should be rejected in favour of H_6A, and that "unnatural" action is a more likely response than "natural" action.

Encounter type (g) For this encounter type, out of a total of 12 subjects, 9 took actions classed as "natural" and 3 took actions classed as "unnatural". The probability (p) of values as extreme as this in either direction is given as:

$p = 0.146$

The conclusion is that, for type (g) encounters, there is insufficient evidence to reject H_0 in favour of H_{6A}.

Encounter type (h) For this encounter type, out of a total of 12 subjects, 11 took actions classed as "natural" and 1 took action classed as "unnatural". The probability (p) of values as extreme as this in either direction is given as:

$p = 0.006$

The conclusion is that, for type (h) encounters, H_0 should be rejected in favour of H_{6A} and that "natural" action is a more likely response than "unnatural" action.

SUMMARY OF TEST RESULTS FOR H_6 AND H_{6A}

The result of the test for H_6 indicates that there is a significant difference between the actions of naïve subjects and subjects with a knowledge of the collision regulations in response to type (f) encounters. Also that naïve subjects are less likely to alter course to starboard as compared to subjects with a knowledge of the regulations.

The results of the tests for H_{6A} indicate that naïve subjects systematically choose manoeuvres classed as "natural" in response to type (f) encounters. This observation may be noted as a justification of the use of the term "natural" for such manoeuvres.

The test results for H_{6A} in respect of subjects with a knowledge of the regulations suggest that:-

(i) They are more likely to choose "unnatural" manoeuvres in response to type (e) encounters.

(ii) The observed results could reasonably have resulted from a random choice of manoeuvre in the case of (f) and (g) type encounters.

(iii) They are more likely to choose "natural" manoeuvres in response to type (h) encounters.

TEST OF SEVENTH HYPOTHESIS (H_7)

The purpose of this test is to determine whether groups of naïve and experienced subjects differ significantly in the patterns of manoeuvres that they make in order to resolve encounters of type (i) in which their ship is originally on a collision course with a target ship crossing at right angles from the port side.

Manoeuvre patterns are nominally classed as "natural" or "unnatural". "Natural" manoeuvres are defined, for this test, as those which cause an initial increase in the rate of approach of the two vessels but which lead to disengagement before the time of the potential collision. Such manoeuvres usually, but not necessarily, produce a high value of "geometric utility" as defined on page 116. Alterations of course to port and increases of speed are examples of "natural" actions in response to type (i) encounters; c.f. class q manoeuvres as illustrated in figure 42.

"Unnatural" manoeuvres are defined, for this test, as those which cause an initial decrease in the rate of approach of the two vessels and which lead to disengagement after the time of the potential collision. Such manoeuvres usually, but not necessarily, produce a low value of "geometric" utility as defined on page 116. Alterations of course to starboard and decreases of speed are examples of "unnatural" actions in response to type (i) encounters; c.f. class t manoeuvres as illustrated in figure 42.

In this discussion, the time of disengagement is defined as the time at which the projected courses of the two ships would no longer intersect if each resumed its original heading.

For the purpose of the test, the null hypothesis is that there is no difference between the proportion of naïve subjects who choose "natural" manoeuvres in type (i) encounters and the proportion of experienced subjects who choose "natural" manoeuvres in response to type (i) encounters. The alternative hypothesis (H_7) is that, in type (i) encounters, naïve subjects take a smaller proportion of "natural" manoeuvres than experienced subjects.

The data for this test were obtained for experienced subjects of group (v) and naïve subjects of group (vi). The results are summarised in a 2 x 2 contingency table below.

	L	U	
E	A = 11	B = 12	A+B = 23
N	C = 15	D = 0	C+D = 15
	A+C = 26	B+D = 12	n = 38

L = Natural Action
U = Unnatural Action
E = Experienced Subjects
N = Naïve Subjects

Critical tables for D, given the observed values of A + B, C + D and B, indicate that a value of 0 corresponds to a level of significance of 0.0005.

The conclusion is that H_o should be rejected in favour of H_7 in the case of type (i) encounters.

It may be noted here that, for the above test for H_7 (and the test which follows for H_8) the sample size is large enough to use the χ^2 test). This test was performed and confirms that the null hypothesis should be rejected but, for uniformity with previous analyses, the Fisher exact probability test is presented above.

TESTS OF AUXILIARY HYPOTHESIS H_{7A}

In addition to establishing that there is a significant difference between the manoeuvre patterns of naïve and experienced subjects in type (i) encounters, it is of interest to investigate the probabilities of finding results as extreme as those observed on the assumption that manoeuvre patterns classed as "natural" or "unnatural" are made at random.

For the purpose of these tests, the null hypothesis, H_o, is that, for type (i) encounters, it is equally likely that subjects take "natural" and "unnatural" action as defined on page 175. The alternative hypothesis, H_{7A}, is that there is a systematic bias towards manoeuvres of one class rather than the other. A 5% level of significance is looked for.

As for similar previous investigations, the binomial test is used, separate tests being made for the group of experienced subjects and the group of naïve subjects.

Experienced Subjects. Out of a total of 23 such subjects, 11 took actions classed as "natural" and 12 took actions classed as "unnatural". The probability of such a division or a division more extreme in either direction is, of course, unity.

The conclusion is that there is no evidence at all to suggest that H_o should be rejected in favour of H_{7A} in the case of experienced subjects responding to type (i) encounters.

Naïve Subjects. Out of a total of 15 such subjects, all took actions which were classed as "natural". The probability (p) of such an extreme observation in either direction is given by:-

$$p = 0.00006$$

The conclusion is that H_o should be rejected in favour of H_{7A} in the case of naïve subjects responding to type (i) encounters.

SUMMARY OF TEST RESULTS FOR H_7 AND H_{7A}

The result of the test for H_7 indicates that there is a significant difference between the actions of naïve subjects and experienced subjects in response to type (i) encounters. Also that naïve subjects are less likely to choose manoeuvres classed as "unnatural" for the purposes of the test.

The results of the tests for H_{7A} indicate that, for experienced subjects, the observed division could reasonably have resulted from a random choice between "natural" and "unnatural" manoeuvres. For naïve subjects there appears to be a systematic bias towards manoeuvres classed as "natural". This observation may also be noted as a justification of the use of the term "natural" for such manoeuvres.

It is of interest that the division of the manoeuvres into "natural" and "unnatural" classes for these tests corresponds exactly and respectively to the division of manoeuvres into classes "q" and "t" for the test of H_4 applied to type (i) encounters.

TEST OF EIGHTH HYPOTHESIS H_8

The purpose of this test is to determine whether groups of naïve and experienced subjects differ significantly in the patterns of manoeuvres that they make in order to resolve encounters of type (j) in which their ship is originally on a collision course with a target ship crossing at right angles from the starboard side.

Manoeuvre patterns are classed in the same way as for the test of H_7. "Natural" manoeuvres are defined as those which cause an initial increase in the rate of approach of the two vessels but which lead to disengagement before the time of the potential collision. Such manoeuvres usually, but not necessarily, produce a high value of "geometrical utility" as defined on page 116. "Unnatural" manoeuvres are defined as those which cause an initial decrease in the rate of approach of the two vessels and which lead to disengagement after the time of the potential collision. Such manoeuvres usually, but not necessarily, produce a low value of "geometrical utility" as defined on page 116. For this classification, the time of disengagement is defined as the time at which the projected courses of the two ships would no longer intersect if each resumed its original velocity.

For the purpose of this test, the null hypothesis, H_o, is that there is no difference between the proportion of naïve subjects who choose "natural" manoeuvres in type (j) encounters and the proportion of experienced subjects who take "natural" action in type (j) encounters. The alternative hypothesis, H_8, is that experienced subjects take proportionally fewer "unnatural" actions than naïve subjects for this type of encounter.

The data for this test were obtained for experienced subjects of group (v) and naïve subjects of group (vi). The results are summarised in a 2 x 2 contingency table below:

	L	U	
N	A = 13	B = 1	A+B = 14
E	C = 23	D = 1	C+D = 24
	A+C = 36	B+D = 2	n = 38

L = "Natural" action
U = "Unnatural" action
N = Naïve subjects
E = Experienced subjects

The probability (p) of a value of D as small as 1 occurring under H_o and with marginal totals as above is given by:-

$$p = 0.607$$

The conclusion is that H_o should not be rejected in favour of H_8.

TESTS OF AUXILIARY HYPOTHESIS H_{8A}

In addition to establishing that there are no grounds for suggesting that there is a significant difference between the manoeuvre patterns of naïve and experienced subjects in type (j) encounters, it is of interest to investigate the probabilities of finding results as extreme as those observed on the assumption that manoeuvre patterns classed as "natural" or "unnatural" are made at random.

For the purpose of these tests, the null hypothesis, H_o, is that, for type (j) encounters, it is equally likely that subjects take "natural" and "unnatural" action as defined on page 178. The alternative hypothesis, H_{8A}, is that there is a systematic bias towards manoeuvres of one class rather than the other. A 5% level of significance is looked for.

As for previous investigations, the binomial test is used. Separate tests are preferred for the group of experienced and the group of naïve subjects although, since there is no significant difference between their manoeuvre patterns, it would be possible to make a single test on the pooled results.

Experienced Subjects Out of a total of 24 such subjects, 23 took action classed as "natural" and 1 took action classed as "unnatural". The probability (p) of such a division or the more extreme division of 24:0, in either direction, under H_o, is given by:-

$$p = 0.000003$$

The conclusion is that H_o should be rejected in favour of H_{8A} and that there is a greater probability that experienced subjects take "natural" action rather than "unnatural" action in response to type (j) encounters.

Naïve Subjects Out of a total of 14 such subjects, 13 took action classed as "natural" and 1 took action classed as "unnatural". The probability (p) of such a division or the more extreme division of 14:0, in either direction, under H_o, is given by:-

$$p = 0.0018$$

The conclusion is that H_o should be rejected in favour of H_{8A} and that there is a greater probability that naïve subjects take "natural" rather than "unnatural" action in response to type (j) encounters.

SUMMARY OF TEST RESULTS FOR H_8 and H_{8A}

The result of the test for H_8 suggests that there is no significant difference between the manoeuvres made by naïve and experienced subjects in response to type (j) encounters.

The results of the tests for H_{8A} indicate that both naïve and experienced subjects resolve type (j) encounters more often by manoeuvres classed as "natural" than by manoeuvres classed as "unnatural".

CORRELATION BETWEEN "E" SCORE AND LENGTH OF EXPERIENCE

As the experimental programme developed and data accumulated, it was noticed that there appeared to be a marked negative correlation between EPI "E" score and length of seagoing experience. All the relevant data collected are tabulated below and a correlation coefficient calculated.

In 1964, Eysenck[79] pointed out that there was a negative correlation (-0.240) between "E" score on his A scale and age. A test is made to investigate whether the correlation found for merchant navy subjects is significantly different from Eysenck's figure.

Subject	Exp.	"E"
1	16	9
2	11	11
3	15	12
4	10	14
5	10	19
6	23	8
7	10	18
8	10	10
9	19	6
10	11	6
11	9	9
12	23	4
13	8	16
14	13	17
15	9	9
16	37	4
17	11	12
18	7	17
19	14	14
20	21	6
21	10	8
22	13	13
23	15	9
24	14	16

Subject	Exp.	"E"
25	28	11
26	31	8
27	25	11
48	49	7
29	19	10
30	11	17
31	9	11
32	11	14
33	7	8
34	12	8
35	11	12
36	27	12
37	25	8
38	9	11
39	13	18
40	11	11
41	11	15
42	11	0
43	18	8
44	7	14
45	39	7
46	12	23
47	12	19
48	13	11

Analysis gives the correlation coefficient (r) as:-

$$r = -0.433$$

This value is appreciably more than the value of -0.240 given by Eysenck, but a test using Fisher's Z transformation shows that the difference falls short of significance at the 5% level.

The conclusion is that, although significant negative correlation is found between "E" score and age for Merchant Navy subjects, it is not significantly higher than Eysenck's figure for the general population.

RE-EXAMINATION OF THE CORRELATION FOUND BETWEEN "E" SCORE AND δM

The negative correlation found between "E" score and length of experience suggests that further analysis is desirable of the positive correlation found between a subjects "E" score and δM, the difference between his miss distance and the median miss distance. (See pp.152-155).

It is possible that the significant relationship could be a negative correlation between a subjects length of experience and δM rather than the established positive correlation between "E" score and δM.

To conduct this analysis, Kendall's partial rank correlation coefficient is used.

The partial rank correlation coefficient measuring the correlation between δM and "E" when length of experience is held constant is designated $\tau_{ME.X}$. Analysis gives:-

$$\tau_{ME.X} = 0.263$$

The partial rank correlation coefficient measuring the correlation between δM and length of experience when "E" is held constant is designated $\tau_{XM.E}$. Analysis gives:-

$$\tau_{XM.E} = -0.283$$

CONCLUSION

There is no test of significance for Kendall's partial rank correlation coefficient, but these results indicate that the previously observed significant positive correlation between δM and "E" score is, in some part, due to an independent negative correlation between δM and length of experience and a negative correlation between length of experience and "E" score. There is, nevertheless, still a strong independent correlation between "E" score and δM when length of experience is held constant.

SUMMARY OF CHAPTER IV

This chapter has given an outline of the rationale which led to the choice of the experimental programme, and a detailed description of the experimental procedures and tests for significance of the several hypotheses.

There remains the interpretation of the results of the experimental programme, and this is the subject matter of chapter V.

CHAPTER V

Discussion and Conclusions

Take my counsel happy man;
Act upon it if you can.

The Gondoliers W.S. Gilbert

BASIS OF STUDY

The purpose of the experimental programme described in chapter IV was to make a first systematic study of the manoeuvre patterns used by mariners in resolving potential collision encounters between ships. Since no known comparable work had previously been carried out which could be used as a starting point, the approach was to use practical experience as a basis for choosing the encounters for study and to make a wide selection of independent and dependent variables which were easily measurable and which might be expected to be inter-related.

PERSONALITY MEASURES

The experiments designed to investigate the relationship between personality measures and manoeuvring behaviour gave evidence of an interesting correlation between a subject's Eysenck Personality Inventory "E" score and the difference between the miss distance he achieved by his manoeuvre and the median value of the miss distances achieved by all subjects (see test for H_{1A}, p.152 et seq.). This finding may be interpreted as indicating that extraverted subjects tend to achieve extreme values of miss distance (either large or small) whilst introverted subjects tend to achieve moderate values of miss distance.

The operational assessment is that the action of the introverted subjects is to be preferred since the "close shaving" implied by small miss distances is obviously undesirable and the exaggerated actions associated with very large values of miss distance are wasteful of both time and sea-room, the latter being important in areas of high shipping density.

The significant negative correlation of 0.424 between EPI "E" score and the length of experience of Merchant Navy navigating officers is also of interest. It is particularly noteworthy that, of the 48 subjects studied, the 31 below the age of thirty had a mean "E" score slightly higher than the population mean of 12.07 quoted by Eysenck[79], but that the 17 subjects above the age of thirty all, without exception, had "E" scores of less than the population mean. Apart from the general tendency of "E" score to decrease with age, the observed distribution of "E" score with the age of M.N. officers would be explained if there was a greater wastage rate amongst officers with high "E" scores than amongst officers with low "E" scores. Such a division would certainly seem reasonable, bearing in mind the nature of life at sea and the personality characteristics associated with high and low "E" scores. Also, the initial appeal of a sea-going career and its association with adventure[82], might be expected to attract the more extraverted young men, thus accounting for the high observed "E" scores of the under thirties. The evidence for these speculations is not conclusive, but it suggests lines for research into the very severe problem of wastage amongst Merchant Navy officers.

What does appear to be established is that the collision avoidance actions of the more introverted officers are more efficient than those of the more extraverted officers and that this is partly, but only partly, because the introverts tend to stay at sea longer and thus to have greater mean experience than the extraverts. Additional experimentation to confirm these findings in other types of encounter would be valuable.

If confirmation is forthcoming, the implication is that selection procedures for entry into the M.N. might usefully be amended. The young man who is desperately keen to go to sea and who performs well in front of a selection committee may not be the one who will later on perform best in collision avoidance manoeuvres or give the longest service at sea.

The experimental results gave no grounds for relating subjects' EPI "N" scores to their observed manoeuvre patterns. The results for Embedded figure test scores were inconclusive but suggested that further investigation might be worthwhile. Again, the usefulness of any results which might be established would be at the selection stage for navigating officers.

END-ON AND NEARLY END-ON ENCOUNTERS

End-on and nearly end-on encounters were studied because most open-sea collisions are found to have developed from initial situations of this class. This was shown to be the case by Thorolf Wikborg in the nineteen-fifties and in 1969 a US Transportation Safety Board Study[83] found that, of 96 collisions considered in open waters, all started from meetings in which the ships were initially end-on or nearly end-on to each other. Three plots of real collisions of this type are contained in appendix VIII, sections A, C, D and E.

Under the experimental conditions, in exactly end-on encounters (type d), experienced subjects all altered course to starboard, showing great consistency in the final miss distance. In similar situations, naïve subjects with no knowledge at all of the collision regulations, took unpredictable action with alterations of course either way.

Analysis showed that the experienced subjects made a systematic choice in altering course to starboard but that the naïve subjects made a choice of port or starboard alterations not significantly different from random. Typical plots of the manoeuvres made by both groups of subjects are illustrated in figures 43 and 44.

Fig. 43

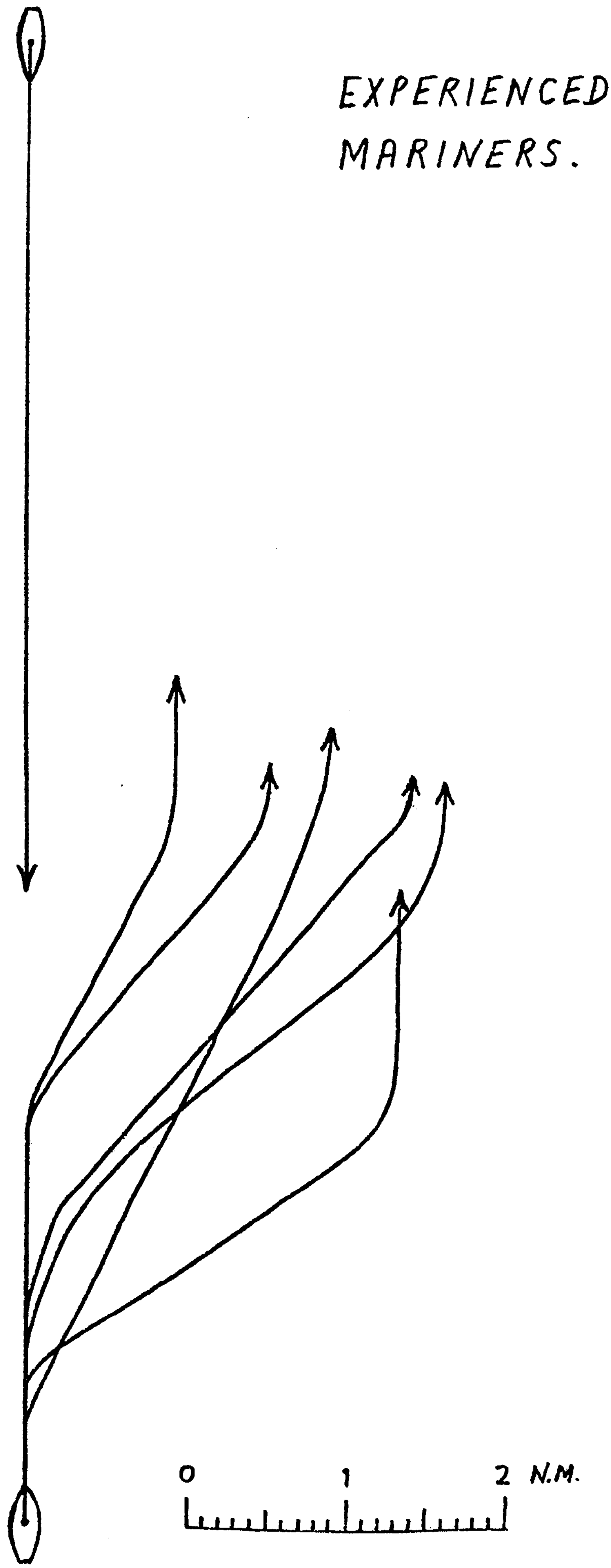
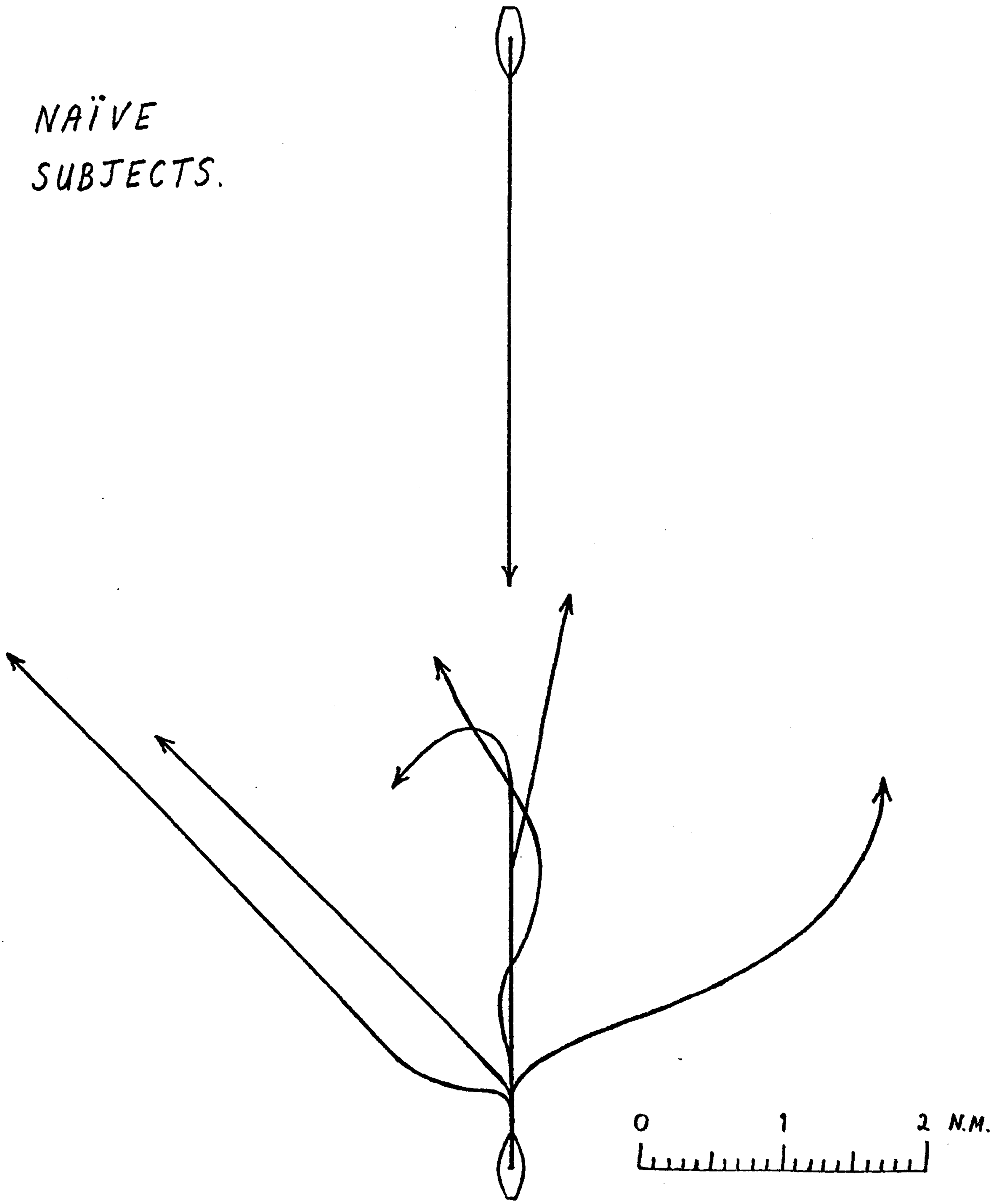
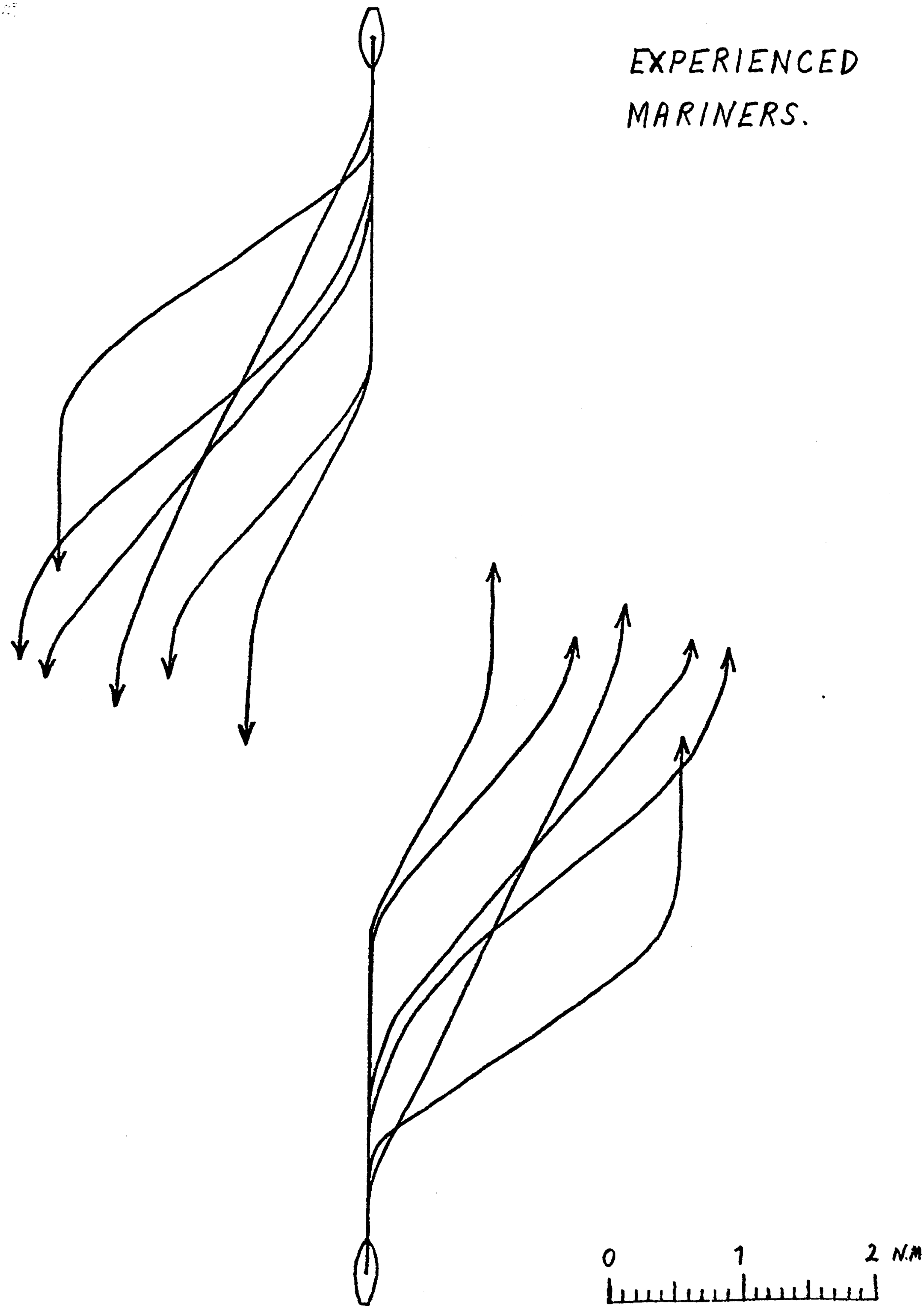


Fig. 44



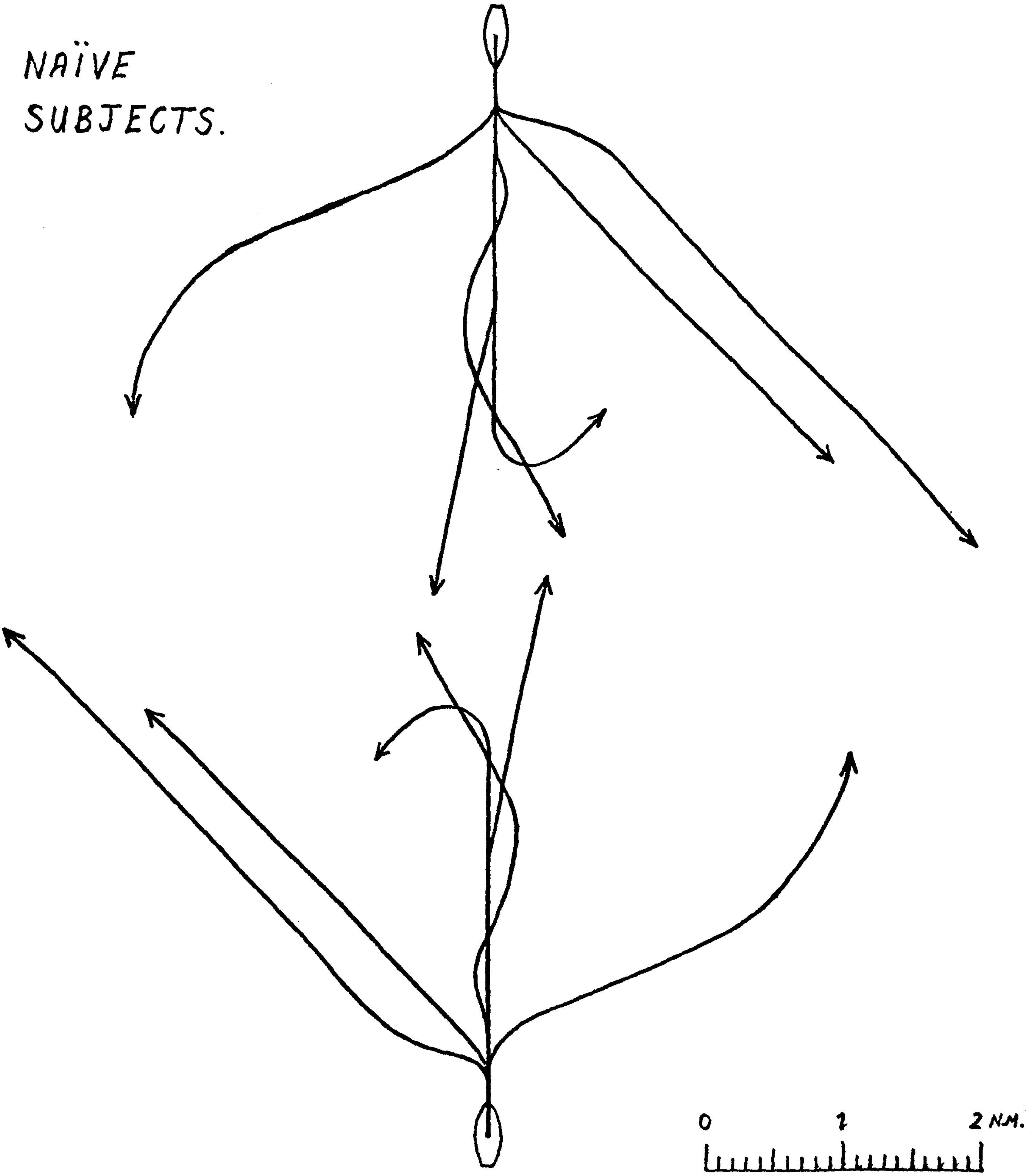
The efficiency and economy of the manoeuvres made by the experienced subjects in end-on encounters is demonstrated in figure 45 below, in which the target ship is made to take precisely the same manoeuvres as the subjects' ships. The manoeuvres for any opposing pair of ships are always complementary and effective in resolving the encounter.

Figure 45



The inconsistency and the lack of economy in the manoeuvres made by the naïve subjects in end-on encounters is demonstrated in figure 46 below in which the target ship is again made to take precisely the same actions as the subjects' ships. The manoeuvres for opposing pairs of ships are frequently conflicting and thus ineffective in resolving the encounters.

Fig. 46



It seems reasonable to ascribe the difference in behaviour between the two groups of subjects to the experienced mariners' knowledge of the collision regulations since there was no significant difference between the actions of mariners with differing levels of experience provided that they knew the rules.

In encounters (type f) between ships on opposite and parallel courses, but offset by one mile starboard to starboard, experienced mariners took inconsistent action approximately equally divided between alterations of course to port and alterations of course to starboard. In similar situations, naïve subjects all altered course to port or maintained course and speed. Analysis showed that the naïve subjects' choice of action was systematic but that the actions of the experienced subjects were compatible with a random choice of port or starboard alterations. The diagrams below show typical plots of the manoeuvres made by experienced subjects (fig. 47) and by naïve subjects (fig. 48)

Fig. 47

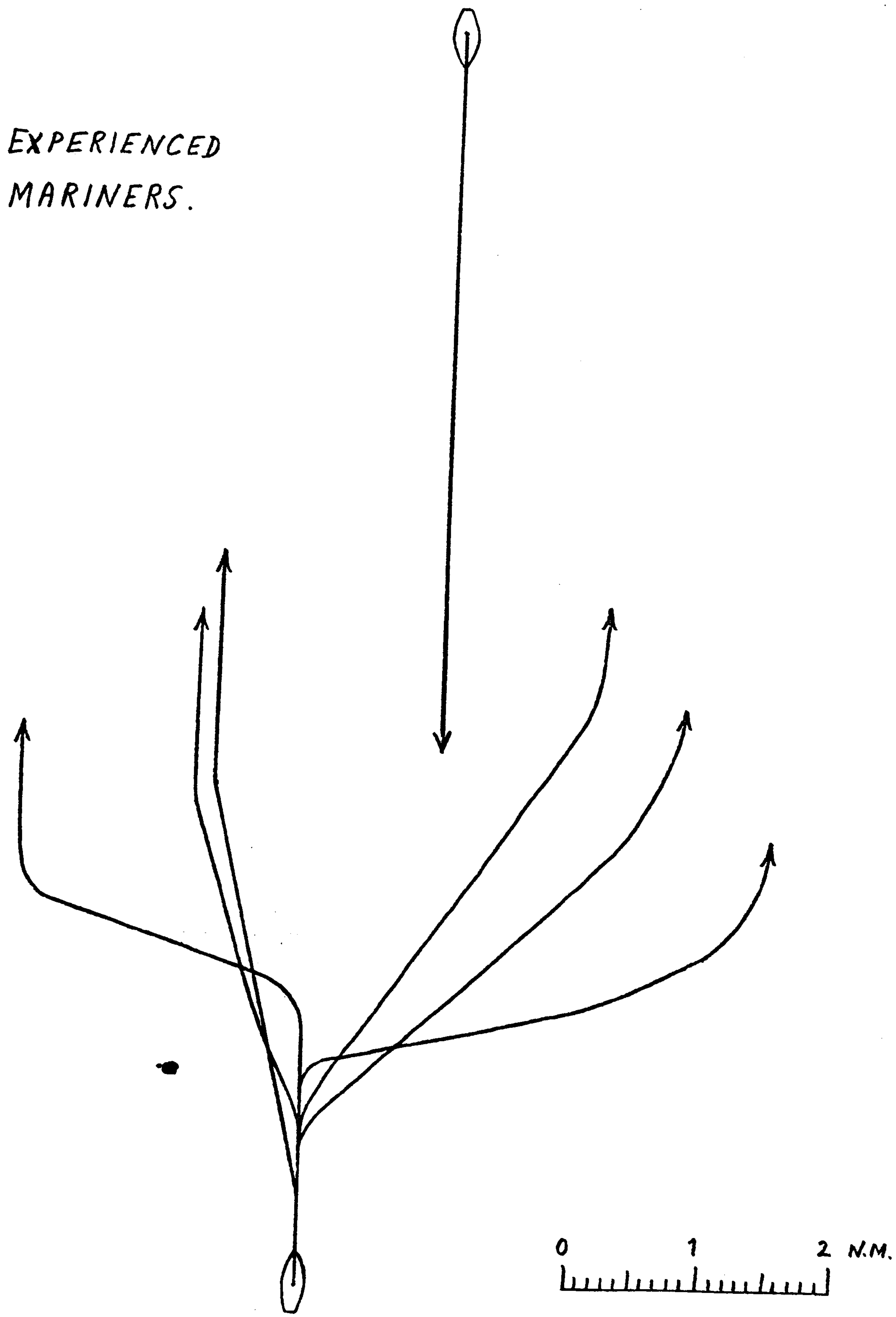
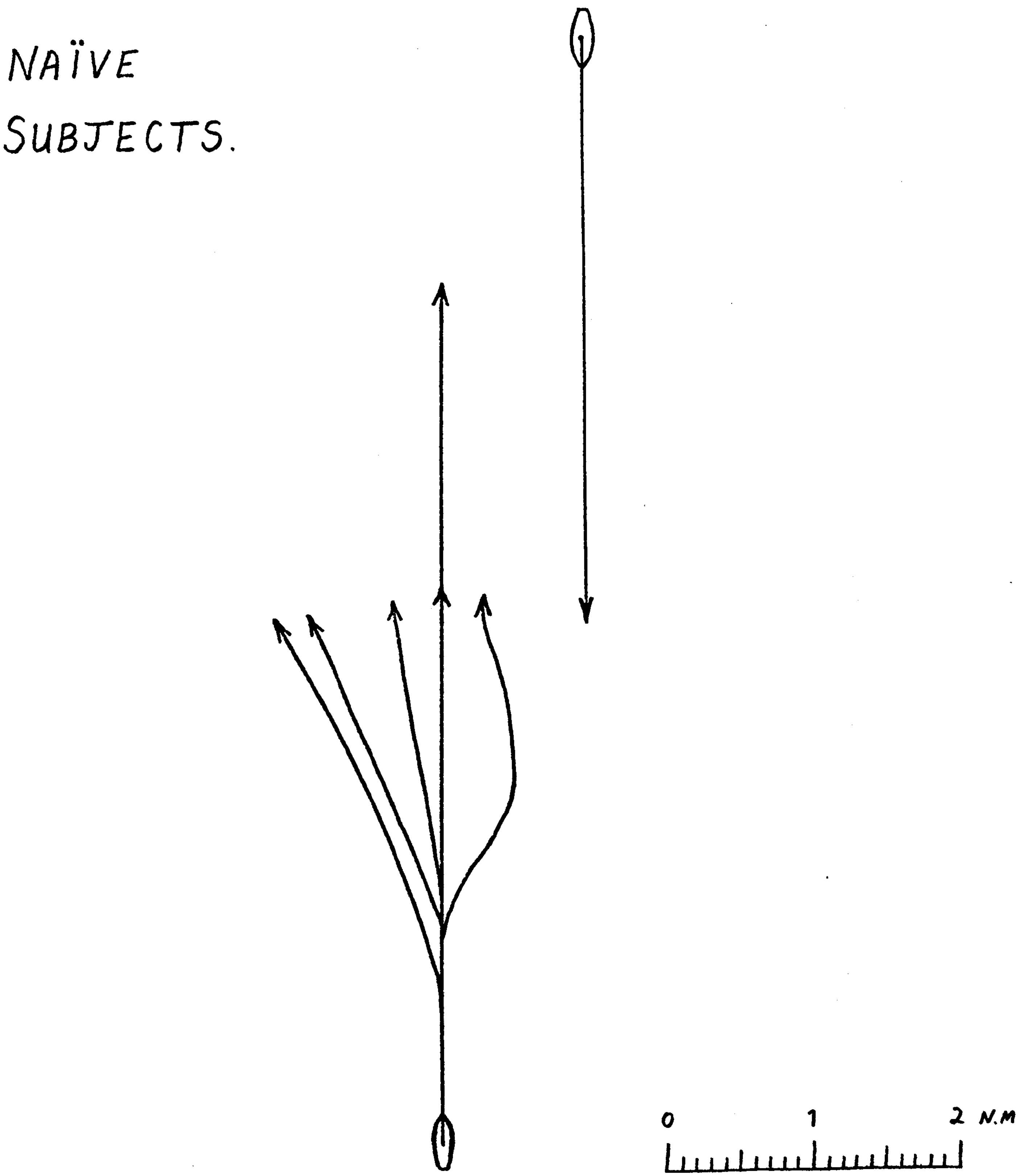
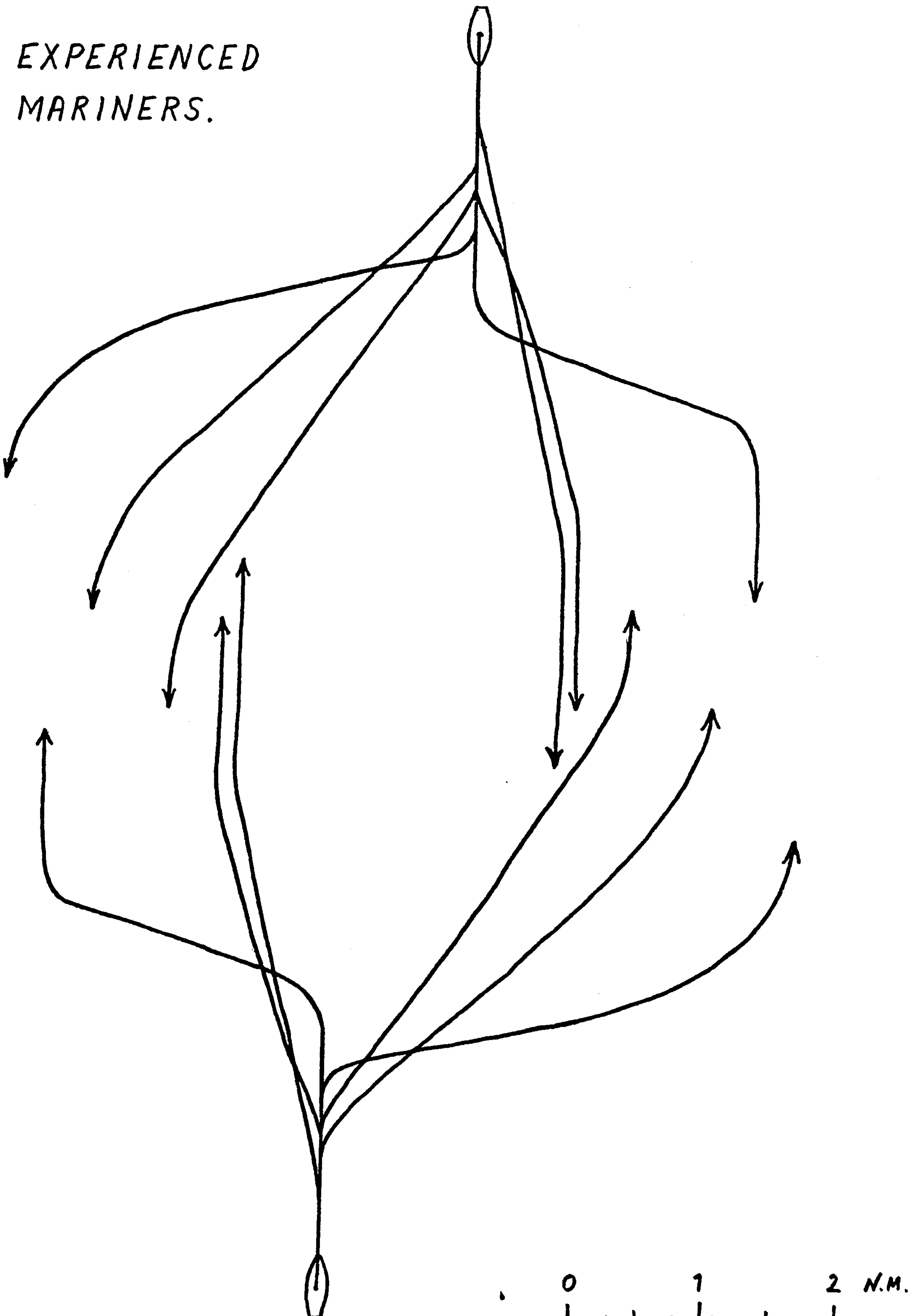


Fig. 48



The inconsistency and lack of economy in the manoeuvres made by the experienced subjects in type (f) encounters is demonstrated by figure 49, in which the target is made to take precisely the same manoeuvres as the subjects' ships. The manoeuvres for opposing pairs of ships are frequently conflicting and thus ineffective in resolving the encounters. The diagram may be compared with the plots of three real life collisions illustrated in appendix VIII, sections A, C and D.

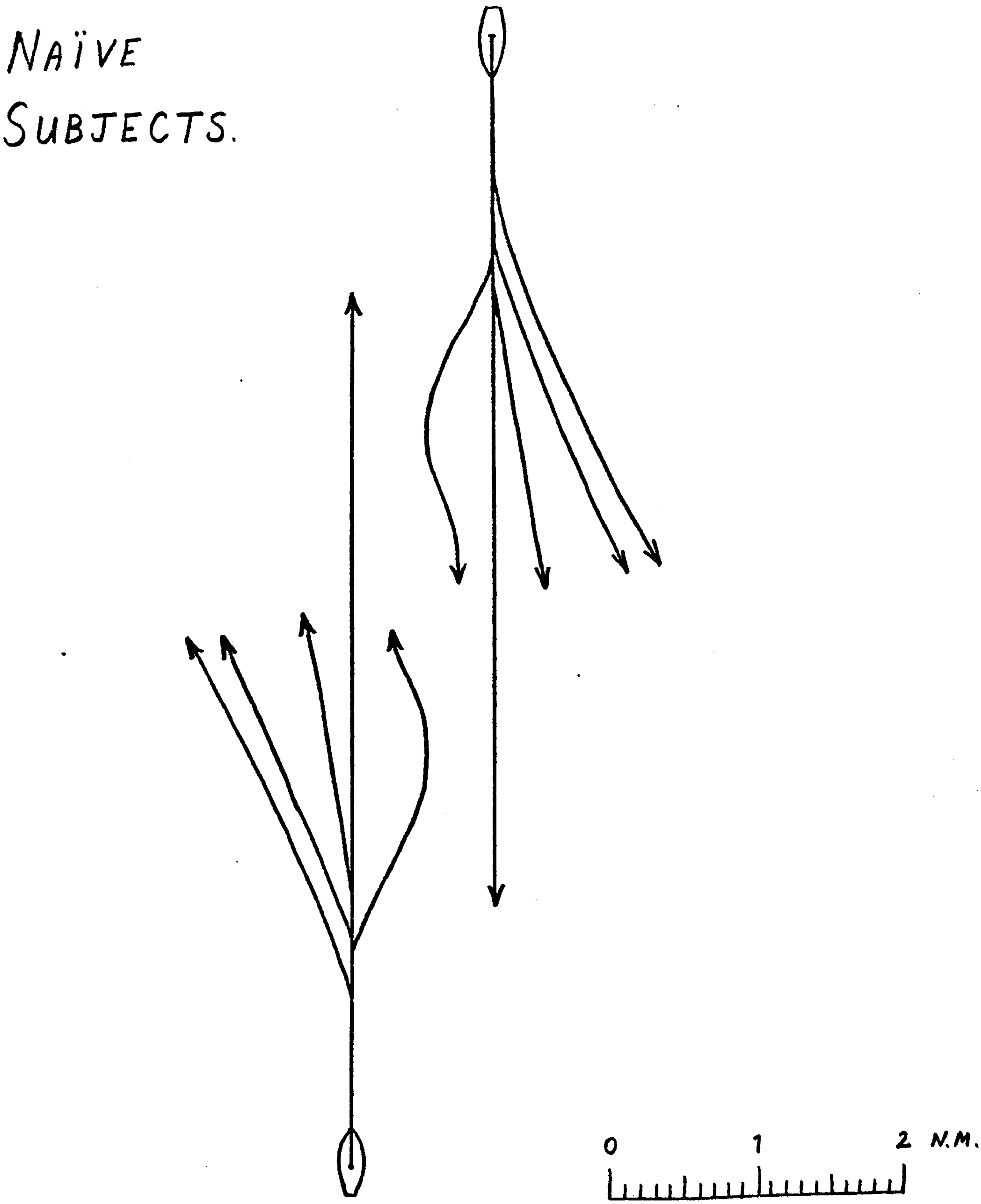
Fig. 49



The efficiency and economy of the manoeuvres made by naïve subjects in response to type (f) encounters is illustrated in figure 50 below, in which the target ship is again made to take precisely the same actions as the subjects' ships. The manoeuvres for any opposing pair of ships are always complementary and effective in resolving the encounter.

Again, the difference in behaviour between the two groups of subjects can be ascribed to the mariners knowledge of the collision regulations and, for this type of encounter, it appears that a knowledge of the collision regulations makes disengagement more difficult.

Fig. 50



THE SECTOR OF UNCERTAINTY

In addition to the tests in type (d) (end-on) and type (f) (1 mile offset) encounters, subjects with a knowledge of the rule were also tested in encounters of types (e), (g) and (h) in which the ships were initially on parallel and opposite courses but offset, starboard to starboard, by ½ mile, 1½ miles and 2 miles respectively. The purpose of these additional encounter types was to establish approximate limits within which experienced subjects take inconsistent actions similar to those observed in the type (f) encounters.

The results of these tests are summarised on pages 137 and 138. The inconsistency may be measured for each encounter type by imagining the subjects set against each other in opposing pairs and counting the number of occurrences of a port alteration by one subject and a starboard alteration by the other. The number of conflicts found in this way may be divided by the total possible number of ways in which opposing pairs might be chosen from amongst the subjects tested, thus giving the probability of conflicting action between any two such subjects, selected at random.

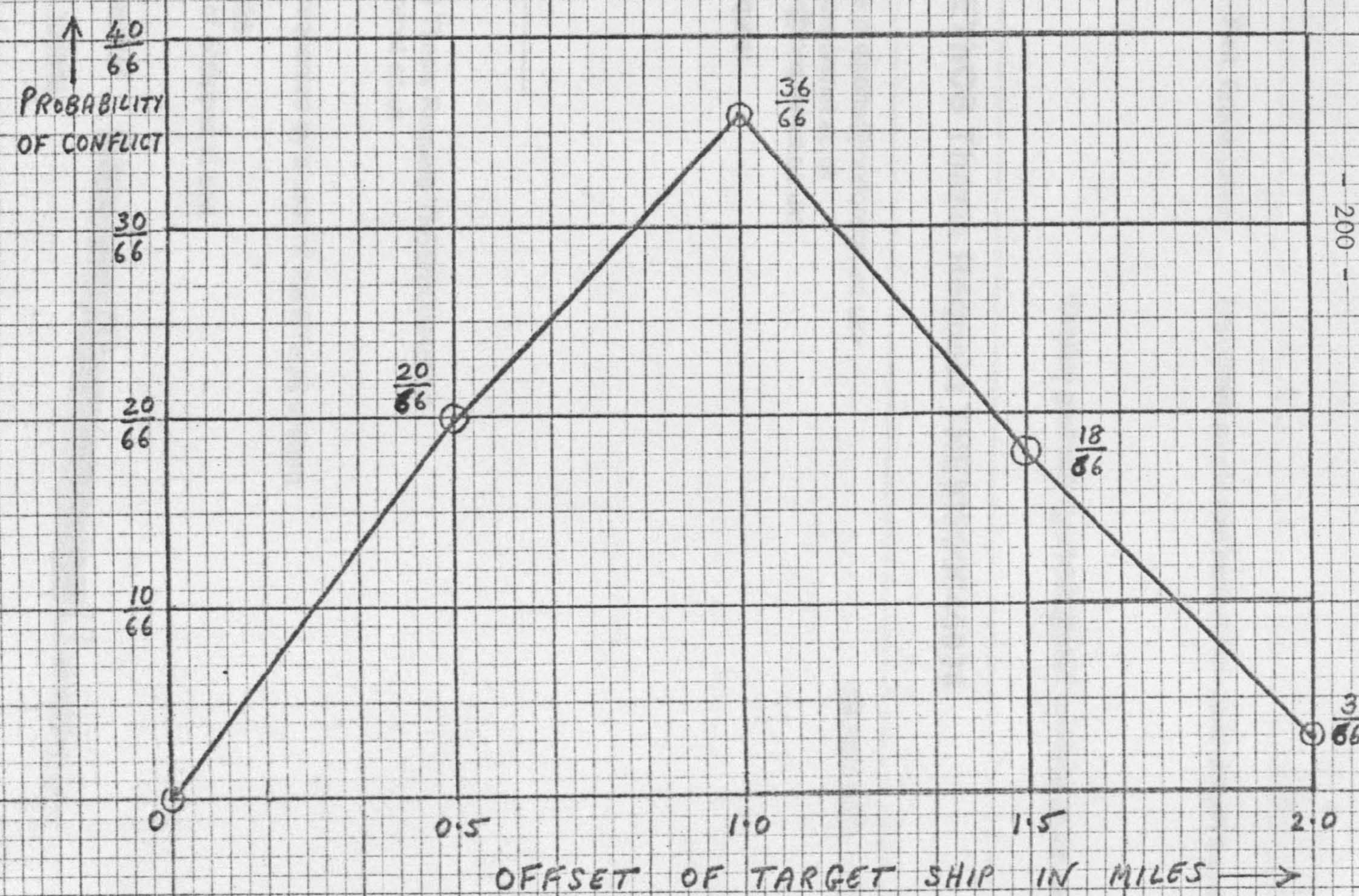
For the 12 subjects tested, the total number of ways in which opposing pairs could be chosen is 66. The number of conflicts counted for the types (d), (e), (f), (g) and (h) encounters was 0, 20, 36, 18 and 3, respectively. The graph of the corresponding probabilities is shown below (fig. 51).

Fig. 51

ACTION BY 12 SUBJECTS WITH KNOWLEDGE OF THE RULES.

SUBJECT	TARGET SHIP OFFSET 0	0·5	1·0	1·5	2·0 N.M.
1	S	S	S	M	M
2	S	S	S	P	M
3	S	P	P	M	M
4	S	P	P	M	M
5	S	S	S	S	S
6	S	S	P	P	M
7	S	S	P	P	P
8	S	S	S	P	M
9	S	S	S	P	M
10	S	S	P	S	P
11	S	S	S	S	P
12	S	S	P	P	M

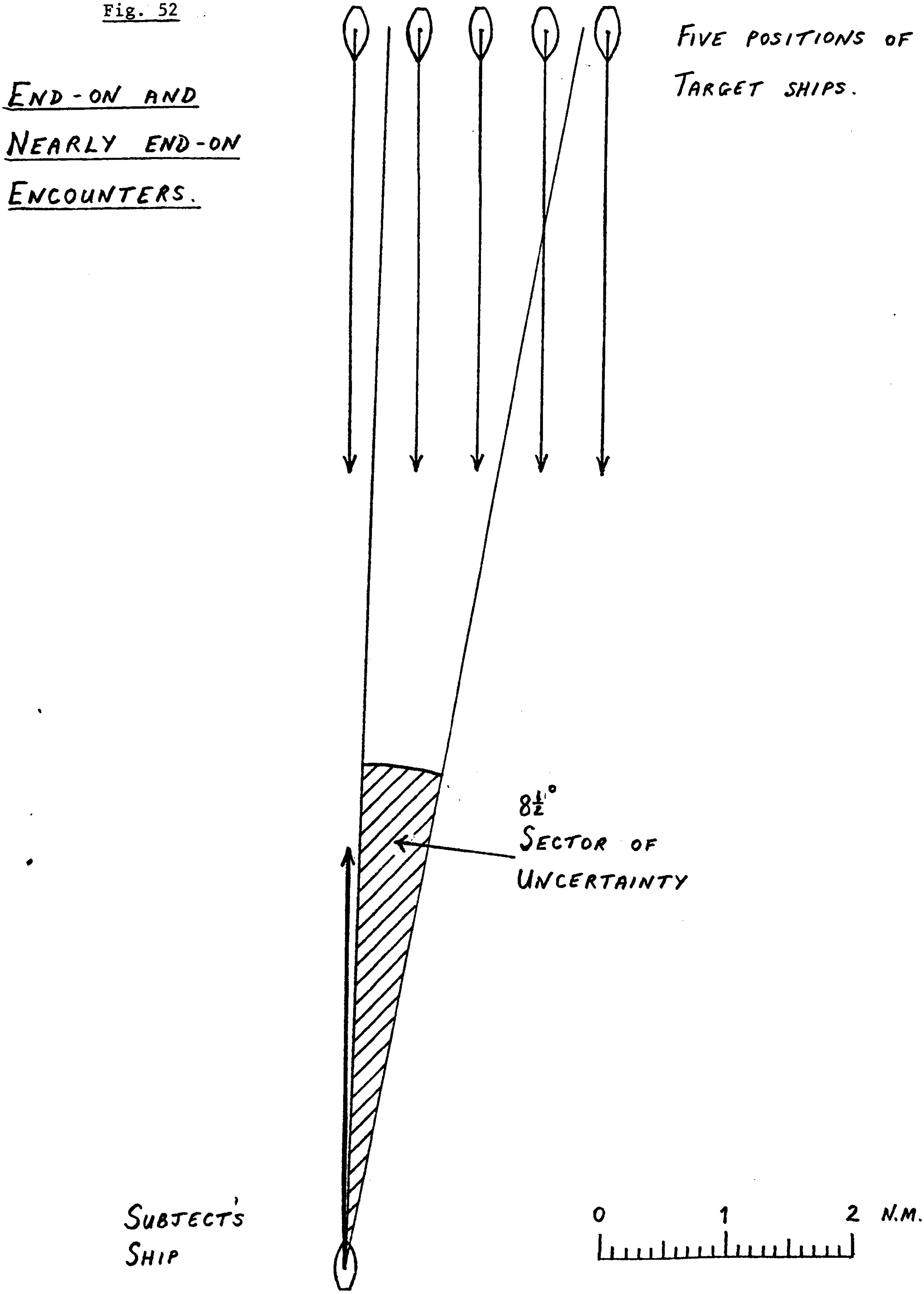
PROBABILITY OF CONFLICTING ACTION IF SUBJECTS ARE SUPPOSED OPPOSING ONE ANOTHER IN PAIRS.



The probabilities are, perhaps, a little optimistic in that conflicts were only counted when the two ships altered course in opposite senses. A conflict could also occur if one ship maintained course and speed and the other made an inadequate alteration of course to starboard. Such a combination of actions has resulted in real life collisions, as for example, the case of the Boulgaria and the Hagen, illustrated in appendix VIII, section E.

The graph shows that the inconsistency of action is important for offsets between the ships' courses of from approximately 0.25 miles to 1.75 miles. At a ten mile distance between the ships, this includes cases in which each ship sees the other within a sector from approximately $1\frac{1}{2}^{\circ}$ to 10° on the starboard bow, as in figure 52 below.

Fig. 52


END-ON AND
NEARLY END-ON
ENCOUNTERS.
FIVE POSITIONS OF
TARGET SHIPS.
8½°
SECTOR OF
UNCERTAINTY
SUBJECT'S
SHIP
0
1
2
N.M.

This sector may be termed the "sector of uncertainty" since it represents the limits within which unpredictable action may be expected from subjects with a knowledge of the collision regulations.

For naïve subjects, the evidence suggests that their actions are inconsistent and unpredictable only for the exactly end-on situation (encounter type (d)) and that they have a very narrow sector of uncertainty. If this is so then, in an area where ships are proceeding mainly on reciprocal courses, it is less ~~more~~ likely that conflicting action would occur if they were all manned by naïve subjects. For encounters of this class, it would seem that the present rules are worse than no rules at all. It is, perhaps, not surprising that such encounters lead to more real life collisions than any others.

The value of the investigation of end-on and nearly end-on encounters has been in identifying, with some precision, a range of situations in which difficulty exists. Further systematic experimentation with encounters in which courses are opposed but not exactly parallel would seem to be a next logical step.

At this stage, a rule on the lines of the 1831 Select Committee recommendation looks attractive (see appendix II(C)). This required that vessels meeting other than directly "stem on" should only alter course so as to make them sheer away from each other. Precisely the action which it appears would be preferred by subjects in the absence of formal regulations. Perhaps the amendments to the end-on rules since 1831 have been retrogressive.

RIGHT ANGLED CROSSING ENCOUNTERS

Right angled crossing encounters were studied because the author's experience suggested that these are situations in which the collision regulations are sometimes disregarded.

Under the experimental conditions, for threats from the starboard side (encounter type (j)), experienced subjects systematically altered course to starboard to pass astern of the ship they were avoiding. Typical manoeuvres are illustrated in figure 53.

In similar encounters, naïve subjects with no knowledge of the rules generally took similar action but with a minority showing a preference for increasing speed to pass ahead of the ship they were avoiding. Typical manoeuvres are illustrated in figure 54.

Fig. 53

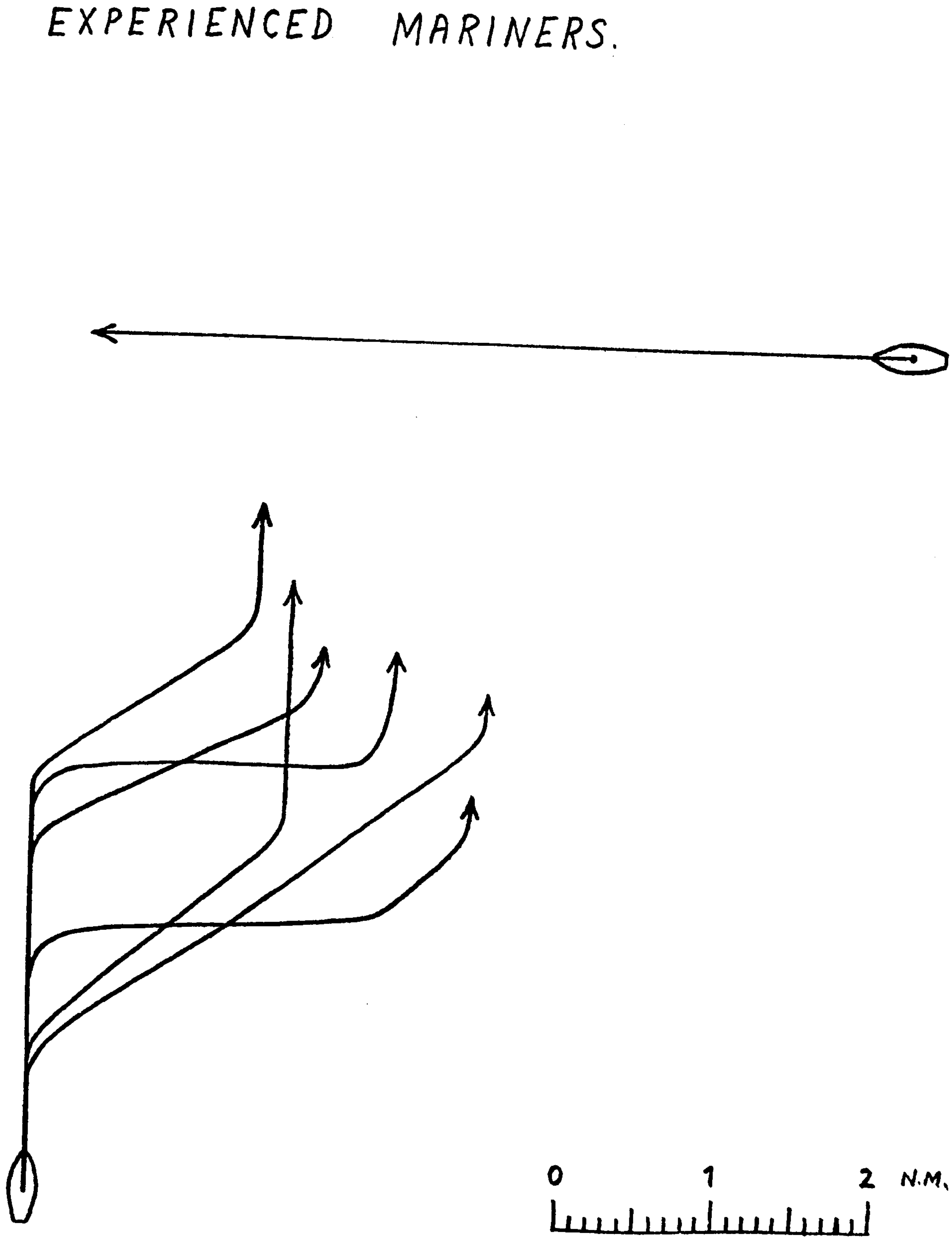
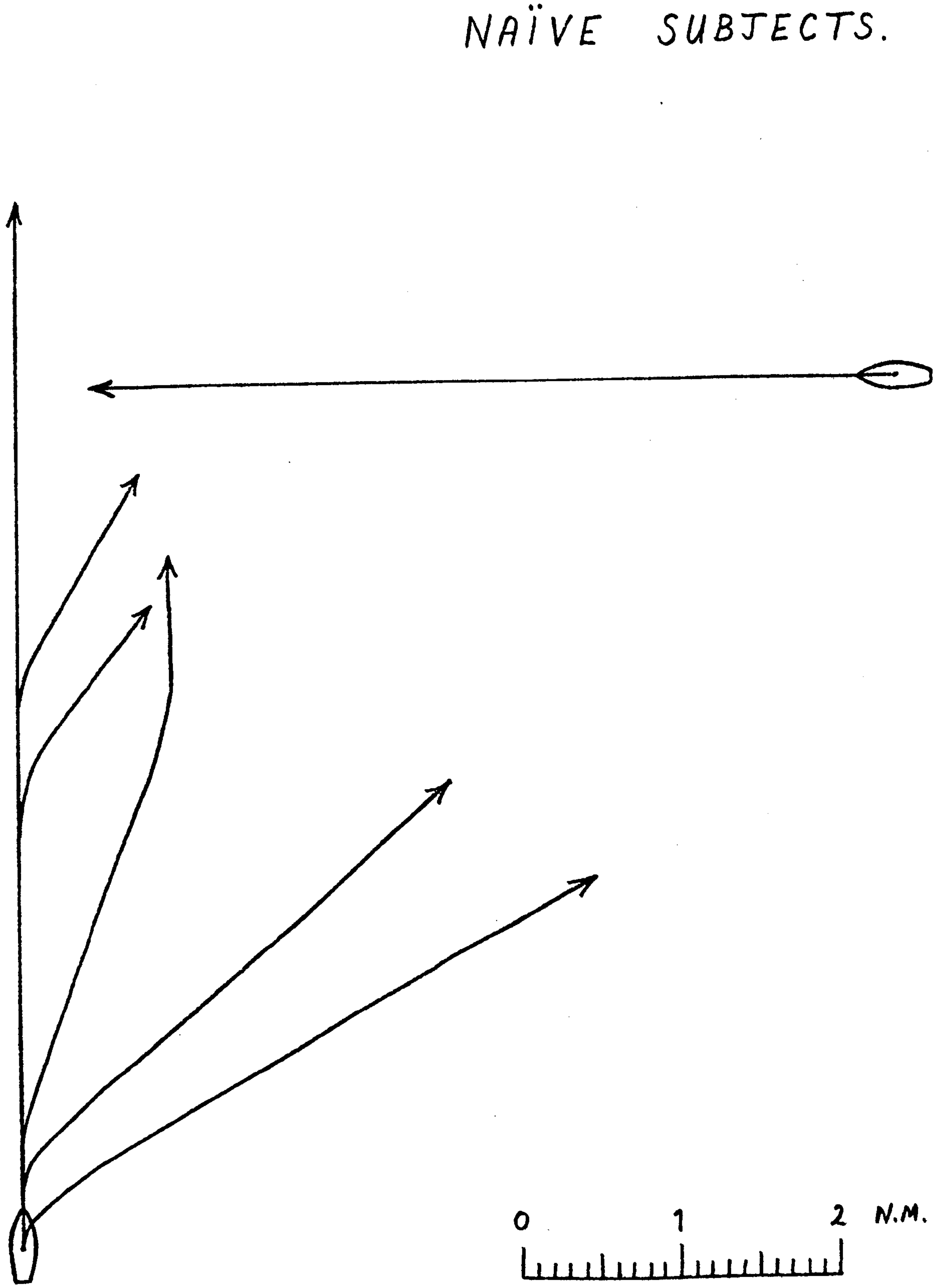


Fig. 54



For both groups, analysis showed that the experimental results were incompatible with random selection of manoeuvres by the subjects.

For type (j) encounters it appears that the natural action is to alter course to starboard or to increase speed. The collision regulations give preference to an alteration of course to starboard, thus reinforcing the choice of this "natural" action for experienced subjects. The response of subjects with a knowledge of the collision regulations is therefore highly predictable for type (j) encounters.

Under the experimental conditions, for threats from the port side (encounter type (i)), experienced mariners took unpredictable action. The experimental results were sufficiently diverse to be compatible with a random choice of manoeuvre by these subjects. Some typical manoeuvres are illustrated in figure 55.

In similar encounters, naïve subjects with no knowledge of the collision regulations either altered course to port to pass astern of the other ship or increased speed to pass ahead. Their overall manoeuvre patterns were close to a mirror image of their manoeuvre patterns for type (j) encounters and again the experimental results were incompatible with random selection of manoeuvres by the subjects. Some typical manoeuvres are illustrated in figure 56.

For type (i) encounters it appears that the natural action is to alter course to port or to increase speed. Both these actions are discouraged by the collision regulations and the diverse results for experienced subjects indicate that they find difficulty in choosing between, on the one hand, action which seems "natural" and expeditious and, on the other hand, action which is "unnatural" but which is approved by the regulations.

Again, an encounter type has been identified in which a knowledge of the collision regulations seems to cause less predictable responses than if there were no rules. Some of the difficulties in devising a solution to this problem were discussed in chapter III (page 83 et seq.) but it may be noted that the apparently "natural" action of increasing speed for type (j) encounters would be complementary to the "natural" action of altering course to starboard for type (i) manoeuvres. Three examples each of these manoeuvres by naïve subjects are shown superimposed in figure 57 below:-

Fig. 55

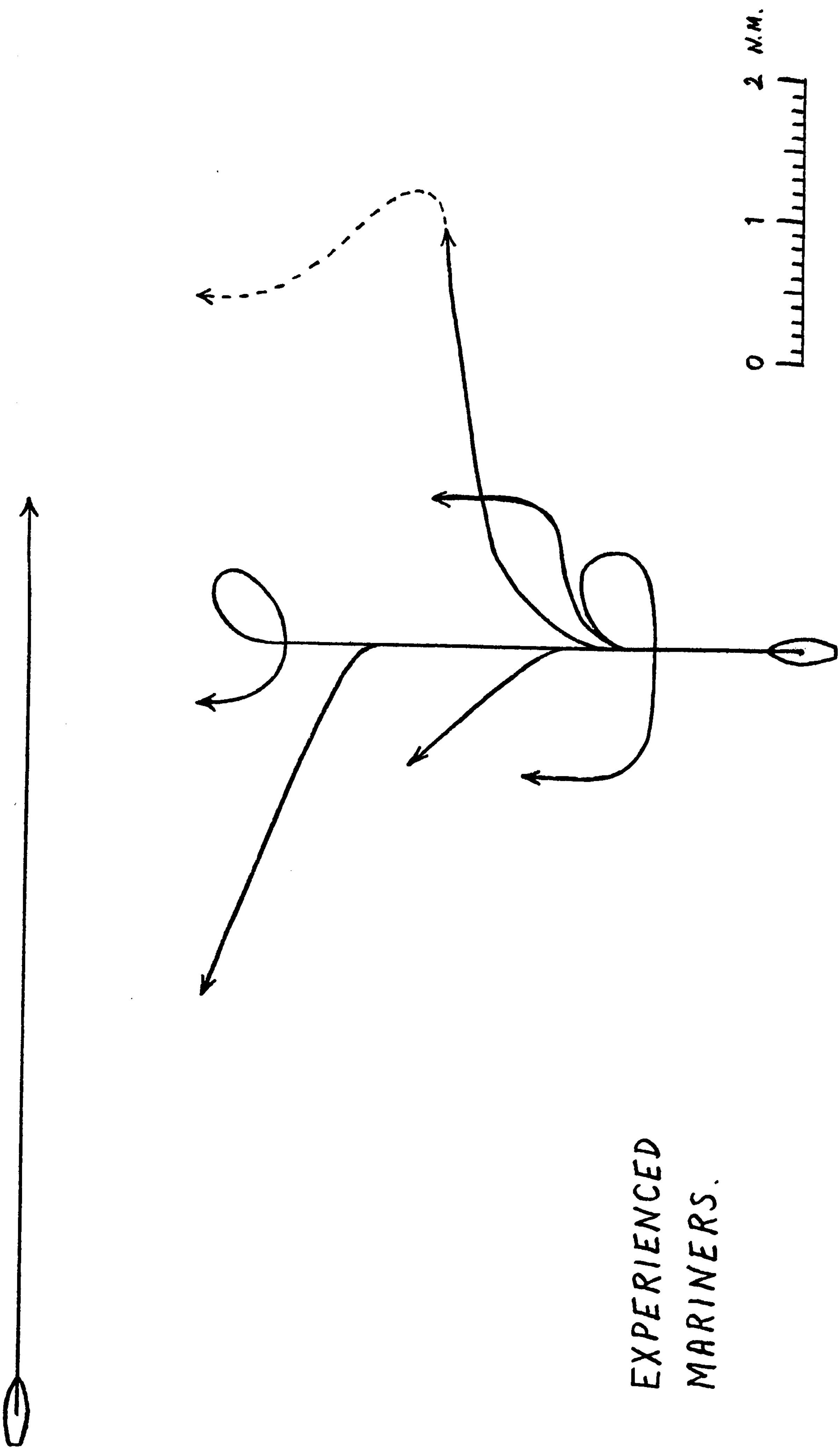


Fig. 56

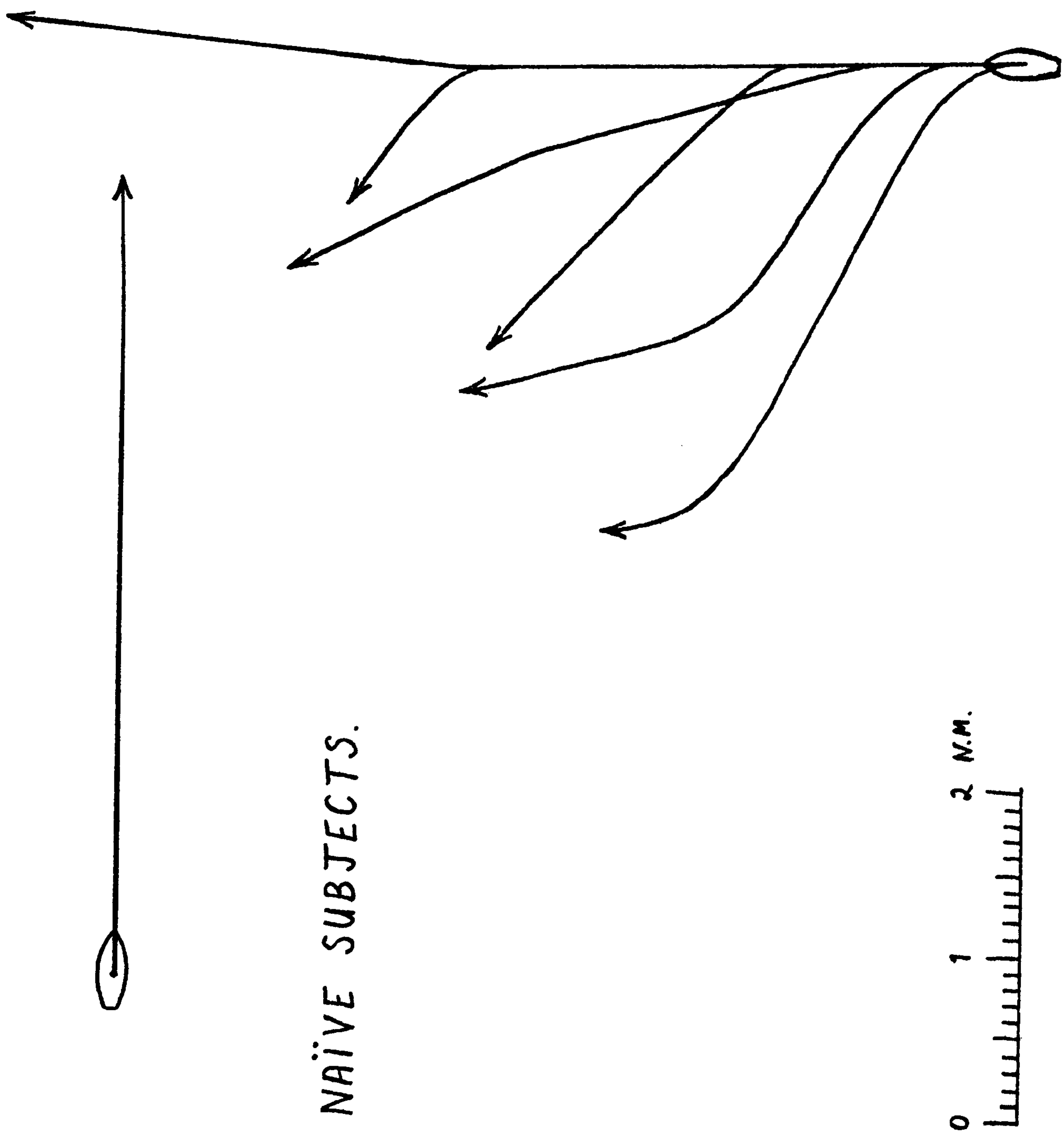
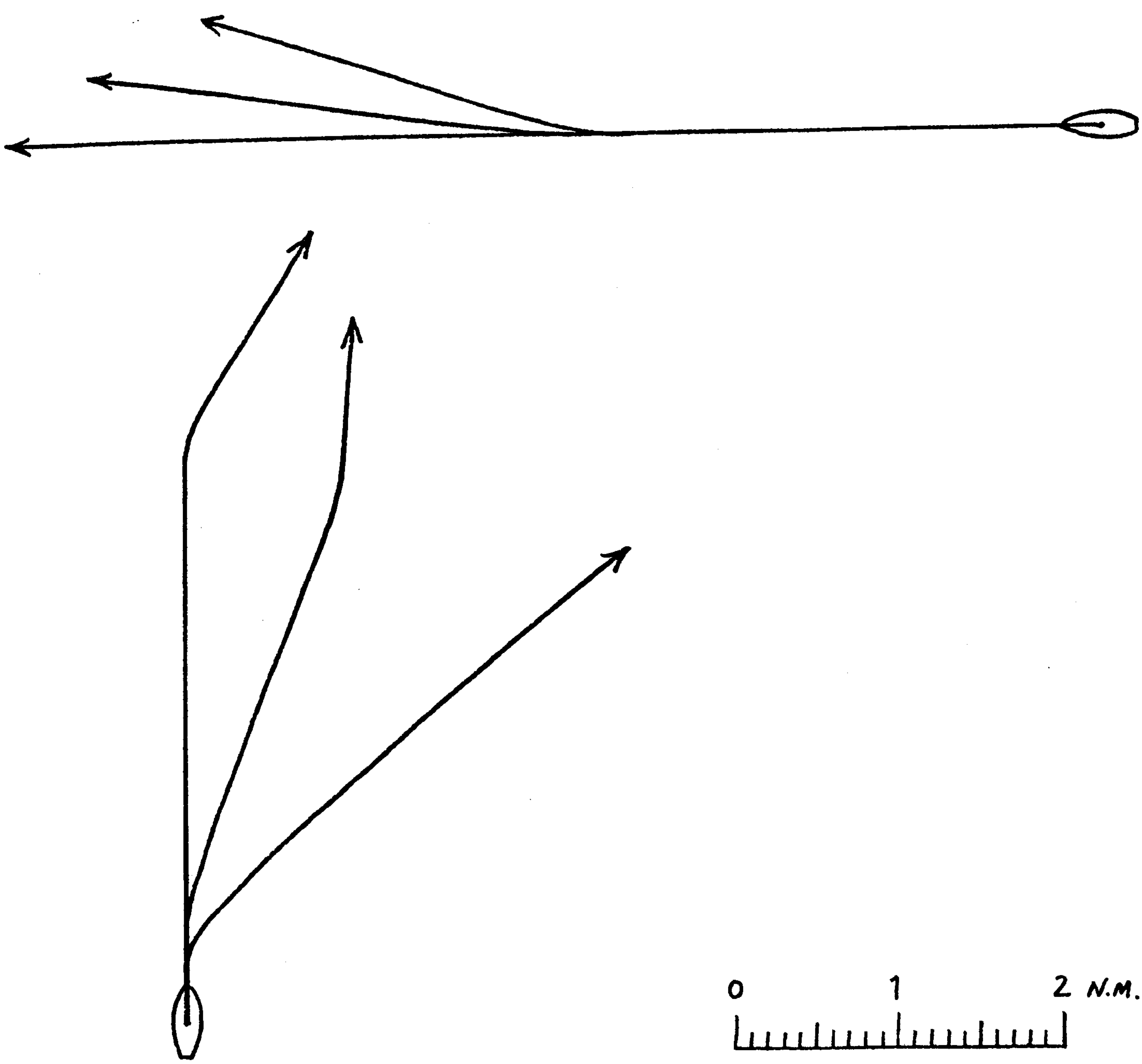


Fig. 57

COMPLEMENTARY ACTION BY NAÏVE SUBJECTS IN RIGHT ANGLED CROSSING ENCOUNTERS.



Disengagement on these lines is consistent with the manoeuvres suggested by Calvert for resolving such encounters and described in chapter III (see page 94 et seq.). It can also be construed that the majority action of the naïve subjects in altering course to port for type (i) encounters lends support to the proposals of Colomb, also described in chapter III(see page 81 et seq.).

Further experimentation would seem desirable to investigate the manoeuvre patterns made in response to right-angled crossing encounters involving a small miss distance rather than a precise geometrical collision. Crossing encounters other than those in which the ships' course lines intersect exactly at right-angles could also usefully be studied.

BEHAVIOUR DIFFERENCES

Behaviour differences have been noted between groups of naïve and experienced subjects in responding to particular encounter types and some conclusions have been drawn. For certain encounter types, however, it is noted that experienced subjects take a diversity of action amongst themselves. In such encounters, the test for H_4 was made to investigate whether a relationship existed between a subjects' length of experience and his manoeuvre patterns. The manoeuvre patterns were dichotomised into classes (q) and (t). The former corresponded to "natural" manoeuvres which involved a measure of risk but which resolved an encounter quickly and the latter corresponded to less "natural" manoeuvres which were safer but which caused a prolonged disengagement.

The right-angled crossing encounter (type (i)) and a near end-on encounter (type (a)) both gave results sufficiently diverse for use in this test. Analysis showed that for both types of encounter, the subjects who chose class (q) manoeuvres were of stochastically greater experience than those who chose class (t) manoeuvres.

This is an interesting finding. It implies that, under the experimental conditions, subjects of low experience tend to take less natural action, presumably because of the weight they give to the collision regulations. Subjects of high experience tend to take more natural action, giving less weight to the collision regulations and showing a significant reversion to the manoeuvre patterns of the naïve subjects.

The reasons for the observed relationship are speculative but it is worthy of note that the original prediction of such a relationship was made on the basis that the choice of a class (q) manoeuvre gives rapid disengagement and thus early relief from anxiety. The response is therefore thought to be reinforced on every occasion that it is used successfully and so becomes more common as a mariner becomes more experienced (See also the discussion on pp. 86 and 87).

This finding should not, of course, be interpreted as suggesting that the more experienced mariners are less safe in collision avoidance procedures. Such evidence as there is, quoted under the "personality measures" section of this chapter (pp. 183 and 184), suggests that, although the more experienced mariners may have a more flexible relationship with the collision regulations, they generally make more efficient disengagement manoeuvres than less experienced mariners.

Further experimentation might be considered to investigate the relationship between independent variables such as length of experience, personality measures, etc. and a more detailed classification of manoeuvre patterns than the crude dichotomy described above. In particular, it is noteworthy that naive subjects as well as experienced subjects show a marked reluctance to reduce speed as a means of avoiding collision. This leads one to suspect that the frequently observed tendency of mariners to maintain immoderate speeds in fog may be due to deeper causes than the obvious one of economic pressures.

SUMMARY

The purpose of the first three chapters of this thesis has been to show how the current International Rules for Preventing Collisions at Sea have become established with a diversity which reflects their evolution from different roots. Also to present a critical analysis of, not only the current Rules, but also the more important proposals that have been made for alternative rules. Such a review is a necessary preliminary to a discussion of improvements which might make the Rules more effective.

The remainder of the thesis describes a wide study of manoeuvre patterns made by subjects in response to various types of encounters between ships. The aims have been to identify the areas where problems exist to present some preliminary findings and to discover promising directions for future research.

These three aims have been broadly achieved but the suggestions for future research made in this chapter are clearly too extensive for one person to follow up. It would seem desirable that a team should be formed and a more ambitious research programme delineated.

The final aim of such a research programme should be to bring greater certainty and safety to the conduct of collision avoidance manoeuvres. Eventually, the behaviour of mariners might be made more predictable in the problem encounters by more efficient selection of personnel, by more effective training and by changes in the collision regulations. All three approaches are important but the last is the most attractive since it is usually easier to change rules than it is to change people.

APPENDICES

APPENDIX I

A Standard for Collision Rate.

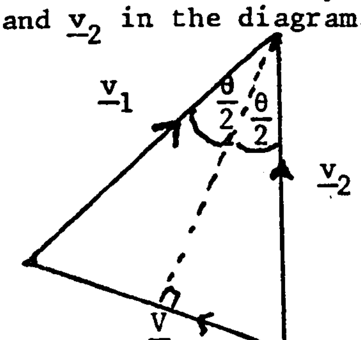
In order to judge the effectiveness of anti-collision measures it is necessary to have some sort of a standard. Many observers have commented on the low rate of serious collisions and have interpreted this as an indication of the efficiency of the Collision Regulations. Others have pointed to the high overall collision rate as an indictment of the Collisions Regulations and at least one (E.S. Calvert "Human Factors and the Collision Problem") has suggested that the situation is not far removed from randomness. Some objective measure is clearly needed.

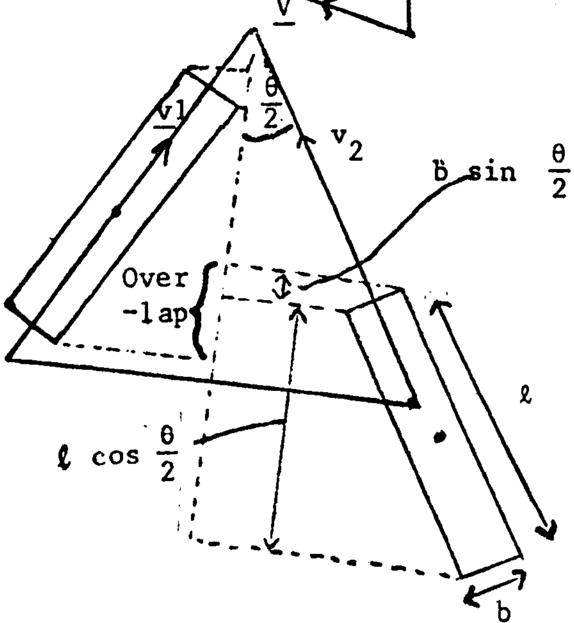
The standard suggested here is the collision rate which would obtain if, with a traffic density equal to that of the area being studied, ships representative of the observed traffic were to move in random directions, so that all directions are equally likely, and to make no collision avoidance manoeuvres. The importance of such a yardstick is that it would allow comparisons to be made between the efficiency of collisions avoidance procedures in areas with differing traffic densities amd differing traffic classes. The suggested standard is crude in that it assumes the same constant speed for all ships in the area being studied and in that the headings of ships in the area may not be in fact randomly distributed.

The development of a standard is based on Clausius treatment of the kinetic theory of gases. It is simplified in that it is applied to a two dimensional rather than a three dimensional situation. It is made more complex by considering ship shapes as elongated rectangles rather than as simple circular discs.

To calculate the number of collisions in unit time, a representative ship is taken which runs constantly at the mean speed (v) of the ships in the area (A) to be studied. The plan shape of the ship is taken as an elongated rectangle with length (ℓ) and breadth (b) equal to the mean length and breadth of the ships in the area. The mean number of ships (n) in the area will be known and hence the mean traffic density.

In a typical encounter between two representative ships, their headings will be inclined at an angle θ, each moving with speed, v, relative to the frame of reference defined by the sea surface. Their velocities are represented by $\underline{v}_1$ and $\underline{v}_2$ in the diagram.





If a frame of reference is used in which ship 1 is stationary then ship 2 will be moving towards it with a relative velocity $\underline{V}$ which is the vector difference between $\underline{v}_2$ and $\underline{v}_1$

The relative speed (V) is given by:-

$$V = 2v \sin \frac{\theta}{2}$$

The two ships will collide if there is an overlap between the projections of their rectangular shapes onto a line perpendicular to the relative velocity vector $\underline{V}$. Such an overlap will occur if the centre of one ship projected onto the line falls within the projection of twice the length of the other, i.e. within a length 2 $(\ell \cos \frac{\theta}{2} + b \sin \frac{\theta}{2})$

The projection of twice the length of one ship, moving with velocity $\underline{V}$ will sweep out an area at a rate R such that:-

$$R = 2V\ (\ell \cos \frac{\theta}{2} + b \sin \frac{\theta}{2})$$

$$= 4\ v \sin \frac{\theta}{2}\ (\ell \cos \frac{\theta}{2} + b \sin \frac{\theta}{2}) \text{ /unit time}$$

Since v is considered constant, this rate is simply a function of θ and its mean value w.r.t. θ is given by:-

$$\int_0^\pi \frac{4v \sin \frac{\theta}{2}\ (\ell \cos \frac{\theta}{2} + b \sin \frac{\theta}{2})\ d\theta}{\pi}$$

$$= \frac{4v}{\pi} \int_0^\pi (\ell \sin \frac{\theta}{2} \cos \frac{\theta}{2} + b \sin^2 \frac{\theta}{2})\ d\theta$$

$$= \frac{2v}{\pi} \int_0^\pi \left[\ell \sin\theta + b(1 - \cos\theta)\right] d\theta$$

$$= \frac{2v}{\pi} \left[-\ell \cos\theta + b\theta - b \sin\theta\right]_0^\pi$$

$$= \frac{2v}{\pi}\ (2\ell + b\pi)$$

$$= \frac{4v\ell}{\pi} + 2bv$$

The mean number of collisions per unit time, for each ship, is the number of other ships whose centres may be expected to fall within this area. This is the product of the area swept out and the mean traffic density (k). For this purpose, the traffic density (k) is calculated from the mean number of ships (n) in the region reduced by one, since the ship sweeping out the area is not to be counted.

Thus:-

Collision rate for each ship $= kv\ (\frac{4\ell}{\pi} + 2b)$ where $k = \frac{n - 1}{A}$

The total number of collisions (N) in unit time is found by multiplying the number of collisions per ship by the mean number of ships (n) in the area and dividing by two since each collision involves two ships.

$$N = \frac{nkv}{2} \left(\frac{4\ell}{\pi} + 2b\right) \text{ /unit time}$$

$$\text{or} \quad N = \frac{n(n-1)v}{2A} \left(\frac{4\ell}{\pi} + 2b\right) \text{ /unit time}$$

In this formula, if v is in knots, and if ℓ and b are in nautical miles, and if A is the traffic density in square miles, then N is the number of collisions per hour.

Example. In the Dover Strait, the area bounded by Folkestone - Gris Nez - Calais - South Falls - Deal - Folkestone is approximately 400 square miles. From NPL survey data, the mean number of ships in the area is 24. The mean speed of ships through the area is taken as 12.5 knots and the mean ship dimensions of 75 metres by 14 metres convert to 0.04 by 0.008 nautical miles.

$$N = \frac{n(n-1)v}{2A} \left(\frac{4\ell}{\pi} + 2b\right)$$

$$= \frac{24 \times 23 \times 12.5}{2 \times 400} \left(\frac{4 \times 0.04 \times 7}{22} + 2 \times 0.008\right)$$

$$= \frac{69}{8} (0.051 + 0.016)$$

$$= \frac{69 \times 0.067}{8}$$

$$= 0.578 \text{ collisions per hour}$$

$$= \underline{5063} \text{ collisions per year.}$$

Currently (1971) the collision rate is about 4 per year in the area considered (See NPL Report Mar. Sci. R101, October 1972).

Clearly the performance of navigators in this area is better than the random velocity situation. It is suggested that the importance of the standard discussed is that it gives a means of measuring how much better.

The standard discussed above may be refined to allow for situations in which the assumption that all values of θ are equally likely is not reasonable.

If it is known that certain values of θ are not likely to occur, the mean rate at which the projection sweeps out an area may be found by integrating between any chosen values of θ instead of from π to 0.

If, for example, the traffic in an area is all moving in the same general direction so that θ is not likely to exceed 30^{o}, the rate is given by:

$$\frac{6 \times 2v}{\pi} \int_{o}^{\frac{\pi}{6}} \left[\ell \sin\theta + b(1 - \cos\theta) \right] d\theta$$

$$= \frac{12v}{\pi} \left[- \ell \cos\theta + b\theta - b \sin\theta \right]_{o}^{\frac{\pi}{6}}$$

$$= \frac{12v}{\pi} \left[-0.866\ell + \frac{\pi b}{6} - 0.5b + \ell \right]$$

$$= \frac{12v}{\pi} \left[0.134\ell + 0.0236b \right]$$

Using the values of ℓ and b, and the values of mean speed and traffic density as in the above example, the corresponding collision rate is given by:-

$$N = \frac{n(n - 1)v}{2A} \cdot \frac{12v(0.134\ell + 0.0236b)}{\pi}$$

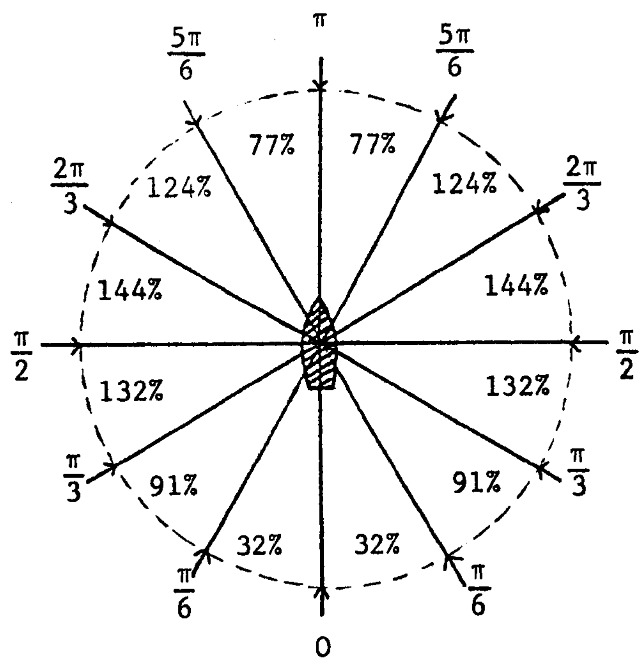
$$= \frac{69}{8} \times 0.0212$$

$$= \underline{0.183 \text{ collisions per hour}}$$

This collision rate is 32% of the rate previously calculated assuming random values of θ. The diagram below illustrates the collision rates which apply when values of θ are equally likely within other 30^{o} sectors. These collision rates are again given as percentages of the rate for random values of θ.

The results summarised in the diagram overleaf show clearly the advantage to be gained by routeing traffic so that adjacent ships move in the same general direction. In general, however, the collision rate is not overly sensitive to restrictions on values which may be taken by θ.

For the Dover Strait, in which about a quarter of the traffic consists of ferries, the collision rate calculated overleaf would seem to be of the right order.


π
5π/6
5π/6
77%
77%
2π/3
124%
124%
2π/3
144%
144%
π/2
π/2
132%
132%
π/3
91%
91%
π/3
32%
32%
π/6
π/6
0

APPENDIX II

Chronological Summary of Rules for Preventing Collisions at Sea

(A) Instructions for the Conduct of Ships of War, issued with the Royal Naval Signal Books prior to the year 1780.

II.

In order to avoid inconvenience from the customary practice founded on the regulations in the General Printed Instructions, with respect to the conduct of Senior Officers towards their Juniors, the ships of war are to bear up for each other, shorten sail, etc., without regard to the seniority of the Commanders, or other claim of distinction, in such manner as shall be found most convenient on either part, and may best guard against the hazard of falling on board each other.

But when ships are upon different tacks, and must cross near each other, the ship on the starboard tack is to keep her wind, while that on the larboard is always to pass to leeward.

(B) Sir C. Knowles' Signal Book for the Royal Navy 1780-1799. General Instructions to the Night Signals, and Instructions to Convoy for Day and Night.

1st. All ships on the larboard tack are to bear up for those on the starboard tack when passing on opposite tacks.

(C) Report of Select Committee of the House of Commons on Steam Navigation, 14th October, 1831. Page 6.

Fourthly. That it should be generally understood that whenever two steam vessels find themselves unexpectedly near each other, "stem on," both vessels are to put their helms a-starboard, unless there be some evident cause to prevent it; and if the vessels be not directly "stem on" to each other, their helms should be only altered so as to make them sheer from each other.

(D) Report of the Royal Commissioners appointed to inquire into the Laws and Regulations relating to Pilotage, 25th February, 1836. Pages 13 and 32.

Another subject which has engaged our attention has been the frequent accidents that have of late occurred from steam vessels coming into collision with other vessels, and it appears that from the recent introduction of this mode of navigation no defined rules have been adopted to guard against such occurrences.

A select committee of the House of Commons was appointed in the year 1831, to consider the question of steam navigation, and the numerous accidents arising from the employment of steam vessels. This branch of the subject came under their consideration, and in the report which they laid before the House they expressed their opinion of the necessity of establishing some regulations, which they briefly suggested; these, however, have never been adopted, and the evil continues to increase.

With sailing vessels, the rule which has been laid down and admitted in courts of law, viz., that when two vessels meet upon contrary tacks, the one on the larboard tack shall bear up, and that upon the starboard tack shall keep her wind, has been attended with the best effects.

We are aware that the same rule is not strictly applicable to steam vessels, and that there exists great difficulty in treating a subject involving the varying nature of the circumstances in which steam vessels are placed in a river, as regards the state of the tide, the depth of water in the river, the draught of water of the steam vessels, and particularly the more or less crowded state of the river, from the number of other vessels in motion, and their relative positions. But rules upon this subject have been laid down and are enforced in the Firth and River of Clyde; and we consider it of the highest importance that some "rule of the road" should be established, to be acted upon whenever circumstances will admit. We therefore annex to our report (Appendix C), a set of rules which have been laid before us, and which, we think, may be adapted with advantage.

APPENDIX C

I. In the Thames and in all rivers and channels of the United Kingdom, and in all cases of wind, weather, and tide, steam vessels are to endeavour to keep on that side of the river or channel which lies on their starboard hand.

II. When two steam vessels are standing on contrary, or nearly contrary directions, if their courses should lead them near each other, each vessel shall keep towards the starboard side of the river or channel, and thus leave each other on the larboard hand.

III. Whenever a steam vessel may have to meet or cross the course of a sailing vessel or of a rowing boat, the steamer shall in all cases yield to the sailing or rowing vessel, whatever may be state of the wind, weather, or tide.

IV. In passing any small rowing or sailing boat, every steam vessel shall, if necessary, slacken or stop her paddles, so as not only to prevent the danger of a too near approach, but even so as to avoid giving them any just cause of alarm.

V. Although a vessel propelled by steam, in any of the above cases, may also have had recourse to the assistance of her sails, this circumstance shall in nowise alter the foregoing restrictions; for otherwise she would only have to hoist some small sail to evade them.

VI. All these regulations shall be equally in force at night as well as by day. And for their more effective execution at night every steam vessel, when in pilotage water, shall carry, between sunset and sunrise, three sufficiently strong lights in lanterns, so as to be seen in all direction, and attached to a yard which must be kept square, and raised at least six feet above the tops of the paddle boxes. This yard may be attached to the mast, or otherwise raised to the requisite height above the vessel's bow for that purpose.

VII. These three lights shall be arranged in the following manner:- One light on each yard-arm, at the distance of six feet from the mast, that is twelve feet apart; and on the larboard yard-arm one additional light, which shall be placed horizontally with respect to the other light, or vertically under it, according to the following conditions.

1. All steam vessels which may be coming up any river or channel shall show the additional light three feet directly under the light at the larboard yard-arm.

2. All steam vessels which may be going down any river or channel shall show the additional light at the same height as the two other lights, and at the distance of three feet inside of the larboard light, or half way between it and the mast.

VIII. For any infraction of the foregoing regulations a fine, varying according to the culpability of the offender, but not exceeding five pounds, should be summarily levied upon the party; and, as the only means of making these regulations effectual, one-half of the fine should be payable to the common informer.

(E) NAVIGATION OF STEAM VESSELS

TRINITY HOUSE, LONDON,
30th October, 1840.

The attention of this Corporation having been directed to the numerous severe, and, in some instances fatal accidents, which have resulted from the collision of vessels navigated by STEAM; and it appearing to be indispensably necessary, in order to guard against the recurrence of similar calamities, that a regulation should be established for the guidance and government of persons entrusted with the charge of such vessels; and,

Whereas the recognized rule for sailing vessels is, that those having the wind fair, shall give way to those on a wind:

That when both are going by the wind, the vessel on the starboard tack shall keep her wind, and the one on the larboard tack bear up, - thereby passing each other on the larboard hand:

That when both vessels have the wind at large or abeam, and meet, they shall pass each other in the same way on the larboard hand, to effect which two last-mentioned objects the helm must be put to port:

And as steam vessels may be considered in the light of vessels navigating with a fair wind, and should give way to sailing vessels on a wind on either tack, it becomes only necessary to provide a rule for their observance, when meeting other steamers, or sailing vessels going large:

Under these considerations, and with the object before stated, this Board has deemed it right to promulgate the following rule, which, on communication with the Lords Commissioners of the Admiralty, the Elder Brethren find has been already adopted in respect of steam vessels in Her Majesty's service, and they desire earnestly to impress upon the minds of all persons having charge of steam vessels, the propriety and urgent necessity of a strict adherence thereto, viz:-

RULE

When STEAM VESSELS on different courses must unavoidably or necessarily cross so near that, by continuing their respective courses, there would be a risk of coming in collision, each vessel shall put her HELM TO PORT, so as always to pass on the LARBOARD side of each other.

A STEAM VESSEL passing another in a narrow channel must always leave the vessel she is passing on the LARBOARD hand.

By order, J. HERBERT, Secretary.

(F) Act for the Regulation of Steam Navigation 9^{o} and 10^{o} Victoria, cap. 100, 28th August, 1846.

IX. And be it enacted, that every steam vessel when meeting or passing any other steam vessel shall pass as far as may be safe on the port side of such other vessel; and every steam vessel navigating any river or narrow channel shall keep as far as is practicable to that side of the fairway or mid-channel of such river or channel which lies on the starboard side of such vessel, due regard being had to the tide, and to the position of each vessel in such tide; and the Master or other person having charge of any such steam vessel, and neglecting to observe these regulations, or either of them, shall for each and every instance of neglect forfeit and pay a sum not exceeding fifty pounds.

(G) An Act amending the Laws for the Regulation of Steam Navigation of 28th August, 1846, 14^{o} and 15^{o} Victoria, cap. 79, 7th August, 1851.

XXVII. Whenever any vessel proceeding in one direction meets a vessel proceeding in another direction and the Master or other person having charge of either such vessel perceives that if both vessels continue their respective courses they will pass so near as to involve any risk of collision, he shall put the helm of his vessel to port, so as to pass on the port side of the other vessel, due regard being had to the tide and to the position of each vessel with respect to the dangers of the channel, and, as regards sailing vessels, to the keeping each vessel under command; and the Master of any steam vessel navigating any river or narrow channel shall keep as far as is practicable to that side of the fairway or mid-channel thereof which lies on the starboard side of such vessel; and if the Master or other person having charge of any steam vessel neglect to observe these regulations, or either of them, he shall for every such offence be liable to a penalty not exceeding £50.

(H) The Merchant Shipping Act, 17^{o} and 18^{o} Victoria, cap. 104, 10th August, 1854.

296. Whenever any ship, whether a steam or a sailing ship, proceeding in one direction, meets another ship, whether a steam or a sailing ship, proceeding in another direction, so that if both ships were to continue their respective courses they would pass so near as to involve any risk of a collision, the helms of both ships shall be put to port, so as to pass on the port side of each other; and this rule shall be obeyed by all steam ships and by all sailing ships, whether on the port or starboard tacks, and whether close-hauled or not, unless the circumstances of the case are such as to render a departure from the rule necessary in order to avoid immediate danger, and subject also to the proviso that due regard shall be had to the dangers of navigation, and, as regards sailing ships on the starboard tack close-hauled, to keeping such ships under command.

297. Every steam ship, when navigating any narrow channel, shall, whenever it is safe and practicable, keep to that side of the fairway or mid-channel which lies on the starboard side of such steam ship.

(I) At the Court at Osborne House, Isle of Wight, the 9th day of January, 1863.

PRESENT,

The QUEEN's Most Excellent Majesty in Council

Whereas the rules and practice observed for preventing collisions at sea, which were formerly adopted by maritime nations, have proved insufficient to satisfy the requirements of modern navigation; and whereas various alterations in such rules and practice, have from time to time been made by different nations, but the rules so altered have been found to be in some cases inconsistent with each other, and in other cases to have the force of municipal law only; and whereas in consequence of communications from the Government of the Emperor of the French inviting Her Majesty's Government to consider the expediency of making the said Rules uniform and international Her Majesty's Government prepared a project of regulations for preventing collisions at sea and submitted it to the Government of the Emperor of the French; and the project so prepared by Her Majesty's Government was approved by the Government of the Emperor of the French with certain modifications which were assented to by Her Majesty's Government; and whereas the said Regulations so modified have been sanctioned by the "Merchant Shipping Act Amendment Act, 1862" and are contained in Table C in the schedule to that Act: and whereas by the said Act it is provided that Her Majesty may from time to time on the joint recommendation of the Admiralty and the Board of Trade by Order in Council modify any of the said regulations or make new regulations in substitution therefor: and whereas certain clerical errors have been discovered in the regulations contained in the schedule to the said Act and the Admiralty and the Board of Trade have jointly recommended Her Majesty to modify the said Regulations for the purpose of correcting the said clerical errors; and the Regulations so modified are appended to this Order: and whereas by virtue of the said Act and of this Order the said Regulations appended hereto will, so far as relates to British ships and also so far as relates to Foreign ships when within British jurisdiction, come into operation on the first day of June, one thousand eight hundred and sixty-three: and whereas it is provided by the same Act that whenever it is made to appear to Her Majesty that the Government of any Foreign country is willing that the Regulations for preventing collision contained in Table C in the schedule to the said Act, or such other regulations for preventing collision as are for the time being in force under the said Act should apply to the ships of such country when beyond the limits of British jurisdiction Her Majesty may by Order in Council direct that such Regulations shall apply to the ships of the said foreign country whether within British jurisdiction or not: and it is further provided by the said Act that whenever an Order in Council has been issued applying any regulation made by or in pursuance of the said Act to the ships of any foreign country such ships shall in all cases arising in any British Court be deemed to be subject to such Regulation, and shall for the purpose of such Regulation be treated as if they were British ships: and whereas it has been made to appear to Her Majesty that the Government of the Emperor of the French is willing that the said Regulations appended to this Order should on and after the first day of June one thousand eight hundred and sixty-three apply to French ships when beyond the limits of British jurisdiction.

Now therefore Her Majesty by virtue of the power vested in Her by the said recited Act, and by and with the advice of Her Privy Council, is pleased to direct:-

First - That the Regulations contained in the schedule to the said Act shall be modified by the substitution for such Regulations of the Regulations appended to this Order.

Secondly - That the said Regulations appended to this Order shall on and after the said first day of June one thousand eight hundred and sixty-three apply to French ships whether within British jurisdiction or not.

Edmund Harrison

REGULATIONS REFERRED TO IN THE FOREGOING ORDER

Regulations for Preventing Collisions at Sea

Contents

PRELIMINARY

Art. 1. In the following Rules every Steam Ship which is under sail and not under steam is to be considered a Sailing Ship; and every Steam Ship which is under steam, whether under sail or not, is to be considered a ship under steam.

RULES CONCERNING LIGHTS

Lights

Art. 2. The Lights mentioned in the following Articles, numbered 3, 4, 5, 6, 7, 8 and 9 and no others, shall be carried in all weathers, from sunset to sunrise.

Lights for Steam Ships

Art. 3. Sea-going Steam-ships when under weigh shall carry:

(a) At the Foremast Head, a bright White Light, so fixed as to show an uniform and unbroken Light over an arc of the horizon of 20 points of the compass; so fixed as to throw the light 10 points on each side of the ship, viz., from right ahead to 2 points abaft the beam on either side; and of such a character as to be visible on a dark night, with a clear atmosphere, at a distance of at least five miles:

(b) On the Starboard Side, a Green Light so constructed as to throw an uniform and unbroken Light over an arc of the horizon of 10 points of the compass; so fixed as to throw the light from right ahead to 2 points abaft the beam on the starboard side; and of such a character as to be visible on a dark night, with a clear atmosphere, at a distance of at least two miles:

(c) On the Port Side, a Red Light, so constructed as to show an uniform and unbroken light over an arc of the horizon of 10 points of the compass; so fixed as to throw the light from right ahead to 2 points abaft the beam on the port side; and of such a character, as to be visible on a dark night, with a clear atmosphere, at a distance of at least two miles:

(d) The said Green and Red Side Lights shall be fitted with inboard screens, projecting at least three feet forward from the Light, so as to prevent these lights from being seen across the bow.

Lights for Steam Tugs

Art. 4. Steam Ships when towing other ships shall carry two bright White Mast-head Lights vertically, in addition to their side lights, so as to distinguish them from other Steam Ships. Each of these Mast-head Lights shall be of the same construction and character as the Mast-head Lights which other Steam-Ships are required to carry.

Lights for Sailing Ships

Art. 5. Sailing Ships under weigh, or being towed, shall carry the same lights as Steam Ships under weigh, with the exception of the White Mast-head Lights, which they shall never carry.

Exceptional Lights for small Sailing Vessels

Art. 6. Whenever, as in the case of small vessels during bad weather, the green and red lights cannot be fixed, these lights shall be kept on deck, on their respective sides of the vessel, ready for instant exhibition; and shall, on the approach of or to other vessels, be exhibited on their respective sides in sufficient time to prevent collision, in such manner as to make them most visible, and so that the green light shall not be seen on the port side, nor the red light on the starboard side.

To make the use of these portable lights more certain and easy, the lanterns containing them shall each be painted outside with the colour of the light they respectively contain, and shall be provided with suitable screens.

Lights for Ships at Anchor

Art. 7. Ships, whether steam ships or sailing ships, when at anchor in roadsteads or fairways, shall exhibit, where it can best be seen, but at a height not exceeding twenty-feet above the hull, a white light, in a globular lantern of eight inches in diameter, and so constructed as to show a clear uniform and unbroken light visible all round the horizon, and at a distance of at least one mile.

Lights for Pilot Vessels

Art. 8. Sailing Pilot Vessels shall not carry the lights required for other sailing vessels, but shall carry a White Light at the mast head, visible all round the horizon, - and shall also exhibit a Flare-up Light every fifteen minutes.

Lights for Fishing Vessels and Boats

Art. 9. Open Fishing Boats and other open boats shall not be required to carry the side lights required for other vessels; but shall, if they do not carry such lights, carry a lantern having a Green Slide on the one side and a Red Slide on the other side; and on the approach of or to other vessels, such lantern shall be exhibited in sufficient time to prevent collision, so that the green light shall not be seen on the port side, nor the red light on the starboard side.

Fishing Vessels and open boats when at anchor, or attached to their nets and stationary, shall exhibit a bright White Light.

Fishing Vessels and open boats shall, however, not be prevented from using a Flare up in addition, if considered expedient.

RULES CONCERNING FOG SIGNALS

Fog Signals

Art. 10. Whenever there is fog, whether by day or night, the Fog Signals described below shall be carried and used, and shall be sounded at least every five minutes; viz:-

(a) Steam Ships under weigh shall use a Steam Whistle placed before the funnel, not less than eight feet from the deck:

(b) Sailing ships under weigh shall use a Fog Horn:

(c) Steam Ships and Sailing Ships when not under weigh shall use a Bell.

STEERING AND SAILING RULES

Two Sailing Ships meeting

Art. 11. If Two Sailing Ships are meeting end on or nearly end on so as to involve risk of collision, the helms of both shall be put to port, so that each may pass on the port side of the other.

Two Sailing Ships crossing

Art. 12. When two sailing ships are crossing so as to involve risk of collision, then, if they have the wind on different sides, the ship with the wind on the port side shall keep out of the way of the ship with the wind on the starboard side; except in the case in which the ship with the wind on the port side is close hauled and the other ship free, in which case the latter ship shall keep out of the way; but if they have the wind on the same side, or if one of them has the wind aft, the ship which is to windward shall keep out of the way of the ship which is to leeward.

Two Ships under Steam meeting

Art. 13. If two ships under steam are meeting end on or nearly end on so as to involve risk of collision, the helms of both shall be put to port, so that each may pass on the port side of the other.

Two Ships under Steam Crossing

Art. 14. If two ships under steam are crossing so as to involve risk of collision, the ship which has the other on her own starboard side shall keep out of the way of the other.

Sailing Ship and Ship under Steam

Art. 15. If two ships, one of which is a sailing ship, and the other a steam ship, are proceeding in such directions as to involve risk of collision, the steam ship shall keep out of the way of the sailing ship.

Ships under Steam to slacken Speed

Art. 16. Every steam ship, when approaching another ship so as to involve risk of collision, shall slacken her speed, or, if necessary, stop and reverse; and every steam ship shall, when in a fog, go at a moderate speed.

Vessels overtaking other Vessels

Art. 17. Every vessel overtaking any other vessel shall keep out of the way of the said last-mentioned vessel.

Construction of Articles 12, 14, 15 and 17

Art. 18. Where by the above rules one of two ships is to keep out of the way, the other shall keep her course, subject to the qualifications contained in the following Article.

Proviso to save special cases

Art. 19. In obeying and construing these rules, due regard must be had to all dangers of navigation; and due regard must also be had to any special circumstances which may exist in any particular case rendering a departure from the above rules necessary in order to avoid immediate danger.

No Ship, under any circumstances,
to neglect proper precautions

Art. 20. Nothing in these Rules shall exonerate any ship, or the owner, or master, or crew thereof, from the consequences of any neglect to carry lights or signals, or of any neglect to keep a proper look-out, or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

(J) At the Court at Osborne House, Isle of Wight, the 30th day of July, 1968.

PRESENT

The QUEEN's Most Excellent Majesty in Council

Whereas by "The Merchant Shipping Act Amendment Act, 1862," it was enacted that on and after the first day of June, one thousand eight hundred and sixty-three, or such later day as might be fixed for the purpose by Order in Council, the Regulations contained in the Table marked C in the Schedule to the said Act should come into operation and be of the same force as if they were enacted in the body of the said Act; but that Her Majesty might from time to time, on the joint recommendation of the Admiralty and the Board of Trade, by Order in

Council, annul or modify any of the said Regulations, or make new Regulations in addition thereto or in substitution therefor; and that any alterations in, or additions to, such Regulations made in manner aforesaid should be of the same force as the Regulations in the said Schedule.

And whereas, by the same Act, it was further provided, that whenever it should be made to appear to Her Majesty that the Government of any Foreign Country is willing that the regulations for preventing collision contained in Table C in the Schedule to the said Act, or such other Regulations for preventing collision as are for the time being in force under the said Act, should apply to the ships of such country when beyond the limits of British jurisdiction, Her Majesty might, by Order in Council, direct that such Regulations shall apply to the ships of the said foreign country, whether within British jurisdiction or not; and it was further provided by the said Act, that whenever an Order in Council had been issued, applying any regulation made by or in pursuance of the said Act to the ships of any foreign country, such ships should, in all cases arising in any British court, be deemed to be subject to such Regulation, and should, for the purpose of such Regulation, be treated as if they were British ships.

And whereas, by an Order in Council made in pursuance of the said recited Act, and dated the ninth day of January, one thousand eight hundred and sixty-three, Her Majesty was pleased to direct:- First, that the Regulations contained in the Schedule to the said Act should be modified by the substitution for such Regulations of certain Regulations appended to the said Order.

Secondly, that the said Regulations appended to the said Order should, on and after the first day of June, one thousand eight hundred and sixty-three, apply to French ships, whether within British jurisdiction or not.

And whereas by several Orders in Council subsequently made, Her Majesty has been pleased to direct that the Regulations appended to the said Order of the ninth of January, one thousand eight hundred and sixty-three, shall apply to ships of the following countries, whether within British jurisdiction or not; that is to say:

Austria
Argentine Republic
Belgium
Brazil
Bremen
Chile
Denmark Proper
Equator (Republic of the)
France
Great Britain
Greece
Hamburg
Hanover
Hawaiian Islands
Hayti
Italy
Lubeck
Mecklenburg-Schwerin
Morocco
Netherlands
Norway
Oldenburg
Peru
Portugal
Prussia
Roman States
Russia
Schleswig
Spain
Sweden
Turkey
United States, Seagoing Ships
United States, Inland Waters
Uraguay.

And whereas Articles 11 and 13 of the said Regulations appended to the said recited Order of the ninth of January, one thousand eight hundred and sixty-three, are as follows; that is to say:-

Article 11. "If two sailing ships are meeting end on, or nearly end on, so as to involve risk of collision, the helms of both shall be put to port, so that each may pass on the port side of the other."

Article 13. "If two ships under steam are meeting end on or nearly end on, so as to involve risk of collision, the helms of both shall be put to port, so that each may pass on the port side of the other."

And whereas there has been doubt or misapprehension concerning the effect of the said two Articles.

And whereas the Admiralty and the Board of Trade have jointly recommended to Her Majesty to make the following additions to the said Regulations, for the purpose of explaining the said recited Articles and of removing the said doubt and misapprehension.

Now, therefore, Her Majesty, by virtue of the powers vested in Her by the said recited Act and by and with the advice of Her Privy Council, is pleased to make the following additions to the said Regulations by way of explanation of the said two recited Articles; that is to say:-

The said two Articles numbered 11 and 13 respectively, only apply to cases where ships are meeting end on, or nearly end on, in such a manner as to involve risk of collision. They, consequently, do not apply to two ships which must, if both keep on their respective courses, pass clear of each other.

The only cases in which the said two Articles apply, are, when each of the two ships is end on, or nearly end on, to the other; in other words, to cases in which, by day, each ship sees the masts of the other in a line, or nearly in a line, with her own; and, by night, to cases in which each ship is in such a position as to see both the side lights of the other.

The said two Articles do not apply, by day, to cases in which a ship sees another a-head crossing her own course; or, by night, to cases where the red light of one ship is opposed to the red light of the other; or where the green light of one ship is opposed to the green light of the other; or where a red light without a green light, or a green light without a red light, is seen a-head; or where both green and red lights are seen anywhere but a-head.

Arthur Helps

(K) At the Court at Osborne House, Isle of Wight, the 14th day of August, 1879.

PRESENT

The Queen's Most Excellent Majesty in Council

Whereas, by "The Merchant Shipping Act Amendment Act, 1862," it was enacted, that on and after the first day of June, one thousand eight hundred and sixty-three, or such later day as might be fixed for the purpose by Order in Council, the Regulations contained in the table marked C in the schedule to the said Act should come into operation and be of the same force as if they were enacted in the body of the said Act; but that Her Majesty might from time to time, on the joint recommendation of the Admiralty and the Board of Trade, by Order in Council, annul or modify any of the said Regulations, or make new Regulations in addition thereto or in substitution therefor; and that any alterations in, or additions to, such Regulations made in manner aforesaid should be of the same force as the Regulations in the said schedule:

And whereas, by the same Act, it was further provided, that whenever it should be made to appear to Her Majesty that the Government of any foreign country was willing that the regulations for preventing collisions contained in Table C in the schedule to the said Act, or such other Regulations for preventing collisions as are for the time being in force under the said Act, should apply to the ships of such country when beyond the limits of British jurisdiction, Her Majesty might, by Order in Council, direct that such Regulations should apply to the ships of the said foreign country, whether within British jurisdiction or not; and it was further provided by the said Act, that whenever an Order in Council had been issued applying any Regulation made by or in pursuance of the said Act to the ships of any foreign country, such ships should, in all cases arising in any British court, be deemed to be subject to such Regulation, and should, for the purpose of such Regulation, be treated as if they were British ships:

And whereas, by an Order in Council made in pursuance of the said recited Act, and dated the ninth day of January one thousand eight hundred and sixty-three, Her Majesty was pleased to direct:- First that the Regulations contained in the schedule to the said Act should be modified by the substitution for such Regulations of certain Regulations appended to the said Order;

Secondly, that the said Regulations appended to the said Order should, on and after the first day of June, one thousand eight hundred and sixty-three, apply to French ships, whether within British jurisdiction or not:

And whereas, by several Orders in Council subsequently made, Her Majesty was pleased to direct that the Regulations appended to the said Order of the ninth of January one thousand eight hundred and sixty-three should apply to ships of the countries specified in the said Orders, whether within British jurisdiction or not:

And whereas, by Order in Council, dated the thirtieth day of July one thousand eight hundred and sixty-eight, Her Majesty, on the joint recommendation of the Admiralty and the Board of Trade, was pleased to make certain additions to the Regulations appended to the said first-recited Order in Council, for the purpose of explaining Articles 11 and 13 of the said Regulations, and of removing doubt and misapprehension concerning the effect of the said two Articles:

And whereas the Admiralty and the Board of Trade have jointly recommended to Her Majesty that the Regulations contained in the Order in Council dated the ninth day of January one thousand eight hundred and sixty-three, and the additions to the said Regulations contained in the said Order in Council of the thirtieth day of July one thousand eight hundred and sixty-eight, shall be annulled from the first day of September one thousand eight hundred and eighty, and that there shall be substituted for the said Regulations and additions respectively the new Regulations hereinafter set forth:

And whereas it has been made to appear to Her Majesty that the governments of the several foreign countries mentioned in the second schedule hereto are respectively willing that the regulations contained in the first schedule hereto shall apply to ships of the said countries respectively whether within British jurisdiction or not:

Now, therefore, Her Majesty, by virtue of the powers vested in Her by the said recited Act, and by and with the advice of Her Privy Council is pleased to direct:-

First, that on and after the first day of September one thousand eight hundred and eighty the Regulations appended to the said Order in Council of the ninth day of January one thousand eight hundred and sixty-three and the additions to the said Regulations contained in the said Order in Council of the thirtieth day of July one thousand eight hundred and sixty-eight shall be annulled and

and that there shall be substituted for the said Regulations and additions respectively the new Regulations contained in the first schedule hereto.

Second, that the said Regulations contained in the said first schedule hereto shall, from and after the first day of September one thousand eight hundred and eighty, apply to ships of the countries mentioned in the said second schedule hereto whether within British jurisdiction or not.

C.L. Peel

FIRST SCHEDULE

Regulations for Preventing Collisions at Sea

Preliminary

Art. 1. In the following rules every steam ship which is under sail and not under steam is to be considered a sailing ship; and every steam ship which is under steam, whether under sail or not is to be considered a ship under steam.

Rules concerning Lights

Art. 2. The lights mentioned in the following Articles, numbered 3,4,5,6,7, 8,9,10 and 11, and no others shall be carried in all weathers, from sunset to sunrise.

Art. 3. A seagoing steam ship when under way shall carry:

(a) On or in front of the foremast, at a height above the hull of not less than 20 feet, and if the breadth of the ship exceeds 20 feet then at a height above the hull not less than such breadth, a bright white light, so constructed as to show an uniform and unbroken light over an arc of the horizon of 20 points of the compass; so fixed as to throw the light 10 points on each side of the ship, viz., from right ahead to two points abaft the beam on either side; and of such a character as to be visible on a dark night, with a clear atmosphere, at a distance of at least five miles.

(b) On the starboard side, a green light so constructed as to show an uniform and unbroken light over an arc of the horizon of ten points of the compass; so fixed as to throw the light from right ahead to 2 points abaft the beam on the starboard side; and of such a character as to be visible on a dark night, with a clear atmosphere, at a distance of at least two miles.

(c) On the port side, a red light, so constructed as to show an uniform and unbroken light over an arc of the horizon of 10 points of the compass; so fixed as to throw the light from right ahead to 2 points abaft the beam on the port side; and of such a character as to be visible on a dark night, with a clear atmosphere, at a distance of at least two miles.

(d) The said green and red side lights shall be fitted with inboard screens projecting at least three feet forward from the light, so as to prevent these lights from being seen across the bow.

Art. 4. A steam ship, when towing another ship shall, in addition to her side lights, carry two bright white lights in a vertical line one over the other, not less than three feet apart, so as to distinguish her from other steam ships. Each of these lights shall be of the same construction and character, and shall be carried in the same position as the white light which other steam ships are required to carry.

Art. 5. A ship, whether a steam ship or a sailing ship, when employed either in laying or in picking up a telegraph cable, or which from any accident is not under command, shall at night carry in the same position as the white light which steam ships are required to carry, and, if a steam ship, in place of that light, three red lights in globular lanterns, each not less than 10 inches in diameter, in a vertical line one over the other, not less than three feet apart: and shall by day carry in a vertical line one over the other, not less than three feet apart, in front of but not lower than her foremast head, three black balls or shapes, each two feet in diameter.

These shapes and lights are to be taken by approaching ships as signals that the ship using them is not under command, and cannot therefore get out of the way.

The above ships, when not making any way through the water, shall not carry the side lights, but when making way shall carry them.

Art. 6. A sailing ship under way, or being towed, shall carry the same lights as are provided by Article 3 for a steam ship under way, with the exception of the white light, which she shall never carry.

Art. 7. Whenever, as in the case of small vessels during bad weather, the green and red side lights cannot be fixed, these lights shall be kept on deck, on their respective sides of the vessel, ready for use: and shall, on the approach of or to other vessels, be exhibited on their respective sides in sufficient time to prevent collision, in such manner as to make them most visible, and so that the green light shall not be seen on the port side nor the red light on the starboard side.

To make the use of these portable lights more certain and easy, the lanterns containing them shall each be painted outside with the colour of the light they respectively contain, and shall be provided with proper screens.

Art. 8. A ship, whether a steam ship or a sailing ship, when at anchor, shall carry, where it can best be seen, but at a height not exceeding 20 feet above the hull, a white light, in a globular lantern of not less than eight inches in diameter, and so constructed as to show a clear uniform and unbroken light visible all round the horizon, at a distance of at least one mile.

Art. 9. A pilot vessel, when engaged on her station on pilotage duty, shall not carry the lights required for other vessels, but shall carry a white light at the mast head, visible all round the horizon, and shall also exhibit a flare-up light or flare-up lights at short intervals, which shall never exceed fifteen minutes.

A pilot vessel, when not engaged on her station on pilotage duty, shall carry lights similar to those of other ships.

Art. 10(a). Open fishing boats and other open boats when under way shall not be obliged to carry the side lights required for other vessels; but every such boat shall in lieu thereof have ready at hand a lantern with a green glass on the one side and a red glass on the other side; and on the approach of or to other vessels, such lantern shall be exhibited in sufficient time to prevent collision, so that the green light shall not be seen on the port side, nor the red light on the starboard side.

(b) A fishing vessel, and an open boat, when at anchor, shall exhibit a bright white light.

(c) A fishing vessel, when employed in drift net fishing, shall carry on one of her masts two red lights in a vertical line one over the other, not less than three feet apart.

(d) A trawler at work shall carry on one of her masts two lights in a vertical line one over the other, not less than three feet apart, the upper light red, and the lower green, and shall also either carry the side lights required for other vessels, or, if the side lights cannot be carried, have ready at hand the coloured lights as provided in Article 7, or a lantern with a red and a green glass as described in paragraph (a) of this Article.

(e) Fishing vessels and open boats shall not be prevented from using a flare-up in addition, if they desire to do so.

(f) The lights mentioned in this Article are substituted for those mentioned in the 12th, 13th and 14th Articles of the Convention between France and England scheduled to the British Sea Fisheries Act, 1868.

(g) All lights required by this Article, except side lights, shall be in globular lanterns so constructed as to show all round the horizon.

Art. 11. A ship which is being overtaken by another shall show from her stern to such last-mentioned ship a white light or a flare-up light.

Sound Signals for Fog, etc.

Art. 12. A steam ship shall be provided with a steam whistle or other efficient steam sound signal, so placed that the sound may not be intercepted by any obstructions, and with an efficient fog horn to be sounded by a bellows or other mechanical means, and also with an efficient bell. A sailing ship shall be provided with similar fog horn and bell.

In fog, mist, or falling show, whether by day or night, the signals described in this Article shall be used as follows; that is to say,

(a) A steam ship under way shall make with her steam whistle, or other steam sound signal, at intervals of not more than two minutes, a prolonged blast.

(b) A sailing ship under way shall make with her fog horn, at intervals of not more than two minutes, when on the starboard tack one blast, when on the port tack two blasts in succession, and when with the wind abaft the beam three blasts in succession.

(c) A steam ship and a sailing ship when not under way shall, at intervals of not more than two minutes, ring the bell.

Speed of Ships to be Moderate in Fog, etc.

Art. 13. Every ship, whether a sailing ship or steam ship, shall in a fog, mist, or falling snow, go at a moderate speed.

Steering and Sailing Rules

Art. 14. When two sailing ships are approaching one another, so as to involve risk of collision, one of them shall keep out of the way of the other as follows, viz:-

(a) A ship which is running free shall keep out of the way of a ship which is close-hauled.

(b) A ship which is close-hauled on the port tack shall keep out of the way of a ship which is close-hauled on the starboard tack.

(c) When both are running free with the wind on different sides, the ship which has the wind on the port side shall keep out of the way of the other.

(d) When both are running free with the wind on the same side, the ship which is to windward shall keep out of the way of the ship which is to leeward.

(e) A ship which has the wind aft shall keep out of the way of the other ship.

Art. 15. If two ships under steam are meeting end on, or nearly end on, so as to involve risk of collision, each shall alter her course to starboard, so that each may pass on the port side of the other.

This Article only applies to cases where ships are meeting end on, or nearly end on, in such a manner as to involve risk of collision, and does not apply to two ships which must, if both keep on their respective courses, pass clear of each other.

The only cases to which it does apply are, when each of the two ships is end on, or nearly end on, to the other; in other words, to cases in which, by day, each ship sees the masts of the other in a line, or nearly in a line, with her own; and by night, to cases in which each ship is in such a position as to see both the side lights of the other.

It does not apply by day, to cases in which a ship sees another ahead crossing her own course; or by night, to cases where the red light of one ship is opposed to the red light of the other, or where the green light of one ship is opposed to the green light of the other, or where a red light without a green light, or a green light without a red light, is seen ahead, or where both green and red lights are seen anywhere but ahead.

Art. 16. If two ships under steam are crossing, so as to involve risk of collision, the ship which has the other on her own starboard side shall keep out of the way of the other.

Art. 17. If two ships, one of which is a sailing ship, and the other a steam ship, are proceeding in such directions as to involve risk of collision, the steam ship shall keep out of the way of the sailing ship.

Art. 18. Every steam ship, when approaching another ship, so as to involve risk of collision, shall slacken her speed or stop and reverse, if necessary.

Art. 19. In taking any course authorised or required by these Regulations, a steam ship under way may indicate that course to any other ship which she has in sight by the following signals on her steam whistle, viz:-

One short blast to mean "I am directing my course to starboard":

Two short blasts to mean "I am directing my course to port":

Three short blasts to mean "I am going full speed astern."

The use of these signals is optional; but if they are used, the course of the ship must be in accordance with the signal made.

Art. 20. Notwithstanding anything contained in any preceding Article, every ship, whether a sailing ship or a steam ship, overtaking any other, shall keep out of the way of the overtaken ship.

Art. 21. In narrow channels every steam ship shall, when it is safe and practicable, keep to that side of the fairway or midchannel which lies on the starboard side of such ship.

Art. 22. Where by the above rules one of two ships is to keep out of the way, the other shall keep her course.

Art. 23. In obeying and construing these rules due regard shall be had to all dangers of navigation; and to any special circumstances which may render a departure from the above rules necessary in order to avoid immediate danger.

No Ship, under any Circumstances to Neglect proper Precautions

Art. 24. Nothing in these rules shall exonerate any ship, or the owner, or master, or crew thereof, from the consequences of any neglect to carry lights or signals, or of any neglect to keep a proper look-out, or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

Reservation of Rules for Harbours and Inland Navigation

Art. 25. Nothing in these rules shall interfere with the operation of a special rule, duly made by Local Authority, relative to the navigation of any harbour, river, or inland navigation.

Special Lights for Squadrons and Convoys

Art. 26. Nothing in these rules shall interfere with the operation of any special rules made by the Government of any nation with respect to additional station and signal lights for two or more ships of war or for ships sailing under convoy.

SECOND SCHEDULE

Austria-Hungary	Italy
Belgium	Netherlands
Chili	Norway
Denmark	Portugal
France	Russia
Germany	Spain
Great Britain	Sweden
Greece	United States

(L) Order in Council, 11th August 1884

SCHEDULE referred to in this Order

Regulations for Preventing Collisions at Sea

Art. 1. In the following rules every steam ship which is under sail and not under steam is to be considered a sailing ship; and every steam ship which is under steam, whether under sail or not, is to be considered a ship under steam.

Rules concerning Lights

Art. 2. The lights mentioned in the following Articles, numbered 3,4,5,6,7, 8,9,10 and 11, and no others, shall be carried in all weathers, from sunset to sunrise.

Art. 3. A seagoing steam ship when under way shall carry:-

(a) On or in front of the foremast, at a height above the hull of not less than 20 feet and if the breadth of the ship exceeds 20 feet, then at a height above the hull not less than such breadth, a bright white light so constructed as to show an uniform and unbroken light over an arc of the horizon of 20 points of the compass, so fixed as to throw the light 10 points on each side of the ship, viz., from right ahead to two points abaft the beam on either side, and of such a character as to be visible on a dark night, with a clear atmosphere, at a distance of at least five miles.

(b) On the starboard side a green light, so constructed as to show an uniform and unbroken light over an arc of the horizon of 10 points of the compass, so fixed as to throw the light from right ahead to two points abaft the beam on the starboard side, and of such a character as to be visible on a dark night, with a clear atmosphere, at a distance of at least two miles.

(c) On the port side a red light, so constructed as to show an uniform and unbroken light over an arc of the horizon of 10 points of the compass, so fixed as to throw the light from right ahead to two points abaft the beam on the port side, and of such a character as to be visible on a dark night, with a clear atmosphere, at a distance of at least two miles.

(d) The said green and red side lights shall be fitted with inboard screens projecting at least 3 feet forward from the light, so as to prevent these lights from being seen across the bow.

Art. 4. A steam ship, when towing another ship, shall, in addition to her side lights, carry two bright white lights in a vertical line one over the other, not less than 3 feet apart, so as to distinguish her from other steam ships. Each of these lights shall be of the same construction and character, and shall be carried in the same position, as the white light which other steam ships are required to carry.

Art. 5(a). A ship, whether a steam ship or a sailing ship, which from any accident is not under command, shall at night carry, in the same position as the white light which steam ships are required to carry, and, if a steam ship, in place of that light, three red lights in globular lanterns, each not less than 10 inches in diameter, in a vertical line one over the other, not less than three feet apart, and of such a character as to be visible on a dark night with a clear atmosphere at a distance of at least two miles; and shall by day carry in a vertical line one over the other, not less than three feet apart, in front of but not lower than her foremast head, three black balls or shapes, each two feet in diameter.

(b) A ship, whether a steam ship or a sailing ship employed in laying or in picking up a telegraph cable, shall at night carry in the same position as the white light which steam ships are required to carry, and, if a steam ship, in place of that light, three lights in globular lanterns each not less than 10 inches in diameter, in a vertical line over one another, not less than 6 feet apart; the highest and lowest of these lights shall be red, and the middle light shall be white, and they shall be of such a character that the red lights shall be visible at the same distance as the white light. By day she shall carry in a vertical line one over the other not less than six feet apart, in front of but not lower than her foremast head, three shapes not less than two feet in diameter, of which the top and bottom shall be globular in shape and red in colour, and the middle one diamond in shape and white.

(c) The ships referred to in this Article, when not making any way through the water, shall not carry the side lights, but when making way shall carry them.

(d) The lights and shapes required to be shown by this Article are to be taken by other ships as signals that the ship showing them is not under command, and cannot therefore get out of the way. The signals to be made by ships in distress and requiring assistance are contained in Article 27.

Art. 6. A sailing ship under way, or being towed, shall carry the same lights as are provided by Article 3 for a steam ship under way with the exception of the white light, which she shall never carry.

Art. 7. Whenever, as in the case of small vessels during bad weather, the green and red side lights cannot be fixed, these lights shall be kept on deck, on their respective sides of the vessel, ready for use; and shall, on the approach of or to other vessels, be exhibited on their respective sides in sufficient time to prevent collision, in such manner as to make them most visible, and so that the green light shall not be seen on the port side nor the red light on the starboard side.

To make the use of these portable lights more certain and easy, the lanterns containing them shall each be painted outside with the colour of the light they respectively contain, and shall be provided with proper screens.

Art. 8. A ship, whether a steam ship or a sailing ship, when at anchor, shall carry, where it can best be seen, but at a height not exceeding 20 feet above the hull, a white light, in a globular lantern of not less than 8 inches in diameter, and so constructed as to show a clear uniform and unbroken light visible all round the horizon, at a distance of at least one mile.

Art. 9. A pilot vessel, when engaged on her station on pilotage duty, shall not carry the lights required for other vessels, but shall carry a white light at the masthead, visible all round the horizon, and shall also exhibit a flare-up light or flare-up lights at short intervals, which shall never exceed fifteen minutes.

A pilot vessel, when not engaged on her station on pilotage duty, shall carry lights similar to those of other ships.

Art. 10. Open boats and fishing vessels of less than 20 tons net registered tonnage, when under way and when not having their nets, trawls, dredges, or lines in the water, shall not be obliged to carry the coloured side lights; but every such boat and vessel shall in lieu thereof have ready at hand a lantern with a green glass on the one side, and a red glass on the other side, and on approaching to or being approached by another vessel such lantern shall be exhibited in sufficient time to prevent collision, so that the green light shall not be seen on the port side nor the red light on the starboard side.

The following portion of this Article applies only to fishing vessels and boats when in the sea off the coast of Europe lying north of Cape Finisterre:-

(a) All fishing vessels and fishing boats of 20 tons net registered tonnage, or upwards, when under way and when not required by the following regulations in this Article to carry and show the lights therein named, shall carry and show the same lights as other vessels under way.

(b) All vessels when engaged in fishing with drift nets shall exhibit two white lights from any part of the vessel where they can be best seen. Such lights shall be placed so that the vertical distance between them shall not be less than 6 feet and not more than 10 feet; and so that the horizontal distance between them measured in a line with the keel of the vessel shall be not less than 5 feet and not more than 10 feet. The lower of these two lights shall be the more forward, and both of them shall be of such a character, and contained in lanterns of such construction as to show all round the horizon, on a dark night with a clear atmosphere, for a distance of not less than three miles.

(c) A vessel employed in line fishing with her lines out shall carry the same lights as a vessel when engaged in fishing with drift nets.

(d) If a vessel when fishing becomes stationary in consequence of her gear getting fast to a rock or other obstruction, she shall show the light and make the fog signal for a vessel at anchor.

(e) Fishing vessels and open boats may at any time use a flare-up in addition to the lights which they are by this Article required to carry and show. All flare-up lights exhibited by a vessel when trawling, dredging, or fishing with any kind of drag net shall be shown at the after part of the vessel, excepting that, if the vessel is hanging by the stern to her trawl, dredge, or drag net, they shall be exhibited from the bow.

(f) Every fishing vessel and every open boat when at anchor between sunset and sunrise shall exhibit a white light visible all round the horizon at a distance of at least one mile.

(g) In fog, mist, or falling snow, a drift net vessel attached to her nets and a vessel when trawling, dredging, or fishing with any kind of drag net, and a vessel employed in line fishing with her lines out, shall at intervals of not more than two minutes make a blast with her fog horn and ring her bell alternately.

Art. 11. A ship which is being overtaken by another shall show from her stern to such last-mentioned ship a white light or a flare-up light.

Sound Signals for Fog, etc.

Art. 12. A steam ship shall be provided with a steam whistle or other efficient steam sound signal, so placed that the sound may not be intercepted by any obstructions, and with an efficient fog horn to be sounded by a bellows or other mechanical means, and also with an efficient bell*. A sailing ship shall be provided with a similar fog horn and bell.

In fog, mist, or falling snow, whether by day or night, the signals described in this Article shall be used as follows; that is to say:-

(a) A steam ship under way shall make with her steam whistle, or other steam sound signal, at intervals of not more than two minutes, a prolonged blast.

(b) A sailing ship under way shall make with her fog horn, at intervals of not more than two minutes, when on the starboard tack one blast, when on the port tack two blasts in succession, and when with the wind abaft the beam three blasts in succession.

(c) A steam ship and a sailing ship, when not under way, shall at intervals of not more than two minutes ring the bell.

Speed of Ships to be moderate in Fog, etc.

Art. 13. Every ship, whether a sailing ship or steam ship, shall, in a fog, mist, or falling snow, go at a moderate speed.

Steering and Sailing Rules

Art. 14. When two sailing ships are approaching one another, so as to involve risk of collision, one of them shall keep out of the way of the other, as follows, viz:

(a) A ship which is running free shall keep out of the way of a ship which is close-hauled.

(b) A ship which is close-hauled on the port tack shall keep out of the way of a ship which is close-hauled on the starboard tack.

(c) When both are running free with the wind on different sides, the ship which has the wind on the port side shall keep out of the way of the other.

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* In all cases where the Regulations require a bell to be used, a drum will be substituted on board Turkish vessels.

(d) When both are running free with the wind on the same side, the ship which is to windward shall keep out of the way of the ship which is to leeward.

(e) A ship which has the wind aft shall keep out of the way of the other ship.

Art. 15. If two ships under steam are meeting end on, or nearly end on, so as to involve risk of collision, each shall alter her course to starboard, so that each may pass on the port side of the other.

This Article only applies to cases where ships are meeting end on, or nearly end on, in such a manner as to involve risk of collision, and does not apply to two ships which must, if both keep on their respective courses, pass clear of each other.

The only cases to which it does apply are, when each of the two ships is end on, or nearly end on, to the other; in other words, to cases in which, by day each ship sees the masts of the other in a line, or nearly in a line, with her own; and by night, to cases in which each ship is in such a position as to see both the side lights of the other.

It does not apply by day to cases in which a ship sees another ahead crossing her own course; or by night to cases where the red light of one ship is opposed to the red light of the other, or where the green light of one ship is opposed to the green light of the other, or where a red light without a green light, or a green light without a red light, is seen ahead, or where both green and red lights are seen anywhere but ahead.

Art. 16. If two ships under steam are crossing, so as to involve risk of collision, the ship which has the other on her own starboard side shall keep out of the way of the other.

Art. 17. If two ships, one of which is a sailing ship and the other a steam ship, are proceeding in such directions as to involve risk of collision, the steam ship shall keep out of the way of the sailing ship.

Art. 18. Every steam ship, when approaching another ship, so as to involve risk of collision, shall slacken her speed or stop and reverse, if necessary.

Art. 19. In taking any course authorised or required by these regulations, a steam ship under way may indicate that course to any other ship which she has in sight by the following signals on her steam whistle, viz:-

One short blast to mean "I am directing my course to starboard."

Two short blasts to mean "I am directing my course to port."

Three short blasts to mean "I am going full speed astern."

The use of these signals is optional, but if they are used the course of the ship must be in accordance with the signal made.

Art. 20. Notwithstanding anything contained in any preceding Article, every ship, whether a sailing ship or a steam ship, overtaking any other, shall keep out of the way of the overtaken ship.

Art. 21. In narrow channels every steam ship shall, when it is safe and practicable, keep to that side of the fairway or mid-channel which lies on the starboard side of such ship.

Art. 22. Where by the above rules one of two ships is to keep out of the way, the other shall keep her course.

Art. 23. In obeying and construing these rules due regard shall be had to all dangers of navigation, and to any special circumstances which may render a departure from the above rules necessary in order to avoid immediate danger.

No Ship, under any Circumstances, to neglect proper Precautions

Art. 24. Nothing in these rules shall exonerate any ship, or the owner, or master, or crew thereof, from the consequences of any neglect to carry lights or signals, or of any neglect to keep a proper look out, or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

Reservation of Rules for Harbours and Inland Navigation

Art. 25. Nothing in these rules shall interfere with the operation of a special rule, duly made by local authority, relative to the navigation of any harbour, river, or inland navigation.

Special Lights for Squadrons and Convoys

Art. 26. Nothing in these rules shall interfere with the operation of any special rules made by the Government of any nation with respect to additional station and signal lights for two or more ships of war or for ships sailing under convoy.

Art. 27. When a ship is in distress and requires assistance from other ships or from the shore, the following shall be the signals to be used or displayed by her, either together or separately, that is to say:

In the daytime -

1. A gun fired at intervals of about a minute;
2. The International Code signal of distress indicated by N C;
3. The distant signal, consisting of a square flag, having either above or below it a ball, or anything resembling a ball.

At night -

1. A gun fired at intervals of about a minute;
2. Flames on the ship (as from a burning tar barrel, oil barrel, etc):
3. Rockets or shells, throwing stars of any colour or description, fired one at a time, at short intervals.

(M) Regulations recommended by the Washington Conference in 1889.

N.B. Variations from 1884 rules in capitals.

Preliminary

THESE RULES SHALL BE FOLLOWED BY ALL VESSELS UPON THE HIGH SEAS AND IN ALL WATERS CONNECTED THEREWITH, NAVIGABLE BY SEA-GOING VESSELS.

In the following Rules every steam-vessel which is under sail and not under steam is to be considered a sailing vessel, and every vessel under steam, whether under sail or not, is to be considered a steam-vessel.

THE WORD "steam-vessel" SHALL INCLUDE ANY VESSEL PROPELLED BY MACHINERY.

A VESSEL IS "under way" WITHIN THE MEANING OF THESE RULES WHEN SHE IS NOT AT ANCHOR, OR MADE FAST TO THE SHORE, OR AGROUND.

Rules concerning Lights, etc.

The word "VISIBLE" in these Rules when applied to lights shall mean visible on a dark night with a clear atmosphere.

Art. 1. The Rules concerning lights shall be complied with in all weathers from sunset to sunrise, AND DURING SUCH TIME NO OTHER LIGHTS WHICH MAY BE MISTAKEN FOR THE PRESCRIBED LIGHTS SHALL BE EXHIBITED.

Art. 2. A steam-vessel when under way shall carry -

(a) On or in front of the foremast, OR IF A VESSEL WITHOUT A FOREMAST THEN IN THE FORE PART OF THE VESSEL, at a height above the hull of not less than 20 feet, and if the breadth of the vessel exceeds 20 feet, then at a height above the hull not less than such breadth, SO, HOWEVER, THAT THE LIGHT NEED NOT BE CARRIED AT A GREATER HEIGHT ABOVE THE HULL THAN 40 FEET, a bright white light, so constructed as to show an unbroken light over an arc of the horizon of 20 points of the compass, so fixed as to throw the light 10 points on each side of the vessel, viz., from right ahead to 2 points abaft the beam on either side, and of such a character as to be visible at a distance of at least 5 miles.

(b) On the starboard side a green light so constructed as to show an unbroken light over an arc of the horizon of 10 points of the compass, so fixed as to throw the light from right ahead to 2 points abaft the beam on the starboard side, and of such a character as to be visible at a distance of at least 2 miles.

(c) On the port side a red light, so constructed as to show an unbroken light over an arc of the horizon on 10 points of the compass, so fixed as to throw the light from right ahead to 2 points abaft the beam on the port side, and of such a character as to be visible at a distance of at least 2 miles.

(d) The said green and red side-lights shall be fitted with inboard screens, projecting at least 3 feet forward from the light, so as to prevent these lights from being seen across the bow.

(e) A STEAM VESSEL WHEN UNDER WAY MAY CARRY AN ADDITIONAL WHITE LIGHT SIMILAR IN CONSTRUCTION TO THE LIGHT MENTIONED IN SUBDIVISION (a). THESE TWO LIGHTS SHALL BE SO PLACED IN LINE WITH THE KEEL THAT ONE SHALL BE AT LEAST 15 FEET HIGHER THAN THE OTHER, AND IN SUCH A POSITION WITH REFERENCE TO EACH OTHER THAT THE LOWER LIGHT SHALL BE FORWARD OF THE UPPER ONE. THE VERTICAL DISTANCE BETWEEN THESE LIGHTS SHALL BE LESS THAN THE HORIZONTAL DISTANCE.

Art. 3. A steam VESSEL when towing another VESSEL shall, in addition to her side lights, carry two bright white lights in a vertical line, one over the other, not less than SIX feet apart, AND WHEN TOWING MORE THAN ONE VESSEL SHALL CARRY AN ADDITIONAL BRIGHT WHITE LIGHT 6 FEET ABOVE OR BELOW SUCH LIGHTS, IF THE LENGTH OF THE TOW, MEASURING FROM THE STERN OF THE TOWING VESSEL TO THE STERN OF THE LAST VESSEL TOWED, EXCEED 600 FEET. Each of these lights shall be of the same construction and character, and shall be carried in the same position as the white light mentioned in Article 2(a), EXCEPT THE ADDITIONAL LIGHT, WHICH MAY BE CARRIED AT A HEIGHT OF NOT LESS THAN 14 FEET ABOVE THE HULL.

SUCH STEAM VESSEL MAY CARRY A SMALL WHITE LIGHT ABAFT THE FUNNEL OR AFTERMAST, FOR THE VESSEL TOWED TO STEER BY, BUT SUCH LIGHT SHALL NOT BE VISIBLE FORWARD OF THE BEAM.

Art. 4(a) A VESSEL WHICH FROM ANY ACCIDENT IS NOT UNDER COMMAND, SHALL CARRY, AT THE SAME HEIGHT AS THE WHITE LIGHT MENTIONED IN ARTICLE 2(a), WHERE THEY

CAN BEST BE SEEN, AND IF A STEAM VESSEL, IN LIEU OF THAT LIGHT, TWO RED LIGHTS, IN A VERTICAL LINE ONE OVER THE OTHER, NOT LESS THAN 6 FEET APART, AND OF SUCH A CHARACTER AS TO BE VISIBLE ALL ROUND THE HORIZON AT A DISTANCE OF AT LEAST 2 MILES; AND SHALL BY DAY CARRY IN A VERTICAL LINE, ONE OVER THE OTHER, NOT LESS THAN 6 FEET APART, WHERE THEY CAN BEST BE SEEN, TWO BLACK BALLS OR SHAPES, EACH 2 FEET IN DIAMETER.

(b) A vessel employed in laying or in picking up a telegraph cable shall carry in the same position as the white light mentioned in Article 2(a), and if a steam vessel, in lieu of that light, three lights in a vertical line one over the other, not less than 6 feet apart. The highest and lowest of these lights shall be red, and the middle light shall be white, and they shall be of such a character as to be visible all round the horizon, at a distance of at least 2 miles. By day she shall carry in a vertical line, one over the other, not less than 6 feet apart, where they can best be seen, three shapes not less than 2 feet in diameter, of which the highest and lowest shall be globular in shape and red in colour, and the middle one diamond in shape and white.

(c) The vessels referred to in this Article when not making way through the water, shall not carry the side lights, but when making way shall carry them.

(d) The lights and shapes required to be shown by this Article are to be taken by other vessels as signals that the vessel showing them is not under command, and cannot therefore get out of the way.

These signals are not signals of vessels in distress and requiring assistance. Such signals are contained in Article 31.

Art. 5. A sailing vessel under way, AND ANY VESSEL being towed shall carry the same lights as are prescribed by Article 2 for a steam vessel under way, with the exception of the white LIGHTS mentioned therein, which they shall never carry.

Art. 6. Whenever, as in the case of small vessels UNDER WAY during bad weather, the green and red side lights cannot be fixed, these lights shall be kept AT HAND, LIGHTED AND ready for use; and shall, on the approach of or to other vessels, be exhibited on their respective sides in sufficient time to prevent collision, in such manner as to make them most visible, and so that the green light shall not be seen on the port side, nor the red light on the starboard side, NOR IF PRACTICABLE MORE THAN 2 POINTS ABAFT THE BEAM ON THEIR RESPECTIVE SIDES.

To make the use of these portable lights more certain and easy, the lanterns containing them shall each be painted outside with the colour of the light they respectively contain, and shall be provided with proper screens.

Art. 7. STEAM VESSELS OF LESS THAN 40, AND VESSELS UNDER OARS OR SAILS, OF LESS THAN 20 TONS, GROSS TONNAGE, RESPECTIVELY, WHEN UNDER WAY, SHALL NOT BE OBLIGED TO CARRY THE LIGHTS MENTIONED IN ARTICLE 2(a)(b) AND (c), BUT IF THEY DO NOT CARRY THEM THEY SHALL BE PROVIDED WITH THE FOLLOWING LIGHTS:

1. STEAM VESSELS OF LESS THAN 40 TONS SHALL CARRY:

(a) IN THE FORE PART OF THE VESSEL, OR ON OR IN FRONT OF THE FUNNEL, WHERE IT CAN BEST BE SEEN, AND AT A HEIGHT ABOVE THE GUNWALE OF NOT LESS THAN 9 FEET, A BRIGHT WHITE LIGHT CONSTRUCTED AND FIXED AS PRESCRIBED IN ARTICLE 2(a), AND OF SUCH A CHARACTER AS TO BE VISIBLE AT A DISTANCE OF AT LEAST 2 MILES.

(b) GREEN AND RED SIDE-LIGHTS, CONSTRUCTED AND FIXED AS PRESCRIBED IN ARTICLE 2(b) AND (c), AND OF SUCH A CHARACTER AS TO BE VISIBLE AT A

DISTANCE OF AT LEAST 1 MILE, OR A COMBINED LANTERN SHOWING A GREEN LIGHT AND A RED LIGHT FROM RIGHT AHEAD TO 2 POINTS ABAFT THE BEAM ON THEIR RESPECTIVE SIDES. SUCH LANTERN SHALL BE CARRIED NOT LESS THAN 3 FEET BELOW THE WHITE LIGHT.

2. SMALL STEAMBOATS, SUCH AS ARE CARRIED BY SEA-GOING VESSELS, MAY CARRY THE WHITE LIGHT AT A LESS HEIGHT THAN 9 FEET ABOVE THE GUNWALE, BUT IT SHALL BE CARRIED ABOVE THE COMBINED LANTERN MENTIONED IN SUB-DIVISION (b).

3. VESSELS UNDER OARS OR SAILS, OF LESS THAN 20 TONS, SHALL HAVE READY AT HAND A LANTERN WITH A GREEN GLASS ON ONE SIDE AND A RED GLASS ON THE OTHER, WHICH, ON THE APPROACH OF OR TO OTHER VESSELS, SHALL BE EXHIBITED IN SUFFICIENT TIME TO PREVENT COLLISION, SO THAT THE GREEN LIGHT SHALL NOT BE SEEN ON THE PORT SIDE NOR THE RED LIGHT ON THE STARBOARD SIDE.

THE VESSELS REFERRED TO IN THIS ARTICLE SHALL NOT BE OBLIGED TO CARRY THE LIGHTS PRESCRIBED BY ARTICLE 4(a), AND ARTICLE 11, LAST PARAGRAPH.

Art. 8. Pilot vessels, when engaged on their station on pilotage duty, shall not show the lights required for other vessels, but shall carry a white light at the mast-head, visible all round the horizon, and shall also exhibit a flare-up light or flare-up lights at short intervals, which shall never exceed 15 minutes.

ON THE NEAR APPROACH OF OR TO OTHER VESSELS THEY SHALL HAVE THEIR SIDE LIGHTS LIGHTED, READY FOR USE, AND SHALL FLASH OR SHOW THEM AT SHORT INTERVALS, TO INDICATE THE DIRECTION IN WHICH THEY ARE HEADING, BUT THE GREEN LIGHT SHALL NOT BE SHOWN ON THE PORT SIDE, NOR THE RED LIGHT ON THE STARBOARD SIDE.

A PILOT VESSEL OF SUCH A CLASS AS TO BE OBLIGED TO GO ALONGSIDE OF A VESSEL TO PUT A PILOT ON BOARD, MAY SHOW THE WHITE LIGHT INSTEAD OF CARRYING IT AT THE MAST-HEAD AND MAY, INSTEAD OF THE COLOURED LIGHTS ABOVE MENTIONED, HAVE AT HAND READY FOR USE A LANTERN WITH A GREEN GLASS ON THE ONE SIDE AND A RED GLASS ON THE OTHER, TO BE USED AS PRESCRIBED ABOVE.

Pilot vessels, when not engaged on their station on pilotage duty, shall carry lights similar to those of other vessels OF THEIR TONNAGE.

Art. 9. FISHING VESSELS AND FISHING BOATS WHEN UNDER WAY AND WHEN NOT REQUIRED BY THIS ARTICLE TO CARRY OR SHOW THE LIGHTS THEREIN NAMED, SHALL CARRY OR SHOW THE LIGHTS PRESCRIBED FOR VESSELS OF THEIR TONNAGE UNDER WAY.

(a) VESSELS AND BOATS WHEN FISHING WITH DRIFT-NETS SHALL EXHIBIT TWO WHITE LIGHTS FROM ANY PART OF THE VESSEL WHERE THEY CAN BEST BE SEEN. SUCH LIGHTS SHALL BE PLACED SO THAT THE VERTICAL DISTANCE BETWEEN THEM SHALL BE NOT LESS THAN 6 FEET AND NOT MORE THAN 10 FEET, AND SO THAT THE HORIZONTAL DISTANCE BETWEEN THEM, MEASURED IN A LINE WITH THE KEEL, SHALL BE NOT LESS THAN 5 FEET AND NOT MORE THAN 10 FEET. THE LOWER OF THESE TWO LIGHTS SHALL BE THE MORE FORWARD, AND BOTH OF THEM SHALL BE OF SUCH A CHARACTER AS TO SHOW ALL ROUND THE HORIZON, AND TO BE VISIBLE AT A DISTANCE OF NOT LESS THAN 3 MILES.

(b) VESSELS WHEN ENGAGED IN TRAWLING, BY WHICH IS MEANT THE DRAGGING OF AN APPARATUS ALONG THE BOTTOM OF THE SEA -

1. IF STEAM VESSELS, SHALL CARRY IN THE SAME POSITION AS THE WHITE LIGHT MENTIONED IN ARTICLE 2(a), A TRICOLOURED LANTERN SO CONSTRUCTED AND FIXED AS TO SHOW A WHITE LIGHT FROM RIGHT AHEAD TO 2 POINTS ON EACH BOW, AND A GREEN LIGHT AND A RED LIGHT OVER AN ARC OF THE HORIZON FROM 2 POINTS ON EITHER BOW TO 2 POINTS ABAFT THE BEAM ON THE STARBOARD AND PORT SIDE RESPECTIVELY; AND NOT LESS THAN 6 NOR MORE THAN 12 FEET BELOW THE TRICOLOURED LANTERN, A WHITE LIGHT IN A LANTERN, SO CONSTRUCTED AS TO SHOW A CLEAR UNIFORM AND UNBROKEN LIGHT ALL ROUND THE HORIZON.

2. IF STEAM VESSELS, SHALL CARRY IN THE SAME POSITION AS THE WHITE LIGHT MENTIONED IN ARTICLE 2(a), A TRICOLOURED LANTERN SO CONSTRUCTED AND FIXED AS TO SHOW A WHITE LIGHT FROM RIGHT AHEAD TO 2 POINTS ON EACH BOW, AND A GREEN LIGHT AND A RED LIGHT OVER AN ARC OF THE HORIZON FROM 2 POINTS ON EITHER BOW TO 2 POINTS ABAFT THE BEAM ON THE STARBOARD AND PORT SIDE RESPECTIVELY; AND NOT LESS THAN 6 NOR MORE THAN 12 FEET BELOW THE TRICOLOURED LANTERN, A WHITE LIGHT IN A LANTERN, SO CONSTRUCTED AS TO SHOW A CLEAR UNIFORM AND UNBROKEN LIGHT ALL ROUND THE HORIZON.

3. IF SAILING VESSELS OF 7 TONS GROSS TONNAGE AND UPWARDS, SHALL CARRY A WHITE LIGHT IN A LANTERN, SO CONSTRUCTED AS TO SHOW A CLEAR, UNIFORM AND UNBROKEN LIGHT ALL ROUND THE HORIZON, AND SHALL ALSO BE PROVIDED WITH A SUFFICIENT SUPPLY OF RED PYROTECHNIC LIGHTS, WHICH SHALL EACH BURN FOR AT LEAST 30 SECONDS, AND SHALL BE SHOWN ON THE APPROACH OF OR TO OTHER VESSELS IN SUFFICIENT TIME TO PREVENT COLLISION.

IN THE MEDITERRANEAN SEA THE VESSELS REFERRED TO IN SUBDIVISION (b) 2, MAY USE A FLARE-UP LIGHT IN LIEU OF A PYROTECHNIC LIGHT.

ALL LIGHTS MENTIONED IN SUBDIVISION b (1) AND (2) SHALL BE VISIBLE AT A DISTANCE OF AT LEAST 2 MILES.

3. IF SAILING VESSELS OF LESS THAN 7 TONS GROSS TONNAGE, SHALL NOT BE OBLIGED TO CARRY THE WHITE LIGHT MENTIONED IN SUBDIVISION b (2) OF THIS ARTICLE, BUT IF THEY DO NOT CARRY SUCH LIGHT, THEY SHALL HAVE AT HAND, READY FOR USE, A LANTERN SHOWING A BRIGHT WHITE LIGHT, WHICH SHALL, ON THE APPROACH OF OR TO OTHER VESSELS, BE EXHIBITED WHERE IT CAN BEST BE SEEN, IN SUFFICIENT TIME TO PREVENT COLLISION; AND THEY SHALL ALSO SHOW A RED PYROTECHNIC LIGHT, AS PRESCRIBED IN SUBDIVISION b (2), OR IN LIEU THEREOF A FLARE-UP LIGHT.

(c) VESSELS AND BOATS WHEN LINE-FISHING WITH THEIR LINES OUT AND ATTACHED TO THEIR LINES, AND WHEN NOT AT ANCHOR OR STATIONARY, SHALL CARRY THE SAME LIGHTS AS VESSELS FISHING WITH DRIFT NETS.

(d) FISHING VESSELS AND FISHING BOATS MAY AT ANY TIME USE A FLARE-UP LIGHT IN ADDITION TO THE LIGHTS WHICH THEY ARE BY THIS ARTICLE REQUIRED TO CARRY AND SHOW. ALL FLARE-UP LIGHTS EXHIBITED BY A VESSEL WHEN TRAWLING OR FISHING WITH ANY KIND OF DRAG-NET SHALL BE SHOWN AT THE AFTER PART OF THE VESSEL, EXCEPTING THAT, IF THE VESSEL IS HANGING BY THE STERN TO HER FISHING GEAR, THEY SHALL BE EXHIBITED FROM THE BOW.

(e) EVERY FISHING VESSEL AND EVERY BOAT WHEN AT ANCHOR SHALL EXHIBIT A WHITE LIGHT VISIBLE ALL ROUND THE HORIZON AT A DISTANCE OF AT LEAST 1 MILE.

(f) IF A VESSEL OR BOAT WHEN FISHING BECOMES STATIONARY IN CONSEQUENCE OF HER GEAR GETTING FAST TO A ROCK OR OTHER OBSTRUCTION, SHE SHALL SHOW THE LIGHT AND MAKE THE FOG-SIGNAL PRESCRIBED FOR A VESSEL AT ANCHOR RESPECTIVELY. (SEE Article 15(d)(e) and last paragraph.)

(g) IN FOG, MIST, FALLING SNOW, OR HEAVY RAIN-STORMS, DRIFT-NET VESSELS ATTACHED TO THEIR NETS, AND VESSELS WHEN TRAWLING, DREDGING, OR FISHING WITH ANY KIND OF DRAG-NET, AND VESSELS LINE-FISHING WITH THEIR LINES OUT, SHALL, IF OF 20 TONS GROSS TONNAGE OR UPWARDS, RESPECTIVELY, AT INTERVALS OF NOT MORE THAN 1 MINUTE, MAKE A BLAST; IF STEAM VESSELS WITH THE WHISTLE OR SIREN AND IF SAILING VESSELS, WITH THE FOG-HORN, EACH BLAST TO BE FOLLOWED BY RINGING THE BELL.

(h) SAILING VESSELS OR BOATS FISHING WITH NETS OR LINES OR TRAWLS, WHEN UNDER WAY, SHALL IN DAYTIME INDICATE THEIR OCCUPATION TO AN APPROACHING VESSEL BY DISPLAYING A BASKET OR OTHER EFFICIENT SIGNAL, WHERE IT CAN BEST BE SEEN.

THE VESSELS REFERRED TO IN THIS ARTICLE SHALL NOT BE OBLIGED TO CARRY THE LIGHTS PRESCRIBED BY ARTICLE 4 (a) AND ARTICLE 11, LAST PARAGRAPH.

Art. 10. A vessel which is being over-taken by another shall show from her stern to such last-mentioned vessel a white light or a flare-up light.

THE WHITE LIGHT REQUIRED TO BE SHOWN BY THIS ARTICLE MAY BE FIXED AND CARRIED IN A LANTERN, BUT IN SUCH CASE THE LANTERN SHALL BE SO CONSTRUCTED, FITTED AND SCREENED THAT IT SHALL THROW AN UNBROKEN LIGHT OVER AN ARC OF THE HORIZON OF 12 POINTS OF THE COMPASS, VIZ., FOR 6 POINTS FROM RIGHT AFT ON EACH SIDE OF THE VESSEL, SO AS TO BE VISIBLE AT A DISTANCE OF AT LEAST 1 MILE. SUCH LIGHT SHALL BE CARRIED AS NEARLY AS PRACTICABLE ON THE SAME LEVEL AS THE SIDE LIGHTS.

Art. 11. A vessel UNDER 150 FEET IN LENGTH, when at anchor, shall carry FORWARD where it can best be seen, but at a height not exceeding 20 feet above the hull, a white light in a lantern so constructed as to show a clear uniform and unbroken light visible all round the horizon at a distance of at least 1 mile.

A VESSEL OF 150 FEET OR UPWARDS IN LENGTH, WHEN AT ANCHOR, SHALL CARRY IN THE FORWARD PART OF THE VESSEL, AT A HEIGHT OF NOT LESS THAN 20 AND NOT EXCEEDING 10 FEET ABOVE THE HULL, ONE SUCH LIGHT, AND AT OR NEAR THE STERN OF THE VESSEL, AND AT SUCH A HEIGHT THAT IT SHALL BE NOT LESS THAN 15 FEET LOWER THAN THE FORWARD LIGHT, ANOTHER SUCH LIGHT.

THE LENGTH OF A VESSEL SHALL BE DEEMED TO BE THE LENGTH APPEARING IN HER CERTIFICATE OF REGISTRY.

A VESSEL AGROUND IN OR NEAR A FAIR-WAY SHALL CARRY THE ABOVE LIGHT OR LIGHTS AND THE TWO RED LIGHTS PRESCRIBED BY ARTICLE 4 (a).

Art. 12. EVERY VESSEL MAY, IF NECESSARY, IN ORDER TO ATTRACT ATTENTION, IN ADDITION TO THE LIGHTS WHICH SHE IS BY THESE RULES REQUIRED TO CARRY, SHOW A FLARE-UP LIGHT OR USE ANY DETONATING SIGNAL THAT CANNOT BE MISTAKEN FOR A DISTRESS SIGNAL.

Art. 13. Nothing in these Rules shall interfere with the operation of any special rules made by the Government of any nation, with respect to additional station and signal lights for two or more ships of war or for vessels sailing under convoy, OR WITH THE EXHIBITION OF RECOGNITION SIGNALS ADOPTED BY SHIP-OWNERS, WHICH HAVE BEEN AUTHORISED BY THEIR RESPECTIVE GOVERNMENTS, AND DULY REGISTERED AND PUBLISHED.

Art. 14. A STEAM VESSEL PROCEEDING UNDER SAIL ONLY BUT HAVING HER FUNNEL UP, SHALL CARRY IN DAYTIME FORWARD, WHERE IT CAN BEST BE SEEN, ONE BLACK BALL OR SHAPE 2 FEET IN DIAMETER.

Sound Signals for Fog, etc.

Art. 15. ALL SIGNALS PRESCRIBED BY THIS ARTICLE FOR VESSELS UNDER WAY SHALL BE GIVEN:-

1. BY "steam-vessels" ON THE WHISTLE OR SIREN.

2. BY "sailing vessels and vessels towed" ON THE FOG-HORN.

THE WORDS "prolonged blast" USED IN THIS ARTICLE SHALL MEAN A BLAST OF FROM 4 TO 6 SECONDS' DURATION.

A steam vessel shall be provided with an efficient whistle or SIREN, SOUNDED BY STEAM OR SOME SUBSTITUTE FOR STEAM, so placed that the sound may not be intercepted by any obstruction, and which an efficient fog-horn, to be sounded by mechanical means, and also with an efficient bell*. A sailing vessel OF 20 TONS GROSS TONNAGE OR UPWARDS shall be provided with a similar fog-horn and bell.

In fog, mist, falling snow, OR HEAVY RAIN-STORMS whether by day or night, the signals described in this Article shall be used as follows, viz:-

(a) A steam vessel HAVING WAY UPON HER shall sound at intervals of not more than 2 minutes, a prolonged blast.

(b) A STEAM VESSEL UNDER WAY, BUT STOPPED AND HAVING NO WAY UPON HER, SHALL SOUND, AT INTERVALS OF NOT MORE THAN 2 MINUTES, TWO PROLONGED BLASTS, WITH AN INTERVAL OF ABOUT 1 SECOND BETWEEN THEM.

(c) A sailing vessel under way shall sound, at intervals of not more than 1 minute, when on the starboard tack one blast, when on the port tack two blasts in succession, and when with the wind abaft the beam, three blasts in succession.

(d) A vessel, when AT ANCHOR, shall, at intervals of not more than 1 minute, ring the bell RAPIDLY FOR ABOUT 5 SECONDS.

(e) A VESSEL AT ANCHOR AT SEA, WHEN NOT IN ORDINARY ANCHORAGE GROUND, AND WHEN IN SUCH A POSITION AS TO BE AN OBSTRUCTION TO VESSELS UNDER WAY, SHALL SOUND, IF A STEAM VESSEL, AT INTERVALS OF NOT MORE THAN 2 MINUTES, TWO PROLONGED BLASTS WITH HER WHISTLE OR SIREN, FOLLOWED BY RINGING HER BELL; OR, IF A SAILING-VESSEL, AT INTERVALS OF NOT MORE THAN 1 MINUTE, TWO BLASTS WITH HER FOG-HORN, FOLLOWED BY RINGING HER BELL.

(f) A VESSEL WHEN TOWING, SHALL, INSTEAD OF THE SIGNALS PRESCRIBED IN SUB-DIVISIONS (a) and (c) OF THIS ARTICLE, AT INTERVALS OF NOT MORE THAN 2 MINUTES, SOUND THREE BLASTS IN SUCCESSION, VIZ: ONE PROLONGED BLAST FOLLOWED BY TWO SHORT BLASTS. A VESSEL TOWED MAY GIVE THIS SIGNAL, AND SHE SHALL NOT GIVE ANY OTHER.

(g) A STEAM VESSEL WISHING TO INDICATE TO ANOTHER "THE WAY IS OFF MY VESSEL, YOU MAY FEEL YOU WAY PAST ME," MAY SOUND THREE BLASTS IN SUCCESSION, VIZ: SHORT, LONG, SHORT, WITH INTERVALS OF ABOUT 1 SECOND BETWEEN THEM.

(h) A VESSEL EMPLOYED IN LAYING OR IN PICKING UP A TELEGRAPH CABLE SHALL, ON HEARING THE FOG-SIGNAL OF AN APPROACHING VESSEL, SOUND IN ANSWER THREE PROLONGED BLASTS IN SUCCESSION.

(i) A VESSEL UNDER WAY, WHICH IS UNABLE TO GET OUT OF THE WAY OF AN APPROACHING VESSEL THROUGH BEING NOT UNDER COMMAND, OR UNABLE TO MAN-OEUVRE AS REQUIRED BY THESE RULES, SHALL, ON HEARING THE FOG-SIGNAL OF AN APPROACHING VESSEL, SOUND IN ANSWER FOUR SHORT BLASTS IN SUCCESSION.

SAILING-VESSELS AND BOATS OF LESS THAN 20 TONS GROSS TONNAGE SHALL NOT BE OBLIGED TO GIVE THE ABOVE-MENTIONED SIGNALS, BUT IF THEY DO NOT, THEY SHALL MAKE SOME OTHER EFFICIENT SOUND-SIGNAL AT INTERVALS OF NOT MORE THAN 1 MINUTE.

Speed of Ships to be Moderate in Fog, etc.

Art. 16. Every vessel shall, in a fog, mist, falling snow, OR HEAVY RAIN-STORMS, go at a moderate speed, HAVING CAREFUL REGARD TO THE EXISTING CIRCUMSTANCES AND CONDITIONS.

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* Note. In all cases where the Rules require a bell to be used, a drum may be substituted on board Turkish vessels, or a gong where such articles are used on board small sea-going vessels.

A STEAM-VESSEL HEARING APPARENTLY FORWARD OF HER BEAM, THE FOG-SIGNAL OF A VESSEL, THE POSITION OF WHICH IS NOT ASCERTAINED, SHALL, SO FAR AS THE CIRCUMSTANCES OF THE CASE ADMIT, STOP HER ENGINES, AND THEN NAVIGATE WITH CAUTION UNTIL DANGER OF COLLISION IS OVER.

Steering and Sailing Rules

Preliminary - Risk of Collision

RISK OF COLLISION CAN, WHEN CIRCUMSTANCES PERMIT, BE ASCERTAINED BY CAREFULLY WATCHING THE COMPASS BEARING OF AN APPROACHING VESSEL. IF THE BEARING DOES NOT APPRECIABLY CHANGE, SUCH RISK SHOULD BE DEEMED TO EXIST.

Art. 17. When two sailing vessels are approaching one another, so as to involve risk of collision, one of them shall keep out of the way of the other as follows, viz:-

(a) A vessel which is running free shall keep out of the way of a vessel which is close-hauled.

(b) A vessel which is close-hauled on the port tack shall keep out of the way of a vessel which is close-hauled on the starboard tack.

(c) When both are running free, with the wind on different sides, the vessel which has the wind on the port side shall keep out of the way of the other.

(d) When both are running free, with the wind on the same side, the vessel which is to windward shall keep out of the way of the vessel which is to leeward.

(e) A vessel which has the wind aft shall keep out of the way of the other vessel.

Art. 18. When two steam-vessels are meeting end on, or nearly end on, so as to involve risk of collision, each shall alter her course to starboard, so that each may pass on the port side of the other.

This Article only applies to cases where vessels are meeting end on, or nearly end on, in such a manner as to involve risk of collision, and does not apply to two vessels which must, if both keep on their respective courses, pass clear of each other.

The only cases to which it does apply are, when each of the two vessels is end on, or nearly end on, to the other; in other words, to cases in which, by day, each vessel sees the masts of the other in a line, or nearly in a line, with her own; and by night, to cases in which each vessel is in such a position as to see both the side lights of the other.

It does not apply, by day, to cases in which a vessel sees another ahead crossing her own course; or by night, to cases where the red light of one vessel is opposed to the red light of the other, or where the green light of one vessel is opposed to the green light of the other, or where a red light without a green light, or a green light without a red light, is seen ahead or where both green and red lights are seen anywhere but ahead.

Art. 19. When two steam-vessels are crossing, so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way of the other.

Art. 20. When a steam vessel and a sailing vessel are proceeding in such directions as to involve risk of collision, the steam-vessel shall keep out of the way of the sailing-vessel.

Art. 21. Where by any of these Rules one of two vessels is to keep out of the way, the other shall keep her course AND SPEED.

Art. 22. EVERY VESSEL WHICH IS DIRECTED BY THESE RULES TO KEEP OUT OF THE WAY OF ANOTHER VESSEL, SHALL, IF THE CIRCUMSTANCES OF THE CASE ADMIT, AVOID CROSSING AHEAD OF THE OTHER.

Art. 23. Every steam-vessel WHICH IS DIRECTED BY THESE RULES TO KEEP OUT OF THE WAY OF ANOTHER VESSEL shall, on approaching her, if necessary, slacken her speed or stop or reverse.

Art. 24. Notwithstanding anything contained in these Rules, every vessel overtaking any other, shall keep out of the way of the overtaken vessel.

EVERY VESSEL COMING UP WITH ANOTHER VESSEL FROM ANY DIRECTION MORE THAN 2 POINTS ABAFT HER BEAM, I.E., IN SUCH A POSITION WITH REFERENCE TO THE VESSEL WHICH SHE IS OVERTAKING, THAT AT NIGHT SHE WOULD BE UNABLE TO SEE EITHER OF THAT VESSEL'S SIDE-LIGHTS, SHALL BE DEEMED TO BE AN OVERTAKING VESSEL; AND NO SUBSEQUENT ALTERATION OF THE BEARING BETWEEN THE TWO VESSELS SHALL MAKE THE OVERTAKING VESSEL A CROSSING VESSEL WITHIN THE MEANING OF THESE RULES, OR RELIEVE HER OF THE DUTY OF KEEPING CLEAR OF THE OVERTAKEN VESSEL UNTIL SHE IS FINALLY PAST AND CLEAR.

AS BY DAY THE OVERTAKING VESSEL CANNOT ALWAYS KNOW WITH CERTAINTY WHETHER SHE IS FORWARD OF OR ABAFT THIS DIRECTION FROM THE OTHER VESSEL, SHE SHOULD, IF IN DOUBT, ASSUME THAT SHE IS AN OVERTAKING VESSEL, AND KEEP OUT OF THE WAY.

Art. 25. In narrow channels every steam vessel shall, when it is safe and practicable, keep to that side of the fairway or mid-channel which lies on the starboard side of such vessel.

Art. 26. SAILING VESSELS UNDER WAY SHALL KEEP OUT OF THE WAY OF SAILING VESSELS OR BOATS FISHING WITH NETS, OR LINES, OR TRAWLS. THIS RULE SHALL NOT GIVE TO ANY VESSEL OR BOAT ENGAGED IN FISHING THE RIGHT OF OBSTRUCTING A FAIR-WAY USED BY VESSELS OTHER THAN FISHING VESSELS OR BOATS.

Art. 27. In obeying and construing these Rules due regard shall be had to all dangers of navigation AND COLLISION, and to any special circumstances which may render a departure from the above Rules necessary in order to avoid immediate danger.

Sound Signals for Vessels in Sight of One Another

Art. 28. THE WORDS "SHORT BLAST," USED IN THIS ARTICLE, SHALL MEAN A BLAST OF ABOUT ONE SECOND'S DURATION,

When vessels are in sight of one another, a steam vessel under way, in taking any course authorised or required by these Rules, SHALL indicate that course by the following signals on her whistle, or SIREN, viz:-

One short blast to mean "I am directing my course to starboard,"

Two short blasts to mean "I am directing my course to port,"

Three short blasts to mean "MY ENGINES ARE going full speed astern."

No Vessel, under any Circumstances, to Neglect Proper Precautions

Art. 29. Nothing in these Rules shall exonerate any vessel, or the owner, or master, or crew thereof, from the consequences of any neglect to carry lights or signals, or of any neglect to keep a proper lookout, or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

Reservation of Rules for Harbours and Inland Navigation

Art. 30. Nothing in these Rules shall interfere with the operation of a special rule, duly made by local authority, relative to the navigation of any harbour, river, or inland WATERS.

Distress Signals

Art. 31. When a vessel is in distress and requires assistance from other vessels or from the shore, the following shall be the signals to be used or displayed by her either together or separately, viz:-

In the daytime -

1. A gun fired at intervals of about a minute;
2. The International Code Signal of distress indicated by NC;
3. The distant signal, consisting of a square flag, having either above or below it a ball or anything resembling a ball;
4. ROCKETS OR SHELLS AS PRESCRIBED BELOW FOR USE AT NIGHT;
5. A CONTINUOUS SOUNDING WITH ANY FOG SIGNAL APPARATUS.

At night -

1. A gun fired at intervals of about a minute;
2. Flames on the vessel (as from a burning tar barrel, oil barrel, etc.);
3. Rockets or shells, BURSTING IN THE AIR WITH A LOUD REPORT, AND throwing stars of any colour or description, fired one at a time, at short intervals;
4. A CONTINUOUS SOUNDING WITH ANY FOG SIGNAL APPARATUS.

(N) At the Court at Windsor, the 27th day of November, 1896.

PRESENT

The QUEEN's Most Excellent Majesty in Council

Whereas by Section four hundred and eighteen of "The Merchant Shipping Act, 1894," Her Majesty is empowered from time to time on the joint recommendation of the Admiralty and the Board of Trade by Order in Council to make Regulations for preventing Collisions at Sea:

And whereas by Section four hundred and thirty-four of the said Act Her Majesty is empowered from time to time by Order in Council to make rules as to signals of distress:

And whereas by an Order in Council dated the eleventh day of August, one thousand eight hundred and eighty-four, and expressed to be made in pursuance of "The Merchant Shipping Act Amendment Act, 1862," and on the joint recommendation of the Admiralty and the Board of Trade, Her Majesty was pleased to direct that, on and after the first day of September, one thousand eight hundred and eighty-four, the regulations contained in the Schedule thereto (being Regulations for preventing Collisions at Sea and as to Signals of Distress) should be substituted for the regulations contained in the First Schedule to an Order in Council made under the same Act and on such joint recommendations as aforesaid and dated the fourteenth day of August, one thousand eight hundred and seventy-nine:

And whereas the Admiralty and the Board of Trade have jointly recommended to Her Majesty that the Regulations for preventing Collisions at Sea contained in the Schedule to the said Order in Council dated the eleventh day of August, one thousand eight hundred and eighty-four, except the Article numbered ten in such Regulations, should, on and after the first day of July, one thousand eight hundred and ninety-seven, be annulled, and that the Regulations for preventing Collisions at Sea contained in Schedule I hereto annexed should, on and after the last-mentioned date, be substituted therefor, with the exception aforesaid, and come into operation as regards British ships and boats:

And whereas it has been made to appear to Her Majesty that it is expedient that the Regulations or Rules as to signals of distress contained in the Schedule to the said Order in Council dated the eleventh day of August, one thousand eight hundred and eighty-four, should, on and after the said first day of July, one thousand eight hundred and ninety-seven, be annulled and that the rules as to signals of distress contained in Schedule II hereto annexed should, on and after the last-mentioned date, be substituted therefor and come into operation as regards British ships and boats:

And whereas the provisions of Section one of "The Rules Publication Act, 1893," have been complied with:

Now, therefore, Her Majesty, by virtue of the power vested in Her by Section four hundred and eighteen of "The Merchant Shipping Act, 1894," and on the joint recommendation of the Admiralty and the Board of Trade, and by and with the advice of Her Privy Council, is pleased to direct that, on and after the first day of July, one thousand eight hundred and ninety-seven, the Regulations for preventing Collisions at Sea contained in the Schedule to the said Order in Council dated the eleventh day of August, one thousand eight hundred and eighty-four, except the Article numbered ten in such Regulations, shall be annulled and the Regulations for preventing Collisions at Sea contained in Schedule I hereto annexed shall be substituted therefor (with the exception aforesaid) and come into operation as regards British ships and boats:

And Her Majesty is further pleased, by virtue of the power vested in Her by Section four hundred and thirty-four of "The Merchant Shipping Act, 1894," and by and with the advice of Her Privy Council, to direct that, on and after the first day of July, one thousand eight hundred and ninety-seven, the Regulations or Rules as to signals of distress contained in the Schedule to the said Order in Council dated the eleventh day of August, one thousand eight hundred and eighty four, shall be annulled and the rules as to signals of distress contained in Schedule II hereto annexed shall be substituted therefor and come into operation as regards British ships and boats.

C.L. Peel

SCHEDULE I

Preliminary

These rules shall be followed by all vessels upon the high seas and in all waters connected therewith, navigable by sea-going vessels.

In the following rules every steam-vessel which is under sail and not under steam is to be considered a sailing vessel, and every vessel under steam, whether under sail or not, is to be considered a steam vessel.

The word "steam vessel" shall include any vessel propelled by machinery.

A vessel is "under way" within the meaning of these rules, when she is not at anchor, or made fast to the shore or aground.

Rules concerning Lights, &c.

The word "visible" in these rules, when applied to lights, shall mean visible on a dark night with a clear atmosphere.

Art. 1. The rules concerning lights shall be complied with in all weathers from sunset to sunrise, and during such time no other lights which may be mistaken for the prescribed lights shall be exhibited.

Art. 2. A steam vessel when under way shall carry -

(a) On or in front of the foremast, or if a vessel without a foremast, then in the fore part of the vessel, at a height above the hull of not less than twenty feet, and if the breadth of the vessel exceeds twenty feet, then at a height above the hull not less than such breadth, so, however, that the light need not be carried at a greater height above the hull than forty feet, a bright white light, so constructed as to show an unbroken light over an arc of the horizon of twenty points of the compass, so fixed as to throw the light ten points on each side of the vessel, viz., from right ahead to two points abaft the beam on either side, and of such a character as to be visible at a distance of at least five miles.

(b) On the starboard side a green light so constructed as to show an unbroken light over an arc of the horizon of ten points of the compass, so fixed as to throw the light from right ahead to two points abaft the beam on the starboard side, and of such a character as to be visible at a distance of at least two miles.

(c) On the port side a red light so constructed as to show an unbroken light over an arc of the horizon of ten points of the compass, so fixed as to throw the light from right ahead to two points abaft the beam on the port side, and of such a character as to be visible at a distance of at least two miles.

(d) The said green and red side-lights shall be fitted with inboard screens projecting at least three feet forward from the light, so as to prevent these lights from being seen across the bow.

(e) A steam vessel when under way may carry an additional white light similar in construction to the light mentioned in subdivision (a). These two lights shall be so placed in line with the keel that one shall be at least 15 feet higher than the other, and in such a position with reference to each other that the lower light shall be forward of the upper one. The vertical distance between these lights shall be less than the horizontal distance.

Art. 3. A steam vessel when towing another vessel shall, in addition to her side-lights, carry two bright white lights in a vertical line one over the other, not less than six feet apart, and when towing more than one vessel shall carry an additional bright white light six feet above or below such lights, if the length of the tow, measuring from the stern of the towing vessel to the stern of the last vessel towed, exceeds six hundred feet. Each of these lights shall be of the same construction and character, and shall be carried in the same position as the white light mentioned in Article 2(a), except the additional light, which may be carried at a height of not less than fourteen feet above the hull.

Such steam vessel may carry a small white light abaft the funnel or after-mast for the vessel towed to steer by, but such light shall not be visible forward of the beam.

Art. 4.(a) A vessel which from any accident is not under command shall carry at the same height as the white light mentioned in Article 2(a), where they can best be seen, and, if a steam vessel, in lieu of that light, two red lights, in a vertical line one over the other, not less than six feet apart, and of such a character as to be visible all round the horizon at a distance of at least two miles; and shall by day carry in a vertical line one over the other not less than six feet apart, where they can best be seen, two black balls or shapes each two feet in diameter.

(b) A vessel employed in laying or in picking up a telegraph cable shall carry in the same position as the white light mentioned in Article 2(a), and if a steam vessel, in lieu of that light, three lights in a vertical line one over the other, not less than six feet apart. The highest and lowest of these lights shall be red, and the middle light shall be white, and they shall be of such a character as to be visible all round the horizon, at a distance of at least two miles. By day she shall carry in a vertical line one over the other, not less than six feet apart, where they can best be seen, three shapes not less than two feet in diameter, of which the highest and lowest shall be globular in shape and red in colour, and the middle one diamond in shape and white.

(c) The vessels referred to in this Article when not making way through the water, shall not carry the side lights, but when making way shall carry them.

(d) The lights and shapes required to be shown by this Article are to be taken by other vessels as signals that the vessel showing them is not under command and cannot therefore get out of the way.

These signals are not signals of vessels in distress and requiring assistance. Such signals are contained in Article 31.

Art. 5. A sailing vessel under way, and any vessel being towed, shall carry the same lights as are prescribed by Article 2 for a steam vessel under way, with the exception of the white lights mentioned therein, which they shall never carry.

Art. 6. Whenever, as in the case of small vessels under way during bad weather, the green and red side-lights cannot be fixed, these lights shall be kept at hand lighted and ready for use; and shall, on the approach of or to other vessels, be exhibited on their respective sides in sufficient time to prevent collision, in such manner as to make them most visible, and so that the green light shall not be seen on the port side nor the red light on the starboard side, nor, if practicable, more than two points abaft the beam on their respective sides.

To make the use of these portable lights more certain and easy, the lanterns containing them shall each be painted outside with the colour of the light they respectively contain, and shall be provided with proper screens.

Art. 7. Steam vessels of less than forty, and vessels under oars or sails of less than twenty, tons gross tonnage, respectively, and rowing boats, when under way, shall not be obliged to carry the lights mentioned in Article 2(a)(b) and (c), but if they do not carry them they shall be provided with the following lights:-

1. Steam vessels of less than forty tons shall carry -

   (a) In the fore part of the vessel, or on or in front of the funnel, where it can best be seen, and at a height above the gunwale of not less than nine feet, a bright white light constructed and fixed as prescribed in Article 2(a), and of such a character as to be visible at a distance of at least two miles.

   (b) Green and red side-lights constructed and fixed as prescribed in Article 2(b) and (c), and of such a character as to be visible at a distance of at least one mile, or a combined lantern showing a green light and a red light from right ahead to two points abaft the beam on their respective sides. Such lantern shall be carried not less than three feet below the white light.

2. Small steamboats, such as are carried by sea-going vessels, may carry the white light at a less height than nine feet above the gunwale, but it shall be carried above the combined lantern, mentioned in sub-division 1(b).

3. Vessels under oars or sails, of less than twenty tons, shall have ready at hand a lantern with a green glass on one side and a red glass on the other, which, on the approach of or to other vessels, shall be exhibited in sufficient time to prevent collision, so that the green light shall not be seen on the port side, nor the red light on the starboard side.

4. Rowing-boats, whether under oars or sail, shall have ready at hand a lantern showing a white light, which shall be temporarily exhibited in sufficient time to prevent collision.

The vessels referred to in this Article shall not be obliged to carry the lights prescribed by Article 4(a), and Article 11, last paragraph.

Art. 8. Pilot vessels, when engaged on their station on pilotage duty shall not show the lights required for other vessels, but shall carry a white light at the masthead, visible all round the horizon, and shall also exhibit a flare-up light or flare-up lights at short intervals, which shall never exceed fifteen minutes.

On the near approach of or to other vessels they shall have their side-lights lighted, ready for use, and shall flash or show them at short intervals, to indicate the direction in which they are heading, but the green light shall not be shown on the port side, nor the red light on the starboard side.

A pilot-vessel of such a class as to be obliged to go alongside of a vessel to put a pilot on board, may show the white light instead of carrying it at the masthead, and may, instead of the coloured lights above mentioned, have at hand ready for use a lantern with a green glass on the one side and a red glass on the other, to be used as prescribed above.

Pilot-vessels, when not engaged on their station on pilotage duty, shall carry lights similar to those of other vessels of their tonnage.

Art. 9. *

Art. 10. A vessel which is being overtaken by another shall show from her stern to such last-mentioned vessel a white light or a flare-up light.

The white light required to be shown by this Article may be fixed and carried in a lantern, but in such case the lantern shall be so constructed, fitted, and screened that it shall throw an unbroken light over an arc of the horizon of twelve points of the compass, viz: for six points from right aft on each side of the vessel, so as to be visible at a distance of at least one mile. Such light shall be carried as nearly as practicable on the same level as the side-lights.

Art. 11. A vessel under one hundred and fifty feet in length, when at anchor, shall carry forward, where it can best be seen, but at a height not exceeding twenty feet above the hull, a white light in a lantern so constructed as to show a clear, uniform, and unbroken light visible all round the horizon at a distance of at least one mile.

A vessel of one hundred and fifty feet or upwards in length, when at anchor, shall carry in the forward part of the vessel, at a height of not less than twenty, and not exceeding forty, feet above the hull, one such light, and at or near the stern of the vessel, and at such a height that it shall be not less than fifteen feet lower than the forward light, another such light.

The length of a vessel shall be deemed to be the length appearing in her certificate of registry.

A vessel aground in or near a fairway shall carry the above light or lights and the two red lights prescribed by Article 4(a).

Art. 12. Every vessel may, if necessary in order to attract attention, in addition to the lights which she is by these Rules required to carry, show a flare-up light, or use any detonating signal that cannot be mistaken for a distress signal.

Art. 13. Nothing in these Rules shall interfere with the operation of any special rules made by the Government of any nation with respect to additional station and signal lights for two or more ships of war or for vessels sailing under convoy, or with the exhibition of recognition signals adopted by shipowners, which have been authorized by their respective Governments and duly registered and published.

Art. 14. A steam-vessel proceeding under sail only, but having her funnel up, shall carry in daytime, forward, where it can best be seen, one black ball or shape two feet in diameter.

Sound-Signals for Fog, &c

Art. 15. All signals prescribed by this Article for vessels under way shall be given -

1. By "steam-vessels," on the whistle or siren.

2. By "sailing-vessels and vessels towed," on the fog-horn.

The words "prolonged blast" used in this Article, shall mean a blast of from four to six seconds' duration.

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* This Article will deal with regulations affecting fishing-boats, and will be the subject of another Order, which will be submitted to Her Majesty for approval at a later date.

A steam-vessel shall be provided with an efficient whistle or siren, sounded by steam, or some substitute for steam, so placed that the sound may not be intercepted by any obstruction, and with an efficient fog-horn, to be sounded by mechanical means, and also with an efficient bell.* A sailing-vessel of twenty tons gross tonnage or upwards shall be provided with a similar fog-horn and bell.

In fog, mist, falling snow, or heavy rain-storms, whether by day or night, the signals described in this Article shall be used as follows, viz:-

(a) A steam-vessel having way upon her, shall sound, at intervals of not more than two minutes, a prolonged blast.

(b) A steam-vessel under way, but stopped and having no way upon her, shall sound, at intervals of not more than two minutes, two prolonged blasts, with an interval of about one second between them.

(c) A sailing-vessel under way shall sound, at intervals of not more than one minute, when on the starboard tack one blast, when on the port tack two blasts in succession, and when with the wind abaft the beam three blasts in succession.

(d) A vessel, when at anchor, shall, at intervals of not more than one minute, ring the bell rapidly for about five seconds.

(e) A vessel when towing, a vessel employed in laying or in picking up a telegraph-cable, and a vessel under way, which is unable to get out of the way of an approaching vessel through being not under command, or unable to manoeuvre as required by these Rules shall, instead of the signals prescribed in subdivisions (a) and (c) of this Article, at intervals of not more than two minutes, sound three blasts in succession, viz: one prolonged blast followed by two short blasts. A vessel towed may give this signal and she shall not give any other.

Sailing-vessels and boats of less than twenty tons gross tonnage shall not be obliged to give the above-mentioned signals, but if they do not, they shall make some other efficient sound-signal at intervals of not more than one minute.

Speed of Ships to be Moderate in Fog, &c.

Art. 16. Every vessel shall, in a fog, mist, falling snow, or heavy rain-storms, go at a moderate speed, having careful regard to the existing circumstances and conditions.

A steam-vessel hearing, apparently forward of her beam, the fog-signal of a vessel the position of which is not ascertained, shall, so far as the circumstances of the case admit, stop her engines, and then navigate with caution until danger of collision is over.

Steering and Sailing Rules

Preliminary - Risk of Collision

Risk of collision can, when circumstances permit, be ascertained by carefully watching the compass bearing of an approaching vessel. If the bearing does not appreciably change, such risk should be deemed to exist.

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* In all cases where the Rules require a bell to be used, a drum may be substituted on board Turkish vessels, or a gong where such articles are used on board small sea-going vessels.

Art. 17. When two sailing-vessels are approaching one another, so as to involve risk of collision, one of them shall keep out of the way of the other, as follows, viz:-

(a) A vessel which is running free shall keep out of the way of a vessel which is close hauled.

(b) A vessel which is close-hauled on the port tack shall keep out of the way of a vessel which is close-hauled on the starboard tack.

(c) When both are running free, with the wind on different sides, the vessel which has the wind on the port side shall keep out of the way of the other.

(d) When both are running free, with the wind on the same side, the vessel which is to windward shall keep out of the way of the vessel which is to leeward.

(e) A vessel which has the wind aft shall keep out of the way of the other vessel.

Art. 18. When two steam vessels are meeting end on, or nearly end on, so as to involve risk of collision, each shall alter her course to starboard, so that each may pass on the port side of the other.

This Article only applies to cases where vessels are meeting end on, or nearly end on, in such a manner as to involve risk of collision, and does not apply to two vessels which must, if both keep on their respective courses, pass clear of each other.

The only cases to which it does apply are when each of the two vessels is end on, or nearly end on, to the other; in other words, to cases in which, by day, each vessel sees the masts of the other in a line, or nearly in a line, with her own; and, by night, to cases in which each vessel is in such a position as to see both the side-lights of the other.

It does not apply, by day, to cases in which a vessel sees another ahead crossing her own course; or by night, to cases where the red light of one vessel is opposed to the red light of the other, or where the green light of one vessel is opposed to the green light of the other, or where a red light without a green light, or a green light without a red light, is seen ahead, or where both green and red lights are seen anywhere but ahead.

Art. 19. When two steam-vessels are crossing, so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way of the other.

Art. 20. When a steam-vessel and a sailing-vessel are proceeding in such directions as to involve risk of collision, the steam-vessel shall keep out of the way of the sailing-vessel.

Art. 21. Where by any of these Rules one of two vessels is to keep out of the way, the other shall keep her course and speed.

NOTE - When in consequence of thick weather or other causes, such vessel finds herself so close that collision cannot be avoided by the action of the giving-way vessel alone, she also shall take such action as will best aid to avert collision. (See Articles 27 and 29).

Art. 22. Every vessel which is directed by these Rules to keep out of the way of another vessel shall, if the circumstances of the case admit, avoid crossing ahead of the other.

Art. 23. Every steam-vessel which is directed by these Rules to keep out of the way of another vessel shall, on approaching her, if necessary, slacken her speed or stop or reverse.

Art. 24. Notwithstanding anything contained in these Rules, every vessel, overtaking any other, shall keep out of the way of the overtaken vessel.

Every vessel coming up with another vessel from any direction more than two points abaft her beam, i.e., in such a position, with reference to the vessel which she is overtaking, that at night she would be unable to see either of that vessel's side-lights, shall be deemed to be an overtaking vessel; and no subsequent alteration of the bearing between the two vessels shall make the overtaking vessel a crossing vessel within the meaning of these Rules, or relieve her of the duty of keeping clear of the overtaken vessel until she is finally past and clear.

As by day the overtaking vessel cannot always know with certainty whether she is forward of or abaft this direction from the other vessel, she should, if in doubt, assume that she is an overtaking vessel and keep out of the way.

Art. 25. In narrow channels every steam-vessel shall, when it is safe and practicable, keep to that side of the fair-way or mid-channel which lies on the starboard side of such vessel.

Art. 26. Sailing-vessels under way shall keep out of the way of sailing-vessels or boats fishing with nets, or lines, or trawls. This Rule shall not give to any vessel or boat engaged in fishing the right of obstructing a fairway used by vessels other than fishing-vessels or boats.

Art. 27. In obeying and construing these Rules, due regard shall be had to all dangers of navigation and collision, and to any special circumstances which may render a departure from the above Rules necessary in order to avoid immediate danger.

Sound Signals for Vessels in Sight of one Another

Art. 28. The words "short blast" used in this Article shall mean a blast of about one second's duration.

When vessels are in sight of one another, a steam vessel under way, in taking any course authorized or required by these Rules, shall indicate that course by the following signals on her whistle or siren, viz:-

One short blast to mean, "I am directing my course to starboard."

Two short blasts to mean, "I am directing my course to port."

Three short blasts to mean, "My engines are going full speed astern."

No Vessel under any Circumstances to neglect proper Precautions

Art. 29. Nothing in these Rules shall exonerate any vessel, or the owner, or master, or crew thereof, from the consequences of any neglect to carry lights or signals, or of any neglect to keep a proper look-out, or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

Reservation of Rules for Harbours and Inland Navigation

Art. 30. Nothing in these Rules shall interfere with the operation of a special rule, duly made by local authority, relative to the navigation of any harbour, river, or inland waters.

SCHEDULE II

Distress Signals

Art. 31. When a vessel is in distress and requires assistance from other vessels or from the shore, the following shall be the signals to be used or displayed by her, either together or separately; viz:-

In the daytime -

1. A gun or other explosive signal fired at intervals of about a minute;
2. The International Code signal of distress indicated by N C;
3. The distant signal, consisting of a square flag, having either above or below it a ball or anything resembling a ball;
4. A continuous sounding with any fog-signal apparatus.

At night -

1. A gun or other explosive signal fired at intervals of about a minute;
2. Flames on the vessel (as from a burning tar-barrel, oil-barrel, &c);
3. Rockets or shells, throwing stars of any colour or description, fired one at a time, at short intervals;
4. A continuous sounding with any fog-signal apparatus.

(O) Order in Council made on 13th October 1910.
Rules 8, 9 and 15 only. Otherwise identical with 1896 regulations.

ARTICLE 8. Pilot-vessels, when engaged on their station on pilotage duty, shall not show the lights required for other vessels, but shall carry a white light at the masthead visible all round the horizon, and shall also exhibit a flare-up light or flare-up lights at short intervals, which shall never exceed fifteen minutes.

On the near approach of or to other vessels they shall have their side-lights lighted, ready for use, and shall flash or show them at short intervals, to indicate the direction in which they are heading, but the green light shall not be shown on the port side, nor the red light on the starboard side.

A pilot-vessel of such a class as to be obliged to go alongside of a vessel to put a pilot on board, may show the white light instead of carrying it at the masthead, and may, instead of the coloured lights above mentioned, have at hand ready for use a lantern with a green glass on the one side and a red glass on the other, to be used as prescribed above.

A steam pilot-vessel exclusively employed for the service of pilots licensed or certified by any pilotage authority or the Committee of any pilotage district, when engaged on her station on pilotage duty and not at anchor, shall, in addition to the lights required for all pilot boats, carry at a distance of eight feet below her white masthead light a red light visible all round the horizon and of such a character as to be visible on a dark night with a clear atmosphere at a distance of at least two miles, and also the coloured side-lights required to be carried by vessels when under way.

When engaged on her station on pilotage duty and at anchor she shall carry, in addition to the lights required for all pilot boats, the red light above mentioned, but not the coloured side-lights.

Pilot-vessels, when not engaged on their station on pilotage duty, shall carry lights similar to those of other vessels of their tonnage.

ARTICLE 9*† Fishing-vessels and fishing-boats, when under way and when not required by this Article to carry or show the lights herein-after specified shall carry or show the lights prescribed for vessels of their tonnage under way.

(a) Open boats, by which it is to be understood boats not protected from the entry of sea water by means of a continuous deck, when engaged in any fishing at night with outlying tackle extending not more than 150 feet horizontally from the boat into the seaway, shall carry one all-round white-light.

Open boats, when fishing at night, with outlying tackle extending more than 150 feet horizontally from the boat into the seaway, shall carry one all round white light, and in addition, on approaching or being approached by other vessels, shall show a second white light at least 3 feet below the first light and at a horizontal distance of at least 5 feet away from it in the direction in which the outlying tackle is attached.

(b) ¢ Vessels and boats, except open boats as defined in sub-division (a), when fishing with drift-nets, shall, so long as the nets are wholly or partly in the water, carry two white lights where they can best be seen. Such lights shall be placed so that the vertical distance between them shall be not less than 6 feet and nor more than 15 feet, and so that the horizontal distance between them, measured in a line with the keel, shall be not less than 5 feet and not more than 10 feet. The lower of these two lights shall be in the direction of the nets, and both of them shall be of such a character as to show all round the horizon, and to be visible at a distance of not less than 3 miles.

Within the Mediterranean Sea and in the seas bordering the coasts of Japan and Korea ** sailing fishing vessels of less than 20 tons gross tonnage shall not be obliged to carry the lower of these two lights; should they, however, not carry it, they shall show in the same position (in the direction of the net or gear) a white light, visible at a distance of not less than one sea mile, on the approach of or to other vessels.

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* This article does not apply to Chinese or Siamese vessels.

† The expression "Mediterranean Sea" contained in sub-sections (b) and (c) of this Article includes the Black Sea and the other adjacent inland seas in communication with it.

¢ Dutch vessels and boats when engaged in the "kol," or hand-line fishing, will carry the lights prescribed for vessels fishing with drift nets.

** Also, as regards Russian vessels, in the seas (excluding the Baltic) bordering the coasts of Russia.

(c) Vessels and boats, except open boats as defined in sub-division (a), when line-fishing with their lines out and attached to or hauling their lines, and when not at anchor or stationary within the meaning of sub-division (h), shall carry the same lights as vessels fishing with drift-nets. When shooting lines, or fishing with towing lines, they shall carry the lights prescribed for a steam or sailing vessel under way respectively.

Within the Mediterranean Sea and in the seas bordering the coasts of Japan and Korea sailing fishing vessels of less than 20 tons gross tonnage shall not be obliged to carry the lower of these two lights; should they, however, not carry it, they shall show in the same position (in the direction of the lines) a white light, visible at a distance of not less than one sea mile on the approach of or to other vessels.

(d) Vessels, when engaged in trawling, by which is meant the dragging of an apparatus along the bottom of the sea -

1. If steam vessels, shall carry in the same position as the white light mentioned in Article 2(a) a tricoloured lantern so constructed and fixed as to show a white light from right ahead to two points on each bow, and a green light and a red light over an arc of the horizon from two points on each bow to two points abaft the beam on the starboard and port sides respectively; and not less than 6 nor more than 12 feet below the tricoloured lantern a white light in a lantern, so constructed as to show a clear uniform and unbroken light all round the horizon.

2. If sailing vessels, shall carry a white light in a lantern, so constructed as to show a clear uniform and unbroken light all round the horizon, and shall also, on the approach of or to other vessels, show, where it can best be seen a white flare-up light or torch in sufficient time to prevent collision

   All lights mentioned in sub-division (d) 1 and 2 shall be visible at at a distance of at least 2 miles.

(e) Oyster dredgers and other vessels fishing with dredge-nets shall carry and show the same lights as trawlers.

(f) Fishing-vessels and fishing-boats may at any time use a flare-up light in addition to the lights which they are by this Article required to carry and show, and they may also use working lights.

(g) Every fishing-vessel and every fishing-boat under 150 feet in length, when at anchor, shall exhibit a white light visible all round the horizon at a distance of at least one mile.

Every fishing-vessel of 150 feet in length or upwards, when at anchor, shall exhibit a white light visible all round the horizon at a distance of at least one mile, and shall exhibit a second light as provided for vessels of such length by Article 11.

Should any such vessel, whether under 150 feet in length, or of 150 feet in length or upwards, be attached to a net or other fishing gear, she shall on the approach of other vessels show an additional white light at least 3 feet below the anchor light, and at a horizontal distance of at least 5 feet away from it in the direction of the net or gear.

(h) If a vessel or boat when fishing becomes stationary in consequence of her gear getting fast to a rock or other obstruction, she shall in daytime haul down the day-signal required by sub-division (k); at night show the light or lights prescribed for a vessel at anchor; and during fog, mist, falling snow, or heavy rain-storms make the signal prescribed for a vessel at anchor. (See sub-division (d), and the last paragraph, of Article 15.)

(i) In fog, mist, falling snow, or heavy rain-storms, drift-net vessels attached to their nets, and vessels when trawling, dredging, or fishing with any kind of drag-net, and vessels line fishing with their lines out, shall, if of 20 tons gross tonnage or upwards, respectively, at intervals of not more than one minute make a blast; if steam vessels, with the whistle or siren, and if sailing vessels, with the fog-horn; each blast to be followed by ringing the bell. Fishing vessels and boats of less than 20 tons gross tonnage shall not be obliged to give the above-mentioned signals; but if they do not, they shall make some other efficient sound signal at intervals of not more than one minute.

(k) All vessels or boats fishing with nets or lines or trawls, when under way, shall in day-time indicate their occupation to an approaching vessel by displaying a basket or other efficient signal where it can best be seen. If vessels or boats at anchor have their gear out, they shall, on the approach of other vessels, show the same signal on the side on which those vessels can pass.

The vessels required by this Article to carry or show the lights herein-before specified shall not be obliged to carry the lights prescribed by Article 4(a) and the last paragraph of Article 11.

Sound-Signals for Fog, &c

ARTICLE 15. All signals prescribed by this Article for vessels under way shall be given:

1. By "steam vessels" on the whistle or siren.
2. By "sailing vessels and vessels towed" on the fog-horn.

The words "prolonged blast" used in this Article, shall mean a blast of from 4 to 6 seconds' duration.

A steam vessel shall be provided with an efficient whistle or siren, sounded by steam or some substitute for steam, so placed that the sound may not be interpreted by any obstruction, and with an efficient fog-horn, to be sounded by mechanical means, and also with an efficient bell.* A sailing vessel of 20 tons gross tonnage or upwards shall be provided with a similar fog-horn and bell.

In fog, mist, falling snow, or heavy rain-storms, whether by day or night, the signals described in this Article shall be used as follows, viz:-

(a) A steam vessel having way upon her, shall sound, at intervals of not more than 2 minutes, a prolonged blast.

(b) A steam vessel under way, but stopped and having no way upon her, shall sound, at intervals of not more than 2 minutes, 2 prolonged blasts, with an interval of about 1 second between them.

(c) A sailing vessel under way shall sound, at intervals of not more than 1 minute, when on the starboard tack one blast, when on the port tack two blasts in succession, and when with the wind abaft the beam three blasts in succession.

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* In all cases where the Rules require a bell to be used a drum may be substituted on board Turkish vessels, or a gong where such articles are used on board small sea-going vessels.

(d) A vessel, when at anchor, shall, at intervals of not more than 1 minute, ring the bell rapidly for about 5 seconds.

(e) A vessel when towing, a vessel employed in laying or in picking up a telegraph cable, and a vessel under way, which is unable to get out of the way of an approaching vessel through being not under command, or unable to manoeuvre as required by these rules shall, instead of the signals prescribed in sub-divisions (a) and (c) of this Article, at intervals of not more than 2 minutes, sound three blasts in succession, viz: one prolonged blast followed by two short blasts. A vessel towed may give this signal and she shall not give any other.

Sailing vessels and boats of less than 20 tons gross tonnage shall not be obliged to give the above-mentioned signals, but if they do not, they shall make some other efficient sound-signal at intervals of not more than 1 minute.*

(P) REGULATIONS FOR PREVENTING COLLISIONS AT SEA

London - 10th June, 1948

PART A - PRELIMINARY AND DEFINITIONS

Rule 1

(a) These Rules shall be followed by all vessels and seaplanes upon the high seas and in all waters connected therewith navigable by seagoing vessels, except as provided in Rule 30. Where, as a result of their special construction, it is not possible for seaplanes to comply fully with the provisions of Rules specifying the carrying of lights and shapes, these provisions shall be followed as closely as circumstances permit.

(b) The Rules concerning lights shall be complied with in all weathers from sunset to sunrise, and during such times no other lights shall be exhibited, except such lights as cannot be mistaken for the prescribed lights or impair their visibility or distinctive character, or interfere with the keeping of a proper look-out.

(c) In the following Rules, except where the context otherwise requires:-

(i) the word "vessel" includes every description of water craft, other than a seaplane on the water, used or capable of being used as a means of transportation on water;

(ii) the word "seaplane" includes a flying boat and any other aircraft designed to manoeuvre on the water;

(iii) the term "power-driven vessel" means any vessel propelled by machinery;

(iv) every power-driven vessel which is under sail and not under power is to be considered a sailing vessel, and every vessel under power, whether under sail or not, is to be considered a power-driven vessel;

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* Dutch steam pilot-vessels, when engaged on their station on pilotage duty in fog, mist, falling snow, or heavy rain-storms are required to make at intervals of 2 minutes at most one long blast with the siren, followed after 1 second by a long blast with the steam whistle and again after 1 second by a long blast on the siren. When not engaged on their station on pilotage duty, they make the same signals as other steamships.

(v) a vessel or seaplane on the water is "under way" when she is not at anchor, or made fast to the shore, or aground;

(vi) the term "height above the hull" means height above the uppermost continuous deck;

(vii) the length and breadth of a vessel shall be deemed to be the length and breadth appearing in her certificate of registry;

(viii) the length and span of a seaplane shall be its maximum length and span as shown in its certificate of airworthiness, or as determined by measurement in the absence of such certificate;

(ix) the word "visible," when applied to lights, means visible on a dark night with a clear atmosphere;

(x) the term "short blast" means a blast of about one second's duration;

(xi) the term "prolonged blast" means a blast of from four to six seconds' duration;

(xii) the word "whistle" means whistle or siren;

(xiii) the word "tons" means gross tons.

PART B - LIGHTS AND SHAPES

Rule 2

(a) A power-driven vessel when under way shall carry:-

(i) On or in front of the foremast, or if a vessel without a foremast then in the forepart of the vessel, a bright white light so constructed as to show an unbroken light over an arc of the horizon of 20 points of the compass (225 degrees), so fixed as to show the light 10 points (112½ degrees) on each side of the vessel, that is, from right ahead to 2 points (22½ degrees) abaft the beam on either side, and of such a character as to be visible at a distance of at least 5 miles.

(ii) Either forward of or abaft the white light mentioned in sub-section (i) a second white light similar in construction and character to that light. Vessels of less than 150 feet in length, and vessels engaged in towing, shall not be required to carry this second white light but may do so.

(iii) These two white lights shall be so placed in a line with and over the keel that one shall be at least 15 feet higher than the other and in such a position that the lower light shall be forward of the upper one. The horizontal distance between the two white lights shall be at least three times the vertical distance. The lower of these two white lights or, if only one is carried, then that light, shall be placed at a height above the hull of not less than 20 feet, and, if the breadth of the vessel exceeds 20 feet, then at a height above the hull not less than such breadth, so however that the light need not be placed at a greater height above the hull than 40 feet. In all circumstances the light or lights, as the case may be, shall be so placed as to be clear of and above all other lights and obstructing superstructures.

(iv) On the starboard side a green light so constructed as to show an unbroken light over an arc of the horizon of 10 points of the compass (112½ degrees), so fixed as to show the light from right ahead to 2 points (22½ degrees) abaft the beam on the starboard side, and of such a character as to be visible at a distance of at least 2 miles.

(v) On the port side a red light so constructed as to show an unbroken light over an arc of the horizon of 10 points of the compass (112½ degrees), so fixed as to show the light from right ahead to 2 points (22½ degrees) abaft the beam on the port side, and of such a character as to be visible at a distance of at least 2 miles.

(vi) The said green and red sidelights shall be fitted with inboard screens projecting at least 3 feet forward from the light, so as to prevent these lights from being seen across the bows.

(b) A sea plane under way on the water shall carry:-

(i) In the forepart amidships where it can best be seen a bright white light, so constructed as to show an unbroken light over an arc of the horizon of 220 degrees of the compass, so fixed as to show the light 110 degrees on each side of the seaplane, namely, from right ahead to 20 degrees abaft the beam on either side, and of such a character as to be visible at a distance of at least 3 miles.

(ii) On the right or starboard wing tip a green light, so constructed as to show an unbroken light over an arc of the horizon of 110 degrees of the compass, so fixed as to show the light from right ahead to 20 degrees abaft the beam on the starboard side, and of such a character as to be visible at a distance of at least 2 miles.

(iii) On the left or port wing tip a red light, so constructed as to show an unbroken light over an arc of the horizon of 110 degrees of the compass, so fixed as to show the light from right ahead to 20 degrees abaft the beam on the port side, and of such a character as to be visible at a distance of at least 2 miles.

Rule 3

(a) A power-driven vessel when towing or pushing another vessel shall, in addition to her sidelights, carry two bright white lights in a vertical line one over the other, not less than 6 feet apart, and when towing more than one vessel shall carry an additional bright white light 6 feet above or below such lights, if the length of the tow, measuring from the stern of the towing vessel to the stern of the last vessel towed, exceeds 600 feet. Each of these lights shall be of the same construction and character and one of them shall be carried in the same position as the white light mentioned in Rule 2(a)(i), except the additional light, which shall be carried at a height of not less than 14 feet above the hull. In a vessel with a single mast, such lights may be carried on the mast.

(b) The towing vessel shall also show either the stern light specified in Rule 10 or in lieu of that light a small white light abaft the funnel or aftermast for the tow to steer by, but such light shall not be visible forward of the beam. The carriage of the white light specified in Rule 2(a)(ii) is optional.

(c) A seaplane on the water, when towing one or more seaplanes or vessels, shall carry the lights prescribed in Rule 2(b)(i),(ii) and (iii); and, in addition, she shall carry a second white light of the same construction and character as the white light mentioned in Rule 2(b)(i), and in a vertical line at least 6 feet above or below such light.

Rule 4

(a) A vessel which is not under command shall carry, where they can best be seen, and, if a power-driven vessel, in lieu of the lights required by Rule 2(a)(i) and (ii), two red lights in a vertical line one over the other not less than 6 feet apart, and of such a character as to be visible all round the horizon at a distance of at least 2 miles. By day, she shall carry in a vertical line one over the other not less than 6 feet apart, where they can best be seen, two black balls or shapes each not less than 2 feet in diameter.

(b) A seaplane on the water which is not under command may carry, where they can best be seen, two red lights in a vertical line, one over the other, not less than 3 feet apart, and of such a character as to be visible all round the horizon at a distance of at least 2 miles, and may by day carry in a vertical line one over the other not less than 3 feet apart, where they can best be seen, two black balls or shapes, each not less than 2 feet in diameter.

(c) A vessel engaged in laying or in picking up a submarine cable or navigation mark, or a vessel engaged in surveying or underwater operations when from the nature of her work she is unable to get out of the way of approaching vessels, shall carry, in lieu of the lights specified in Rule 2(a)(i) and (ii), three lights in a vertical line one over the other not less than 6 feet apart. The highest and lowest of these lights shall be red, and the middle light shall be white, and they shall be of such a character as to be visible all round the horizon at a distance of at least 2 miles. By day, she shall carry in a vertical line one over the other not less than 6 feet apart, where they can best be seen, three shapes each not less than 2 feet in diameter, of which the highest and lowest shall be globular in shape and red in colour, and the middle one diamond in shape and white.

(d) The vessels and seaplanes referred to in this Rule, when not making way through the water, shall not carry the coloured sidelights, but when making way they shall carry them.

(e) The lights and shapes required to be shown by this Rule are to be taken by other vessels and seaplanes as signals that the vessel or seaplane showing them is not under command and cannot therefore get out of the way.

(f) These signals are not signals of vessels in distress and requiring assistance. Such signals are contained in Rule 31.

Rule 5

(a) A sailing vessel under way and any vessel or seaplane being towed shall carry the same lights as are prescribed in Rule 2 for a power-driven vessel or a seaplane under way, respectively, with the exception of the white lights specified therein, which they shall never carry. They shall also carry stern lights as specified in Rule 10, provided that vessels towed, except the last vessel of a tow, may carry, in lieu of such stern light, a small white light as specified in Rule 3(b).

(b) A vessel being pushed ahead shall carry, at the forward end, on the starboard side a green light and on the port side a red light, which shall have the same characteristics as the lights described in Rule 2(a)(iv) and (v) and shall be screened as provided in Rule 2(a)(vi), provided that any number of vessels pushed ahead in a group shall be lighted as one vessel.

Rule 6

(a) In small vessels, when it is not possible on account of bad weather or other sufficient cause to fix the green and red sidelights, these lights shall be kept at hand lighted and ready for immediate use, and shall, on the approach of or to other vessels, be exhibited on their respective sides in sufficient time to prevent collision, in such manner as to make them most visible, and so that the green light shall not be seen on the port side nor the red light on the starboard side, nor, if practicable, more than 2 points (22½ degrees) abaft the beam on their respective sides.

(b) To make the use of these portable lights more certain and easy, the lanterns containing them shall each be painted outside with the colour of the lights they respectively contain, and shall be provided with proper screens.

Rule 7

Power-driven vessels of less than 40 tons, vessels under oars or sails of less than 20 tons, and rowing boats, when under way shall not be required to carry the lights mentioned in Rule 2, but if they do not carry them they shall be provided with the following lights:-

(a) Power-driven vessels of less than 40 tons, except as provided in section (b) shall carry:-

(i) In the forepart of the vessel, where it can best be seen, and at a height above the gunwale of not less than 9 feet, a bright white light constructed and fixed as prescribed in Rule 2(a)(i) and of such a character as to be visible at a distance of at least 3 miles.

(ii) Green and red sidelights constructed and fixed as prescribed in Rule 2(a)(iv) and (v), and of such a character as to be visible at a distance of at least 1 mile, or a combined lantern showing a green light and a red light from right ahead to 2 points (22½ degrees) abaft the beam on their respective sides. Such lantern shall be carried not less than 3 feet below the white light.

(b) Small power-driven boats, such as are carried by seagoing vessels, may carry the white light at a less height than 9 feet above the gunwale, but it shall be carried above the sidelights or the combined lantern mentioned in sub-section (a)(ii).

(c) Vessels of less than 20 tons, under oars or sails, except as provided in section (d), shall, if they do not carry the sidelights, carry where it can best be seen a lantern showing a green light on one side and a red light on the other, of such a character as to be visible at a distance of at least 1 mile, and so fixed that the green light shall not be seen on the port side, nor the red light on the starboard side. Where it is not possible to fix this light, it shall be kept ready for immediate use and shall be exhibited in sufficient time to prevent collision and so that the green light shall not be seen on the port side nor the red light on the starboard side.

(d) Small rowing boats, whether under oars or sail, shall only be required to have ready at hand an electric torch or a lighted lantern showing a white light, which shall be exhibited in sufficient time to prevent collision.

(e) The vessels and boats referred to in this Rule shall not be required to carry the lights or shapes prescribed in Rules 4(a) and 11(e).

Rule 8

(a)(i) Sailing pilot-vessels, when engaged on their station on pilotage duty and not at anchor, shall not show the lights prescribed for other vessels, but shall carry a white light at the masthead visible all round the horizon at a distance of at least 3 miles, and shall also exhibit a flare-up light or flare-up lights at short intervals, which shall never exceed 10 minutes.

(ii) On the near approach of or to other vessels they shall have their sidelights lighted ready for use and shall flash or show them at short intervals, to indicate the direction in which they are heading, but the green light shall not be shown on the port side, nor the red light on the starboard side.

(iii) A sailing pilot-vessel of such a class as to be obliged to go alongside of a vessel to put a pilot on board may show the white light instead of carrying it at the masthead and may, instead of the sidelights above mentioned have at hand ready for use a lantern with a green glass on the one side and a red glass on the other to be used as prescribed above.

(b) A power-driven pilot-vessel when engaged on her station on pilotage duty and not at anchor shall, in addition to the lights and flares required for sailing pilot-vessels, carry at a distance of 8 feet below her white masthead light a red light visible all round the horizon at a distance of at least 3 miles and also the sidelights required to be carried by vessels when under way. A bright intermittent all round white light may be used in place of a flare.

(c) All pilot-vessels, when engaged on their stations on pilotage duty and at anchor, shall carry the lights and show the flares prescribed in sections (a) and (b), except that the sidelights shall not be shown. They shall also carry the anchor light or lights prescribed in Rule 11.

(d) All pilot-vessels, whether at anchor or not at anchor, shall, when not engaged on their stations on pilotage duty, carry the same lights as other vessels of their class and tonnage.

Rule 9

(a) Fishing vessels when not fishing shall show the lights or shapes prescribed for similar vessels of their tonnage. When fishing they shall show only the lights or shapes prescribed by this Rule, which lights or shapes, except as otherwise provided, shall be visible at a distance of at least 2 miles.

(b) Vessels fishing with trolling (towing) lines, shall show only the lights prescribed for a power-driven or sailing vessel under way as may be appropriate.

(c) Vessels fishing with nets or lines, except trolling (towing) lines, extending from the vessel not more than 500 feet horizontally into the seaway shall show, where it can best be seen, one all round white light and in addition, on approaching or being approached by another vessel, shall show a second white light at least 6 feet below the first light and at a horizontal distance of at least 10 feet away from it (6 feet in small open boats) in the direction in which the outlying gear is attached. By day such vessels shall indicate their occupation by displaying a basket where it can best be seen; and if they have their gear out while at anchor, they shall, on the approach of other vessels, show the same signal in the direction from the anchor ball towards the net or gear.

(d) Vessels fishing with nets or lines, except trolling (towing) lines, extending from the vessel more than 500 feet horizontally into the seaway shall show, where they can best be seen, three white lights at least 3 feet apart in a vertical triangle visible all round the horizon. When making way through the water, such vessels shall show the proper coloured sidelights but when not making way they shall not show them. By day they shall show a basket in the forepart of the vessel as near the stem as possible not less than 10 feet above the rail; and, in addition, where it can best be seen, one black conical shape, apex upwards. If they have their gear out while at anchor they shall, on the approach of other vessels, show the basket in the direction from the anchor ball towards the net or gear.

(e) Vessels when engaged in trawling, by which is meant the dragging of a dredge net or other apparatus along or near the bottom of the sea, and not at anchor:-

(i) If power-driven vessels, shall show in the same position as the white light mentioned in Rule 2(a)(i) a tricoloured lantern, so constructed and fixed as to show a white light from right ahead to 2 points (22½ degrees) on each bow, and a green light and a red light over an arc of the horizon from 2 points (22½ degrees) on each bow to 2 points (22½ degrees) abaft the beam on the starboard and port sides, respectively; and not less than 6 nor more than 12 feet below the tri-coloured lantern a white light in a lantern, so constructed as to show a clear, uniform, and unbroken light all round the horizon. They shall also show the stern light specified in Rule 10(a).

(ii) If sailing vessels, shall carry a white light in a lantern so constructed as to show a clear, uniform, and unbroken light all round the horizon, and shall also, on the approach of or to other vessels show, where it can best be seen, a white flare-up light in sufficient time to prevent collision.

(iii) By day, each of the foregoing vessels shall show, where it can best be seen a basket.

(f) In addition to the lights which they are by this Rule required to show vessels fishing may, if necessary in order to attract attention of approaching vessels, show a flare-up light. They may also use working lights.

(g) Every vessel fishing, when at anchor, shall show the lights or shape specified in Rule 11(a), (b) or (c); and shall, on the approach of another vessel or vessels, show an additional white light at least 6 feet below the forward anchor light and at a horizontal distance of at least 10 feet away from it in the direction of the outlying gear.

(h) If a vessel when fishing becomes fast by her gear to a rock or other obstruction she shall in daytime haul down the basket required by sections (c), (d) or (e) and show the signal specified in Rule 11(c). By night she shall show the light or lights specified in Rule 11(a) or (b). In fog, mist, falling snow, heavy rainstorms or any other condition similarly restricting visibility, whether by day or by night, she shall sound the signal prescribed by Rule 15(c)(v), which signal shall also be used, on the near approach of another vessel, in good visibility.

NOTE - For fog signals for fishing vessels, see Rule 15(c)(ix).

Rule 10

(a) A vessel when under way shall carry at her stern a white light, so constructed that it shall show an unbroken light over an arc of the horizon of 12 points of the compass (135 degrees), so fixed as to show the light 6 points (67½ degrees) from right aft on each side of the vessel, and of such a character as to be visible at a distance of at least 2 miles. Such light shall be carried as nearly as practicable on the same level as the sidelights.

NOTE - For vessels engaged in towing or being towed, see Rules 3(b) and 5.

(b) In a small vessel, if it is not possible on account of bad weather or other sufficient cause for this light to be fixed, an electric torch or a lighted lantern shall be kept at hand ready for use and shall, on the approach of an overtaking vessel, be shown in sufficient time to prevent collision.

(c) A seaplane on the water when under way shall carry on her tail a white light, so constructed as to show an unbroken light over an arc of the horizon of 140 degrees of the compass, so fixed as to show the light 70 degrees from right aft on each side of the seaplane, and of such a character as to be visible at a distance of at least 2 miles.

Rule 11

(a) A vessel under 150 feet in length, when at anchor, shall carry in the forepart of the vessel, where it can best be seen, a white light in a lantern so constructed as to show a clear, uniform, and unbroken light visible all round the horizon at a distance of at least 2 miles.

(b) A vessel of 150 feet or upwards in length, when at anchor, shall carry in the forepart of the vessel, at a height of not less than 20 feet above the hull, one such light, and at or near the stern of the vessel and at such a height that it shall be not less than 15 feet lower than the forward light, another such light. Both these lights shall be visible all round the horizon at a distance of at least 3 miles.

(c) Between sunrise and sunset every vessel when at anchor shall carry in the forepart of the vessel, where it can best be seen, one black ball not less than 2 feet in diameter.

(d) A vessel engaged in laying or in picking up a submarine cable or navigation mark, or a vessel engaged in surveying or underwater operations, when at anchor, shall carry the lights or shapes prescribed in Rule 4(c) in addition to those prescribed in the appropriate preceding sections of this Rule.

(e) A vessel aground shall carry by night the light or lights prescribed in sections (a) or (b) and the two red lights prescribed in Rule 4(a). By day she shall carry, where they can best be seen, three black balls, each not less than 2 feet in diameter, placed in a vertical line one over the other, not less than 6 feet apart.

(f) A seaplane on the water under 150 feet in length, when at anchor, shall carry, where it can best be seen, a white light, visible all round the horizon at a distance of at least 2 miles.

(g) A seaplane on the water 150 feet or upwards in length, when at anchor, shall carry, where they can best be seen, a white light forward and a white light aft, both lights visible all round the horizon at a distance of at least 3 miles; and, in addition, if the seaplane is more than 150 feet in span, a white light on each side to indicate the maximum span, and visible, so far as practicable, all round the horizon at a distance of 1 mile.

(h) A seaplane aground shall carry an anchor light or lights as prescribed in sections (f) and (g), and in addition may carry two red lights in a vertical line, at least 3 feet apart, so placed as to be visible all round the horizon.

Rule 12

Every vessel or seaplane on the water may, if necessary in order to attract attention, in addition to the lights which she is by these Rules required to carry, show a flare-up light or use a detonating or other efficient sound signal that cannot be mistaken for any signal authorised elsewhere under these Rules.

Rule 13

(a) Nothing in these Rules shall interfere with the operation of any special rules made by the Government of any nation with respect to additional station and signal lights for ships of war, for vessels sailing under convoy, or for seaplanes on the water; or with the exhibition of recognition signals adopted by shipowners, which have been authorised by their respective Governments and duly registered and published.

(b) Whenever the Government concerned shall have determined that a naval or other military vessel or waterborne seaplane of special construction or purpose cannot comply fully with the provisions of any of these Rules with respect to the number, position, range or arc of visibility of lights or shapes, without interfering with the military function of the vessel or seaplane, such vessel or seaplane shall comply with such other provisions in regard to the number, position, range or arc of visibility of lights or shapes as her Government shall have determined to be the closest possible compliance with these Rules in respect of that vessel or seaplane.

Rule 14

A vessel proceeding under sail, when also being propelled by machinery, shall carry in the daytime forward, where it can best be seen, one black conical shape, point upwards, not less than 2 feet in diameter at its base.

Rule 15

(a) A power-driven vessel shall be provided with an efficient whistle, sounded by steam or by some substitute for steam, so placed that the sound may not be intercepted by any obstruction, and with an efficient fog-horn, to be sounded by mechanical means, and also with an efficient bell. A sailing vessel of 20 tons or upwards shall be provided with a similar fog-horn and bell.

(b) All signals prescribed by this Rule for vessels under way shall be given:

(i) by power-driven vessels on the whistle;
(ii) by sailing vessels on the fog-horn;
(iii) by vessels towed on the whistle or fog-horn.

(c) In fog, mist, falling snow, heavy rainstorms, or any other condition similarly restricting visibility, whether by day or night, the signals prescribed in this Rule shall be used as follows:-

(i) A power-driven vessel making way through the water, shall sound at intervals of not more than 2 minutes a prolonged blast.

(ii) A power-driven vessel under way, but stopped and making no way through the water, shall sound at intervals of not more than 2 minutes two prolonged blasts, with an interval of about 1 second between them.

(iii) A sailing vessel under way shall sound, at intervals of not more than 1 minute, when on the starboard tack one blast, when on the port tack two blasts in succession, and when with the wind abaft the beam three blasts in succession.

(iv) A vessel when at anchor shall at intervals of not more than 1 minute ring the bell rapidly for about 5 seconds. In vessels of more than 350 feet in length the bell shall be sounded in the forepart of the vessel, and in addition there shall be sounded in the after part of the vessel, at intervals of not more than 1 minute for about 5 seconds, a gong or other instrument, the tone and sounding of which cannot be confused with that of the bell. Every vessel at anchor may in addition, in accordance with Rule 12, sound three blasts in succession, namely, one short, one prolonged, and one short blast, to give warning of her position and of the possibility of collision to an approaching vessel.

(v) A vessel when towing, a vessel engaged in laying or in picking up a submarine cable or navigation mark, and a vessel under way which is unable to get out of the way of an approaching vessel through being not under command or unable to manoeuvre as required by these Rules shall, instead of the signals prescribed in subsections (i),(ii) and (iii) sound, at intervals of not more than 1 minute, three blasts in succession, namely, one prolonged blast followed by two short blasts.

(vi) A vessel towed, or, if more than one vessel is towed, only the last vessel of the tow, if manned, shall, at intervals of not more than 1 minute, sound four blasts in succession, namely, one prolonged blast followed by three short blasts. When practicable, this signal shall be made immediately after the signal made by the towing vessel.

(vii) A vessel aground shall give the signal prescribed in sub-section (iv) and shall, in addition, give three separate and distinct strokes on the bell immediately before and after each such signal.

(viii) A vessel of less than 20 tons, a rowing boat, or a seaplane on the water, shall not be obliged to give the above-mentioned signals, but if she does not, she shall make some other efficient sound signal at intervals of not more than 1 minute.

(ix) A vessel when fishing, if of 20 tons or upwards, shall at intervals of not more than 1 minute, sound a blast, such blast to be followed by ringing the bell; or she may sound, in lieu of these signals, a blast consisting of a series of several alternative notes of higher and lower pitch.

Rule 16

Speed to be moderate in fog, &c.

(a) Every vessel, or seaplane when taxi-ing on the water, shall, in fog, mist, falling snow, heavy rainstorms or any other condition similarly restricting visibility, go at a moderate speed, having careful regard to the existing circumstances and conditions.

(b) A power-driven vessel hearing, apparently forward of her beam, the fog-signal of a vessel the position of which is not ascertained, shall, so far as the circumstances of the case admit, stop her engines, and then navigate with caution until danger of collision is over.

PART C - STEERING AND SAILING RULES

Preliminary

1. In obeying and construing these Rules, any action taken should be positive, in ample time, and with due regard to the observance of good seamanship.

2. Risk of collision can, when circumstances permit, be ascertained by carefully watching the compass bearing of an approaching vessel. If the bearing does not appreciably change, such risk should be deemed to exist.

3. Mariners should bear in mind that seaplanes in the act of landing or taking off, or operating under adverse weather conditions, may be unable to change their intended action at the last moment.

Rule 17

When two sailing vessels are approaching one another, so as to involve risk of collision, one of them shall keep out of the way of the other, as follows:-

(a) A vessel which is running free shall keep out of the way of a vessel which is close-hauled.
(b) A vessel which is close-hauled on the port tack shall keep out of the way of a vessel which is close-hauled on the starboard tack.
(c) When both are running free, with the wind on different sides, the vessel which has the wind on the port side shall keep out of the way of the other.
(d) When both are running free, with the wind on the same side, the vessel which is to windward shall keep out of the way of the vessel which is to leeward.
(e) A vessel which has the wind aft shall keep out of the way of the other vessel.

Rule 18

(a) When two power-driven vessels are meeting end on, or nearly end on, so as to involve risk of collision, each shall alter her course to starboard, so that each may pass on the port side of the other. This Rule only applies to cases where vessels are meeting end on, or nearly end on, in such a manner as to involve risk of collision, and does not apply to two vessels which must, if both keep on their respective courses, pass clear of each other. The only cases to which it does apply are when each of two vessels is end on, or nearly end on, to the other; in other words, to cases in which, by day, each vessel sees the masts of the other in a line, or nearly in a line, with her own; and by night, to cases in which each vessel is in such a position as to see both the sidelights of the other. It does not apply, by day, to cases in which a vessel sees another ahead crossing her own course; or, by night, to cases where the red light of one vessel is opposed to the red light of the other or where the green light of one vessel is opposed to the green light of the other or where a red light without a green light or a green light without a red light is seen ahead, or where both green and red lights are seen anywhere but ahead.

(b) For the purposes of this Rule and Rules 19 to 29 inclusive, except Rule 20(b), a seaplane on the water shall be deemed to be a vessel, and the expression "power-driven vessel" shall be construed accordingly.

Rule 19

When two power-driven vessels are crossing, so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way of the other.

Rule 20

(a) When a power-driven vessel and a sailing vessel are proceeding in such directions as to involve risk of collision, except as provided in Rules 24 and 26, the power-driven vessel shall keep out of the way of the sailing vessel.

(b) A seaplane on the water shall, in general, keep well clear of all vessels and avoid impeding their navigation. In circumstances, however, where risk of collision exists, she shall comply with these Rules.

Rule 21

Where by any of these Rules one of two vessels is to keep out of the way, the other shall keep her course and speed. When, from any cause, the latter vessel finds herself so close that collision cannot be avoided by the action of the giving-way vessel alone, she also shall take such action as will best aid to avert collision (see Rules 27 and 29).

Rule 22

Every vessel which is directed by these Rules to keep out of the way of another vessel shall, if the circumstances of the case admit, avoid crossing ahead of the other.

Rule 23

Every power-driven vessel which is directed by these Rules to keep out of the way of another vessel shall, on approaching her, if necessary, slacken her speed or stop or reverse.

Rule 24

(a) Notwithstanding anything contained in these Rules, every vessel overtaking any other shall keep out of the way of the overtaken vessel

(b) Every vessel coming up with another vessel from any direction more than 2 points (22½ degrees) abaft her beam, i.e. in such a position, with reference to the vessel which she is overtaking, that at night she would be unable to see either of that vessel's sidelights, shall be deemed to be an overtaking vessel; and no subsequent alteration of the bearing between the two vessels shall make the overtaking vessel a crossing vessel within the meaning of these Rules, or relieve her of the duty of keeping clear of the overtaken vessel until she is finally past and clear.

(c) If the overtaking vessel cannot determine with certainty whether she is forward of or abaft this direction from the other vessel, she shall assume that she is an overtaking vessel and keep out of the way.

Rule 25

(a) In a narrow channel every power-driven vessel when proceeding along the course of the channel shall, when it is safe and practicable, keep to that side of the fairway or mid-channel which lies on the starboard side of such vessel.

(b) Whenever a power-driven vessel is nearing a bend in a channel where a power-driven vessel approaching from the other direction cannot be seen, such vessel, when she shall have arrived within one-half mile of the bend, shall give a signal by one prolonged blast of her whistle, which signal shall be answered by a similar blast given by any approaching power-driven vessel that may be within hearing around the bend. Regardless of whether an approaching vessel on the farther side of the bend is heard, such bend shall be rounded with alertness and caution.

Rule 26

All vessels not engaged in fishing shall, when under way, keep out of the way of any vessels fishing with nets or lines or trawls. This Rule shall not give to any vessel engaged in fishing the right of obstructing a fairway used by vessels other than fishing vessels.

Rule 27

In obeying and construing these Rules due regard shall be had to all dangers of navigation and collision, and to any special circumstances, including the limitations of the craft involved, which may render a departure from the above Rules necessary in order to avoid immediate danger.

PART D - MISCELLANEOUS

Rule 28

(a) When vessels are in sight of one another, a power-driven vessel under way, in taking any course authorised or required by these Rules, shall indicate that course by the following signals on her whistle, namely:-

One short blast to mean "I am altering my course to starboard."
Two short blasts to mean "I am altering my course to port."
Three short blasts to mean "My engines are going astern."

(b) Whenever a power-driven vessel which, under these Rules, is to keep her course and speed, is in sight of another vessel and is in doubt whether sufficient action is being taken by the other vessel to avert collision, she may indicate such doubt by giving at least five short and rapid blasts on the whistle. The giving of such a signal shall not relieve a vessel of her obligations under Rules 27 and 29 or any other Rule, or of her duty to indicate any action taken under these Rules by giving the appropriate sound signals laid down in this Rule.

(c) Nothing in these Rules shall interfere with the operation of any special rules made by the Government of any nation with respect to the use of additional whistle signals between ships of war or vessels sailing under convoy.

Rule 29

Nothing in these Rules shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of any neglect to carry lights or signals, or of any neglect to keep a proper look-out, or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

Rule 30

Reservation of Rules for Harbours and Inland Navigation

Nothing in these Rules shall interfere with the operation of a special rule duly made by local authority relative to the navigation of any harbour, river, lake, or inland water, including a reserved seaplane area.

Rule 31

Distress Signals

When a vessel or seaplane on the water is in distress and requires assistance from other vessels or from the shore, the following shall be the signals to be used or displayed by her, either together or separately, namely:-

(a) A gun or other explosive signal fired at intervals of about a minute.

(b) A continuous sounding with any fog-signal apparatus.

(c) Rockets or shells, throwing red stars fired one at a time at short intervals.

(d) A signal made by radiotelegraphy or by any other signalling method consisting of the group •••---••• in the Morse Code.

(e) A signal sent by radiotelephony consisting of the spoken word "Mayday."

(f) The International Code Signal of distress indicated by N.C.

(g) A signal consisting of a square flag having above or below it a ball or anything resembling a ball.

(h) Flames on the vessel (as from a burning tar barrel, oil barrel, &c.).

(i) A rocket parachute flare showing a red light.

The use of any of the above signals, except for the purpose of indicating that a vessel or a seaplane is in distress, and the use of any signals which may be confused with any of the above signals, is prohibited.

NOTE - A radio signal has been provided for use by vessels in distress for the purpose of actuating the auto-alarms of other vessels and thus securing attention to distress calls or messages. The signal consists of a series of twelve dashes, sent in 1 minute, the duration of each dash being 4 seconds, and the duration of the interval between two consecutive dashes 1 second.

Rule 32

All orders to helmsmen shall be given in the following sense: right rudder or starboard to mean "put the vessel's rudder to starboard"; left rudder or port to mean "put the vessel's rudder to port."

(Q) INTERNATIONAL REGULATIONS FOR PREVENTING COLLISIONS AT SEA, 1960

At the invitation of the Inter-Governmental Maritime Consultative Organization, a Conference was held in London from May 17 to June 17, 1960, for the purpose of drawing up a Convention to replace the International Convention for the Safety of Life at Sea signed in London on June 10, 1948, as well as for the purpose of revising the International Regulations for Preventing Collisions at Sea, 1948.

The revised International Regulations for Preventing Collisions at Sea, which came into effect on September 1, 1965, are reproduced hereunder. Also reproduced are recommendations on the use of radar information as an aid to avoiding collisions at sea.

PART A - PRELIMINARY AND DEFINITIONS

Rule 1

(a) These Rules shall be followed by all vessels and seaplanes upon the high seas and in all waters connected therewith navigable by seagoing vessels, except as provided in Rule 30. Where, as a result of their special construction, it is not possible for seaplanes to comply fully with the provisions of Rules specifying the carrying of lights and shapes, these provisions shall be followed as closely as circumstances permit.

(b) The Rules concerning lights shall be complied with in all weathers from sunset to sunrise, and during such times no other lights shall be exhibited, except such lights as cannot be mistaken for the prescribed lights or do not impair their visibility or distinctive character, or interfere with the keeping of a proper look-out. The lights prescribed by these Rules may also be exhibited from sunrise to sunset in restricted visibility and in all other circumstances when it is deemed necessary.

(c) In the following Rules, except where the context otherwise requires:-

(i) the word "vessel" includes every description of water craft, other than a seaplane on the water, used or capable of being used as a means of transportation on water;

(ii) the word "seaplane" includes a flying boat and any other aircraft designed to manoeuvre on the water;

(iii) the term "power-driven vessel" means any vessel propelled by machinery;

(iv) every power-driven vessel which is under sail and not under power is to be considered a sailing vessel, and every vessel under power, whether under sail or not, is to be considered a power-driven vessel;

(v) a vessel or seaplane on the water is "under way" when she is not at anchor, or made fast to the shore, or aground;

(vi) the term "height above the hull" means height above the uppermost continuous deck;

(vii) the length and breadth of a vessel shall be her length overall and largest breadth;

(viii) the length and span of a seaplane shall be its maximum length and span as shown in its certificate of airworthiness, or as determined by measurement in the absence of such certificate;

(ix) vessels shall be deemed to be in sight of one another only when one can be observed visually from the other;

(x) the word "visible", when applied to lights, means visible on a dark night with a clear atmosphere;

(xi) the term "short blast" means a blast of about one second's duration;

(xii) the term "prolonged blast" means a blast of from four to six seconds' duration;

(xiii) the word "whistle" means any appliance capable of producing the prescribed short and prolonged blasts;

(xiv) the term "engaged in fishing" means fishing with nets, lines or trawls but does not include fishing with trolling lines.

PART B - LIGHTS AND SHAPES

Rule 2

(a) a Power-driven vessel when under way shall carry:-

(i) On or in front of the foremast, of if a vessel without a foremast then in the forepart of the vessel, a white light so constructed as to show an unbroken light over an arc of the horizon of 225 degrees (20 points of the compass), so fixed as to show the light 112½ degrees (10 points) on each side of the vessel, that is, from right ahead to 22½ degrees (2 points) abaft the beam on either side, and of such a character as to be visible at a distance of least 5 miles.

(ii) Either forward or abaft the white light prescribed in sub-section (i) a second white light similar in construction and character to that light. Vessels of less than 150 feet in length shall not be required to carry this second white light but may do so.

(iii) These two white lights shall be so placed in a line with and over the keel that one shall be at least 15 feet higher than the other and in such a position that the forward light shall always be shown lower than the after one. The horizontal distance between the two white lights shall be at least three times the vertical distance. The lower of these two white lights or, if only one is carried, then that light, shall be placed at a height above the hull of not less than 20 feet, and, if the breadth of the vessel exceeds 20 feet, then at a height above the hull not less than such breadth, so however that the light need not be placed at a greater height above the hull than 40 feet. In all circumstances the light or lights, as the case may be, shall be so placed as to be clear of and above all other lights and obstructing super-structures.

(iv) On the starboard side a green light so constructed as to show an unbroken light over an arc of the horizon of 112½ degrees (10 points of the compass), so fixed as to show the light from right ahead to 22½ degrees (2 points) abaft the beam on the starboard side, and of such a character as to be visible at a distance of at least 2 miles.

(v) On the port side a red light so constructed as to show an unbroken light over an arc of the horizon of 112½ degrees (10 points of the compass), so fixed as to show the light from right ahead to 22½ degrees (2 points) abaft the beam on the port side, and of such a character as to be visible at a distance of at least 2 miles.

(vi) The said green and red sidelights shall be fitted with inboard screens projecting at least 3 feet forward from the light, so as to prevent these lights from being seen across the bows.

(b) A seaplane under way on the water shall carry:-

(i) In the forepart amidships where it can best be seen a white light, so constructed as to show an unbroken light over an arc of the horizon of 220 degrees of the compass, so fixed as to show the light 110 degrees on each side of the seaplane, namely, from right ahead to 20 degrees abaft the beam on either side, and of such a character as to be visible at a distance of at least 3 miles.

(ii) On the right or starboard wing tip a green light, so constructed as to show an unbroken light over an arc of the horizon on 110 degrees of the compass, so fixed as to show the light from right ahead to 20 degrees abaft the beam on the starboard side, and of such a character as to be visible at a distance of at least 2 miles.

(iii) On the left or port wing tip a red light, so constructed as to show an unbroken light over an arc of the horizon of 110 degrees of the compass, so fixed as to show the light from right ahead to 20 degrees abaft the beam on the port side, and of such a character as to be visible at a distance of at least 2 miles.

Rule 3

(a) A power-driven vessel when towing or pushing another vessel or seaplane shall, in addition to her sidelights, carry two white lights in a vertical line one over the other, not less than 6 feet apart, and when towing and the length of the tow, measuring from the stern of the towing vessel to the stern of the last vessel towed, exceeds 600 feet, shall carry three white lights in a vertical line one over the other, so that the upper and lower lights shall be the same distance from, and not less than 6 feet above or below the middle light. Each of these lights shall be of the same construction and character and one of them shall be carried in the same position as the white light prescribed in Rule 2(a)(i). None of these lights shall be carried at a height of less than 14 feet above the hull. In a vessel with a single mast, such lights may be carried on the mast.

(b) The towing vessel shall also show either the stern light prescribed in Rule 10 or in lieu of that light a small white light abaft the funnel or after-mast for the tow to steer by, but such light shall not be visible forward of the beam.

(c) Between sunrise and sunset a power-driven vessel engaged in towing, if the length of tow exceeds 600 feet, shall carry, where it can best be seen, a black diamond shape at least 2 feet in diameter.

(d) A seaplane on the water, when towing one or more seaplanes or vessels, shall carry the lights prescribed in Rule 2(b)(i), (ii) and (iii); and, in addition, she shall carry a second white light of the same construction and character as the white light prescribed in Rule 2(b)(i), and in a vertical line at least 6 feet above or below such light.

Rule 4

(a) A vessel which is not under command shall carry, where they can best be seen, and, if a power-driven vessel, in lieu of the lights prescribed in Rule 2(a)(i) and (ii), two red lights in a vertical line one over the other not less than 6 feet apart, and of such a character as to be visible all round the horizon at a distance of at least 2 miles. By day, she shall carry in a vertical line one over the other not less than 6 feet apart, where they can best be seen, two black balls or shapes each not less than 2 feet in diameter.

(b) A seaplane on the water which is not under command may carry, where they can best be seen, and in lieu of the light prescribed in Rule 2(b)(i), two red lights in a vertical line, one over the other, not less than 3 feet apart, and of such a character as to be visible all round the horizon at a distance of at least 2 miles, and may by day carry in a vertical line one over the other not less than 3 feet apart, where they can best be seen, two black balls or shapes, each not less than 2 feet in diameter.

(c) A vessel engaged in laying or in picking up a submarine cable or navigation mark, or a vessel engaged in surveying or underwater operations, or a vessel engaged in replenishment at sea, or in the launching or recovery of aircraft when from the nature of her work she is unable to get out of the way of approaching vessels, shall carry, in lieu of the lights prescribed in Rule 2(a)(i) and (ii), or Rule 7(a)(i), three lights in a vertical line one over the other so that the upper and lower lights shall be the same distance from, and not less than 6 feet above or below, the middle light. The highest and lowest of these lights shall be red, and the middle light shall be white, and they shall be of such a character as to be visible all round the horizon at a distance of at least 2 miles. By day, she shall carry in a vertical line one over the other not less than 6 feet apart, where they can best be seen, three shapes each not less than 2 feet in diameter, of which the highest and lowest shall be globular in shape and red in colour, and the middle one diamond in shape and white.

(d)(i) A vessel engaged in minesweeping operations shall carry at the fore truck a green light, and at the end or ends of the fore yard on the side or sides on which danger exists, another such light or lights. These lights shall be carried in addition to the light prescribed in Rule 2(a)(i) or Rule 7(a)(i), as appropriate, and shall be of such a character as to be visible all round the horizon at a distance of at least 2 miles. By day she shall carry black balls, not less than 2 feet in diameter, in the same position as the green lights.

(ii) The showing of these lights or balls indicates that it is dangerous for other vessels to approach closer than 3,000 feet astern of the minesweeper or 1,500 feet on the side or sides on which danger exists.

(e) The vessels and seaplanes referred to in this Rule, when not making way through the water, shall show neither the coloured side-lights nor the stern light, but when making way they shall show them.

(f) The lights and shapes prescribed in this Rule are to be taken by other vessels and seaplanes as signals that the vessel or seaplane showing them is not under command and cannot therefore get out of the way.

(g) These signals are not signals of vessels in distress and requiring assistance. Such signals are contained in Rule 31.

Rule 5

(a) A sailing vessel under way and any vessel or seaplane being towed shall carry the same lights as are prescribed in Rule 2 for a power-driven vessel or a seaplane under way, respectively, with the exception of the white lights prescribed therein, which they shall never carry. They shall also carry stern lights as prescribed in Rule 10, provided that vessels towed, except the last vessel of a tow, may carry, in lieu of such stern light, a small white light as prescribed in Rule 3(b).

(b) In addition to the lights prescribed in section (a), a sailing vessel may carry on the top of the foremast two lights in a vertical line one over the other, sufficiently separated so as to be clearly distinguished. The upper light shall be red and the lower light shall be green. Both lights shall be constructed and fixed as prescribed in Rule 2(a)(i) and shall be visible at a distance of at least 2 miles.

(c) A vessel being pushed ahead shall carry, at the forward end, on the starboard side a green light and on the port side a red light, which shall have the same characteristics as the lights prescribed in Rule 2(a)(iv) and (v) and shall be screened as provided in Rule 2(a)(vi), provided that any number of vessels pushed ahead in a group shall be lighted as one vessel.

(d) Between sunrise and sunset a vessel being towed, if the length of the tow exceeds 600 feet, shall carry where it can best be seen a black diamond shape at least 2 feet in diameter.

Rule 6

(a) When it is not possible on account of bad weather or other sufficient cause to fix the green and red sidelights, these lights shall be kept at hand lighted and ready for immediate use, and shall, on the approach of or to other vessels, be exhibited on their respective sides in sufficient time to prevent collision, in such manner as to make them most visible, and so that the green light shall not be seen on the port side nor the red light on the starboard side, nor, if practicable, more than 22½ degrees (2 points) abaft the beam on their respective sides.

(b) To make the use of these portable lights more certain and easy, the lanterns containing them shall each be painted outside with the colour of the lights they respectively contain, and shall be provided with proper screens.

Rule 7

Power-driven vessels of less than 65 feet in length, vessels under oars or sails of less than 40 feet in length, and rowing boats, when under way shall not be required to carry the lights prescribed in Rules 2,3 and 5, but if they do not carry them they shall be provided with the following lights:-

(a) Power-driven vessels of less than 65 feet in length, except as provided in sections (b) and (c), shall carry:-

- (i) In the forepart of the vessel, where it can best be seen, and at a height above the gunwale of not less than 9 feet, a white light constructed and fixed as prescribed in Rule 2(a)(i) and of such a character as to be visible at a distance of at least 3 miles.
- (ii) Green and red sidelights constructed and fixed as prescribed in Rule 2(a)(iv) and (v), and of such a character as to be visible at a distance of at least 1 mile, or a combined lantern showing a green light and a red light from right ahead to 22½ degrees (2 points) abaft the beam on their respective sides. Such lantern shall be carried not less than 3 feet below the white light.

(b) Power-driven vessels of less than 65 feet in length when towing or pushing another vessel shall carry:-

- (i) In addition to the sidelights or the combined lantern prescribed in section (a)(ii) two white lights in a vertical line, one over the other not less than 4 feet apart. Each of these lights shall be of the same construction and character as the white light prescribed in section (a)(i) and one of them shall be carried in the same position. In a vessel with a single mast such lights may be carried on the mast.

(ii) Either a stern light as prescribed in Rule 10 or in lieu of that light a small white light abaft the funnel or aftermast for the tow to steer by, but such light shall not be visible forward of the beam.

(c) Power-driven vessels of less than 40 feet in length may carry the white light at a less height than 9 feet above the gunwale but it shall be carried not less than 3 feet above the sidelights or the combined lantern prescribed in section (a)(ii).

(d) Vessels of less than 40 feet in length, under oars or sails, except as provided in section (f), shall, if they do not carry the sidelights, carry, where they can best be seen, a lantern showing a green light on one side and a red light on the other, of such a character as to be visible at a distance of at least 1 mile, and so fixed that the green light shall not be seen on the port side, nor the red light on the starboard side. Where it is not possible to fix this light, it shall be kept ready for immediate use and shall be exhibited in sufficient time to prevent collision and so that the green light shall not be seen on the port side nor the red light on the starboard side.

(e) The vessels referred to in this Rule when being towed shall carry the sidelights or the combined lantern prescribed in sections (a) or (d) of this Rule, as appropriate, and a stern light as prescribed in Rule 10, or, except the last vessel of the tow, a small white light as prescribed in section (b)(ii). When being pushed ahead they shall carry at the forward end the sidelights or combined lantern prescribed in sections (a) or (d) of this Rule, as appropriate, provided that any number of vessels referred to in this Rule when pushed ahead in a group shall be lighted as one vessel under this Rule unless the overall length of the group exceeds 65 feet when the provisions of Rule 5(c) shall apply.

(f) Small rowing boats, whether under oars or sail, shall only be required to have ready at hand an electric torch or a lighted lantern, showing a white light which shall be exhibited in sufficient time to prevent collision.

(g) The vessels and boats referred to in this Rule shall not be required to carry the lights or shapes prescribed in Rules 4(a) and 11(e) and the size of their day signals may be less than is prescribed in Rules 4(c) and 11(c).

Rule 8

(a) A power-driven pilot-vessel when engaged on pilotage duty and under way:-

(i) Shall carry a white light at the masthead at a height of not less than 20 feet above the hull, visible all round the horizon at a distance of at least 3 miles and at a distance of 8 feet below it a red light similar in construction and character. If such a vessel is of less than 65 feet in length she may carry the white light at a height of not less than 9 feet above the gunwale and the red light at a distance of 4 feet below the white light.

(ii) Shall carry the sidelights or lanterns prescribed in Rule 2(a)(iv) and (v) or Rule 7(a)(ii) or (d), as appropriate, and the stern light prescribed in Rule 10.

(iii) Shall show one or more flare-up lights at intervals not exceeding 10 minutes. An intermittent white light visible all round the horizon may be used in lieu of flare-up lights.

(b) A sailing pilot-vessel when engaged on pilotage duty and under way:-

(i) Shall carry a white light at the masthead visible all round the horizon at a distance of at least 3 miles.

(ii) Shall be provided with the sidelights, or lantern prescribed in Rules 5(a) or 7(d), as appropriate, and shall, on the near approach of or to other vessels, have such lights ready for use, and shall show them at short intervals to indicate the direction in which she is heading, but the green light shall not be shown on the port side nor the red light on the starboard side. She shall also carry the stern light prescribed in Rule 10.

(iii) Shall show one or more flare-up lights at intervals not exceeding 10 minutes.

(c) A pilot-vessel when engaged on pilotage duty and not under way shall carry the lights and show the flares prescribed in sections (a)(i) and (iii) or (b)(i) and (iii), as appropriate, and if at anchor shall also carry the anchor lights prescribed in Rule 11.

(d) A pilot-vessel when not engaged on pilotage duty shall show the lights or shapes for a similar vessel of her length.

Rule 9

(a) Fishing vessels when not engaged in fishing shall show the lights or shapes for similar vessels of their length.

(b) Vessels engaged in fishing, when under way or at anchor, shall show only the lights and shapes prescribed in this Rule, which lights and shapes shall be visible at a distance of at least 2 miles.

(c)(i) Vessels when engaged in trawling, by which is meant the dragging of a dredge net or other apparatus through the water, shall carry two lights in a vertical line, one over the other, not less than 4 feet nor more than 12 feet apart. The upper of these lights shall be green and the lower light white and each shall be visible all round the horizon. The lower of these two lights shall be carried at a height above the sidelights not less than twice the distance between the two vertical lights.

(ii) Such vessels may in addition carry a white light similar in construction to the white light prescribed in Rule 2(a)(i) but such light shall be carried lower than and abaft the all-round green and white light.

(d) Vessels when engaged in fishing, except vessels engaged in trawling, shall carry the lights prescribed in section (c)(i) except that the upper of the two vertical lights shall be red. Such vessels if of less than 40 feet in length may carry the red light at a height of not less than 9 feet above the gunwale and the white light not less than 3 feet below the red light.

(e) Vessels referred to in sections (c) and (d), when making way through the water, shall carry the sidelights or lanterns prescribed in Rule 2(a)(iv) and (v) or Rule 7(a)(ii) or (d), as appropriate, and the stern light prescribed in Rule 10. When not making way through the water they shall show neither the sidelights nor the stern light.

(f) Vessels referred to in section (d) with outlying gear extending more than 500 feet horizontally into the seaway shall carry an additional all-round white light at a horizontal distance of not less than 6 feet nor more than 20 feet away from the vertical lights in the direction of the outlying gear. This additional white light shall be placed at a height not exceeding that of the white light prescribed in section (c)(i) and not lower than the sidelights.

(g) In addition to the lights which they are required by this Rule to carry, vessels engaged in fishing may, if necessary in order to attract the attention of an approaching vessel, use a flare-up light, or may direct the beam of their searchlight in the direction of a danger threatening the approaching vessel, in such a way as not to embarrass other vessels. They may also use working lights but fishermen shall take into account that specially bright or insufficiently screened working lights may impair the visibility and distinctive character of the lights prescribed in this Rule.

(h) By day vessels when engaged in fishing shall indicate their occupation by displaying where it can best be seen a black shape consisting of two cones each not less than 2 feet in diameter with their points together one above the other. Such vessels if of less than 65 feet in length may substitute a basket for such black shape. If their outlying gear extends more than 500 feet horizontally into the seaway vessels engaged in fishing shall display in addition one black conical shape, point upwards, in the direction of the outlying gear.

NOTE - Vessels fishing with trolling lines are not "engaged in fishing" as defined in Rule 1(c)(xiv).

Rule 10

(a) Except where otherwise provided in these Rules, a vessel when under way shall carry at her stern a white light, so constructed that it shall show an unbroken light over an arc of the horizon of 135 degrees (12 points of the compass), so fixed as to show the light 67½ degrees (6 points) from right aft on each side of the vessel, and of such a character as to be visible at a distance of at least 2 miles.

(b) In a small vessel, if it is not possible on account of bad weather or other sufficient cause for this light to be fixed, an electric torch or a lighted lantern showing a white light shall be kept at hand ready for use and shall, on the approach of an overtaking vessel, be shown in sufficient time to prevent collision.

(c) A seaplane on the water when under way shall carry on her tail a white light, so constructed as to show an unbroken light over an arc of the horizon of 140 degrees of the compass, so fixed as to show the light 70 degrees from right aft on each side of the seaplane, and of such a character as to be visible at a distance of at least 2 miles.

Rule 11

(a) A vessel of less than 150 feet in length, when at anchor, shall carry in the forepart of the vessel, where it can best be seen, a white light visible all round the horizon at a distance of at least 2 miles. Such a vessel may also carry a second white light in the position prescribed in section (b) of this Rule but shall not be required to do so. The second white light, if carried, shall be visible at a distance of at least 2 miles and so placed as to be as far as possible visible all round the horizon.

(b) A vessel of 150 feet or more in length, when at anchor, shall carry near the stem of the vessel, at a height of not less than 20 feet above the hull, one such light, and at or near the stern of the vessel and at such a height that it shall be not less than 15 feet lower than the forward light, another such light. Both these lights shall be visible at a distance of at least 3 miles and so placed as to be as far as possible visible all round the horizon.

(c) Between sunrise and sunset every vessel when at anchor shall carry in the forepart of the vessel, where it can best be seen, one black ball not less than 2 feet in diameter.

(d) A vessel engaged in laying or in picking up a submarine cable or navigation mark, or a vessel engaged in surveying or underwater operations, when at anchor, shall carry the lights or shapes prescribed in Rule 4(c) in addition to those prescribed in the appropriate preceding sections of this Rule.

(e) A vessel aground shall carry the light or lights prescribed in sections (a) or (b) and the two red lights prescribed in Rule 4(a). By day she shall carry, where they can best be seen, three black balls, each not less than 2 feet in diameter, placed in a vertical line one over the other, not less than 6 feet apart.

(f) A seaplane on the water under 150 feet in length, when at anchor, shall carry, where it can best be seen, a white light, visible all round the horizon at a distance of at least 2 miles.

(g) A seaplane on the water 150 feet or upwards in length, when at anchor, shall carry, where they can best be seen, a white light forward and a white light aft, both lights visible all round the horizon at a distance of at least 3 miles; and, in addition, if the seaplane is more than 150 feet in span, a white light on each side to indicate the maximum span, and visible, so far as practicable, all round the horizon at a distance of 1 mile.

(h) A seaplane aground shall carry an anchor light or lights as prescribed in sections (f) and (g), and in addition may carry two red lights in a vertical line, at least 3 feet apart, so placed as to be visible all round the horizon.

Rule 12

Every vessel or seaplane on the water may, if necessary in order to attract attention, in addition to the lights which she is by these Rules required to carry, show a flare-up light or use a detonating or other efficient sound signal that cannot be mistaken for any signal authorised elsewhere under these Rules.

Rule 13

(a) Nothing in these Rules shall interfere with the operation of any special rules made by the Government of any nation with respect to additional station and signal lights for ships of war, for vessels sailing under convoy, for fishing vessels engaged in fishing as a fleet or for seaplanes on the water.

(b) Whenever the Government concerned shall have determined that a naval or other military vessel or waterborne seaplane of special construction or purpose cannot comply fully with the provisions of any of these Rules with respect to the number, position, range or arc of visibility of lights or shapes, without interfering with the military function of the vessel or seaplane, such vessel or seaplane shall comply with such other provisions in regard to the number, position, range or arc of visibility of lights or shapes as her Government shall have determined to be the closest possible compliance with these Rules in respect of that vessel or seaplane.

Rule 14

A vessel proceeding under sail, when also being propelled by machinery, shall carry in the daytime forward, where it can best be seen, one black conical shape, point downwards, not less than 2 feet in diameter at its base.

PART C - SOUND SIGNALS AND CONDUCT IN RESTRICTED VISIBILITY

Preliminary

1. The possession of information obtained from radar does not relieve any vessel of the obligation of conforming strictly with the Rules and, in particular, the obligations contained in Rules 15 and 16.

2. The Annex to the Rules contains recommendations intended to assist in the use of radar as an aid to avoiding collision in restricted visibility.

Rule 15

(a) A power-driven vessel of 40 feet or more in length shall be provided with an efficient whistle, sounded by steam or by some substitute for steam, so placed that the sound may not be intercepted by any obstruction, and with an efficient fog horn to be sounded by mechanical means, and also with an efficient bell. A sailing vessel of 40 feet or more in length shall be provided with a similar fog horn and bell.

(b) All signals prescribed in this Rule for vessels under way shall be given:-

(i) by power-driven vessels on the whistle;
(ii) by sailing vessels on the fog horn;
(iii) by vessels towed on the whistle or fog horn.

(c) In fog, mist, falling snow, heavy rainstorms, or any other condition similarly restricting visibility, whether by day or night, the signals prescribed in this Rule shall be used as follows:-

(i) A power-driven vessel making way through the water shall sound at intervals of not more than 2 minutes a prolonged blast.

(ii) A power-driven vessel under way, but stopped and making no way through the water, shall sound at intervals of not more than 2 minutes two prolonged blasts, with an interval of about 1 second between them.

(iii) A sailing vessel under way shall sound, at intervals of not more than 1 minute, when on the starboard tack one blast, when on the port tack two blasts in succession, and when with the wind abaft the beam three blasts in succession.

(iv) A vessel when at anchor shall at intervals of not more than 1 minute ring the bell rapidly for about 5 seconds. In vessels of more than 350 feet in length the bell shall be sounded in the forepart of the vessel, and in addition there shall be sounded in the after part of the vessel, at intervals of not more than 1 minute for about 5 seconds, a gong or other instrument, the tone and sounding of which cannot be confused with that of the bell. Every vessel at anchor may in addition, in accordance with Rule 12, sound three blasts in succession, namely, one short, one prolonged, and one short blast, to give warning of her position and of the possibility of collision to an approaching vessel.

(v) A vessel when towing, a vessel engaged in laying or in picking up a submarine cable or navigation mark, and a vessel under way which is unable to get out of the way of an approaching vessel through being not under command or unable to manoeuvre as required by these Rules shall, instead of the signals prescribed in sub-sections (i), (ii), and (iii) sound, at intervals of not more than 1 minute, three blasts in succession, namely one prolonged blast followed by two short blasts.

(vi) A vessel towed, or, if more than one vessel is towed, only the last vessel of the tow, if manned, shall, at intervals of not more than 1 minute, sound four blasts in succession, namely, one prolonged blast followed by three short blasts. When practicable, this signal shall be made immediately after the signal made by the towing vessel.

(vii) A vessel aground shall give the bell signal and, if required, the gong signal, prescribed in sub-section (iv) and shall, in addition, give 3 separate and distinct strokes on the bell immediately before and after such rapid ringing of the bell.

(viii) A vessel engaged in fishing when under way or at anchor shall at intervals of not more than 1 minute sound the signal prescribed in sub-section (v). A vessel when fishing with trolling lines and under way shall sound the signals prescribed in sub-sections (i), (ii) or (iii) as may be appropriate.

(ix) A vessel of less than 40 feet in length, a rowing boat, or a seaplane on the water, shall not be obliged to give the above-mentioned signals but if she does not, she shall make some other efficient sound signal at intervals of not more than 1 minute.

(x) A power-driven pilot-vessel when engaged on pilotage duty may, in addition to the signals prescribed in sub-sections (i), (ii) and (iv), sound an identity signal consisting of 4 short blasts.

Rule 16

(a) Every vessel, or seaplane when taxi-ing on the water, shall, in fog, mist, falling snow, heavy rainstorms or any other condition similarly restricting visibility, go at a moderate speed having careful regard to the existing circumstances and conditions.

(b) A power-driven vessel hearing, apparently forward of her beam, the fog-signal of a vessel the position of which is not ascertained, shall, so far as the circumstances of the case admit, stop her engines, and then navigate with caution until danger of collision is over.

(c) A power-driven vessel which detects the presence of another vessel forward of her beam before hearing her fog signal or sighting her visually may take early and substantial action to avoid a close quarters situation but, if this cannot be avoided, she shall, so far as the circumstances of the case admit, stop her engines in proper time to avoid collision and then navigate with caution until danger of collision is over.

PART D - STEERING AND SAILING RULES

Preliminary

1. In obeying and construing these Rules, any action taken should be positive, in ample time, and with due regard to the observance of good seamanship.

2. Risk of collision can, when circumstances permit, be ascertained by carefully watching the compass bearing of an approaching vessel. If the bearing does not appreciably change, such risk should be deemed to exist.

3. Mariners should bear in mind that seaplanes in the act of landing or taking off, or operating under adverse weather conditions, may be unable to change their intended action at the last moment.

4. Rules 17 to 24 apply only to vessels in sight of one another.

Rule 17

(a) When two sailing vessels are approaching one another, so as to involve risk of collision, one of them shall keep out of the way of the other as follows:-

(i) When each has the wind on a different side, the vessel which has the wind on the port side shall keep out of the way of the other.

(ii) When both have the wind on the same side, the vessel which is to windward shall keep out of the way of the vessel which is to leeward.

(b) For the purposes of this Rule the windward side shall be deemed to be the side opposite to that on which the mainsail is carried or, in the case of a square-rigged vessel, the side opposite to that on which the largest fore-and-aft sail is carried.

Rule 18

(a) When two power-driven vessels are meeting end on, or nearly end on, so as to involve risk of collision, each shall alter her course to starboard, so that each may pass on the port side of the other. This Rule only applies to cases where vessels are meeting end on, or nearly end on, in such a manner as to involve risk of collision, and does not apply to two vessels which must, if both keep on their respective course, pass clear of each other. The only cases to which it does apply, are when each of two vessels is end on, or nearly end on, to the other; in other words, to cases in which, by day, each vessel sees the masts of the other in a line, or nearly in a line, with her own; and by night, to cases in which each vessel is in such a position as to see both the sidelights of the other. It does not apply, by day, to cases in which a vessel sees another ahead crossing her own course; or, by night, to cases where the red light of one vessel is opposed to the red light of the other or where the green light of one vessel is opposed to the green light of the other or where a red light without a green light or a green light without a red light is seen ahead, or where both green and red lights are seen anywhere but ahead.

(b) For the purposes of this Rule and Rules 19 to 29 inclusive, except Rule 20(c) and Rule 28, a seaplane on the water shall be deemed to be a vessel, and the expression "power-driven vessel" shall be construed accordingly.

Rule 19

When two power-driven vessels are crossing, so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way of the other.

Rule 20

(a) When a power-driven vessel and a sailing vessel are proceeding in such directions as to involve risk of collision, except as provided for in Rules 24 and 26, the power-driven vessel shall keep out of the way of the sailing vessel.

(b) This Rule shall not give to a sailing vessel the right to hamper, in a narrow channel, the safe passage of a power-driven vessel which can navigate only inside such channel.

(c) A seaplane on the water shall, in general, keep well clear of all vessels and avoid impeding their navigation. In circumstances, however, where risk of collision exists, she shall comply with these Rules.

Rule 21

Where by any of these Rules one of two vessels is to keep out of the way, the other shall keep her course and speed. When, from any cause, the latter vessel finds herself so close that collision cannot be avoided by the action of the giving-way vessel alone, she also shall take such action as will best avert collision (see Rules 27 and 29).

Rule 22

Every vessel which is directed by these Rules to keep out of the way of another vessel shall, so far as possible, take positive early action to comply with this obligation, and shall, if the circumstances of the case admit, avoid crossing ahead of the other.

Rule 23

Every power-driven vessel which is directed by these Rules to keep out of the way of another vessel shall, on approaching her, if necessary, slacken her speed or stop or reverse.

Rule 24

(a) Notwithstanding anything contained in these Rules, every vessel overtaking any other shall keep out of the way of the overtaken vessel.

(b) Every vessel coming up with another vessel from any direction more than 22½ degrees (2 points) abaft her beam, i.e., in such a position, with reference to the vessel which she is overtaking, that at night she would be unable to see either of that vessel's sidelights, shall be deemed to be an overtaking vessel; and no subsequent alteration of the bearing between the two vessels shall make the overtaking vessel a crossing vessel within the meaning of these Rules or relieve her of the duty of keeping clear of the overtaken vessel until she is finally past and clear.

(c) If the overtaking vessel cannot determine with certainty whether she is forward of or abaft this direction from the other vessel, she shall assume that she is an overtaking vessel and keep out of the way.

Rule 25

(a) In a narrow channel every power-driven vessel when proceeding along the course of the channel shall, when it is safe and practicable, keep to that side of the fairway or mid-channel which lies on the starboard side of such vessel.

(b) Whenever a power-driven vessel is nearing a bend in a channel where a vessel approaching from the other direction cannot be seen, such power-driven vessel, when she shall have arrived within one-half (½) mile of the bend, shall give a signal by one prolonged blast on her whistle which signal shall be answered by a similar blast given by any approaching power-driven vessel that may be within hearing around the bend. Regardless of whether an approaching vessel on the farther side of the bend is heard, such bend shall be rounded with alertness and caution.

(c) In a narrow channel a power-driven vessel of less than 65 feet in length shall not hamper the safe passage of a vessel which can navigate only inside such channel.

Rule 26

All vessels not engaged in fishing, except vessels to which the provisions of Rule 4 apply, shall, when under way, keep out of the way of vessels engaged in fishing. This Rule shall not give to any vessel engaged in fishing the right of obstructing a fairway used by vessels other than fishing vessels.

Rule 27

In obeying and construing these Rules due regard shall be had to all dangers of navigation and collision, and to any special circumstances, including the limitations of the craft involved, which may render a departure from the above Rules necessary in order to avoid immediate danger.

PART E - SOUND SIGNALS FOR VESSELS IN SIGHT OF ONE ANOTHER

Rule 28

(a) When vessels are in sight of one another, a power-driven vessel under way, in taking any course authorised or required by these Rules, shall indicate that course by the following signals on her whistle, namely:-

One short blast to mean "I am altering my course to starboard."
Two short blasts to mean "I am altering my course to port."
Three short blasts to mean "My engines are going astern."

(b) Whenever a power-driven vessel which, under these Rules, is to keep her course and speed, is in sight of another vessel and is in doubt whether sufficient action is being taken by the other vessel to avert collision, she may indicate such doubt by giving at least five short and rapid blasts on the whistle. The giving of such a signal shall not relieve a vessel of her obligations under Rules 27 and 29 or any other Rule, or of her duty to indicate any action taken under these Rules by giving the appropriate sound signals laid down in this Rule.

(c) Any whistle signal mentioned in this Rule may be further indicated by a visual signal consisting of a white light visible all round the horizon at a distance of at least 5 miles, and so devised that it will operate simultaneously and in conjunction with the whistle-sounding mechanism and remain lighted and visible during the same period as the sound signal.

(d) Nothing in these Rules shall interfere with the operation of any special rules made by the Government of any nation with respect to the use of additional whistle signals between ships of war or vessels sailing under convoy.

PART F - MISCELLANEOUS

Rule 29

Nothing in these Rules shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of any neglect to carry lights or signals, or of any neglect to keep a proper look-out, or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

Rule 30

Nothing in these Rules shall interfere with the operation of a special rule duly made by local authority relative to the navigation of any harbour, river, lake, or inland water, including a reserved seaplane area.

Rule 31

Distress Signals

(a) When a vessel or seaplane on the water is in distress and requires assistance from other vessels or from the shore, the following shall be the signals to be used or displayed by her, either together or separately, namely:-

(i) A gun or other explosive signal fired at intervals of about a minute.
(ii) A continuous sounding with any fog-signalling apparatus.
(iii) Rockets or shells, throwing red stars fired one at a time at short intervals.
(iv) A signal made by radiotelegraphy or by any other signalling method consisting of the group ···−−−··· in the Morse Code.
(v) A signal sent by radiotelephony consisting of the spoken word "Mayday".
(vi) The International Code Signal of distress indicated by N.C.
(vii) A signal consisting of a square flag having above or below it a ball or anything resembling a ball.
(viii) Flames on the vessel (as from a burning tar barrel, oil barrel &c).
(ix) A rocket parachute flare or a hand flare showing a red light.
(x) A smoke signal giving off a volume of orange-coloured smoke.
(xi) Slowly and repeatedly raising and lowering arms outstretched to each side.

NOTE - Vessels in distress may use the radiotelegraph alarm signal or the radiotelephone alarm signal to secure attention to distress calls and message. The radiotelegraph alarm signal, which is designed to actuate the radiotelegraph auto alarms of vessels so fitted, consists of a series of twelve dashes, sent in 1 minute, the duration of each dash being 4 seconds, and the duration of the interval between 2 consecutive dashes being 1 second. The radiotelephone alarm signal consists of 2 tones transmitted alternately over periods of from 30 seconds to 1 minute.

(b) The use of any of the foregoing signals, except for the purpose of indicating that a vessel or seaplane is in distress, and the use of any signals which may be confused with any of the above signals, is prohibited.

ANNEX TO THE RULES

Recommendations on the Use of Radar Information as an Aid to Avoiding Collisions at Sea.

(1) Assumptions made on scanty information may be dangerous and should be avoided.

(2) A vessel navigating with the aid of radar in restricted visibility must, in compliance with Rule 16(a), go at a moderate speed. Information obtained from the use of radar is one of the circumstances to be taken into account when determining moderate speed. In this regard it must be recognised that small vessels, small icebergs and similar floating objects may not be detected by radar. Radar indications of one or more vessels in the vicinity may mean that "moderate speed" should be slower than a mariner without radar might consider moderate in the circumstances.

(3) When navigating in restricted visibility the radar range and bearing alone do not constitute ascertainment of the position of the other vessel under Rule 16(b) sufficiently to relieve a vessel of the duty to stop her engines and navigate with caution when a for signal is heard forward of the beam.

(4) When action has been taken under Rule 16(c) to avoid a close quarters situation, it is essential to make sure that such action is having the desired effect. Alterations of course or speed or both are matters as to which the mariner must be guided by the circumstances of the case.

(5) Alteration of course alone may be the most effective action to avoid close quarters provided that:-

(a) There is sufficient sea room

(b) It is made in good time.

(c) It is substantial. A succession of small alterations of course should be avoided.

(d) It does not result in a close quarters situation with other vessels.

(6) The direction of an alteration of course is a matter in which the mariner must be guided by the circumstances of the case. An alteration to starboard, particularly when vessels are approaching apparently on opposite or nearly opposite courses, is generally preferable to an alteration to port.

(7) An alteration of speed, either alone or in conjunction with an alteration of course, should be substantial. A number of small alterations of speed should be avoided.

(8) If a close quarters situation is imminent, the most prudent action may be to take all way off the vessel.

(R)

INTERNATIONAL REGULATIONS FOR PREVENTING COLLISIONS AT SEA, 1972

PART A - GENERAL

Rule 1

Application

(a) These Rules shall apply to all vessels upon the high seas and in all waters connected therewith navigable by seagoing vessels.

(b) Nothing in these Rules shall interfere with the operation of special rules made by an appropriate authority for roadsteads, harbours, rivers, lakes or inland waterways connected with the high seas and navigable by seagoing vessels. Such special rules shall conform as closely as possible to these Rules.

(c) Nothing in these Rules shall interfere with the operation of any special rules made by the Government of any State with respect to additional station or signal lights or whistle signals for ships of war and vessels proceeding under convoy, or with respect to additional station or signal lights for fishing vessels engaged in fishing as a fleet. These additional station or signal lights or whistle signals shall, so far as possible, be such that they cannot be mistaken for any light or signal authorized elsewhere under these Rules.

(d) Traffic separation schemes may be adopted by the Organization for the purpose of these Rules.

(e) Whenever the Government concerned shall have determined that a vessel of special construction or purpose cannot comply fully with the provisions of any of these Rules with respect to the number, position, range or arc of visibility of lights or shapes, as well as to the disposition and characteristics of sound-signalling appliances, without interfering with the special function of the vessel, such vessel shall comply with such other provisions in regard to the number, position, range or arc of visibility of lights or shapes, as well as to the disposition and characteristics of sound-signalling appliances, as her Government shall have determined to be the closest possible compliance with these Rules in respect of that vessel.

Rule 2

Responsibility

(a) Nothing in these Rules shall exonerate any vessel, or the owner, master or crew thereof, from the consequences of any neglect to comply with these Rules or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

(b) In construing and complying with these Rules due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved which may make a departure from these Rules necessary to avoid immediate danger.

Rule 3

General Definitions

For the purpose of these Rules, except where the context otherwise requires:

(a) The word "vessel" includes every description of water craft, including non-displacement craft and seaplanes, used or capable of being used as a means of transportation on water.

(b) The term "power-driven vessel" means any vessel propelled by machinery.

(c) The term "sailing vessel" means any vessel under sail provided that propelling machinery, if fitted, is not being used.

(d) The term "vessel engaged in fishing" means any vessel fishing with nets, lines, trawls or other fishing apparatus which restrict manoeuvrability, but does not include a vessel fishing with trolling lines or other fishing apparatus which do not restrict manoeuvrability.

(e) The word "seaplane" includes any aircraft designed to manoeuvre on the water.

(f) The term "vessel not under command" means a vessel which through some exceptional circumstance is unable to manoeuvre as required by these Rules and is therefore unable to keep out of the way of another vessel.

(g) The term "vessel restricted in her ability to manoeuvre" means a vessel which from the nature of her work is restricted in her ability to manoeuvre as required by these Rules and is therefore unable to keep out of the way of another vessel.

The following vessels shall be regarded as vessels restricted in their ability to manoeuvre:

- (i) a vessel engaged in laying, servicing or picking up a navigation mark, submarine cable or pipeline;
- (ii) a vessel engaged in dredging, surveying or underwater operations;
- (iii) a vessel engaged in replenishment or transferring persons, provisions or cargo while underway;
- (iv) a vessel engaged in the launching or recovery of aircraft;
- (v) a vessel engaged in minesweeping operations;
- (vi) a vessel engaged in a towing operation such as renders her unable to deviate from her course.

(h) The term "vessel constrained by her draught" means a power-driven vessel which because of her draught in relation to the available depth of water is severely restricted in her ability to deviate from the course she is following.

(i) The word "underway" means that a vessel is not at anchor, or made fast to the shore, or aground.

(j) The words "length" and "breadth" of a vessel mean her length overall and greatest breadth.

(k) Vessels shall be deemed to be in sight of one another only when one can be observed visually from the other.

(l) The term "restricted visibility" means any condition in which visibility is restricted by fog, mist, falling snow, heavy rainstorms, sandstorms or any other similar causes.

PART B - STEERING AND SAILING RULES

SECTION I - CONDUCT OF VESSELS IN ANY CONDITION OF VISIBILITY

Rule 4

Application

Rules in this Section apply in any condition of visibility.

Rule 5

Look-out

Every vessel shall at all times maintain a proper look-out by sight and hearing as well as by all available means appropriate in the prevailing circumstances and conditions so as to make a full appraisal of the situation and of the risk of collision.

Rule 6

Safe Speed

Every vessel shall at all times proceed at a safe speed to that she can take proper and effective action to avoid collision and be stopped within a distance appropriate to the prevailing circumstances and conditions.

In determining a safe speed the following factors shall be among those taken into account:

(a) By all vessels:

- (i) the state of visibility;
- (ii) the traffic density including concentrations of fishing vessels or any other vessels;
- (iii) the manoeuvrability of the vessel with special reference to stopping distance and turning ability in the prevailing conditions;
- (iv) at night the presence of background light such as from shore lights or from back scatter of her own lights;
- (v) the state of wind, sea and current, and the proximity of navigational hazards;
- (vi) the draught in relation to the available depth of water.

(b) Additionally, by vessels with operational radar:

- (i) the characteristics, efficiency and limitations of the radar equipment;
- (ii) any constraints imposed by the radar range scale in use;
- (iii) the effect on radar detection of the sea state, weather and other sources of interference;
- (iv) the possibility that small vessels, ice and other floating objects may not be detected by radar at an adequate range;
- (v) the number, location and movement of vessels detected by radar;
- (vi) the more exact assessment of the visibility that may be possible when radar is used to determine the range of vessels or other objects in the vicinity.

Rule 7

Risk of Collision

(a) Every vessel shall use all available means appropriate to the prevailing circumstances and conditions to determine if risk of collision exists. If there is any doubt such risk shall be deemed to exist.

(b) Proper use shall be made of radar equipment if fitted and operational, including long-range scanning to obtain early warning of risk of collision and radar plotting or equivalent systematic observation of detected objects.

(c) Assumptions shall not be made on the basis of scanty information, especially scanty radar information.

(d) In determining if risk of collision exists the following considerations shall be among those taken into account:

(i) such risk shall be deemed to exist if the compass bearing of an approaching vessel does not appreciably change;

(ii) such risk may sometimes exist even when an appreciable bearing change is evident, particularly when approaching a very large vessel or a tow or when approaching a vessel at close range.

Rule 8

Action to avoid Collision

(a) Any action taken to avoid collision shall, if the circumstances of the case admit, be positive, made in ample time and with due regard to the observance of good seamanship.

(b) Any alteration of course and/or speed to avoid collision shall, if the circumstances of the case admit, be large enough to be readily apparent to another vessel observing visually or by radar; a succession of small alterations of course and/or speed should be avoided.

(c) If there is sufficient sea room, alteration of course alone may be the most effective action to avoid a close-quarters situation provided that it is made in good time, is substantial and does not result in another close-quarters situation.

(d) Action taken to avoid collision with another vessel shall be such as to result in passing at a safe distance. The effectiveness of the action shall be carefully checked until the other vessel is finally past and clear.

(e) If necessary to avoid collision or allow more time to assess the situation, a vessel shall slacken her speed or take all way off by stopping or reversing her means of propulsion.

Rule 9

Narrow Channels

(a) A vessel proceeding along the course of a narrow channel or fairway shall keep as near to the outer limit of the channel or fairway which lies on her starboard side as is safe and practicable.

(b) A vessel of less than 20 metres in length or a sailing vessel shall not impede the passage of a vessel which can safely navigate only within a narrow channel or fairway.

(c) A vessel engaged in fishing shall not impede the passage of any other vessel navigating within a narrow channel or fairway.

(d) A vessel shall not cross a narrow channel or fairway if such crossing impedes the passage of a vessel which can safely navigate only within such channel or fairway. The latter vessel may use the sound signal prescribed in Rule 34(d) if in doubt as to the intention of the crossing vessel.

(e) (i) In a narrow channel or fairway when overtaking can take place only if the vessel to be overtaken has to take action to permit safe passing, the vessel intending to overtake shall indicate her intention by sounding the appropriate signal prescribed in Rule 34(c)(i). The vessel to be overtaken shall, if in agreement, sound the appropriate signal prescribed in Rule 34(c)(ii) and take steps to permit safe passing. If in doubt she may sound the signals prescribed in Rule 34(d).

(ii) This Rule does not relieve the overtaking vessel of her obligation under Rule 13.

(f) A vessel nearing a bend or an area of a narrow channel or fairway where other vessels may be obscured by an intervening obstruction shall navigate with particular alertness and caution and shall sound the appropriate signal prescribed in Rule 34(e).

(g) Any vessel shall, if the circumstances of the case admit, avoid anchoring in a narrow channel.

Rule 10

Traffic Separation Schemes

(a) This Rule applies to traffic separation schemes adopted by the Organization.

(b) A vessel using a traffic separation scheme shall:

(i) proceed in the appropriate traffic lane in the general direction of traffic flow for that lane;

(ii) so far as practicable keep clear of a traffic separation line or separation zone;

(iii) normally join or leave a traffic lane at the termination of the lane, but when joining or leaving from the side shall do so at as small an angle to the general direction of traffic flow as practicable.

(c) A vessel shall so far as practicable avoid crossing traffic lanes, but if obliged to do so shall cross as nearly as practicable at right angles to the general direction of traffic flow.

(d) Inshore traffic zones shall not normally be used by through traffic which can safely use the appropriate traffic lane within the adjacent traffic separation scheme.

(e) A vessel, other than a crossing vessel, shall not normally enter a separation zone or cross a separation line except:

(i) in cases of emergency to avoid immediate danger;

(ii) to engage in fishing within a separation zone.

(f) A vessel navigating in areas near the termination of traffic separation schemes shall do so with particular caution.

(g) A vessel shall so far as practicable avoid anchoring in a traffic separation scheme or in areas near its terminations.

(h) A vessel not using a traffic separation scheme shall avoid it by as wide a margin as is practicable.

(i) A vessel engaged in fishing shall not impede the passage of any vessel following a traffic lane.

(j) A vessel of less than 20 metres in length or a sailing vessel shall not impede the safe passage of a power-driven vessel following a traffic lane.

SECTION II - CONDUCT OF VESSELS IN SIGHT OF ONE ANOTHER

Rule 11

Application

Rules in this Section apply to vessels in sight of one another.

Rule 12

Sailing Vessels

(a) When two sailing vessels are approaching one another, so as to involve risk of collision, one of them shall keep out of the way of the other as follows:

- (i) when each has the wind on a different side, the vessel which has the wind on the port side shall keep out of the way of the other;
- (ii) when both have the wind on the same side, the vessel which is to windward shall keep out of the way of the vessel which is to leeward;
- (iii) if a vessel with the wind on the port side sees a vessel to windward and cannot determine with certainty whether the other vessel has the wind on the port or on the starboard side, she shall keep out of the way of the other.

(b) For the purposes of this Rule the windward side shall be deemed to be the side opposite to that on which the mainsail is carried or, in the case of a square-rigged vessel, the side opposite to that on which the largest fore-and-aft sail is carried.

Rule 13

Overtaking

(a) Notwithstanding anything contained in the Rules of this Section any vessel overtaking any other shall keep out of the way of the vessel being overtaken.

(b) A vessel shall be deemed to be overtaking when coming up with another vessel from a direction more than 22.5 degrees abaft her beam, that is, in such a position with reference to the vessel she is overtaking, that at night she would be able to see only the sternlight of that vessel but neither of her sidelights.

(c) When a vessel is in any doubt as to whether she is overtaking another, she shall assume that this is the case and act accordingly.

(d) Any subsequent alteration of the bearing between the two vessels shall not make the overtaking vessel a crossing vessel within the meaning of these Rules or relieve her of the duty of keeping clear of the overtaken vessel until she is finally past and clear.

Rule 14

Head-on Situation

(a) When two power-driven vessels are meeting on reciprocal or nearly reciprocal courses so as to involve risk of collision each shall alter her course to starboard so that each shall pass on the port side of the other.

(b) Such a situation shall be deemed to exist when a vessel sees the other ahead or nearly ahead and by night she could see the masthead lights of the other in a line or nearly in a line and /or both sidelights and by day she observes the corresponding aspect of the other vessel.

(c) When a vessel is in any doubt as to whether such a situation exists she shall assume that it does exist and act accordingly.

Rule 15

Crossing Situation

When two power-driven vessels are crossing so as to involve risk of collision, the vessel which has the other on her own starboard side shall keep out of the way and shall, if the circumstances of the case admit, avoid crossing ahead of the other vessel.

Rule 16

Action by Give-way Vessel

Every vessel which is directed by these Rules to keep out of the way of another vessel shall, so far as possible, take early and substantial action to keep well clear.

Rule 17

Action by Stand-on Vessel

(a) (i) Where by any of these Rules one of two vessels is to keep out of the way the other shall keep her course and speed.

(ii) The latter vessel may however take action to avoid collision by her manoeuvre alone, as soon as it becomes apparent to her that the vessel required to keep out of the way is not taking appropriate action in compliance with these Rules.

(b) When, from any cause, the vessel required to keep her course and speed finds herself so close that collision cannot be avoided by the action of the give-way vessel alone, she shall take such action as will best aid to avoid collision.

(c) A power-driven vessel which takes action in a crossing situation in accordance with sub-paragraph (a)(ii) of this Rule to avoid collision with another power-driven vessel shall, if the circumstances of the case admit, not alter course to port for a vessel on her own port side.

(d) This Rule does not relieve the give-way vessel of her obligation to keep out of the way.

Rule 18

Responsibilities between Vessels

Except where Rules 9, 10 and 13 otherwise require:

(a) A power-driven vessel underway shall keep out of the way of:

(i) a vessel not under command;
(ii) a vessel restricted in her ability to manoeuvre;
(iii) a vessel engaged in fishing;
(iv) a sailing vessel.

(b) A sailing vessel underway shall keep out of the way of:

(i) a vessel not under command;
(ii) a vessel restricted in her ability to manoeuvre;
(iii) a vessel engaged in fishing.

(c) A vessel engaged in fishing when underway shall, so far as possible, keep out of the way of:

(i) a vessel not under command;
(ii) a vessel restricted in her ability to manoeuvre.

(d) (i) Any vessel other than a vessel not under command or a vessel restricted in her ability to manoeuvre shall, if the circumstances of the case admit, avoid impeding the safe passage of a vessel constrained by her draught, exhibiting the signals in Rule 28.

(ii) A vessel constrained by her draught shall navigate with particular caution having full regard to her special condition.

(e) A seaplane on the water shall, in general, keep well clear of all vessels and avoid impeding their navigation. In circumstances, however, where risk of collision exists, she shall comply with the Rules of this Part.

SECTION III - CONDUCT OF VESSELS IN RESTRICTED VISIBILITY

Rule 19

Conduct of Vessels in Restricted Visibility

(a) This Rule applies to vessels not in sight of one another when navigating in or near an area of restricted visibility.

(b) Every vessel shall proceed at a safe speed adapted to the prevailing circumstances and conditions of restricted visibility. A power-driven vessel shall have her engines ready for immediate manoeuvre.

(c) Every vessel shall have due regard to the prevailing circumstances and conditions of restricted visibility when complying with the Rules of Section I of this Part.

(d) A vessel which detects by radar alone the presence of another vessel shall determine if a close-quarters situation is developing and/or risk of collision exists. If so, she shall take avoiding action in ample time, provided that when such action consists of an alteration of course, so far as possible the following shall be avoided:

(i) an alteration of course to port for a vessel forward of the beam, other than for a vessel being overtaken;

(ii) an alteration of course towards a vessel abeam or abaft the beam.

(e) Except where it has been determined that a risk of collision does not exist, every vessel which hears apparently forward of her beam the fog signal of another vessel, or which cannot avoid a close-quarters situation with another vessel forward of her beam, shall reduce her speed to the minimum at which she can be kept on her course. She shall if necessary take all her way off and in any event navigate with extreme caution until danger of collision is over.

PART C - LIGHTS AND SHAPES

Rule 20

Application

(a) Rules in this Part shall be complied with in all weathers.

(b) The Rules concerning lights shall be complied with from sunset to sunrise, and during such times no other lights shall be exhibited, except such lights as cannot be mistaken for the lights specified in these Rules or do not impair their visibility or distinctive character, or interfere with the keeping of a proper look-out.

(c) The lights prescribed by these Rules shall, if carried, also be exhibited from sunrise to sunset in restricted visibility and may be exhibited in all other circumstances when it is deemed necessary.

(d) The Rules concerning shapes shall be complied with by day.

(e) The lights and shapes specified in these Rules shall comply with the provisions of Annex 1 to these Regulations.

Rule 21

Definitions

(a) "Masthead light" means a white light placed over the fore and aft centreline of the vessel showing an unbroken light over an arc of the horizon of 225 degrees and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on either side of the vessel.

(b) "Sidelights" means a green light on the starboard side and a red light on the port side each showing an unbroken light over an arc of the horizon of 112.5 degrees and so fixed as to show the light from right ahead to 22.5 degrees abaft the beam on its respective side. In a vessel of less than 20 metres in length the sidelights may be combined in one lantern carried on the fore and aft centreline of the vessel.

(c) "Sternlight" means a white light placed as nearly as practicable at the stern showing an unbroken light over an arc of the horizon of 135 degrees and so fixed as to show the light 67.5 degrees from right aft on each side of the vessel.

(d) "Towing light" means a yellow light having the same characteristics as the "sternlight" defined in paragraph (c) of this Rule.

(e) "All-round light" means a light showing an unbroken light over an arc of the horizon of 360 degrees.

(f) "Flashing light" means a light flashing at regular intervals at a frequency of 120 flashes or more per minute.

Rule 22

Visibility of Lights

The lights prescribed in these Rules shall have an intensity as specified in Section 8 of Annex 1 to these Regulations so as to be visible at the following minimum ranges:

(a) In vessels of 50 metres or more in length:

- a masthead light, 6 miles;
- a sidelight, 3 miles;
- a sternlight, 3 miles;
- a towing light, 3 miles;
- a white, red, green or yellow all-round light, 3 miles.

(b) In vessels of 12 metres or more in length but less than 50 metres in length:

- a masthead light, 5 miles; except that where the length of the vessel is less than 20 metres, 3 miles;
- a sidelight, 2 miles;
- a sternlight, 2 miles;
- a towing light, 2 miles;
- a white, red, green or yellow all-round light, 2 miles.

(c) In vessels of less than 12 metres in length:

- a masthead light, 2 miles;
- a sidelight, 1 mile;
- a sternlight, 2 miles;
- a towing light, 2 miles;
- a white, red, green or yellow all-round light, 2 miles.

Rule 23

Power-driven vessels underway

(a) A power-driven vessel underway shall exhibit:

(i) a masthead light forward;
(ii) a second masthead light abaft of and higher than the forward one; except that a vessel of less than 50 metres in length shall not be obliged to exhibit such light but may do so;
(iii) sidelights;
(iv) a sternlight.

(b) An air-cushion vessel when operating in the non-displacement mode shall, in addition to the lights prescribed in paragraph (a) of this Rule, exhibit an all-round flashing yellow light.

(c) A power-driven vessel of less than 7 metres in length and whose maximum speed does not exceed 7 knots may, in lieu of the lights prescribed in paragraph (a) of this Rule, exhibit an all-round white light. Such vessel shall, if practicable, also exhibit sidelights.

Rule 24

Towing and Pushing

(a) A power-driven vessel when towing shall exhibit:

(i) instead of the light prescribed in Rule 23(a)(i), two masthead lights forward in a vertical line. When the length of the tow, measuring from the stern of the towing vessel to the after end of the tow exceeds 200 metres, three such lights in a vertical line;

(ii) sidelights;
(iii) a sternlight;
(iv) a towing light in a vertical line above the sternlight;
(v) when the length of the two exceeds 200 metres, a diamond shape where it can best be seen.

(b) When a pushing vessel and a vessel being pushed ahead are rigidly connected in a composite unit they shall be regarded as a power-driven vessel and exhibit the lights prescribed in Rule 23.

(c) A power-driven vessel when pushing ahead or towing alongside, except in the case of a composite unit, shall exhibit:

(i) instead of the light prescribed in Rule 23(a)(i), two masthead lights forward in a vertical line;
(ii) sidelights;
(iii) sternlight.

(d) A power-driven vessel to which paragraphs (a) and (c) of this Rule apply shall also comply with Rule 23(a)(ii).

(e) A vessel or object being towed shall exhibit:

(i) sidelights;
(ii) a sternlight;
(iii) when the length of the tow exceeds 200 metres, a diamond shape where it can best be seen.

(f) Provided that any number of vessels being towed or pushed in a group shall be lighted as one vessel,

(i) a vessel being pushed ahead, not being part of a composite unit, shall exhibit at the forward end, sidelights;

(ii) a vessel being towed alongside shall exhibit a sternlight and at the forward end, sidelights.

(g) Where from any sufficient cause it is impracticable for a vessel or object being towed to exhibit the lights prescribed in paragraph (e) of this Rule, all possible measures shall be taken to light the vessel or object towed or at least to indicate the presence of the unlighted vessel or object.

Rule 25

Sailing Vessels underway and Vessels under Oars

(a) A sailing vessel underway shall exhibit:

(i) sidelights;
(ii) a sternlight.

(b) In a sailing vessel of less than 12 metres in length the lights prescribed in paragraph (a) of this Rule may be combined in one lantern carried at or near the top of the mast where it can best be seen.

(c) A sailing vessel underway may, in addition to the lights prescribed in paragraph (a) of this Rule, exhibit at or near the top of the mast, where they can best be seen, two all-round lights in a vertical line, the upper being red and the lower green, but these lights shall not be exhibited in conjunction with the combined lantern permitted by paragraph (b) of this Rule.

(d) (i) A sailing vessel of less than 7 metres in length shall, if practicable, exhibit the lights prescribed in paragraph (a) or (b) of this Rule, but if she does not, she shall have ready at hand an electric torch or lighted lantern showing a white light which shall be exhibited in sufficient time to prevent collision.

(ii) A vessel under oars may exhibit the lights prescribed in this Rule for sailing vessels, but if she does not, she shall have ready at hand an electric torch or lighted lantern showing a white light which shall be exhibited in sufficient time to prevent collision.

(e) A vessel proceeding under sail when also being propelled by machinery shall exhibit forward where it can best be seen a conical shape, apex downwards.

Rule 26

Fishing Vessels

(a) A vessel engaged in fishing, whether underway or at anchor, shall exhibit only the lights and shapes prescribed in this Rule.

(b) A vessel when engaged in trawling, by which is meant the dragging through the water of a dredge net or other apparatus used as a fishing appliance, shall exhibit:

(i) two all-round lights in a vertical line, the upper being green and the lower white, or a shape consisting of two cones with their apexes together in a vertical line one above the other; a vessel of less than 20 metres in length may instead of this shape exhibit a basket;

(ii) a masthead light abaft of and higher than the all-round green light; a vessel of less than 50 metres in length shall not be obliged to exhibit such a light but may do so;

(iii) when making way through the water, in addition to the lights prescribed in this paragraph, sidelights and a sternlight.

(c) A vessel engaged in fishing, other than trawling, shall exhibit:

(i) two all-round lights in a vertical line, the upper being red and the lower white, or a shape consisting of two cones with apexes together in a vertical line one above the other; a vessel of less than 20 metres in length may instead of this shape exhibit a basket;

(ii) when there is outlying gear extending more than 150 metres horizontally from the vessel, an all-round white light or a cone apex upwards in the direction of the gear;

(iii) when making way through the water, in addition to the lights prescribed in this paragraph, sidelights and a sternlight.

(d) A vessel engaged in fishing in close proximity to other vessels may exhibit the additional signals described in Annex II to these Regulations.

(e) A vessel when not engaged in fishing shall not exhibit the lights or shapes prescribed in this Rule, but only those prescribed for a vessel of her length.

Rule 27

Vessels not under Command or Restricted in their Ability to Manoeuvre

(a) A vessel not under command shall exhibit:

(i) two all-round red lights in a vertical line where they can best be seen;

(ii) two balls or similar shapes in a vertical line where they can best be seen;

(iii) when making way through the water, in addition to the lights prescribed in this paragraph, sidelights and a sternlight.

(b) A vessel restricted in her ability to manoeuvre, except a vessel engaged in minesweeping operations, shall exhibit:

(i) three all-round lights in a vertical line where they can best be seen. The highest and lowest of these lights shall be red and the middle light shall be white;

(ii) three shapes in a vertical line where they can best be seen. The highest and lowest of these shapes shall be balls and the middle one a diamond;

(iii) when making way through the water, masthead lights, sidelights and a sternlight, in addition to the lights prescribed in sub-paragraph (i);

(iv) when at anchor, in addition to the lights or shapes prescribed in sub-paragraphs (i) and (ii), the light, lights or shape prescribed in Rule 30.

(c) A vessel engaged in a towing operation such as renders her unable to deviate from her course shall, in addition to the lights or shapes prescribed in sub-paragraphs (b)(i) and (ii) of this Rule, exhibit the lights or shape prescribed in Rule 24(a).

(d) A vessel engaged in dredging or underwater operations, when restricted in her ability to manoeuvre, shall exhibit the lights and shapes prescribed in paragraph (b) of this Rule and shall in addition, when an obstruction exists, exhibit:

(i) two all-round red lights or two balls in a vertical line to indicate the side on which the obstruction exists;

(ii) two all-round green lights or two diamonds in a vertical line to indicate the side on which another vessel may pass;

(iii) when making way through the water, in addition to the lights prescribed in this paragraph, masthead lights, sidelights and a sternlight;

(iv) a vessel to which this paragraph applies when at anchor shall exhibit the lights or shapes prescribed in sub-paragraphs (i) and (ii) instead of the lights or shape prescribed in Rule 30.

(e) Whenever the size of a vessel engaged in diving operations makes it impracticable to exhibit the shapes prescribed in paragraph (d) of this Rule, a rigid replica of the International Code flag "A" not less than 1 metre in height shall be exhibited. Measures shall be taken to ensure all-round visibility.

(f) A vessel engaged in minesweeping operations shall, in addition to the lights prescribed for a power-driven vessel in Rule 23, exhibit three all-round green lights or three balls. One of these lights or shapes shall be exhibited at or near the foremast head and one at each end of the fore yard. These lights or shapes indicate that it is dangerous for another vessel to approach closer than 1,000 metres astern or 500 metres on either side of the minesweeper.

(g) Vessels of less than 7 metres in length shall not be required to exhibit the lights prescribed in this Rule.

(h) The signals prescribed in this Rule are not signals of vessels in distress and requiring assistance. Such signals are contained in Annex IV to these Regulations.

Rule 28

Vessels constrained by their Draughts

A vessel constrained by her draught may, in addition to the lights prescribed for power-driven vessels in Rule 23, exhibit where they can best be seen three all-round red lights in a vertical line, or a cylinder.

Rule 29

Pilot Vessels

(a) A vessel engaged on pilotage duty shall exhibit:

- (i) at or near the masthead, two all-round lights in a vertical line, the upper being white and the lower red;
- (ii) when underway, in addition, sidelights and a sternlight;
- (iii) when at anchor, in addition to the lights prescribed in sub-paragraph (i), the anchor light, lights or shape.

(b) A pilot vessel when not engaged on pilotage duty shall exhibit the lights or shapes prescribed for a similar vessel of her length.

Rule 30

Anchored Vessels and Vessels aground

(a) A vessel at anchor shall exhibit where it can best be seen:

- (i) in the fore part, an all-round white light or one ball;
- (ii) at or near the stern and at a lower level than the light prescribed in sub-paragraph (i), an all-round white light.

(b) A vessel of less than 50 metres in length may exhibit an all-round white light where it can best be seen instead of the lights prescribed in paragraph (a) of this Rule.

(c) A vessel at anchor may, and a vessel of 100 metres and more in length shall, also use the available working or equivalent lights to illuminate her decks.

(d) A vessel aground shall exhibit the lights prescribed in paragraph (a) or (b) of this Rule and in addition, where they can best be seen:

- (i) two all-round red lights in a vertical line;
- (ii) three balls in a vertical line.

(e) A vessel of less than 7 metres in length, when at anchor or aground, not in or near a narrow channel, fairway or anchorage, or where other vessels normally navigate, shall not be required to exhibit the lights or shapes prescribed in paragraphs (a),(b) or (d) of this Rule.

Rule 31

Seaplanes

Where it is impracticable for a seaplane to exhibit lights and shapes of the characteristics or in the positions prescribed in the Rules of this Part she shall exhibit lights and shapes as closely similar in characteristics and position as is possible.

PART D - SOUND AND LIGHT SIGNALS

Rule 32

Definitions

(a) The word "whistle" means any sound signalling appliance capable of producing the prescribed blasts and which complies with the specifications in Annex III to these Regulations.

(b) The term "short blast" means a blast of about one second's duration.

(c) The term "prolonged blast" means a blast of from four to six seconds' duration.

Rule 33

Equipment for Sound Signals

(a) A vessel of 12 metres or more in length shall be provided with a whistle and a bell and a vessel of 100 metres or more in length shall, in addition, be provided with a gong, the tone and sound of which cannot be confused with that of the bell. The whistle, bell and gong shall comply with the specifications in Annex III to these Regulations. The bell or gong or both may be replaced by other equipment having the same respective sound characteristics, provided that manual sounding of the required signals shall always be possible.

/ (b) A vessel of less than 12 metres in length shall not be obliged to carry the sound signalling appliances prescribed in paragraph (a) of this Rule but if she does not, she shall be provided with some other means of making an efficient sound signal.

Rule 34

Manoeuvring and Warning Signals

(a) When vessels are in sight of one another, a power-driven vessel underway, when manoeuvring as authorized or required by these Rules, shall indicate that manoeuvre by the following signals on her whistle:

- one short blast to mean "I am altering my course to starboard";
- two short blasts to mean "I am altering my course to port";
- three short blasts to mean "I am operating astern propulsion".

(b) Any vessel may supplement the whistle signals prescribed in paragraph (a) of this Rule by light signals, repeated as appropriate whilst the manoeuvre is being carried out:

(i) these light signals shall have the following significance:

- one flash to mean "I am altering my course to starboard";
- two flashes to mean "I am altering my course to port";
- three flashes to mean "I am operating astern propulsion";

(ii) the duration of each flash shall be about one second, the interval between flashes shall be about one second, and the interval between successive signals shall be not less than ten seconds;

(iii) the light used for this signals shall, if fitted, be an all-round white light, visible at a minimum range of 5 miles, and shall comply with the provisions of Annex I.

(c) When in sight of one another in a narrow channel or fairway:

(i) a vessel intending to overtake another shall in compliance with Rule 9(e)(i) indicate her intention by the following signals on her whistle:

- two prolonged blasts followed by one short blast to mean "I intend to overtake you on your starboard side";

- two prolonged blasts followed by two short blasts to mean "I intend to overtake you on your port side";

(ii) the vessel about to be overtaken when acting in accordance with Rule 9(e)(i) shall indicate her agreement by the following signal on her whistle:

- one prolonged, one short, one prolonged and one short blast, in that order.

(d) When vessels in sight of one another are approaching each other and from any cause either vessel fails to understand the intentions or actions of the other, or is in doubt whether sufficient action is being taken by the other to avoid collision, the vessel in doubt shall immediately indicate such doubt by giving at least five short and rapid blasts on the whistle. Such signal may be supplemented by a light signal of at least five short and rapid flashes.

(e) A vessel nearing a bend or an area of a channel or fairway where other vessels may be obscured by an intervening obstruction shall sound one prolonged blast. Such signal shall be answered with a prolonged blast by any approaching vessel that may be within hearing around the bend or behind the intervening obstruction.

(f) If whistles are fitted on a vessel at a distance apart of more than 100 metres, one whistle only shall be used for giving manoeuvring and warning signals.

Rule 35

Sound Signals in restricted Visibility

In or near an area of restricted visibility, whether by day or night, the signals prescribed in this Rule shall be used as follows:

(a) A power-driven vessel making way through the water shall sound at intervals of not more than 2 minutes one prolonged blast.

(b) A power-driven vessel underway but stopped and making no way through the water shall sound at intervals of not more than 2 minutes two prolonged blasts in succession with an interval of about 2 seconds between them.

(c) A vessel not under command, a vessel restricted in her ability to manoeuvre, a vessel constrained by her draught, a sailing vessel, a vessel engaged in fishing and a vessel engaged in towing or pushing another vessel shall, instead of the signals prescribed in paragraphs (a) or (b) or this Rule, sound at intervals of not more than 2 minutes three blasts in succession, namely one prolonged followed by two short blasts.

(d) A vessel towed or if more than one vessel is towed the last vessel of the tow, if manned, shall at intervals of not more than 2 minutes sound four blasts in succession, namely one prolonged followed by three short blasts. When practicable, this signal shall be made immediately after the signal made by the towing vessel.

(e) When a pushing vessel and a vessel being pushed ahead are rigidly connected in a composite unit they shall be regarded as a power-driven vessel and shall give the signals prescribed in paragraphs (a) or (b) of this Rule.

(f) A vessel at anchor shall at intervals of not more than one minute ring the bell rapidly for about 5 seconds. In a vessel of 100 metres or more in length the bell shall be sounded in the forepart of the vessel and immediately after the ringing of the bell the gong shall be sounded rapidly for about 5 seconds in the after part of the vessel. A vessel at anchor may in addition sound three blasts in succession, namely one short, one prolonged and one short blast, to give warning of her position and of the possibility of collision to an approaching vessel.

(g) A vessel aground shall give the bell signal and if required the gong signal prescribed in paragraph (f) of this Rule and shall, in addition, give three separate and distinct strokes on the bell immediately before and after the rapid ringing of the bell. A vessel aground may in addition sound an appropriate whistle signal.

(h) A vessel of less than 12 metres in length shall not be obliged to give the above-mentioned signals but, if she does not, shall make some other efficient sound signal at intervals of not more than 2 minutes.

(i) A pilot vessel when engaged on pilotage duty may in addition to the signals prescribed in paragraphs (a),(b) or (f) of this Rule sound an identity signal consisting of four short blasts.

Rule 36

Signals to attract Attention

If necessary to attract the attention of another vessel any vessel may make light or sound signals that cannot be mistaken for any signal authorized elsewhere in these Rules, or may direct the beam of her searchlight in the direction of the danger, in such a way as not to embarrass any vessel.

Rule 37

Distress Signals

When a vessel is in distress and requires assistance she shall use or exhibit the signals prescribed in Annex IV to these Regulations.

PART E - EXEMPTIONS

Rule 38

Exemptions

Any vessel (or class of vessels) provided that she complies with the requirements of the International Regulations for Preventing Collisions at Sea, 1960, the keel of which is laid or which is at a corresponding stage of construction before the entry into force of these Regulations may be exempted from compliance therewith as follows:

(a) The installation of lights with ranges prescribed in Rule 22, until four years after the date of entry into force of these Regulations.

(b) The installation of lights with colour specifications as prescribed in Section 7 of Annex I to these Regulations, until four years after the date of entry into force of these Regulations.

(c) The repositioning of lights as a result of conversion from Imperial to metric units and rounding off measurement figures, permanent exemption.

(d) (i) The repositioning of masthead lights on vessels of less than 150 metres in length, resulting from the prescriptions of Section 3(a) of Annex I, permanent exemption.

(ii) The repositioning of masthead lights on vessels of 150 metres or more in length, resulting from the prescriptions of Section 3(a) of Annex I to these Regulations, until nine years after the date of entry into force of these Regulations.

(e) The repositioning of masthead lights resulting from the prescriptions of Section 2(b) of Annex I, until nine years after the date of entry into force of these Regulations.

(f) The repositioning of sidelights resulting from the prescriptions of Section 3(b) of Annex I, until nine years after the date of entry into force of these Regulations.

(g) The requirements for sound signal appliances prescribed in Annex III, until nine years after the date of entry into force of these Regulations.

ANNEX I

POSITIONING AND TECHNICAL DETAILS OF LIGHTS AND SHAPES

1. Definition

The term "height above the hull" means height above the uppermost continuous deck.

2. Vertical positioning and spacing of lights

(a) On a power-driven vessel of 20 metres or more in length the mast-head lights shall be placed as follows:

(i) the forward masthead light, or if only one masthead light is carried, then that light, at a height above the hull of not less than 6 metres, and, if the breadth of the vessel exceeds 6 metres, then at a height above the hull not less than such breadth, so however that the light need not be placed at a greater height above the hull than 12 metres;

(ii) when two masthead lights are carried the after one shall be at least 4.5 metres vertically higher than the forward one.

(b) The vertical separation of masthead lights of power-driven vessels shall be such that in all normal conditions of trim the after light will be seen over and separate from the forward light at a distance of 1000 metres from the stem when viewed from sea level.

(c) The masthead light of a power-driven vessel of 12 metres but less than 20 metres in length shall be placed at a height above the gunwale of not less than 2.5 metres.

(d) A power-driven vessel of less than 12 metres in length may carry the uppermost light at a height of less than 2.5 metres above the gunwale. When however a masthead light is carried in addition to sidelights and a sternlight, then such masthead light shall be carried at least 1 metre higher than the sidelights.

(e) One of the two or three masthead lights prescribed for a power-driven vessel when engaged in towing or pushing another vessel shall be placed in the same position as the forward masthead light of a power-driven vessel.

ANNEX II

ADDITIONAL SIGNALS FOR FISHING VESSELS FISHING IN CLOSE PROXIMITY

1. General

The lights mentioned herein shall, if exhibited in pursuance of Rule 26(d), be placed where they can best be seen. They shall be at least 0.9 metre apart but at a lower level than lights prescribed in Rule 26(b)(i) and (c)(i). The lights shall be visible all round the horizon at a distance of at least 1 mile but at a lesser distance than the lights prescribed by these Rules for fishing vessels.

2. Signals for trawlers

(a) Vessels when engaged in trawling, whether using demersal or pelagic gear, may exhibit:

(i) when shooting their nets:
two white lights in a vertical line;

(ii) when hauling their nets:
one white light over one red light in a vertical line;

(iii) when the net has come fast upon an obstruction:
two red lights in a vertical line.

(b) Each vessel engaged in pair trawling may exhibit:

(i) by night, a searchlight directed forward and in the direction of the other vessel of the pair;

(ii) when shooting or hauling their nets or when their nets have come fast upon an obstruction, the lights prescribed in 2(a) above.

3. Signals for purse seiners

Vessels engaged in fishing with purse seine gear may exhibit two yellow lights in a vertical line. These lights shall flash alternately every second and with equal light and occultation duration. These lights may be exhibited only when the vessel is hampered by its fishing gear.

ANNEX III

TECHNICAL DETAILS OF SOUND SIGNAL APPLIANCES

1. Whistles

(a) Frequencies and range of audibility

The fundamental frequency of the signal shall lie within the range 70-700 Hz.

The range of audibility of the signal from a whistle shall be determined by those frequencies, which may include the fundamental and/or one or more higher frequencies, which lie within the range 180-700 Hz (± 1 per cent) and which provide the sound pressure levels specified in paragraph 1(c) below.

(b) Limits of fundamental frequencies.

To ensure a wide variety of whistle characteristics, the fundamental frequency of a whistle shall be between the following limits:

(i) 70-200 Hz, for a vessel 200 metres or more in length;

(ii) 130-350 Hz, for a vessel 75 metres but less than 200 metres in length;

(iii) 250-700 Hz, for a vessel less than 75 metres in length.

(c) Sound signal intensity and range of audibility.

A whistle fitted in a vessel shall provide, in the direction of maximum intensity of the whistle and at a distance of 1 metre from it, a sound pressure level in at least one 1/3rd-octave band within the range of frequencies 180-700 Hz (± 1 per cent) of not less than the appropriate figure given in the table below.

Length of Vessel in metres	1/3rd-octave band level at 1 metre in dB referred to 2×10^{-5} N/m^2	Audibility range in nautical miles
200 or more	143	2
75 but less than 200	138	1.5
20 but less than 75	130	1
Less than 20	120	0.5

The range of audibility in the table above is for information and is approximately the range at which a whistle may be heard on its forward axis with 90 per cent probability in conditions of still air on board a vessel having average background noise level at the listening posts (taken to be 68 dB in the octave band centred on 250 Hz and 63 dB in the octave band centred on 500 Hz).

In practice the range at which a whistle may be heard is extremely variable and depends critically on weather conditions; the values given can be regarded as typical but under conditions of strong wind or high ambient noise level at the listening post the range may be much reduced.

(d) Directional properties

The sound pressure level of a directional whistle shall be not more than 4 dB below the sound pressure level on the axis at any direction in the horizontal plane within ±45 degrees of the axis. The sound pressure level at any other direction in the horizontal plane shall be not more than 10 dB below the sound pressure level on the axis, so that the range in any direction will be at least half the range on the forward axis. The sound pressure level shall be measured in that 1/3rd-octave band which determines the audibility range.

(e) Positioning of whistles

When a directional whistle is to be used as the only whistle on a vessel, it shall be installed with its maximum intensity directed straight ahead.

A whistle shall be placed as high as practicable on a vessel, in order to reduce interception of the emitted sound by obstructions and also to minimize hearing damage risk to personnel. The sound pressure level of the vessel's own signal at listening posts shall not exceed 110 dB (A) and so far as practicable should not exceed 100 dB (A).

(f) Fitting of more than one whistle

If whistles are fitted at a distance apart of more than 100 metres, it shall be so arranged that they are not sounded simultaneously.

(g) Combined whistle systems

If due to the presence of obstructions the sound field of a single whistle or of one of the whistles referred to in paragraph 1(f) above is likely to have a zone of greatly reduced signal level, it is recommended that a combined whistle system be fitted so as to overcome this reduction. For the purposes of the Rules a combined whistle system is to be regarded as a single whistle. The whistles of a combined system shall be located at a distance apart of not more than 100 metres and arranged to be sounded simultaneously. The frequency of any one whistle shall differ from those of the others by at least 10 Hz.

2. Bell or Gong

(a) Intensity of signal

A bell or gong, or other device having similar sound characteristics shall produce a sound pressure level of not less than 110 dB at 1 metre.

(b) Construction

Bells and gongs shall be made of corrosion-resistant material and designed to give a clear tone. The diameter of the mouth of the bell shall be not less than 300 mm for vessels of more than 20 metres in length, and shall be not less than 200 mm for vessels of 12 to 20 metres in length. Where practicable, a power-driven bell striker is recommended to ensure constant force but manual operation shall be possible. The mass of the striker shall be not less than 3 per cent of the mass of the bell.

3. Approval

The construction of sound signal appliances, their performance and their installation on board the vessel shall be to the satisfaction of the appropriate authority of the State where the vessel is registered.

ANNEX IV

DISTRESS SIGNALS

1. The following signals, used or exhibited either together or separately, indicate distress and need of assistance:

(a) a gun or other explosive signal fired at intervals of about a minute;

(b) a continuous sounding with any fog-signalling apparatus;

(c) rockets or shells, throwing red stars fired one at a time at short intervals;

(d) a signal made by radiotelegraphy or by any other signalling method consisting of the group ···−−−··· (SOS) in the Morse Code;

(e) a signal sent by radiotelephony consisting of the spoken word "Mayday";

(f) the International Code Signal of distress indicated by N.C.;

(g) a signal consisting of a square flag having above or below it a ball or anything resembling a ball;

(h) flames on the vessel (as from a burning tar barrel, oil barrel, etc.);

(i) a rocket parachute flare or a hand flare showing a red light;

(j) a smoke signal giving off orange-coloured smoke;

(k) slowly and repeatedly raising and lowering arms outstretched to each side;

(l) the radiotelegraph alarm signal;

(m) the radiotelephone alarm signal;

(n) signals transmitted by emergency position-indicating radio beacons.

2. The use or exhibition of any of the foregoing signals except for the purpose of indicating distress and need of assistance and the use of other signals which may be confused with any of the above signals is prohibited.

3. Attention is drawn to the relevant sections of the International Code of Signals, the Merchant Ship Search and Rescue Manual and the following signals:

(a) a piece of orange-coloured canvas with either a black square and circle or other appropriate symbol (for identification from the air);

(b) a dye marker.

Appendix III

The Roll of Judgements of Oleron

Article 15

If a ship is in her passage, at anchor or moored and another vessel comes from abroad and is not well steered, and strikes herself against the ship which is in her way, if the ship is damnified by the blow which the other vessel gave her and that thereby wines are beaten out of the casks and sunk in each of the said ships, according to reason the damage of the blow ought to be valued and divided half by half of the two said ships and the wines that are therein, and likewise the damages amongst the merchandises to be parted and the master of the vessel which fell foul and struck the other is bound and also his mariners to swear on the Holy Evangelists that they did not fall foul willingly or wilfully. And the reason why this Judgement was made is chiefly that an old vessel might not purposely be put in the way of a better, whereby she may endamage or prejudice another vessel but when they know that they ought to part the damage by halves they will be willing to remove her out of the way.

Appendix IV

Clarification of some nautical terms

Introduction

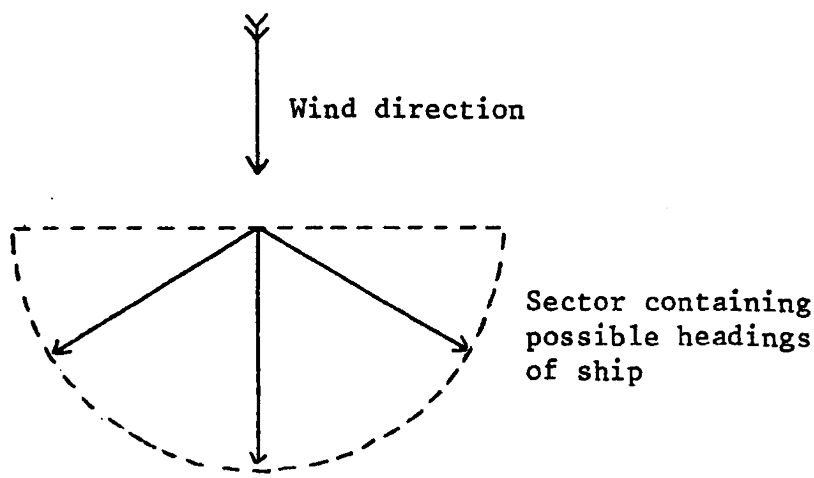
One tends to think of "jargon" as a recent innovation made necessary by the limitations of traditional vocabularies when faced with the requirements of new and complex technological concepts. In practice, however, it seems that new words and phrases are often invented either to create an impression or simply for fun when perfectly adequate description is possible in every-day language. Nor is jargon a recent development. Specialised terms which come under this heading were in use at sea well before navigation became a technology and, since many were written into official publications, their use is unavoidable in a treatment of the historical development of the collision regulations. The meanings of some of these terms are considered below:

Sailing Terms

(1) "With the wind free"
"With the wind fair"
"Running before the wind"

These three terms are virtually synonymous and refer to a vessel sailing with a following wind; i.e. with the wind coming from a direction within the vessel's astern semi-circle as in figure (a) below.

Fig. (a)



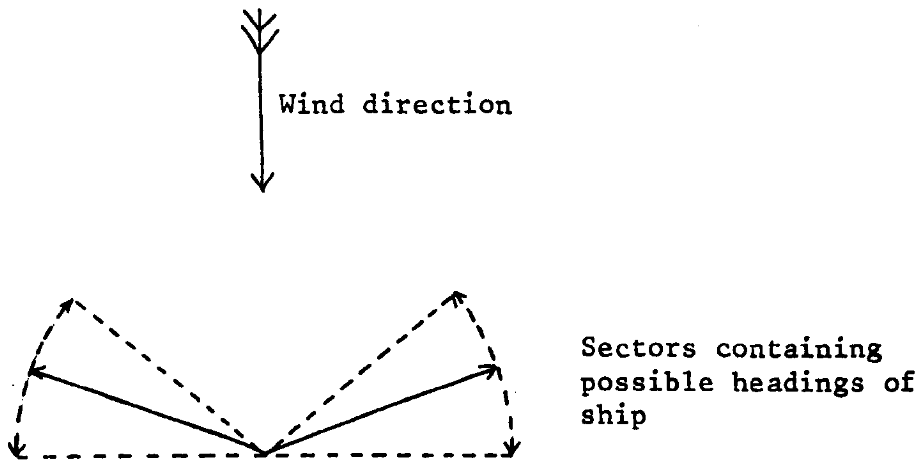
When sailing with a following wind, a square rigged sailing vessel has considerable freedom of action in terms of course alteration but can only stop by turning into the wind.

When sailing with a following wind, a fore and aft rigged sailing vessel has less freedom of action in that some alterations of course may involve "jibing", i.e. changing the side on which the mainsail is carried. This is often a difficult, and occasionally a dangerous, operation.

(2) "Tacking"
"Close hauled"
"On a wind"

These three terms are again almost synonymous and refer to a vessel sailing against the wind; i.e. with the wind coming from a direction within a vessel's forward semi-circle, as in figure (b) below.

Fig. (b)



Sailing vessels cannot, of course, sail directly into the wind but they can sail so that they are heading at an acute angle to the direction from which the wind is blowing. For square rigged ships, the smallest such angle is about six points of the compass (i.e. $67\frac{1}{2}^{o}$), but vessels with fore and aft sails can sail at angles as small as 45^{o} to the wind direction, depending upon their design.

(3) "Wind abeam"

This term simply means sailing so that a vessel is heading at right-angles to the wind direction.

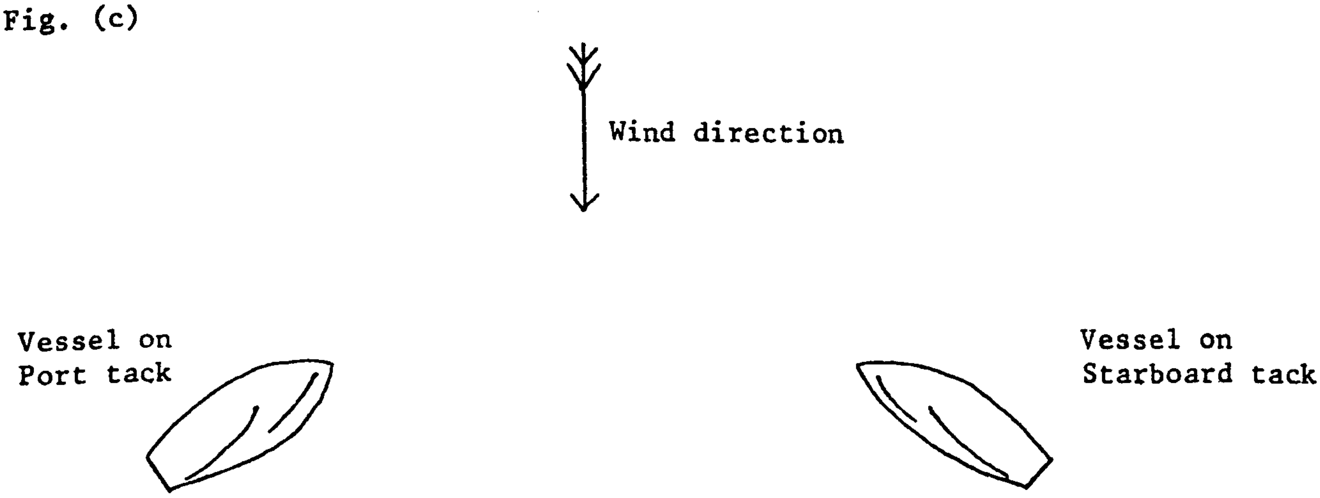
(4) "Starboard tack"

Sailing at an acute angle to the direction from which the wind is blowing and such that the ship's starboard side is to windward. See figure (c) below.

(5) "Port tack"

Sailing at an acute angle to the direction from which the wind is blowing and such that the ship's port side is to windward. See figure (c) below.

Fig. (c)



Helm Orders

(1) "Starboard"
"Larboard"
"Port"

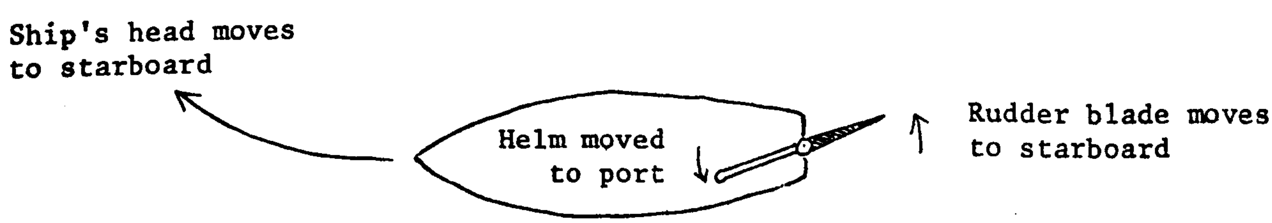
Starboard refers to the right hand side of a ship, looking towards the bows.

Larboard or port refers to the left hand side of a ship, looking towards the bows. "Larboard" was used more commonly than "Port" until the middle of the 19th century, during which period the similarity between the sounds of the words larboard and starboard caused the term port to be preferred to the term larboard. It is of interest that the Trinity House rules of 1840 contained both the terms larboard and port (see appendix II E).

(2) "Starboard helm"
"Larboard helm"
"Port helm"

Steering orders were originally given in terms of the direction in which a vessel's helm (or tiller) should be moved. Thus, if it was required that a vessel should alter course to starboard (i.e. to the right), the rudder blade had to be moved to starboard but the helm had to be moved to larboard or port (i.e. to the left). The corresponding order would have been either "larboard helm" or simply "larboard", or "port helm" or simply "port". See figure (d) below for the relationship between helm and rudder movements.

Fig. (d)



In a similar way, if it was required that a vessel should alter course to port, the corresponding order would have been "starboard helm" or simply "starboard".

When rudder movements were controlled by steering wheels rather than tillers, the orders in terms of helm movements became inappropriate but the conservatism of mariners was such that they persisted in most countries until the 20th century and, in the UK until 1933. After that date, orders relating to alterations of course were given in the direct sense so that "starboard wheel" or "starboard" meant that the rudder blade and the ship's head both moved to starboard, and "port wheel" or "port" meant that the rudder blade and the ship's head both moved to port. In the United States the terms right and left were preferred to the terms starboard and port. (See appendix II(P), rule 32).

Appendix V

Aids to Memory in Four Verses, by Thomas Gray, 14th October, 1867.

1. Two Steam Ships meeting

When both side lights you see ahead -
Port your helm, and show your RED.

2. Two Steam Ships passing.

GREEN to GREEN - or RED to RED -
Perfect safety - Go ahead!

3. Two Steam Ships Crossing.
Note: This is the position of greatest danger; there is nothing for it but good look-out, caution, and judgement.

If to Starboard RED appear,
It is your duty to keep clear;
To act as judgement ways is proper:-
To Port or Starboard - Back - or, Stop her!

But when, upon your Port is seen
A Steamer's Starboard light of GREEN,
There's not so much for you to do,
For GREEN to Port keeps clear of you.

4. All ships must keep a good look-out and Steamships must stop and go astern, if necessary.

Both in safety and in doubt,
Always keep a good lookout;
In danger with no room to turn,
Ease her! - Stop her! - Go astern!

APPENDIX VI

IMCO
SUB-COMMITTEE ON SAFETY OF NAVIGATION - 9th session
Agenda item 2

NAV IX/2/8
1 April 1970

Original: ENGLISH

REVISION OF THE INTERNATIONAL REGULATIONS FOR PREVENTING COLLISIONS AT SEA

Note by the Government of the USSR

Improvement of both the Steering and Sailing Rules and the Rules for Conduct in Restricted Visibility is the most important and the most complicated problem in a matter of the revision of the Collision Regulations.

With this in view a broad discussion concerning the above problem was held in the USSR in which many ship's masters took part. On the basis of both the results of the discussion and the replies obtained from Soviet navigators on the ICS questionnaire it appears necessary to make the following comments relating to the change of the Regulations, in addition to these expressed in our previously submitted Notes (NAV VI/8/1 and NAV VIII/2/6.)

1. Necessity of Changing the Collision Regulations

In our view the question whether the existing Rules need revising is to be discussed first of all. Statistics of collisions might serve as the main indication of inadequacy of the Rules. In this regard the document NAV VIII/WP.1 by the British delegation is of great interest and usefulness. The results of statistical analysis the document contains coincide to a considerable extent with conclusions of similar investigations carried out in the USSR.

We agree that in the majority of cases infringements of the Rules and human errors are factors in collisions. It should be recognized however that certain objective reasons of collisions exist connected to some extent with imperfection of the present Rules.

Practice of application of the Collision Regulations, their thorough analysis and consideration of the comments on them submitted to IMCO allow to find out certain deficiencies of the Rules. The major of them are as follows:

(a) The Collision Regulations include as separate parts the rules for vessels in restricted visibility and the rules for navigation in clear weather. Actions prescribed in these parts are not the same. This complicates the Rules, and in conditions of variable visibility may impede the choice of a proper manoeuvre as well as its proper implementation. But the mentioned shortcoming is objectively caused by the difference in both the conditions of navigation and the character of information obtained by navigator under different weather conditions.

(b) Manoeuvres to avoid collision in low visibility as prescribed in the Regulations need precising; the indications relating to manoeuvring which are given in Recommendations do not overcome the lack of guidance provided by the Rules themselves, since the Recommendations are only advisable but not obligatory provisions. This deficiency becomes very appreciable now because the majority of ships are fitted with radar.

(c) There is no clear limitation as to application of Rule 18; this leads to some uncertainty in responsibilities of ships concerned. This defect, though well-known, has not been eliminated so far.

(d) Provision of Rule 21 requiring a vessel which is given the way to keep her course and speed until collision cannot be avoided by the action of the giving-way vessel alone, is too rigid. Over the recent years this provision became apparently unsuitable because of broadening the range of speeds used at sea; in case of vessels with greatly different speeds it is difficult for the slower craft to keep out of the way of the fast one.

2. Character of Proposed Changes

Though the majority of specialists agree that the Regulations need changing, the character and scope of the changes required is a matter for dispute.

There are two different views as to the ways of improving the Rules. These are expressed in particular in proposals submitted to IMCO.

One view is that the Regulations themselves as well as their basic requirements require radical changes. Adherents of this view believe that the new Manoeuvring Rules must be designed so as to be applicable equally for any visibility. To achieve this, it was proposed:

- to require both vessels to take action for avoiding collision;
- to establish a unified manoeuvre which would provide compatibility of actions undertaken by both vessels.

The opposite view is that any revision of the principles on which the present Regulations are based is unnecessary or undesirable; action in clear weather should not be the same as in reduced visbility, and, consequently the rules governing these actions should remain as separate parts in the Collision Regulations. To improve the Regulations, it was proposed:

- to modify Rule 21 in order to make the Rule more flexible;
- to add new Rules for vessels in restricted visibility using certain provisions of the present Recommendations on the Use of Radar Information.

Since both views have their own merits and deficiencies, they should be considered in detail.

3. Creation of New Manoeuvring Rules Covering Both Clear and Restricted Visibility

Proposals on creation of the new Manoeuvring Rules aim at simplification of the present Regulations and at unification of actions to be undertaken by vessels in any visibility. If the Rules are so worded as to be applicable in all visibility conditions, major deficiencies of the existing Rules 18 and 21 would be eliminated. These are the merits of the proposals on complete reform of the Collision Regulations. But before these proposals are agreed to, the following comments concerning their shortcomings are worth discussing:

(a) Conditions of navigation in good visibility are not the same as in reduced visibility. Navigation in low visibility requires a vessel to go at a moderate speed, to give the fog signal and to stop her engines when hearing the fog signal of the other vessel. This determines the need of having special Rules applicable in restricted visibility only. Besides that, if the Rules are added by provisions concerning the use of radar information (that seems desirable), the difference between the Rules for clear weather and those for restricted visibility would be even greater than it is now.

(b) In our view both vessels should not have obligation to take avoidance action in any visibility. According to the present Rules vessels have the obligation to take action in good visibility only, while in reduced visibility they have the right to manoeuvre. This seems reasonable since, as far as safety of passing is concerned, radar observation, though very useful in navigation, cannot be recognized as equivalent to visual sighting. Contrary to visual sighting, radar observation does not provide:

- full (100%) reliability of both the continuity of observation and the detection of all the vessels approaching;
- mutuality of observation;
- possibility to obtain at once all the information needed for successful manoeuvring to avoid collision.

These are the reasons why in many cases a vessel fitted with operational radar and detecting by the radar an approaching vessel, should not take any other action than slowing down and stopping her engines, if she is lacking of all the information required. According to the Recommendations on the Use of Radar Information no action should be taken on the basis of scanty information. Therefore for vessels fitted with radar the new Regulations should retain the right, but not the obligation, to take early and substantive action to avoid close quarters, provided that the vessel has sufficient information needed for safe passing. At the same time it should be noted that from Rule 29 it follows that any vessel fitted with radar should try to exercise her right to undertake anti-collision action.

(c) Dual responsibility to take action means, in essence, that in situations of multi-ship encounters all vessels involved must manoeuvre to avoid collision; this may create complicated situations in congested areas. If responsibility for manoeuvre is assigned to each party to an encounter, probability of wrong action will, of course, increase due to failure to evaluate the whole situation properly. Besides, in view of general responsibility to give way some of ship's masters will prefer not to manoeuvre, but to rely on the action of the others.

(d) It should be recognized that the majority of so-called hampered vessels are unable to perform the obligatory action for collision avoidance. Therefore the proposed principle will not be universal. In view of this fact a special identification signal should be established for hampered vessels. Such signal is already in use for vessels in clear weather, but it appears rather difficult to establish an effective signal for conditions of poor visibility. The existing sound signals are not suitable, since their audibility is low, they are heard from short ranges, and in many cases it is difficult to determine what vessel they belong to. As far as radiotelephone or radar signals are concerned, they are not likely to be used on a large scale in the near future for such purposes.

Thus in conditions of poor visibility a vessel approaching the hampered one will not have sufficient information concerning the movement of the latter and therefore will expect the hampered vessel to take action to avoid collision. This situation is undesirable and dangerous.

(e) The main objection concerns the necessity of establishing a unified manoeuvre, so that the manoeuvres conducted by vessels did not have the effect of mutually cancelling each other.

Without going into detail of the proposals concerned it should be recognized that to introduce any unified manoeuvre means to restrict free choice of action to prevent collision. There is a certain contradiction here. On the one hand, a vessel is proposed to have the obligation to take action, on the other hand it is proposed at the same time to introduce a unified manoeuvre, i.e. to restrict vessel's possibilities to perform her obligation. The more strictly the Rules prescribe a manoeuvre to avoid collision, the more often the situation will arise when production of the prescribed manoeuvre is impossible and therefore a vessel involved is unable to fulfil her obligation. These situations may occur mostly in congested and restricted waters, i.e. in the areas in which the majority of collisions happen. Therefore for these areas the Rules prescribing a fixed manoeuvre are apparently unsuitable.

(f) As far as the most popular proposed manoeuvre involving a decrease of bearing of the other vessel is concerned, it should be noted that this manoeuvre is unsatisfactory in the case when a threat goes from the port relative bearings:

- In poor visibility the manoeuvre proposed is in conflict with such a usual action as reduction of speed, since the latter results in an increase of bearing of an approaching vessel;

- For conditions of clear weather the proposed manoeuvre is also unsuitable in the cases when a vessel should keep out of the way of a hampered vessel which is seen ahead the port beam, since both a reduction of speed and an alteration to port in order to pass by the stern lead to an increase of bearing, i.e. the proposed principle is broken.

(g) From the above it follows that though it is desirable to introduce the Manoeuvring Rules equally applicable to any visibility, the problem of designing such Rules is insoluble at present. It seems that the deficiencies as listed above overcome the advantages expected if such Rules are adopted.

In view of the above-mentioned we believe that the basic principles the present Rules are based upon should be retained. The Rules for vessels in clear weather and the Rules for navigation in restricted visibility should remain as separate parts in the Collision Regulations. This conclusion is in line with the majority (more than 71%) of views expressed by Soviet seamen in their replies on the ICS questionnaire.

4. <u>Proposals on Changing the Steering and Sailing Rules</u>

Having doubt as to the possibility of radical revision of the principles on which the present Regulations are based, we believe however that since the Regulations are not free from certain deficiencies, the measures should be taken to improve the existing Rules. In the first place the Rules for vessels approaching on crossing courses need changing. These Rules might be expanded to include a new provision to the effect that under certain circumstances a vessel which is given the way is allowed to alter her course to starboard in good time, in order to avoid close quarters situations. This means that the basic principle of distribution of vessels' responsibilities remains unchanged, i.e. a vessel which has another vessel on her starboard side shall keep out of the way of the other, while a vessel which is given the way shall usually keep her course and speed, as Rule 21 requires. However, if there are certain indications that a vessel which should give way is experiencing difficulties in complying with her obligation because of a variety of reasons, for instance because of great difference in speed, the privileged vessel may take early action to facilitate safe passing. An alteration to starboard only might be used as such an action, since this alteration does not restrict freedom of action choice for the giving-way vessel. It seems reasonable to retain the requirement that the giving-way vessel should, if the circumstances of the case permit, avoid crossing ahead of the other. In the majority of cases the proposed alteration to starboard will either provide safe passing or delay the moment of close quarters; in the latter case there would be more time for further action. It should be noted that the right to alteration of starboard should be used by ships' masters wisely, i.e. only in the case when such an action really facilitates safe passing.

In our view an alteration to starboard should be early and substantial, so that the giving-way vessel could assess this manoeuvre and to take it into account in her intended action. It is very desirable for a vessel making an alteration to starboard to give a special sound signal (and a light signal in future).

Since the right of alteration to starboard is given to vessels approaching on crossing courses only, i.e. it does not relate to overtaken vessels, to sailing vessels, etc., to which

Rule 21 apply, question arises as to the place in the Regulations for inserting a provision concerning such alteration. The provisions might be put either in Rule 19 or in Rule 21. In our view Rule 19 is more appropriate for accommodating it. At the same time it is reasonable to develop this Rule so as to include in it all manoeuvring requirements for vessels in crossing situations.

Thus, it is suggested that the requirements should be grouped together according to the following situations of encounter:

- meeting end on, or nearly end on (the existing Rule 18);
- crossing (the present Rule 19 expanded by the above mentioned addition and by appropriate provisions of Rules 21, 22 and 23);
- overtaking (the existing Rule 24 added by appropriate provisions of Rules 21,22 and 23).

The above proposals relating to the structure of the Rules aim at simplification and concretization of the Manoeuvring Rules.

5. Changing the Rules for Vessels in Restricted Visibility

(a) As it has been stated in our Note (NAV VIII/2/6) the Rules for vessels in restricted visibility are to be revised and expanded. They should refer only to actions to be taken by vessels and therefore all provisions concerning sound signals given in fog could be excluded from Part C and transferred to Part B.

(b) The Rules for vessels in restricted visibility should incorporate a rule concerning moderate speed (Rule 16(a)) added by provisions of paragraph 2 of the Recommendations), a rule for vessels navigating without the aid of radar (Rule 16(b)) and a rule for vessels navigating the aid

aid of radar (Rule 16(c) added by some provisions of paragraphs 3-7 of the Recommendations).

(c) To achieve compatibility of actions to be undertaken by vessels fitted with radar in conditions of restricted visibility, it is proposed to impose restrictions on course alteration to port in meeting or crossing situations. It should be recognized that at present the absolute compatibility of vessels' manoeuvres in fog could hardly be achieved. Therefore the Rules should require vessels to take early and bold action when approaching, so that the situation arisen after manoeuvring could easily be assessed by the other vessel(s).

In our view it is undesirable or even dangerous to retain unrestricted choice of actions for vessels approaching in fog, since this is one of the reasons why in some cases the manoeuvres made by vessels are incompatible. Therefore the first slight step ahead in achieving the desired compatibility of actions could be made by imposing restrictions on alteration to port.

6. Conclusion

In summary, the following main conclusions have been reached and the following proposals are being put forward:

(a) Both the Steering and Sailing Rules and the Rules for Conduct in Restricted Visibility have certain deficiencies. Therefore they need improving and changing.

(b) When revising the Manoeuvring Rules the present principle of judging the vessels' rights and obligations depending on their relative location should remain unchanged, for this principle provides for most simple and clear analyses of any situation.

(c) New Regulations should contain as separate parts the Rules for clear visibility and those for restricted ones, as conditions of navigation and character of information obtained are different according to visibility conditions.

(d) To make the Manoeuvring Rules more concise, it seems to be desirable to improve their structure; to this end, requirements should be grouped according to situations of approaching, in the same way as in the existing Rule 18.

(e) To improve Rule 21, it is felt to be reasonable in situations of crossing to allow a vessel which is given way to make early alteration to starboard under certain circumstances, in order to avoid close quarters.

(f) Provisions concerning fog sound signals should be excluded from the Rules for vessels in restricted visibility and transferred to Part B.

(g) The Rules for vessels in restricted visibility should be amended by adding some provisions of the Recommendations on the Use of Radar Information.

(h) The Rules for vessels in restricted visibility should contain three basic provisions concerning:

- moderate speed;
- navigation in fog without the aid of radar;
- navigation and manoeuvres in fog with the aid of radar.

(i) When establishing principles of manoeuvring for vessels navigating with operational radar in conditions of restricted visibility, limitations should be imposed on course alteration to port, when meeting or crossing.

Appendix VII

In figures (a) and (b) below, $\underline{V}_A$ and $\underline{V}_B$ are the initial velocity vectors of ships A and B respectively. $\overline{V_A + \delta V_A}$ is the new velocity vector of ship A after an alteration of course through 86°. $V_A - V_B$ is the initial relative velocity of ship A with respect to ship B and $\overline{(V_A + \delta V_A) - V_B}$ is the new relative velocity of ship A with respect to ship B after the alteration of course. The nearest approach between ship A and ship B is the length of a perpendicular dropped from the initial position of ship B onto the vector $(V_A + \delta V_A) - V_B$, produced if necessary.

Diagram (a) is for an alteration of course to port by ship A and diagram (b) is for an alteration of course to starboard.

In figure (a) the distance of nearest approach is found to be 2.1 miles and the time required for ship A to reach the point of nearest approach is 6½ minutes.

In diagram (b) the distance of nearest approach is found to be 0.3 miles and the time required for ship A to reach the point of nearest approach is 45 minutes.

Initially, ship A was proceeding at 10 knots with 2 miles to go to the collision point and ship B was proceeding at 12½ knots with 2½ miles to go to the collision point.

Fig. (a)

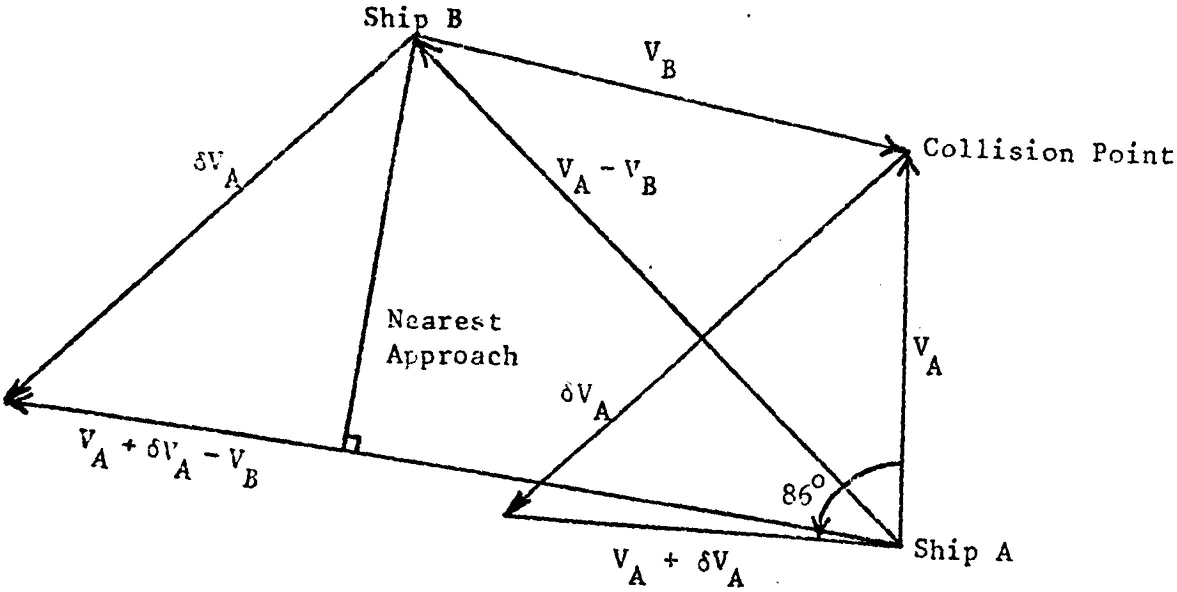


Fig. (b)

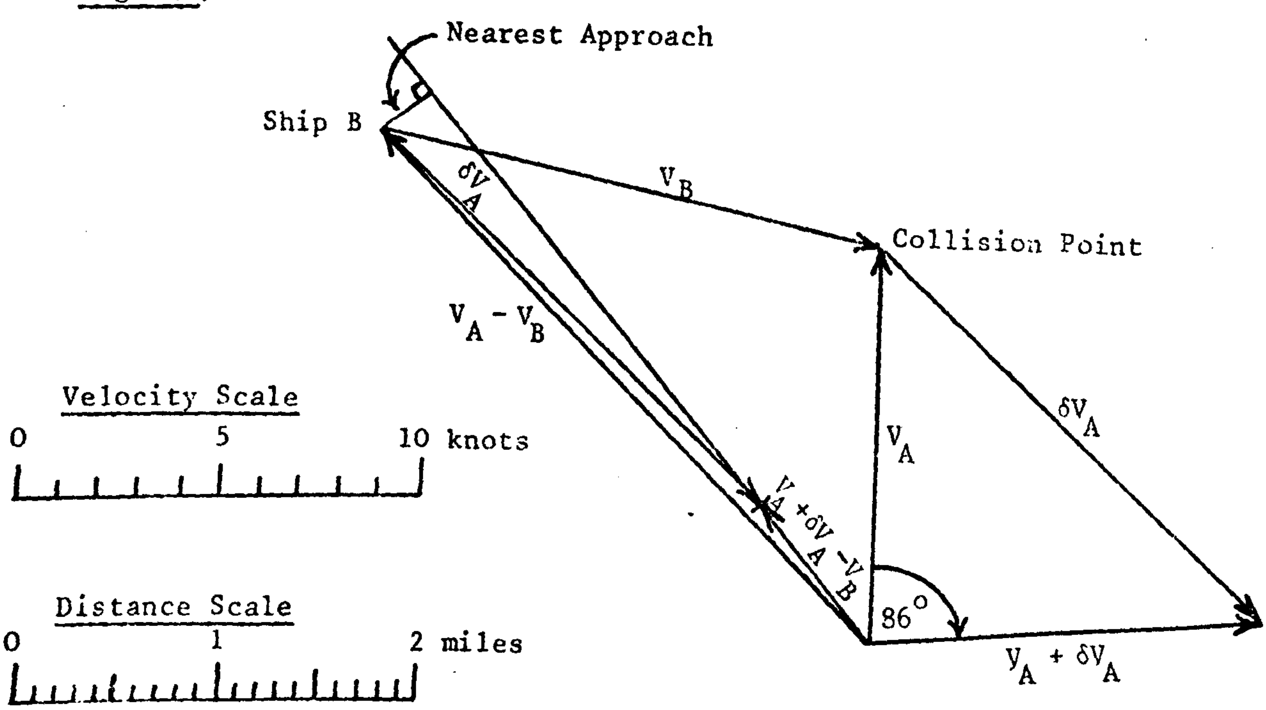
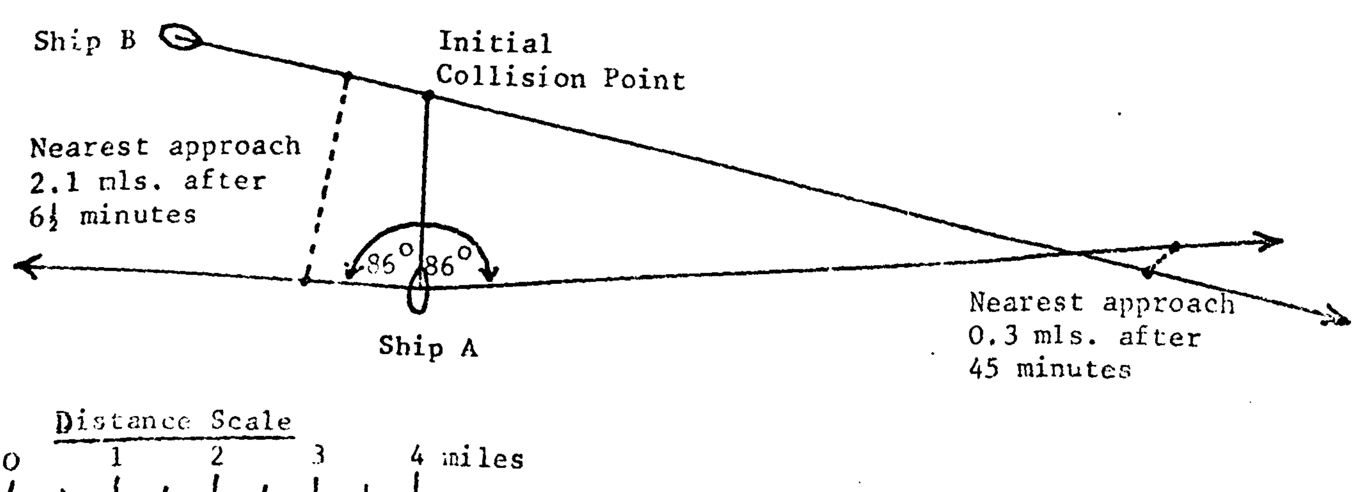
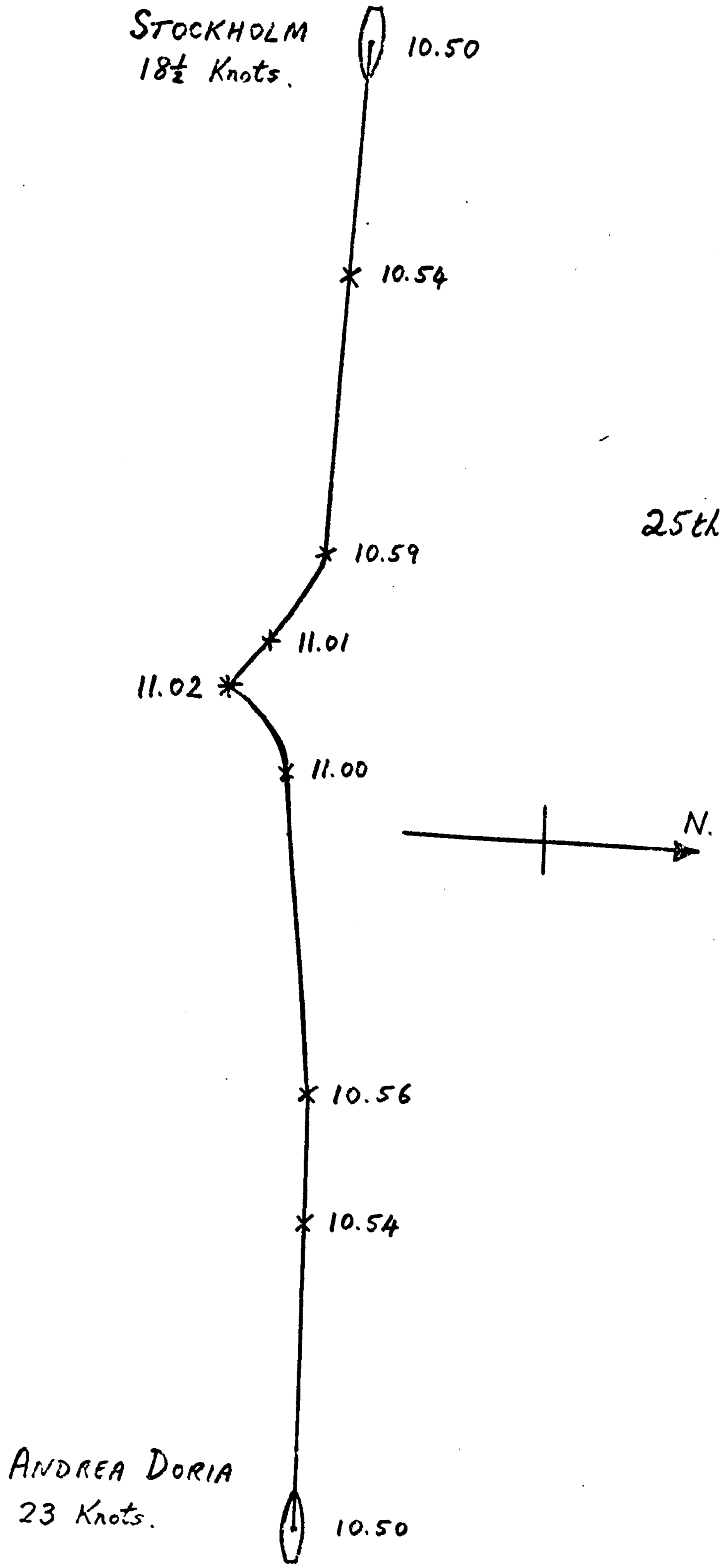


Fig. (c) (Absolute tracks of ships)



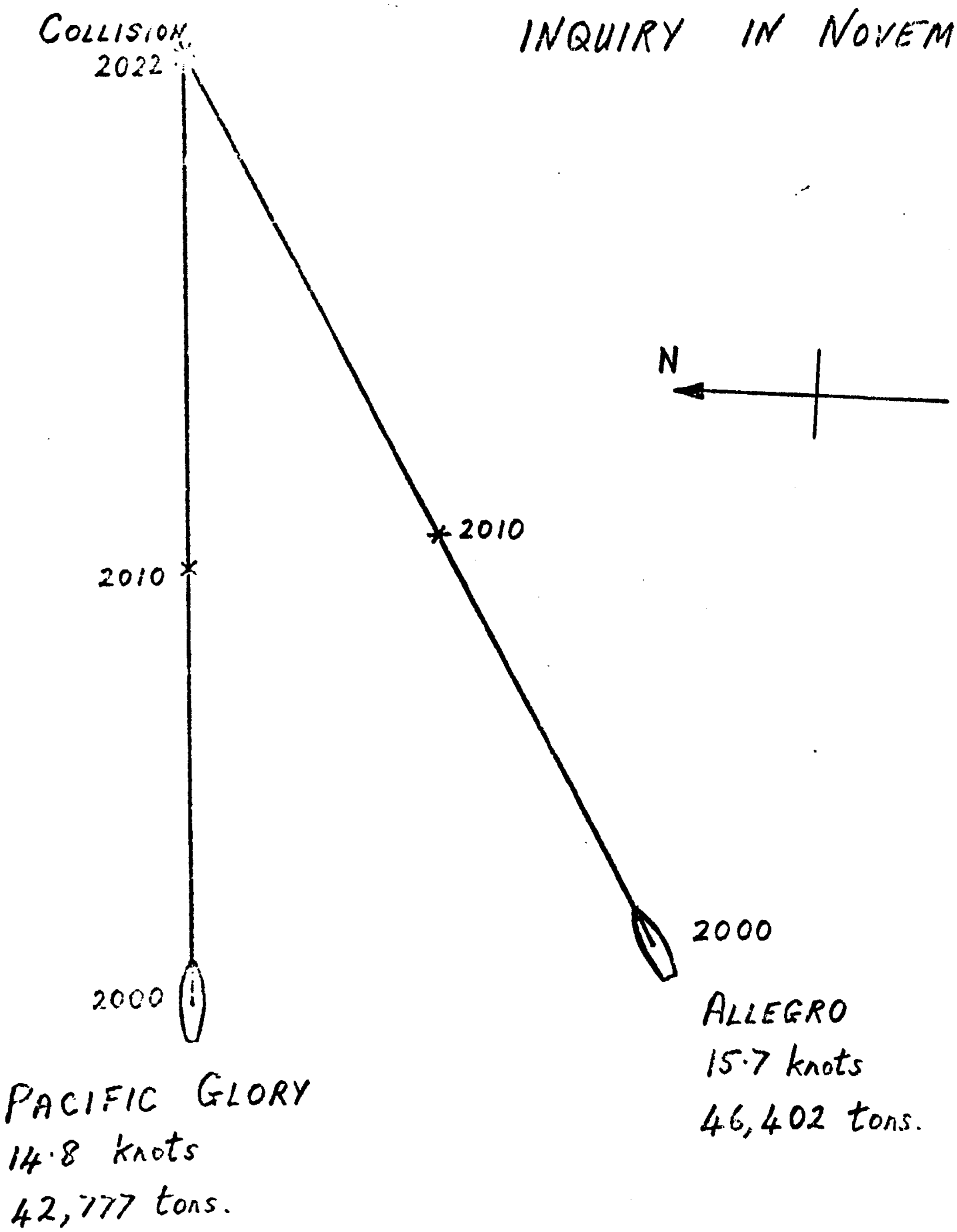
APPENDIX VIII(A)



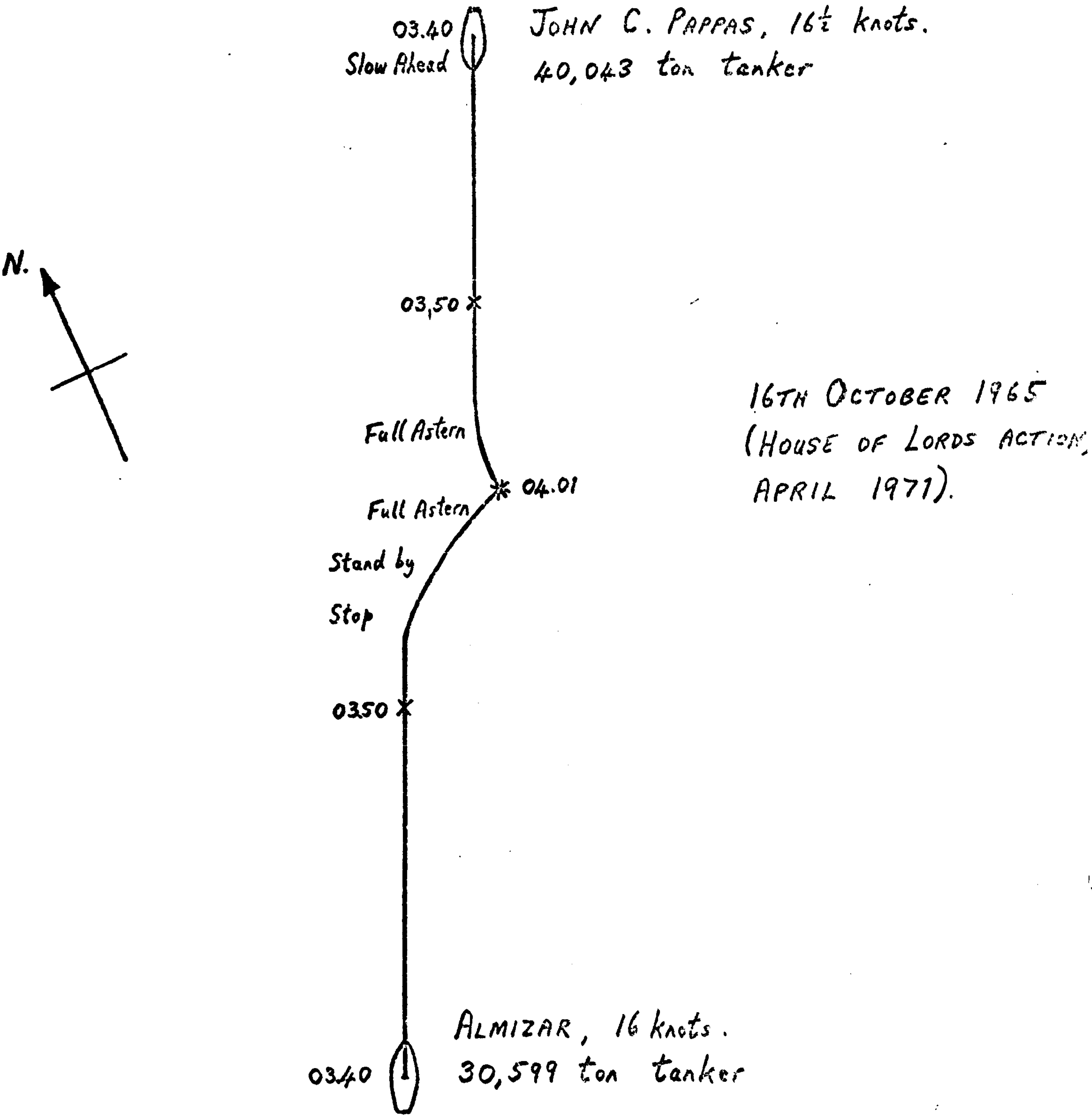
25th JULY 1956

APPENDIX VIII (B)

COLLISION BETWEEN "ALLEGRO" AND "PACIFIC GLORY" ON 23RD. OCTOBER 1970 (LIBERIAN GOVERNMENT INQUIRY IN NOVEMBER 1970).

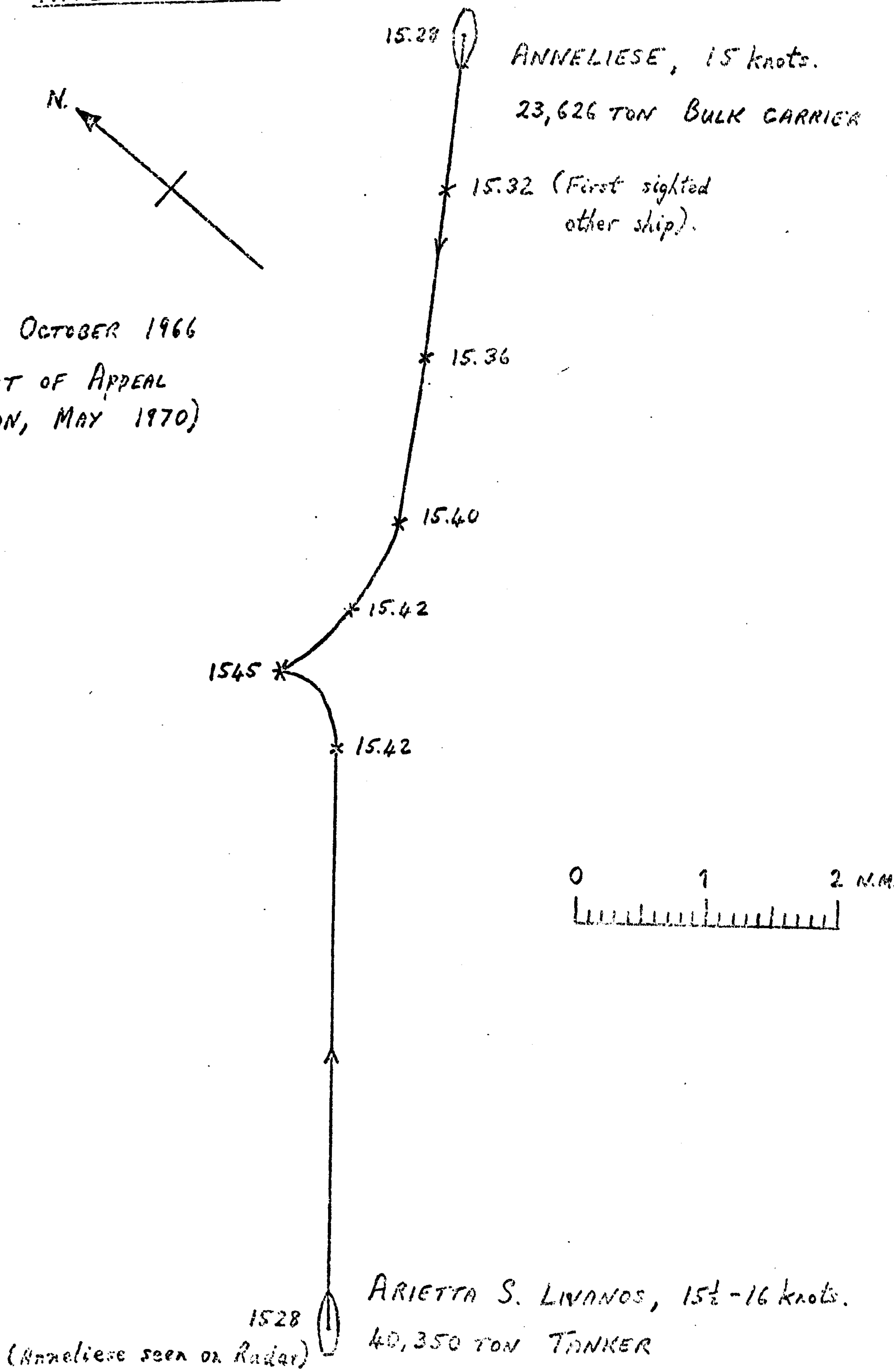


APPENDIX VIII (C)



APPENDIX VIII(D)

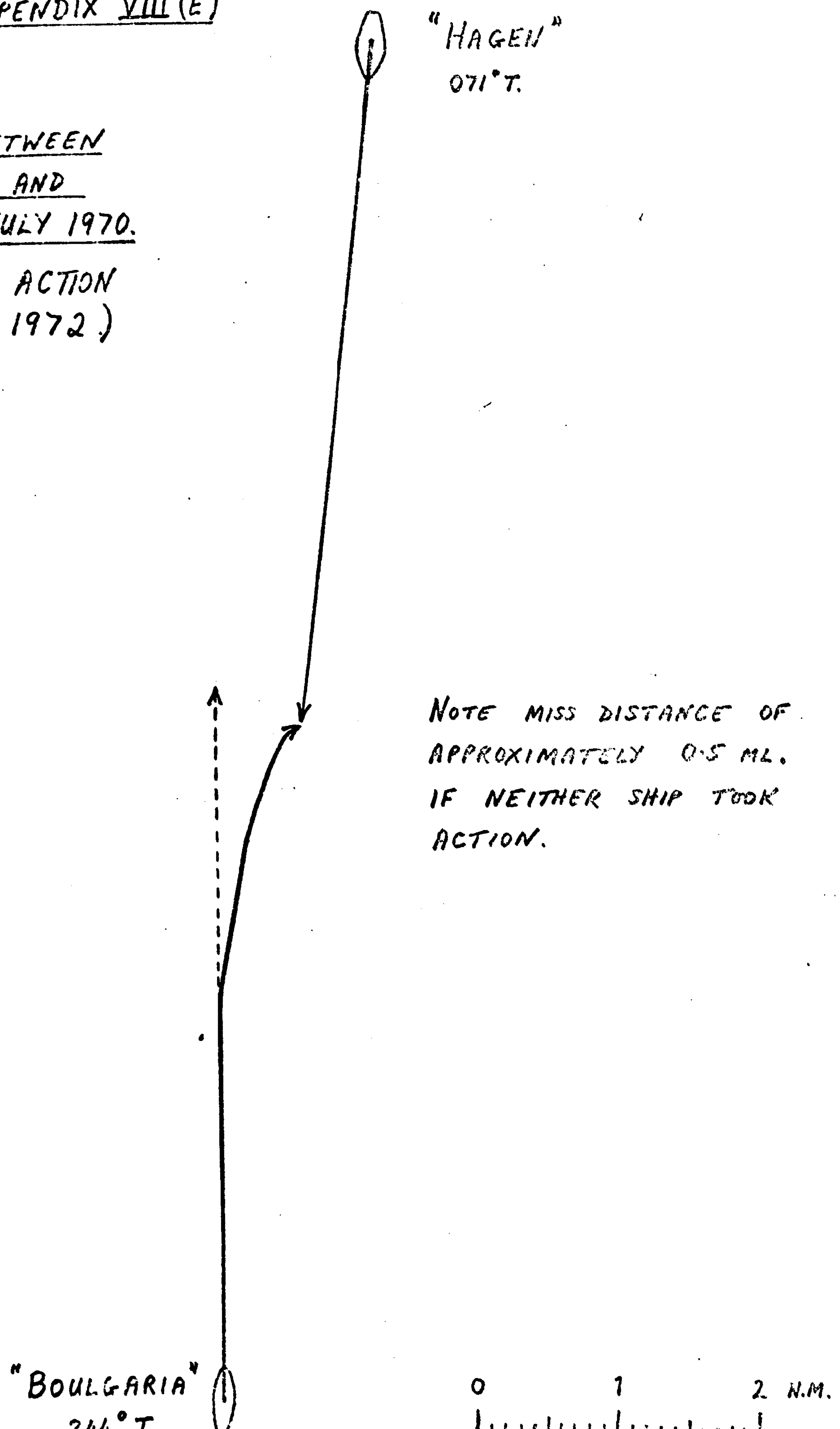
22ND OCTOBER 1966
(COURT OF APPEAL
ACTION, MAY 1970)



APPENDIX VIII (E)

COLLISION BETWEEN "BOULGARIA" AND "HAGEN" - JULY 1970.

(HIGH COURT ACTION DECEMBER 1972.)



APPENDIX IX

MARINE RADAR SIMULATOR

SERIES SY2010

1 INTRODUCTION AND BRIEF DATA

1.1 Introduction

The Solartron transistorised radar simulator series SY2010 is designed to provide a synthetic, but highly realistic, means of training pupils in the interpretation of data presented to them on the display units of a typical marine radar.

1.1.1 The Equipment

In order that the SY2010 range of simulators is able to meet different marine radar training requirements, the equipment has been constructed to give a selection of modules which together provide a variety of simulator functions.

The basic equipment offers a maximum of ten targets for a single own ship system, and up to four or five targets for the two and three own ship systems. The own ship moving base is fully manoeuvreable and can be made to represent a large range of vessels, by virtue of a number of preset adjustments which determine the characteristic delays between demand and achievement in changes of course and speed. These delays vary considerably from ship to ship depending on such factors as waterline length, beam, number and type of engines and so on. These delays are switched out when the own ship is capable of performing as a hovercraft.

Realism of the responses displayed is enhanced by the inclusion of simulated receiver noise, sea clutter, mast/funnel blanking (shadow sector). In addition, coastline responses are displayed to represent selected locations with simulated automatic coastline shadowing. Tidal stream speed and direction can be set in as required, and, where the own ship doubles as a hovercraft, wind speed and direction can be set in to affect the hovercraft movement.

The transistorised simulator possesses a high degree of inherent reliability and is designed to maintain stated accuracies over long periods with little or no adjustment. Fault finding and maintenance is greatly simplified by the modular construction, permitting substitution checking and sub-unit replacement.

1.1.1.1 Summary of Units

Each simulator in the series comprises the following main units:

(a) One double-bay or treble-bay rack assembly housing the computing and coastline generating equipment (including power units).

(b) One, two or three own ship control units.

(c) One/two target control units.

(d) One instructor's control unit (normally with three own ship systems only).

(e) One junction box (two and three own ship configurations).

1.1.2 Arrangement of Manual

The manual is divided into two parts, Part 1 comprising the system description, operating instructions and system maintenance and Part 2 the unit and sub-unit descriptions, schedules and interconnection data.

1.1.2.1 Part 1

Section 1 summarises the facilities and lists the units making up the specific equipment. Section 2 provides operating instructions while Section 3 gives some treatment of the circuits employed in this type of equipment.

A detailed description of the system is contained in Section 4, and Section 5 provides maintenance instructions. Section 6 contains the system setting-up procedure.

1.1.2.2 Part 2

Part 2 of the manual comprises the relevant circuit digrams, component lists, component location data (where available) and circuit description for the individual sub-units in numerical order.

1.2 Data Summary

1.2.1 Purpose

The purpose of each radar simulator is to provide artificial echoes on PPI displays, representing the target vessels, the other own ship/s (as applicable) and a coastline, as observed from one/two/three moving radar-carrying vessels.

1.2.2 Environment

Playing Area	:	a square of side 60 nautical miles. Two controls enable the initial position of each target and own ship to be set in terms of Northings and Eastings up to 30 nm from the centre of the playing area.
Coastline	:	The playing area is extended by 15 nm in each direction to allow the full range of coastline to be seen from the edge of the playing area, thus making a total viewing area of 90 x 90 nm.

1.2.3. Simulated Radar Head Characteristics

Aerial Rotation	:	20 RPM fixed.
Horizontal Angular Beamwidth	:	an effective angle of 1^{o}, increasing by a factor of 3:1 as range decreases between 30% and 3% of maximum radar range (i.e. accounting for the returns due to side-lobes).

1.2.4 Radar Characteristics

Pulse Length	:	0.2μS.
PRF	:	800/1,000 PPS.
Sea Clutter	:	maximum range 5 miles, decaying at the rate of approximately 10dB/1,000 yards.

Noise : variable intensity receiver noise.

1.2.5 Target Response Characteristics

Speed : variable from 0 to 30 knots ± 2% of maximum.

Course : 0-360° ± 2° at maximum speed.

± 4° at 10% of maximum speed.

Range of 1st Detection : continuously variable from 20% to 100%.

1.2.6 Own Ship Controls

Course : the course of the own ship is varied by the HELM control (calibrated 30° PORT - 0 - 30° STARBOARD with a positive indication of the "midships" position), within the characteristic limitations set-in on the preset controls detailed below.

Speed Telegraph : STOP, DEAD SLOW, SLOW, HALF and FULL both ahead and astern. Actual speed is indicated on a calibrated meter.

1.2.6.1 Own Ship Characteristic Preset Controls

(a) Maximum Ahead Speed : continuously variable from 0 to 30 knots.

(b) Maximum Astern Speed : continuously variable from 0 to 15 knots.

(c) Ahead Speed Adjustments: HALF speed preset enables variation of 0.65-0.75 of maximum set in (a).

SLOW preset enables variation of 0.45-0.55 of maximum.

DEAD SLOW preset enables variation of 0.25-0.35 of maximum.

(d) Rudder Delay : continuously variable from 5 to 30 seconds after change is demanded.

1.2.7 Three Own Ship Simulator

1.2.7.1 Target and Own Ship Speeds

In the three own ship system the following speeds are provided as standard:

Own Ship : Two scales are provided, 0-30 knots and 0-90 knots to simulate hovercraft/hydrofoil speeds.

Targets : 0-100 knots.

1.2.7.2 Coastline Generator

A time-sharing arrangement enables the coastline responses to be seen by all three own ships. The responses are produced from a single transparency and the figures quoted previously are modified as follows:

(a) Maximum range of responses : 12 nm.

(b) Minimum range of responses : ¼ nm.

(c) Positional tolerance of coastline feature : 2% of area side.

1.2.8 Accuracies

1.2.8.1 Method of Computing

Briefly, the method of computing and converting positional data is as follows:

(a) All own ships and targets are given an initial position in terms of cartesian co-ordinates, the results of subsequent movements also being resolved and integrated into these terms.

(b) Positions of all ships and targets relative to each own ship are established as rectangular displacements.

(c) Positional information is then resolved in terms of range and bearing.

1.2.8.2 Cartesian Co-ordinate Positions

The computation of the present position of each own ship and each target in relation to the integrated effects of course and speed is referred to the centre

(e) Speed Delay : the circuitry ensures that changes of speed conform to the following laws:

Acceleration: $S = (V - v)(1 - e^{-t/k}) + v$

Deceleration: $S = (V - v) e^{-t/k} + v$

where S = speed t minutes after change has been made.

V = higher speed

v = lower speed

k = a constant depending upon type of ship.

Provision is made for continuous variation of "k" between values of 2 and 20 by means of the preset control.

(f) Maximum Rate of Turn : continuously variable 50 to 120° per minute.

(g) Loss of Speed in Turn : switched in proportions of 0, 10%, 20% or 30% of actual speed at commencement of turn.

(h) Shadow Sector ON/OFF : switches in a blind sector representing that created by the funnel or superstructure.

(j) Speed Delay Override : enables own ship speed to be set quickly at the commencement of an exercise.

(k) Set Heading : enables own ship heading to be set quickly at the commencement of an exercise.

(l) Speed Meter ON/OFF : switches speed meter out of circuit if not required for student's use.

(m) Video ON/OFF : switches off own ship response, if necessary.

(n) Range of Detection : determines range of first detection by other own ship/s (if simulated).

of the playing area. This "actual" position of the target can best be verified by reading the co-ordinate voltages on a digital voltmeter or similar device. The accuracy to which the target and ship controls determine these positions within the playing area are as follows:

(a) Initial Position

Targets and own ship/s can be set anywhere in a square playing area of 60 nm side to an accuracy of ± 2% of playing area side.

(b) Heading

The accuracy of course set to course made good relates to speed as follows:

(i) ± 2^{o} at maximum speed.

(ii) ± 4^{o} at 10% of maximum speed.

(c) Speed

The accuracy of indicated speed is as follows:

(i) Target Ship : ± 5% or ½ knot, whichever is greater.

(ii) Own Ship/s : ± 5% or ½ knot, whichever is greater.

(iii) Target Aircraft/Helicopter/Hovercraft : 2% of maximum.

1.2.8.3 Relative Cartesian Co-ordinates

These are obtained by subtracting the co-ordinates of each own ship from each of the targets and each of the other own ships (if simulated), and is performed to an accuracy of 0.3% of playing area side.

1.2.8.4 Relative Ranges and Bearings

In generating the range and bearing from the relative cartesian co-ordinates the following accuracies apply:

(a) Range : the range accuracy of any own ship to another own ship or target is ± 2% of maximum radar range (maximum radar range - 15 nm).

(b) Bearing : the bearing accuracy of any own ship to another own ship or target is $\pm 1^{\circ}$ at maximum radar range and better than $\pm 5^{\circ}$ at 10% of maximum radar range.

1.2.9 Simulator Outputs

The trainer normally provides sync, video and anti-clutter signals to the displays.

1.2.10 Power Supplies

The equipment requires the following AC mains supply:

(a) Voltage : 220-240V RMS stable to $\pm$ 10%

(b) Frequency : 50 c/s $\pm$ 2 c/s.

1.3 Specific Features of Radar Simulator Type SY2013A

Marine radar simulator Type SY2013A simulates three own ships and four targets, and includes a number of non-standard features.

1.3.1 Own Ship Control Unit

This is a standard unit with the added facility of GIGANTIC SHIP simulation. A single switch increases the speed and rudder delays by a factor of approximately 4:1.

1.3.2 Other Own Ship Facilities

As well as the main own ship control unit, each own ship is equipped with a second control unit enabling preset course selection and facilitating operation as a hovercraft.

(a) Preset Course Selector

This part of the control unit includes a heading dial, helm control and a NORMAL/DEMANDED switch. In the NORMAL position of this switch the own ship operates from the main own ship control unit, but in the DEMANDED position the own ship automatically turns onto a new heading at a rate determined by the helm control on this unit. As soon as the new heading is achieved a lamp indicates this state and the course is maintained until a fresh heading is set in.

(b) Hovercraft Operation

This is controlled effectively by a speed selector switch, 0-30/0-90, the 0-90 position selecting operation of the own ship as a hovercraft. The speed and helm controls on the own ship control unit are then replaced by controls on this unit, and the preset course selector becomes inoperative.

1.3.3 Yaw

Switched facilities for introducing yaw into the own ships' motion is provided. Three amplitudes are available for each own ship - 2°, 4° or 6°.

1.3.4 Wind and Tide

All targets are affected by the tidal stream set in, but, since the own ships are capable of operating as ships or hovercraft, a choice of wind or tide effect is available for each own ship.

1.3.5 Azimuth Stabilisation

The turning information generated by the simulator is inherently north stabilised, but, because the display equipment is designed to operate from unstabilised data, it is necessary to unstabilise the information available to the displays. Azimuth stabiliser units are included to achieve this, one for each own ship display, and each houses repeaters for own ship speed and heading.

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